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To Evaluate the Accuracy of APACHE IV Mortality Prediction of ICU Patients with Perforation Peritonitis Patients, Requiring Emergency Laparotomy

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ABSTRACT

APACHE (Acute Physiology and Chronic Health Evaluation) score is one of the several intensive care units (ICU) scoring systems. The death rate of patients admitted to ICU's is much higher than that of other areas. APACHE IV score is the youngest APACHE score was introduced in 2006 and used for estimating the risk of short-term mortality from actual clinical data in the first day after admission as well as predicting the length of intensive care unit (ICU) stay. To evaluate the accuracy of APACHE IV mortality prediction of ICU patients with perforation peritonitis patients, requiring emergency laparotomy. This is a prospective cohort study done in tertiary care center in central India ''To evaluate the accuracy of APACHE IV mortality prediction of ICU patient with perforation peritonitis patients, requiring emergency laparotomy" was conducted in Department of Surgery in 50 patients, Surgical Abdominal Sepsis admitted in Surgical intensive care unit (SICU) during study period, for two years periods. Inclusion criteria. All patients belonging to ≥16 years of age who were admitted in SICU, as a result of perforation peritonitis, requiring exploratory laparotomy, Patients willing to participate in the study after written informed consent. Exclusion criteria- Age < 16 years, Sepsis secondary to trauma, Laparotomies for non-septic indications. After obtaining Ethical clearance from Institute's Ethical Committee, all the patients fulfilling the inclusion criteria were enrolled in the study. Written consent was obtained from all the study participants. The participants were divided in two groups i.e. survivors and non survivors based on their outcome. Data was compiled using MS excel and comparison of APACHE IV score was made between the two groups (survivors and non-survivors) and its predictive efficacy was analysed. Mean age of patients in present study was 36±16.14 years. In present study, 42 (84%) out of 50 patients were males while 8 (16%) were females. All 5 patients who died were males. Most common etiology of SABS was small intestine perforation (36%) followed by gastric perforation (26%). Mean Apache score was maximum in intra-abdominal abscess (105) followed by ischemia (57) and gastric perforation and was minimum in large intestine perforation (29.3). Mean of MAP of 45 patients in survivor group was 82.55 mm Hg while the same in non-survivors was 75 mm Hg. Mechanical ventilation was used in total of 3 patients, out of which 1 survived and 2 patients succumbed to death. The association of mechanical ventilation usage with mortality (chi square test) amongst survivors and non survivors was found to be statistically significant ($p = 0.0008$). Deranged Sodium was seen in 11 out of 45 survivors (24.4%) and 2 out of 5 (40%) non survivors. The survivors had a mean urine output of 1020 mL and non-survivors had a mean urine output of 350 mL. In case of serum creatinine, mean of survivor group was 0.98 while in non-survivors is 1.74. Mean albumin in survivor group was 3.09 mg dL^{-1} and in non-survivors was 1.94. There was no mortality in 43 patients with APACHE Score <60. 60-80 score group had 2 patients with no mortality and 5 patients belonged to score > 80 with 100% mortality. Test of significance (Fischer exact test) showed statistically significant association between mortality and Apache score ($p<0.0001$). Mean APACHE score of Survivor group was 39.0 while that of non-survivor group was 86.20 and overall mean of all patients was 44.46. In present study, 12 patients had APS score less than 30 with no mortality. 1 out of 31 patients in 30-60 score range died while 4 out of 7 died in case of score > 60. A receiver operating characteristic (ROC) curve, comparative analysis of the mortality predictions with APACHE IV is done and shows AUC = 0.911 and $p<0.001$. Thus, showing the high predictive efficacy of APACHE IV score. The mean observed length of stay of all patients was 6.65 days against an expected LOS (length of stay) of 4.6 days. Overall O:E Ratio was 1.44 against O:E of 1.21 in non-survivors with observed and expected LOS of 10.2 and 8.42 days. The difference was statistically significant with $p = 0.02$. from this study we predict and evaluate the accuracy of APACHE IV mortality prediction of ICU patients with perforation peritonitis patients, requiring emergency laparotomy, which is essential for all healthcare workers.

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Key Words
SICU, emergency laparotomy, perforation peritonitis

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INTRODUCTION

APACHE (Acute Physiology and Chronic Health Evaluation) score is one of the several intensive care unit (ICU) scoring systems. The death rate of patients admitted to ICU's is much higher than that of other areas.

APACHE has two components: Acute Physiology Score (APS) and the chronic health evaluation, which incorporates the influence of co-morbid conditions (such as diabetes and cirrhosis). Out of these, physiological scoring is aimed at measuring the immediate status of the patient and focuses on the vital organs and their functional evaluation. It is a reflection of long-term disease process. Results of the evaluation can be used to estimate the mortality rate for patients in the ICU and during the hospitalization[1]. APACHE IV score is the youngest APACHE score was introduced in 2006 and used for estimating the risk of short-term mortality from actual clinical data in the first day after admission as well as predicting the length of intensive care unit (ICU) stay[2,3]. Sepsis is defined as "life-threatening organ dysfunction caused by a dysregulated host response to infection" and accounts for approximately 20% of Intensive Care Unit (ICU) admissions.

Surgical abdominal sepsis (SABS) defined as patients with evidence of preoperative severe sepsis or septic shock with a suspected or known abdominal source of infection requiring laparotomy for source control[4].

Severe Sepsis is defined as meeting at least one of the following criterions of SIRS with evidence of organ dysfunction[5].

- TEMPERATURE >38°C or <36°C
- HR >90 min^{-1}
- RR >20 min^{-1} or $PaCO_2$ <32 mm Hg
- WBC Count >12,000 cells mm^{-1^3} or <4,000 cells mm^{-3} or >10% immature bands
- Evidence of organ dysfunction
- Hypoperfusion (Lactate >1 mmol L^{-1})
- Hypotension (SBP <90 mmHg)

Aim and objectives: This is a prospective cohort study done in tertiary care center in central India ''To evaluate the accuracy of APACHE IV mortality prediction of ICU patients with perforation peritonitis patients, requiring emergency laparotomy" was conducted in Department of Surgery in 50 patients, Surgical Abdominal Sepsis admitted in Surgical intensive care unit (SICU) during study period, for two years periods

Inclusion criteria: All patients belonging to ≥16 years of age who were admitted in SICU, patients with perforation peritonitis, requiring exploratory laparotomy. Patients willing to participate in the study after written informed consent.

Exclusion criteria:

- Age <16 years
- Sepsis secondary to trauma
- Laparotomies for non-septic indications

MATERIALS AND METHODS

After obtaining Ethical clearance from Institute's Ethical Committee, all the patients fulfilling the inclusion criteria were enrolled in the study. Written consent was obtained from all the study participants. Physiological data and Biochemical data were collected at the time of admission or within 24 hrs of admission.

The variables used to calculate APACHE-IV score included age, sex, dates of admission, discharge or death, systolic and diastolic blood pressure, body temperature, heart rate, respiratory rate, glucose, blood urea nitrogen, serum sodium, creatinine, blood hematocrit, white blood cells, serum albumin and bilirubin, urine output during the first 24 hrs of ICU admission, pH, fraction of inspired oxygen, partial pressure of carbon dioxide and partial pressure of oxygen.

Death or discharge and length of stay in ICU were followed up by referring to patients' medical records. Additionally, APACHE-IV score, Glasgow coma score (GCS) and acute physiology score (APS) were calculated by APACHE IV calculator. (Online tool)

The present study enrolled 50 patients and the participants were divided in two groups i.e., survivors and non survivors based on their outcome.

Data was compiled using MS excel and comparison of APACHE IV score was made between the two groups (survivors and non-survivors) and its predictive efficacy was analysed.

Statistical analysis: APACHE scores and outcome variables were compared between survivors and non-survivors using Student's t-test/Fischer exact test wherever applicable.

- Accuracy of APACHE-IV was assessed using the Area under the Receiver Operator characteristic Curve (AUROC)
- Data Analysis was done using SPSS software

The present study enrolled 50 patients fulfilling inclusion criteria during the study period. The patients were observed during hospital stay until final outcome i.e., discharge or death. On the basis of their final outcome i.e., survival; patients were divided in two groups:

- Survivors
- Non-survivors

In 2016, the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3)[6] were released according to which, SIRS (Systemic Inflammatory response syndrome) is defined as the presence of two or more of:

- Temperature >38°C or <36°C
- Heart rate >90 min^{-1}
- Respiratory rate >20 min^{-1} or PaCO2 <32 mm hg
- WBC count >12000 mm^{-3} or <4000 mm^{-3} or >10% immature bands

Sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection. It's the primary cause of death from infection, especially if not recognized and treated promptly. It's a syndrome caused by pathogen factors and host factors (e.g., sex, race and other genetic determinants, age, co-morbidities, environment) with characteristics that evolve over time. What differentiates sepsis from infection is an aberrant or dysregulated host response and the presence of organ dysfunction. The clinical and biological phenotype of sepsis can however be modified by preexisting acute illness, long-standing co- morbidities, medication and interventions.

Sepsis-induced organ dysfunction may be occult, therefore, its presence should be considered in any patient presenting with infection. Patients with suspected infection who are likely to have a prolonged ICU stay or to die in the hospital can be promptly identified at the bedside with qSOFA, ie., alteration in mental status, systolic blood pressure <100 mm Hg, or respiratory rate $\geq$22 min^{-1}.

Septic shock is a further subset of sepsis in which underlying circulatory and cellular/metabolic abnormalities are profound enough to substantially increase mortality. Patients with septic shock can be identified with a clinical construct of sepsis with persisting hypotension requiring vasopressors to maintain MAP $\geq$65 mm Hg and having a serum lactate level >2 mmol L^{-1} (18 mg dL^{-1}) despite adequate volume resuscitation.

With these criteria, hospital mortality is in excess of 40%[7] (Fig. 1).

Following pulmonary sepsis, abdominal sepsis is the second most common form of sepsis requiring intensive care unit (ICU) management. In a nation-wide survey of ICU-treated adults with severe sepsis in Finland, an intra-abdominal source was found in 32% of patients and was associated with a hospital mortality rate of 30%[8].

Prediction scores: Scoring systems have been developed in response to an increasing emphasis on the evaluation and monitoring of health services. These systems enable comparative audit and evaluative research of intensive care. The ideal components of a scoring system are data collected during the course of routine patient management that are easily measured, objective and reproducible. Scoring systems, developed in the 1980s are applicable to heterogeneous groups of critically ill patients.

The evaluation of severity of illness in the critically ill patient is made through the use of severity scores and prognostic models. Severity scores are instruments that aim at stratifying patients based on the severity of illness, assigning to each patient an increasing score as their severity of illness increases. Prognostic models, apart from their ability to stratify patients according to their severity, predict a certain outcome (usually the vital status at hospital discharge) based on a given set of prognostic variables and a certain modeling equation[9].

Types of ICU outcome scoring systems specific[10]

Head injury	Glasgow coma score
Burns	%+age~mortality
Trauma	Injury severity score (ISS) trauma score
IHD	NYHA/AHA classification
Pancreatitis	Ranson's scoring criteria
Liver failure	Child Pugh classification, MELD Score, PELD Score

General[11,12]

Anatomical scoring: Depends on the anatomical area involved.

- Useful for trauma audits and research
- Injury severity score (ISS), abbreviated injury score (AIS)

Therapeutic scoring: Based on type and amount of treatment received.

- Sum of weighted scores of therapeutic interventions, Correlates well with outcome, Wide applicability
- e.g. therapeutic intervention scoring system (TISS)

Physiological: Based on degree of derangement of routinely measured physiological variables. Designed for quality review rather than prognosis

- Acute physiology and chronic health evaluation (APACHE), Simplified Acute Physiology Score (SAPS)

Specific models[13]

First generation	APACHE I
Second generation	SAPS I
	MPM I
	APACHE II
Third generation	SAPS II
	MPM II
	APACHE III
Fourth generation	SAPS III MPM III
	APACHE IV

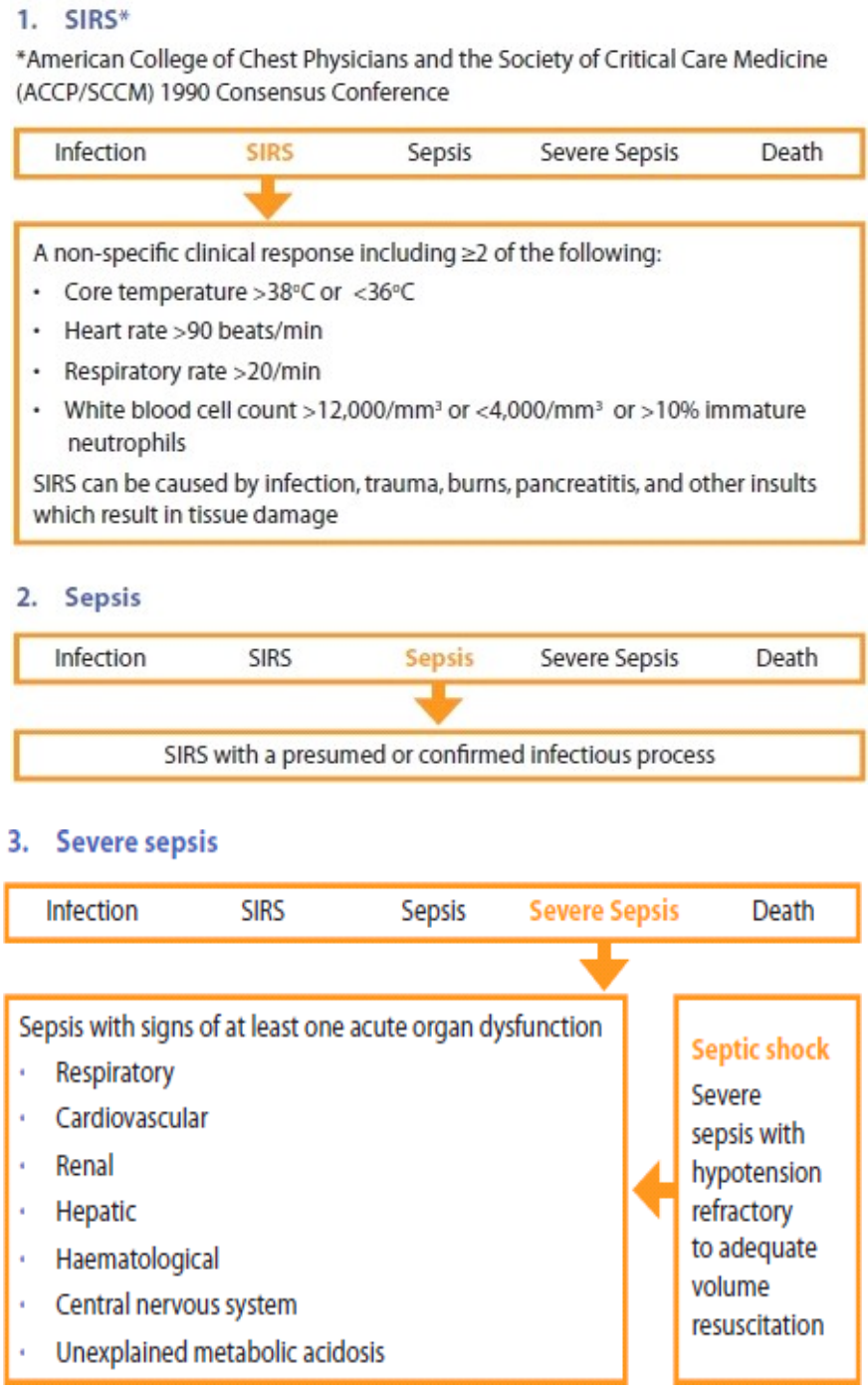

Fig. 1: Clinical features for identifying patients with sepsis and septic shock

Organ dysfunction scores[14]**:** To risk-adjust patients with longer, more severe illnesses like sepsis and acute respiratory distress syndrome, several models of organ dysfunction or failure have become available, including:

- Multiple organ dysfunction score (MODS)
- Sequential organ failure assessment (SOFA)
- Logistic organ dysfunction score (LODS)

Sequential organ failure assessment (SOFA)[15]**:** Previously known as Sepsis related Organ failure assessment, The Sequential Organ Failure Assessment (SOFA) score was developed to quantify the severity of patients' illness, based on the degree of organ dysfunction, was introduced in 1994 and further revised in 1996.

The SOFA score is composed of scores from six organ systems, each graded from 0-4 points according

Table 1: Etiological breakup of diseases with mortality

Etiology	No. of patients	Survivors	Non-survivors	Mean apache score
Large intestine perforation	3 (6%)	3	0	29.3
Small intestine perforation	18 (36%)	18 (100%)	0	43.0
Gastric perforation	13 (26%)	10 (76.92%)	3 (23.07%)	50.4
Abscess (Intra-abdominal)	1 (2%)	0	1 (100%)	105.0
Appendicular perforation	4 (8%)	4 (100%)	0	43.5
Large intestine obstruction	2 (4%)	2 (100%)	0	34.0
Small intestine obstruction	7 (14%)	7 (100%)	0	35.0
Ischemia/infarction	2 (4%)	1 (50%)	1(50%)	57.0

to the degree of dysfunction, giving a possible score of 0-24. The SOFA scoring system takes into account the time course of a patient's condition during the entire ICU stay.

Organ dysfunction can be identified as an acute change in total SOFA score ≥2 points consequent to the infection. The baseline SOFA score can be assumed to be zero in patients not known to have preexisting organ dysfunction.

ASOFA score ≥2 reflects an overall mortality risk of approximately 10% in a general hospital population with suspected infection[16]

APACHE IV[3,4]: APACHE IV score is the youngest APACHE score was introduced in 2006 and used for estimating the risk of short-term mortality from actual clinical data in the first day after admission as well as predicting the length of intensive care unit (ICU) stay. after a series of improvements, suggesting that APACHE IV is more accurate. According to recent studies, APACHE IV exhibits satisfactory discriminatory performance both in the United States, where it was first developed and outside the United States. APACHE IV scores can be used as a clinical predictor for early tracheostomy in patients with respiratory failure in ICU. Patients with APACHE IV scores greater than eighty are less likely to be extubated successfully. Outcome has usually been measured as death before discharge from hospital after intensive care. As the acute physiology score rise there was a linear increase in ICU stay until the score exceeded 80, at which point ICU stay decreased.

APACHE IV is a successful scoring system assessing severity of illness and prognosis of ICU patients. It has been evaluated and validated in our patients for mortality outcome.

RESULTS

Mean age of patients in present study was 36±16.14 years. Out of total 50 patients, 7 patients belonged to less than 20 years of age, with no mortality. About 33 patients belonged to 20-50 years of age group with 3 deaths and 10 patients belonged to more than 50 years with 2 deaths.

In present study, 42 (84%) out of 50 patients were males while 8 (16%) were females. All 5 patients who died were males.

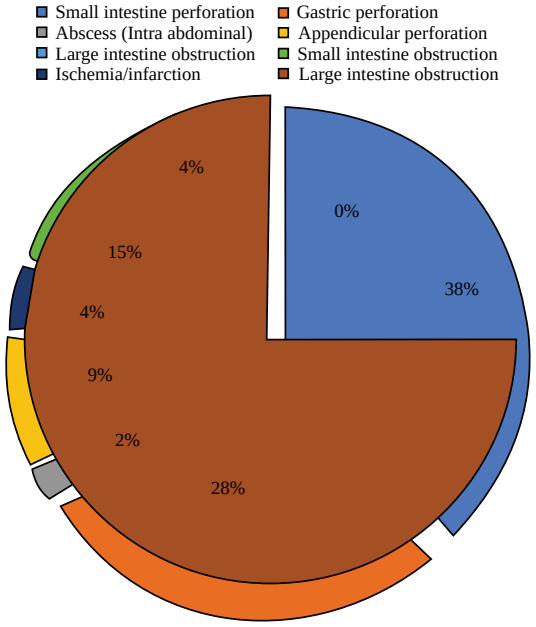

Fig. 2: Ethiological breakup of disease with motality

Most common etiology of SABS was small intestine perforation (36%) followed by gastric perforation (26%), Small intestinal obstruction (14%), appendicular perforations (8%), large bowel perforations (6%), large bowel obstructions (4%) and intra-abdominal abscess (1%). Mean Apache score was maximum in intra-abdominal abscess (105) followed by ischemia (57) and gastric perforation and was minimum in large intestine perforation (29.3) (Table 1 and Fig. 2).

Mean of MAP of 45 patients in survivor group was 82.55 mm Hg while the same in non-survivors was 75 mm Hg. Test of significance could not be applied as the data in the two groups was less (Table 2).

Mechanical ventilation was used in total of 3 patients, out of which 1 survived and 2 patients succumbed to death. The association of mechanical ventilation usage with mortality (chi square test) amongst survivors and non survivors was found to be statistically significant (p = 0.0008) (Table 3).

Deranged Sodium was seen in 11 out of 45 survivors (24.4%) and 2 out of 5(40%)non survivors. The association of mortality with deranged sodium level using chi square test was found to be statistically insignificant in present study (p = 0.45) (Table 4).

Table 2: MAP values in survivors and non survivors

	No. of patients	MAP (mm Hg)
Survivors	45	82.55
Non-survivors	5	75

Table 3: Use of mechanical ventilation in survivors and non- survivors

Mechanical ventilation used	Survivors	Non-survivors
Yes	1	2
No	44	3

p = 0.0008

Table 4: Sodium levels in survivors and non-survivors

Sodium level	Survivors	Non-survivors
Hypo/hypernatremia	11	2
Normal Na+	34	3

p = 0.45

Table 5: Mean Urine output comparison in survivors and non-survivors

	No. of patients	Mean urine output
Survivors	45	1020
Non-survivors	5	350

Table 6: Serum Creatinine comparison in survivors and non-survivors

	No of patients	Mean serum creatinine
Survivors	45	0.98
Non-survivors	5	1.74

Table 7: Serum Albumin in Survivors and non-survivors

	No. of patients	Mean serum albumin
Survivors	45	3.09
Non-survivors	5	1.94

While the survivors had a mean urine output of 1020 mL and non-survivors had a mean urine output of 350 mL. Test of significance could not be applied as the data was less (Table 5).

In case of serum creatinine, mean of survivor group was 0.98 while in non-survivors is 1.74. Test of significance could not be applied as the data was less (Table 6).

Mean albumin in survivor group was 3.09 mg dL^{-1} and in non-survivors was 1.94. Test of significance could not be applied as the data was less (Table 7).

Apache score: There was no mortality in 43 patients with APACHE Score <60. 60-80 score group had 2 patients with no mortality and 5 patients belonged to score >80 with 100% mortality. For the ease of analysis, Apache score was divided into ≤80 and >80. Test of significance (Fischer exact test) showed statistically significant association between mortality and Apache score (p<0.0001). Mean APACHE score of Survivor group was 39.0 while that of non-survivor group was 86.20 and overall mean of all patients was 44.46 (Table 8).

APS score: In present study, 12 patients had APS score less than 30 with no mortality. 1 out of 31 patients in 30-60 score range died while 4 out of 7 died in case of score >60 (Table 9).

Estimated mortality rates: A receiver operating characteristic (ROC) curve, comparative analysis of the mortality predictions with APACHE IV is done and shows AUC = 0.911 and p<0.001. Thus, showing the high predictive efficacy of APACHE IV score.

Table 8a: Division of cases on basis of apache score

Apache score	Total patients	Mortality
<60	43	0
60-80	2	0
>80	5	5

p<0.0001

Table 8b: Mean APACHE Scores of both groups

Groups	Mean apache score
Survivors (n = 45)	39.00
Non-survivors (n = 5)	86.20
Overall (n = 50)	44.46

Table 9 Division of cases on basis of APS score

APS Score	Total patients	Mortality
<30	12	0
30-60	31	1
>60	7	4

Length of stay (LOS): The mean observed length of stay of all patients was 6.65 days against an expected LOS (length of stay) of 4.6 days. Overall O:E Ratio was 1.44 against O:E of 1.21 in non-survivors with observed and expected LOS of 10.2 and 8.42 days. The difference was statistically significant with p = 0.02 (Table 10).

DISCUSSIONS

There has been much debate on the need for objective directives to follow for an ICU admission triage, which aims to efficiently provide critically ill patients with resources within ICUs[17]. A substantial amount of research has also been conducted on the efficacy of existing physiological scores in predicting mortality in ICUs[18].

Since the APACHE scoring system is based on objective physiological factors, it eliminates the possibility of errors made by the user. It also allows for simultaneous comparison and prospective analyses of patients from different ICUs and can be applied to a wide diversity of patients. APACHE has always been an important scoring and has been found realistic in all its versions[19,20].

The present study entitled "Evaluation of Predictive Efficacy of Apache IV Score in Surgical Abdominal Sepsis" was conducted on 50 patients admitted in S.I.C.U. of People's Hospital diagnosed with Surgical Abdominal Sepsis requiring exploratory laparotomy. Mean age of patients in our study was 36±16.14 years. 33 patients belonged to 20-50 years of age followed by 10 patients of >50 years age and 7 patients of <20 years of age. Whereas mortality was observed in 2 and 3 patients belonging to >50 years and 20-50 years of age group respectively. There was an age-wise increase in the rate of mortality as in the results above but the relation was not found to be statistically significant. Similar findings were seen in the study by Moses *et al*.[1] who also had similar results[1]. In another study by Chan *et al*., the mean age of study participants was 62.8±15.2 years. They found

a significant difference in age between survivors (60.7 years, 95% CI 58.3, 63.2) and non-survivors (67.9 years, 95% CI 64.1, 71.6)[21].

Majority of participants in present study were males that is 84% while only 16% participants were females. Mortality was observed in 5 males in our study. In a study by Ghorbani *et al*.[22] in Iran, study population comprised of 53.9% males and 46.1% females.[33] In another study by Shoukat *et al*.[23] 55.5% and 44.5% participants were males and females respectively. Out of 86 male patients, mortality occurred in 41 (47.67%) patients and did not occur in 45 (52.33%) patients, while 69 patients were females in which mortality occurred in 31 (44.92%) and not in 38 (55.08%) patients[38].

Most common etiology observed in present study was small intestine perforation (36%), followed by gastric perforation (26%) and Small intestinal obstruction (14%).

Similar disease patterns were found in the study by Wetr *et al*.[23] and Vishwani *et al*.[24], both of which included patients of sepsis undergoing exploratory laparotomy.

In present study, based on mortality, patients were divided into 2 groups, survivor and non survivor. Mean of MAP of 45 patients in survivor group was 82.55 mm Hg while the same in non-survivors was 75 mm Hg. Not much studies have considered mean arterial pressure. The abdominal perfusion pressure (mean arterial pressure– intra- abdominal pressure) has been shown to correlate with survival when maintained at levels greater than 50-60 mm Hg but level I evidence examining this as an end point of resuscitation has yet to be obtained[25].

In present study, mechanical ventilation was used in 3 patients. The association of mechanical ventilation usage with mortality amongst survivors and non survivors was found to be statistically significant (p = 0.0008). Martin *et al*.[26] in their study could not assess the association of mechanical ventilation and mortality, since mechanical ventilation was required in all patients[41].

The present study observed insignificant association of mortality with deranged sodium level. The mean urine output among survivors was 1020 mL and that in non- survivors was 350 mL. In case of serum creatinine, mean of survivor group was 0.98 while in non-survivors is 1.74. Mean albumin in survivor group was 3.09 mg dL^{-1} and in non-survivors was 1.94. Test of significance could not be applied as the data was less. The development of Acute Kidney injury is common following laparotomy, reaches greatest prevalence 48h after initial laparotomy and is an independent predictor of increased mortality[27].

In present study it was observed, higher the Apache score, worst is the prognosis and more the mortality. Test of significance showed statistically significant association between mortality and Apache score (p<0.0001). Ghorbani M et al also observed significant difference in mean Apache score amongst survivors and non survivors (p<0.001)[22]. El-Naggar *et al*. observed APACHE IV scores were significantly higher between dead than alive patients on admission and after 48 h but were not able to predict death in ICU[28]. Chan et al. suggested APACHE-IV crudely distinguished between survivors and non-survivors[21].

Also present study observed higher the Apache score, worst the prognosis and more the mortality. These findings were similar to study by El-Naggar *et al*.[28] and Saleh *et al*.[29] Yamin observed mean APACHE IV score of survivors to be 54.55, while mean APACHE IV score of non survivor was 85.07 which was significantly higher. About 63.9% patients had APACHE IV score <60, out of these 14.8% didn't survive. 27.8% patients had APACHE IV score >81 out of these 65.8% didn't survive (p<0.001). The 62.1% of overall population show the same outcome as predicted by APACHE IV (p = 0.61)[45].

The ROC curve showed the results to be pretty accurate with an AUC = 0.91 and p<0.01.AUC was 0.93 in a study in Turkey by Ayazoglu[30] In a study in South Korea also, AUC was 0.80 and significantly better than its predecessors[31]. Zimmerman *et al*.[3] concluded APACHE IV had good discrimination (area under the receiver operating characteristic curve = 0.88) and calibration (Hosmer-Lemeshow C statistic = 16.9, p = 0.08). For 90% of 116 ICU admission diagnoses, the ratio of observed to predicted mortality was not significantly different from 1.0[33]. Kuzniewicz *et al*.[32] also found similar results. They observed APACHE IV had the best discrimination (area under the receiver operating characteristic curve [AUC], 0.892) compared to MPM(0) III (AUC, 0.809) and SAPS II (AUC, 0.873, p<0.001).

The models differed substantially in data abstraction times, as follows: MPM(0)III, 11.1 min (95% confidence interval [CI], 8.7 to 13.4); SAPS II, 19.6 min (95% CI, 17.0 to 22.2) and APACHE IV, 37.3 min (95% CI, 28.0 to 46.6)[32].

In terms of length of stay (LOS), Mean of all patients was 6.65 days against an expected LOS of 4.6 days. Overall O:E (Observed LOS : Expected LOS) Ratio was 1.44 against, O:E of 1.21 in non-survivors with observed and expected LOS of 10.2 and 8.42 days. The results were pretty accurate with higher accuracy in non-survivor than the survivor group. The slightly higher prediction of Length of stay in survivor group by APACHE IV may be because of a conservative approach

to shift and discharge patients in the institute because of most patients were from the rural and low socio-economic group and hence the patient factors have to be kept in mind[34].

In a pilot study predicting ICU length of stay using APACHE-IV in severe sepsis patients by Chattopadhyay and Chatterjee in Cleveland, Ohio, similar results was found with a significant over-prediction of length of stay[35].

Lack of inpatient bed availability is a major contributor to emergency department (ED) crowding. Important reductions in LOS at ED (and others) and smoothening of ambulance diversion occur in urban academic medical center after an increase in adult ICU beds. A recent study demonstrated that the most notable change after ICU expansion was a decrease in time spent on ambulance diversion. Increasing ICU beds appears to have shortened ED LOS for ICU patients but has less effect on other admitted patients and apparently, no effect on patients discharged home. In emergency care a perfect balance between given resources and demand is much more difficult to achieve and maintain. In reality, certain key resources, e.g., ICU beds, are often over-utilized[36].

In conclusion, in this work, the APACHE IV scoring system exhibits satisfactory discrimination in predicting mortality in ICU patients with Surgical Abdominal Sepsis undergoing exploratory Laparotomy.

Results in terms of Length of stay are not accurate and a further workup on the same is required. Although, the results may be improved after removing the limitation of the study which is small sample size.

Hence, a larger study with greater sample size and if possible, involvement of multiple centers is recommended which could help in reaching some conclusive and milestone results.

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