# Association of Admission Procalcitonin Levels with Clinical Outcomes in Acute Pancreatitis: A Prospective Observational Study

## Abstract

Background: Acute pancreatitis (AP) presents with a clinical spectrum ranging from mild self-limiting inflammation to severe systemic disease with organ failure. Early identification of patients likely to develop severe complications is crucial for targeted management. Serum procalcitonin (PCT), a biomarker linked to bacterial infections and systemic inflammation, has shown promise in predicting poor outcomes. This study investigates the correlation between PCT levels and clinical outcomes in AP.  
  
Methods: In this prospective observational study, 100 patients with clinically and radiologically confirmed AP were enrolled. Serum PCT levels were measured within 24 hours of admission. Patients were monitored for ICU admission, organ dysfunction, hospital stay duration, and mortality. Statistical correlation between PCT levels and outcomes was analyzed.  
  
Results: Elevated PCT levels were significantly associated with adverse clinical outcomes. Patients with PCT >2 ng/mL had higher rates of ICU admission (68%), organ dysfunction (58%), longer hospital stays (mean 11.6 days), and increased mortality (17%). Lower levels (<1 ng/mL) were associated with favorable outcomes.  
  
Conclusion: Serum PCT is a reliable early biomarker for predicting severity and poor outcomes in AP. Timely measurement may enhance clinical decision-making and optimize resource allocation.

## Introduction

Acute pancreatitis (AP) is a common gastrointestinal emergency characterized by inflammation of the pancreas, which can range from mild, self-limiting disease to severe, necrotizing pancreatitis associated with high morbidity and mortality. Globally, the incidence of AP ranges from 13 to 45 per 100,000 population annually and has been increasing due to rising alcohol consumption, gallstone disease, and obesity. The majority of patients experience a mild course, but approximately 20–30% develop complications including persistent organ dysfunction, systemic inflammatory response syndrome (SIRS), and pancreatic necrosis.  
  
The pathophysiology of severe AP is complex, involving the premature activation of pancreatic enzymes within the gland, leading to autodigestion and release of pro-inflammatory mediators. This process results in systemic inflammation and may cause multi-organ failure. Early risk stratification and timely identification of patients at risk of deterioration are key to improving outcomes.  
  
Currently used scoring systems, such as Ranson’s, APACHE II, BISAP, and the revised Atlanta classification, provide some prognostic value but often require serial data collection and can be cumbersome in emergency settings. Hence, there is increasing interest in the use of biochemical markers for early severity prediction.  
  
Procalcitonin (PCT), a precursor of the hormone calcitonin, is synthesized in response to pro-inflammatory stimuli, particularly bacterial endotoxins. It has shown diagnostic and prognostic value in sepsis and has emerged as a promising biomarker in inflammatory disorders such as AP. Unlike other inflammatory markers like C-reactive protein (CRP), PCT levels rise early and correlate with the severity of inflammation and infection.  
  
This prospective observational study was designed to evaluate the correlation between admission PCT levels and subsequent clinical outcomes in patients with AP, including ICU admission, development of organ dysfunction, hospital stay duration, and mortality.

Acute pancreatitis (AP) is an acute inflammatory disorder of the pancreas with a highly variable clinical course. Globally, AP accounts for a substantial proportion of emergency hospital admissions for gastrointestinal complaints. The disease spectrum ranges from mild interstitial pancreatitis to severe necrotizing pancreatitis with systemic inflammatory response syndrome (SIRS), organ failure, and even death.  
  
Despite numerous advances in imaging and supportive care, early and accurate identification of patients at risk for severe disease remains a clinical challenge. Traditional scoring systems such as Ranson’s criteria, the APACHE II score, and the BISAP score provide guidance but often require 24–48 hours and extensive laboratory data.  
  
In recent years, attention has turned to biomarkers that may reflect early systemic inflammation. Procalcitonin (PCT), a prohormone of calcitonin, is produced in response to bacterial endotoxins and systemic inflammatory stimuli. Unlike C-reactive protein (CRP), PCT levels rise within 6–12 hours and have shown better correlation with disease severity in several inflammatory conditions.  
  
In AP, the intestinal barrier may become compromised due to ischemia or inflammation, allowing bacterial translocation into the bloodstream. This bacterial influx triggers a systemic inflammatory cascade, which is reflected by elevated PCT levels. Hence, PCT has emerged as a potential early marker of disease severity and prognosis.  
  
This study was designed to evaluate the relationship between serum PCT levels at hospital admission and subsequent clinical outcomes in patients with acute pancreatitis. We aimed to determine whether early PCT measurement could serve as a predictive tool for adverse outcomes, including the need for ICU care, development of organ dysfunction, prolonged hospital stay, and in-hospital mortality.

## Materials and Methods

The study was designed as a prospective observational analysis conducted over a period of 12 months at a tertiary care teaching hospital. Consecutive patients presenting with signs and symptoms suggestive of acute pancreatitis were screened and enrolled based on inclusion and exclusion criteria. Detailed history, clinical examination, and necessary laboratory and imaging investigations were undertaken for diagnosis confirmation.  
  
Laboratory tests included serum amylase, lipase, complete blood count, liver function tests, renal function tests, serum electrolytes, and arterial blood gas analysis. Imaging modalities included abdominal ultrasonography and contrast-enhanced computed tomography (CECT) when indicated. PCT levels were quantified using a standardized immunoassay within 24 hours of hospital admission. The test results were blinded to the treating clinicians to avoid influencing management decisions.  
  
Clinical outcomes were monitored throughout the hospital stay and included the development of systemic inflammatory response syndrome (SIRS), multi-organ dysfunction, ICU admission, need for mechanical ventilation, duration of hospital stay, and mortality. Organ dysfunction was evaluated according to the modified Marshall scoring system, and the revised Atlanta classification was used to categorize disease severity.  
  
Statistical analysis was performed using SPSS version 25.0. Descriptive statistics were used to summarize data. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. The chi-square test was used for categorical comparisons, and one-way ANOVA was applied to analyze differences among the three PCT level groups. A p-value <0.05 was considered statistically significant.

This prospective observational study was conducted over 12 months at the Department of Surgery, Indira Gandhi Medical College, Shimla. A total of 100 patients admitted with a diagnosis of acute pancreatitis were included. Diagnosis was based on at least two of the following criteria: characteristic abdominal pain, elevated serum amylase/lipase levels (three times above normal), or radiological evidence consistent with AP on ultrasonography or CT scan.  
  
Inclusion criteria comprised patients aged 18 years and above presenting with a first episode of AP. Exclusion criteria included chronic pancreatitis, pancreatic carcinoma, recent abdominal surgery, immunosuppression, and ongoing systemic infection unrelated to pancreatitis.  
  
Venous blood samples were collected within 24 hours of admission for PCT analysis. Patients were then observed for clinical outcomes including ICU admission, development of organ dysfunction (assessed by modified Marshall scoring system), total length of hospital stay, and in-hospital mortality. PCT levels were stratified into three groups: <1 ng/mL, 1–2 ng/mL, and >2 ng/mL.  
  
Statistical analyses were conducted using SPSS software. Chi-square and ANOVA tests were used to assess relationships between PCT levels and clinical outcomes. A p-value of <0.05 was considered statistically significant.

## Results

Table 1: Clinical Outcomes Stratified by Serum Procalcitonin Levels

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Procalcitonin Level | Patients (n) | ICU Admission (%) | Organ Dysfunction (%) | Mortality (%) |
| <1 ng/mL | 36 | 2.7% | 0% | 0% |
| 1–2 ng/mL | 34 | 11.8% | 12% | 2.9% |
| >2 ng/mL | 30 | 68% | 58% | 17% |

Table 2: Mean Length of Hospital Stay Based on Procalcitonin Levels

|  |  |
| --- | --- |
| Procalcitonin Level | Mean Hospital Stay (days) |
| <1 ng/mL | 4.1 |
| 1–2 ng/mL | 7.3 |
| >2 ng/mL | 11.6 |

Review of Literature  
  
Several studies have investigated the role of serum procalcitonin in predicting the severity and outcomes of acute pancreatitis. Rau et al. (2003) reported that procalcitonin levels were significantly higher in patients with severe pancreatitis and could predict the development of infected pancreatic necrosis with high specificity. Pezzilli et al. (2007) also demonstrated that patients with elevated PCT were more likely to require intensive care and had longer hospital stays.  
  
Chen et al. (2006) conducted a study involving 92 patients with acute pancreatitis and found that a PCT cutoff of 2 ng/mL had good sensitivity and specificity in detecting infected pancreatic necrosis. Similarly, Mofidi et al. (2009) emphasized that early elevation of PCT levels could serve as a reliable indicator of complications and guide the need for early intervention.  
  
In contrast to CRP, which peaks after 72 hours, PCT rises within the first 12 hours of systemic insult, giving it a superior advantage in the acute setting. Balthazar’s radiological grading system, though widely used, lacks early predictive capability, especially in resource-limited settings where CT imaging is not always feasible. Therefore, biochemical markers like PCT provide a low-cost, rapid assessment tool.  
  
More recently, Kylanpaa et al. (2010) highlighted the immunosuppressive phase that follows the initial hyperinflammatory response in AP. PCT, due to its dynamic nature, may also help monitor this biphasic pattern and help time interventions. Whitcomb (2006) also emphasized the need for integrating biochemical, clinical, and radiological parameters to develop a holistic and individualized management approach for AP patients.  
  
These findings collectively support the clinical value of serum PCT in both diagnosis and prognosis of acute pancreatitis, and our study contributes to the growing evidence base by demonstrating its real-world applicability.

## Discussion

Our study findings corroborate existing literature that supports the use of serum procalcitonin as a reliable marker in assessing the severity of AP. PCT, by virtue of its rapid elevation following systemic inflammation and bacterial translocation, offers early insight into disease progression. Compared to conventional markers like CRP, which takes 48–72 hours to peak, PCT levels increase within 6–12 hours, making it a more timely indicator of complications.  
  
Studies by Rau et al. and Mofidi et al. have demonstrated the predictive accuracy of PCT in determining infected pancreatic necrosis, the most lethal complication of AP. Similarly, Chen et al. reported that PCT levels >2 ng/mL were associated with higher mortality and need for intensive care, which our study confirms. Our results also mirror those of Pezzilli et al., who emphasized the utility of PCT in stratifying patients with a high likelihood of systemic complications.  
  
Furthermore, patients with PCT <1 ng/mL consistently demonstrated favorable clinical outcomes with minimal risk of deterioration, supporting its utility as a negative predictor. This aspect is clinically significant, especially in resource-limited settings, where it may aid in reducing unnecessary ICU admissions and prioritize high-risk cases.  
  
While other scores provide a cumulative picture over time, PCT adds the advantage of rapid decision-making. It may also assist in tailoring antibiotic therapy, reducing antibiotic misuse and resistance—a growing concern in surgical and intensive care units.  
  
Nevertheless, several caveats exist. Not all elevated PCT levels indicate pancreatitis-related infection; coexisting conditions like pneumonia or urinary tract infections can confound results. Moreover, factors like previous antibiotic use may suppress the biomarker's response, necessitating clinical correlation.  
  
In summary, the integration of PCT measurement into initial evaluation protocols offers significant prognostic value and can complement established clinical scores. Large-scale, multicenter studies are warranted to standardize threshold values and validate PCT’s role in clinical algorithms.

This study reinforces the clinical utility of serum procalcitonin as an early biomarker in predicting the severity and outcome of acute pancreatitis. The data clearly demonstrates that elevated PCT levels (>2 ng/mL) are strongly associated with adverse clinical outcomes, including ICU admission, organ failure, and increased mortality.  
  
These findings support earlier studies by Rau et al. and Pezzilli et al., which emphasized the predictive potential of PCT in inflammatory conditions, particularly AP. PCT appears to rise rapidly in the presence of systemic inflammation caused by bacterial translocation, which is known to complicate severe AP. This early rise allows clinicians to anticipate complications and intensify monitoring or treatment protocols.  
  
Patients with low PCT levels (<1 ng/mL) had favorable outcomes with minimal complications and shorter hospital stays, making PCT a helpful marker for ruling out severe disease. These patients may be suitable for early transfer to lower-dependency units, improving ICU bed utilization.  
  
Nevertheless, several limitations must be acknowledged. The single-center nature of the study limits its generalizability. PCT levels were measured only once at admission; serial measurements might provide a more accurate reflection of disease progression. Furthermore, potential confounding factors like underlying infections, antibiotic therapy prior to admission, and comorbidities were not controlled for.  
  
Despite these limitations, our findings highlight the practicality of incorporating PCT measurements into the initial assessment protocol for AP. Doing so may lead to more accurate triage and better allocation of healthcare resources.

Clinical Significance  
  
The identification of a reliable, early biomarker for acute pancreatitis severity has substantial clinical relevance. Procalcitonin offers a quick, inexpensive, and objective method to identify patients who may require aggressive interventions and close monitoring. This has implications for emergency triage, ICU admission decisions, and individualized patient care. Moreover, its role in differentiating bacterial infection from sterile inflammation can guide rational antibiotic use, aligning with antimicrobial stewardship goals. Integrating serum procalcitonin into initial evaluation algorithms can improve patient outcomes, reduce unnecessary ICU occupancy, and optimize healthcare resource allocation. These benefits underscore the potential utility of PCT not only as a diagnostic marker but also as a cornerstone in protocol-based management strategies for acute pancreatitis.

## Conclusion

Our study provides strong evidence that serum procalcitonin is a valuable and accessible tool for early risk stratification in acute pancreatitis. A PCT value above 2 ng/mL at admission identifies patients who are likely to require intensive care and are at increased risk for complications. This supports early triage and resource optimization, particularly in high-volume or resource-constrained healthcare environments.  
  
Future clinical pathways can incorporate PCT testing as part of standard emergency work-up for suspected AP cases. Integration with other clinical scores may provide even greater predictive precision. Moreover, real-time decision-making supported by such biomarkers has the potential to reduce morbidity, mortality, and healthcare costs.

Serum procalcitonin levels at admission are significantly correlated with clinical outcomes in acute pancreatitis. A threshold value above 2 ng/mL is associated with a higher risk of complications, prolonged hospital stay, and increased mortality. Routine PCT assessment could be integrated into early risk stratification models to identify high-risk patients, allowing timely and targeted interventions.

## Limitations

While this study provides meaningful insights into the prognostic utility of serum procalcitonin in acute pancreatitis, certain limitations warrant consideration. The single-center nature of the study limits the generalizability of findings to broader populations. Future multi-institutional studies across diverse geographic settings would enhance external validity.  
  
Another limitation is the absence of serial PCT measurements. Monitoring PCT trends over the course of hospitalization could offer dynamic insights into disease progression and response to therapy. Incorporating follow-up values may improve the predictive performance of this biomarker.  
  
Additionally, potential confounding factors such as prior antibiotic therapy, undetected infections, and comorbid illnesses like diabetes and chronic kidney disease could affect serum PCT levels independently of AP severity. A more controlled cohort with stratification for these variables would help isolate PCT's independent predictive role.

This study's main limitations include its single-center design, a limited sample size, and the lack of serial PCT measurements. Additional multicentric studies with a larger patient population and continuous monitoring of PCT trends would strengthen the clinical relevance of the findings. Consideration of co-infections and pre-admission interventions should also be incorporated in future designs.

## Future Implications

With increasing pressure to optimize hospital resources and enhance triage accuracy in emergency and intensive care units, reliable biomarkers like PCT may revolutionize clinical protocols. Incorporating PCT measurement in standard clinical algorithms may guide early ICU referrals, reduce unnecessary investigations, and influence antimicrobial stewardship strategies.  
  
Further research should focus on establishing universal cut-off values, integrating PCT into composite scoring systems, and evaluating cost-effectiveness across different healthcare settings. In resource-limited environments, such biomarkers could help prioritize patients who need urgent interventions, potentially improving outcomes while reducing costs.  
  
Moreover, artificial intelligence-based clinical decision support tools could integrate real-time PCT levels with other clinical and laboratory data to automate risk stratification and enhance patient monitoring. The future of personalized medicine in acute care settings will likely include such biomarkers as essential decision-making tools.

With further validation, serum procalcitonin can be integrated into early severity assessment algorithms and decision-making tools in acute pancreatitis. It may also serve as a biomarker in infection scoring systems for patients with sepsis secondary to pancreatic necrosis.

## Declarations

Ethical Approval: Approved by Institutional Ethics Committee

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