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Prognostic Utility Of POP Scale, PMS, And Pseudocholinesterase In Acute Organophosphate Poisoning: A Prospective Observational Study

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Abstract: *Organophosphate (OP) toxicity continues to pose a major public health challenge worldwide, especially in low- and middle-income countries where pesticide application in agriculture is extensive. According to the World Health Organization (WHO), pesticide-related toxicities contribute to over 300,000 deaths each year, with OP compounds accounting for a significant proportion (1). The fundamental pathophysiological mechanism of organophosphate poisoning is the irreversible inhibition of acetylcholinesterase, a critical enzyme that degrades acetylcholine at synaptic clefts and neuromuscular junctions. This enzymatic blockade results in the excessive accumulation of acetylcholine, leading to persistent stimulation of cholinergic receptors and the onset of a cholinergic crisis, which manifests as a constellation of muscarinic, nicotinic, and central nervous system symptoms (2). Clinically, OP poisoning manifests across a broad spectrum, ranging from non-specific symptoms like nausea, vomiting, and dizziness to life-threatening complications such as convulsions, respiratory paralysis, and ultimately death (3).*

INTRODUCTION

To facilitate early risk assessment and guide clinical decision-making in organophosphate (OP) poisoning, several scoring systems have been introduced to evaluate disease severity and predict clinical outcomes. Among these, the Peradeniya Organophosphorus Poisoning (POP) scale—originating from Sri Lanka—has gained broad clinical acceptance. This validated tool employs six key clinical indicators: pupillary diameter, respiratory rate, muscle fasciculations, level of consciousness, seizure activity, and heart rate. Based on the composite score, patients are stratified into mild, moderate, or severe categories of OP poisoning, thereby aiding in timely and appropriate therapeutic interventions (4). Despite its utility, the POP scale alone may not fully predict mortality, necessitating additional prognostic markers such as the Poisoning Mortality Score (PMS) and pseudocholinesterase (PChE) levels. The Poisoning Mortality Score (PMS) is a recently developed tool designed to predict fatal outcomes by considering factors such as age, severity of poisoning, and laboratory parameters [(5)]. Studies have shown that incorporating PMS alongside clinical severity scores like the POP scale enhances the ability to predict mortality risk more accurately [(6)]. Similarly, pseudocholinesterase levels serve as an important biochemical marker of OP poisoning severity. Since OP compounds irreversibly inhibit cholinesterase, serum PChE levels often correlate with poisoning severity and recovery trends [(7)]. Lower PChE levels at presentation are associated with increased severity and poorer outcomes, making it a valuable adjunct for prognosis [(8)].

Several studies have explored the correlation between the POP scale and biochemical markers such as PChE, highlighting their role in guiding clinical management.

However, the role of these markers in improving treatment outcomes and mortality reduction remains a topic of ongoing research. The present study is designed to assess the clinical severity and prognostic "outcomes in patients with organophosphate poisoning by employing the Peradeniya Organophosphorus Poisoning (POP) scale, the Poisoning Severity Score (PSS), and serum pseudocholinesterase (PChE)" activity as evaluative tools. By correlating these parameters, we seek to improve early risk stratification and guide clinical decision-making. The findings of this study could help refine existing prognostic models and contribute to better resource allocation in emergency settings.

MATERIALS AND METHODS

Design and Setting: Prospective observational study over 18 months (May 2023–Oct 2024) in the Emergency Medicine Department, Sri Devaraj Urs Medical College, Karnataka, India.

Participants: 100 consecutive adult patients (>18 years) with confirmed OP poisoning. Exclusions: mixed poison ingestion, chronic liver disease, neuromuscular disorders, unknown toxins.

Sample Size: 'The sample size estimation for the present study was based on a previously published investigation evaluating the Peradeniya Organophosphorus Poisoning (POP) 'Scale as a prognostic indicator of clinical outcomes in organophosphate poisoning Kamath SD et al. reported correlation coefficient of 0.4903, considering alpha error of 1%, at a power of 90% with 99% CI, 55 cases of organophosphate poisoning were required, expecting a dropout rate of 20% the final sample size will be 66 cases of organophosphorus poisoning.

- 'The standard normal deviate for $\alpha = Z_\alpha = 2.5758$'
- 'The standard normal deviate for $\beta = Z_\beta = 1.2816$'
- 'C = 0.5 * ln[(1+r)/(1-r)] = 0.5365'

'Total sample size = $N = [(Z_\alpha + Z_\beta)/C]^2 + 3 = 55$'

Method of Data Collection:

A structured proforma was employed to systematically document each patient's demographic information, clinical symptoms, vital signs, laboratory parameters—including pseudocholinesterase levels—along with details of treatment interventions and clinical outcomes. The severity of organophosphate poisoning was evaluated at the time of admission using the 'Peradeniya Organophosphorus Poisoning (POP) scale', while the Poisoning Mortality Score (PMS) was computed for each case to assess prognostic implications. Patients were monitored for a range of in-hospital outcomes, including the development of complications, requirement for ventilatory support, duration of ICU stay, and mortality.

Statistical Analysis:

'Data entry was performed using Microsoft Excel, and statistical analysis was conducted with IBM SPSS Statistics version 22 (Somers, NY, USA)'. 'Categorical variables were summarized as frequencies and proportions, and comparisons between qualitative variables were made using the Chi-square test. Continuous variables were expressed as means ±standard deviation (SD)'. Visual representations of data, including bar diagrams and pie charts, were created using MS Excel and MS Word. 'A p-value less than 0.05 was considered to indicate statistical significance'.

RESULTS

In the present study, most subjects were in the age group of 21-30 years and 31-40 years, each comprising 29.0% of the total sample. The mean age of the subjects was 35.99 ±13.687 years and the majority of the subjects were male, constituting 75.0% of the total sample, while females accounted for 25.0%

Regarding the distribution of compounds, compound Chlorpyrifos was the most common, found in 62.0% of cases, followed by compound Propofenos in 20.0% of subjects.

About 41.0% of subjects had moderate Peredeniya Organophosphorous Poisoning severity (scores of 4-7), followed by 39.0% with mild severity (scores of 0-3), while 20.0% had severe Peredeniya Organophosphorous Poisoning severity (scores of 8-11).

In terms of Poisoning mortality score severity risk levels, 55.0% of subjects were categorized as low risk (31-50), while 32.0% had an intermediate risk (51-65), and 13.0% were at high risk (>65). No subjects fell into the very low-risk category.

Based on Proud Foot classification, 47.0% of subjects were classified as severe, 28.0% as moderate, and 25.0% as mild.

Table 1: Correlation between POP score and Outcome parameters

	Ventilator stay days	ICU stay days	Hospital stay days

		Ventilator stay days	ICU stay days	Hospital stay days
PMS SCORE	Pearson Correlation	0.678**	0.319**	-0.107
	P value	<0.001*	0.001*	0.290
	N	100	100	100

POP score	Pearson Correlation	0.615**	0.472**	0.294**
	P value	<0.001*	<0.001*	0.003*
	N	100	100	100

A statistically significant positive correlation was observed between Peradeniya Organophosphorus Poisoning (POP) scores and several clinical outcomes parameter. Specifically, higher POP scores were associated with prolonged duration of ventilator support '(r = 0.615, p < 0.001), extended ICU stay (r = 0.472, p < 0.001), and increased total hospital stay (r = 0.294, p = 0.003)'. These correlations, significant at the 0.01 level (two-tailed), suggest that greater severity of poisoning as reflected by the POP score correlates with poorer clinical outcomes and increased resource utilization.

TABLE 2: CORRELATION BETWEEN PMS SCORE AND OUTCOME PARAMETERS

Similarly as shown in Table 2, PMS scores were positively correlated with ventilator stay days (r = 0.678, p < 0.001) and ICU stay days (r = 0.319, p = 0.001), but no significant correlation was found with hospital stay days (p = 0.290)

Table 3: Correlation between Pseudocholinesterase level and Outcome parameters

		Ventilator stay days	ICU stay days	Hospital stay days
Pseudocholinesterase level	Pearson Correlation	-.566**	-.717**	-.485**
	P value	.000	.000	.000
	N	100	100	100

Pseudocholinesterase levels as per Table 3 showed a significant negative correlation with ventilator stay days ($r = -0.566$, $p < 0.001$), ICU stay days ($r = -0.717$, $p < 0.001$), and hospital stay days ($r = -0.485$, $p < 0.001$), indicating that lower levels were associated with worse outcomes.

The overall outcome of the study showed that 88.0% of subjects were discharged, while 12.0% experienced mortality.

Table 4: Association between POP Score, PMS Score, Pseudocholinesterase level and Proud foot classification with Outcome

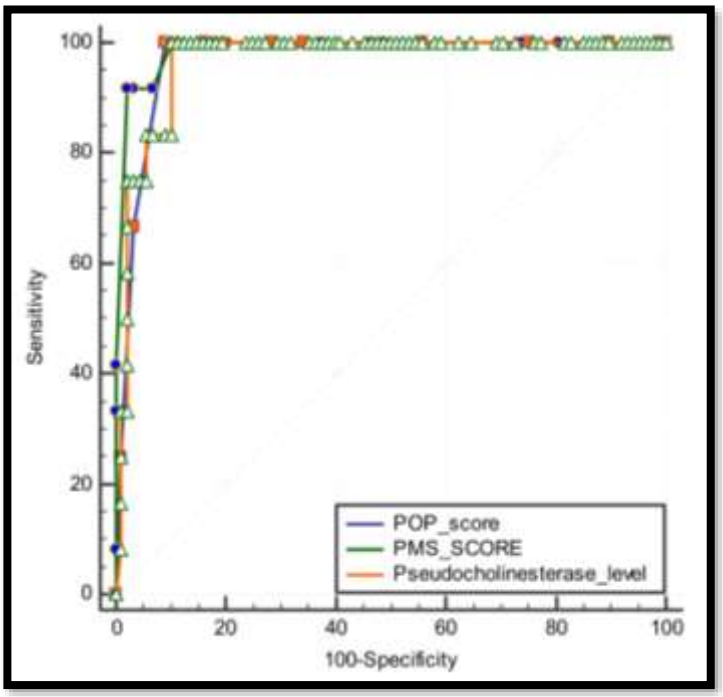
		Outcome				P value
		Discharge		Mortality		
		Count	Row N %	Count	Row N %	
POP Severity	Mild (0-3)	39	100.0 %	0	0.0%	<0.001 *
	Moderate (4-7)	41	100.0 %	0	0.0%	
	Severe (8-11)	8	40.0%	12	60.0 %	
PMS Severity	0-30 (Very Low Risk)	0	0.0%	0	0.0%	<0-.001*
	31 to 50 (Low Risk)	55	100.0 %	0	0.0%	
	51 to 65 (Intermediate Risk)	31	96.9%	1	3.1%	
	>65 (High Risk)	2	15.4%	11	84.6 %	
Pseudocholinesterase level	Mild Poisoning (4000 - 8000)	33	100.0 %	0	0.0%	<0.001 *
	Moderate Poisoning (1000-4000)	45	100.0 %	0	0.0%	
	Severe Poisoning (<1000)	10	45.5%	12	54.5 %	
Proud foot classification	Mild	25	100.0 %	0	0.0%	<0.001 *
	Moderate	28	100.0 %	0	0.0%	

	Severe	35	74.5%	12	25.5 %	

Table 4 : Pearson Chi-Square Tests

A significant association was observed between POP severity and outcome ($p < 0.001$). All patients with mild or moderate POP severity survived, whereas 60.0% of those with severe POP severity succumbed.
PMS severity was also significantly associated with outcome ($p < 0.001$). While all low-risk patients survived, 84.6% of high-risk patients experienced mortality.
Pseudocholinesterase levels were significantly associated with outcomes ($p < 0.001$), with all patients in the mild and moderate poisoning categories surviving, whereas 54.5% of those with severe poisoning did not survive.
Proud Foot classification was significantly associated with outcomes ($p < 0.001$), where all mild and moderate cases survived, while 25.5% of severe cases experienced mortality.

Figure 1: ROC Curve showing Comparison of Area under the ROC curve (AUC) for POP Score, PMS Score and Pseudocholinesterase levels in predicting mortality.



The ROC analysis in Figure 1 showed that POP score had an AUC of 0.968 ($p < 0.0001$) in predicting mortality, with an optimal cut-off score of >7, achieving a sensitivity of 100% and specificity of 90.91%.
The PMS score had an AUC of 0.987 ($p < 0.0001$) with an optimal cut-off of >57, showing 100% sensitivity and 89.77% specificity in predicting mortality.
Pseudocholinesterase levels had an AUC of 0.965 ($p < 0.0001$) with an optimal cut-off of ≤900, achieving 100% sensitivity and 89.77% specificity in predicting mortality.

DISCUSSION

The study demonstrates high predictive accuracy of the Peradeniya Organophosphorus Poisoning (POP) scale, Poisoning Mortality Score (PMS), and pseudocholinesterase levels in assessing clinical severity and mortality among organophosphate poisoning patients, with PMS showing the highest area under the curve (AUC = 0.987).

These findings are consistent with existing literature. **Kamath and Gautam (2021)**[9] reported the POP scale to be a reliable prognostic marker, showing significant correlation with patient outcomes and mortality risk, though their reported AUC was slightly lower, likely due to differences in sample size and inclusion criteria. Similarly, **Chintale et al. (2016)**[10] observed that higher POP scores aligned with increased clinical severity and mortality, though their study lacked ROC-based validation. **Dubey et al. (2016)**[11] also emphasized POP scale effectiveness, correlating it with biochemical markers such as serum amylase and CPK, but reported moderate specificity, possibly due to demographic and regional toxin variations.

The PMS score's superior performance in the current study echoes findings by **Krishna Moorthy et al. (2023)**[12] who demonstrated its enhanced sensitivity over traditional scores like SOFA and APACHE II, attributing its reliability to incorporation of multiple physiological and clinical parameters.

In evaluating pseudocholinesterase levels, **Chaudhary et al. (2019)**[13] and **Ahmed et al. (2014)**[14] found strong inverse relationships with clinical severity, aligning closely with the present study's AUC of 0.965, although variations in lab techniques and population enzyme baselines might explain minor differences in specificity. Collectively, these results reinforce the utility of multimodal assessment in organophosphate poisoning, with PMS emerging as the most robust predictor, while POP scale and pseudocholinesterase levels remain valuable adjuncts, especially in resource-limited settings.

CONCLUSION

The findings from the study demonstrated a strong positive correlation between POP scores and critical outcome parameters such as ventilator duration, ICU stay, and overall hospitalisation, underscoring the scale's value in assessing clinical severity. Similarly, PMS scores exhibited significant associations with the need for ventilator support and ICU admission, highlighting its predictive strength for morbidity and mortality. Serum pseudocholinesterase levels, on the other hand, showed strong inverse relationships with clinical outcomes, with lower levels corresponding to more severe disease presentations and poorer prognoses. Comparative analysis across these parameters revealed that all three tools — POP, PMS, and pseudocholinesterase levels — were significantly linked with therapeutic requirements, including atropine and pralidoxime doses, and the length of critical care interventions.

Furthermore, receiver operating characteristic (ROC) curve analysis affirmed the high predictive accuracy of all three models in determining mortality risk, with PMS scoring slightly higher in diagnostic precision. Overall, the study highlights that POP and PMS scoring systems, along with biochemical markers like pseudocholinesterase, can be reliably used for early risk stratification, guiding treatment intensity, and anticipating outcomes in organophosphate poisoning cases. These tools serve as essential components for clinical decision-making in emergency and intensive care settings, enabling timely and targeted interventions that can potentially reduce morbidity and improve survival rates among affected individuals.

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