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Original Article

Procalcitonin as a Prognostic Factor in Intensive Care Unit Admissions for Sepsis and Septic Shock

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Abstract:

Background: *Each year, sepsis causes millions of deaths globally and is the most common cause of death in hospitalized people. A variety of studies has investigated whether a Procalcitonin-guided protocol can optimize the therapeutic approach in patients with sepsis or septic shock.*

Objective: *To evaluate Procalcitonin as a prognostic one of the marker of sepsis in patients admitted to the emergency room or intensive care unit.*

Patient and Methods: *A cross sectional observational study conducted in anesthesia and intensive care department. It included 100 adult patient enrolled in this study within inclusion criteria for sepsis and septic shock and admitted to intensive care. Diagnosis of sepsis was taken in patient suspected or proved infection. Blood sample collected form all patient at admission from peripheral blood to measure procalcitonin level. Follow up continued until outcome is determined as discharged well, morbidity occurred, or death documented.*

Results: *The higher source of infection was due to wound infection (23%). About 55 of studied patient have GCS between 13 - 15. Mean procalcitonin level at admission was significantly high in patients with mortality or morbidity than that in patients who discharged well with a cutoff point of PCT level at admission was 17.0 µg/L.*

Conclusion: *Procalcitonin can be used as prognostic factor in-patient with sepsis with other markers. Lower PCT level where significantly associated with good prognosis.*

Keywords*: Procalcitonin, sepsis, outcome, prognosis, ICU, Iraq*

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1. INTRODUCTION

Sepsis is a medical emergency that describes as immunological response of the body to an infectious process that can lead to end-stage organ dysfunction and death. It remains one of the major causes of morbidity and mortality in intensive care units (ICU) patients (1). Septic shock is severe sepsis plus persistently low blood pressure, despite the administration of intravenous fluids (2). Sepsis occurs in 1–2% of all hospitalizations and accounts for approximately 25% of ICU hospitalized patients. Since sepsis rarely being reported as a primary diagnosis (often a complication of cancer or other illness), the incidence, mortality, and morbidity rates of sepsis are likely underestimated (3). Moreover, up to 25% of patients with severe sepsis and 50% of patients with septic shock will suffer mortality (4). However, overall mortality from sepsis syndromes can vary from 30% to 50% (5). Risk factors that predispose to sepsis include diabetes, malignancy, chronic kidney and liver disease, corticosteroids, immunosuppression, burns, major surgery, trauma, indwelling catheters, prolonged hospitalization, hemodialysis and extremes of age (6). The early detection of patients with unfavorable prognosis or with an increased risk of mortality is essential in order to prevent consequent organ dysfunction, which would increase the degree of complications and hence, patient mortality (7). Procalcitonin (PCT) is a peptide precursor of the hormone calcitonin (involved in calcium homeostasis). The level of PCT rises in a response to a pro-inflammatory stimulus, especially of bacterial origin. It is therefore often classed as an acute phase reactant (8). A variety of studies have investigated whether a PCT-guided protocol can optimize the therapeutic approach in patients with sepsis or septic shock, mainly by monitoring PCT kinetics and cessation of antibiotics once PCT has decreased to <0.5 ng/ml or by at least 80–90% of the peak in combination with clinical improvement (9). An important consideration in septic patients is that renal impairment and a reduced GFR may lower PCT clearance, thus may be higher than expected (10). PCT can help the clinical decision making while identifying invasive bacterial infection in children with unexplained fever (11). PCT levels correlate with the degree of illness in pediatric patients with sepsis or urinary tract infections making it effective as a prognostic lab value in these patients (12). The aim of this study is to evaluate PCT as a prognostic marker of sepsis in patients admitted to the emergency room or intensive care unit.

2. PATIENTS AND METHODS

Study design, setting, and time: This was a cross sectional observational study conducted in the ICU of Anesthesia Department in Baghdad Teaching Hospital, Medical City Complex, Baghdad, Iraq during a period of six months from (January to July 2020).

Study Population and sample size: The study included 100 adult patients diagnosed as sever sepsis or septic shock admitted to the ICU from Emergency Department, medical word and theatre. Diagnosis of sepsis was performed according to adapted American College of Chest Physicians / Society of Critical Care Medicine criteria. The presence of two or more of the following in a patient suspected or proven to have infection was taken as diagnostic of sepsis. The criteria include temperature >38°C or <36°C, heart rate > 90 beats/minute, respiratory rate > 20 breaths/minute or PaCO2 <32 mmHg and WBC count >12,000 cells/mm3 or < 4000 cells/mm3 or > 10% immature (band) forms (13). Patients with Immunocompromised state (malignancy), viral infection (respiratory virus and hepatitis virus A, B, C) and patient with terminal stage of any chronic disease (like as cirrhosis) were excluded from the study. All the patients signed an informed consent that allows us to record their information for research purposes as long as the patient anonymity and confidentiality of their medical records are maintained. Sepsis was classified as microbiologically documented when microorganisms were recovered from the infection site or blood, and as clinically documented when objective signs and symptoms of infection were found but cultures were negative.

Data collection: The data was collected by a well-designed questionnaire including socio-demographic characteristics (Age, gender, residence, and occupation), previous medical, surgical and drug history, suspected source of infection, complete physical examination with vital signs (Temp, MAP, GCS, RR, HR), laboratory investigation (Samples were collected once patient admitted to ICU. After admission, all patients were requested for complete investigations include CBC, LFT, RFT, S. electrolytes, coagulation profile with apart of two ml of blood for PCT assay. The blood sample was collected from peripheral blood, blood and urine culture also requested before antibiotic started. Radiological imaging also requested. Series of samples including PCT requested through duration of ICU admission), and duration of hospital and ICU stay documented. Treatment received include treatment of the cause of infection, antibiotic according to causative microorganism, antiulcer measure, anticoagulant, analgesic, sedation, feeding (enteral or parenteral), electrolyte correction,

glycemic control, indwelling catheter (central venous line, arterial line and others), fluid balance input and output (central venous pressure), organ support mechanical ventilation and continuous renal replacement therapies, and vasopressor. Outcome is determined as discharged well, morbidity occurred, or death documented.

Statistical analysis: It was performed using SPSS windows version 26 Software. The data presented as mean, standard deviation and ranges. Categorical data presented by frequencies and percentages. Independent t-test (two tailed) was used to compare the PCT level according to outcome. Receiver operating characteristic (ROC) curve analysis was constructed for PCT level at admission as predictor for morbidity and mortality. P value < 0.05 was considered significant.

3. RESULTS

In this study, mean of age of patients was 48.0 ± 14.6 years; 56% of them were females; 35% were housewives; 57% were living in urban area; 36% were known cases of hypertension and diabetes; and 33% had history of both emergency and elective operations as shown in (Table 1). 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%); staphylococcus was the most common microorganism shown in positive blood cultures (24%) as shown in (Table 2). We noticed that 62% of study patients were discharged well; while 34% of them were died as shown in (Figure 1). Comparison in PCT level at admission according to outcome is shown in (Table 3). Mean of PCT level at admission was significantly higher in patients who died or who ended with morbidity than that in patients who discharged well (32.22 versus 9.95 µg/L, P= 0.001). Receiver operating characteristic (ROC) curve analysis was constructed for PCT level at admission as predictor for morbidity and mortality. 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 as a marker for prediction of morbidity and mortality as shown in (Figure 2) and (Table 4).

Table 1. Distribution of study patients by general characteristics (n= 100)

Variable		No.	%
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	Hypertension	29	29.0
	Diabetes	14	14.0
	Hypertension + Diabetes	36	36.0
	Organ failure	5	5.0
	No	16	16.0
Surgical history	Emergency	28	28.0
	Elective	19	19.0
	Emergency + Elective	33	33.0
	No	20	20.0

Table 2. Distribution of study patients by clinical characteristics (n= 100)

Variable		No.	%
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

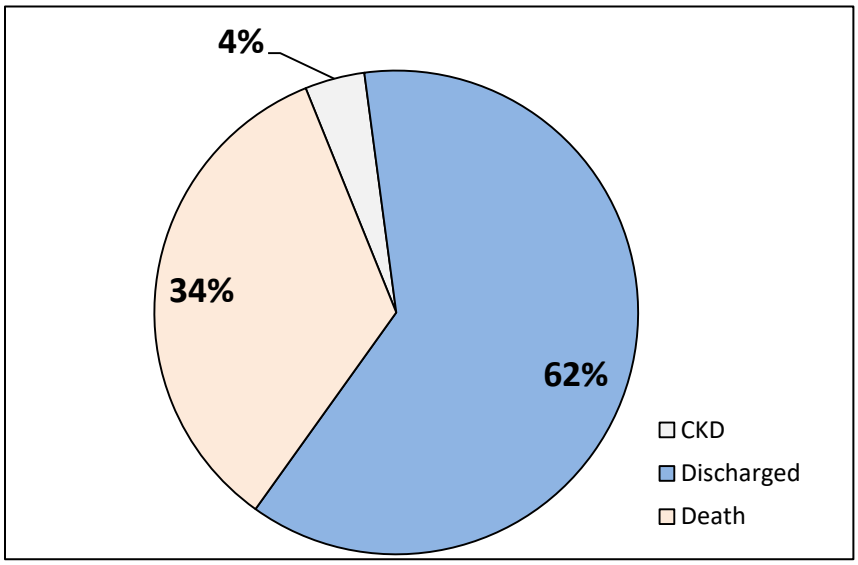

Figure 1. Distribution of study patients by outcome of sepsis

Table 3. Comparison in PCT level at admission according to outcome

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

Table 4. Diagnostic accuracy for marker of morbidity and mortality

Parameter	
PCT Level cutoff value	17.0
Sensitivity	81.6%
Specificity	93.5%
PPV	88.6%
NPV	89.2%
Accuracy	89.0%

PPV: Positive predictive value, NPV: Negative predictive value

4. DISCUSSION

Sepsis response to treatment is complex and not all patients with infections display related signs or symptoms. The early identification of patients with un-favorable prognosis or with an increased risk of mortality is essential in order to prevent consequent organ dysfunction, which would increase the degree of complications and hence, patient mortality (7). In this context, PCT and its kinetics is one of the most studied biomarkers. In fact, PCT kinetics over time has shown to improve the monitoring of critically ill septic patients (14). In this study, higher levels of PCT were significantly associated with poor prognosis (morbidity and mortality) with cut point of PCT at admission was 17.0 µg/L. This result agreed with results found by studies conducted by Jekarl DW et al in 2019 (15), Jain S et al in 2014 (7), and by Karlsson et al in 2010 (16) when all of them reported higher PCT levels among non-survivor patients compared to those who survived. In fact, PCT test has been applied to a variety of clinical use as it is a related biomarker, indicating infection and severity, as well as prognosis in case of infectious diseases. Although PCT is widely used clinically, its value for sepsis diagnosis has also been challenged recently (17). In the current work, the majority of study patients were discharged well (60%); while death was occurred in 34% of them. Also, the most common suspected source of infection was wound infection (23%). Different results observed in different studies as in Jekarl DW et al in 2019 when showed lower mortality rate (11.2%) and nearly half of the septic patients had respiratory tract infection as a source of sepsis among the participants (46.7%) (15). In Grozdanovski K et al study in 2012, higher mortality rate was detected (51.6%) in patients diagnosed with sepsis, the lung was the most common site of infection (65.8%) and respiratory failure was the most common organ failure (54.9%) (18). The differences observed in the above mentioned studies can be relating to many reasons as comorbidities or drugs that impair the immune defense of patients, etiology of sepsis as its surgical or medical etiology, causative organism, multidrug resistance of the causative organism, infection site, or presence of bacteremia or viremia proved by culture. In conclusion, PCT can be used in diagnosis and as prognostic factor in patients with sepsis admitted to the ICU and emergency room. Lower PCT level where significantly associated with good prognosis.

5. CONCLUSION

Procalcitonin can be used as prognostic factor in-patient with sepsis with other markers. Lower PCT level where significantly associated with good prognosis.

Ethical Issues: All ethical issues were approved by the authors from the Iraqi Ministry of Health. Verbal and signed informed consents were obtained from all patients who included in the study during their first visit.

Conflict of interest: None

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Bibliography

1. *Kaukonen K-M, Bailey M, Suzuki S, Pilcher D, Bellomo R. Mortality related to severe sepsis and septic shock among critically ill patients in Australia and New Zealand, 2000-2012. Jama. 2014;311(13):1308-16.*
2. *Dellinger RP, Levy MM, Rhodes A, Annane D, Gerlach H, Opal SM, et al. Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock, 2012. Intensive care medicine. 2013;39(2):165-228.*
3. *Hines AL, Barrett ML, Jiang HJ, Steiner CA. Conditions with the largest number of adult hospital readmissions by payer, 2011: statistical brief# 172. 2014.*
4. *Mayr FB, Yende S, Linde-Zwirble WT, Peck-Palmer OM, Barnato AE, Weissfeld LA, et al. Infection rate and acute organ dysfunction risk as explanations for racial differences in severe sepsis. Jama. 2010;303(24):2495-503.*
5. *Liu V, Escobar GJ, Greene JD, Soule J, Whippy A, Angus DC, et al. Hospital deaths in patients with sepsis from 2 independent cohorts. Jama. 2014;312(1):90-2.*
6. *Heffner. SMAC. Septic shock. Treasure Island (FL): StatPearls Publishing;. 2020.*
7. *Jain S, Sinha S, Sharma SK, Samantaray JC, Aggrawal P, Vikram NK, et al. Procalcitonin as a prognostic marker for sepsis: a prospective observational study. BMC Res Notes. 2014;7:458-.*
8. *Long SS, Prober CG, Fischer M. Principles and practice of pediatric infectious diseases E-Book: Elsevier Health Sciences; 2017.*
9. *Sager R, Kutz A, Mueller B, Schuetz P. Procalcitonin-guided diagnosis and antibiotic stewardship revisited. BMC medicine. 2017;15(1):1-11.*
10. *Heredia-Rodríguez M, Bustamante-Munguira J, Fierro I, Lorenzo M, Jorge-Monjas P, Gómez-Sánchez E, et al. Procalcitonin cannot be used as a biomarker of infection in heart surgery patients with acute kidney injury. Journal of critical care. 2016;33:233-9.*
11. *Trippella G, Galli L, De Martino M, Lisi C, Chiappini E. Procalcitonin performance in detecting serious and invasive bacterial infections in children with fever without apparent source: a systematic review and meta-analysis. Expert review of anti-infective therapy. 2017;15(11):1041-57.*

12. *Memar MY, Varshochi M, Shokouhi B, Asgharzadeh M, Kafil HS. Procalcitonin: the marker of pediatric bacterial infection. Biomedicine & Pharmacotherapy. 2017;96:936-43.*
13. *Munford RS. Severe sepsis and septic shock. In: Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J, editors. Harrison's principles of internal medicine. 18th ed. New York: Mc Graw Hill; 2012. pp. 2223–31.*
14. *Bouadma L, Luyt C-E, Tubach F, Chastre J, Wolff M. Procalcitonin in intensive care units: the PRORATA trial–Authors' reply. The Lancet. 2010;375(9726):1606-7.*
15. *Jekarl DW, Lee S, Kim M, Kim Y, Woo SH, Lee WJ. Procalcitonin as a prognostic marker for sepsis based on SEPSIS-3. Journal of clinical laboratory analysis. 2019;33(9):e22996.*
16. *Karlsson S, Heikkinen M, Pettilä V, Alila S, Väisänen S, Pulkki K, et al. Predictive value of procalcitonin decrease in patients with severe sepsis: a prospective observational study. Critical Care. 2010;14(6):1-10.*
17. *Su L, Feng L, Song Q, Kang H, Zhang X, Liang Z, et al. Diagnostic value of dynamics serum sCD163, sTREM-1, PCT, and CRP in differentiating sepsis, severity assessment, and prognostic prediction. Mediators of inflammation. 2013;2013.*
18. *Grozdanovski K, Milenkovic Z, Demiri I, Spasovska K, Cvetanovska M, Kirova-Urosevic V. Early prognosis in patients with community-acquired severe sepsis and septic shock: analysis of 184 consecutive cases. Prilozi. 2012;33(2):105-16.*