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Research Article

# Optimizing Strategies for Sepsis Management: Lessons from Al-Najaf Teaching Hospital

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## ABSTRACT

**Background:** Every year, sepsis is the most common cause of death in hospitalized individuals. Various studies have investigated whether a procalcitonin-guided protocol could optimize the therapeutic approaches in sepsis patients. The evaluation of procalcitonin is a predictive marker for sepsis in individuals admitted to the emergency room or intensive care unit.
**Methods:** Cross-sectional observational analysis was conducted in the anesthesia department and intensive care unit. It included 100 adult patients enrolled in this study within inclusion criteria for those who have sepsis and septic shock and were admitted to intensive care. A diagnosis of sepsis was taken in a patient with suspected or proven infection. Blood samples from peripheral blood were collected from all patients at admission to measure procalcitonin levels. Follow-up continued until the outcome was determined as discharged well, morbidity occurred, or death was documented.
**Results:** The higher source of infection was due to a wound (23%). About 55 of the studied patients have a GCS between 13 - 15. The average procalcitonin level when patients were admitted was much higher in those who died or had complications compared to those who were discharged in good health, with a key level of 17.0 µg/L.
**Conclusion:** Patients with sepsis and other markers can use procalcitonin as a prognostic factor. Lower PCT levels were significantly associated with favourable prognosis.

## Introduction

Sepsis is a term used in medicine to describe the body's immune reaction to an infectious process that can cause end-organ malfunction and death. It continues to be a significant factor in the morbidity and death of patients in intensive care units (ICUs) [1]. Septic shock is a severe form of sepsis characterized by persistently low blood pressure, even after the administration of intravenous fluids [2]. One to two percent of all hospitalized patients and about 25% of ICU patients have sepsis. The incidence, morbidity, and mortality rates are probably underestimated [3] because sepsis is rarely documented as a primary diagnosis. Additionally, up to 25% of those patients who have severe sepsis, while 50% of individuals who have septic shock, will die [4]. Yet, all sepsis syndromes' mortality

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rates can vary from 30% to 50% [5]. Many factors can increase a patient's chances of getting sepsis, especially if they have weakened immune systems. These factors include being very young or old, having diabetes, using corticosteroids, experiencing trauma or major surgery, having cancer, suffering from chronic kidney or liver disease, having burns, using indwelling catheters, and being in the hospital for a long time. [6]. The early identification of individuals with a poor prognosis and an elevated risk of death is crucial because of its role in the prevention of further multiorgan dysfunction and the ensuing increasing risk of complications and patient mortality [7]. The peptide precursor to the calcitonin hormone is called procalcitonin (PCT). The amount of PCT increases because of the inflammatory stimulus, particularly one with an origin from bacteria. As a result, it’s mostly designated as an acute phase reactant [8]. Many studies have explored whether using a PCT-guided plan could enhance treatment for people with septic syndromes, mainly by monitoring PCT levels and stopping antibiotics when PCT drops below 0.5 ng/ml or by at least 80–90% from its highest point, along with signs of clinical improvement. [9]. Renal failure and a reduced GFR may lower PCT clearance, which could result in higher levels than anticipated in sepsis patients [10]. In children with unexplained fever, PCT can aid clinical decision-making by detecting invasive bacterial infection [11]. In pediatric patients with sepsis or urinary tract infections, PCT levels correlate with the severity of the illness, making it useful as a predictive laboratory test [12]. The study aims to assess PCT as an indicator of prognosis for sepsis in individuals who are hospitalized in the intensive care department or emergency room.

## Methods

### Study design, location, and duration

From June to December 2023, a cross-sectional observational analysis was done in the anesthesia department and critical care unit at Al-Najaf Teaching Hospital, Al-Najaf Health Directorate, Al-Najaf, Iraq. The study obtained ethics approval from the Ethical Committee of the Faculty of Medicine, Jabir Ibn Hayyan University for Medical and Pharmaceutical Sciences No.465 JMU- July 4, 2022).

### Study Population and sample size

100 adult individuals who were diagnosed with septic shock or severe sepsis and admitted from emergency rooms, hospitals, and operating rooms were included in the study. The study diagnosed sepsis based on modified American College of Chest Physicians/Society of Critical Care Medicine guidelines. A patient was judged to have sepsis if at least two or more of the below criteria were present in addition to the confirmed or suspected infection.

The criteria include temperature >38°C or <36°C; heart rate > 90 beats/minute; respiratory rate > 20 breaths/minute or $PaCO_2$ < 32 mmHg; and WBC count > 12,000 cells/mm3 or < 4000 cells/mm3 or > 10% immature (band) forms [13]. Patients with an immunocompromised state (malignancy), viral infection (respiratory virus and hepatitis virus A, B, or C), and patients with the terminal stage of any chronic disease (like cirrhosis) were excluded from the study.

Each patient completed an informed consent form allowing researchers to record information about them as long as the patient's identity and the privacy of their medical records are protected. When bacteria were cultured from the blood or the infection site, sepsis was categorized as microbiologically documented and clinically documented when symptoms and infection signs were present but the cultures were negative.

### Data collection

The information was gathered using a carefully designed questionnaire that included details about the person's age, gender, where they live, and their job, as well as their past medical and surgical history, any medications they were taking, the suspected cause of the infection, a full physical exam with vital signs (like temperature, blood pressure, consciousness level, breathing rate, and heart rate), and lab tests (samples were taken as soon as the patient was admitted to the ICU). After admission, all patients were requested to complete investigations including CBC, LFT, RFT, S. electrolytes, and coagulation profile with a part of two ml of blood for PCT assay. The blood sample was collected from peripheral blood, and blood and urine cultures were also requested before the antibiotic started. Radiological imaging was also requested. A series of samples, including PCT, requested through the duration of ICU admission, and the duration of hospital and ICU stay were documented. The treatment given includes addressing the infection's cause, using antibiotics based on the specific germs, providing measures to prevent ulcers, giving blood thinners, pain relief, sedation, feeding through tubes, correcting electrolyte levels, managing blood sugar, using long-term catheters (like central venous lines and arterial lines), monitoring fluid intake and output (including central venous pressure), supporting organs with mechanical ventilation and continuous kidney treatments, and using medications to raise blood pressure. The outcome is determined as discharged well, morbidity occurred, or death documented.

### Analytical statistics

Software SPSS Windows version 26 was used to conduct it. The data were provided as mean, SD, and ranges. Expressed as frequencies and percentages for categorical data. To compare the PCT level according to an outcome, an independent t-test with two tails was performed. The PCT level upon admission was constructed using a receiver operating characteristic (ROC) curve analysis as a predictor for morbidity and mortality. A p-value less than 0.05 is a significant consideration.

## Results

In this study, the mean age of patients was 48.0 ± 14.6 years; 56% of them were females; 35% were housewives; 57% were living in urban areas; 36% were known cases of hypertension and diabetes; and 33% had a history of both emergency and elective operations, as presented in (Table 1).

**Table 1- The study patients' distribution by general characteristics**

| Variable | No. (n= 100) | Percentage (%) |
|---|---|---|
| Age (Year) | | |
| < 30 | 6 | 6.0 |
| 30 – 59 | 52 | 52.0 |
| ≥ 60 | 42 | 42.0 |
| Gender | | |
| Male | 44 | 44.0 |
| Female | 56 | 56.0 |
| Occupation | | |
| Housewife | 35 | 35.0 |
| Employee | 34 | 34.0 |
| Military | 23 | 23.0 |
| Student | 2 | 2.0 |
| Retired | 6 | 6.0 |
| Residence | | |
| Urban | 57 | 57.0 |
| Rural | 43 | 43.0 |
| Medical history | | |
| No | 16 | 16.0 |
| Hypertension | 29 | 29.0 |
| Diabetes | 14 | 14.0 |
| Hypertension + Diabetes | 36 | 36.0 |
| Organ failure | 5 | 5.0 |
| Surgical history | | |
| No | 20 | 20.0 |
| Emergency | 28 | 28.0 |
| Elective | 19 | 19.0 |
| Emergency + Elective | 33 | 33.0 |

In this study, the most common suspected source of infection was wound infection (23%); 55% of patients had GCS between 13–15; Klebsiella was the most common microorganism shown in positive urine cultures (36%); and Staphylococcus was the most common microorganism shown in positive blood cultures (24%), as presented in (Table 2). We noticed that 62% of study patients were discharged well, while 34% of them died, as shown in (Figure 1).

**Table 2- The study patients' distribution by clinical characteristics**

| Variable | No. (n= 100) | Percentage (%) |
|---|---|---|
| Suspected source of infection | | |
| Wound infection | 23 | 23.0 |
| Perforated DU | 10 | 10.0 |
| Burn | 10 | 10.0 |
| Abortion | 9 | 9.0 |
| Diabetic foot | 7 | 7.0 |
| Severe UTI | 7 | 7.0 |
| Drains | 7 | 7.0 |
| Others | 27 | 27.0 |
| Glasgow Coma Scale (GCS) | | |
| 3 - 8 | 12 | 12.0 |
| 9 - 12 | 33 | 33.0 |
| 13 – 15 | 55 | 55.0 |
| Urine culture | | |
| Negative | 37 | 37.0 |
| Klebsiella | 36 | 36.0 |
| E-coli | 13 | 13.0 |
| Staphylococcus | 10 | 10.0 |
| Pseudomonas | 4 | 4.0 |
| Blood Culture | | |
| Negative | 39 | 39.0 |
| Staphylococcus | 24 | 24.0 |
| Salmonella | 14 | 14.0 |
| E-coli | 12 | 12.0 |
| Acineto | 7 | 7.0 |
| Enterobacteria | 4 | 4.0 |

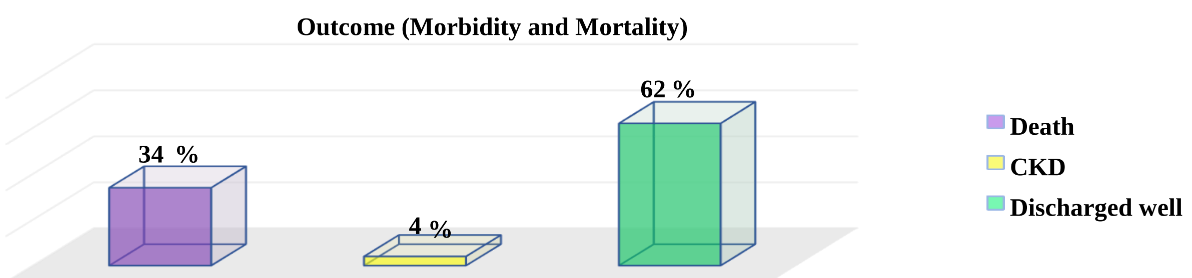


**Figure 1- Distribution of study patients by outcome of sepsis**

Comparison of PCT level at admission according to outcome is shown in (Table 3). The mean PCT level at admission was higher in patients who died or who ended with morbidity than in patients who discharged well (32.22 versus 9.95 µg/L, P= 0.001).

Receiver operating characteristic (ROC) curve analysis was constructed for the PCT level at admission as a predictor for morbidity and mortality. As shown in (Figure 2) and (Table 3), the cut point of PCT level at admission was 17.0 µg/L, so PCT level at admission > 17.0 µg/L is predictive for morbidity and mortality. PCT level was 81.6% sensitive, 93.5% specific, and 89% accurate (Table 4), as a marker for prediction of morbidity and mortality.

## Discussion

Treatment response in sepsis is complicated, and not all patients exhibit the same symptoms or indicators. So, to avoid multi-organ dysfunction, which could raise the risk of complications and ultimately mortality, it is crucial to identify patients with poor prognoses early on [7]. One of the most extensively researched biomarkers in this area is PCT and its kinetics. In actuality, PCT kinetics has proven to improve the monitoring of critically ill septic patients throughout time [14]. In this study, higher levels of PCT were significantly associated with poor prognosis (morbidity and mortality), with the cut point of PCT at admission being 17.0 µg/L. This finding matched what Jekarl DW et al. in 2019 [15], Jain S et al. in 2014 [7], and Karlsson et al. in 2010 [16] all reported, which was that non survivor patients had higher PCT levels than those who survived. In reality, the PCT test has been used in numerous clinical settings since it is a relevant biomarker that can predict outcomes and indicate the severity of an infection. Although PCT is frequently employed in clinical settings, its efficacy in the detection of sepsis has recently come under scrutiny [17]. For categorical data, the data were expressed as frequencies and percentages. Additionally, wound infection was the most typical suspected source of infection (23%). Different studies showed varying results; for example, Jekarl DW et al. in 2019 found a lower death rate of 11.2%, and almost half of the septic patients had a respiratory tract infection as the cause of their sepsis (46.7%) [15]. According to a 2012 study by Grozdanovski K et al. [18] patients who had sepsis had a higher mortality rate (51.6%), the lung was the most frequently infected organ (65.8%), and the failure of the lungs was the most frequently occurring organ dysfunction (54.9%).

**Table 3- Comparison in PCT level at admission according to outcome**

| PCT Level at admission | Outcome (Morbidity and Mortality) | | P value |
|---|---|---|---|
| | Death or morbidity Mean ± SD | Discharged Well Mean ± SD | |
| | 32.22 ± 22.6 | 9.95 ± 5.3 | 0.001 |

**Table 4- Diagnostic accuracy for marker of morbidity and mortality**

| PCT Level | Cut-off value | Sensitivity | Specificity | PPV | NPV | Accuracy |
|---|---|---|---|---|---|---|
| | 17.0 | 81.6% | 93.5% | 88.6% | 89.2% | 89% |

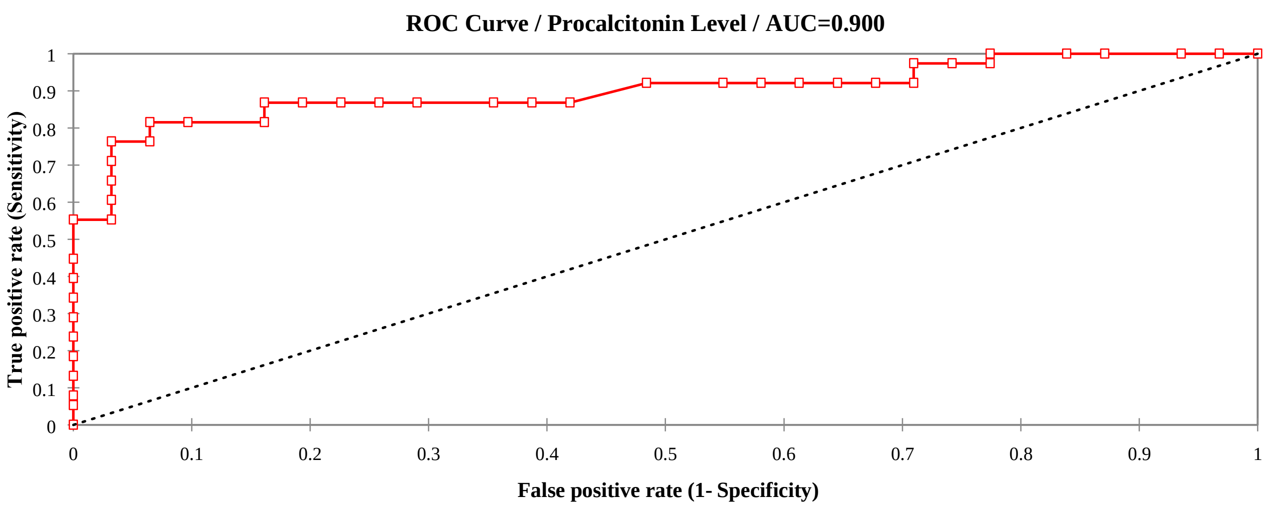


**Figure 2- ROC curve for PCT Level at admission as a marker of morbidity and mortality**

The differences found in the aforementioned studies can be attributed to a variety of factors, including comorbidities, medications that weaken patients' immune systems, the surgical or medical causes of sepsis, the site of the infection, the presence of bacteremia or viremia confirmed by culture, the causative organism, and multidrug resistance.

## Conclusion

In conclusion, PCT can be used to diagnose and predict outcomes in patients with sepsis who are hospitalized in the emergency room and intensive care unit. A better prognosis was strongly associated with lower PCT levels.

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