



Original Article

## Knowledge, Attitudes, and Practices of Indian Intensivists Regarding Procalcitonin as a Biomarker of Sepsis: A Cross-Sectional Survey

Garvita Khatri<sup>1</sup>, Anshul Gaur<sup>2</sup>, Debapriya Sarkar<sup>3</sup>

<sup>1</sup>Postgraduate Resident, Department of Anaesthesiology and Critical Care, Santosh Medical College & Hospital, Ghaziabad, Uttar Pradesh, India

<sup>2</sup>Assistant Professor, Department of Anaesthesiology and Critical Care, Santosh Medical College & Hospital, Ghaziabad, Uttar Pradesh, India

<sup>3</sup>Associate Professor, Department of Anaesthesiology and Critical Care, Santosh Medical College & Hospital, Ghaziabad, Uttar Pradesh, India

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### Corresponding Author:

**Dr. Garvita Khatri**

Postgraduate Resident,  
Department of Anaesthesiology  
and Critical Care, Santosh Medical  
College & Hospital, Ghaziabad,  
Uttar Pradesh, India

Email: [garvita21@gmail.com](mailto:garvita21@gmail.com)

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### ABSTRACT

**Background:** Procalcitonin (PCT) has long been considered as a biomarker to guide diagnosis, monitoring, and antimicrobial stewardship in sepsis. Despite international evidence supporting its role, data on awareness and utilization among Indian intensivists are limited.

**Objective:** To evaluate the knowledge, attitudes, and practices of Indian clinicians regarding PCT use in sepsis management and to identify barriers to its routine adoption.

**Methods:** A web-based cross-sectional survey comprising 16 structured questions was disseminated to intensivists across India in the month of September, 2025. The questionnaire assessed respondent demographics, knowledge of PCT physiology and guidelines, attitudes toward its reliability, current usage practices, and perceived barriers. Responses were analysed using descriptive statistics. Ethical approval was obtained from the Institutional Ethics Committee.

**Results:** A total of 153 clinicians responded, predominantly from Anaesthesia and Critical Care backgrounds, with a balanced distribution of ICU experience levels. 81.7% reported 24/7 access to PCT testing. While most recognized bacterial infections as the principal trigger and identified  $<0.05$  ng/mL as the normal reference, guideline awareness was variable. The mean reliability score was 3.56/5 (median 4), and 79.1% agreed that PCT improves antimicrobial stewardship. Over 73.2% ordered PCT routinely, though serial monitoring was largely selective. 83.3% reported stopping antibiotics based on PCT trends. Major barriers included high cost (56.9%), limited turnaround time (34.6%), and interpretation challenges in CKD and immunocompromised patients (20.3%). Importantly, over 90% recommended routine PCT use in ICU practice, though many expressed reservations about cost and standardization.

**Discussion:** PCT is perceived as a useful adjunct in sepsis care, mainly for antibiotic de-escalation, but inconsistent practices and significant barriers limit its wider adoption in Indian ICUs.

**Conclusions:** There is an urgent need for national protocols, cost-effective and rapid assays, and clinician training to optimize PCT integration into sepsis management and stewardship programs in India.

**Keywords:** Procalcitonin (PCT), Sepsis, Antimicrobial Stewardship Intensive Care Unit (ICU), Knowledge, Attitudes, and Practices (KAP) Survey.

### INTRODUCTION

Procalcitonin (PCT) has emerged as an important biomarker in the diagnosis and management of sepsis, serving as a valuable tool for early identification of bacterial infections, assessment of disease severity, and guidance of antimicrobial

therapy. Its rapid rise in response to systemic bacterial infections, relative suppression in viral illnesses, and correlation with severity of organ dysfunction make it particularly useful in critical care settings where timely decision-making is crucial. [1] Over the past two decades, global evidence has consistently demonstrated that PCT-guided protocols can reduce unnecessary antibiotic exposure, support antimicrobial stewardship, and help clinicians stratify patients based on risk, thereby improving outcomes and optimizing resource utilization. [2] Despite this robust evidence base, real-world adoption of PCT varies widely across countries due to differences in cost, availability, clinician familiarity, and local clinical guidelines.

In India, where sepsis remains a major contributor to ICU mortality, the potential utility of PCT is especially relevant. The high burden of infectious diseases, rising antimicrobial resistance, and heterogeneity in healthcare infrastructure further highlight the importance of reliable biomarkers such as PCT in improving diagnostic precision and therapeutic decision-making. [3-4] However, the extent to which Indian intensivists understand, trust, and implement PCT-based strategies in their daily practice remains poorly characterized. clinicians' knowledge and attitudes strongly influence biomarker utilization, yet data specific to PCT awareness, perceived benefits, limitations, and practice patterns among Indian critical care physicians are limited. Hence, this study seeks to assess the knowledge, attitudes, and practices of Indian intensivists regarding the use of PCT in sepsis management.

## MATERIAL AND METHODS

The present study was designed as a web-based cross-sectional survey conducted among intensivists practicing across India. A structured questionnaire containing 16 close-ended items was developed to assess clinicians' knowledge of procalcitonin physiology, interpretation, and sepsis guidelines, along with their attitudes regarding its reliability and utility in clinical decision-making. The survey also explored current practice patterns related to PCT-guided diagnosis, monitoring, and antibiotic stewardship, as well as perceived barriers to its routine use. The questionnaire link was disseminated electronically through professional networks and critical care forums during September 2025. Only practicing intensivists willing to participate were included. Responses were collected anonymously, compiled in a secure database, and analysed using descriptive statistics. Institutional Ethics Committee approval was obtained prior to data collection.

## RESULTS

The study included 153 participants from diverse medical specialties. The majority were from Anaesthesia and Critical Care (59.5%), followed by Internal Medicine (15.0%) and Pulmonary Medicine and Critical Care (11.1%), while other specialties such as Emergency Medicine (8.5%), Cardiology, Cardiac Surgery, Gynaecology, Microbiology, Paediatric Critical Care, Pharmacology, and RMO contributed less than 2% each.

With regard to professional experience, 65.4% had less than 5 years, while 17.6% had 5–10 years and 17.0% had more than 10 years of clinical experience.

In terms of workplace, Private/Corporate hospitals accounted for the largest share (52.9%), followed by Teaching Institutes (35.3%) and Government hospitals (11.8%).

Access to procalcitonin (PCT) testing in ICUs was high, with 81.7% reporting 24/7 availability, 17.0% having limited or delayed access, and only 1.3% with no access at all.

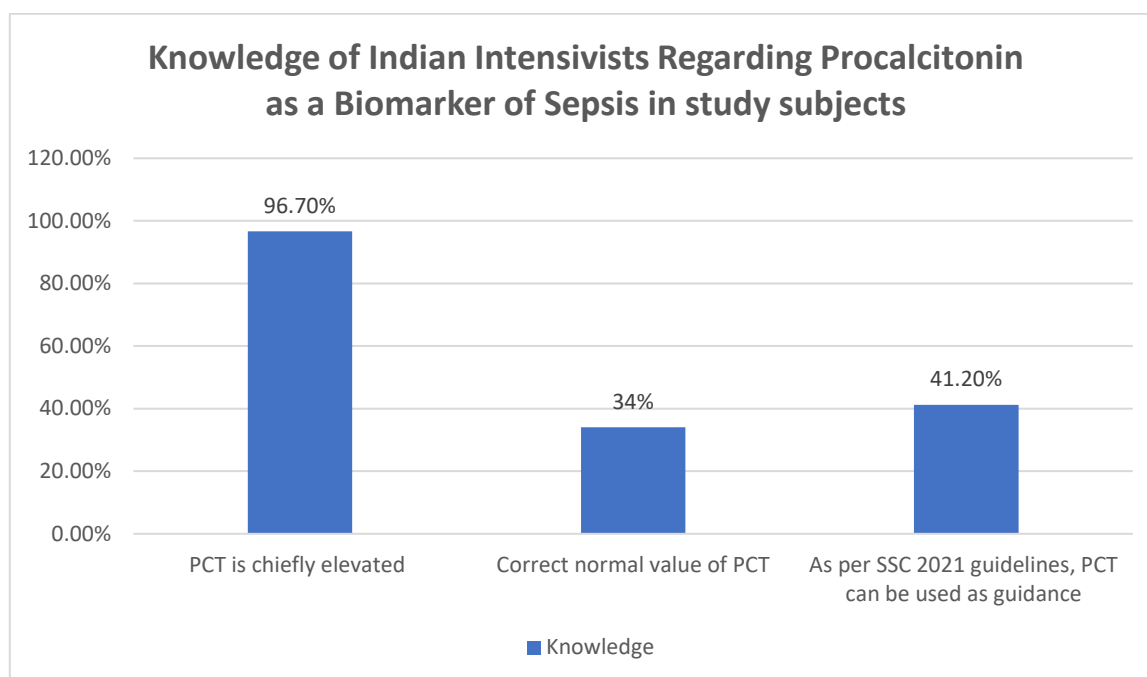
**Table 1 : Knowledge of Indian Intensivists Regarding Procalcitonin as a Biomarker in study subjects (n=153)**

|                                                                    |                                                         | No. | %     |
|--------------------------------------------------------------------|---------------------------------------------------------|-----|-------|
| <b>PCT is chiefly elevated in</b>                                  | Bacterial infections                                    | 148 | 96.7% |
|                                                                    | Others                                                  | 5   | 3.3%  |
| <b>Normal Value of PCT</b>                                         | <0.05 ng/mL                                             | 68  | 44.4% |
|                                                                    | <0.5 ng/mL                                              | 52  | 34.0% |
|                                                                    | <1.0 ng/mL                                              | 33  | 21.6% |
| <b>As per SSC 2021 guidelines, PCT can be used as guidance for</b> | Both initiation and de-escalation of antibiotic therapy | 53  | 34.6% |
|                                                                    | De-escalation of antibiotic therapy                     | 63  | 41.2% |
|                                                                    | Diagnosing sepsis                                       | 26  | 17.0% |
|                                                                    | Initiation of antibiotic therapy                        | 11  | 7.2%  |

The majority of intensivists (96.7%) correctly identified bacterial infections as the primary condition in which procalcitonin (PCT) is elevated, while a small proportion (3.3%) attributed it to other causes.

Regarding the normal reference value of PCT, 44.4% reported <0.05 ng/mL, 34.0% cited <0.5 ng/mL, and 21.6% mentioned <1.0 ng/mL, reflecting variability in knowledge about cut-off levels.

As per the Surviving Sepsis Campaign (SSC) 2021 guidelines, most participants (41.2%) recognized the role of PCT in antibiotic de-escalation, while 34.6% reported its use for both initiation and de-escalation of antibiotic therapy. A smaller proportion considered its role in diagnosing sepsis (17.0%) or initiation of antibiotic therapy alone (7.2%).



**Table 2: Attitude of Indian Intensivists Regarding Procalcitonin as a Biomarker in study subjects (n=153)**

|                                                                                            |                                      | No. | %    |
|--------------------------------------------------------------------------------------------|--------------------------------------|-----|------|
| <b>How reliable do you consider PCT as a biomarker of sepsis*</b>                          | 0                                    | 5   | 3.3  |
|                                                                                            | 1                                    | 6   | 3.9  |
|                                                                                            | 2                                    | 11  | 7.2  |
|                                                                                            | 3                                    | 40  | 26.1 |
|                                                                                            | 4                                    | 57  | 37.3 |
|                                                                                            | 5                                    | 34  | 22.2 |
| <b>What do you believe is the most important role of PCT in clinical practice?</b>         | Initiating antibiotics               | 24  | 15.7 |
|                                                                                            | Not very useful in my practice       | 1   | 0.7  |
|                                                                                            | Prognostication (Severity/Mortality) | 28  | 18.3 |
|                                                                                            | Stopping/de-escalating antibiotics   | 100 | 65.4 |
| <b>Do you think incorporating PCT-guided protocols improves antimicrobial stewardship?</b> | Strongly disagree                    | 3   | 2.0  |
|                                                                                            | Disagree                             | 5   | 3.3  |
|                                                                                            | Neutral                              | 24  | 15.7 |
|                                                                                            | Agree                                | 84  | 54.9 |
|                                                                                            | Strongly agree                       | 37  | 24.2 |

On a reliability scale of 0–5 (with 5 being most reliable), 37.3% of intensivists rated PCT as 4, while 22.2% rated it as 5, and 26.1% rated it as 3, indicating that the majority considered PCT a fairly reliable biomarker of sepsis. A smaller proportion gave lower ratings (7.2% rated 2, 3.9% rated 1, and 3.3% rated 0).

When asked about the most important role of PCT in clinical practice, the majority (65.4%) reported its use for stopping or de-escalating antibiotics, followed by prognostication in terms of severity/mortality (18.3%), and initiating antibiotics (15.7%). Only 0.7% felt it was not very useful in their practice.

Most intensivists agreed that incorporating PCT-guided protocols improves antimicrobial stewardship, with 54.9% agreeing and 24.2% strongly agreeing. A smaller fraction remained neutral (15.7%), while only 3.3% disagreed and 2.0% strongly disagreed.

**Table 3: Practice of Indian Intensivists Regarding Procalcitonin as a Biomarker in study subjects (n=153)**

|                                                                                                           |                             | No. | %    |
|-----------------------------------------------------------------------------------------------------------|-----------------------------|-----|------|
| <b>How often do you use PCT testing in your critical care practice?</b>                                   | Occasionally                | 38  | 24.8 |
|                                                                                                           | Rarely                      | 3   | 2.0  |
|                                                                                                           | Routinely                   | 112 | 73.2 |
| <b>How often do you repeat PCT testing in your ICU?</b>                                                   | 48 hourly                   | 39  | 25.5 |
|                                                                                                           | Based on clinical judgement | 106 | 69.3 |
|                                                                                                           | Daily                       | 8   | 5.2  |
| <b>Have you ever stopped antibiotics based on PCT levels (Alone or combined with clinical judgement)?</b> | No                          | 21  | 13.7 |
|                                                                                                           | Yes, frequently             | 60  | 39.2 |
|                                                                                                           | Yes, occasionally           | 72  | 47.1 |
| <b>In which patient subgroup do you find PCT interpretation most challenging?</b>                         | All of the above            | 109 | 71.2 |
|                                                                                                           | CKD/ESRD                    | 12  | 7.8  |
|                                                                                                           | Immunocompromised           | 22  | 14.4 |
|                                                                                                           | Post-Op patients            | 3   | 2.0  |

The majority of intensivists (73.2%) reported using PCT testing routinely in their critical care practice, while 24.8% used it occasionally and only 2.0% rarely used it.

Regarding repeat testing, most relied on clinical judgment (69.3%), whereas 25.5% repeated testing every 48 hours and 5.2% performed daily testing.

When asked about antibiotic stewardship, 86.3% of respondents reported having stopped antibiotics based on PCT levels—either occasionally (47.1%) or frequently (39.2%)—while 13.7% had never done so.

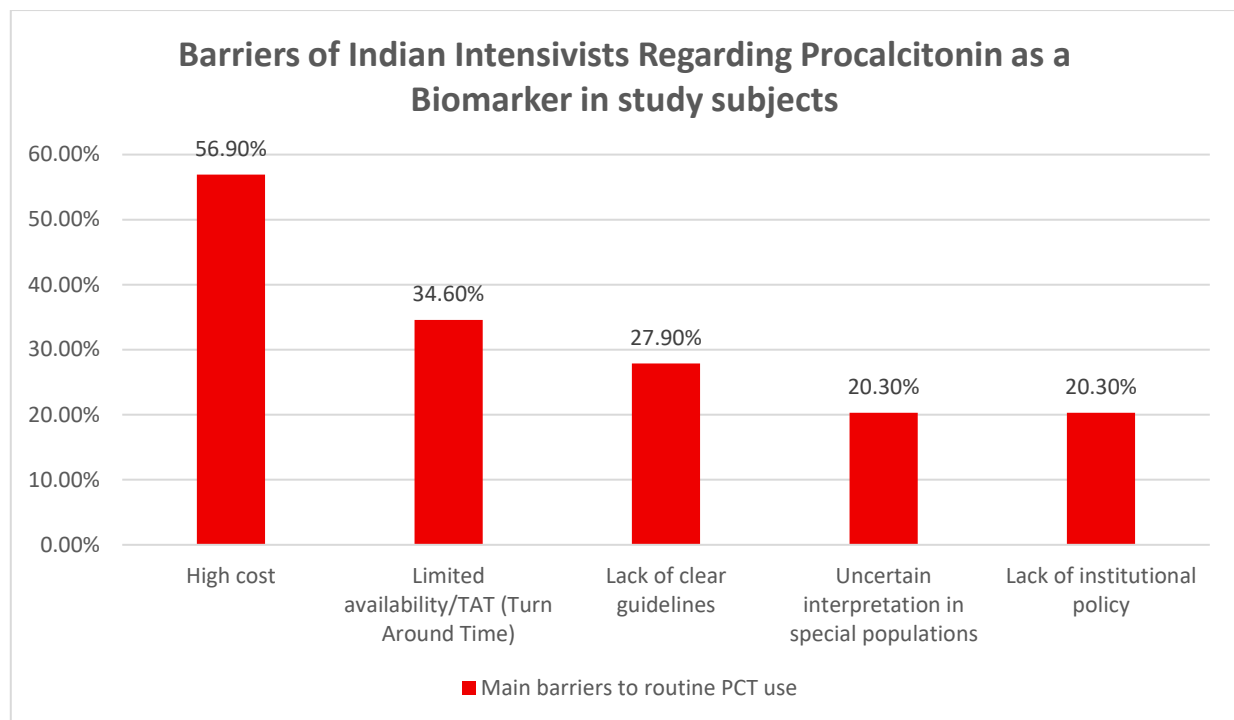
The most challenging subgroup for PCT interpretation was reported as “all of the above” (71.2%), indicating difficulty across multiple patient categories, followed by immunocompromised patients (14.4%), CKD/ESRD patients (7.8%), and post-operative patients (2.0%).

**Table 4: Barriers of Indian Intensivists Regarding Procalcitonin as a Biomarker in study subjects (n=153)**

|                                                                                                |                                                 | No. | %     |
|------------------------------------------------------------------------------------------------|-------------------------------------------------|-----|-------|
| <b>What are the main barriers to routine PCT use in your practice? (Select all that apply)</b> | High cost                                       | 87  | 56.9% |
|                                                                                                | Limited availability/TAT (Turn Around Time)     | 53  | 34.6% |
|                                                                                                | Lack of clear guidelines                        | 51  | 27.9% |
|                                                                                                | Uncertain interpretation in special populations | 31  | 20.3% |
|                                                                                                | Lack of institutional policy                    | 31  | 20.3% |
| <b>Would you recommend routine PCT use in similar ICU settings?</b>                            | No                                              | 5   | 3.3%  |
|                                                                                                | Yes, but with reservations                      | 79  | 51.6% |
|                                                                                                | Yes, strongly                                   | 69  | 45.1% |

The most frequently cited barrier to routine PCT use was its high cost (56.9%), followed by limited availability or delayed turnaround time (34.6%), lack of clear guidelines (27.9%), and challenges with interpretation in special populations (20.3%). An equal proportion (20.3%) also reported the absence of institutional policy as a barrier.

Despite these limitations, the majority of intensivists expressed support for PCT use, with 45.1% strongly recommending and 51.6% recommending with reservations its routine use in similar ICU settings. Only a small minority (3.3%) did not recommend its use.



## DISCUSSION

This cross-sectional survey provides important insights into the knowledge, attitudes, and practice patterns of Indian intensivists regarding the use of procalcitonin (PCT) in sepsis management. With sepsis continuing to carry a high burden of morbidity and mortality in India, the appropriate utilization of biomarkers such as PCT has the potential to significantly influence early diagnosis, therapeutic decisions, and antimicrobial stewardship.[5] The findings of the present study reveal a generally positive outlook toward PCT among clinicians, although several barriers still hinder its universal adoption.

The overwhelming majority of participants correctly identified bacterial infections as the main condition associated with elevated PCT levels. This correlates well with the established literature indicating that PCT rises rapidly in the presence of systemic bacterial infections and correlates strongly with sepsis severity [6]. The relatively high recognition of PCT's diagnostic and prognostic value suggests that clinicians are aware of its biochemical behaviour, including suppression during viral infections and reduction following recovery. Such awareness is essential for appropriate test interpretation and reinforces PCT's role in clinical differentiation between bacterial and non-bacterial etiologies.

Most intensivists rated PCT as moderately to highly reliable, consistent with previous research demonstrating the clinical robustness of PCT-guided strategies for improving diagnostic confidence and risk stratification [2,7]. Furthermore, a significant proportion acknowledged PCT's role in antibiotic de-escalation, aligning with global antimicrobial stewardship guidelines that recommend PCT to reduce unnecessary antibiotic exposure without compromising patient safety [8]. The high proportion of participants reporting routine use of PCT and frequent reliance on serial measurements highlights the integration of PCT into everyday ICU practice. Existing evidence indicates that serial PCT trends offer better prognostic utility than single measurements, particularly for predicting treatment failure and mortality [4].

Despite this favourable trend, the survey underscores persistent barriers. The most prominent challenge identified was the high cost of PCT testing—a considerable concern in low- and middle-income countries where resource allocation remains constrained. This finding is consistent with earlier studies from similar healthcare settings, where affordability directly influences biomarker adoption [3]. Additional barriers such as limited availability, delayed turnaround time, and absence of institutional protocols reflect variability in hospital infrastructure and the need for more uniform healthcare policies. These issues suggest that while clinicians value PCT, systemic factors limit its full integration into clinical pathways.

Interestingly, experience-based analysis showed a statistically significant difference only in the understanding of normal PCT reference values. More experienced clinicians correctly identified  $<0.5$  ng/mL as the threshold more frequently, indicating that clinical exposure and familiarity enhance interpretive accuracy. However, attitudes and practice-related behaviours did not differ significantly between experience groups, demonstrating that PCT has achieved widespread acceptance across the spectrum of ICU physicians.

Overall, the study highlights that Indian intensivists possess strong knowledge and demonstrate favourable attitudes toward PCT use. Widespread adoption of PCT-guided protocols, particularly for antibiotic de-escalation, reflects alignment with

international stewardship practices. Nevertheless, addressing cost-related and logistical barriers, along with developing standardized national guidelines, will be crucial to ensuring optimal and equitable use of PCT in sepsis management across India.

## CONCLUSION

This study shows that most Indian intensivists have good knowledge and a positive attitude toward procalcitonin use in sepsis care. PCT is widely perceived as a reliable biomarker, especially for guiding antibiotic de-escalation and improving antimicrobial stewardship. Routine use is common, and many clinicians modify treatment based on PCT levels. However, high cost, limited availability, and lack of clear institutional protocols remain major barriers. Overall, PCT is well-accepted, but addressing practical challenges is essential for its wider and more consistent implementation in critical care settings.

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