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To Study Correlation between MOD Score and Biomarker Values for Early Prediction of MODS in Suspected Cases of Sepsis Cases in Hospital

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Abstract

Background: Utility of biomarkers in early prediction of multiple organ dysfunction syndrome (MODS) in suspected cases of sepsis presenting to the Emergency Department (ED).

Aim and Objectives: To correlate the biomarker values (Pro-calcitonin (PCT), C-reactive protein (CRP), NT-pro BNP and Neutrophil gelatinase associated lipocalin (NGAL) with multiple organ dysfunction (MOD) score and to evaluate their role in early prediction of MODS in suspected sepsis patients presenting to ED.

Methods: This is a prospective observational study conducted on 65 patients with suspected sepsis. Patients of 18-65 years presented in the ED with triage complaints of fever, respiratory, urinary and abdominal infections, who were sepsis screen positive on arrival and admitted, were enrolled in the study. They were categorized into two groups: Group 1 (MODS score Positive at 48 or 72 hours) and Group 2 (MOD score Negative). Biomarker values in both the groups and its correlation with MOD score was analyzed.

Results: At 48 hours, 40 (61.5%) patients were MODS positive with PCT (Sensitivity 100%, OR-12.6, CI-0.6-255.04, p=0.098), CRP (Sensitivity 100%, OR-27.0, CI-1.44-504.0, p=0.027), NT-pro BNP (Sensitivity 82.5%, OR-7.07, CI-2.55-22.16, p=0.0008) and NGAL (Sensitivity 77.5%, OR-82.9, CI-9.7-698.16, p=0.0001) with PPV of NGAL (96.88%) and NT-pro BNP (76.74%) and 100% NPV for PCT and CRP.

Conclusion: This study established a good correlation of NT-pro BNP and NGAL with positive MODS score suggestive of and highly predictive of developing MODS in suspected cases of sepsis. The normal value of PCT and CRP on arrival in patients with suspected sepsis rules out MODS even at 72 hours during their hospital stay.

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INTRODUCTION

Sepsis is a significant global health problem accounts for a significant proportion of Intensive Care Unit (ICU) admissions.[1] Sepsis, when associated with multiple organ dysfunction and shock are the major contributors to poor

outcome.[2] Multiple organ dysfunction syndrome (MODS) have a very high morbidity and mortality rate and are the most frequent cause of death (approx. 47%) in the ICU. As the number of organs that failed increased from one to four, the mortality rate progressively increased from 30% to 100%.[3]

Systemic inflammatory response syndrome (SIRS) criteria in sepsis were established in 1992 as part of the American College of Chest Physicians/ Society of Critical Care Medicine Consensus Conference.[4] In Sepsis-3, the task force presents quick sepsis related organ failure assessment (qSOFA) score as simple bed side criteria that can be used not only as a mortality predictor but also as a screening tool for sepsis.[5] Physicians identifying sepsis in many Emergency Departments (EDs) have routinely used the SIRS criteria and after the publication of Sepsis-3, qSOFA has become an additional screening tool.[6] An accurate assessment and early identification of impending organ dysfunction or shock may influence the outcome since this is the major drive for mortality in sepsis.[7] Emergency physicians plays a central role in early detection of acute and severe infections as well as in starting an appropriate treatment.[8] Proper diagnosis and early prediction of severity can allow them to do accurate and prompt interventions for better outcomes and prognosis.

The Multiple Organ Dysfunction (MOD) Score given by Mar shall *et al.* in 1995 includes all the six organ system parameters suggesting the presence or absence of MODS, which can be used as the guide for early screening using multiple biomarkers in ED.[9] Biomarkers have become an integral part of medicine, aiding in the diagnosis and treatment of numerous conditions.[9-12] Pro-calcitonin (PCT) is a useful marker for diagnosis of systemic and local infections, and for prognostic stratification in patients with acute infectious diseases at their arrival in the ED. C-Reactive protein (CRP) is a general acute phase reactant protein that rises in concentration up to 1000-fold in the blood in response to inflammation and infection.[13] CRP is a well established biomarker of infection and inflammation.[14] N-terminal pro b-type natriuretic peptide (NT-proBNP) values are frequently increased in severe sepsis and septic shock. Values are significantly higher in non-survivors than survivors.[15,16] Increased plasma Neutrophil gelatinase associated lipocalin (NGAL) concentrations was seen in patients with suspected sepsis who presented to the ED were associated with the development of acute kidney injury.[11]

We are receiving lot of sepsis patients and an accurate assessment and early prediction of impending organ dysfunction can influence their outcome. In addition, there is a dearth of Indian studies on the role of biomarkers in sepsis. Therefore, this study planned to explore the diagnostic utilities of PCT, CRP, NT pro-BNP and NGAL in patients with suspected sepsis for early screening of MODS in the ED.

Aims and Objectives

To study the correlation between multiple organ dysfunction score and biomarker values for early prediction of setting in of multiple organ dysfunction syndrome in suspected cases of sepsis in a hospital.

Study Objectives

To correlate the biomarker values (Pro-calcitonin, C-reactive protein (CRP), NT-proBNP and NGAL) at admission in suspected cases of sepsis presenting to emergency department (ED) with multiple organ dysfunction score at 48 hours and 72 hours of admission and to evaluate their role in early prediction of MODS.

MATERIALS AND METHODS

Study Design

The study was a prospective observational study, conducted at a single centre at North India for a period of one year (December 2014 to December 2015). All patients between 25 and 65 years of age with triage complaints of fever, respiratory, urinary and abdominal infections who were sepsis screen positive [Systemic Inflammatory Response Syndrome (SIRS) and qsofa positive] on arrival and admitted were included in the study. In both, the patients fulfill the sepsis definition if they have ≥ 2 criteria upon admission in combination with a suspected infection [SIRS criteria and qSOFA score as given in (Table 1)].

Patients with age below 18 and more than 65 year, pregnant, Immunocompromised, or with previous history of hepato-renal, cardiac and respiratory disease were excluded.

Approval was taken from the Institutional ethical committee and informed written consent was obtained before enrolment from all patients.

For those who were unconscious surrogate consent from a legal guardian or other duly authorized representative was taken. Fresh informed consent from each participant was taken after they regain consciousness.

Table 1: SIRS and qSOFA criteria

International SIRS criteria originally defined by the American College of Chest Physicians/Society of Critical Care Medicine consensus conference committee.[4]
SIRS criteria:
Temperature > 38 °C or < 36 °C; heart rate > 90 beats per minute; respiratory rate > 20 breaths per minute or $PaCO_2$ < 4.3 kPa; white blood cell count > 12.0 × 109/L or < 4.0 × 109/L or > 10% immature bands.
qSOFA criteria that was presented in 'Sepsis-3':[5]
Respiratory rate ≥ 22 breaths per minute; altered mentation (Glasgow Coma Scale (GCS) < 15); systolic blood pressure ≤ 100 mmHg).

Data Collection

After enrolment, clinical characteristics of each patient recorded including demographics, symptoms and signs, medical history, ABG, chest X-ray and standard blood tests including cultures. 4ml of additional blood sample was taken for biomarkers including PCT, CRP, NT-pro BNP and NGAL on arrival of patient in the ED.

Multiple Organ Dysfunction Syndrome Score (MOD Score) was applied to screen all patients for confirming Multiple Organ Dysfunction Syndrome at 48 hours. If the MOD Score was zero at 48 hours, cases were followed upto 72 hours to reconfirm late setting of Multiple Organ Dysfunction Syndrome.

Study cases was categorised into two groups: Group-1 included patients with MODS score Positive at 48 or 72 hours and Group-2 included the patients with MODS score Negative.

Biomarkers Measurement

For each case, 4 ml blood collected. In the ED, point of care testing of biomarkers were done as follows:

- Serum Procalcitonin (PCT) done using COBAS e 411 (Roche, Siemens) machine.
- Serum CRP done using *Daderxlmax* (Siemens) machine.
- N-terminal B-type natriuretic peptide testing performed on the triage platform using a standard commercially available assay (Triage Assay, Alere).
- The Triage NGAL Test (Alere Inc, San Diego, CA, USA) is an immunoassay in a single-use plastic cartridge that contains a fluorescently labelled monoclonal antibody against NGAL labelled with a fluorescent dye and NGAL.
- Laboratory thresholds used to determine elevation of biomarkers as PCT (Normal value <0.046 ng/ml), CRP (Normal value <6 mg/ml), NT-proBNP (Normal value < 450 ng/L) and (NGAL (Normal value < 280 ng/L).

Statistical Analysis

The study was designed to include 65 patients to ensure a sample size of convenience assuming 10% attrition. SPSS version 17 (SPSS, Inc., Chicago, IL, USA) was used for data analysis. Continuous data presented as mean and standard deviation (SD) whereas categorical data were expressed in terms of frequencies and percentages. Descriptive statistics were calculated and differences in the mean of two independent groups (Group-1: MODS positive at 48 or 72 hours and Group-2: MODS negative), were compared applying Chi square test. A two-sided p-level of < 0.05 considered statistically significant.

An association between the MODS score and biomarker values in terms of validity was assessed by sensitivity and specificity and its diagnostic value was assessed by positive predictive values (PPV), negative predictive values (NPV) and likelihood ratio (LR). Kappa agreement ratio was used to look for the agreement of all the biomarkers with MODS status. (<0 as indicating no agreement and 0–0.20 as slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1 as almost perfect agreement).

RESULTS

In one year, 1200 patients came to the emergency department with triage complaints of fever, respiratory, urinary and abdominal infections. Total 850 cases were sepsis screen positive (quick sequential organ Failure Assessment (qSOFA) and systemic inflammatory response syndrome (SIRS) positive) and after applying inclusion and exclusion criteria, 785 patients were excluded and 65 patients were enrolled for the study as shown in Fig. 1. After enrolment, clinical characteristics of each patient recorded including demographics, symptoms and signs, medical history, ABG, chest X-ray and standard blood tests including cultures. 4ml of additional blood sample was taken for

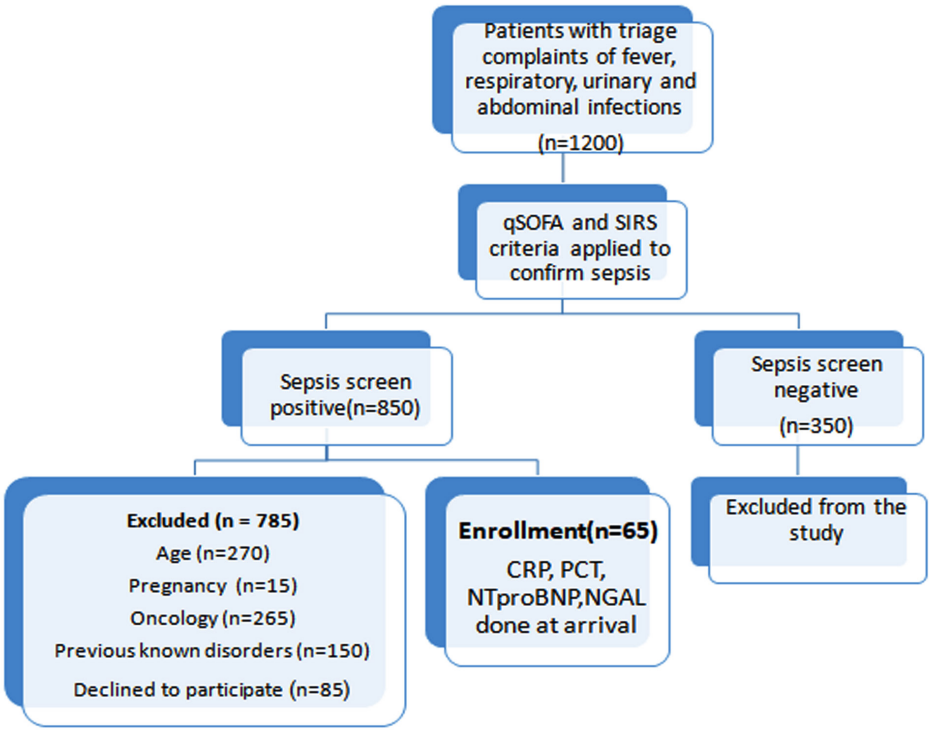

Fig. 1: Consort Flow Diagram for the Study

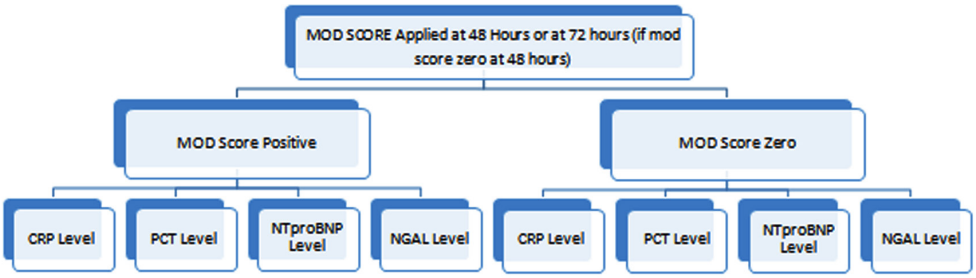

Fig. 2: End point at 48 hours or at 72 hours (if mod score zero at 48 hours)

biomarkers including PCT, CRP, NT-proBNP and NGAL on arrival of patient in the ED.

Patient Demography

Study cases was categorised into two groups: Group-1 included 40 (61.53%) patients with MODS score positive at 48 or 72 hours and Group-2 included 25 (38.47%) patients with MODS score Negative. (Fig. 2) The baseline characteristics of the patients among these groups (table 2). Majority of patients were in age group of 51-65 years of age. There was no significant difference between gender and age distribution in both the groups. There was no statistically significant difference in terms of presenting complaints including respiratory tract infection, abdominal infections, urinary tract infections and fever in both the groups as shown in table 2.

Table 2: Baseline Characteristics of 65 enrolled patients

		Group-1 (n = 40) n (%)	Group-2 (n = 25) n(%)	p-value	OR	CI (Min-Max)
Gender, n (%)	Male (n = 40)	27 (67.5)	13 (52.0)	0.87	1.08	0.41-2.83
	Female (n = 25)	13 (32.5)	12 (48.0)			

table cont....

Age, n (%)	< 50 yrs. old (n=31)	18 (45.0)	13 (52.0)	0.58	0.75	0.2-2.1
	≥ 50 yrs. old (n=34)	22 (55.0)	12 (48.0)			
Presenting complains,n (%)	Respiratory tract infection (36; 55.3%)	19 (47.5)	17 (42.5)	0.71	0.81	0.26-2.49
	Abdominal (14; 21.5%)	9 (22.5)	5 (20.0)	0.81	1.16	0.34-3.97
	Urinary tract infection (9; 13.8%)	7 (17.5)	2(8.0)	0.29	2.43	0.46-12.81
	Fever (6; 9.2%)	5 (12.5)	1 (0.48)	0.27	3.4	0.37-31.22

Biomarker Testing

Biomarkers including PCT, CRP, NT pro BNP, NGAL were done in all the patients on arrival in ED. PCT came out positive in 62 patients (95.4%), CRP was positive in 59 patients (90.8%), NT pro BNP was positive in 43 patients (66.2%) and NGAL was positive in 46 patients (70.76%).

The magnitudes of association of MODS score with biomarkers (NT-proBNP, C-reactive protein (CRP), Pro-calcitonin and NGAL) as shown in Table 3 and 4. At 48 hours, 40 (61.5%) were MODS positive patients with PCT (Sensitivity 100%, OR-2.6, CI-0.6-255.04, p=0.098), CRP (Sensitivity 100%, OR-27.0, CI-1.44-504.0, p=0.098), NT-proBNP (Sensitivity 82.5%, OR-7.07, CI-2.55-22.16, p=0.0008) and NGAL (Sensitivity 77.5%, OR-82.9, CI-9.7-698.16, p=0.0001). The chance of MODS in patients with high pro-calcitonin values was 12.6; high C-reactive protein (CRP) was 27 times; high Pro-calcitonin values was 7.07 times and with high NGAL values was 82.6 times as compared to those patients who had normal biomarkers values respectively as shown in table 3.

Table 3: Association of MODS score with biomarkers (Pro-calcitonin, C-reactive protein (CRP), NT-proBNP and NGAL

Biomarkers	Group-1 MODS score positive N=40; n (%)	Group-2 MODS score negative N=25; n (%)	p-value	OR	CI	Kappa
Pro-calcitonin (n=62)	40 (100.0)	22 (88.0)	0.098	12.6	0.6-255.04	0.144
C reactive protein (n=59)	40 (100.0)	19 (76.0)	0.027	27	1.44-504.0	0.28
NT-proBNP (n=43)	33 (82.5)	10 (40.0)	0.0008	7.07	2.25-22.16	0.43
NGAL (n=46)	31 (77.5)	15 (60.0)	0.0001	82.6	9.7-698.16	0.69

All biomarkers showed good sensitivity for MODS at 48 hours. The validity, diagnostic value and accuracy of biomarkers (Pro-calcitonin, C-reactive protein (CRP), NT-pro BNP and NGAL) with MODS at 48 hours shown in table 4 and at 72 hours shown in table 5. PCT, CRP showed poor specificity and NT-proBNP, NGAL showed fair and good specificity respectively. Positive and Negative Likelihood ratios of biomarkers at 48 hours suggests that NT-pro BNP and NGAL has good association with the disease and negative Likelihood ratio of all biomarkers reassure the absence of the disease. NGAL and NT-pro BNP both have good positive predictive value and PCT and CRP showed excellent negative predictive value for MODS at 48 hours in suspected patients of sepsis.

Cohen kappa showed slight agreement while using PCT in MODS positive and MODS negative patients (kappa=0.144), while CRP showed fair agreement (kappa=0.28). NT - pro BNP and NGAL showed moderate and substantial agreement respectively (kappa=0.43; 0.69 respectively) for MODS in suspected sepsis patients.

All MODS negative patients followed again at 72 hours to look for late setting in of MODS using MODS scoring. Out of 25 patients, only one patient (4%) becomes MODS positive at 72 hours. Validity, Diagnostic value and Accuracy of biomarkers (Pro-calcitonin, C-reactive protein (CRP), NT-pro BNP and NGAL) with MODS at 72 hours showed almost similar results as at 48 hours as shown in table 5.

To summarize, NT-proBNP and NGAL showed moderate and substantial agreement for MODS respectively and both biomarkers showed good specificity, positive predictive value and positive likelihood ratio. PCT and CRP showed good sensitivity, negative likelihood ratio and negative predictive value for MODS in suspected sepsis patients.

Table 4: Validity, Diagnostic value and Accuracy of biomarkers (Pro-calcitonin, C-reactive protein (CRP), NT-proBNP and NGAL) with MODS at 48 hours.

Statistical tools		Pro-calcitonin		CRP		NT-proBNP		NGAL	
		Value	95% CI	Value	95% CI	Value	95% CI	Value	95% CI
		(%)		(%)		(%)		(%)	
Validity	Sensitivity	100	91.19-100.0	100	91.19-100.0	82.5	67.22-92.66	77.5	61.55-89.16
	Specificity	12	2.55-31.22	24	9.36-045.13	60	38.67-78.87	96.6	79.65-99.90
Diagnostic values	PPV	64.52	51.34-76.26	67.8	54.36-79.38	76.74	61.37-88.24	96.88	83.78-99.92
	NPV	100	29.24-100.00	100	54.07-100.00	68.18	45.13-86.14	72.73	54.48-86.70
Diagnostic accuracy	LR+	1.14	0.98-1.31	132	1.06-1.64	2.06	1.25-3.40	19.37	2.82-133.17
	LR-	0.01	–	0.01	–	0.29	0.14-0.61	0.23	0.13-0.42

Table 5: Validity, Diagnostic value and Accuracy of biomarkers (Pro-calcitonin, C-reactive protein (CRP), NT-proBNP and NGAL) with MODS at 72 hours

Statistical tools		Pro-calcitonin		CRP		NT-proBNP		NGAL	
		Value	95% CI	Value	95% CI	Value	95% CI	Value	95% CI
		(%)		(%)		(%)		(%)	
Validity	Sensitivity	100	91.19-100.0	100	91.19-100.0	82.5	67.22-92.66	77.5	61.55-89.16
	Specificity	12	2.55-31.22	24	9.36-045.13	60	38.67-78.87	96.6	79.65-99.90
Diagnostic values	PPV	64.52	51.34-76.26	67.8	54.36-79.38	76.74	61.37-88.24	96.88	83.78-99.92
	NPV	100	29.24-100.00	100	54.07-100.00	68.18	45.13-86.14	72.73	54.48-86.70
Diagnostic accuracy	LR+	1.14	0.98-1.31	132	1.06-1.64	2.06	1.25-3.40	19.37	2.82-133.17
	LR-	0.01	–	0.01	–	0.29	0.14-0.61	0.23	0.13-0.42

DISCUSSION

Sepsis is a significant health problem with high rates of morbidity and mortality and sepsis when associated with organ dysfunction and shock are major contributors to poor outcome.[2]

The assessment of risk stratification and prognosis in sepsis is based on the clinical scoring systems. However, they are inefficient to provide definite clues on organ dysfunctions or failures.[17,18] The potential clinical usefulness of some innovative biomarkers has been discussed in the diagnosis, staging, and monitoring of sepsis and these biomarker guided strategies may allow more refined risk stratification and lead to improved patient care and outcomes.[16,18]

In the present study, prevalence of sepsis was more in male as compared to females; this was in concordance with the study done by Yi-Ling Chan *et al.* and Mina Hur *et al.* which showed higher prevalence of sepsis among males.[11,19] The median age of patient was 53 years in this study and majority of patients were in age group of 51-65 years of age. Mina Hur *et al.* reported median age of 67.5 years in their study.[11] Difference in median age might be due to the selection criteria as there was no age limit in their study and this study have limited the age group from 18 to 65 years of age to avoid bias.

Disease categorization was done in this study to correlate it with biomarker values to understand MODS in suspected sepsis. In this study, majority of patients with suspected sepsis had respiratory complaints (55.3%) which was in concordance with study done by Bouza *et al.* (50.5%)[20], Magrini *et al.* (50.1%)[3] and Wester *et al.* also found that respiratory complaints were comparatively more in patients with sepsis who were below 65 years of age.[21] The clinical manifestations of sepsis are highly variable, depending on the initial site of infection, the causative organism, the pattern of acute organ dysfunction, the underlying health

status of the patient, and the interval before initiation of treatment. Acute organ dysfunction most commonly affects the respiratory and cardiovascular systems.[2,21]

Pro-Calcitonin (PCT)

In this study, PCT was positive in 95.4% of SIRS patients on arrival in ED that was in concordance with the study done by Mina Hur *et al.* who reported positive PCT values above 0.05ng/ml in 91.7% of suspected sepsis patients.[11]

Study done by Junyan Qu *et al.* showed positive results for PCT in all their patients (100%) with PCT value >0.06ng/ml as reference in their study.[22] Although study done by Nanda *et al.* showed 74% patients with positive PCT values which may be because reference for positive PCT result in their study was value >0.5ng/ml.[23]

In the present study, PCT at arrival showed a sensitivity of 100%, OR-12.6, CI-0.6-255.04, p=0.098, for early detection of MODS at 48 hours and kappa = 0.144, suggesting poor prediction of PCT for the possibility of development of MODS as PCT was positive in MODS negative patients also. In this study, PCT has a good NPV value that signifies that the normal value of PCT rules out the possibility of MODS in SIRS-positive patients. Studies done by Magrini *et al.* (Sensitivity 71%, Specificity 22%, PPV 30% and NPV 61%) and Nanda *et al.* (Sensitivity 85.7%, Specificity 85.7%, PPV 11.7% and NPV 93.9%) also showed near similar results in their studies.[3, 23]

C-Reactive Protein (CRP)

In present study, on arrival screen positive suspected sepsis showed elevated CRP in 90.8% patients. Study done by Pavare Jane *et al.* showed similar results with elevated CRP in 100% patients of SIRS with sepsis and in 71% patients with SIRS without sepsis.[27] Study done by Castelli *et al.* also showed that all 157 patients (100%) of SIRS with sepsis were showing positive CRP values.[25]

In present study, CRP which was done on arrival showed (Sensitivity 100%, OR-27.0, CI-1.44-504.0, p=0.027), Cohen kappa showed fair agreement (kappa= 0.28), suddesting that CRP cannot predict development of MODS as it can be positive in MODS negative patients also due to underlying infection and inflammatory response. Magrini *et al.* studied CRP and showed significant results when it was done on day 5 of admission (p<0.02) but when CRP was done on arrival, it was not significant (p=0.74).[3]

CRP has a high NPV, which means that the normal value of CRP in suspected sepsis patients almost rules out the disease. Studies done by Magrini *et al.* (Sensitivity 100%, PPV 67.8%, NPV 100%), Hong-Xiang Li *et al.* (Sensitivity 90%, Specificity 68%, PPV 81% and NPV 83%), Hisamuddin *et al.* (Sensitivity 76.92%, Specificity 53.49%, PPV 80% and NPV 48.94%) and Sierra *et al.* (Sensitivity 94.3%, Specificity 87.3%, PPV 90.4% and NPV 92.3%) showed near similar results which were in concordance with this study.[3,26]

N-Terminal pro-B-Type Natriuretic Peptide (NT-proBNP).

In this study, NT-proBNP was positive in 66% of patients with suspected sepsis at the time of admission (Sensitivity 82.5%, OR-7.07, CI-2.55-22.16, p=0.0008), PPV for MODS and Cohen kappa showed moderate agreement (kappa= 0.43) suggestive of high possibility of developing MODS during hospital stay. Mina Hur *et al.* grouped sepsis patients into survivors and non-survivors and they found that BNP concentrations were significantly higher in the non-survivors than in the survivors (p= 0.0002).[11] Mina Hur *et al.* also used SOFA score and they found that elevated levels of NT pro BNP were associated with the cardiovascular subscore of SOFA score. They concluded that multimarker strategy including BNP, NGAL and PCT seems to be an objective and useful approach for the diagnosis, staging, assessing organ dysfunction or failures along with establishing sepsis severity.[11]

NTpro-BNP level represents a rapid and relatively inexpensive method and proves to be a powerful predictor of mortality in patients with sepsis.[16, 27] In this study, NTpro-BNP results was in concordance with study done by Fei Wang *et al.* (Sensitivity 79%, Specificity 60%, LR+ 2.06, LR- 0.32) and Mokart D *et al.* (Sensitivity 86%, Specificity 77%, PPV 79% and NPV 85%).[27,28]

Neutrophil gelatinaseassociated lipocalin (NGAL).

NGAL values were positive in 49% of patients of suspected sepsis on arrival in ED. A study done by Angeletti *et al.* also showed positive NGAL value in 36.3% of suspected sepsis patients at the time of admission.[29] NGAL was positive in 77.5% (31 out of 40) MODS positive patients at 48 hours and in 4% MODS negative patients, suggestive of it's high specificity and positive predictive value for MODS. NGAL values was statistically significant at 48 hours for early MODS detection in suspected sepsis patients (p=0.001) and Cohen kappa showed

substantial agreement while in MODS positive and MODS negative patients (kappa= 0.69) which suggests that patients with NGAL positive values are highly predictive of developing MODS during the illness. In this study, NGAL showed good specificity, Positive predictive value and Positive likelihood ratio, which was in concordance with studies done by Shapiro *et al.*[17] Among 25 (38.5%) MODS negative patients at 48 hours, only one patient (4%) became MODS positive at 72 hours of hospital admission. Similar results of Chi square and Cohen kappa were found in this study at 72 hours of hospital admission for all the biomarkers. One sepsis screenpositive patient who became MODS positive at 72 hour was diagnosed with dengue fever and hematological sub score of MODS score was raised leading to MODS positivity due to low platelet count because of the disease. Later on, this patient were recovered without any need of platelet transfusion and was discharged.

Taken together, these findings imply the clinical usefulness of these innovative biomarkers to assess the organ dysfunctions or failure in suspected sepsis patients on their arrival in ER. Poor prognosis of the disease can be anticipated and management accordingly by predicting MODS early.

CONCLUSION

This study established good correlation, moderate and substantial agreement of NT-pro BNP and NGAL with positive MODS score suggesting that these biomarkers can be used to screen and early predictive of developing MODS in suspected cases of sepsisin the ED atarrival. The normal value of PCT and CRP on arrival in patients with suspected sepsis rules out MODS even at 72 hours during their hospital stay.

Recommendation

- All suspected sepsis cases (SIRS and qSOFA positive patients) should under go multiple biomarker tests on arrival in ED.
- Consider that MODS will be less likely if PCT and CRP are normal on arrival.
- NTproBNP and NGAL needs serial testing at 48 or at 72 hours to diagnose MODS.
- Patients with positive NT pro BNP and NGAL should be admitted under monitored care due to high likelihood of developing MODS.

Conflict of interest: The authors have not received funding for the study and declare no conflicts of interest. Medical writing experts have not been used.

Limitation

Limitations of our study includes that, it is a small cohort from a single center more sample size gives better results.

Statement of Equal Authors' Contribution

All authors have contributed equally in preparing the manuscript.

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