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Original Article

The significance of Systemic Immune-Inflammation Index, pan-immune-inflammation value, and Systemic Inflammation Response Index in the etiopathogenesis of acute pancreatitis

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ABSTRACT

Aims: The Systemic Immune-Inflammation Index (SII), Systemic Inflammation Response Index (SIRI), and pan-immune-inflammation value (PIV) are recently developed markers for systemic inflammatory response. This study aimed to investigate the relationship between SII and SIRI, and serum amylase and lipase levels in patients with acute pancreatitis (AP).

Methods: A total of 101 patients diagnosed with AP and 118 healthy volunteers were included in the study. The diagnosis of AP was based on contrast-enhanced abdominal CT and elevated serum amylase and lipase levels. SII, SIRI, PIV, WBC, CRP, N/L ratios, and other biochemical parameters of all cases were compared with those of the control group.

Results: Upon analysis of the data, serum lipase and amylase levels, as well as SII, SIRI, and PIV indices, were found to be statistically significantly higher in AP patients compared to the control group ($p<0.001$). Other acute phase reactants, WBC and CRP levels, and the N/L ratio were also statistically significantly higher in AP patients compared to the control group ($p<0.001$). In ROC analysis, high area under the curve (AUC) values were found for N/L, SII, SIRI, and PIV, which were 0.823, 0.831, 0.890, and 0.895, respectively ($p<0.001$).

Conclusion: The SII, SIRI, and PIV may be useful in indicating the severity of the disease in patients with AP.

Keywords: Acute pancreatitis, Systemic Immune-Inflammation Index, Systemic Inflammation Response Index, pan-immune-inflammation value, lipase

INTRODUCTION

Acute pancreatitis (AP) is an acute inflammatory process of the pancreas characterized by severe abdominal pain and elevated pancreatic enzymes. In recent years, significant increases in the incidence of AP and related hospitalizations have been observed.[1,2] Severe AP can lead to the Systemic Inflammatory Response Syndrome (SIRS). Intraacinar activation of proteolytic enzymes is associated with leukocyte chemotaxis, cytokine release, oxidative stress, and microcirculatory damage. The common factor underlying all these mechanisms is an excessive inflammatory response.[3,4] The establishment of an effective inflammatory response and the maintenance of tissue homeostasis depend on successful coordination among neutrophils, macrophages, and other immune cells, which is controlled by inflammatory mediators (e.g., cytokines and chemokines).[5,6]

The Systemic Inflammatory Index (SII) was developed by formulating simple parameters (e.g., neutrophil, lymphocyte, and platelet counts) and was first used to assess the prognosis of hepatocellular carcinoma.[7]

The SII, Systemic Inflammation Response Index (SIRI), and pan-immune inflammation value (PIV) are markers developed in recent years for the systemic inflammatory response. The aim of this study was to investigate the relationship between SII, SIRI, and PIV and serum amylase and lipase levels in patients with AP.

METHODS

The study was approved by the Ankara City Hospital, Clinical Researches Ethics Committee (Date: 15.02.2023, Decision No: E223-3380). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Patients' demographic, clinical, laboratory data, and radiological findings were obtained from electronic medical records and hospital computer-generated forms. Cases were divided into two groups (AP and healthy control group). The patients' baseline values and laboratory results were retrieved

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from the electronic medical record system, and the groups were compared. The following parameters were analyzed in all groups: WBC, platelets, neutrophils, lymphocytes, monocytes, urea, serum creatinine, ALT, AST, ALP, amylase, lipase, CRP, and the N/L ratio.

To evaluate cases diagnosed with AP, patients' demographic data were assessed along with clinical, laboratory, and radiological findings. Chest and abdominal computed tomography (CT) scan findings were evaluated to determine pancreatic injury.

The diagnosis of AP was made based on the internationally accepted 2012 Atlanta classification, requiring the presence of at least two of the following three criteria: 1) Typical epigastric abdominal pain consistent with AP, 2) Serum amylase and/or lipase levels exceeding three times the upper limit of normal, 3) Findings consistent with AP on cross-sectional imaging methods such as contrast-enhanced CT. Complete blood counts and biochemical parameters at the time of presentation were recorded. The etiology of AP (gallstones, alcohol, hyperlipidemia, idiopathic, etc.) was determined from patient records to the extent possible. However, since the primary objective of this study was to evaluate diagnostic performance and the sample size might be insufficient for subgroup analyses, the potential confounding effect of etiology on inflammatory indices was not examined in detail. Patients were analyzed in two groups: a control group consisting of 118 completely healthy individuals and 101 AP patients.

- **SII is calculated using the following formula:** SII=platelet count×neutrophil /lymphocyte
- **SIRI is calculated using the following formula:** SIRI=neutrophil×monocyte /lymphocyte count
- **PIV is calculated using the following formula:** PIV=neutrophil×monocyte×platelet /lymphocyte count

Statistical Analysis

The data were analyzed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov test was used to assess the normality of data distribution. Descriptive statistics were presented as mean±standard deviation (SD) for normally distributed variables and as median and interquartile range (IQR) for non-normally distributed variables.

Group comparisons were conducted using student t-test for normally distributed variables and the Kruskal-Wallis test for non-normally distributed variables. Differences in categorical variables were analysed using the Chi-square test or Fisher's exact test, as appropriate.

Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal cut-off values for amylase, lipase, SII, SIRI, PIV, and NLR. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 101 patients with AP and 118 healthy controls were included. Baseline demographic and laboratory characteristics are summarised in **Table 1.** There was no significant difference in age between the groups (p=0.063).

Patients with AP exhibited a markedly increased systemic inflammatory response, as reflected by significantly elevated

Table 1. Demographic results of control and AP groups

Characteristics	Control group (n=118)	AP group (n=101)	p-value*
Age, median (IQR), range, years	49 (21), 20-79	56 (27), 21-84	0.063[a]
Gender, male/female	60/58	54/47	0.699[b]
Length of hospital stay, mean±SD	-	6.2±4.5	-
CT findings			
Normal findings	-	22 (21.8)	-
Pancreatic diffuse edema, thick	-	20 (19.8)	-
Nodular lesion in the pancreas	-	1 (1)	-
Pancreatic duct prominent	-	6 (5.9)	-
Inflammatory contaminations in peripancreatic adipose tissue, fluid	-	48 (47.5)	-
Partial edematous appearance in the pancreas	-	25 (24.8)	-
Fluid around the pancreas	-	12 (11.9)	-
Hypodense appearance in pancreas, necrosis	-	8 (7.9)	-
Mass in the pancreas	-	1 (1)	-
Fatty atrophic changes in the pancreas	-	2 (2)	-
Other findings	-	2 (2)	-
Comorbidities	-		
Systemic hypertension, n, (%)	-	30 (29.7)	-
Diabetes mellitus, n, (%)	-	17 (16.8)	-
Congestive heart disease, n, (%)	-	11 (10.9)	-
Chronic renal disease, n, (%)	-	4 (4.0)	-
Thyroid dysfunctions, n, (%)	-	5 (5.0)	-
Chronic obstructive pulmonary disease, n, (%)	-	9 (8.9)	-
Other		22 (21.8)	-
WBC, $\times10^9$/L	7.3 (3.1)	9.6 (6.3)	<0.001
NEU, $\times10^9$/L	4.4 (3.1)	7.9 (5.5)	<0.001
Lymphocytes, $\times10^9$/L	1.9 (1.1)	1.3 (0.9)	<0.001
Monocytes, $\times10^9$/L	0.26 (0.15)	0.53 (0.31)	<0.001
Platelet, $\times10^9$/L	244 (91)	253 (94)	0.111
N/L	2.2 (1.9)	6.3 (8.0)	<0.001
CRP, g/L	0.22 (0.40)	17 (34.20)	<0.001
Amylase, U/L	65 (32)	659 (1029)	<0.001
Lipase, U/L	34 (16)	819 (1859)	<0.001
AST, U/L	22 (17)	76 (167)	<0.001
ALT, U/L	24 (19)	90 (215)	<0.001
Na, mEq/L	140 (3)	139 (4)	0.416
K, mEq/L	4.2 (0.5)	4.1 (0.6)	0.698
Glucose, mg/dl	105 (53)	105 (53)	<0.001
Urea, mg/dl	27 (9)	32 (16)	<0.001
Serum creatinine, mg/dl	0.74 (0.24)	0.79 (0.27)	0.3
SII	554 (500)	1480 (1976)	<0.001
SIRI	0.59 (0.85)	2.8 (5.4)	<0.001
PIV	147 (212)	841 (1160)	<0.001

[a]Comparison of two groups based on Mann-Whitney U, [b]comparison of two groups based on Chi-square test. The significance level was set at p<0.05. AP: Acute pancreatitis, IQR: Interquartile range, SD: Standard deviation, CT: Computed tomography, WBC: White blood cell, NEU: Neutrophil, CRP: C-reactive protein, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, Na: Sodium, K: Potassium, SII: Systemic Immune-Inflammatory Index, SIRI: Systemic Inflammation Response Index, PIV: Pan immune inflammation value, N/L: neutrophil-to-lymphocyte ratio

SII, SIRI, and PIV values compared with controls (all p<0.001) (**Table 1**).

Correlation analyses showed that inflammatory indices were positively associated with pancreatic enzyme levels in the AP group, whereas no significant correlations were observed in controls (**Tables 2 and 3**). Notably, no significant correlation was found between lipase and PIV.

Table 2. Correlations between amylase and other parameters

	Control group (n=118)		Acute pancreatitis group (n=101)	
Parameters	**rho**	**p-value**	**rho**	**p-value**
SII	-0.017	0.853	0.301	**0.002**
SIRI	-0.011	0.910	0.253	**0.011**
PIV	-0.069	0.461	0.238	**0.018**
N/L	0.045	0.630	0.310	**0.002**

SII: Systemic Immune-Inflammatory Index, SIRI: Systemic Inflammation Response Index, PIV: Pan immune inflammation value, rho: Spearman correlation coefficient, p-values less than .05 were considered significant highlighted in bold. N/L: neutrophil-to-lymphocyte ratio

Table 3. Correlations between lipase and other parameters

	Control group (n=118)		Acute pancreatitis group (n=101)	
Parameters	**rho**	**p value**	**rho**	**p-value**
SII	-0.098	0.294	0.278	**0.005**
SIRI	-0.114	0.219	0.201	**0.046**
PIV	-0.122	0.191	0.170	0.092
N/L	-0.109	0.244	0.299	**0.003**

SII: Systemic Immune-Inflammatory Index, SIRI: Systemic Inflammation Response Index, PIV: Pan immune inflammation value, rho: Spearman correlation coefficient, p-values less than .05 were considered significant highlighted in bold. N/L: neutrophil-to-lymphocyte ratio

ROC analysis results are presented in **Table 4** and **Figure** PIV and SIRI demonstrated the highest diagnostic performance, with AUC values of 0.895 and 0.890, respectively, outperforming SII (AUC=0.831) and the N/L ratio (AUC=0.823) (**Table 4**). Both indices showed high sensitivity (82.2%) with good specificity, supporting their diagnostic value. Overall, these findings highlight PIV and SIRI as the most robust biomarkers for the diagnosis of AP.

DISCUSSION

AP is a common inflammatory disease characterized by sudden onset, rapid progression, and high rates of morbidity and mortality. Therefore, timely and accurate assessment of the clinical condition and prognosis of patients with AP is of critical importance for management strategies. In addition to traditional biochemical and radiological methods used in diagnosis, the role of new-generation indices—which reflect the inflammatory process and are easily accessible and cost-effective—in diagnosis and prognosis has been intensively investigated in recent years.[8] In this study, the efficacy of markers such as the SII, PIV, and SIRI in the diagnosis of AP

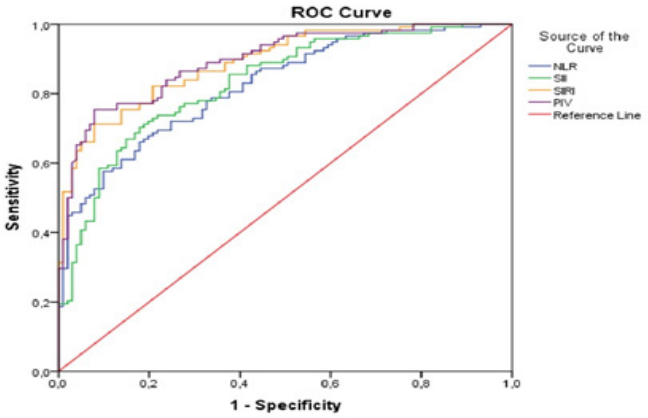


Figure. The ROC curves of NLR, SII, SIRI and PIV in predicting acute pancreatitis on admission

ROC: Receiver operating characteristic, NLR: Neutrophils to lymphocytes ratio, SII: Systemic Immune Inflammatory Index, SIRI: Systemic Inflammation Response Index, PIV: Pan immune inflammation value

was investigated by comparing them with a healthy control group.

The pathophysiology of AP is characterized by a complex inflammatory cascade that develops following damage to pancreatic acinar cells. Neutrophils and macrophages play a central role in this process.[6] In particular, neutrophil extracellular traps (NETs) and neutrophil infiltration have been identified as key mechanisms amplifying local and systemic inflammation in pancreatic tissue. Gukovsky and colleagues[5] have highlighted common mechanisms linking inflammation, autophagy, and obesity in the pathogenesis of pancreatitis and pancreatic cancer. The systemic response observed in AP is a result of a cytokine storm, macrophage-mediated inflammation, and uncontrolled neutrophil infiltration.[8] The reflection of these complex processes in numerical changes in peripheral blood cells makes hematological indices valuable and dynamic tools for evaluating the pathophysiology of AP.

In clinical practice, serum amylase and lipase levels have long been accepted as standard markers for the diagnosis of AP. In our study, we found that levels of these enzymes were statistically significantly higher in the AP group compared to the control group (p<0.001). Additionally, levels of C-reactive protein (CRP), another common marker of inflammation, were also significantly higher in the AP group (p<0.001). However, these traditional markers have certain limitations. Amylase and lipase levels may not always correlate with disease severity, may exhibit low specificity, or may remain within normal limits in some cases.[8] CRP, on the other hand, has limited sensitivity in the early diagnostic phase because it peaks 24–48 hours after the onset of inflammation.

Traditionally used parameters such as CRP, WBC, or the N/L ratio reflect only certain aspects of the inflammatory process. In contrast, multicomponent indices such as PIV and SIRI provide a more comprehensive picture of the immune system

Table 4. The parameters in diagnosis of patients with acute pancreatitis on admission

Variables	Cut-off value	AUC (95% CI)	Sensitivity (%)	Specificity (%)	p-value
Systemic Immune-Inflammatory Index	≥1131.77	0.831 (0.778-0.884)	80.5	64.4	<0.05
Systemic Inflammation Response Index	≥1.49	0.890 (0.849-0.931)	82.2	79.2	<0.05
Pan immune inflammation value	≥385.41	0.895 (0.855-0.936)	82.2	77.2	<0.05
N/L	≥3.96	0.823 (0.770-0.877)	80.5	62.4	<0.05

AUC: Area under the curve, CI: Confidence interval, N/L: neutrophil-to-lymphocyte ratio

and the inflammatory response by incorporating neutrophils, monocytes, lymphocytes, and, in the case of PIV, platelets into their formulas. In our study, the fact that PIV and SIRI demonstrated superior AUC values compared to the N/L ratio and SII supports the hypothesis that this comprehensive approach enhances diagnostic accuracy. In particular, the fact that PIV includes platelets—which play a critical role in coagulation and hemostasis—in addition to inflammatory cells, gives it a theoretical advantage in a complex disease such as AP, where microcirculatory damage is a primary concern.

Our study found that SII demonstrated high efficacy in the diagnosis of AP (AUC: 0.831, 80.5% sensitivity, 64.4% specificity). SII reflects immune-inflammatory interactions by combining neutrophils, lymphocytes, and platelets. Hu and colleagues[7] noted that SII was initially developed for prognostic prediction in hepatocellular carcinoma but is also valuable in hematological malignancies. Subsequently, the use of SII has expanded to a wide range of conditions, including invasive vulvar cancer[9] and asthma and drug-induced respiratory diseases.[10] Most studies in the literature have evaluated the role of SII in AP in terms of disease severity and prognosis. For example, Liu et al.[11] reported a high AUC value of 0.920 in distinguishing severe AP (SAP), while Zhang et al.[12] and Bıyık et al.[13] also highlighted the success of SII in prognosis prediction. The fact that the AUC value obtained in our study differs somewhat from these studies can be explained by our focus on "diagnosis" rather than "prognosis." However, our achievement of a higher performance than the AUC value of 0.739 reported by Salehi et al.[14] for AP severity demonstrates that SII is a strong candidate in the diagnostic process as well.

One of the most striking findings of our study is SIRI's superior performance in the diagnosis of AP (AUC: 0.890, 82.2% sensitivity, 79.2% specificity). With its composition including neutrophils, monocytes, and lymphocytes, SIRI more comprehensively reflects the complex cellular interactions in the pathophysiology of AP. The prognostic value of SIRI has previously been demonstrated in stroke,[15] ANCA-associated vasculitis,[16] and various malignancies.[17] Specifically regarding AP, Bıyık et al.[13] reported that SIRI is a potential biomarker for predicting disease severity (AUC: 0.782). The AUC value of 0.890 obtained in our study suggests that SIRI has a much stronger potential not only in prognosis but also in the early diagnosis phase. Indeed, recent studies by Wu et al.[18] and Araiza-Rodríguez et al.[19] have demonstrated a dose-dependent relationship between SIRI and AP severity, thereby reinforcing the clinical significance of this index.

Similarly, PIV, which demonstrated the highest diagnostic performance in our study (AUC: 0.895, 82.2% sensitivity, 77.2% specificity), emerges as a promising marker for the diagnosis of AP. By integrating neutrophils, monocytes, lymphocytes, and platelets, PIV overcomes the limitations of parameters that focus on only two cell types, such as NLR or PLR1.[20,21] The prognostic value of PIV has been investigated in many malignancies; a meta-analysis by Guven et al.[22] demonstrated that it is a strong biomarker in various types of cancer.

A very recent study by Zhang and Hu[23] demonstrated that PIV is an independent and strong predictor of in-hospital mortality in critically ill patients with AP (OR: 1.21, p=0.015). Our study makes a critical contribution to this literature by demonstrating that PIV is not only a reliable tool for prognosis but also an extremely reliable tool for diagnosing AP at the time of emergency department presentation (AUC: 0.895). These findings indicate that PIV is one of the most comprehensive markers reflecting "pan-immune" activation in the pathophysiology of AP.

In conclusion, our ROC analysis data demonstrated that PIV and SIRI exhibit superior accuracy in the diagnosis of AP compared to N/L (AUC: 0.823) and SII (AUC: 0.831). The high AUC values of these three new indices demonstrate that they offer low-cost, rapid, and reliable tools for supporting the diagnosis and quickly assessing the severity of inflammation in patients with suspected AP in emergency department settings. The importance of hematological ratios, emphasized by researchers such as Ventriglia et al.[20] and Cao et al.[21] in various pathologies, has been taken to a further level in the diagnosis of AP in our study (PIV and SIRI). Validation of our findings through broader and prospective studies will facilitate the incorporation of these indices into routine clinical practice.

Limitations

Our study has several limitations. Its retrospective design and single-center nature may limit the generalizability of the findings. Additionally, no subgroup analyses were conducted to assess the specific effects of AP etiology (gallstones, alcohol, etc.) on these indices. Most importantly, external validation through prospective studies in different populations is required to fully integrate these high diagnostic performance values into clinical practice.

CONCLUSION

This study has demonstrated that easily accessible and cost-effective markers such as SII, SIRI, and PIV exhibit high diagnostic performance in the diagnosis of AP. In particular, the fact that PIV and SIRI demonstrate superior AUC values compared to N/L and SII in predicting AP diagnosis underscores the clinical potential of these new-generation indices. These markers can be used as rapid and reliable tools to support standard diagnostic methods in patients presenting with suspected AP. Our findings require validation through broader, prospective studies aimed at better understanding the role of these indices in the pathophysiology of AP and determining their place in clinical practice.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was approved by the Ankara City Hospital, Clinical Researches Ethics Committee (Date: 15.02.2023, Decision No: E223-3380).

Informed Consent

This retrospective study used pre-existing anonymized patient data. No additional intervention was performed, and there was no direct patient contact. The study was approved by the Ethics Committee, and the requirement for written informed consent was waived by the ethics committee.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest
The authors declare no conflicts of interest related to this study.

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Author Contributions
Concept: AK; Design: AK, GA; Data Collection and/or Processing: AK, GA, EÇ; Analysis and/or Interpretation: AK, GA; Literature Review: AK, EÇ; Writing the Article: AK, EÇ; Critical Review: AK, GA.

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Original Article

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Temporal and regional patterns of aeromedical evacuation after the 6 February 2023 Kahramanmaraş earthquakes

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ABSTRACT

Aims: To assess the demographic and clinical profiles of earthquake survivors airlifted after the 6 February 2023 Kahramanmaraş earthquakes and to examine the temporal and regional patterns of aeromedical transfers in the initial 20 days post-disaster

Methods: This descriptive retrospective study analyzed data from the Emergency Health Automation System (EHAS) concerning patients evacuated by fixed-wing and helicopter air ambulances following the 6 February 2023 Kahramanmaraş earthquakes. Descriptive statistics were used to evaluate demographic characteristics, transfer indications, air ambulance type, referring and receiving provinces, and the daily distribution of transfers.

Results: Fixed-wing air ambulances accounted for 2.248 transfers, while helicopters accounted for 333. Adults (≥18 years) comprised 69.4% of fixed-wing and 62.8% of helicopter transfers, with a comparable gender distribution. Transfers during the early post-earthquake phase were predominantly related to severe trauma, including crush injuries and surgical emergencies, whereas non-traumatic conditions—particularly cardiovascular, neurological, and infectious diagnoses—became more prominent in subsequent days. Most fixed-wing transfers originated from Kahramanmaraş, Adıyaman, and Adana, with receiving centers concentrated in Ankara and İstanbul. Helicopter retrievals were initially clustered in Kahramanmaraş before shifting to Hatay, while Adana emerged as the most frequent destination. Overall, transfer patterns reflected a temporal shift from acute trauma evacuation to broader medical referral needs.

Conclusion: Aeromedical evacuations were shaped by evolving clinical priorities and constraints in regional healthcare capacity. The coordinated use of fixed-wing and helicopter platforms enabled rapid patient redistribution, underscoring the importance of flexible transfer planning and integrated command structures in large-scale disasters.

Keywords: Earthquake, aeromedical evacuation, mass casualty incident, disaster response, emergency medical services

INTRODUCTION

Because of its geology and tectonics, Turkiye is among the countries most prone to natural disasters, with earthquakes, floods, landslides, and avalanches occurring frequently across the country.[1] National awareness and institutional ability in disaster management have continuously evolved, particularly following the 1999 Gölcük and 2011 Van earthquakes. The twin earthquakes that struck Kahramanmaraş on 6 February 2023, with epicenters in Pazarcık (Mw 7.7) and Elbistan (Mw 7.6), affected 11 provinces (Kahramanmaraş, Hatay, Adıyaman, Malatya, Gaziantep, Kilis, Osmaniye, Adana, Diyarbakır, Şanlıurfa, and Elazığ) and further underscored the necessity of risk-based approaches in disaster preparedness and response.[1]

Large-scale disasters generate a sudden surge in medical need that can rapidly exceed the capacity of the healthcare system, increasing morbidity and mortality when treatment is delayed.[2] Following an earthquake, damage to healthcare facilities and disruption of ground transportation routes typically necessitate the rapid relocation of patients to less-affected areas. In disaster scenarios, the prehospital phase may be prolonged due to security concerns, restricted access, and triage difficulties, with evidence indicating that the interval from event notification to hospital arrival is longer than under normal conditions.[3,4] Concurrently, hospitals may lack sufficient beds, intensive care capacity, staff, or technical resources, necessitating transfer of patients to referral centers with greater capacity.[5,6] In this context, air

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ambulance systems constitute an essential component of disaster response, particularly when rapid evacuation is required and ground transportation is insufficient, enabling both patient evacuation and interfacility transfer over time.

Air ambulance systems comprise two principal platforms: helicopter emergency medical services and fixed-wing aircraft. Helicopters are better suited to short-distance transfers and evacuations from areas that are difficult to access or severely damaged, whereas fixed-wing aircraft are more appropriate for long-distance transfers and large-scale interfacility transport.[7]

Air ambulance systems worldwide vary in organizational structure, fleet composition, mission profile, and degree of integration with the broader healthcare system. Despite this variability, appropriate patient selection and effective transfer planning remain consistently critical determinants of system performance.[8] Position statements and consensus agreements have delineated the criteria for suitable air ambulance utilization, underscoring that excessive use or improper deployment may jeopardize patient safety and system viability.[9] The Ministry of Health in Turkiye coordinates air ambulance services, which are provided by both helicopters and fixed-wing planes.[10]

Following the 2010 Yushu earthquake in China, thousands of patients were rapidly evacuated by air to hospitals across different regions, an approach reported to have played a critical role in the disaster response.[11] A similar necessity arose during the 6 February 2023 Kahramanmaraş earthquakes, which rendered several hospitals in the affected area non-functional and resulted in substantial casualties among healthcare personnel, causing major disruptions in service delivery. In these conditions, large-scale aeromedical evacuation operations were conducted with the participation of national and multinational teams, employing air ambulance systems to transfer patients to operational centers.[12]

This study seeks to assess the demographic and clinical profiles of earthquake survivors airlifted after the February 6, 2023, Kahramanmaraş Earthquakes, as well as to examine the receiving healthcare facilities, the types of air ambulances employed, and the temporal distribution of the transfers. The results are anticipated to elucidate the operational difficulties faced in aeromedical transfer planning during disaster response and to guide organizational improvements for future large-scale disasters.

METHODS

This study was approved by the Ankara Etlik City Hospital Scientific Researches Evaluation and Ethics Committee (Date: 22.10.2025, Decision No: AESH-BADEK1-2025-580). All procedures were carried out in accordance with ethical guidelines and the principles of the Declaration of Helsinki.

This descriptive retrospective study analyzed data from earthquake survivors who were transported by air ambulance following the 6 February 2023 Kahramanmaraş Earthquakes. The study evaluated patients' age, gender, clinical characteristics, dates of air transfer, referring and receiving provinces, and their distribution according to air ambulance type. Data were retrospectively obtained from the Emergency Health Automation System (EHAS), operated by the Ministry of Health of Turkiye.

Clinical diagnoses were derived from transfer documentation recorded in the EHAS. As transfer records frequently contained descriptive clinical summaries rather than standardized ICD-10 codes, a thematic classification was applied by the authors, grouping cases into traumatic (e.g., crush syndrome, compartment syndrome, amputation) and non-traumatic categories (e.g., cardiovascular, neurological, infectious diseases). This classification represents an approximation based on available documentation and constitutes a limitation of the study.

Missing data were observed primarily in the early post-earthquake phase, during which the surge in patient volume exceeded local healthcare capacity and resulted in incomplete documentation. Gaps were noted in exact patient age, laboratory findings, and advanced imaging results, whereas data on patient gender, referring province, and receiving province were complete across all records. Due to missing age data in a subset of records, age analysis was limited to a binary classification of adult (≥18 years) versus pediatric patients rather than a continuous variable. Documentation quality improved progressively as local healthcare infrastructure was restored in the days following the initial impact.

The unit of analysis in this study was the transfer event rather than the individual patient. In some cases, patients may have undergone more than one air ambulance transfer during the study period; for example, an initial helicopter transfer from a district to a provincial center, followed by a subsequent fixed-wing transfer to a tertiary facility after a period of stabilization. As EHAS records each transfer event independently, it was not possible to link multiple transfers belonging to the same patient. This represents a limitation of the study, as the total number of transfer events may exceed the number of individual patients treated. A total of 32 transfers were identified as sequential air ambulance transfers, initially by helicopter to a provincial center followed by fixed-wing transfer to a tertiary facility after stabilization. No sequential helicopter-to-helicopter transfers were identified.

The analysis included patients transferred by helicopter and/or fixed-wing air ambulance due to traumatic injuries, non-traumatic acute medical conditions, or disruption of healthcare access resulting from the disaster, which prevented the safe continuation of ongoing monitoring or treatment. Inclusion criteria comprised being affected by the 6 February 2023 Kahramanmaraş Earthquakes and having been transported by helicopter and/or fixed-wing air ambulance. Patients transferred by means other than air ambulance, such as ground ambulance or private vehicles, were excluded. Additionally, cases with incomplete or insufficient key demographic or clinical data in the EHAS records were excluded from the analysis.

Statistical Analysis

The data were analyzed using descriptive methods. Continuous variables were reported as mean±standard deviation according to their distribution, while categorical variables were expressed as frequencies and percentages (%).

Demographic characteristics, transfer indications, and temporal patterns were compared according to air ambulance

type (fixed-wing versus helicopter). The daily distribution of referring and receiving provinces was evaluated for the first 20 days following the 6 February 2023 earthquakes and is presented graphically.

All analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). As this was a descriptive study, analyses were limited to descriptive statistics.

RESULTS

During the study period, 1.561 of 2.248 fixed-wing transfers (69.4%) and 209 of 333 helicopter transfers (62.8%) involved adult patients (≥18 years). The gender distribution was comparable between male and female patients across both transfer types.

Analysis of transfer indications over time showed that evacuations during the early post-earthquake phase were predominantly attributable to severe traumatic injuries, including crush syndrome, compartment syndrome, and amputation. In subsequent days, non-traumatic conditions—including cardiovascular, neurological, and infectious diagnoses—became more prevalent. This temporal pattern is illustrated in **Figure 1**, which presents the daily distribution of traumatic and non-traumatic transfers throughout the study period.

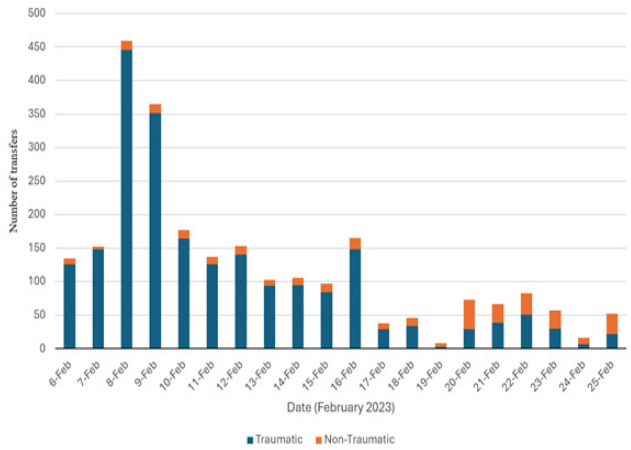


Figure 1. Daily distribution of traumatic and non-traumatic air ambulance transfers (fixed-wing and helicopter) following the 6 February 2023 Kahramanmaraş earthquakes

Among fixed-wing transfers, the referring provinces were predominantly concentrated in the early phase of the study period, led by Kahramanmaraş, Adıyaman, and Adana (**Figure 2**).

During the same period, the daily distribution of receiving provinces showed that most fixed-wing transfers were directed to Ankara and İstanbul, particularly during the early stages of the disaster (**Figure 3**). In contrast, transfers to İzmir and Antalya were infrequent and largely confined to the first several days after the earthquakes.

Figure 4 presents the daily distribution of referring provinces for helicopter transfers during the same period. In the early days following the earthquakes, most retrievals originated from Kahramanmaraş, whereas in subsequent days, Hatay became the predominant referring province.

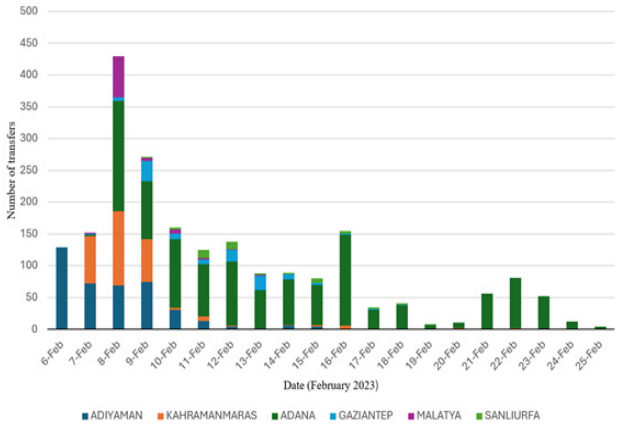


Figure 2. Daily distribution of referring provinces for fixed-wing air ambulance transfers in the initial 20 days after the 6 February 2023 earthquakes

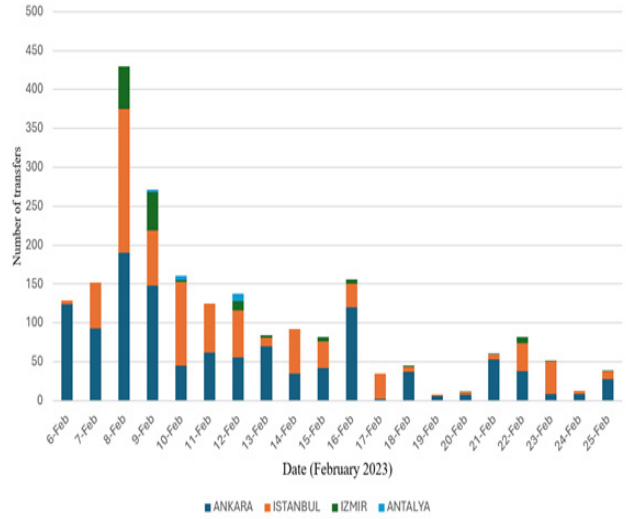


Figure 3. Daily distribution of receiving provinces for fixed-wing air ambulance transfers in the initial 20 days after the 6 February 2023 earthquakes

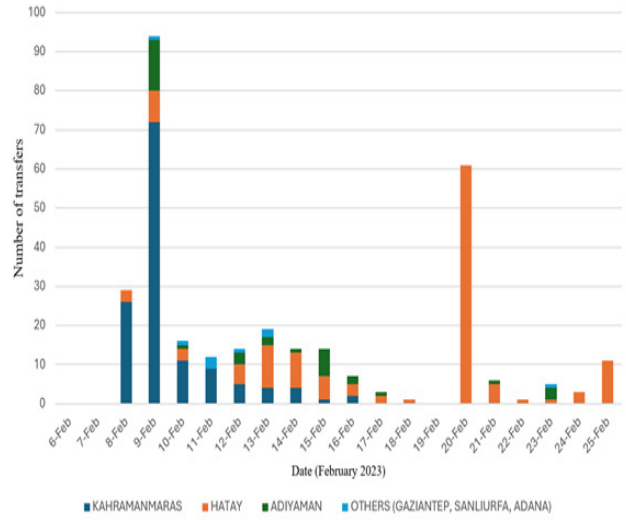


Figure 4. Daily distribution of referring provinces for helicopter ambulance transfers in the initial 20 days after the 6 February 2023 earthquakes

Figure 5 presents the daily distribution of receiving provinces for helicopter transfers during the same period. Adana was the most frequent destination, emerging as the predominant receiving province for helicopter transfers (**Figure 5**).

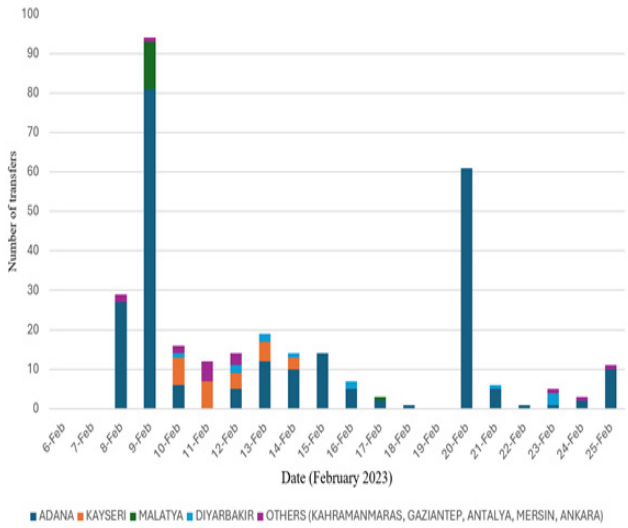


Figure 5. Daily distribution of receiving provinces for helicopter ambulance transfers in the initial 20 days after the 6 February 2023 earthquakes

DISCUSSION

This study assessed patient demographics, transfer trends, and the temporal distribution of aeromedical evacuations conducted by air ambulance following the 6 February 2023 Kahramanmaraş earthquakes. Our findings indicate that, during the early stages of the disaster, air ambulance transfers were predominantly attributable to severe traumatic injuries, whereas cardiovascular, neurological, and infectious diagnoses became increasingly common in subsequent days. Fixed-wing transfers were most frequent during the first several days, with receiving centers concentrated in Ankara and İstanbul, while helicopter retrievals were initially concentrated in Kahramanmaraş before shifting predominantly to Hatay.

These findings indicate that during large-scale disasters, aeromedical evacuation is essential not only for managing patient volume but also for coordinating clinical prioritization and reallocating regional healthcare capacity.

A study examining the aeromedical evacuation operations of the Norwegian Armed Forces reported the transport of 184 patients—all secondary transfers—many of whom presented with significant physiological derangement, notably crush injuries.[13] Similarly, a field report from an EMT type 1 unit stationed in Türkoğlu[14] noted that, beginning in the first week after the earthquake, admissions increasingly comprised infectious diseases and exacerbations of chronic conditions, while trauma-related presentations declined.

These findings collectively suggest that the clinical profile of disaster-affected populations evolves over time, consistent with the pattern observed in our study: an early phase dominated by trauma, followed by a gradual increase in non-traumatic medical conditions. Experience from the Great East Japan earthquake similarly demonstrates that aeromedical evacuation extends beyond patient transport alone. Consistent with our findings on clinical prioritization and regional clustering of transfers, these reports underscore the importance of centralized command structures, efficient information dissemination, and synchronized referral-receiving networks for comprehensive capacity management during large-scale disasters.[15]

In disaster-affected regions, local healthcare infrastructure is typically overwhelmed or rendered partially non-functional. Helicopter ambulances served a dual role, providing rapid retrieval of patients from earthquake-affected districts with limited road accessibility, as well as interfacility transfers to nearby, less-affected provinces. Fixed-wing aircraft, in turn, enabled long-distance transfer of patients from capacity-constrained local hospitals to tertiary referral centers. Together, these two platforms operated in a complementary manner, helping to alleviate the burden on the overwhelmed regional healthcare system during the disaster response.

The evaluation and management of pediatric patients in disaster scenarios is recognized as more complex than for adults, owing to physiological differences, age-specific triage criteria, and potential constraints in accessing adequately equipped facilities.[16] In our study, pediatric patients accounted for 30.6% of fixed-wing transfers and 37.2% of helicopter transfers, underscoring the substantial role of air ambulance systems in the evacuation of children during disasters. These findings suggest that the inclusion of pediatric patients in aeromedical systems warrants consideration not only from a triage perspective but also in relation to advanced transfer planning and the capacity of referral centers to deliver age-appropriate care.

Assa et al.[17] reported that air ambulance systems support disaster response by enabling balanced distribution of patients across facilities, thereby preventing overcrowding of peripheral healthcare centers. Consistent with this, our findings provide observational data on the temporal and spatial deployment of air ambulances following the 6 February 2023 earthquakes, highlighting the operational roles of both fixed-wing and helicopter platforms in the field.

Our findings indicate that transfers were initially concentrated in high-capacity tertiary centers, notably Ankara and İstanbul. In subsequent days, transfer volume declined and referrals became more evenly distributed, reflecting a transition from acute crisis management to more organized interfacility transfers alongside the gradual restoration of local healthcare services. This pattern underscores the importance of coordinated, nationally structured transfer planning in large-scale disaster management.

Experience from disasters in Japan has demonstrated that centralized command structures and inter-agency collaboration are critical to the effective functioning of air ambulance systems.[18] During the Kumamoto earthquake, air medical transport operations highlighted the efficient utilization of helicopter ambulances during the initial phase of the disaster, alleviating strain on the healthcare system in the early hours.[18]

The shift in clinical profile observed in our study, from trauma-predominant transfers in the early phase to non-traumatic conditions in the later phase, has direct implications for regional healthcare capacity planning. Disaster response systems should anticipate this temporal evolution and pre-position resources accordingly, ensuring that receiving centers are equipped not only for acute trauma management but also for the surge in cardiovascular, neurological, and infectious disease cases that follows.

In our study, the early concentration and regional clustering of both fixed-wing and helicopter transfers exhibit a similar pattern,

underscoring the necessity of swift and coordinated aeromedical evacuation during the acute phase of large-scale disasters.

In our study, fixed-wing retrievals during the initial days after the earthquake originated primarily from Adıyaman and Kahramanmaraş, whereas in subsequent days, a larger proportion of transfers originated from Adana. This pattern cannot be attributed solely to clinical demand; it also reflects operational constraints affecting aviation infrastructure within the disaster zone. Hatay Airport reportedly became non-operational following the earthquake, requiring aircraft to land at alternative, smaller airports.[19] Malatya Airport was also temporarily closed due to structural damage to its terminal building, with flights operating on a limited basis thereafter.[19] These findings indicate that aeromedical transfer planning during disasters is influenced not only by patient volume and clinical urgency but also by the accessibility and operational status of airport infrastructure.

These findings highlight that aeromedical evacuation planning should incorporate not only clinical demand projections but also infrastructure vulnerability assessments, including airport operability, to ensure uninterrupted patient transfer capacity during large-scale disasters.

Limitations

This study has several constraints. First, the retrospective and descriptive design precludes causal inference. Because the analysis was restricted to patients transported by air ambulance, exclusion of those transferred by ground ambulance may have introduced selection bias with respect to illness severity. In addition, reliance on administrative registry data limits the availability of detailed clinical information and renders the accuracy of transfer indications dependent on coding practices. The absence of long-term outcome data further prevents assessment of the direct impact of aeromedical evacuation on mortality and morbidity.

Furthermore, detailed clinical indications could not be systematically extracted due to the descriptive and inconsistent nature of transfer documentation within EHAS, where records frequently contained narrative clinical summaries rather than standardized diagnostic codes. As a result, clinical classification was limited to a broad traumatic versus non-traumatic categorization. Future studies incorporating standardized clinical coding systems would enable more granular analysis of aeromedical evacuation indications. Due to limitations in the administrative registry data, a detailed breakdown of clinical indications by aircraft type could not be performed. This represents an area for future investigation.

Despite these limitations, the study provides valuable observational insights by encompassing a large, nationwide cohort and by delineating the temporal and spatial patterns of air ambulance utilization under disaster conditions, thereby contributing meaningful evidence to the existing literature.

CONCLUSION

This study demonstrates that effective utilization of air ambulance systems in large-scale disasters requires adaptive planning aligned with evolving clinical demands, supported by strong interinstitutional coordination. Structuring aeromedical evacuation strategies to address the transition from an acute trauma-dominated phase to a broader burden of non-traumatic medical conditions may enhance overall system performance. Future prospective, multicenter studies are warranted to better define the impact of aeromedical evacuations on clinical outcomes.

ETHICAL DECLARATIONS

Ethics Committee Approval

This study was approved by the Ankara Etlik City Hospital Scientific Researches Evaluation and Ethics Committee (Date: 22.10.2025, Decision No: AESH-BADEK1-2025-580).

Informed Consent

This retrospective study used pre-existing anonymized patient data. No additional intervention was performed, and there was no direct patient contact. The study was approved by the Ethics Committee, and the requirement for written informed consent was waived by the ethics committee.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: EA, EU; Design: EÇ; Control: ŞY; Resources: EA, EU; Data Collection and/or Processing: KDB; Analysis and/or Interpretation: EA; Literature Review: EA, ŞY; Writing the Article: EA, EU, EÇ; Critical Review: KDB.

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Review

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Approach to community-acquired pneumonia in high-risk patient groups in the emergency department

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ABSTRACT

Pneumonia remains one of the leading causes of morbidity and mortality worldwide, with a particularly severe clinical course observed in high-risk patient groups. Elderly individuals, immunocompromised patients, and pregnant women are especially vulnerable to adverse outcomes because of increased susceptibility to infection, atypical clinical presentations, diagnostic challenges, and a greater risk of complications. In these populations, delayed recognition and treatment may substantially worsen prognosis. Current evidence also highlights the importance of individualized diagnostic evaluation, timely microbiological assessment, and appropriate antimicrobial therapy tailored to patient-specific risk factors. Given that emergency physicians are frequently responsible for the initial assessment and stabilization of these patients, early recognition, accurate risk stratification, and timely disposition decisions are essential to optimize clinical outcomes. This narrative review summarizes current evidence regarding the clinical characteristics, diagnostic evaluation, and management of pneumonia in high-risk patient populations, with particular emphasis on emergency department assessment, risk stratification, early therapeutic decision-making, and disposition planning.

Keywords: Geriatrics, pregnancy, immunosuppression, point-of-care ultrasound, pneumonia, opportunistic infections

INTRODUCTION

Pneumonia represents a significant cause of morbidity and mortality worldwide.[1] The disease tends to be more severe and is associated with worse clinical outcomes in high-risk groups, such as the elderly, immunocompromised individuals, and pregnant women.[2] In these populations, alterations in immune response, coexisting comorbidities, and atypical clinical presentations may lead to delayed diagnosis and complicate the management process. Therefore, early recognition of pneumonia and timely initiation of appropriate treatment are of critical importance in improving prognosis. Moreover, in these patient groups where standard diagnostic and therapeutic approaches may not always prove sufficient, an individualized and multidisciplinary management strategy should be adopted. This review discusses the clinical characteristics, diagnostic approaches, and current treatment principles of pneumonia in high-risk patient groups, with an emphasis on emergency department management considerations.

PNEUMONIA IN OLDER ADULTS

In older adults, immunosenescence, multiple comorbidities, malnutrition, and a decline in functional capacity significantly increase the risk of developing pneumonia.[3-5] Additionally, conditions such as dementia, cerebrovascular diseases, and dysphagia predispose this population to aspiration pneumonia.[6] It is clinically important to distinguish between aspiration pneumonia and standard community-acquired pneumonia in elderly patients, as their pathophysiology, microbiology, and empiric antibiotic strategies differ substantially. Aspiration pneumonia typically involves the aspiration of oropharyngeal secretions or gastric contents in patients with impaired protective airway reflexes, and most commonly affects dependent lung segments (right lower lobe, posterior segments). While anaerobic organisms historically were considered predominant, contemporary evidence suggests that aerobic gram-negative bacteria and polymicrobial infections are more common in institutionalized and hospitalized elderly patients. Routine anaerobic coverage is not universally recommended in the emergency department for aspiration events unless there is clinical evidence of lung abscess, empyema, or a prolonged aspiration episode with putrid sputum; in such cases, adding anaerobic coverage (e.g., with amoxicillin-clavulanate, piperacillin-tazobactam, or clindamycin in combination with a beta-lactam) should be considered in accordance with current ATS/IDSA guidance.[7] In elderly patients, infection often presents not with classic symptoms such as fever, cough, and sputum production, but rather with nonspecific manifestations including confusion, falls, loss of appetite, or functional decline.[8] Therefore, maintaining a high index of clinical suspicion is essential for timely diagnosis.

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Streptococcus pneumoniae (S. pneumoniae) remains the most common causative pathogen of community-acquired pneumonia in older adults. However, *Haemophilus influenzae (H. influenzae)*, *Moraxella catarrhalis*, gram-negative bacteria, and respiratory viruses also represent important etiological agents in this population.[9,10] The need for empiric antimicrobial therapy targeting resistant pathogens should be determined based on individual risk factors—such as prior isolation of methicillin-resistant *Staphylococcus aureus* (MRSA) or *Pseudomonas aeruginosa (P. aeruginosa)*, recent hospitalization, and recent intravenous antibiotic exposure—rather than residence in a long-term care facility alone.

A detailed medical history, thorough physical examination, and appropriate imaging studies constitute the cornerstone of the diagnostic approach. Although chest radiography remains the first-line imaging modality, lung ultrasonography may be used for diagnostic purposes in centers with adequate expertise and can serve as an alternative to chest radiography in selected patients. In the emergency department setting, a systematic review and meta-analysis of 17 prospective studies including 5,108 patients demonstrated that point-of-care lung ultrasound (LUS) achieved a pooled diagnostic sensitivity of 92% and specificity of 93% for community-acquired pneumonia, substantially outperforming standard chest radiography while avoiding ionizing radiation and enabling rapid bedside assessment.[11] LUS findings such as consolidation with dynamic air bronchograms, focal B-line patterns, and associated pleural effusion can support or refute the diagnosis of pneumonia at the bedside, facilitating faster clinical decision-making in the emergency department.[12] In cases where the diagnosis remains uncertain, chest computed tomography (CT) may provide additional diagnostic value.[13] Laboratory evaluation should include a complete blood count, biochemical tests, inflammatory markers, and microbiological investigations when clinically indicated. Procalcitonin levels should not be used as the sole criterion for initiating or discontinuing antibiotic therapy; rather, they should be interpreted as an adjunctive biomarker within the context of the overall clinical assessment.[14] In patients with suspected aspiration pneumonia, evaluation of swallowing function, assessment of protective airway reflexes, and, when indicated, advanced diagnostic studies such as videofluoroscopic swallowing examination are recommended.[15]

Treatment should be tailored according to disease severity and individual patient risk factors. For mild to moderate community-acquired pneumonia, beta-lactam–based regimens or, in appropriately selected patients, respiratory fluoroquinolones may be considered.[16] In severe cases, risk factors for MRSA and *P. aeruginosa* should be carefully assessed, and appropriate broad-spectrum antimicrobial therapy should be initiated when indicated.[17] In patients who achieve clinical stability, a treatment duration of approximately 3–5 days is generally considered sufficient.[18] In older adults, special consideration should be given to renal function, potential drug–drug interactions, and treatment-related adverse effects when selecting and monitoring antimicrobial therapy.[19]

From an emergency department perspective, the evaluation of older adults presenting with suspected community-acquired pneumonia requires a comprehensive approach because atypical clinical presentations, frailty, and multiple comorbidities frequently complicate early recognition and may mask disease severity. Initial assessment should extend beyond the identification of classic infectious symptoms and include careful evaluation of mental status, baseline functional capacity, respiratory rate, oxygen saturation, hemodynamic stability, and the presence of sepsis or acute organ dysfunction. Diagnostic investigations should be guided by the initial clinical assessment. While chest radiography remains the first-line imaging modality, point-of-care LUS may facilitate rapid bedside diagnosis, and chest CT should be reserved for patients with persistent clinical suspicion despite inconclusive initial imaging or when alternative diagnoses are being considered. Appropriate laboratory investigations and microbiological specimens should be obtained whenever feasible before the initiation of antimicrobial therapy, particularly in patients with severe disease or risk factors for multidrug-resistant pathogens. Although validated severity assessment tools such as CURB-65 and the Pneumonia Severity Index provide valuable support for risk stratification, they may underestimate disease severity in older adults because they do not adequately capture frailty, functional impairment, or atypical presentations; therefore, they should always be interpreted in conjunction with clinical judgment. Continuous reassessment during the emergency department stay is essential, as clinical deterioration may occur despite initially subtle findings. Prompt initiation of appropriate empiric antimicrobial therapy, timely correction of hypoxemia with supplemental oxygen, and close monitoring for respiratory and hemodynamic deterioration constitute the cornerstones of emergency department management. Decisions regarding hospital admission should integrate not only severity scores but also frailty, comorbidities, cognitive impairment, functional decline, the ability to maintain adequate oral intake and medication adherence, caregiver support, and the availability of appropriate outpatient follow-up.

Vaccination against pneumococcal disease, influenza, and COVID-19 plays a pivotal role in the prevention of pneumonia among older adults.[20-22] To reduce the risk of aspiration, assessment of swallowing function, implementation of appropriate nutritional strategies, and maintenance of good oral hygiene are recommended.[23] Given that older individuals recovering from pneumonia may experience functional decline, cognitive deterioration, and reduced quality of life, post-treatment rehabilitation and supportive care should also be considered integral components of comprehensive patient management.[24]

COMMUNITY-ACQUIRED PNEUMONIA IN IMMUNOCOMPROMISED PATIENTS

Conditions associated with impaired immune function include solid organ transplantation, hematologic malignancies, the use of immunosuppressive therapies, and primary or secondary immunodeficiency disorders. In these individuals, pneumonia occurs more frequently, follows a more severe clinical course, and presents unique diagnostic and therapeutic challenges due to the involvement of opportunistic pathogens.[25,26] The risk of pneumonia and the spectrum of potential causative organisms vary considerably according to the type and severity of immunosuppression.[27]

In immunocompromised patients, pneumonia may frequently present with atypical clinical manifestations. Classic symptoms such as fever, cough, and sputum production may be subtle or even absent.[28] Therefore, maintaining a high index of suspicion and initiating diagnostic evaluation promptly are essential. Although chest radiography remains the first-line imaging modality, chest CT substantially improves diagnostic sensitivity, particularly in the early stages of disease or when chest radiographic findings are inconclusive.[29] Analysis of bronchoalveolar lavage specimens using culture-based, antigen-detection, and polymerase chain reaction-based methods plays a critical role in pathogen identification.[30,31] While *S. pneumoniae*, *H. influenzae*, and atypical bacteria remain common causative pathogens in this population, opportunistic infections must also be considered in the presence of immunosuppression. Important pathogens include *Pneumocystis jirovecii (P. jirovecii)*, *Aspergillus spp.*, cytomegalovirus, other herpesviruses, *Mycobacterium tuberculosis*, and nontuberculous mycobacteria.[32-36] The spectrum of causative agents varies depending on the type and duration of the patient's underlying immunodeficiency, and the immunosuppressive treatments used.[27]

Because delays in treatment may lead to serious adverse outcomes, empiric antimicrobial therapy should be initiated without delay. When selecting an appropriate treatment regimen, clinicians should consider the patient's immune status, likely pathogens, local antimicrobial resistance patterns, and previous microbiological findings.[29] The need for expanded antimicrobial coverage targeting resistant pathogens such as MRSA and *P. aeruginosa* should be evaluated only in patients with relevant individual risk factors.[37] Whenever feasible, appropriate clinical specimens should be obtained before the initiation of antimicrobial therapy, and molecular diagnostic techniques should be utilized to facilitate pathogen identification and enable timely transition to targeted therapy.[38]

Vaccination is one of the basic approaches to protection. Pneumococcal and influenza vaccines are recommended, and COVID-19 and RSV vaccines should also be considered as part of protective strategies in appropriate patient groups.[39] However, in some immunodeficiency conditions, additional protective measures may be necessary as the vaccine response may be insufficient. In patients at high risk for *P. jirovecii*, trimethoprim-sulfamethoxazole prophylaxis is the standard protective approach.[40]

From an emergency department perspective, immunocompromised patients presenting with suspected community-acquired pneumonia require an expedited and systematic evaluation because rapid clinical deterioration and opportunistic infections are common. Initial assessment should include careful evaluation of respiratory status, hemodynamic stability, the severity and type of the underlying immunodeficiency, recent immunosuppressive therapies, and previous microbiological findings, as these factors directly influence both the differential diagnosis and the initial management strategy. Diagnostic investigations should be individualized according to the patient's immune status. While chest radiography is generally obtained as the initial imaging modality, early chest CT should be considered in patients with persistent clinical suspicion despite inconclusive initial imaging or in those at high risk for opportunistic pulmonary infections. Appropriate microbiological specimens, including blood cultures and respiratory samples when indicated, should be obtained as early as possible without delaying treatment. Continuous clinical reassessment throughout the emergency department stay is essential to detect early respiratory or hemodynamic deterioration requiring escalation of care. Empiric antimicrobial therapy should be initiated promptly after appropriate specimens have been collected whenever feasible. Because validated severity scores have limited applicability in immunocompromised populations, decisions regarding hospital admission and intensive care unit referral should rely primarily on clinical judgment, the degree of immunosuppression, and the patient's overall clinical stability. Early consultation with infectious diseases specialists, together with hematology, oncology, or transplant teams when appropriate, may facilitate timely diagnostic evaluation and optimization of subsequent targeted antimicrobial therapy.

BACTERIAL PNEUMONIA IN INDIVIDUALS LIVING WITH HUMAN IMMUNODEFICIENCY VIRUS (HIV) INFECTION

The widespread use of antiretroviral therapy has led to a substantial reduction in the incidence of opportunistic infections and bacterial pneumonia among people living with Human Immunodeficiency Virus (HIV). Nevertheless, bacterial pneumonia remains an important cause of morbidity and mortality, particularly in individuals with advanced immunosuppression.[41] Effective ART, sustained viral suppression, and recovery of $CD4^+$ T-lymphocyte counts are among the most important factors associated with a reduced risk of pneumonia.[42] Therefore, maintaining clinical vigilance for infectious complications and implementing appropriate preventive strategies remain essential components of care for individuals living with HIV. Although ART significantly decreases the incidence of bacterial pneumonia, the risk persists, particularly among patients with low $CD4^+$ T-cell counts.[43] A $CD4^+$ T-cell count below 200 cells/μL markedly increases the risk of pneumonia, whereas counts below 50 cells/μL are associated with a higher frequency of infections caused by opportunistic and drug-resistant pathogens.[44] In addition, cigarette smoking, intravenous substance use, chronic lung diseases such as chronic obstructive pulmonary disease and bronchiectasis, malnutrition, neutropenia, and corticosteroid therapy are important risk factors that facilitate the development of infection.[45-47]

In individuals living with HIV, the etiological spectrum of bacterial pneumonia largely resembles that observed in the general population. *S. pneumoniae* remains the most frequently isolated pathogen, followed by *H. influenzae*.[48] However, in the setting of advanced immunosuppression, *P. aeruginosa* and other gram-negative bacteria are encountered more frequently. Recent studies have demonstrated that among patients receiving effective ART and achieving adequate immunological control, the distribution of causative pathogens increasingly resembles that of the general population. Nevertheless, invasive pneumococcal disease continues to represent a significant source of morbidity and mortality in people living with HIV.[49,50] Clinically,

bacterial pneumonia most commonly presents with classic symptoms such as fever, cough, sputum production, and dyspnea. However, clinical manifestations may be attenuated in patients with advanced immunosuppression, potentially leading to delays in diagnosis. Imaging findings most frequently include lobar or segmental consolidation, although multifocal infiltrates and diffuse pulmonary opacities may also be observed. Chest CT provides valuable additional information for characterizing pulmonary infiltrates and establishing the differential diagnosis.[51]

When pulmonary infiltrates are identified in individuals living with HIV, the differential diagnosis should remain broad. *P. jirovecii* pneumonia, tuberculosis, fungal infections, and viral pneumonias represent important alternative diagnoses that should be carefully considered. An acute onset of symptoms, the presence of purulent sputum, and the identification of focal or lobar consolidation on imaging are generally regarded as findings that support a bacterial etiology. During the diagnostic evaluation, the patient's $CD4^+$ T-cell count, HIV viral load, and ART status should be systematically assessed, as these factors have important implications for both the differential diagnosis and subsequent management.

From an emergency department perspective, the initial management of individuals living with HIV and suspected bacterial pneumonia should be guided not only by the severity of the acute illness but also by the patient's level of immune dysfunction. Because opportunistic pulmonary infections may mimic bacterial pneumonia, emergency physicians should maintain a broad differential diagnosis, particularly in patients with advanced HIV disease or uncertain antiretroviral treatment status. Empiric antimicrobial therapy should not be delayed while the diagnostic evaluation is ongoing, and early consultation with infectious diseases specialists should be considered in patients with severe disease or suspected opportunistic infections. Decisions regarding hospital admission should take into account the patient's overall clinical status, immune function, ability to ensure close outpatient follow-up, and the risk of rapid clinical deterioration.

COMMUNITY-ACQUIRED PNEUMONIA DURING PREGNANCY

Pneumonia during pregnancy is an important clinical condition associated with significant maternal and fetal morbidity and mortality. Pregnancy-specific physiological changes—including elevation of the diaphragm, reduction in functional residual capacity, increased oxygen demand, and modulation of the immune system—reduce tolerance to hypoxemia and may contribute to a more severe course of respiratory infections. Viral pneumonias, particularly those caused by influenza, varicella, and SARS-CoV-2, are known to present with greater severity during pregnancy. Furthermore, the effects of maternal infection and hypoxemia on the fetoplacental circulation may increase the risk of adverse obstetric outcomes, including preterm delivery and low birth weight.[52]

Pneumonia typically presents with classic respiratory symptoms, including fever, cough, dyspnea, and pleuritic chest pain. However, physiological changes of pregnancy, such as tachycardia and mild dyspnea, may overlap with manifestations of infection and complicate the diagnostic process. Therefore, findings such as tachypnea (>20 breaths/min) and oxygen saturation levels below 95% should be regarded as important warning signs suggestive of pneumonia. Imaging studies play a pivotal role in the diagnostic evaluation. Chest radiography is considered a safe first-line imaging modality during pregnancy, as fetal radiation exposure remains extremely low (<0.01 mGy) when appropriate abdominal shielding is used.[53] Lung ultrasonography is being increasingly utilized in pregnant patients because it does not involve ionizing radiation, can be performed at the bedside, and is highly effective in detecting peripheral consolidations and pleural effusions. In centers with appropriate expertise, it can provide substantial diagnostic value as part of the evaluation of suspected pneumonia.[54]

In the treatment of community-acquired pneumonia during pregnancy, antibiotic selection should be guided by disease severity, the presence of comorbidities, local resistance patterns, and the fetal safety profile of the antimicrobial agents. Current guidelines emphasize that antibiotic therapy should not be delayed in pregnant patients and that maintenance of adequate maternal oxygenation is a primary therapeutic objective. For mild disease managed in the outpatient setting, a combination of amoxicillin or amoxicillin–clavulanate with azithromycin has been recommended;[55] however, it must be emphasized that macrolide monotherapy is no longer recommended as a first-line strategy in settings where macrolide resistance among *S. pneumoniae* exceeds 25%, in accordance with the 2019 ATS/IDSA guidelines.[7] Azithromycin should therefore be used as a combination partner rather than monotherapy in pregnant patients with CAP, and local resistance patterns should guide empiric choices. In patients with penicillin allergy, third-generation oral cephalosporins may be used with caution; however, clinicians should note that cefpodoxime and cefditoren have limited safety data in pregnancy and should be used only when no safer alternatives exist, with close attention to local resistance profiles. In more severe penicillin allergy, a combination of clindamycin and azithromycin may be chosen. Respiratory fluoroquinolones—while effective against resistant pathogens—should generally be avoided during pregnancy due to concerns regarding fetal cartilage toxicity, as highlighted in ACOG guidance on maternal respiratory infections.[56] Tetracyclines (especially doxycycline) and clarithromycin should similarly be avoided. In cases requiring inpatient treatment, intravenous ceftriaxone or cefotaxime in combination with azithromycin is recommended.[57]

In pregnant patients with pneumonia, the decision to hospitalize should be based on a comprehensive assessment of both infection severity and maternal–fetal risks. Although pregnant individuals who can maintain adequate oral intake, have no significant comorbidities, and can be closely monitored may be managed in the outpatient setting, hospitalization should be considered in the presence of hypoxemia, rapid clinical deterioration, inability to tolerate oral intake, significant comorbid conditions, or the need for assessment of fetal well-being. Because maternal hypoxemia can directly affect fetal oxygenation, the hospitalization

threshold for pregnant women should be kept lower than in the general population.[52]

Emergency physicians play a central role in the initial evaluation and stabilization of pregnant patients with pneumonia. In the emergency department, rapid assessment of oxygen saturation, respiratory rate, and fetal heart rate should be prioritized upon presentation. Because standard severity scoring tools such as CURB-65 are not validated in pregnancy and may underestimate severity, clinical parameters—including SpO_2 below 95%, respiratory rate above 30 breaths/min, and systolic blood pressure below 90 mmHg—should guide immediate triage and disposition decisions. Early obstetric consultation should be obtained in the emergency department for all pregnant patients with pneumonia requiring hospitalization. Point-of-care LUS can be performed rapidly at the bedside to assess consolidation and pleural effusion without radiation exposure, complementing the initial diagnostic evaluation. In patients with moderate-to-severe disease, empiric antibiotic therapy should be initiated within one hour, while the obstetric team should be engaged early to coordinate fetal assessment and subsequent inpatient management.

During hospitalization, supplemental oxygen therapy should be continued until clinical stability is achieved, with maternal oxygen saturation maintained above 95% and arterial oxygen tension (PaO_2) above 70 mmHg. Antibiotic treatment and supportive therapies should be started without delay, and fetal assessment should be planned according to gestational age and clinical condition. Patients with severe clinical conditions, those requiring mechanical ventilation, or those needing advanced supportive treatment should be monitored in the intensive care unit.[55] In centers with dedicated obstetric intensive care facilities, close collaboration between obstetric and intensive care teams should be ensured, and a multidisciplinary approach should be adopted.[58] Such an approach contributes to the prevention of maternal and fetal complications and may improve overall perinatal outcomes.

Seasonal influenza and COVID-19 vaccination play a central role in the prevention of pneumonia during pregnancy.[59] Vaccination has been shown to reduce the risk of severe infection, pneumonia, hospitalization, and intensive care unit admission among pregnant individuals. Consequently, current clinical guidelines consider vaccination one of the fundamental preventive strategies recommended throughout pregnancy.

CONCLUSION

Pneumonia in older adults, immunocompromised individuals, and pregnant patients continues to pose substantial diagnostic and therapeutic challenges because of atypical clinical presentations, altered host responses, and heterogeneous etiological pathogens. Improving outcomes in these vulnerable populations requires an individualized approach that extends beyond appropriate antimicrobial therapy to include timely recognition, comprehensive diagnostic evaluation, accurate risk stratification, multidisciplinary collaboration, and well-informed disposition planning. As emergency physicians are frequently responsible for the initial evaluation and stabilization of these patients, incorporating evidence-based emergency department management principles into routine clinical practice has the potential to facilitate earlier diagnosis, optimize therapeutic decision-making, and improve both short- and long-term clinical outcomes. Although considerable advances have been achieved in diagnostic imaging, molecular microbiological techniques, and antimicrobial therapies, important knowledge gaps remain regarding emergency department–specific risk stratification, standardized diagnostic pathways, and individualized management strategies for high-risk patient populations. Future prospective studies evaluating emergency department workflows, the integration of point-of-care diagnostic modalities, and tailored treatment algorithms are warranted to strengthen the evidence base and support the development of updated clinical guidelines for these vulnerable patient groups.

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The Intercontinental Journal of Emergency Medicine

Case Report

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Arrhythmia secondary to CO poisoning after hookah smoking

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ABSTRACT

Our case study highlights the importance of considering CO poisoning in young adults, particularly after hookah smoking. Ongoing monitoring and suspicion of hookah use are emphasized in such cases. A 28-year-old male non-smoker without a medical history of chronic illness was brought to the Emergency Medicine department complaining of nausea, dizziness, palpitation, and falling. His ECG still atrial fibrillation (AF). According to blood gas values, CO-Hb level was 21.6%. The patient was diagnosed with CO poisoning and was administered high-flow oxygen with a non-rebreather mask. The patient underwent cardioversion. It should not be forgotten that cardiac rhythm problems may occur after smoke hookah.

Keywords: Emergency, CO poisoning, hookah, atrial fibrillation

INTRODUCTION

Carbon monoxide (CO) poisoning, known as the silent killer, is a global health threat responsible for numerous fatal poisonings. The condition, whether acute or chronic, presents with symptoms ranging from mild to severe, including headache, dizziness, and weakness. Acute poisoning leads to critical effects such as myocardial and brain damage, pulmonary edema, and shock. CO's mechanism involves its high affinity for hemoglobin, causing hypoxia and tissue damage. It also induces vascular changes contributing to myocardial damage and arrhythmias. Management requires a comprehensive approach, including thorough medical assessment and continuous monitoring of vital signs. Normobaric oxygen therapy is the primary treatment, with targets for carboxyhemoglobin levels. The efficacy of hyperbaric oxygen therapy (HBO) is debated, and its use lacks clear indications. Our case study highlights the importance of considering CO poisoning in young adults, particularly after hookah smoking. Ongoing monitoring and suspicion of hookah use are emphasized in such cases.

CASE REPORT

A 28-year-old male non-smoker without a medical history of chronic illness was brought to the emergency medicine department complaining of nausea, dizziness, palpitation, and falling. After the detailed medical history taking, it was learned that these complaints started after smoking hookah, and the patient also had minor head trauma. Upon arrival at the emergency department, his vital signs were as follows: blood pressure 106/73, heart rate: 96/minute, respiratory rate: 12/minute, temperature: 36.6°C, and oxygen saturation 95% in room air. There wasn't any pathological sign on physical examination.

According to blood gas values, pH was 7.38 (normal: 7.35 to 7.45), the pressure of carbon dioxide (pCO_2): 44.4 mmHg (normal: 35-45 mmHg), bicarbonate (HCO_3) 24.1 mmol/L (normal: 22-26 mmol/L) and the CO-Hb level was 21.6% (normal: up to 3% in non-smokers and up to 10% heavy smokers. The patient was diagnosed with CO poisoning and was administered high-flow oxygen with a non-rebreather mask. Almost one and half hours into oxygen therapy, the patient's complaints regressed, and the CO-Hb level was decreased to 12%. The patient who continued on oxygen therapy did not report chest pain, and his ECG still showed atrial fibrillation (AF) (**Figure 1**). Serial troponin results came within the normal range. Therefore, the patient was consulted with cardiology and hospitalized with a medical cardioversion plan. Transthoracic echocardiography (ECHO) was performed by cardiology team and showed a preserved left ventricular systolic function with a left ventricle ejection fraction of 60%, no wall motion abnormalities, and non-significant trace mitral regurgitation with normal pulmonary artery systolic pressure. The patient was administered metoprolol 100 mg twice daily and enoxaparin 60 mg twice daily. Thrombus was not observed after TEE (transesophageal ECHO) and medical cardioversion was performed. The patient was discharged after sinus rhythm (**Figure 2**) was observed on ECG, hemodynamics remained stable, and his complaints regressed.

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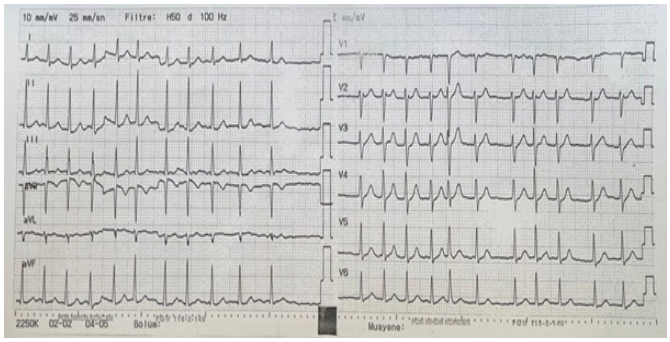


Figure 1. An electrocardiogram showed atrial fibrillation

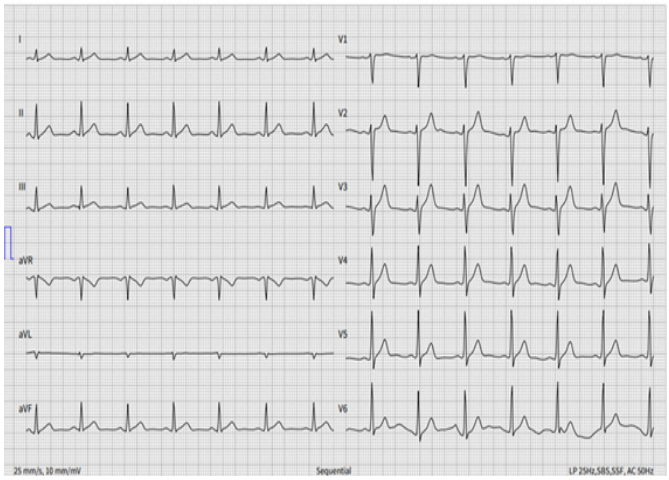


Figure 2. An electrocardiogram showed sinus rhythm after treatment

DISCUSSION

CO poisoning is a common emergency known as the silent killer. It is odorless, colorless, and tasteless, which may be responsible for more than half of all fatal poisonings in the world.[1] CO poisoning may be acute or chronic and can cause a range of acute effects from mild symptoms to critical illness. It is also reported that headache (91% of patients), dizziness (77%), and weakness (53%) are the most common symptoms.[2,3] Acute CO poisoning causes severe myocardial damage as well as brain edema, pulmonary edema, and shock since myocardial oxygen demand is higher than in peripheral tissues at rest.[4] ACOP can result in myocardial ischemia, infarction, dysrhythmia, cardiomyopathy, heart failure, cardiogenic shock, and sudden death. The mechanism of CO poisoning is related to the higher affinity of CO for hemoglobin than oxygen, and hypoxia is the main cause of tissue damage it causes.[4,5] Moreover, CO can increase vascular permeability, accelerate platelet aggregation, and induce coronary artery spasm. All these factors lead to myocardial damage.[4] Cardiac arrhythmias, including premature atrial and ventricular contractions, atrial and ventricular fibrillation, have been reported in CO poisoning, although not as common as ST-T wave changes and ischemic changes. CO exposure lowers the threshold for malignant ventricular arrhythmias and may cause premature death.[6] Several mechanisms have been demonstrated in the development of dysrhythmia, including hypoxia-induced altered calcium gradients, increased diastolic intracellular calcium, increased calcium sensitivity of myofilaments, and a hyperadrenergic state. CO also plays a pro-dysrhythmic role through early depolarization and prolonged action potential by increasing nitric oxide levels.[1,6] Because of the broad spectrum of symptoms, critical management of CO poisonings, including a detailed medical history and physical examination, is recommended. In addition, vital parameters such as heart rate, blood pressure, oxygen saturation, and blood gas analysis should be constantly monitored.[7] Treatment of CO poisoning begins with normobaric oxygen through a non-rebreathing mask and aggressive supportive care. It is the cornerstone of therapy as it accelerates the dissociation of CO from the mitochondrial cytochrome system.[6] Also, Akdemir et al.[8] showed that the rhythm returned to sinus rhythm under normobaric oxygen therapy in a patient with AF rhythm on ECG caused by CO poisoning. For the treatment of CO poisoning, Henry et al.[9] recommended that the patient breathe 100% oxygen until the symptoms disappeared. Treatment should be continued until the symptoms disappear and the carboxyhemoglobin level drops to 5% to 10%. If the cardiovascular system is affected by poisoning, it is recommended that the carboxyhemoglobin level fall below 2%.

The benefit of hyperbaric oxygen therapy is still debated. Some patients may benefit from HBO, but the indications for this treatment are uncertain.[3,7]

In our case, the management of the treatment, serial electrocardiography, vital and blood gas follow-ups of a young male patient presenting with palpitations and syncope, which may be an indication of cardiac involvement after hookah smoking, are discussed. Studies have shown that hookah use should be suspected in cases of CO poisoning, especially in adolescents and young adults.[10,11]

CONCLUSION

It should not be forgotten that cardiac rhythm problems may occur after smoke hookah.

ETHICAL DECLARATIONS

Informed Consent

Written informed consent was obtained from the patient included in this report. Signed consent forms are retained by the authors and are available upon request.

Peer Review Process

This report underwent external peer review.

Conflict of Interest

The authors declare no conflicts of interest.

Financial Disclosure

This case report did not receive any financial support.

Author Contributions

Concept: MBE, CK; Design: CK, GK; Control: CK; Resources: FY, MBE; Materials: MBE; Data Collection and/or Processing: MBE, CK; Analysis and/or Interpretation: CK, GK; Literature Review: GK; Writing the Article: MBE, CK, FY, GK; Critical Review: CK, GK, MBE.

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Letter to the Editor

Comment on: early lactate clearance and short-term outcomes in ICU patients admitted from the emergency department

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Keywords: Lactate clearance, emergency department, intensive care unit

Dear Editor,

I read with great interest the recent article by Taştemur and Demir[1] entitled "Prognostic significance of early lactate clearance in patients with suspected infection admitted to the intensive care unit from the emergency department". The authors should be commended for addressing a clinically relevant and operationally important question at the interface of emergency medicine and intensive care.

From the perspective of an emergency physician, the study highlights a critical phase of care: the early transition from the emergency department to the intensive care unit, where initial resuscitative decisions and trajectory-defining interventions occur. In this context, the demonstration that early lactate clearance within the first six hours is associated with 28-day mortality reinforces the concept that dynamic metabolic markers provide incremental prognostic value beyond static measurements obtained at presentation.[2]

I particularly appreciate the pragmatic inclusion criteria based on "suspected infection," which more accurately reflect real-world emergency department practice, where treatment decisions often precede definitive diagnostic confirmation. This approach enhances the external validity of the findings and aligns with the time-sensitive nature of emergency care.

The study also underscores an important clinical nuance: patients with similar baseline severity scores (e.g., APACHE II) may exhibit divergent physiological trajectories, as captured by lactate kinetics.[3] This observation is highly relevant in emergency settings, where early risk stratification must often rely on limited yet rapidly evolving data. Serial lactate assessment may therefore serve as a valuable adjunct to clinical judgment, helping to identify patients who require more aggressive monitoring or escalation of care during the early resuscitation window.[4]

From an operational standpoint, the integration of lactate clearance into emergency department workflows is feasible, given the widespread availability of point-of-care or rapid laboratory lactate measurements. The emphasis on a 6-hour reassessment window is also consistent with current resuscitation practices and could be incorporated into protocolized care pathways without substantial resource burden.

We also find the discussion on the dissociation between inflammatory markers and lactate dynamics particularly insightful. This reinforces the growing understanding that metabolic and immunological responses in critical illness may evolve independently, further supporting the need for multimodal assessment strategies in early patient evaluation.[5]

While acknowledging the inherent limitations of a single-center retrospective design, we believe this study contributes meaningfully to the ongoing effort to refine early risk stratification in patients with suspected infection. Future prospective, multicenter investigations incorporating standardized resuscitation protocols and time-dependent interventions would be valuable to further validate and operationalize these findings.

In conclusion, this work provides clinically actionable insight for both emergency and critical care physicians and supports the integration of dynamic lactate monitoring into early decision-making processes. I thank the authors for their contribution to this important field.

ETHICAL DECLARATIONS

Peer Review Process

This letter was externally peer-reviewed.

Conflict of Interest

The author declare no conflicts of interest.

Financial Disclosure

No financial support was received for the preparation or publication of this letter.

Author Contributions

The author is solely responsible for the conception, data collection, analysis, and writing of this manuscript.

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Author reply: "prognostic significance of early lactate clearance in patients with suspected infection admitted to the intensive care unit from the emergency department"

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Dear Editor,

We thank the author for their thoughtful comments on our study, "prognostic significance of early lactate clearance in patients with suspected infection admitted to the intensive care unit from the emergency department".

The author correctly points out that using "suspected infection" as a primary inclusion criterion reflects the daily reality of emergency and intensive care. In practice, life-saving interventions often begin well before a formal diagnosis is confirmed. Our findings support the idea that lactate clearance provides a dynamic view of a patient's physiological trajectory that static scores, like APACHE II, might miss at a single time point.

We also agree that the observed gap between inflammatory markers and lactate kinetics suggests a complex metabolic-immune interaction. This reinforces the need for a multimodal approach during the first hours of resuscitation.

In conclusion, these comments underscore the clinical utility of serial lactate monitoring in identifying high-risk patients during the transition from emergency to critical care. We appreciate the author's perspective, which further validates the importance of dynamic monitoring in early patient management.

Sincerely,

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