Section: Emergency Medicine

Original Research Article

CORRELATION BETWEEN SERUM CHOLINESTERASE LEVELS AND CLINICAL SEVERITY USING PERADENIYA ORGANOPHOSPHORUS POISONING (POP) SCALE IN PATIENTS WITH ORGANOPHOSPHORUS POISONING

Modi Grishmaben Sureshkumar[1], Bhoomika Barada[2], Jaini Patel[3]

[1]Assistant Professor, GMERS Medical College, Sola, Ahmedabad, Gujarat, India.
[2]Assistant Professor, GMERS Medical College, Sola, Ahmedabad, Gujarat, India.
[3]Assistant Professor, GMERS Medical College, Sola, Ahmedabad, Gujarat, India.

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Corresponding Author:
Dr. Modi Grishmaben Sureshkumar,
Email: modi.grishma1992@gmail.com

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ABSTRACT

Background: Organophosphate (OP) poisoning is a major public health problem, particularly in developing countries like India, where it is commonly associated with agricultural exposure and intentional self-harm. It contributes significantly to morbidity and mortality due to its rapid onset and potentially fatal complications. Early identification of severity is essential for appropriate management and prognostication. This study aimed to evaluate the correlation between serum cholinesterase levels and clinical severity using the Peradeniya Organophosphorus Poisoning (POP) scale. **Materials and Methods:** This prospective observational study was conducted at a tertiary care hospital in Gujarat, India, from January 2019 to June 2019. A total of forty patients with confirmed organophosphate poisoning were included in the study. Clinical severity at presentation was assessed using the POP scale. Serum cholinesterase levels were measured at admission using the colorimetric method. The correlation between cholinesterase levels, POP scores, ventilatory requirements, and patient outcomes was analyzed using the chi-square test. **Results:** Among 40 patients, 60% were male, and the majority (50%) were aged 21–30 years. Male patients outnumbered female patients in this study. The most common route of poisoning was ingestion. Based on the POP scale, 80% of patients had mild poisoning. Serum cholinesterase levels were within the normal range (>3500 IU) in 60% of patients. Serum cholinesterase levels showed a significant correlation with clinical severity as categorized by the POP scale. Higher POP scale scores were associated with increased severity. Lower cholinesterase levels were linked to a greater need for ventilatory support and poorer outcomes, indicating their prognostic value. **Conclusion:** The present study concluded that serum cholinesterase levels show a significant correlation with clinical severity as categorized by the POP scale. Together, these parameters are useful for early risk stratification and prognostication in organophosphorus (OP) poisoning.

INTRODUCTION

Organophosphates are one of the most common poisons presented in the Emergency Medicine department. OP poisoning is primarily a problem in developing countries. Owing to the limited availability of facilities and resources, not all OP poisoning patients are managed in the ICU. Therefore, it is important to consider the clinical features and other factors that indicate the severity of poisoning and the criteria to predict the need for ICU admission.

India is a tropical country where agriculture plays a vital role in the nation's economy. More than 60% are farmers. Pesticides are the most frequent hazardous compounds to which farmers are exposed, with OP compounds being the most common cause of accidental exposure due to their use as agricultural insecticides. Owing to their low cost and easy availability, these agents are frequently used for suicidal and homicidal purposes.

Organophosphates act by irreversibly inhibiting the enzyme cholinesterase, resulting in the accumulation of acetylcholine at synapses and neuromuscular junctions, leading to cholinergic over activity. RBC cholinesterase is a sensitive indicator, but it is difficult to estimate in poisoning. The Peradeniya Organophosphorus Poisoning (POP) scale could be a

simple and effective system to determine the severity of OP poisoning and the need for ventilator support. The Peradeniya Organophosphorus Poisoning scale assesses the severity of poisoning based on symptoms at presentation.

The Peradeniya Organophosphorus Poisoning (POP) score is obtained at initial presentation and represents the muscarinic, nicotinic, and central effects of acute cholinergic manifestations of OP poisoning. A score of 0–3 is considered mild poisoning, 4–7 is considered moderate poisoning, and 8–11 is considered severe poisoning.

The present study aims to correlate serum cholinesterase levels with the clinical criteria score described by the POP scale, which may help in determining the severity of poisoning, predicting clinical outcomes, and making timely decisions regarding the transfer of patients for intensive care management.

MATERIALS AND METHODS

The study was conducted in the Emergency Medicine Department at New Civil Hospital, Surat, Gujarat, from January 2019 to June 2019. It was a hospital-based, prospective observational study that included 40 patients who satisfied the inclusion and exclusion criteria. Approval was obtained from the Institutional Ethics Committee, and all procedures were followed in accordance with the Helsinki Declaration of 1975, as revised in 2013.

Informed written consent was obtained from all patients or their legally authorized representatives before their inclusion in the study. The study included patients aged 12 years and older who had a confirmed history of exposure to organophosphate compounds and who presented within 24 hours of exposure. Patients suffering from poisoning due to substances other than organophosphates, those with mixed poisoning, individuals who were brought in dead with a history of organophosphate exposure, patients discharged against medical advice, pregnant patients, and those who did not consent to participate in the study were excluded.

All eligible patients underwent detailed history taking, including information on route and quantity of exposure, as well as any prior treatment, followed by a comprehensive clinical examination that focused on vital parameters, pupillary size, respiratory, cardiovascular, and central nervous system findings.

The diagnosis was made based on history or evidence of exposure to OP compound within 24 hours; characteristic manifestations of OP poisoning include, miosis, fasciculations, excessive salivation, corroborative evidence like empty containers, and odor of gastric aspirates. Clinical severity was assessed and categorized according to POP scale. The score was obtained at initial presentation before any medical intervention and it represented the muscarinic, nicotinic and central effects of the acute cholinergic manifestations of OP poisoning. A score of 0 to 3 is considered as mild poisoning, 4 to 7 as moderate poisoning and 8 to 11 as severe poisoning.

Upon confirmation of OP poisoning, 3–4 mL of venous blood was collected upon admission for laboratory investigations, which included complete blood count, random blood sugar, renal and liver function tests, and serum cholinesterase levels. Serum cholinesterase was measured using a colorimetric method, where butyrylcholinesterase hydrolyzes butyrylthiocholine to form thiocholine, which then reacts with dithiobisnitrobenzene to produce a yellow-colored compound. This compound can be measured spectrophotometrically at a wavelength of 405 nm, with the rate of color formation directly proportional to enzyme activity. Based on the enzyme activity, the severity of poisoning was categorized as follows: normal (greater than 50%, more than 3500 IU), mild (20–50%, 1400–3500 IU), moderate (10–20%, 700–1400 IU), and severe (less than 10%, less than 700 IU). Patients were closely monitored throughout their hospital stay until the outcome was determined.

Statistical Analysis: Chi-square test was used. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Age distribution of patients

Age group (Years)	No. of cases	Present Study
<20	5	12.50%
21- 30	20	50%
31-40	8	20%
41-50	5	12.50%
>50	2	5%
Total	40	100%

The age of patients ranged from 19 to 68 years. The majority of patients (50%) were in the age group of 21–30 years, followed by 31–40 years (20%), while 12.5% each were in the age groups <20 years and 41–50 years, and 5% were above 50 years.

Table 2: Gender distribution of cases

Gender	No. of patients	Present study
Male	24	60%
Female	16	40%
Total	40	100%
M:F ratio	--------	1.5:1

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Out of 40 patients, 24 (60%) were males and 16 (40%) were females, with a male-to-female ratio of 1.5:1, showing male predomince.

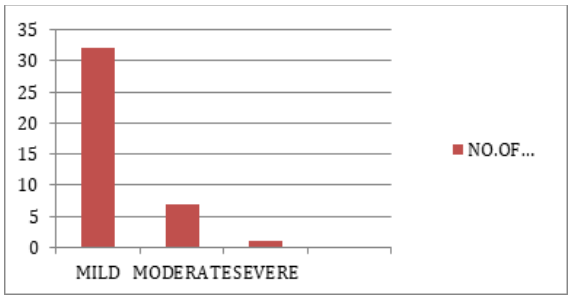


Figure 1: Graph showing severity according to pop scale

According to the POP scale, the majority of patients had mild poisoning (80%), followed by moderate (17.5%) and severe poisoning (2.5%).

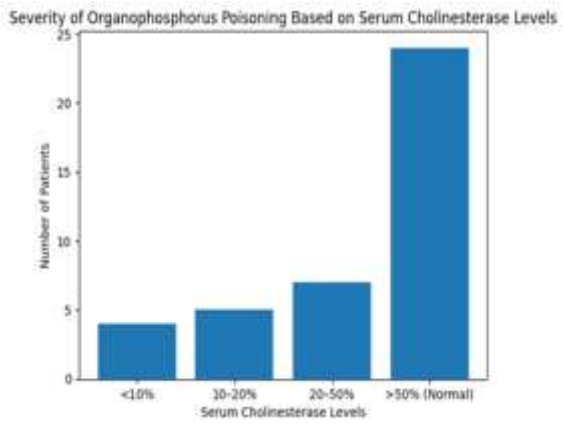


Figure 2

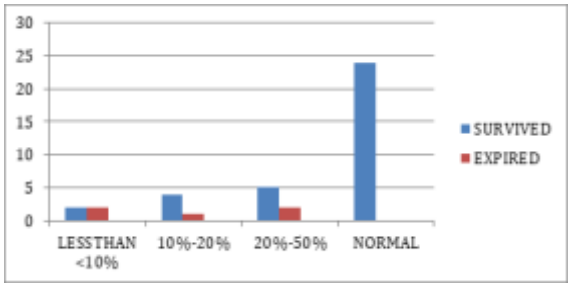
Based on serum cholinesterase levels, 60% of patients had values within the normal range (>50%, >3500 IU), while 17.5% had mild reduction (20–50%), 12.5% had moderate reduction (10–20%), and 10% had severe reduction (<10%).

Table 3: Corealtion between serumcholinesterase and ventilatory support

Serum cholinesterase level	Total	Ventilatory support	
		YES	NO
Less than < 10%	4	2 (50%)	2 (50%)
10%- 20%	5	3 (60%)	2 (30%)
20%- 50%	7	4 (57.14%)	3 (42.85%)
Normal	24	3 (12.5%)	21 (87.5%)
Total	40	12 (30%)	28 (70%)

Chisquare -8.86 p –value=0.03120

87% of patients with normal range of serum cholinesterase level did not required ventilatory support. 57% patient with less than 50% of serum cholinesterase required ventilatory support.



Chisquare =10.48 p-value=0.014

Figure: 4 Graph showing corelaton between serum cholinestrase and outcome

Patients with severely reduced cholinesterase levels (<700 IU) had the highest mortality rate (50%), indicating severe toxicity. As cholinesterase levels increased, survival rates improved, with patients in the 700–1400 IU group showing 80% survival and those in the 1400–3500 IU group showing 71.42% survival.

Table 4: Comparison of severity according to pop scale vs. Plasma cholinesterase level

POP SCALE	SERUM CHOLINESTRASE							
	<10% LEVEL		10%-20% LEVEL		20%-50% LEVEL		>50% LEVEL	
	TOTAL NO OF PATIENS IN <10%	NO OF PATIENTS EXPIRED IN <10% (MORTALITY %)	TOTAL NO OF	NO OF PATIENT EXPIREID IN 10-20% (MORTALITY %)	TOTAL NO OF PATIENT IN 20%-50%	NO OF PATIENT EXPIRED IN 20%-50% (MORATALITY %)	TOTAL NO OF PATIENTS IN >50%	NO OF PATIENTS EXPIRED IN >50% (MORTALITY %)
MILD	3	1 (33.3%)	4	1 (25%)	3	1 (33.3%)	22	0 (0%)
MODERATE	1	1 (100%)	0	0 (0%)	4	1(25%)	2	0(0%)

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SEVERE	0	0 (0%)	1	0 (0%)	0	0 (0%)	0	0(0%)
TOTAL	4	2 (50%)	5	1 (2O%)	7	2 (28.5%)	24	0(0%)

Chisquare =17.07 p-value=0.00902

A statistically significant negative correlation was observed between POP scale and serum cholinesterase levels, indicating that as the severity of poisoning increased, serum cholinesterase levels decreased. The association was found to be statistically significant ($\chi^2 = 17.07$, $p < 0.05$), supporting the role of serum cholinesterase as a reliable biochemical marker for assessing severity in OP poisoning.

DISCUSSION

The study was conducted at the Emergency Medicine Department of Government Medical College in Surat, where a total of 40 cases were studied. The clinical and diagnostic findings of this study are compared with those in the literature.

In the present study, the majority of patients were in the age group of 20 to 30 years, which aligns with the observations made in the DR UMA study. Additionally, 20% of patients were found in the age group of 31 to 40 years, a finding that was also reported in the DR UMA study. Meanwhile, 12.5% of patients were in the age group of 41 to 50 years, and a smaller group comprised those under 20 years of age. These observations are similar to those noted in the DR UMA study.

In our study, we included a total of 40 patients, comprising 24 males and 16 females. This results in a male-to-female ratio of 1.5:1. Our findings indicate that there were significantly more male patients than female patients, which is consistent with the observations from the DR UMA study.

In the present study, the POP scale was calculated for all patients at the time of their initial presentation. Most patients who presented to the emergency department had mild poisoning (80%), which is comparable to Rehman's study (70%) and the DR UMA study (65%). Meanwhile, the number of patients presenting with moderate poisoning was lower (17.5%) compared to the DR UMA study (33%) and Rehman's study (26%). This difference may be attributed to patients receiving preliminary treatment before arriving at the emergency department.

Serum cholinesterase levels were assessed in all patients upon admission to the hospital and classified according to the Proudfoot scale, which categorizes cases as subclinical (normal), mild, moderate, or severe poisoning. Among the patients presenting to the emergency department, 60% experienced subclinical poisoning, with serum cholinesterase levels remaining within the normal range (greater than 50%). This finding is comparable to the studies conducted by Honnematti et al., which reported that 48% of patients had serum cholinesterase levels above 50%, and by Dr. Uma, who found that 65% of patients fell into this category. Only 17% of patients had serum cholinesterase levels below 50%.

Total number of patients who had serum cholinesterase level less than 10 % in our study was 10% which was comparable to Honnematti and DR UMA study in which 7% and 5% patients had serum cholinesterase level less than 10%.

The majority of patients (60%) in our study presented with subclinical poisoning, with serum cholinesterase levels greater than 50% (3500 IU). Patients whose serum cholinesterase levels were below 50% experienced higher mortality rates compared to those with levels above 50% (3500 IU). This difference was statistically significant, with a p-value of less than 0.005. These findings are in accordance with those of Namba et al., who identified a definitive correlation between plasma cholinesterase (PChE) levels and the severity of poisoning. They consider PChE levels to be a valid marker for assessing severity and prognosticating outcomes in patients with organophosphate poisoning.

In our study, we found that 87% of patients with a normal range of serum cholinesterase levels did not require ventilatory support. In contrast, 57% of patients with serum cholinesterase levels below 50% did need ventilatory support. This indicates a significant correlation between serum cholinesterase levels and the necessity for ventilatory assistance.

There was the significant correlation between the severity of poisoning categorized by the POP scale and the serum cholinesterase at the time of initial presentation of the patients ($P<0.005$). The current study observed the significant correlation between the degree of derangement in serum cholinesterase level and severity of poisoning at the initial presentation. Higher the score on the POP scale, the greater was the degree of derangement in the serum cholinesterase level.

CONCLUSION

The present study demonstrates a significant correlation between plasma (serum) cholinesterase levels and the clinical severity of OP poisoning at the time of initial presentation. Lower cholinesterase levels are associated with increased severity, more pronounced clinical manifestations, and a higher likelihood of requiring ventilator support.

The POP scale, when used in conjunction with serum cholinesterase levels, serves as a reliable and effective tool for assessing severity and predicting clinical outcomes. In resource-limited settings where cholinesterase estimation is not readily available, the POP scale can still be utilized for early risk stratification.

Timely recognition of moderate to severe poisoning and prompt administration of appropriate antidotes in adequate doses and duration are critical in improving

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patient outcomes and reducing morbidity and mortality in OP poisoning.

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