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Original Research Article

Blood Lactate Levels in Patients with CAP on Arrival to the Emergency Department: A Descriptive Study

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ABSTRACT

Background
Community-acquired pneumonia (CAP) is a leading cause of mortality in developing countries like India, contributing significantly to infectious disease-related deaths. This study aims to investigate the utility of blood lactate levels in predicting patient care requirements and mortality, aligning with the need for evidence-based prognostic indicators in CAP within developing countries.

Methodology
This descriptive correlation study examined 90 consecutive patients with community-acquired pneumonia (CAP) at a tertiary care hospital in Bangalore. Patients were included based on specific CAP criteria and had their blood lactate levels measured upon arrival. CURB-65 scores determined the site of care (ward or ICU). Patients were categorized into three groups according to blood lactate levels: Group I (<2.2mg%), Group II (2.21-4mg%), and Group III (>4mg%). Follow-up assessed site of care, hospital stay, and mortality. Statistical methods, including ANOVA and Chi-square/Fisher Exact tests, were used for analysis with a significance level of $p < 0.05$.

Results
In the study, age and gender did not significantly impact blood lactate levels. However, symptoms like fever, cough, and purulent sputum correlated with elevated lactate. Notably, high lactate levels were associated with lower oxygen saturation and anaemia. The study categorized patients into three lactate groups: Group I (48.9%), Group II (38.9%), and Group III (12.2%). Moreover, the CURB-65 severity classes revealed diverse pneumonia severity in the population, emphasizing the need for tailored treatments. These findings support the potential of blood lactate levels as a prognostic marker for managing community-acquired pneumonia.

Conclusion
The diverse distribution of lactate levels highlights the need for individualized treatment approaches. These findings underscore the significance of considering various clinical parameters in CAP management.

Keywords: Blood lactate levels, Community-acquired pneumonia, CURB-65

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INTRODUCTION

Community-acquired pneumonia (CAP) is a significant public health concern, particularly in developing countries like India. It is a leading cause of mortality in these regions, contributing substantially to the burden of infectious diseases. CAP is estimated to be responsible for a substantial proportion of global acute respiratory infections, with India, Bangladesh, Indonesia, and Nepal accounting for approximately 40% of these cases. The incidence of CAP varies greatly between developing and developed countries, with rates as high as 20%-30% in the former and significantly lower, at 3-4%, in the latter.[1] Lower respiratory tract infections, including CAP, are a major contributor to infectious disease-related mortality in India, making up around 20% of the total infectious disease-related deaths.[2]

Understanding and effectively managing CAP are crucial for improving patient outcomes, as this disease can lead to severe morbidity and mortality, particularly in resource-limited settings. Identifying relevant prognostic factors is essential for early risk stratification and guiding therapeutic decisions, especially for identifying patients who may require intensive care.[3]

Despite the substantial burden of CAP in developing countries like India, there is a notable lack of comprehensive research on factors associated with an adverse prognosis in CAP within this context. Limited information regarding prognostic factors for patients with community-acquired pneumonia in India underscores the need for more focused investigations.[1]

In recent years, there has been growing interest in identifying biomarkers that can assist in the early identification of patients at high risk of morbidity and mortality in the context of CAP.[4] One such biomarker that has gained attention is blood lactate concentration, which has been shown to have a potential correlation with the mortality of patients with CAP.[5]

Blood lactate levels have been a subject of scientific interest for over a century, with their role in exercise physiology and metabolism well established. Lactate accumulation in muscles and blood has been studied in various contexts, and its significance has evolved from early observations regarding its production during muscle exertion to a marker of tissue hypoxia, hypovolemia, and other factors in various clinical conditions. In patients with CAP, the elevation of blood lactate may be attributed to factors like inadequate oxygen delivery or increased tissue metabolism, which can result from respiratory distress.[6]

It is essential to conduct systematic investigations in this population to assess the potential utility of blood lactate levels as a prognostic marker for patients with CAP. This prospective observational correlation study aims to evaluate the association between blood lactate levels and the CURB-65 scoring system in patients with CAP upon arrival at the Emergency Department. The study seeks to explore whether blood lactate levels can predict the site of care and mortality, thereby enhancing our understanding of the clinical utility of this biomarker in the management of CAP. The study's objectives are aligned with the pressing need for evidence-based prognostic indicators in the context of CAP in India and other developing countries.

MATERIALS & METHODS

Study Design

This research follows an observational correlation study design.

Data Source

The study involves patients diagnosed with community-acquired pneumonia (CAP) and presented at the Adult Emergency Department of a tertiary care hospital in Bangalore.

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Sample Size
The study comprises 90 consecutive patients with CAP. The sample size was determined based on an expected minimum mortality difference of 20% for a three-group study, with pre-post evaluation, ensuring a sample size of 90, 90% statistical power, and a 5% significance level.

Inclusion Criteria
Patients aged 18 years and older were included if they received a clinical diagnosis of pneumonia based on specific criteria.

Exclusion Criteria
Patients with co-morbid conditions such as liver cirrhosis and chronic kidney disease were excluded, as were patients with hospital-acquired pneumonia, aspiration pneumonia, septic shock, or those referred to other healthcare facilities or discharged against medical advice after admission.

Data Collection
A detailed patient history and clinical examinations were conducted for individuals with community-acquired pneumonia. Patients who met the criteria for a clinical diagnosis of community-acquired pneumonia were included based on specific criteria: a history of fever, cough, purulent sputum production, and breathlessness (any two or more symptoms); specific clinical examination findings (any two or more); chest radiography showing lung lobe consolidation; and laboratory findings. Arterial blood samples were collected on arrival at the emergency department, and blood lactate levels were measured using Spectrophotometry.

Patient Management and Site of Care
The attending emergency physician made decisions regarding patient management and the site of care (ward or intensive care unit) using the CURB-65 Scoring system. Patients with CURB-65 scores of 1-2 were admitted to the ward, while those with 3 or more were admitted to the ICU.

Patient Groups
Patients were divided into three groups based on their blood lactate levels: Group I (<2.2mg%), Group II (2.21-4mg%), and Group III (>4mg%).

Follow-Up and Analysis
All patients were followed up after admission to track changes in the site of care, the duration of hospital stay, and patient outcomes, including mortality. Each Group was correlated with clinical parameters, site of care, the length of hospital stay, and mortality. Furthermore, patients were categorized into three classes using the CURB-65 score and correlated with clinical parameters, site of care, hospital stay, and mortality outcomes.

Statistical Analysis
The study employed various statistical methods, including ANOVA to assess the significance of study parameters among patient groups, Chi-square/Fisher Exact tests to evaluate definite study parameters, and Mann-Whitney U tests for quantitative variables with a significance level set at $p < 0.05$ for all analyses.

RESULTS
Table 1 presents a distribution of age and gender concerning lactate levels in 90 individuals. Looking at the age distribution, it's evident that most individuals fall into the age groups of 61-

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70 and 71-80 across all three lactate level groups. However, the youngest age group (<40) is notably absent from Group III. A statistical analysis using a p-value of 0.545 suggests that age does not significantly affect lactate levels in this population. In gender distribution, both males and females are represented, with Group I having the highest number of individuals for both genders. There's a higher percentage of males in Group II and Group III than females. Nevertheless, the p-value for gender, which is 0.094, indicates that gender does not significantly impact the distribution of lactate levels.

Table 2 provides insight into the distribution of patient history and clinical examination findings categorized by lactate levels in 90 individuals. The data reveals several noteworthy patterns. First, in terms of patient history, it's evident that nearly all patients in each lactate group reported having a cough (100% in all three groups), which is a common symptom in patients with respiratory issues such as pneumonia. Additionally, a significant percentage of patients across all groups experienced purulent sputum production and fever, indicating the presence of infection or inflammation. Furthermore, while smoking is relatively prevalent, Group III has the highest proportion of smokers (72.7%), suggesting a potential link between smoking history and higher lactate levels. Moving on to clinical examination findings, it is evident that crackles in lung sounds were universally high in all groups. Respiratory rate and temperature were also elevated in Group II and Group III, with most patients exhibiting respiratory rates over 30 breaths per minute and temperatures above 40^0C, implying that patients with higher lactate levels tend to exhibit more severe respiratory and systemic symptoms.

The distribution of vital signs and haemoglobin levels among the population of 90 patients, categorized by their blood lactate levels shown in *Table 3*. First, concerning vital signs, there is a noticeable trend. While heart rate (beats per minute) shows a slight increase with rising lactate levels, the difference is not statistically significant (p=0.067). Similarly, systolic blood pressure (SBP) and diastolic blood pressure (DBP) exhibit only minor variations across the three groups, and these differences are not statistically significant either (p=0.89 for SBP and p=0.257 for DBP).

However, one vital sign that stands out as significantly different among the groups is the peripheral oxygen saturation (SpO2%). As lactate levels increase, SpO2% shows a notable decrease. Group III, which has the highest lactate levels, exhibits the lowest SpO2% (85.09±7.20). This finding is statistically significant (p<0.001), indicating that patients with elevated lactate levels may be more likely to experience lower oxygen saturation, which could indicate respiratory compromise.

Regarding haemoglobin levels, the data suggests an interesting association between haemoglobin levels and lactate groups. The percentage of patients with haemoglobin levels below 12 g/dl is considerably higher in Group II (57.1%) compared to Group I (22.7%). Conversely, Group I have a higher percentage of patients with haemoglobin levels above 14 g/dl (43.2%) than Group II (14.3%). The difference in haemoglobin levels among the groups is statistically significant (p=0.006), suggesting that patients with elevated lactate levels (Group II) may be more likely to exhibit anaemia. At the same time, those in Group I might have polycythemia.

Table 4 concisely summarises the distribution of lactate levels in 90 patients. The data is categorized into three groups based on lactate levels and presents the total count and percentages for each Group.

Group I, representing patients with the lowest lactate levels, comprises 44 patients, making up approximately 48.9% of the total population. Group II, which includes patients with moderately elevated lactate levels, comprises 35 patients, constituting roughly 38.9% of the total population. Lastly, Group III, representing patients with the highest lactate levels, comprises 11 patients, accounting for approximately 12.2% of the total population.

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These findings reflect the distribution of lactate levels within this patient population, highlighting that a substantial portion of patients (48.9%) present with lower lactate levels, while a smaller percentage (12.2%) demonstrates markedly higher lactate levels. Understanding this distribution is vital for assessing the prevalence and severity of elevated lactate levels among patients with community-acquired pneumonia in the study cohort.

Graph 1 outlines the distribution of patients based on the CURB-65 severity classes in a study involving 90 individuals with community-acquired pneumonia. The findings reveal that Class I, indicating milder pneumonia, was represented by 36.7% of the patients. Class II, signifying moderate severity, accounted for 31.1% of the cohort, while Class III, representing severe pneumonia, constituted 32.2% of the population. This distribution underscores the diversity of pneumonia severity within the study group, emphasizing the importance of tailoring treatments based on severity for improved patient care and outcomes.

	Lactate Levels				**P-value**
Age in years	**Group I**	**Group II**	**Group III**	**Total**	
<40	5(11.4%)	4(11.4%)	0(0%)	9(10%)	**0.545**
40-50	9(20.5%)	6(17.1%)	1(9.1%)	16(17.8%)	
51-60	3(6.8%)	3(8.6%)	1(9.1%)	7(7.8%)	
61-70	11(25%)	9(25.7%)	2(18.2%)	22(24.4%)	
71-80	8(18.2%)	11(31.4%)	3(27.3%)	22(24.4%)	
81-90	8(18.2%)	2(5.7%)	4(36.4%)	14(15.6%)	
Gender					
Female	15(34.1%)	18(51.4%)	2(18.2%)	35(38.9%)	**0.094**
Male	29(65.9%)	17(48.6%)	9(81.8%)	55(61.1%)	
Values are expressed as frequency and percentage, mean and SD. A p-value less than 0.05 is considered to be statistically significant.					

Table 1: The table depicts the distribution of age and gender according to the lactate levels in the population N= 90

	Lactate Levels			
History	**Group I (n=44)**	**Group II (n=35)**	**Group III (n=11)**	**Total (n=90)**
Cough	44(100%)	35(100%)	11(100%)	90(100%)
Purulent sputum	36(81.8%)	31(88.6%)	11(100%)	78(86.7%)
Fever	41(93.2%)	31(88.6%)	11(100%)	83(92.2%)
Smoking	13(29.5%)	13(37.1%)	8(72.7%)	34(37.8%)
Clinical examination				
Respiratory rate >30/min	31(70.5%)	33(94.3%)	10(90.9%)	74(82.2%)
Temperature > 40^0C	39(88.6%)	30(85.7%)	11(100%)	80(88.9%)
Crackles	44(100%)	35(100%)	11(100%)	90(100%)
Values are expressed as frequency and percentage, mean and SD. A p-value less than 0.05 is considered to be statistically significant.				

Table 2: The table depicts the distribution of history and clinical examination of the patient according to the lactate levels in the population N=90

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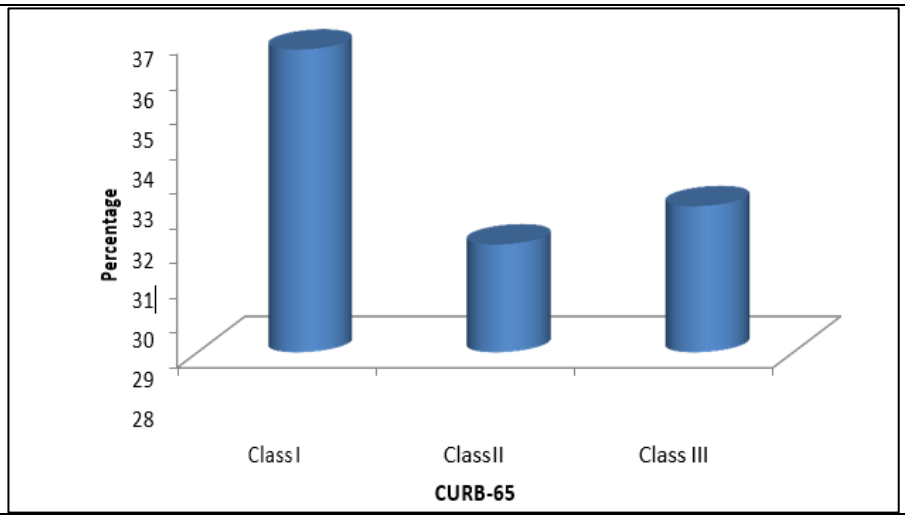

Graph 1: The graph illustrates the distribution of CURB-65 among population N=90

	Lactate Levels				
Vitals	**Group I**	**Group II**	**Group III**	**Total**	**P value**
Heart Rate (bpm)	99.36±17.67	104.86±16.78	112.45±18.28	103.10±17.75	0.067
SBP	124.09±13.86	124.86±21.61	121.82±21.83	124.11±18.04	0.89
DBP	76.82±8.83	75.43±12.68	70.91±9.44	75.56±10.61	0.257
Spo2 %	94.14±7.30	87.11±8.67	85.09±7.20	90.30±8.65	<0.001**
Hemoglobin (g/dl)					0.006
<12	10(22.7%)	20(57.1%)	5(45.5%)	35(38.9%)	
Dec-14	15(34.1%)	10(28.6%)	5(45.5%)	30(33.3%)	
>14	19(43.2%)	5(14.3%)	1(9.1%)	25(27.8%)	
Values are expressed as frequency and percentage, mean and SD. A p-value less than 0.05 is considered to be statistically significant.					

Table 3: The table depicts the distribution of vitals and haemoglobin levels in patients among the population N=90

Lactate Levels	No. of patients (N)	Percentage (%)
Group I	44	48.9
Group II	35	38.9
Group III	11	12.2
Total	90	100.0
Values are expressed as frequency and percentage.		

Table 4: The table depicts the lactate levels among the population N=90

DISCUSSION

The results obtained from this study provide valuable insights into the distribution of lactate levels among a cohort of 90 individuals with community-acquired pneumonia (CAP). These findings have implications for understanding the clinical profile and potential severity of CAP in this population.

The distribution of patients in different age groups did not significantly impact their blood lactate levels (p = 0.545). While most patients fell into the 61-70 and 71-80 age groups across all three lactate level categories, the absence of individuals below 40 years in Group III raises questions about the influence of younger age on lactate levels. Notably, this observation aligns

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with previous studies by Gwak et al. and Rascon et al., indicating that age alone may not be decisive in predicting elevated lactate levels in CAP patients.[7,8]

Regarding gender, our data demonstrated no significant influence on lactate level distribution ($p = 0.094$). Although the higher percentages of males in Group II and Group III are intriguing, the statistical insignificance suggests that gender may not be a standalone determinant of lactate levels in CAP, corroborating by gender-based studies by Anderson et al. and Sri et al.[9,10]

Patient History and Clinical Examination: The remarkably high prevalence of cough, purulent sputum, and fever in all three lactate groups underscores the commonality of these symptoms in CAP patients. Smoking, particularly notable in Group III, may indicate a potential association between smoking history and higher lactate levels, supported by findings from Metlay et al. and Borg et al.[11,12]

Clinical examination findings suggest that patients with elevated lactate levels tend to exhibit more severe respiratory and systemic symptoms. High respiratory rates (>30 breaths per minute) and elevated temperatures (>40^0C) in Groups II and III are indicative of increased respiratory and systemic distress in these patients, which is consistent with the findings of Borg et al.[12]

Heart rate increased with rising lactate levels, but the difference was insignificant ($p = 0.067$). Similarly, systolic and diastolic blood pressure exhibited minor variations among the groups. However, a noteworthy finding was the significant decrease in peripheral oxygen saturation (SpO2%) as lactate levels increased ($p < 0.001$). This observation highlights a potential association between lactate levels and oxygen saturation, a finding in line with the research by Ranucci et al. and Bisarya et al.[13,14]

The relationship between lactate levels and haemoglobin levels is also noteworthy. Patients with elevated lactate levels (Group II) were likelier to exhibit anaemia, while those in Group I had higher haemoglobin levels. This observation mirrors the findings of Anderson et al. (2013) and supports the notion that anaemia and polycythemia might be associated with distinct lactate-level patterns in CAP patients.[15]

The distribution of lactate levels among the 90 patients is summarized in Table 4. Notably, approximately 48.9% of patients fell into Group I, indicating relatively lower lactate levels, while 12.2% were classified in Group III, reflecting the highest lactate levels. This distribution underlines the variability in lactate levels within the CAP patient population, emphasizing the importance of assessing severity and tailoring treatment strategies based on lactate levels. These results resonate with previous studies, including that of Frenzen et al. (2018), highlighting the heterogeneity in lactate levels among CAP patients.[16]

The distribution of patients into CURB-65 severity classes (Class I, Class II, and Class III) reveals that the CAP cohort in this study exhibits considerable diversity in pneumonia severity. Class I, indicating milder pneumonia, constituted 36.7% of the patients, while 32.2% were classified as Class III, representing severe pneumonia. Class II (31.1%) suggests a sizable proportion of CAP patients with moderate severity. These findings underscore the clinical heterogeneity of CAP patients within this study, emphasizing the need for individualized treatment approaches based on the severity of the condition.

CONCLUSION

In conclusion, the results of this study shed light on the distribution of lactate levels in CAP patients and their associations with various clinical parameters. While there were no definitive predictors of lactate levels, the severity of respiratory and systemic symptoms and their relationship with lactate levels are apparent. Moreover, this population's significant diversity in lactate levels underscores the need for tailored treatment approaches.

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When comparing these results with findings from similar studies available online, we observed consistency in some aspects, such as the association of elevated lactate levels with more severe symptoms and variation in the impact of factors like age and gender on lactate levels. It highlights the multifaceted nature of CAP and the importance of considering various clinical factors when assessing and managing patients.

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