

COMPARISON OF APACHE II, SOFA, POISON SEVERITY SCORING SYSTEM IN PREDICTING OUTCOME OF THE PATIENTS ADMITTED IN TOXICOLOGY ICU IN TERTIARY CARE HOSPITAL

S. Parimala Sundari¹, C. Adithyan²

¹Professor, Department of General Medicine, Madras Medical College, Tamilnadu, India

²Junior Resident, Department of General Medicine, Madras Medical College, Tamilnadu, India

Received : 02/09/2023
Received in revised form : 27/10/2023
Accepted : 09/11/2023

Keywords:

APACHE II, SOFA, Predicted Mortality Rate, Poisoning Severity Score, Drugs, Chemicals.

Corresponding Author:

Dr. C. Adithyan,

Email: adithyandr2009@gmail.com

DOI: 10.47009/jamp.2023.5.6.302

Source of Support: Nil,

Conflict of Interest: None declared

Int J Acad Med Pharm
2023; 5 (6); 1474-1478



Abstract

Background: Poisoning is a significant global health issue, causing numerous deaths annually. Common agents include alcohol, drugs, chemicals, pesticides, plant toxins, and household poisons. This study aimed to determine and compare the predictive and intensity value of three standard criteria of SOFA, APACHE II, and PSS scores for severity and prognostic relevance in treating poisoned patients. **Materials and Methods:** This prospective analytical study was conducted on 250 patients admitted to the Toxicology ICU in Government Rajiv Gandhi Government Hospital & Madras Medical College during the study period from June 2022 to November 2022. A proforma was used to gather patient demographic and clinical information, including age, sex, address, occupation, marital status, type of poisoning, and previous hospitalisation. Poisoning severity scores were assessed at admission and post-infection. **Result:** Males contributed to the majority of cases. Most of the patients were between 21-30 years of age. Suicidal contributed to the majority of the manner of poisoning, around 84%. The mean score of the death group was greater than that of the surviving group. There is a significant difference in mean APACHE II and SOFA between mortality ($p < 0.0001$). The APACHE II score with the highest accuracy, specificity, and positive predictive value and with sensitivity was better than other scores in predicting the clinical outcome. The Predicted Mortality Rate of SOFA was 30%, and APACHE II was 40%. **Conclusion:** APACHE II score was more predictive in clinical outcomes than SOFA and PSS due to poisoning and is recommended to poison centres as an effective criterion.

INTRODUCTION

Poisoning is a huge global health issue that significantly increases death. Despite the lack of complete statistics on the prevalence of poisoning and its effects, a lot of poisoning cases and deaths occur yearly.^[1,2] Immediate judgments and medical treatments are crucial in the treatment of these poisoned, as many poisoned patients were brought to the Intensive Care Unit (ICU) due to physiological instability and disruption of their important systems, including heart, kidney, and lung.^[3,4] India experiences about 50,000 poisoning-related fatalities. The most prevalent agents include alcohol, sedative drugs, chemicals (corrosive acids and copper sulphate), pesticides (organophosphates, carbamates, chlorinated hydrocarbons, and pyrethroids), as well as plant toxins (Datura, oleander, strychnos, and gastro-intestinal irritants like castor, croton, and calotropis, among others) and household poisons (most commonly cleaning agents).^[5] Poisoning from aluminium phosphide has been on the rise, and

herbicides like paraquat are experiencing an increase in prevalence.^[6]

In the last thirty years, there has been a significant increase in the prediction criteria of disease intensity and their use in the ICU medical system. To prioritise patient needs, assess the severity of poisoning, establish standards of care, allocate the best facilities to the most critically ill patients, and predict mortality, we can utilise predictive criteria of the disease outcomes.^[7] The most popular prognosis scoring scales among the numerable scoring models are the Sepsis-related Organ Failure Assessment (SOFA) and the Acute Physiology and Chronic Health Evaluation II (APACHE II). Since patients who have suffered from poisoning, these scores have not been compared together.^[8]

Poisoning Severity Score (PSS) is one of the criteria submitted by Persson et al. in 1998. This criterion was standardised for scoring poisoning severity and qualitative assessment of side effects, identifying the real risks, and comparing the data.^[9,10] The World Health Organisation (IPCS/EC/EAPCCT)

recommends it for assessing the poisoning. This study aimed to determine and compare the predictive and intensity value of three standard criteria of Sequential Organ Failure Assessment (SOFA) score, Acute Physiology and Chronic Health Evaluation (APACHE) II, and Poisoning Severity Score (PSS) in the short-term clinical outcome of poisoned patients.

MATERIALS AND METHODS

This prospective analytical study was conducted on 250 patients admitted to the Toxicology ICU in Government Rajiv Gandhi Government Hospital & Madras Medical College during the study period from June 2022 to November 2022. Ethical Committee approval was obtained before the study started.

Inclusion criteria

All Patients aged >18 years of age with acute poisoning and Envenomation admitted to Toxicology ICU and patients giving consent for the study were included.

Exclusion criteria

Patients who died in less than 24 hours were transferred out from the ICU within 48 hours, and patients who were treated elsewhere for > 72 hours and referred for further management were excluded. The patients in this study underwent detailed history and examination documented after obtaining Informed consent. A previously designed proforma was used to collect the demographic and clinical details of the patients. A detailed history was taken, and a clinical examination was performed. Age, sex, Address, Occupation, Marital status, Type of Poisoning, Manner of Poisoning, Amount of Poisoning, Co-morbidities, Previous history of similar illness in Past, and Prior Hospitalisation were collected.

All patients underwent routine toxicological investigations: Complete Blood Count, Renal

Function Test, Liver Function Test, Serum Electrolytes, Arterial Blood Gas, and other supportive investigations. Data was collected in 3 parts: Demographic information, applications of 3 criteria and final condition of the patient. The scores of Poisoning severity of 3 criteria were done at the time of admission and subsequent days until transfer out of the Toxicology ICU.

Statistical analysis

The data collected during the study was formulated into a master chart in Microsoft Office Excel, and statistical analysis was done with the help of a computer using the statistical software package SPSS V.17 for Windows. Using this software, frequencies, mean, standard deviation, Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, and Multi-variance were analysed, and a p-value of < 0.05 was taken as significant.

RESULTS

Males contributed to the majority of cases, around 56.8%, whereas females contributed to only 43.2%. Most of the patients were between 21-30 years of age. The youngest patient was 13 years of age, and the oldest was 86 years of age. Suicidal contributed to the majority of manner of poisoning, around 84%, whereas accidental contributed to only 16% of the cases.

Out of 250 patients, the majority of patients, around 91.6%, did not have any co-morbidities, 3.6% of patients have T2DM, SHTN, 0.8% of patients have coronary heart disease, 0.4% of patients have hypothyroid, psychiatric illness, decompensated liver disease, and heart failure.

Only 16% of patients required mechanical ventilation, and the remaining 84% of patients did not require mechanical ventilation. Only 12.8% of patients expired, and the remaining 87.2% survived due to meticulous care [Table 1].

Table 1: Demographic data of the study

		Frequency	Percentage
Gender	Female	108	43.20%
	Male	142	56.80%
Age group	<20	44	17.60%
	21-30	102	40.80%
	31-40	44	17.60%
	41-50	29	11.60%
	51-60	23	9.20%
	>61	8	3.20%
Manner of Poisoning	Accidental	40	16.00%
	Suicidal	210	84.00%
Co-morbidities	HFREF	1	0.40%
	CAD	2	0.80%
	DCLD	1	0.40%
	Hypothyroid	1	0.40%
	Psychiatric illness	1	0.40%
	SHTN	9	3.60%
	T2DM	9	3.60%
	Nil	229	91.60%
On Mechanical Ventilation	No	210	84.00%
	Yes	40	16.00%
Mortality	No	218	87.20%
	Yes	32	12.80%

Table 2: Frequency distribution of clinical outcomes based on poisoning severity score, mean APACHE II, and Mean SOFA outcome

		Outcomes			
		Recovery	Discharged with side effects	Dead	Total
Poison Severity Score	1	80	0	1	81
	2	111	0	4	115
	3	27	0	27	54
Mean APACHE II	>21.87	1	0	29	30
	<21.87	217	0	3	220
Mean SOFA	>7	2	0	28	30
	<7	216	0	4	220

Table 3: Mean APACHE II and SOFA between Mortality

	Mortality	Mean	Std. Deviation	P value
Mean APACHE II	No	4.83	4.43	<0.0001
	Yes	33.27	9.08	
Mean SOFA	No	1.41	2	<0.0001
	Yes	10.91	3.53	

Table 4: Frequency of samples and criteria average of SOFA, APACHE II, and PSS

Criterion	Clinical outcomes	Frequency of samples	Criteria average
SOFA	Dead	32	10.91±3.53
	Survived	218	1.41±2.0
APACHE II	Dead	32	33.27±9.08
	Survived	218	4.83±4.53
PSS	Dead	32	2.94±0.2
	Survived	218	2.34±0.5

Table 5: ROC of mean APACHE II and SOFA

	Values			
	Mean ROC	Min ROC	Max ROC	Significance Levels
SOFA	0.966	0.865	0.982	<0.0001
APACHE II	0.984	0.924	0.991	<0.0001

Table 6: Predictive of scores

Scores	Values				
	Accuracy	Sensitivity	Specificity	PPV	NPV
SOFA	97.64%	87.50%	99.08%	93.33%	98.18%
APACHE II	98.40%	90.63%	99.54%	96.67%	98.64%
PSS	87.20%	84.38%	87.61%	50%	97.45%

Table 7: Predicted Mortality Rate

Scores	Predicted Mortality Rate
SOFA	30%
APACHE II	40%

The mortality rate increased due to the severity of the poisoning, and 27 patients from Grade 3 poisoning have died. In APACHE II, with a mean score >21.87, only one patient recovered; the rest of the patients died. In SOFA mean score of >7, only 2 Patients recovered; the remaining 28 patients died [Table 2]. The scores of poisoning severity using SOFA in the patients with poisoning were around 0–16.25, and the mean was 10.91±3.53. The overall score of SOFA can be 0–24. The calculated cut point of SOFA was 7 (the patients with a score of >7 might lead to death, and a score of <7 might lead to survival). The mean score of the death group was greater than that of the surviving group. A significant difference in mean APACHE II and SOFA between mortality ($p<0.0001$) [Table 3].

According to the independent t-test, the results were significant at 0.001 in the three criteria.

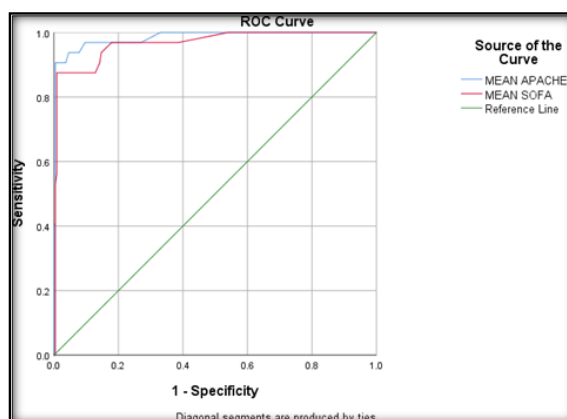


Figure 1: ROC curve of mean APACHE II and SOFA

The maximum and minimum coefficient correlation of SOFA was 0.982 and 0.865. The maximum and minimum coefficient correlation of APACHE II was 0.991 and 0.924. The APACHE II score covers most

samples with the highest surface area under the curve (AUC) [Table 5].

Accuracy, sensitivity, specificity, and positive and negative predictive values of SOFA, APACHE II, PSS in the short-term clinical outcome in the patients with poisoning were 97.64%, 87.50%, 99.08%, 93.33%, 98.18%, 98.40%, 90.63%, 99.54%, 96.67%, 98.64%, 87.20%, 84.38%, 87.61%, 50%, 97.45% respectively. The APACHE II score with the highest accuracy, specificity, and positive predictive value and with sensitivity was better than other scores in predicting the clinical outcome [Table 6]. The Predicted Mortality Rate of SOFA was 30%, and APACHE II was 40% [Table 7].

DISCUSSION

In our study, most patients were between 21-30 years (40.8%) of age, ranging between 16 and 86 years. Out of 250 poisoned patients in the ICU, there were 142 men (56.8%) and 108 women (43.2%). However, in Ebrahimi K et al. study, 41% of the samples were men, indicating that the number of women was greater than that of men.⁴ In another study, the mean age was 31.2 years, indicating the prevalence of poisoning problems among young people.^[11] The percentage of men with poisoning (76%) was higher than the percentage of women with poisoning.^[12]

In our study, Rodenticide was the most common cause of poisoning with 64 cases (25.6%), drug intoxication 44 cases (17.6%), poisoning by pesticides 42 cases (16.8%), out of which paraquat were 29 cases, snake bite 21 cases (8.4%), Bathroom acid and Cleaner 19 cases (7.6%) Unknown bite 14 cases (5.6%), Plant Poisoning 8 cases (3.2%), Scorpion sting 6 cases (2.4%), Supravasol Poisoning 2 cases (0.8%) remaining 30 cases (12%) were minor Poisonings. According to the findings of a different study, alcohol was only 10%, pesticides were 30%, and drugs were 33.4%.^[13] In another study, 17.98% of the cases were drug-poisoned.^[14] As a result of drug availability, drug toxicity was the primary cause in all three of the studies, as mentioned earlier. Opium was the leading cause of death (45.9%) in another investigation.^[4,15,16]

Suicide was the most frequent method of poisoning (84%), followed by unintentional poisoning (16%), which was comparable with the Tsoussi et al. study's (73% suicide) findings.^[17] Additionally, suicide was the primary cause of poisoning (87.3%) in a study by Sam et al. and was the primary cause of poisoning (52.2%) in a study by Vincent and Sakr.^[18,19] In a study, murder (1.4%), work issues (4.2%), and accidents (7% each) were listed as other methods of creating poison. Suicide can be committed for a variety of reasons, including ease (less pain and less terribleness) and cultural concerns (parental education).^[4]

Out of 250 patients, the majority of patients, around 91.6%, did not have any co-morbidities, 3.6% of patients have T2DM, SHTN, 0.8% of patients have

coronary heart disease, 0.4% of patients have Hypothyroid, Psychiatric illness, Decompensated Liver Disease, Heart Failure. The scores of poisoning severity using SOFA in the patients with poisoning were around 0–16.25, and the mean was 10.91±3.53. The overall score of SOFA can be 0–24. The calculated cut point of SOFA was 7 (the patients with a score of >7 might lead to death, and a score of < 7 might lead to survival).

The percentage of predictive death probability in the evaluated patients using SOFA was 30%. In a study by Ebrahimi K et al., the male score of SOFA was 7.5, consistent with the present study.^[4] In our study, SOFA's maximum and minimum coefficient correlation were 0.982 and 0.865. which did not match the study's findings by Halim et al. (liver system = 0.03 and cardiovascular = 0.969).^[20] The causes of the variations could be the physical side effects of surgery (Halim et al.20 study) or poisoning (present study) and how those effects are reflected in the pertinent criterion.

The scores of poisoning severity using APACHE 4 varied in the patients with poisoning (1–57), and the mean was 33.27±9.08. The maximum of creatinine variables (correlation coefficient = 0.45) had a higher correlation with the score of APACHE II. The cut point of this criterion was 21.87. The condition of the patients with APACHE scores of 21.87 and higher may lead to death, and the condition of the patients with APACHE scores of lower than 21.87 may lead to survival. The predictive rate of mortality using APACHE II was 40%, which was higher than the previous studies. In this research, the maximum and minimum coefficient correlation of SOFA was 0.991 and 0.924, which was higher when compared to the SOFA score.

In our study, the severity of poisoning considering PSS in 81 cases (32.4%) was Grade 1, in 115 cases (46%) was Grade 2, and in 54 cases (21.6%) was Grade 3. The mean criteria in the surviving group were 2.34±0.5, and in the death group were 2.94±0.2. In a study by Ebrahimi K et al., the severity of poisoning considering PSS in two cases (1.7%) was Grade 1, in 63 cases (52.5%) was Grade 2, and in 55 cases (45.8%) was Grade 3.4 Comparing the poisoning severity between men and women in both the mentioned study and the current one, the poisoning in men was more severe. Due to the manner of selecting very ill patients in the ICU, the study's results, as mentioned earlier, exhibited patterns that were different from those of the current investigation when taking into account the degree of poisoning; it appears that the patients in this study were too ill.

Comparing accuracy, sensitivity, specificity, and positive and negative predictive values of PSS, SOFA, and APACHE II in predicting the short-term clinical outcome in the patients with poisoning, it is revealed that the higher accuracy value was relevant to APACHE II (98.40%), the higher sensitivity value was relevant to APACHE II (90.63%), the higher specificity value and positive predictive value was

relevant to APACHE II (99.54% & 96.67%), and the higher negative predictive value was relevant to APACHE II (98.64%).

The criteria's respective AUCs (SOFA and APACHE 4) were 0.966 and 0.994 respectively. The past investigations demonstrated the acceptable performance of the three criteria in various patient groups and studies despite no study incorporating all three criteria. In a study by "Peter et al,"^[21] APACHE II (AUC = 0.77) showed better performance in comparison with Saps2 (AUC = 0.77). Although in previous studies, the accuracy of SOFA was higher than APACHE II, our study showed that APACHE II was more accurate than SOFA in Poisoning Patients.

CONCLUSION

All three scoring systems are useful tools for predicting the outcome of patients with poisoning, but APACHE II is the most accurate and reliable tool. This is likely due to the fact that APACHE II takes into account a wider range of factors, including the patient's underlying health conditions and the severity of their organ dysfunction. Thus, the results showed that it is possible to use APACHE II to predict the clinical outcomes and determine the poisoning severity in poisoning centres.

REFERENCES

- Gunnell D, Eddleston M, Phillips MR, Konradsen F. The global distribution of fatal pesticide self-poisoning: Systematic review. *BMC Public Health* 2007;7. <https://doi.org/10.1186/1471-2458-7-357>.
- World Health Organization. Global health risks: Mortality and burden of disease attributable to selected major risks. Genève, Switzerland: World Health Organization; 2009.
- Rasimas JJ, Sinclair CM. Assessment and management of toxidromes in the critical care unit. *Critical care clinics*. 2017 Jul 1;33(3):521-41. <https://doi.org/10.1016/j.ccc.2017.03.002>.
- Ebrahimi K, Raigani AA, Jalali R, Rezaei M. Determining and comparing predictive and intensity value of severity scores – "Sequential organ failure assessment score," "Acute physiology and chronic health Evaluation 4," and "Poisoning severity score" – in short-term clinical outcome of patients with poisoning in an ICU. *Indian J Crit Care Med* 2018;22:415–21. https://doi.org/10.4103/ijccm.ijccm_238_17.
- Bannur V, Jirli PS, Honnunar RS, Koulapur VV, Pujar SS. Pattern of Poisoning Cases at a Tertiary Health Care Centre- A Cross Sectional Study. *Medico-Legal Update*. 2019;19:124.
- Bonvoisin T, Utyasheva L, Knipe D, Gunnell D, Eddleston M. Suicide by pesticide poisoning in India: a review of pesticide regulations and their impact on suicide trends. *BMC Public Health* 2020;20. <https://doi.org/10.1186/s12889-020-8339-z>.
- Sam KG, Kondabolu K, Pati D, Kamath A, Pradeep Kumar G, Rao PGM. Poisoning severity score, APACHE II and GCS: Effective clinical indices for estimating severity and predicting outcome of acute organophosphorus and carbamate poisoning. *J Forensic Leg Med* 2009;16:239–47. <https://doi.org/10.1016/j.jflm.2008.12.004>.
- Koh SO, Kim KJ, Bang EC, Na SW, Nam YT. Relationships between APACHE II and APACHE III scores and mortality rate in intensive care unit patients. *Daehan Macwi'gwa Haghojeji* 1999;37:814. <https://doi.org/10.4097/kjae.1999.37.5.814>.
- Persson HE, Sjöberg GK, Haines JA, de Garbino JP. Poisoning severity score. Grading of acute poisoning. *J Toxicol Clin Toxicol* 1998;36:205–13. <https://doi.org/10.3109/15563659809028940>.
- Sigdel D, Jha SK, Kathet R, Mainali UK, Pokhrel R, Dwivedi A. Pattern and outcome of acute poisoning cases in a tertiary care hospital in eastern Nepal. *Int J Contemp Med Res*. 2019;6:27-31. <https://doi.org/10.21276/ijcmr.2019.6.4.53>.
- Jaikhani SM, Naik JD, Thakur MS, Langare SD, Pandey VO. Retrospective analysis of poisoning cases admitted in a tertiary care hospital. *Int J Recent Trends Sci Technol*. 2014;10:365-8.
- Wang L, Wu Y, Yin P, Cheng P, Liu Y, Schwebel DC, et al. Poisoning deaths in China, 2006–2016. *Bull World Health Organ* 2018;96:314-326A. <https://doi.org/10.2471/blt.17.203943>.
- Mintegi S, Azkunaga B, Prego J, Qureshi N, Dalziel SR, Arana-Arri E, et al. International epidemiological differences in acute poisonings in pediatric emergency departments. *Pediatr Emerg Care* 2019;35:50–7. <https://doi.org/10.1097/pec.0000000000001031>.
- Adepu R, Churi S, Jesslin J. Assessment of prevalence and mortality incidences due to poisoning in a South Indian tertiary care teaching hospital. *Indian J Pharm Sci* 2010;72:587. <https://doi.org/10.4103/0250-474x.78525>.
- Karbakhsh M, Salehian Zandi N. Acute opiate overdose in Tehran: The forgotten role of opium. *Addict Behav* 2007;32:1835–42. <https://doi.org/10.1016/j.addbeh.2006.12.014>.
- Peppin JF, Coleman JJ, Paladini A, Varrassi G. What your death certificate says about you may be wrong: A narrative review on CDC's efforts to quantify prescription opioid overdose deaths. *Cureus* 2021. <https://doi.org/10.7759/cureus.18012>.
- Tsaousi GG, Pitsis AA, Ioannidis GD, Pourzitaki CK, Yannacou-Peftoulidou MN, Vasilakos DG. Implementation of EuroSCORE II as an adjunct to APACHE II model and SOFA score, for refining the prognostic accuracy in cardiac surgical patients. *J Cardiovasc Surg (Torino)* 2015;56:919–27. PMID: 24525523.
- Sam KG, Kondabolu K, Pati D, Kamath A, Pradeep Kumar G, Rao PGM. Poisoning severity score, APACHE II and GCS: Effective clinical indices for estimating severity and predicting outcome of acute organophosphorus and carbamate poisoning. *J Forensic Leg Med* 2009;16:239–47. <https://doi.org/10.1016/j.jflm.2008.12.004>.
- Vincent JL, Sakr Y. SOFA so good for predicting long-term outcomes. *Resuscitation* 2012;83:537–8. <https://doi.org/10.1016/j.resuscitation.2012.02.024>.
- Halim DA, Murni TW, Redjeki IS. Comparison of Apache II, SOFA, and modified SOFA scores in predicting mortality of surgical patients in Intensive Care Unit at Dr. Hasan Sadikin General Hospital. *Crit Care Shock*. 2009;12:12.
- Peter JV, Thomas L, Graham PL, Moran JL, Abhilash KPP, Jasmine S, et al. Performance of clinical scoring systems in acute organophosphate poisoning. *Clin Toxicol (Phila)* 2013;51:850–4. <https://doi.org/10.3109/15563650.2013.841181>.