Zagazig University Medical Journal
www.zumj.journals.ekb.eg
https://dx.doi.org/10.21608/zumj.2020.38002.1912 Volume 29, Issue 1, - January 2023, Page (90-96) Supplement Issue

Manuscript ID ZUMJ-2008-1912 (R1)
DOI **10.21608/zumj.2020.38002.1912**

ORIGINAL ARTICLE

Presepsin versus Other Inflammatory Markers for The Diagnosis of Acute Bacterial Infections in Chronic Hemodialysis Patients

Manal Saad Negm1, Muhammad Tarek Abdel Ghafar2, Reham Abdel Kader Elkhouly3

1 Internal medicine Department, Nephrology Division, Faculty of Medicine, Tanta University, Egypt.
2 Clinical pathology Department, Faculty of Medicine, Tanta University, Egypt.
3Tropical medicine and infectious diseases Department, Faculty of Medicine, Tanta University, Egypt

Corresponding author
Reham Abdel Kader Elkhouly
Tropical medicine and infectious diseases Department, Faculty of Medicine, TantaUniversity, Egypt
E-mail:
Reham.elkholy@med.tanta.edu.eg.

Submit Date 2020-08-04
Revise Date 2020-09-13
Accept Date 2020-10-23

ABSTRACT

Background: Infection comes after cardiovascular disease with fatal outcome in patients with End-Stage Renal Disease ESRD and no standardized conventional biomarker for diagnosis of bacterial infection. Presepsin is a fraction of soluble subtypes of CD14 (sCD14- ST) and can be used as a biomarker for acute bacterial infections. This study aims to evaluate of presepsin as a possible biomarker of acute bacterial infections in chronic hemodialysis (HD) patients in Egypt and comparing it with other inflammatory markers, such as C-reactive protein (CRP), ferritin and albumin.

Methods: This study included 60 chronic HD patients that were divided into 2 groups: 30 HD patients with infection (infection group), 30 HD patients without infection as control (non -infection group). Total leucocytic count (TLC), Erythrocyte Sedimentation Rate (ESR), (CRP), ferritin, albumin and presepsin levels were measured in the patients groups.

Results: presepsin levels were significantly higher in the infection group than in the non-infection group. presepsin levels were significantly and positively correlated with serum ferritin and CRP. At a cut off value of 970 ng/L; the sensitivity of presepsin was 73.3% and the specificity was 81.2%.

Conclusion: presepsin was better than TLC and ESR, it was not inferior to CRP and ferritin and it was not superior to albumin for the diagnosis of acute bacterial infections in HD patients. Presepsin could be used as a biomarker for the diagnosis of acute bacterial infections in HD patients with moderate sensitivity and specificity at a cut off value of 970 ng/L .

Keywords: Hemodialysis, Presepsin, CRP, Ferritin

INTRODUCTION

Patients with End-Stage Renal Disease (ESRD) can acquire bacterial infections more frequently than individuals with normal renal function, especially infections of the urinary system, pneumonia, and sepsis **[1].** The infection comes after cardiovascular disease with fatal outcome in patients with ESRD **[2].** No standardized biomarkers for clinical diagnosis of bacterial infection although many such as total leucocytic count (TLC), C-reactive protein (CRP) and ferritin were tested for this purpose **[3].**

Monocytes/macrophages have CD 14 receptors on their surfaces **[4, 5].** This receptor can detect antigens of bacteria **[6].** The concentration of soluble subtypes of CD14 (sCD14- ST) can be measured in the blood **[7].** Presepsin is a fraction of sCD14- ST and it is formed by proteases in plasma **[8, 9].** Presepsin can be measured in normal individuals, its concentration increases in bacterial infections due to the natural immune reaction in the host **[8].**

Multiple researches tested the accuracy of presepsin for detecting acute bacterial infection in patients without the renal disease **[10-12].** More studies are needed to evaluate presepsin in patients with ESRD and to determine a cutoff value for diagnosing bacterial infections and sepsis **[13].**

Our study aimed at evaluation of presepsin as a possible biomarker of acute bacterial infections in chronic hemodialysis patients in Egypt and comparing it with other inflammatory markers, such as CRP, ferritin and albumin

PATIENTS AND METHODS

This is a cross-sectional study carried out at Tanta University Hospitals during the period from October 2019 to March 2020. Chronic hemodialysis patients who attended to

Hemodialysis Unit at the Internal Medicine department during this period were referred to the Tropical Medicine department and they were examined for clinical signs of acute bacterial infection.

The diagnosis of acute bacterial infection was suspected by clinical signs and investigations including; fever (temperature more than 38), respiratory symptoms (cough, expectoration, dyspnea and chest crepitation), skin manifestations (redness and hotness), urinary symptoms (dysuria, loin pain and tenderness), laboratory investigations Complete Blood Count (CBC), Erythrocyte Sedimentation Rate (ESR) and urine analysis), imaging such as chest x-ray and the diagnosis was confirmed by bacterial culture of suitable patients' specimen (sputum, skin swab, blood culture from infected vascular access, urine).

The inclusion criterion for this study was all chronic hemodialysis patients with or without acute bacterial infection. The exclusion criteria were patients with autoimmune or malignant disease, patients receiving immunosuppressant drugs and patients with liver cirrhosis, pregnancy, extremes of ages, immune compromising diseases such as AIDS and diabetes mellitus (recorded in patients' files).

All patients received bicarbonate base dialysis using a low flux dialyzer with an average blood flow of 300–350 mL/min, three times per week, with a target four hours duration for each dialysis session [14].

Forty-five patients with manifestations of acute bacterial infection were recruited for infection group and according to the inclusion and exclusion criteria; 30 patients were enrolled as infection group (group I) after their bacterial infection was proved by culture, and 15 patients were excluded; 10 because of their negative bacterial culture and 5 had systemic lupus. Thirty chronic hemodialysis patients with no clinical or laboratory evidence of infection were enrolled as non- infection control group (group II).

All patients were subjected to full history taking, clinical examination including weight, height and body mass index (BMI) calculation and laboratory investigations (CBC, ESR, albumin, ferritin, CRP and presepsin). Blood samples were withdrawn before the dialysis session.

Laboratory assessment of infection markers:

Blood samples were taken from each subject by standard venipuncture before dialysis session and delivered into a plain vacutainer tube and then into K3 EDTA tube. EDTA blood samples were used for CBC. Serum was separated from the blood sample in the plain tube by centrifugation for 15 min at 3000 rpm and stored at − 4°C for other infection marker assay [15].

CBC was performed on ERMA PCE- 210 automated cell counter, Japan [16]. Serum ferritin and CRP were measured by immune-turbidimetric method whereas; serum albumin was measured by modified bromocresol green colourimetric method [17, 18, 19]. All kits were purchased from Spectrum Diagnostics, Egypt (catalogue no Ferritin Turbi Latex REF: 562 001, CRP REF: 542 001, Albumin REF: 210 001) and assays were performed on Biosystem BTS-350 semi-automated chemistry analyzer (Spain).

The serum presepsin level was estimated by sandwich Enzyme-Linked Immunosorbent Assay (ELISA) technique using human Presepsin ELISA kit provided by Shanghai Sunred Biological Technology Co., Ltd. The reagents were prepared according to the manufacturer package insert data and serial dilutions of the standard with the provided dilution buffer from 4.8 to 0.3 mg/L were obtained. The assay was performed onto a 96-well microtiter plate following the procedure steps in the package insert with colourimetric detection using Tecan Spectra II Microplate Reader (Switzerland). The logit-log standard curve was displayed and from which the sample concentrations were calculated [20].

Ethical approval

The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. This study was approved by the ethics committee of the Faculty of Medicine, Tanta University. All participants in this study were informed about the study objectives and agreed to participate and signed written informed consents.

Statistical analyses

The data were presented as median (interquartile range, IQR) and mean + standard deviation. The data were compared between the infection group and the non- infection group using student's t-test or the Mann-Whitney U test for the normally or non-normally distributed numerical variables respectively. Chi-square test was used to compare the categorical variables. Pearson correlation analysis and stepwise regression analysis were performed to assess the relation between serum presepsin and other infection markers. A receiver operating characteristic (ROC) analysis was performed to determine the performance characteristics of the infection markers. The optimal cutoffs were determined via Youden's index. Diagnostic Areas Under Curve AUCs were compared using DeLong's test. Binary logistic regression was used to combine the infection markers. P values less than 0.05 were considered

significant. All statistical analysis was performed via the SPSS V.22 and medCalc.

RESULTS

Demographic, clinical and laboratory characteristics of the studied groups:

This study included 60 chronic hemodialysis patients that were divided into 2 groups: 30 (HD) patients with infection (infection group), 30 HD patients without infection as control (non -infection group).

In the infection group the types of infection were; pneumonia in12 patients (40.0%) , infected vascular access in 10 patients (33.3%) , cellulitis in 6 patients (20.0%) and subcutaneous abscess in 2 patients (6.7%) . Cultures done were; sputum in 12 patients (40.0%), blood culture from infected vascular access in 10 patients (33.3%), and skin swab in 8 patients (26.7 %). Species of bacteria found in culture were; *Staphylococcus aureus* in 12 cultures (40.0%), *Streptococcus pneumonia* in 6 cultures (20.0%), *Haemophilus influenza* in 6 cultures (20.0%), *Coagulase- negative staphylococci* in 4 cultures (13.33), *Pseudomonas aurogenosa* in 2 cultures (6.66%).

The level of presepsin, CRP, ferritin and body temperature in infection group was significantly higher than that in the non-infection group. ($p < 0.005$, < 0.001, $p < 0.001$, $p < 0.001$) respectively while albumin level was significantly lower in infection group ($p = 0.004$). However, no significant difference in the age, gender, duration of dialysis, BMI, TLC, ESR (1^{ST} hour) between infection and non- infection groups among HD patients (Table 1).

Correlation analysis and multiple logistic regression analysis of the serum presepsin level with other infection markers:

The serum presepsin level correlated significantly and positively with the serum CRP and serum ferritin ($r = 0.440$, $P= 0.007$; and $r = 0.514$, $P = 0.002$) respectively. No significant correlations were found between serum presepsin and TLC, ESR or serum albumin. Presepsin concentrations were independently associated with increased serum ferritin ($t = 3.225$, $P = 0.003$) (Table 2).

The performance characteristics of the presepsin and other infection markers in the infection group vs. non- infection controls:

A receiver operating characteristic (ROC) curve analysis was carried out to assess the predictive performance of infection markers in HD patients. For presepsin, ferritin, CRP , and albumin, the Areas Under Curve (AUCs) were (0.804, 0.871, 0.927 and 0.779) respectively. The AUC for presepsin was non -significantly higher than that for albumin (AUC difference= 0.0250, P = 0.8319) and non-significantly lower than that for ferritin (AUC difference= 0.0667, P= 0.5615), and CRP (AUC difference= 0.123, P=0.1407). The AUC of combined presepsin and ferritin was non-significantly higher than that for presepsin (AUC difference= 0.142, P =0.0784). At cut-off values of (>970 ng/l, >110 ng/ml, >4.0 mg/L and < 3.7g/dl) for presepsin, ferritin, CRP and albumin respectively , the sensitivity was (73.3 %, 80 %, 100 %, 80 %) respectively and the specificity was (81.2 %, 100 %,68.7 %, 68.7 %) respectively (Table 3) (Fig.1).

Table (1): Demographic, clinical and laboratory characteristics of the studied groups:

Characteristic	(group I) (n=30)	(group II) (n=30)	Test	P-Value
Age (years)	55.3 ± 12.8	46.4 ± 14.1	t=1.828	0.078
Gender *n* (%) **Male** **Female**	 16 (53.3%) 14 (46.7%)	 18 (60%) 12(40%)	X^2=0.272	0.602
Duration of dialysis (years)	6.33 ± 4.43	7.88 ± 5.16	U=104.0	0.545
BMI	24.4 ± 3.76	24.6 ± 3.95	t=-0.200	0.843
Body Temperature °C	38.4 ± 0.78	37.1 ± 0.31	t=6.341	**<0.001***
TLC	5286.7 ± 1546.8	6318.8 ± 2250.1	t=-1.496	0.150
ESR (1^{st} hour)	49.13 ± 21.3	40.56 ± 21.0	t=1.128	0.269
Albumin (g/dl)	3.47 ± 0.34	3.81 ± 0.24	t=-3.134	**<0.004***
CRP (mg/l)	14.0 ± 7.75	3.81 ± 2.83	U=17.5	**<0.001***
Ferritin (ng/ml)	577.5 ± 401.4	71.7 ± 29.9	U=31.0	**<0.001***
Presepsin (ng/l)	1530 ± 955	728 ± 446	U=47.0	**<0.005***

n, number; BMI, Body mass index; TLC, Total leucocytic count; ESR, Erythrocyte sedimentation rate ; g/dl: gram per decilitre; CRP, C reactive protein; mg/l: milligram per litre; ng/ml: nanogram per millilitre; ng/l: nanogram per litre; *P < 0.05 significant. Note that; t-test used for numerical normally distributed variables, Mann Whitney U test used for numerical non-normally distributed variables, Chi-square X^2 used for categorical variables.

Table (2): Correlation analysis and multiple logistic regression analysis of the serum Presepsin level with other infection markers:

	Serum Presepsin level (ng/l)				
	Univariate analysis		Multivariate logistic regression analysis		
Characteristic	**r**	**P-value**	**Standardized Beta coefficient**	**t**	**P-value**
TLC	0.056	0.383	---	---	---
ESR (1st hour)	0.264	0.076	---	---	---
Albumin (g/dl)	-0.176	0.172	---	---	---
CRP (mg/l)	0.440	**0.007***	0.238	1.221	0.233
Ferritin (ng/ml)	0.514	**0.002***	0.514	3.225	**0.003***

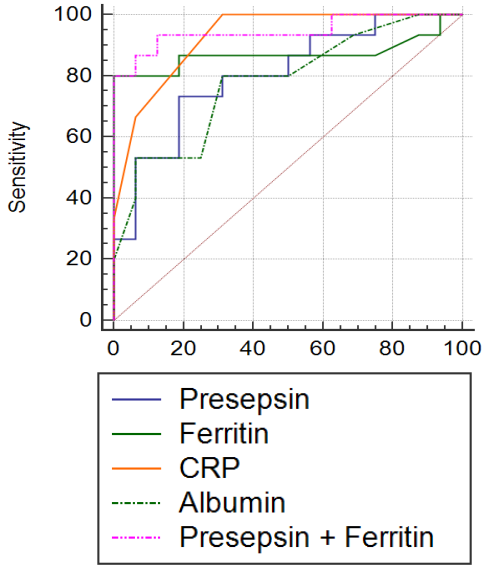
Notes: TLC, Total leucocytic count; ESR, Erythrocyte sedimentation rate; g/dl: gram per decilitre; CRP, C reactive protein; mg/l: milligram per litre; ng/ml: nanogram per millilitre; ng/l: nanogram per litre r, correlation coefficient; t statistics, the coefficient divided by its standard error; *P < 0.05 significant.

Table (3): The performance characteristics of the Presepsin and other infection markers in the infection group vs. non- infection controls:

	AUC	P-Value	95% C.I	Youden index	Cut off	Sensitivity	Specificity
Albumin (g/dl)	0.779	<0.001*	0.595-0.907	0.488	<3.7	80.0	68.7
CRP (mg/l)	0.927	<0.001*	0.774-0.989	0.688	>4.0	100	68.7
Ferritin (ng/ml)	0.871	<0.001*	0.701-0.964	0.800	> 110	80.0	100
Presepsin (ng/l)	0.804	<0.001*	0.623-0.924	0.546	>970	73.3	81.2
Presepsin + Ferritin	0.946	<0.001*	0.800-0.995	0.808	---	93.3	87.5

AUC, Area under curve; C.I, Confidence Interval ; g/dl: gram per decilitre; CRP, C reactive protein; mg/l: milligram per litre; ng/ml: nanogram per millilitre; ng/l: nanogram per litre, *P < 0.05 significant. Note that, cut-off values were determined via Youden index.

Figure 1: The performance characteristics of Presepsin and other infection markers.



DISCUSSION

In the current study, the level of presepsin and CRP were significantly higher in HD infection group than in the non-infection group ($p < 0.005$, $p < 0.001$) respectively. No significant difference in the age, gender, duration of dialysis, BMI, TLC or ESR (1^{ST} hour) between infection and non-infection groups among HD patients.

Our results agreed with Shiota J, et al [21], who found that presepsin and CRP concentrations were significantly higher in skin infection HD group than in the non- infection HD group and non-significant results were found in the age, gender, WBC count between groups. Similarly, Titova EA, et al [22] found an elevation in the presepsin level in HD patients with lung infection compared to HD patients without infection. Our study differs from the previous two studies in that infection group in our study included pneumonia, cellulitis, infected vascular access and subcutaneous abscesses. Also, multiple studies investigated the role of presepsin in bacterial infections in patients without renal impairment and concluded that presepsin concentrations were significantly higher in infection groups versus non-infection groups [23, 24, 25].

Our study found that ferritin level was significantly higher in HD infection group ($p < 0.001$) than in non-infection group and this was similar to a study concluded that high ferritin concentration was positively correlated with a high risk of infection in malnourished patients [26].

In our study, albumin level was significantly lower in HD infection group ($p = 0.004$), this result was in accordance with Kshirsagar AV, et al [27] who found significant low albumin in HD patients with severe teeth infection ($P = 0.01$) and with Adeniyi OA, et al [28] who revealed that values of albumin in the HD infection group were significantly less than in controls ($P < 0.0001$).

In our study the serum presepsin level correlated significantly and positively with the serum CRP ($r = 0.440$, $P= 0.007$). Similarly, Ugajin M, et al [29], studied patients with pneumonia and noted significant positive correlations between presepsin level and CRP ($rs =0.375$, $P<0.001$), also Behnes, et al [30] studied ICU patients with infection and showed that presepsin positively and significantly correlated with CRP ($r = 0.22$, $P =0.02$). In contrast to our study, Sally MS, et al [31] investigated patients with infection who were managed in the emergency department and concluded that presepsin correlated positively but non-significantly with CRP. The authors of the latter study mentioned that the non-significance may be due to the small number of patients included in the study.

ROC curve analysis showed that the AUC for presepsin was non-significantly lower than that for CRP (AUC difference=0.123, P=0.1407). In accordance with our study, Enguix-Armada A, et al [32] concluded that the AUCs for CRP (0.922) and presepsin (0.948) showed a similar diagnostic value. Presepsin was found to have a significantly higher AUC than CRP in many other studies [21, 23, 24, 25, 31, 34], this contradiction may be due to small sample size in our study.In our study, no significant correlations were found between presepsin and albumin, ROC curve analysis showed that the AUC for presepsin was non - significantly higher than that for albumin (AUC difference= 0.0250, P = 0.8319). in contrast to our results Ugajin M, et al, [29] found significant negative correlations between presepsin and albumin level ($r =−0.33$, $P<0.001$), also, Nagata T, et al, [13] studied patients with renal impairment and some patients were on hemodialysis and they found that levels of serum albumin significantly and negatively correlated with presepsin levels ($r = -0.370$, $P = 0.004$). The non- significant result in our study may be due to the small sample size of patients included in our study.

In our study presepsin level correlated significantly and positively with ferritin ($r = 0.514$, $P = 0.002$*). Even after adjusting for confounders, plasma presepsin concentrations were independently associated with increased serum ferritin levels ($t = 3.225$, $P = 0.003$*). ROC curve analysis showed that the AUC for presepsin was non-significantly lower than that for ferritin (AUC difference=0.0667, P=0.5615), These results are in accordance with Kato S, et al [26] who found that ferritin concentrations were significantly higher in HD infection group but we did not find studies that investigated bacterial infection and correlated presepsin with ferritin level.

At a cut-off value of (> 970 ng/l) for presepsin, the sensitivity was (73.3 %) and the specificity was (81.2 %). Many studies that included patients with normal renal function found moderate sensitivity and specificity of presepsin as in our study but with lower cut off values ranging from 300 ng/l to 600 ng/l, [24, 25, 35]. This may be due to accumulation of presepsin in the blood of hemodialysis patients that were included in our study also Nagata et al concluded that presepsin levels were high in patients receiving HD and its levels increased when glomerular filtration rate decreased in patients with renal impairment who were not on HD [13].

Shiota J, et al [21] who studied HD patients with skin infections reported a higher sensitivity of presepsin (86%) than in our study (73.3%) but at a higher cut off value (2080 ng/l) than in our study (970 ng/l) also they found a lower sensitivity (69%)

of CRP versus (80%) in our study but at a cut off value (10.7 mg/L) versus (4.0 mg/L) in our study.

Limitations of the current study:

More studies are needed to confirm our results including larger number of patients, involving sepsis and determining the optimum cutoff values for localized infections versus sepsis in HD patients.

CONCLUSION

Our study investigated the validity of presepsin versus other inflammatory markers for the diagnosis of acute bacterial infections in HD patients and concluded that presepsin was better than TLC and ESR, it was not inferior to CRP and ferritin and it was not superior to albumin. Presepsin could be used as a biomarker for the diagnosis of acute bacterial infections in HD patients with moderate sensitivity and specificity at a cut off value of more than 970 ng/l .

Abbreviations:

ESRD: End-Stage Renal Disease; sCD14-ST: soluble CD14 Subtype; CRP: C Reactive Protein; HD: Hemodialysis; TLC: Total Leucocytic Count; CBC: Complete Blood Count; ELISA: Enzyme-Linked Immunosorbent Assay; IQR: Inter Quartile Range; ROC: Receiver Operating Characteristic; AUC: Area Under Curve.

Declaration of interest:

Authors declared no conflict of interest.

Authors' Contributions

MN: Designed the study, interpreted the data, drafted and revised the paper, MT: responsible for the laboratory investigation and analysis of the data, RE: Designed the study, interpreted the data, drafted and revised the paper. All authors approved the final manuscript.

REFERENCES:

1. Evans R, Caskey F, Fluck R, Crowley L, Davies J, Nsonwu O, et al. UK Renal Registry 18th annual report: chapter 12 epidemiology of reported infections amongst patients receiving dialysis for established renal failure in England 2013 to 2014: a joint report from Public Health England and the UK Renal Registry. Nephron. 2016;132(Suppl. 1):279-88.
2. Collins AJ, Foley RN, Chavers B, Gilbertson D, Herzog C, Ishani A, et al. Us renal data system 2013 annual data report. Am J kidney Dis. 2014 Jan; 63 (Suppl. 1): A7.
3. Nishida O, Ogura H, Egi M, Fujishima S, Hayashi Y, Iba T, et al: The Japanese Clinical Practice Guidelines for Management of Sepsis and Septic Shock 2016 (J-SSCG 2016). J Intensive Care. 2018; 6:7.
4. Lonez C, Irvine KL, Pizzuto M, Schmidt BI, Gay NJ, Ruysschaert JM, et al. Critical residues involved in Toll-like receptor 4 activations by cationic lipid nanocarriers are not located at the lipopolysaccharide-binding interface. Cell Mol Life Sci. 2015 Oct; 72(20):3971-82.
5. Van der Mark VA, Ghiboub M, Marsman C, Zhao J, van Dijk R, Hiralall JK, et al. Phospholipid flippases attenuate LPS-induced TLR4 signalling by mediating endocytic retrieval of Toll-like receptor 4. Cell Mol Life Sci. 2017; 74(4):715-30.
6. Bas S, Gauthier BR, Spenato U, Stingelin S, Gabay C. CD14 is an acute-phase protein. J Immunol. 2004;172(7):4470-9.
7. Pugni L, Pietrasanta C, Milani S, Vener C, Ronchi A, Falbo M, et al. Presepsin (soluble CD14 subtype): reference ranges of a new sepsis marker in term and preterm neonates. PLoS One. 2015 Dec 31;10(12): e0146020.
8. Chenevier-Gobeaux C, Borderie D, Weiss N, Mallet-Coste T, Claessens YE. Presepsin (sCD14-ST), an innate immune response marker in sepsis. Clin Chim Acta. 2015 Oct 23; 450:97-103.
9. Urbonas V, Eidukaitė A, Tamulienė I. The predictive value of soluble biomarkers (CD14 subtype, interleukin-2 receptor, human leucocyte antigen-G) and procalcitonin in the detection of bacteremia and sepsis in pediatric oncology patients with chemotherapy-induced febrile neutropenia. Cyto. 2013 Apr; 62(1):34-7.
10. Masson S, Caironi P, Fanizza C, Thomae R, Bernasconi R, Noto A, et al. Circulating presepsin (soluble CD14 subtype) as a marker of host response in patients with severe sepsis or septic shock: data from the multicenter, randomized ALBIOS trial. Intensive Care Med. 2015; 41(1):12-20.
11. Klouche K, Cristol JP, Devin J, Gilles V, Kuster N, Larcher R, et al. Diagnostic and prognostic value of soluble CD14 subtype (Presepsin) for sepsis and community-acquired pneumonia in ICU patients. Ann Intensive Care. 2016;6(1):59.
12. Claessens YE, Trabattoni E, Grabar S, Quinquis L, Der Sahakian G, Anselmo M, et al. (sCD14-ST) concentrations in acute pyelonephritis in adult patients. Clin Chim Acta. 2017 Jan 1; 464:182-188.
13. Nagata T, Yasuda Y, Ando M, Abe T, Katsuno T, Kato S, et al. Clinical impact of kidney function on presepsin levels. PloS one. 2015; 10 (6): e0129159.
14. Ashby D, Borman N, Burton J, Corbett R, Davenport A, Farrington K, et al. Renal association clinical practice guidelines on hemodialysis. BMC Nephrol. 2019; 20, 379.
15. Tuck MK, Chan DW, Chia D, Godwin AK, Grizzle WE, Krueger KE, et al. Standard operating procedures for serum and plasma collection: early detection research network consensus statement standard operating procedure integration working group. J Proteome Res. 2009; 8 (1): 113-117.

16. Butarello M. Quality specification in hematology: the automated blood cell count. Clin Chim Acta. 2004; 346(1): 45-54.
17. Borque L, Rus A, Bellod L& Seco ML. Development of automated immunoturbidimetric ferritin assay. Clin Chem Lab Med. 1999; 37(9): 899- 905.
18. Dupuy AM, Badiou S, Descomps & Cristol JP. Immunoturbidimetric determination of C-reactive protein CRP and high sensitivity CRP on heparin plasma. Comparison with serum determination. Clin Chem Lab Med. 2003; 41(7): 948-949.
19. Doumas BT, Watson WA& Biggs HG. Albumin standard and the measurement of serum albumin with bromocresol green. Clin Chim Acta. 1971; 31: 87-96.
20. Aydin S. A short history, principles, and types of ELISA, and ourlaboratory experience with peptide/ proteinanalyses using ELISA. Peptides. 2015; 72: 4-15.
21. Shiota J, Tagawa H, Ohura N& Kasahara H. Presepsin is a potent biomarker for diagnosing skin wound infection in hemodialysis patients compared to white blood cell count, high-sensitivity C-reactive protein, procalcitonin, and soluble CD14. Ren Replace Ther. 2017; 3(1):31.
22. Titova EA, Eirikh AR, Titova ZA, Zhgut OG, Ivanova SI, Zateeva TN, et al. Change in the presepsin level in hemodialysis patients with pneumonia and sepsis. Bulletin Med Sci. 2019; (13):73-77.
23. Vodnik T, Kaljevic G, Tadic T& Majkic-Singh N. Presepsin (sCD14-ST) in preoperative diagnosis of abdominal sepsis. Clin Chem Lab Med. 2013; 51(10):2053-62.
24. Kweon OJ, Choi JH, Park SK &Park AJ. Usefulness of presepsin (sCD14 subtype) measurements as a new marker for the diagnosis and prediction of disease severity of sepsis in the Korean population. J Crit Care. 2014 Dec; 29(6):965-70.
25. Shozushima T, Takahashi G, Matsumoto N, Kojika M, Endo S& Okamura Y. Usefulness of presepsin (sCD14-ST) measurements as a marker for the diagnosis and severity of sepsis that satisfied diagnostic criteria of systemic inflammatory response syndrome. J Infect Chemother. 2011;17(6):764-9.
26. Kato S, Lindholm B, Yuzawa Y, Tsuruta Y, Nakauchi K, Yasuda K, et al. High ferritin level and malnutrition predict a high risk of infection-related hospitalization in incident dialysis patients: a Japanese prospective cohort study. Blood purif. 2016;42(1):56-63.
27. Kshirsagar AV, Craig RG, Beck JD, Moss K, Offenbacher S, Kotanko P, et al. Severe periodontitis is associated with low serum albumin among patients on maintenance hemodialysis therapy. Clin J Am Soc Nephrol. 2007;2(2):239-44.
28. Adeniyi OA& Tzamaloukas AH. The relation between Access-Related Infection and Preinfection Serum Albumin Concentration in Patients on Chronic Hemodialysis. Hemodial Int. 2003;7(4):304-10.
29. Ugajin M, Matsuura Y, Matsuura K& Matsuura H. Impact of initial plasma presepsin level for clinical outcome in hospitalized patients with pneumonia. J Thorac D. 2019 Apr;11(4):1387- 1396.
30. Behnes M, Bertsch T, Lepiorz D, Lang S, Brinkmann F, Brueckmann M, et al. Diagnostic and prognostic utility of soluble CD 14 subtype (presepsin) for severe sepsis and septic shock during the first week of intensive care treatment. Crit Care 2014; 18(5):507.
31. Sally MS, Malaka Z&Hayam AH. Soluble CD14 Subtype (Presepsin) Assay for Early Diagnosis of Sepsis in Egyptian Patients. Med J Cairo Univ. 2018; 86:1025-32.
32. Enguix-Armada A, Escobar-Conesa R, García-De La Torre A, De La Torre-Prados MV. The usefulness of several biomarkers in the management of septic patients: C-reactive protein, procalcitonin, presepsin and mid-regional pro-adrenomedullin. Clin Chem and Lab Med. 2016; 54(1):163-8.
33. Romualdo LG, Torrella PE, González MV, Sánchez RJ, Holgado AH, Freire AO, et al. Diagnostic accuracy of presepsin (soluble CD14 subtype) for prediction of bacteremia in patients with systemic inflammatory response syndrome in the Emergency Department. Clini Biochem. 2014 May 1;47(7-8):505-8.
34. Hou YS, Wang H, Chen H, Wu LF, Lu LF, He Y et al. Pathfast presepsin assay for early diagnosis of systemic inflammatory response syndrome in patients with nephrolithiasis. Biomed Res Int. 2015: Article ID792572, 6 pages.
Endo S, Suzuki Y, Takahashi G, Shozushima T, Ishikura H, Murai A, et al. Usefulness of presepsin in the diagnosis of sepsis in a multicenter prospective study. J Infect Chemother. 2012; 18(6):891-7

How to cite
Negm, M., Abdel Ghafar, M., Elkhouly, R. PRESEPSIN VERSUS OTHER INFLAMMATORY MARKERS FOR THE DIAGNOSIS OF ACUTE BACTERIAL INFECTIONS IN CHRONIC HEMODIALYSIS PATIENTS. Zagazig University Medical Journal, 2023; (90-96): -. doi: 10.21608/zumj.2020.38002.1912