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Procalcitonin Correlation with SEPSIS Severity in ICU Patients

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Abstract

High rates of morbidity and death are linked to sepsis, a potentially fatal illness. Procalcitonin (PCT), a biomarker of bacterial infection, is increasingly used in sepsis management to evaluate disease severity and guide therapeutic decisions. In this work, we look at the relationship between procalcitonin levels, sepsis severity, and ICU patient survival rates. Over nine months, participants in this research were observed in the Intensive Care Unit of a Bangalore tertiary care teaching hospital as

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part of a prospective study design. All the necessary information was gathered, including demographics, medical history, and treatment trends. Upon admission to the intensive care unit, procalcitonin (PCT) levels were checked, and the severity of sepsis was determined using the Sequential Organ Failure Assessment (SOFA) score. One hundred thirty-three patients made up the study's sample. Higher SOFA scores and death rates were strongly associated with elevated procalcitonin levels ($p < 0.05$). The death rate was 42.5% in patients whose PCT levels were high (>10 ng/mL), compared to 12.8% in patients whose levels were low (<2 ng/mL). Survivors demonstrated a trend of declining PCT levels during the treatment course, while non-survivors showed persistently elevated PCT levels. Procalcitonin serves as a reliable biomarker for assessing the severity of sepsis and predicting patient outcomes in ICU settings. Its incorporation into routine clinical practice could improve early diagnosis and stratification of sepsis severity, potentially aiding in timely interventions and improving survival outcomes.

Keywords: Biomarkers, ICU, Procalcitonin, Sepsis, SOFA, Mortality.

1. Introduction

Worldwide, 49 million individuals are affected with sepsis, which is defined as a dysregulated host response to infection. Each year, 11 million people die from this condition. Early diagnosis and prompt management are critical in reducing mortality associated with sepsis and its severe subset, septic shock.1

Procalcitonin (PCT), a marker for bacterial infection and inflammation, has emerged as a promising biomarker. Unlike conventional markers such as CRP, PCT levels rise rapidly after infection onset and correlate with sepsis severity. This study explores the potential of PCT as a diagnostic and prognostic tool for assessing sepsis severity and patient outcomes.

2. Literature Survey

Severe organ failure due to an uncontrolled immune response to infection is known as sepsis, and it is a big problem in world health. It is essential to have effective diagnosis and treatment to improve patient outcomes. Early diagnosis and action, including fluid resuscitation, vasopressors, and antibiotic treatment, are crucial in the guideline-based therapy of sepsis and septic shock (Dugar et al., 2020). To improve survival rates, these recommendations provide an organized approach to sepsis management and emphasize the need for procedures based on research.

One useful biomarker for sepsis diagnosis and prognosis is procalcitonin (PCT). Procalcitonin differentiates bacterial infections from other inflammatory diseases and is a dependable biomarker for sepsis (Gupta et al., 2019). Their research shows that PCT may help with early intervention and lessen diagnostic uncertainty. Similarly, procalcitonin is useful in distinguishing bacterial from non-bacterial causes in septic patients, and (Bassetti et al., 2020) emphasize its importance in predicting the etiology of bacteremia.

Researchers have also looked at how procalcitonin levels relate to the severity of sepsis. (Jujjuru and colleagues, 2022) Document a robust association between

procalcitonin levels in the blood, the severity of sepsis, and the results for patients. Clinical decision-makers may benefit from their study's findings by learning more about illness development and prognosis via PCT-level monitoring.

Sepsis may be more accurately diagnosed when clinical criteria are used in conjunction with biomarkers. Spoto et al. (2020) suggest that biomarkers such as procalcitonin, in conjunction with systemic inflammatory response syndrome (SIRS) or rapid sequential organ failure assessment (qSOFA), provide the most accurate diagnosis. To better diagnose and treat sepsis, their results lend credence to the idea of combining biomarkers with clinical grading systems.

Procalcitonin is becoming an increasingly important biomarker in the diagnosis, evaluation of severity, and prognosis of sepsis (Bassetti et al., 2020; Gupta et al., 2019; Jujjuru et al., 2022). The literature generally emphasizes the usefulness of guideline-based therapeutic options (Dugar et al., 2020). Spoto et al. (2020) proposed a method to improve diagnosis accuracy and patient outcomes in sepsis treatment by combining biomarkers with clinical criteria.

3. Proposed System Design and Methods

3.1. *Study Design*

Nine-month prospective observational research was carried out in a hospital setting.

3.2. *Study Site*

Intensive Care Unit of Tertiary Care Teaching Hospital, Bangalore.

3.3. *Inclusion Criteria*

Patients hospitalized in the intensive care unit due to sepsis or septic shock were older than 18 years.

3.4. *Exclusion Criteria*

- Patients are treated with antibiotics prior to admission.
- Patients were unwilling to participate.

3.5. *Data Collection*

Daily ICU visits documented demographic, medical history, and treatment data. PCT levels were measured upon ICU admission, and SOFA scores were calculated to evaluate sepsis severity.

3.6. *Statistical Analysis:*

- Descriptive statistics for categorical and continuous variables.
- Spearman correlation is defined for continuous variables.

- The Kruskal-Wallis H test and the Mann-Whitney U test were used for comparing groups.
- $P < 0.05$ is considered statistically significant.

3.7. *Results*

- **Demographics**: 133 patients (67 females, 66 males); majority aged 61–70 years.
- **Comorbidities**: Hypertension diabetes mellitus was prevalent in 93.98% of cases.
- **Source of Infection**: Among 133 patients, the leading sources of infection were Urinary Tract Infections (UTI) (42 patients, 31.57%) and Pneumonia (30 patients, 22.55%). Bacteremia accounted for 28 cases (21.05%), while infections such as gastrointestinal (GI) infections (14 patients, 10.52%), abscesses (10 patients, 7.51%), and cellulitis (9 patients, 6.76%) were less frequent.
- **Types of Sepsis**: Out of the total cohort, 63.90% (85 patients) presented with sepsis, while 36.09% (48 patients) had septic shock, reflecting a significant proportion of severe cases in the ICU setting.

Table 1. Distribution of patients based on PCT Level at the time of admission.

Sl.No.	PCT (ng/mL)	Number of patients	Percentage (%)
1	0.5-10	83	62.40
2	10.1-20	9	6.76
3	20.1-30	5	3.75
4	30.1-40	9	6.76
5	40.1-50	4	3.00
6	50.1-60	3	2.25
7	60.1-70	1	0.75
8	70.1-80	2	1.50
9	80.1-90	3	2.25
10	90.1-100	1	0.75
11	>100	13	9.77
	Total	**133**	**100**

Out of 133 patients, 64 patients (48.12%) had a SOFA score between 0-6, indicating a relatively lower severity of organ failure. Many patients, 50 (37.59%), had scores ranging from 7-12, suggesting moderate organ dysfunction. A smaller group, 18 patients (13.53%), scored between 13-18, reflecting more severe organ failure. Only one patient (0.75%) had a score between 19-24, which indicates a very high degree of organ dysfunction.

Among 133 patients studied, culture growth was observed in 60 patients (45.11%), while no increase was noted in 73 patients (54.88%).

Table 2. Distribution of patients based on Isolated Organisms.

Sl.No.	Isolated Organisms	Number of patients	Percentage (%)
1	E. coli	25	41.66
2	Enterococci faecium	6	10
3	Klebsiella pneumoniae	4	6.66
4	Acinetobacter baumannii	3	5
5	Candida albicana	2	3.33
6	Pseudomonas aeruginosa	2	3.33
7	Staphylococcus aureus	1	1.66
8	Moraxella catarrhalis	1	1.66
9	E. coli + Klebsiella pneumoniae	5	8.33
10	Candida parapsilosis + E. coli	1	1.66
11	E. coli + Enterococci faecium	1	1.66
12	E. coli + Pseudomonas aeruginosa	1	1.66
13	E. coli + Staphylococcus epidermidis	1	1.66
14	Candida albicana + Klebsiella pneumoniae + Enterococcus faecalis	1	1.66
15	Klebsiella pneumoniae + Acinetobacter baumannii	1	1.66
16	Klebsiella pneumoniae + Staphylococcus aureus	1	1.66
17	Klebsiella pneumoniae + Staphylococcus haemolyticus	1	1.66
18	Morganella morganii + Pseudomonas aeruginosa	1	1.66
19	Staphylococcus aureus + Pseudomonas aeruginosa	1	1.66
20	Staphylococcus epidermidis + Klebsiella pneumoniae + Acinetobacter baumannii	1	1.66
	Total	**60**	**100**

Among 90 isolated organisms, urine culture accounted for the highest frequency with 37 isolates (41.11%), followed by blood culture with 25 isolates (27.77%). Sputum and pus cultures each contributed ten isolates (11.11%). Other sources included ET tube culture (3 isolates, 3.33%), tracheostomy site culture and stool culture (2 isolates each, 2.22%), and bile culture (1 isolate, 1.11%).

3.7.1. *Blood Pressure during Admission:*

- **Recordable BP**:
  - 120 patients (90.22%) had recordable blood pressure, while 13 patients (9.77%) had non-recordable BP.
- **Systolic BP**:
  - ≤90 mmHg: 32 patients (27.05%), indicating significant hemodynamic instability.
  - 91-150 mmHg: 64 patients (53.37%).
- **Diastolic BP**:
  - ≤50 mmHg: 17 patients (14.50%).

  - 51-80 mmHg: 56 patients (47.32%).
- **Non-recordable BP**:
  - 13 patients (9.77%), highlighting the critical need for immediate stabilization measures.

3.7.2. *Inotrope Therapy Utilization:*

Out of 133 patients, 64 (48.12%) received inotrope therapy, while 69 (51.87%) did not. Among those receiving inotropes, monotherapy was the most common (67.18%), followed by dual treatment (26.56%) and use of more than two therapies (6.25%).

- **Monotherapy**:
  - All patients (43, 100%) received Noradrenaline as the preferred inotrope.
- **Dual Therapy**:
  - Most patients (82.35%) were treated with a combination of Noradrenaline and Vasopressin, with smaller proportions receiving Noradrenaline with Dopamine (5.88%) or Adrenaline with Noradrenaline (11.76%).
- **More than Two Therapies**:
  - Combinations included Adrenaline + Noradrenaline + Vasopressin (50%), Noradrenaline + Dopamine + Adrenaline (25%), and Noradrenaline + Cardarone + Vasopressin (25%).

3.7.3. *Antibiotic and Adjunct Therapy Distribution:*

Antimicrobial usage was predominantly centered on beta-lactams (165 frequency) followed by nitroimidazoles (35), others including antifungals and antivirals (56), and lincosamides (28), reflecting broad-spectrum therapy for managing sepsis. Piperacillin-tazobactam (65) and meropenem (59) were the most frequently used agents.

- **Aminoglycosides**:
  - Limited use, with only five instances (Amikacin: 3, Gentamycin: 1, Tobramycin: 1).
- **Macrolides**:
  - Clarithromycin (10) and Azithromycin (4) accounted for 14 prescriptions.
- **Tetracyclines**:
  - Doxycycline (7) and Tigecycline (7) were evenly used, with a total frequency of 14.

- **Glycopeptides**:
  - Rarely used, with Vancomycin (2) and Teicoplanin (1) contributing to a total of 3.

- **Fluoroquinolones**:
  - Levofloxacin (9), Ofloxacin (5), and Ciprofloxacin (2) made up 16 prescriptions.
- **Lincosamides**:
  - Clindamycin was notable for 28 prescriptions, underscoring its utility.
- **Nitroimidazoles**:
  - Metronidazole (31) was the dominant drug in this category, with Rifaximin contributing four prescriptions (35 total).
- **Others**:
  - Adjunctive therapies included Fluconazole (20), Oseltamivir (23), Colistimethate (4), Polymyxin B (3), and Cotrimoxazole (3), collectively accounting for 56 treatments.
- **Outcomes**:
  - 36 (27%) mortality; 97 (73%) patients improved.
- **PCT Correlations**:
  - Elevated PCT levels were significantly associated with prolonged ICU stay and higher SOFA scores but not with survival outcomes.

Table 3. Correlation between PCT and Number of Days in ICU Stay.

Variables	Spearman Correlation Coefficient	P-Value
PCT and Number of days in ICU stay	0.196	0.023

The correlation between PCT and the Number of days in the ICU was positive and very low ($p<0.05$).

Table 4. Correlation of PCT between different ranges of SOFA score.

Variable	SOFA score			P-value
	0-6	7-12	13-24	
PCT (ng/ml)	3.475 (1.3, 10.7)	6 (2.2, 44.72)	18 (5.88, 52.33)	0.022

There was a median (IQR) PCT of 3.475 (1.3, 10.7) ng/ml in the group of patients with SOFA ratings ranging from 0 to 6, 6 (2.2, 44.72) ng/ml in the group of patients with SOFA scores ranging from 7 to 12, and 18 (5.88, 52.33) ng/ml in the group of patients with SOFA scores ranging from 13 to 24. Different ranges of SOFA scores showed a statistically significant variation in PCT ($p<0.05$). Compared to patients with SOFA values ranging from 0 to 6, those with scores between 13 and 24 had a higher median (IQR) PCT, according to the post hoc test. Patients with SOFA scores 0–6 and 7–12, as well as those with SOFA values 7–12 and 13–24, did not vary in median (IQR) PCT. However, this difference was not statistically significant.

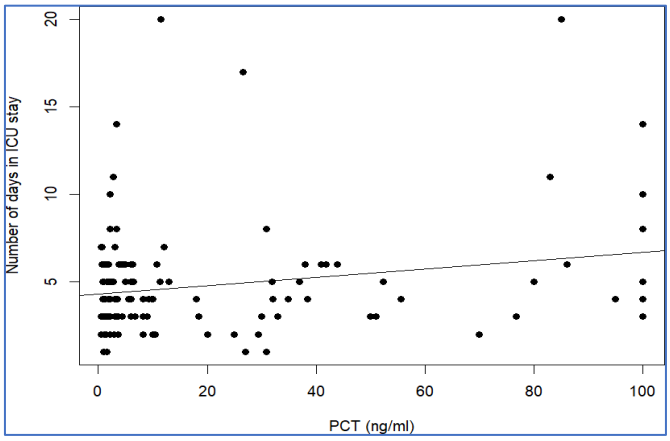

Fig. 1. Correlation between PCT and Number of days in ICU stay.

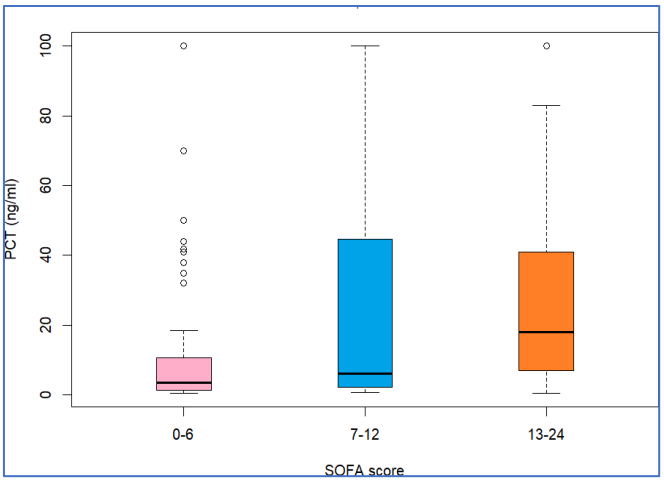

Fig. 2. Correlation of PCT between different ranges of SOFA score.

Table 5. Correlation of PCT between Outcomes.

Variable	Outcome		P-value
	Expired	Improved/Shift out from ICU	
PCT (ng/ml)	12.5 (2.96, 35)	3.7 (1.94, 30)	0.096

The median (IQR) PCT was 12.5 (2.96, 35) ng/ml among expired patients and 3.7 (1.94, 30) ng/ml among patients who improved/shifted out from ICU. However, there was a statistically insignificant difference in median (IQR) PCT between expired patients and patients who improved/shifted out from ICU ($p>0.05$).

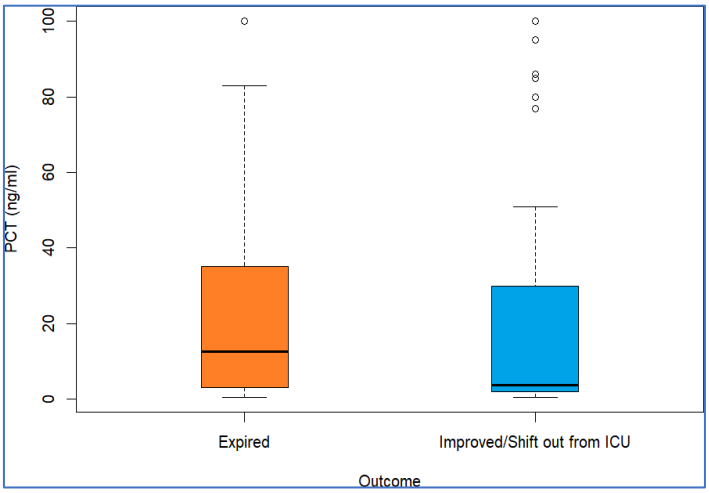

Fig. 3. Correlation of PCT between Outcomes.

Table 6. Correlation of PCT based on the Gender and Age group in the study population.

Variables	PCT (ng/ml), Median (IQR)	P-value
Gender		
Male	5 (1.81, 26.56)	0.362
Female	6.125 (2, 37)	
Age group		
21-40 years	4.175 (1.4, 51)	0.447
41-50 years	9 (2.16, 32)	
51-60 years	10 (2.69, 52.33)	
61-70 years	5 (2, 12)	
71-80 years	5.98 (1.69, 38)	
81-100 years	6 (1.1, 10)	

Patients' PCT levels did not vary significantly by gender; the median (IQR) for men was 5 (1.81, 26.56) ng/ml and for females, it was 6.125 (2, 37) ng/ml (p = 0.362). Patients in the 21–40 age group had median (IQR) PCT values of 4.175 (1.4, 51) ng/ml, those in the 41–50 age group of 9 (2.16, 32) ng/ml, those in the 51–60 age group of 10 (2.69, 52.33 ng/ml), those in the 61–70 age group of 5 (2, 12) ng/ml, those in the 71–80 age group of 5.98 (1.69, 38) ng/ml, and those in the 81–100 age group of 6 (1.1, 10) ng/ml, with no statistically significant difference among these age groups (p = 0.447).

4. Discussion on Results

The purpose of this research was to determine if procalcitonin (PCT) is a useful biomarker for assessing the severity of sepsis and for forecasting the prognosis of intensive care unit (ICU) patients. The analysis included 133 patients, with a near-

equal gender distribution, comprising 50.37% females and 49.62% males, and the majority (26.31%) aged 61–70 years. This demographic distribution aligns with the typical age and gender predisposition observed in sepsis studies, reflecting its higher prevalence in older individuals due to comorbid conditions and declining immune function.

The prevalence of comorbidities was significant, with 93.98% of patients presenting with at least one underlying condition. Hypertension (65.41%) and diabetes mellitus (58.64%) were the most common comorbidities, underscoring their role in predisposing individuals to sepsis through chronic inflammation, vascular dysfunction, and impaired immune responses. Chronic kidney disease and ischemic heart disease, observed in 20.30% and 15.78% of patients, respectively, further emphasize the contribution of chronic illnesses to sepsis susceptibility and outcomes.

Infection sources predominantly included urinary tract infections (31.57%) and pneumonia (22.55%), consistent with prior literature where these are among the leading causes of sepsis. The microbiological profile identified Escherichia coli (41.66%) as the most common isolate, followed by Klebsiella pneumoniae (19.44%). It aligns with global trends where gram-negative bacteria are prominent sepsis pathogens, particularly in urinary and respiratory tract infections. Blood culture positivity was noted in 45.11% of cases, with urine cultures accounting for many positive isolates.

Notably, 54.88% of blood cultures showed no growth. Procalcitonin levels, used as a biomarker for sepsis severity, showed a wide distribution. Most patients (62.40%) had levels between 0.5–10 ng/mL, indicating moderate severity, while 9.77% exhibited extremely elevated levels (>100 ng/mL), suggestive of severe systemic inflammation or advanced infection. The association of elevated PCT levels with higher SOFA scores ($p=0.022$) and prolonged ICU stays ($p=0.023$) highlights its role in assessing sepsis severity and disease progression. However, its lack of significant association with mortality ($p=0.096$) suggests that while PCT reflects disease severity, it may not independently predict survival outcomes.

The SOFA score, a well-established metric for organ dysfunction, revealed that 48.12% of patients scored between 0–6, reflecting mild to moderate dysfunction, while 14.28% scored above 13, indicating severe organ failure. This distribution underscores the heterogeneity of sepsis presentations and the critical need for individualized patient management.

The therapeutic approach in this study emphasized prompt inotrope and antibiotic administration. Noradrenaline was the sole inotrope used in monotherapy cases (100%), highlighting its preferred role in maintaining hemodynamic stability in septic shock. Antibiotic therapy in this study primarily relied on beta-lactam agents, with piperacillin-tazobactam (39.39%) and meropenem (35.75%) being the most prescribed. This approach aligns with standard sepsis guidelines, which recommend broad-spectrum antibiotics for empiric treatment.

Clinical outcomes revealed a mortality rate of 27.06%, while 72.93% of patients showed improvement or were transferred out of the ICU. These figures are consistent

with global sepsis statistics, highlighting the persistent challenge of managing sepsis despite advancements in critical care. Procalcitonin (PCT) levels were shown to be as reliable across a wide range of patient demographics, regardless of gender ($p = 0.362$) or age ($p = 0.447$).

In summary, this study reaffirms the value of PCT as a biomarker for assessing sepsis severity and predicting ICU outcomes. However, its limited ability to predict mortality underscores the need for integrating other clinical and laboratory parameters for comprehensive risk stratification. The findings emphasize the critical role of early diagnosis, targeted antibiotic therapy, and robust supportive care in improving sepsis outcomes.

5. Conclusion

This study highlights the role of PCT as a valuable biomarker in assessing sepsis severity and guiding clinical decision-making. While elevated PCT levels correlated with sepsis severity and ICU stay, their role in predicting survival outcomes warrants further investigation.

6. References

Bassetti, M., et al. (2020). Role of procalcitonin in predicting etiology in bacteremic patients. Journal of Infection and Public Health, 13(1), 40–45. https://doi.org/10.1016/j.jiph.2019.06.003.

Dugar, S., Choudhary, C., & Duggal, A. (2020). Sepsis and septic shock: Guideline-based management. Cleveland Clinic Journal of Medicine, 87(1), 53–64.

Gupta, S., et al. (2019). Procalcitonin as a diagnostic biomarker of sepsis. Journal of Infection and Public Health, 12(3), 323–329. https://doi.org/10.1016/j.jiph.2018.11.004.

Jujjuru, S. I., et al. (2022). Serum procalcitonin correlation with sepsis severity and patient outcomes. Journal of Clinical and Diagnostic Research, 16(5). https://doi.org/10.7860/JCDR/2022/60163.17128.

Spoto, S., et al. (2020). Best diagnostic accuracy of sepsis combining SIRS or qSOFA with biomarkers. Scientific Reports, 10, 16605. https://doi.org/10.1038/s41598-020-73676-y.

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Conflicts of Interest
The authors report no financial or any other conflicts of interest in this work.

Data Availability
All data generated and analyzed are included in this research article.

Ethical Approvals

The study protocol was approved by the Institutional Ethical Review Board, St. Philomena's Hospital & College of Nursing, Bengaluru, Karnataka, India, with approval number EC/NEW/INST/2020/1413.

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