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PREDICTION OF MORTALITY OF SURGICAL CRITICALLY ILL PATIENTS USING APACHE II, SOFA, C-REACTIVE PROTEIN/ALBUMIN RATIO AND LACTATE LEVELS IN A TERTIARY CARE CENTRE

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ABSTRACT

Background: Intensive care units (ICU) personnel have responsibility of treatment of critical patients so as to improve their outcome. "The Acute Physiology and Chronic Health Evaluation II (APACHE II)" is most commonly used scoring systems to judge prognosis. **Objective -** To find out the prognostic value of "APACHE II score", "SOFA score", "lactate levels" and "CRP/Albumin (CRP/Alb)" ratio for finding out the prognosis of surgical ICU patients. **Materials and Methods:** 75 patients admitted in surgical Intensive Care Unit (ICU) were included in the study. "APACHE II score", "SOFA score", "lactate levels" and "CRP/Albumin (CRP/Alb)" ratio of patients admitted into an ICU were calculated. **Results:** Range of APACHE II Score was 7-39 with mean 25.48 , the range of SOFA Score was 3-15 with mean 8.27 , the range of CRP/Albumin Ratio was 4.0- 27.0 with mean 16.46 and the range of Lactate Levels was 1.3- 9.8 with mean 5.77. **Conclusions:** Among the parameters investigated in this study, APACHE II score was found to be the best predictor of mortality based on ROC curve analysis (AUC=0.97), CRP/albumin ratio was found to be the most statistically significant variable (p value= 0.069) for predicting mortality amongst surgical critically ill patients. Although further studies are required in future so as to determine the cut-off values in predicting the prognosis and mortality.

KEYWORDS

Albumin, APACHE II, Lactate

INTRODUCTION

Rates of mortality of patients in surgical intensive care units are quite high, thus causing increased financial burden and loss of productivity. There are several factors influencing mortality like efficiency of staff, reason for ICU admissions, patient demography and infrastructure of ICU.[1] It is quite important to examine the patient for preexisting renal, cardiac, hematologic or hepatic comorbidities.[2]

Distinct markers of inflammation have been elucidated: acute phase proteins, cytokines/chemokines, reactive oxygen and nitrogen species, prostaglandins and cyclooxygenase-related factors. C Reactive Protein, blood lactate, albumin, CRP/albumin ratio correspond with degree of inflammation during immediate postoperative period. [3,4]

Various scoring systems were initiated for early diagnosis and management of such patients.

"Acute physiology and chronic health evaluation (APACHE)"[5], "Sequential Organ Failure Assessment (SOFA)",[6] and "Simplified Acute Physiology Score (SAPS)"[7] are used quite frequently to assess prognosis of surgical patients. Timely recognition of patients who are at risk of sepsis make outcome better. Thus globally investigators are trying to identify prognostic indicators for surgically critically ill patients.[8]

Thus this study was performed to evaluate the prognostic value of "APACHE II score", "SOFA score", "lactate levels" and "CRP/ Albumin (CRP/Alb)" ratio for finding out the prognosis of surgical ICU patients.

MATERIALS AND METHODS

It was a prospective observational study which was performed in a tertiary care centre to evaluate the efficacy of "APACHE II", "SOFA scores", "C-reactive protein/albumin ratio", and lactate levels in predicting mortality among surgical critically ill patients. All patients between ages of 18 and 75 who reported to surgery emergency with acute abdominal symptoms, such as abdominal discomfort, abdominal distention , non-passage of flatus and faeces, repetitive vomiting and signs of shock (septicaemic and haemorrhagic), were included in the study. Patients whose symptoms get relieved without needing surgical intervention or who denied to sign the consent form were excluded from the study. Sample size was 75. Informed written consent was taken from all the patients. A comprehensive history and physical examination were conducted, including monitoring of vital signs (pulse, temperature, blood pressure and respiratory rate).Blood investigations, including liver function tests, renal function tests, complete blood count, serum electrolytes, random blood glucose, viral markers, serum LDH, serum CRP, prothrombin time, and arterial blood gas analysis, were sent on the day of presentation, the 1st, 3rd, 7th and 10th day post operatively. Highest values of CRP/ Albumin ratio and Lactate levels were taken into consideration.

SOFA score was calculated on Day 0 and day 2 of admission and mean of both the values was taken for calculation.

APACHE II score was calculated on the day of admission and the 1st, 3rd, 7th, and 10th post op days respectively and mean of the values was taken for calculation.

Statistical Analysis

For statistical analysis, data was entered into a Microsoft Excel Spreadsheet and then analyzed by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA). Mean and Standard Deviation were used to categorize numerical variables and count & percentages were used for categorical variables. Logistic regression was performed considering "APACHE II score", "SOFA score", "CRP/ Albumin ratio" and Lactate levels as independent variables and mortality as the dependent variable. Correlation & its corresponding statistical significance was calculated between the independent and dependent variables. P-value < 0.05 was considered statistically significant.

RESULTS

Seventy five surgical patients admitted to the ICU of a tertiary care Hospital were studied. The study was done to ascertain the mortality risk of surgical critically ill patients admitted to the intensive care unit (ICU) of a tertiary care facility.

Table 1 -Diagnosis of Patients

Diagnosis	No. of Patients	Percentage (%)
Acute intestinal obstruction	31	41.3
Obstructed femoral hernia	5	6.7
Obstructed inguinal hernia	4	5.3
Perforation peritonitis	35	46.7

Out of 75 patients, maximum 35 (46.7 %) had perforation peritonitis followed by 31 (41.3%) who presented with acute intestinal obstruction (Table 1).

Table 2- Minimum and Maximum Observed Value APACHE II Score, SOFA Score, CRP/Albumin Ratio and Lactate levels

Variables	Minimum observed value	Maximum observed value	Mean	SD

APACHE II Score	7	39	25.48	8.74
SOFA Score	3	15	8.27	3.37
CRP/Albumin Ratio	4.0	27.0	16.46	6.28
Lactate Levels (mmol/L)	1.3	9.8	5.77	2.59

Table 2 shows that the range of APACHE II Score was 7-39 with mean 25.48, the range of SOFA Score was 3-15 with mean 8.27, the range of CRP/Albumin Ratio was 4.0- 27.0 with mean 16.46 and the range of Lactate Levels was 1.3- 9.8 with mean 5.77.

Table 3 - Outcomes of (Survived/Expired) Patients

OUTCOME	No. of Patients	Percentage (%)
EXPIRED	44	58.7
SURVIVED	31	41.3

Table 3 shows that out of 75 patients, 44 (58.7 %) expired and 31 (41.3%) survived.

Table 4- Comparison Between Outcomes and APACHE II Score

	OUTCOME (SURVIVED/EXPIRED)	N	Mean	Std. Deviation
APACHE II SCORE	Expired	44	31.70	5.093
	Survived	31	16.65	3.720

Table 5- Comparison Between Outcomes with SOFA Score

	OUTCOME (SURVIVED/EXPIRED)	N	Mean	Std. Deviation
SOFA SCORE	Expired	44	10.48	2.406
	Survived	31	5.13	1.522

Table 6- Comparison Between Outcomes with CRP/Albumin Ratio

	OUTCOME (SURVIVED/EXPIRED)	N	Mean	Std. Deviation
CRP/ALBUMIN RATIO	Expired	44	20.9870	3.22790
	Survived	31	10.0290	3.11661

Table 7- Comparison Between Outcomes with LACTATE (mmol/l)

	OUTCOME (SURVIVED/EXPIRED)	N	Mean	Std. Deviation
LACTATE (mmol/l)	Expired	44	7.509	1.6104
	Survived	31	3.294	1.4194

Table 4 to 7 shows the comparison of the mean values of each prognostic marker (APACHE II, SOFA score, CRP/Albumin ratio, and lactate levels) between survived and expired.

Table 8- Correlation with Mortality

Variables	Corr. Coeff (r)	p-value
APACHE II Score	0.85 (strong correlation)	P< 0.001
SOFA Score	0.79(strong correlation)	P< 0.001
CRP/Albumin Ratio	0.86(strong correlation)	P< 0.001
Lactate Levels: 0.81	0.81(strong correlation)	P< 0.001

Table 8 represents the correlation of various parameters with mortality.

Table 9- Logistic Regression Analysis

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	12.874a	0.694	0.935
a. Estimation terminated at iteration number 9 because parameter estimates changed by less than .001.			

Here Pseudo R^2 (Nagelkerke R Square) value was 0.935 means 93.5 % excellent predictive power (Table 9).

Although APACHE II and CRP/Albumin ratio have borderline significance, the model suggests that CRP/Albumin ratio is the strongest predictor of mortality among surgical critically ill patients.

ROC Curve Analysis

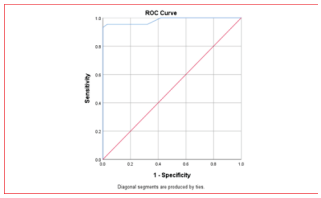

Fig 1 - ROC Curve for the test Variable APACHE II Score

APACHE II Score: AUC = 0.98 (Excellent predictor)

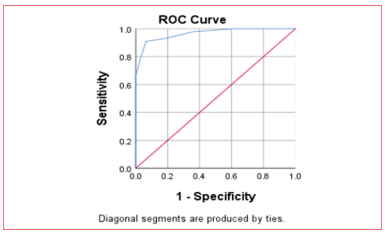

Fig 2: ROC Curve for the Test Variable SOFA Score

SOFA Score: AUC = 0.97 (Excellent predictor)

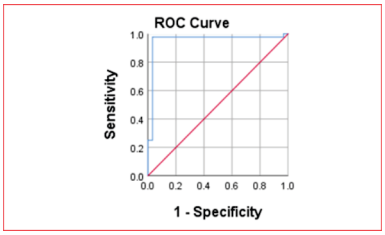

Fig 3: ROC Curve for the Test Variable CRP/Albumin Ratio

CRP/Albumin Ratio: AUC = 0.95 (Very strong predictor)

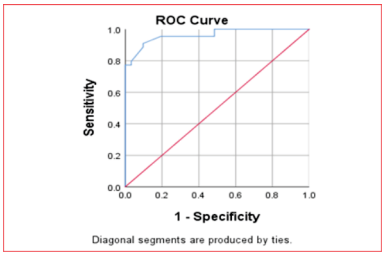

Fig 4: ROC Curve for the Test Variable Lactate Levels

Lactate Levels: AUC = 0.96 (Very strong predictor)

DISCUSSION

The present study was done to find out the risk of mortality of surgical critically ill patients admitted to the intensive care unit (ICU) of a tertiary care facility by comparison of predictive accuracy of APACHE II score, SOFA score, C-reactive protein/albumin (CRP/Alb) ratio, and lactate levels.

Various studies have shown that treatment delivered to surgical ICU patients should not just be confined to clinical procedures. Different systems which have been used for dealing with ICU complications after major surgery and mortality prediction are APACHE II, SAPS 3, and SOFA. So this study was undertaken to judge the prognostic value of APACHE II score, SOFA score, lactate levels and CRP/Albumin (CRP/Alb) ratio for finding out the prognosis of surgical ICU patients.

Among 75 patients, 18 (24%) were in the age group 21-30 years followed by 15 (20.0 %) in the age group 51-60 years, which was very much similar to the study done by Thakur et al. [9], wherein most of the patients fell in the age group 21-30 years.

In the present study, it was observed that range of APACHE II Score was 7-39 with mean 25.48 , the range of SOFA Score was 3-15 with mean 8.27 , the range of CRP/Albumin Ratio was 4.0- 27.0 with mean 16.46 and the range of Lactate Levels was 1.3- 9.8 with mean 5.77. Out of total 75 patients, there was a mortality of 58.7 %, which was quite high as compared to study conducted by Grissom et al. [10] , wherein the mortality was 17.3%, while low as compared to study conducted by Thakur et al. [9], where the mortality out of 72 patients was 87.50%.

The mean value of APACHE II score in non survivors was 31.70 in our study while in a study done by Thakur et al[9], it was 20.76. The mean value of SOFA score in non survivors was 10.48 in this study which was comparable to the mean value of 11.11 mentioned in a study done in 2023 by Thakur et al [9].

The AUROC curve for 'APACHE II score' was 0.98 while that for 'SOFA score' was 0.97. CRP/albumin ratio had an AUROC curve of 0.95 while lactate levels had an AUROC curve of 0.96. APACHE II score was found to be the best predictor of mortality based on ROC

curve analysis (AUC=0.97), which was very similar to the result concluded in 2017 by Jaiswal P, Agrawal S et al. [11]

As per the regression analysis performed, CRP/albumin ratio was found to be the most statistically significant variable (p value= 0.069) for predicting mortality amongst surgical critically ill patients.

"APACHE II score", "SOFA score", "CRP/Albumin ratio" and lactate levels, had significant correlation with mortality with correlation coefficients being 0.85, 0.79, 0.86 and 0.81 respectively and the p value for each one of them being <0.001, which was statistically significant.

This reflects levels have a very strong potential in predicting mortality in surgical patients with sepsis. Comparative studies conducted by Ratanarat et al.[12] and Thakur et al.[9] revealed a similar outcome.

Our study suggests that all four parameters have similar discriminative powers for predicting mortality in surgical ICU patients. Although ratio of C Reactive Protein /Albumin had the highest specificity (97.3%) and sensitivity (97.7%). APACHE II score had a specificity of 100% with a sensitivity of 93.2% and predictive accuracy of 96%.

A previous study conducted by Ganar et al. [13] in 2019 had results revealing SOFA score to be a better predictor of mortality than the APACHE 2 score in critically ill patients.

When analyzed together, APACHE II score and CRP/Albumin ratio demonstrated strong predictive capability for mortality in critically ill surgical patients.

CONCLUSION

This study demonstrates the efficacy of a multimodal predictive model that combines the APACHE II score, SOFA score, lactate levels and CRP/Albumin (CRP/Alb) ratio. SOFA and APACHE II scores are valid measures of organ dysfunction and severity of illness. Lactate levels have a quite high correlation with mortality risk and are an essential biomarker of metabolic distress. CRP/Albumin ratio is the strongest independent risk factor for mortality while APACHE II score is the best classifier of mortality.

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