MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.36478/makrjms.2024.12.944.952

Serum Creatine Phosphokinase Levels as Prognostic Biomarker in Organophosphate Poisoning in A Tertiary Care Hospital

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Abstract

Organophosphates (OPs) are a diverse group of chemical compounds formed by esterifying phosphoric acid with alcohol. Common uses for these compounds include insecticides, herbicides, and nerve agents in chemical warfare. This study aims to determine the prognostic value of serum CPK levels in OP poisoning and compare its predictive accuracy with the POP Scale. By integrating biochemical markers with clinical evaluation, the study seeks to improve early risk stratification, ensuring that high-risk patients receive timely and appropriate medical attention. This was a prospective observational study conducted in the Department of General Medicine at PESIMSR Hospital over a period of 18 months. The study population consisted of patients admitted with organophosphate poisoning during the study period. Patients were selected using a purposive sampling technique. Based on the study conducted by Bhattacharyya K. et al., the required sample size was estimated to be 100, and therefore, a total of 100 patients were included in the study. Patients were eligible for inclusion if they had a history of exposure to an organophosphorous compound and were above 18 years of age. A total of 59 participants (61.5%) required ventilator support, while 37 participants (38.5%) did not, indicating that a significant proportion of the study population experienced respiratory compromise necessitating mechanical ventilation. the association between the presence of intermediate syndrome and the severity of poisoning based on the POP score among the study participants (N=96). None of the participants with mild POP scores developed intermediate syndrome, while 6 participants (13.0%) with moderate scores and 10 participants (55.6%) with severe scores did. This study shows that the POP score, which measures organophosphate poisoning severity, is linked to biochemical markers, clinical outcomes, and sequelae. A substantial fall in serum pseudocholinesterase and a gradual increase in CPK were related to increased poisoning severity, ventilator support, intermediate syndrome, and fatality. All deaths were serious, emphasising the necessity for quick risk assessment. High CPK levels predicted respiratory failure and poor clinical prognosis, while low pseudocholinesterase levels predicted intermediate syndrome and death.

OPEN ACCESS

Key Words

Creatine phosphokinase, organophosphorus poisoning

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Received: 27th October 2024
Accepted: 11th November 2024
Published: 30th December 2024

Citation: Dr. Gajula Sudeshna, Dr. Vamshi Krishna Gatla, Dr. Patchava Alekhya and Dr. K. Mohan, 2024. Serum Creatine Phosphokinase Levels as Prognostic Biomarker in Organophosphate Poisoning in A Tertiary Care Hospital. Res. J. Med. Sci., 18: 944-952, doi: 10.36478/makrjms.2024.12.944.952

INTRODUCTION

Organophosphates (OPs) are a diverse group of chemical compounds formed by esterifying phosphoric acid with alcohol. Common uses for these compounds include insecticides, herbicides, and nerve agents in chemical warfare[1]. These inhibit critical enzymes in the nervous systems of pests, making them effective for agricultural use[2]. These have been linked to numerous poisoning incidents across the globe[3], especially in developing countries, as OPs are extensively used for both agricultural and domestic purposes, increasing the risk of exposure and poisoning[4]. The World Health Organisation has classified OPs as highly toxic pesticides, yet developing countries continue to use them extensively due to their low cost and easy accessibility[5].

The World Health Organisation estimates that there are over 3 million cases of acute poisoning and around 300,000 deaths annually worldwide[6]. A meta-analysis on OP poisoning in Nepal reported that the overall prevalence of OP poisoning in Nepal was found to be 36.7%. Hospital-based studies showed a higher prevalence (36.9%)[7]. In India, organophosphate poisoning is a common cause of death, particularly in the southern and central regions, as these substances are readily available and easily accessible for self-harm[8]. Studies in India indicate that the incidence of suicidal poisoning involving organophosphates ranges from 10.3% to 43.8%[9]. OP poisoning remains a common cause of hospital admissions and Intensive Care Unit (ICU) stays in developing countries[10-12]. In another Indian study, the incidence of OP poisoning was around 1.26 lakhs during the period of 12 months in 2007, as reported by Ravi *et al*.

Exposure to OPCs can occur through various routes, including ingestion, inhalation, or skin absorption[13]. The International Labour Organisation (ILO) and WHO recommend that farmers wear personal protective equipment (PPE) during pesticide application to reduce exposure and safeguard their health. Farmers and agricultural workers are at the highest risk, particularly when applying pesticides without adequate safety measures or protective equipment[14].

In India, the situation is exacerbated by a lack of awareness regarding safety protocols and the unrestricted sale of hazardous chemicals. A study by DAS et al. in Kurnool District, Andhra Pradesh, assessed baseline knowledge of organophosphorus (OP) poisoning hazards among 230 agricultural workers. The findings showed that 0% were aware of pesticide entry through skin contact, while 8.69% recognised inhalation as a route of exposure, and 32.17% identified ingestion as a risk. Awareness of personal protective equipment (PPE) use was 52%, while 28% stored used pesticide tins at home. Additionally, 0% knew about the proper disposal of empty pesticide containers[15]. These gaps, along with practices such as spraying pesticides in open environments, significantly increase the likelihood of accidental poisonings.

The pathophysiology of OP poisoning primarily involves the inhibition of acetylcholinesterase (AChE), an enzyme essential for breaking down acetylcholine, a key neurotransmitter for nerve transmission. When AChE is inhibited, acetylcholine accumulates at neuromuscular junctions, leading to overstimulation of cholinergic receptors in the nervous system[16]. This results in a range of symptoms categorised by severity. Mild symptoms include salivation, lacrimation, urination, diarrhoea, and gastrointestinal distress, known as the "SLUD" syndrome. As poisoning progresses,Moderate symptoms like muscle twitching, tremors, and increased respiratory secretions may occur. In severe cases, respiratory muscle paralysis can lead to respiratory failure, the primary cause of death. Central nervous system symptoms may also appear, such as confusion and seizures[17,18]. Respiratory failure due to acute cholinesterase crisis is the most common complication of OPC poisoning, which leads to death. A review and meta-analysis showed a significant positive association between OP exposure and respiratory diseases, with a link to wheezing and asthma. A significant association was also observed between OP exposure and DM. However, no significant association was found between OP exposure and CVD. While OP exposure was linked to increased risks of respiratory diseases and DM[19].

Early recognition of organophosphate (OP) poisoning and timely ventilatory support can significantly improve survival outcomes. The Peradeniya Organophosphorus Poisoning (POP) Scale remains a widely used clinical tool for assessing poisoning severity by categorising patients as mild, moderate, or severe based on symptoms such as pupil size, muscle fasciculations, respiratory distress, and consciousness level[20].

There is an increasing focus on identifying biochemical markers that can aid in assessing the severity of OP poisoning and predicting patient outcomes. One such marker is serum creatine phosphokinase (CPK), an enzyme primarily found in muscle tissue. Elevated CPK levels indicate muscle injury and systemic toxicity, both of which are relevant in OP poisoning. Continuous muscle fasciculations and cholinergic overstimulation caused by OP compounds lead to muscle damage, resulting in higher CPK levels in the bloodstream. Studies have shown that elevated CPK levels are associated with severe poisoning, a higher risk of intermediate syndrome, respiratory failure, and the need for mechanical ventilation. Monitoring CPK levels may help in the early detection of complications, allowing for timely interventions such

as ventilatory support and intensive care[21-23].

Traditional markers like erythrocyte cholinesterase (EChE) and pseudocholinesterase (BChE) are commonly used to assess OP poisoning severity. However, these tests require specialised laboratory facilities and can be costly. In contrast, CPK is a readily available and cost-effective marker that provides real-time insights into muscle damage and systemic toxicity. This makes it particularly useful in resource-limited settings where access to advanced laboratory tests is restricted.

This study aims to determine the prognostic value of serum CPK levels in OP poisoning and compare its predictive accuracy with the POP Scale. By integrating biochemical markers with clinical evaluation, the study seeks to improve early risk stratification, ensuring that high-risk patients receive timely and appropriate medical attention. A better understanding of CPK's role in OP poisoning may contribute to improved patient management, reduced hospital stays, and lower mortality rates. Incorporating CPK as a routine biomarker could help refine current treatment strategies and enhance patient care in OP poisoning cases.

Aims and Objectives: To determine the prognostic significance of serum creatine phosphokinase levels in OP Poisoning.

MATERIALS AND METHODS

This was a prospective observational study conducted in the Department of General Medicine at PESIMSR Hospital over a period of 18 months. The study population consisted of patients admitted with organophosphate poisoning during the study period. Patients were selected using a purposive sampling technique. Based on the study conducted by Bhattacharyya K. *et al*.[21], the required sample size was estimated to be 100, and therefore a total of 100 patients were included in the study.

Patients were eligible for inclusion if they had a history of exposure to an organophosphorous compound, were above 18 years of age, and belonged to either sex. Patients were excluded if they presented to the hospital with a remote history of poisoning greater than 24 hours, had pre-existing seizure disorders, neuromuscular diseases, or a history of atypical pseudocholinesterase.

The tools used in this study included sterile disposable 2 mL syringes, gloves, yellow vacutainers, and the Peradeniya Organophosphorus Poisoning (POP) Scale, which was employed to assess the severity of poisoning.

Data were collected using a structured proforma that was developed to record patient information systematically. This included demographic details such as name, age, sex, inpatient number, diagnosis, date of admission, date of discharge, address, case number, and occupation. Clinical information recorded included presenting complaints, relevant past medical history, family history, personal history regarding lifestyle habits such as smoking and alcohol consumption, and findings from the general examination. At admission, vital parameters such as temperature, respiratory rate, oxygen saturation (SpO_2), heart rate, and blood pressure were documented. Systemic examination included assessment of the cardiovascular, respiratory, abdominal, and central nervous systems. Laboratory investigations included complete blood count, renal function tests, liver function tests, and serum electrolytes.

Study-specific parameters included measurement of serum creatine phosphokinase (CPK) levels and assessment using the POP scale. These parameters were recorded at four time points: at admission, on Day 1, Day 3, and Day 5 of hospital stay. Treatment details such as the dose of atropine and pralidoxime used, as well as the date of intubation and extubation in ventilated patients, were also documented. Additional information collected included the number of days on mechanical ventilation, total length of ICU stay, and final clinical outcome at discharge in terms of recovery or complications.

For sample collection and biochemical analysis, written informed consent was obtained from each patient at the time of admission. A 2 mL venous blood sample was collected under aseptic precautions in a plain vacutainer tube. The sample was allowed to clot, and serum was separated by centrifugation. Serum CPK levels were then measured at admission, Day 1, Day 3, and Day 5 using the Dry-Chemistry Vitros 250 Analyzer (Johnson and Johnson). Routine Biorad quality controls were used throughout to ensure the reliability of results. The normal reference range for serum CPK was considered as 20–200 IU/L.

The data will be entered into MS Excel 2019 version and further analysed using SPSS (version-23.0; SPSS, Inc., Chicago, IL, USA).

For descriptive analysis, categorical variables were analysed using frequency and percentages. Continuous variables were summarised using mean ± standard deviation (SD) for normally distributed data, while the median with interquartile range (IQR) was used for skewed data.Appropriate graphs, including bar charts, histograms, and box plots, were generated to visually represent the distribution of key variables and enhance interpretability.

RESULTS AND DISCUSSIONS

Table 6 presents the distribution of ventilator support requirement among the study participants (N=96). A total of 59 participants (61.5%) required ventilator support, while 37 participants (38.5%) did

not, indicating that a significant proportion of the study population experienced respiratory compromise necessitating mechanical ventilation.

Table 2 shows the distribution of intermediate syndrome among the study participants (N=96). Sixteen participants (16.7%) developed intermediate syndrome, while the majority (n=80, 83.3%) did not exhibit this complication, suggesting that although relatively uncommon, intermediate syndrome was a notable clinical concern in a subset of cases.

Table 3 presents the outcomes of the study participants (N=96). The vast majority of participants survived (n=91, 94.8%), while 5 participants (5.2%) succumbed to poisoning. This indicates a high overall survival rate among the study population.

Table 4 illustrates the association between POP score severity and two biochemical markers—serum pseudocholinesterase and CPK—among the study participants (N=96). A significant decline in serum pseudocholinesterase levels was observed with increasing severity: mild cases had a mean of 3019 U/mL (SD ±873.2), moderate cases 1603.9 U/mL (SD ±281.5), and severe cases 930.5 U/mL (SD ±238.2). Similarly, CPK levels at admission and on subsequent days (1st, 3rd, and 5th) increased progressively with severity. On admission, the CPK levels were 288.5 U/mL in mild cases, 306.0 U/mL in moderate, and 492.9 U/mL in severe cases. By the 5th day, levels decreased in all groups but remained highest in the severe group (480.6 U/mL). The differences across all severity levels for both markers were statistically significant ($p < 0.001$), indicating a strong correlation between higher POP scores and more profound biochemical disturbances.

Table 5 highlights the association between the occurrence of intermediate syndrome and levels of serum pseudocholinesterase and CPK among the study participants (N=96). Participants who developed intermediate syndrome had significantly lower serum pseudocholinesterase levels (mean 1038.4 U/mL, SD ±378.0) compared to those without the syndrome (mean 2131.6 U/mL, SD ±947.2), with a p-value <0.001. Additionally, CPK levels were markedly higher in participants with intermediate syndrome at all time points. At admission, the mean CPK level was 621.2 U/mL in the affected group versus 278.0 U/mL in those without the syndrome.This difference persisted on Day 1 (686.9 vs. 343.2 U/mL), Day 3 (709.4 vs. 220.2 U/mL), and Day 5 (751.9 vs. 117.1 U/mL), all with p-values <0.001. These findings indicate a strong and statistically significant association between the development of intermediate syndrome and both reduced serum pseudocholinesterase and elevated CPK levels.

Table 6 shows the association between the presence of intermediate syndrome and the severity of poisoning based on the POP score among the study participants (N=96). None of the participants with mild POP scores developed intermediate syndrome, while 6 participants (13.0%) with moderate scores and 10 participants (55.6%) with severe scores did. In contrast, all participants with mild scores and the majority with moderate scores (87.0%) did not develop intermediate syndrome. Only 44.4% of those with severe POP scores were free of intermediate syndrome. The association was statistically significant ($p < 0.001$), indicating that the likelihood of developing intermediate syndrome increases with higher POP scores.

Table 7 presents the association between clinical outcomes and POP score severity among the study participants (N=96). All participants with mild and moderate POP scores survived (100%), while deaths occurred exclusively among those with severe POP scores, with 5 out of 18 participants (27.8%) in this group succumbing to poisoning. The remaining 13 participants (72.2%) with severe scores survived. This association was statistically significant ($p < 0.001$), indicating that higher POP scores are strongly linked to increased mortality risk in organophosphate poisoning cases

In this study, the majority of participants (77.1%) were between 17 and 40 years old, followed by 20.8% between 41 to 60 years. The overall mean age was 32.7 years with a standard deviation (SD) of 10.9 years. Of the total participants, 55.2% were male, while 44.8% were female, indicating a slightly higher representation of males in the study. In line with this study, several studies have consistently shown that OP poisoning predominantly affects young adults, particularly those in the 21–30 years age group. Falia *et al*.[29] reported that the majority of their patients (54.3%) were in this age group, while Razwiedani et al.[30] found 23.7% of cases in the same range, followed by 31-40 years (16.9%). Selvaraj *et al*.[31,32] also observed that two- thirds (67%) of OP poisoning cases fell between 21 and 40 years, with 39% specifically aged 21-30 years. Similar age trends were observed by Edwin *et al*, Dayanand *et al*.[33], and Padmanaba et al.[34], with 60–80% of patients between 21 and 30 years. This age group is particularly vulnerable due to a combination of emotional instability and significant life pressures related to career, finances, and relationships, often intensified in agricultural settings where access to lethal pesticides is easy. Gender-wise, a male predominance is consistently observed across studies similar to our study. Falia *et al*. reported 61.7% of cases as male, while Reddy *et al*.[40] found 69.16% male and 30.84% female cases. Similarly, Kamath *et al*.,[27,28] and Mevada *et al*.[25,26] documented higher incidences among males, with male proportions ranging from 58.9% to 70.4%.

Table 1: Need for ventilator support distribution among the study participants (N=96)

Ventilator required	Frequency (n)	Percentage (%)
Yes	59	61.5
No	37	38.5
Total	96	100.0

Table 2: Intermediate syndrome distribution among the study participants (N=96)

Intermediate syndrome	Frequency (n)	Percentage (%)
Yes	16	16.7
No	80	83.3
Total	96	100.0

Table 3: Outcomes distribution among the study participants (N=96)

Outcomes	Frequency (n)	Percentage (%)
Death	5	5.2
Survival	91	94.8
Total	96	100.0

Table 4: Association of POP score with serum pseudocholinesterase and creatine phosphokinase among the study participants (N=96)

Markers Mean (SD)	POP Score			P value*
	Mild	Moderate	Severe	
Serum Pseudocholinesterase (U/mL)	3019 (873.2)	1603.9 (281.5)	930.5 (238.2)	
Creatine phosphokinase (U/mL)				<0.001
At admission	288.5 (147.3)	306.0 (171.8)	492.9 (212.9)	<0.001
1st Day	356.4 (175.6)	372.2 (196.8)	550.9 (213.9)	<0.001
3rd Day	227.5 (115.6)	273.7 (193.6)	505.6 (266.4)	<0.001
5th Day	121.9 (63.6)	192.4 (220.5)	480.6 (337.1)	<0.001

*One-way ANOVA Test (p <0.05 – significant)

Table 5: Association of intermediate syndrome with serum pseudocholinesterase and creatine phosphokinase among the study participants (N=96)

Markers Mean (SD)	Intermediate syndrome		P value*
	Yes	No	
Serum Pseudocholinesterase (U/mL)	1038.4 (378.0)	2131.6 (947.2)	<0.001
Creatine phosphokinase (U/mL)			
At admission	621.2 (85.2)	278.0 (144.5)	<0.001
1st Day	686.9 (79.2)	343.2 (171.1)	<0.001
3rd Day	709.4 (81.1)	220.2 (111.4)	<0.001
5th Day	751.9 (96.4)	117.1 (61.3)	<0.001

*Independent t test (p <0.05 – significant)

Table 6: Association of intermediate syndrome with POP score among the study participants (N=96)

Intermediate syndrome	POP Score			P value*
	Mild	Moderate	Severe	
Yes	0 (0.0)	6 (13.0)	10 (55.6)	<0.001
No	32 (100.0)	40 (87.0)	8 (44.4)	
Total	32 (100.0)	46 (100.0)	18 (100.0)	

*Chi-squared test (p <0.05 – significant)

Table 7: Association of outcomes with POP score among the study participants (N=96)

Outcomes	POP Score			P value*
	Mild	Moderate	Severe	
Death	0 (0.0)	0 (0.0)	5 (27.8)	<0.001
Survival	32 (100.0)	46 (100.0)	13 (72.2)	
Total	32 (100.0)	46 (100.0)	18 (100.0)	

*Chi-squared test (p <0.05 – significant)

The most commonly consumed compound in this study participants was a combination of Chlorpyrifos and Cypermethrin (43.7%). This was followed by Chlorpyrifos alone (20.8%) and Profenofos combined with Cypermethrin (12.5%). Other compounds were consumed by smaller proportions of participants, including Monocrotophos and Dichlorvos (5.2%), Phenthoate with Cypermethrin (3.1%), and several others. Similar to our study, Chlorpyrifos emerges as a particularly prevalent compound, identified as the most commonly consumed OP in studies by Reddy *et al*.[40], Saswati Kar *et al*.[41], Selvaraj *et al*.[33], and Edwin *et al*.[34] Reddy et al. reported chlorpyrifos in 24.55% of cases, while Edwin et al. noted a higher proportion at 45%. Similarly, Saswati Kar *et al*. and Selvaraj *et al*. identified chlorpyrifos as the leading agent. In contrast, other studies highlighted different predominant compounds. Kamath *et al*.[27] and Jha *et al*. found

monocrotophos to be the most frequently ingested, comprising 23% and 20.4% of cases, respectively. Dayanand *et al*.[33] identified dimethoate (18.75%) as the most common, followed by diazinon, paraoxon, and malathion. Additionally, other OP compounds such as phorate, quinalphos, profenofos, methyl parathion, dichlorvos, and triazophos were frequently documented.

In this study, majority of participants experienced moderate poisoning (47.9%), followed by (33.3%) with mild poisoning. Severe poisoning was observed in 18.8% of the total. Studies assessing the severity of OP poisoning using the POP scale show considerable variation in the distribution of mild, moderate, and severe cases. Some studies, such as those by Brinda Mevada *et al*.[24] and Nimesh B. Malaviya *et al*.[26], reported a predominance of mild cases. Mevada *et al*.[24] found that 72% of patients had mild poisoning, 25.33% moderate, and only 2.77% severe. Similarly, Malaviya *et al*.[28] reported 47 out of 60 patients as having mild poisoning and the rest as moderate, with no severe cases recorded.

Some studies observed a higher proportion of moderate and severe cases. Kamath *et al*.[29] found 27% mild, 37% moderate, and 36% severe cases. Dayanand et al.[33] recorded 25% mild, 45% moderate, and 30% severe cases among 320 patients.

Saswati Kar *et al*.[41] also reported a significant number of moderate and severe cases, with 32 mild, 50 moderate, and 17 severe. Jha *et al*.[44] reported 58.3% mild, 36.7% moderate, and 5% severe cases.These variations may be attributed to differences in patient referral patterns, timing of hospital presentation, types and doses of OP compounds consumed, and disparities in healthcare access.In this study, the mean haemoglobin level was 13.6 g/dL, the mean total leukocyte count was 12.1 $\times 10^3$/cubic mm, and the mean platelet count was 274.1 K/microliter. Biochemical parameters showed mean urea and creatinine levels of 20.9 mg/dL and 0.7 mg/dL respectively. Electrolyte levels were within normal ranges, with mean sodium at 140.0 mEq/L, potassium at 3.8 mEq/L, and chloride at 105.8 mEq/L. The mean D-dimer level was notably elevated at 2215.6 ng/ml (SD ±1752.1). Serum pseudocholinesterase averaged 1949.4 U/mL (SD ±967.7), reflecting the extent of organophosphate exposure. CPK levels showed a peak on the 1st day (mean 400.4 U/mL) and gradually decreased by the 5th day (mean 222.9 U/mL). The mean total dose of atropine administered was 30.0 mg (SD ±16.4), while the mean dose of pralidoxime was 4.7 g (SD ±2.8). In the study by Ehdaa A. Mahmoud et al.[43], mean WBC and platelet counts were elevated ($12.725 \pm 4.994 \times 10^3/mm^3$ and $342.080 \pm 81.954 \times 10^3/mm^3$ respectively), while mean Hb was 12.539 ± 1.611 g/dL. Similarly, Indira A. Hundekari et al.[44] reported a decline in Hb and a progressive rise in WBC counts with increasing severity of OP poisoning, showing a significant elevation in leukocyte counts even in Grade I cases ($p < 0.001$). Hb levels declined significantly from Grade II onwards ($p < 0.05$).

Roy *et al*. reported that survivors consistently had higher Hb (12.77–13.23 g/dL vs. 9.49–10.96 g/dL in non-survivors, $p < 0.0001$), lower WBC counts, and significantly better renal function, with lower urea and creatinine levels. Non-survivors showed clear markers of multi-organ dysfunction, including severe anemia, leukocytosis, hyponatremia, hyperglycemia, and elevated urea and creatinine, indicating systemic involvement and poor prognosis.

Hundekari *et al*.[44] reported a marked decline across Grades I–V (from 4586.4 ± 259.9 U/L to 614 ± 211 U/L; $p < 0.001$), while Mahmoud *et al*.[43] reported mean PChE levels of 1127.670 ± 655.790 U/L. These findings highlight the diagnostic and prognostic utility of ChE levels, as well as the oxidative stress and cellular injury resulting from cholinesterase inhibition.

In this study, a total of 59 participants (61.5%) required ventilator support, while 37 participants (38.5%) did not, indicating that a significant proportion of the study population experienced respiratory compromise necessitating mechanical ventilation. Various studies have reported mechanical ventilation requirements among OP poisoning cases. Alva et al.[46] systematic review of 28,593 cases found a high ventilator requirement of 71.7%. Similarly, Nimesh B. Malaviya *et al*.[28] reported mechanical ventilation in 61.7% of mild and all moderate cases, while Sangita D. Kamath *et al*.[29] noted that 45% of patients required ventilatory support. In contrast, lower rates were observed in studies by Falia *et al*.[29] (19%), and Saswati Kar *et al*.[41] (23 out of 99).

Sixteen participants of this study (16.7%) developed intermediate syndrome, while the majority (83.3%) did not exhibit this complication, suggesting that although relatively uncommon, intermediate syndrome was a notable clinical concern in a subset of cases. The vast majority of participants survived (94.8%). The prevalence of Intermediate Syndrome in OP poisoning varies significantly across studies. Ananta Uprety et al. reported a notably high prevalence of 90.9%, with symptoms appearing between days 2 to 5 post-ingestion. In contrast, Umakanth et al. observed a much lower prevalence of 5.88%, with common clinical features including neck, facial, and proximal limb muscle weakness, and 40% of cases showing extra- ocular muscle involvement. These variations suggest that IMS prevalence may be influenced by factors such as the specific OP compound involved and patient-related clinical variables.

This study revealed significant biochemical and clinical correlations in poisoning severity. Serum pseudocholinesterase levels declined markedly with increasing severity ($p < 0.001$), while CPK levels rose progressively at admission and on follow- up days ($p < 0.001$). Participants requiring ventilator support had significantly higher CPK levels at all time points. Those who developed intermediate syndrome exhibited lower pseudocholinesterase (1038.4 ± 378.0 vs. 2131.6 ± 947.2 U/mL, $p < 0.001$) and higher CPK levels ($p < 0.001$). Non-survivors (n=5) had lower pseudocholinesterase (620 ± 248.9 vs. 2022.5 ± 939.2 U/mL, $p = 0.001$) and elevated CPK ($p < 0.001$). Mortality (27.8%) occurred exclusively in severe cases ($p< 0.001$), with no deaths in mild/moderate groups. These findings highlight the strong association between biochemical markers, clinical severity, and adverse outcomes in poisoning.

Das *et al*. found a significant positive correlation between initial CPK levels and poisoning severity (POP scale), atropine requirement on day 1, and poor outcomes. Patients requiring ventilation had higher mean CPK levels (848.72 IU/L) compared to those who did not (420.79 IU/L). Similarly, those who developed intermediate syndrome had significantly elevated CPK levels (913.44 IU/L). Mortality was associated with markedly higher initial CPK levels (1340.06 IU/L), while survivors had significantly lower levels (373.79 IU/L). The study suggests that serum CPK is a useful marker for assessing severity and predicting outcomes in OP poisoning cases.

In line with our study, Parate *et al*. found a significant correlation between CPK levels and OP poisoning severity (POP scale). Patients with severe poisoning had higher CPK levels (297.07on day 0) compared to moderate (198.43 IU/L) and mild cases (105 IU/L). CPK levels decreased over time, with severe cases showing persistently elevated levels even on day 5 (225.26 ± 51.56 IU/L). Patients who developed respiratory failure had significantly higher CPK levels ($P = 0.00001$). Additionally, those with intermediate syndrome exhibited elevated CPK levels, confirming its role as a prognostic marker] Similarly, Prakash et al. found a significant correlation between CPK levels and OP poisoning severity. Patients with a POP score >4 had significantly higher CPK levels compared to those with a POP score <4. In a study by Biswas *et al*. although pseudocholinesterase levels showed a better correlation with intubation risk, the association was not statistically significant. Initial CPK levels and POP severity stratification had limited predictive value for overall severity[30]. Lastly, Shreesh Kadur et al. found that elevated CPK levels (=170 IU/L) were observed in 34 patients, of whom 26 (76.5%) required ventilatory support, demonstrating a statistically significant association ($p=0.00$). Among patients with CPK <170 IU/L, only 4.5% required ventilation. The study concluded that CPK levels can serve as an affordable and accessible biomarker for predicting the severity of OP poisoning.

CONCLUSION

This study shows that the POP score, which measures organophosphate poisoning severity, is linked to biochemical markers, clinical outcomes, and sequelae. A substantial fall in serum pseudocholinesterase and a gradual increase in CPK were related with increased poisoning severity, ventilator support, intermediate syndrome, and fatality. All deaths were serious, emphasising the necessity for quick risk assessment. High CPK levels predicted respiratory failure and poor clinical prognosis, while low pseudocholinesterase levels predicted intermediate syndrome and death. This study demonstrated that serum pseudocholinesterase and CPK levels accurately predict acute OP poisoning severity and prognosis. Clinical severity as indicated by the POP score was strongly correlated with pseudocholinesterase activity declining and CPK levels rising (peaking at 400.4 U/mL on admission). Patients with intermediate syndrome or ventilator support had decreased pseudocholinesterase and greater CPK levels, predicting problems. These findings support repeated pseudocholinesterase and CPK monitoring in clinical decision-making, particularly for high-risk patients who may benefit from more aggressive action and intense monitoring to improve acute OP Poisoning outcomes. These findings emphasise the need to monitor these indicators closely and treat severe cases intensively to improve clinical outcomes.

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