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Original Research Article

Correlation between Respiratory Failure and Serum Creatine Phosphokinase Levels in Organophosphate Poisoning

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Abstract:

Background: Organophosphate (OP) poisoning is a significant global health issue, particularly in agricultural settings, and is associated with severe toxicity, including respiratory distress, neurological impairment, and, in extreme cases, death. Early prognosis is critical in managing OP poisoning, and biomarkers such as serum creatine phosphokinase (CPK) have been suggested to predict patient outcomes. This study aims to evaluate the role of CPK levels as a prognostic indicator in organophosphate poisoning.

Methods: A cross-sectional, prospective study was conducted on 100 patients with pesticide poisoning admitted to Government Theni Medical College & Hospital from April 2020 to April 2021. Demographic, clinical, and laboratory data were collected, and serum CPK levels were measured at admission, 48 hours, and 96 hours. The relationship between CPK levels and patient outcomes (survival or death) was analyzed using statistical tests including Chi-square, t-tests, and ANOVA.

Results: Of the 100 patients, 72% were male, and the majority (57%) was aged between 20 and 40 years. The study found a significant association between elevated CPK levels and mortality ($p = 0.015$ at presentation; $p = 0.038$ at 48 hours; $p = 0.02$ at 96 hours). Non-survivors had substantially higher CPK levels, with a mean of 1024.66 IU/L at presentation, compared to 28.68 IU/L in survivors. Additionally, albumin levels were lower in non-survivors (mean 3.16 g/dL vs. 3.94 g/dL in survivors), further suggesting a link between severe poisoning and poor outcomes.

Discussion: Elevated serum CPK levels were strongly associated with increased mortality in organophosphate poisoning, likely reflecting muscle injury and systemic toxicity. These findings are consistent with previous studies, supporting the utility of CPK as a prognostic marker. Monitoring CPK levels may provide critical insights into the severity of poisoning and guide treatment decisions, particularly in the early stages of management.

Conclusion: This study highlights the potential of CPK levels as an effective prognostic tool in organophosphate poisoning. Elevated CPK levels are significantly correlated with poor outcomes, underscoring the importance of early detection and monitoring. Future prospective studies are needed to refine CPK's role in clinical practice and establish intervention thresholds for improving patient survival.

Keywords: Organophosphate poisoning, creatine phosphokinase, prognosis, biomarkers, pesticide poisoning, mortality, clinical outcomes.

Introduction

Organophosphate poisoning is a major public health hazard worldwide, especially in agricultural contexts where these chemicals are widely utilized. Organophosphates inhibit acetylcholinesterase, causing acetylcholine to accumulate at synapses and resulting in a variety of toxicological effects including as respiratory discomfort, neurological damage, and, in severe cases, death. Clinical therapy of organophosphate poisoning frequently demands a quick assessment of the patient's condition and prognosis to inform treatment recommendations [1]. Recent research has demonstrated the use of biochemical indicators to aid in the prediction of organophosphate poisoning outcomes. Among these, serum creatine phosphokinase (CPK) levels have emerged as an

encouraging prognostic indication. Elevated CPK levels may indicate muscle injury from persistent hypoxia and neuromuscular dysfunction caused by severe poisoning. Understanding the association between CPK levels and patient outcomes may provide useful information about the severity of poisoning and the possibility of recovery [2].

Although all of these biomarkers are commonly utilized, CPK and LDH are thought to be more specific and effective in the case of acute OP poisoning. This could be owing to their ease of use, low cost, and continuous monitoring of their level throughout the course of therapy [3]. Managing organophosphate poisoning requires an interprofessional team, including an emergency department and specialist pharmacists. Diagnosis is challenging. Common laboratory tests include CBC, glucose levels, troponin, liver and renal function, and arterial blood gas, all of which provide little information on OP [4]. Doctors often prescribe several current medications, such pralidoxime and atropine, to treat patients who have been poisoned by organophosphate pesticides and chemicals [5].

Considering the potential association between blood creatine phosphokinase (CPK) or lactate dehydrogenase (LDH) levels and OPC poisoning is critical since early detection of poisoning severity can considerably minimize patient burden and fatality rates [6]. This study will look into the role of CPK levels as a prognostic factor in organophosphate poisoning patients. By examining the relationship between initial CPK levels and clinical outcomes, we hope to determine the biomarker's importance in predicting death and morbidity. Finally, the findings may improve clinical decision-making and management techniques for organophosphate poisoning, stressing the importance of timely and successful therapeutic measures.

Materials and Methods

Study Design: This cross-sectional prospective study was done to assess patient outcomes in cases of pesticide poisoning. The study examined demographic, clinical, and laboratory data from patients admitted to Government Theni Medical College & Hospital, Theni, between April 2020 and April 2021. The study was approved by the Institute Ethical Committee at Government Theni Medical College & Hospital in Theni, Tamil Nadu.

Patient Population

Inclusion Criteria:

- Adults and adolescents aged 12 years and older diagnosed with pesticide poisoning.
- Patients with complete medical records.

Exclusion Criteria: Patients with co-existing disorders, such as myopathy, diabetes mellitus, chronic pancreatic diseases, chronic liver diseases, mental problems, myocardial infarction, myocarditis, or pregnancy, were excluded.

Sample Collection: At the time of admission, after obtaining informed consent, approximately 5 ml of blood was drawn in a plain tube using aseptic precaution. The blood was allowed to coagulate, and serum was collected using centrifugation, which was then used to analyze the following parameters. Samples are also collected at 48 and 96 hours after admission.

Estimation Parameters: The enzyme creatine kinase catalyzes the reaction of creatine phosphate and adenosine diphosphate (ADP) to create creatine and adenosine triphosphate (ATP). It is estimated kinetically using the International Federation of Clinical Chemistry (IFCC) approach. The rate of absorbance change at 340 nm is monitored, and it is directly related to creatine kinase activity. It is done using a semi-automated analyzer. The typical range is 46 to 171 IU/L in men and 24 to 145 IU/L in women. There are three isoforms of creatine kinase: CK-BB, CK-MB, and CK-MM, which are found in the brain and smooth muscle, myocardium, and skeletal muscle, respectively. Bromocresol green (BCG) is used to assess serum albumin levels. The kit uses bromocresol green to generate a colored complex, particularly albumin. The intensity of color measured at 620 nm is related to albumin content.

Statistical Analysis

The biological parameters were associated with the POP scale utilizing intercorrelations. To determine the relationship between qualitative variables, the Chi-square test of significance was performed. T-tests were used to compare differences in continuous variables (such as CPK and albumin levels) between survivors and non-survivors. One-way ANOVA is employed as a significance test to evaluate the many parameters associated with the substance used for poisoning. P-value of <0.05 was considered as statistical significance.

Results

The demographic analysis of the patient group reveals a considerable gender disparity among the 100 patients surveyed. There were 28 female patients (28%) and 72 male patients (72%) (Table 1). This data shows that the research group is dominated by men, which may have consequences for assessing population health trends and requirements.

Table 1: Distribution of patients by sex

Sex	No. of Patients	Percentage
Female	28	28%
Male	72	72%
Grand Total	100	100%

The age distribution of patients by sex demonstrates significant trends across age groups. Males aged 20 to 40 have the highest representation, with 35 patients (57%), followed by those aged 40 to 60 (20 patients, 23%) and those over 60 (13 patients, 14%). Only four male patients (6% of the total) are under the age of twenty. Female patients, on the other hand, had a different distribution, with the majority falling between the ages of 20 and 40 (22 individuals, or 57%). However, the numbers drop dramatically in the later age groups, with only three females (23%) aged 40 to 60 and one (14%) over 60. Overall, this data reveals that both sexes are largely between the ages of 20 and 40, but there is a significant decline in representation as age increases, notably among females (Fig. 1).

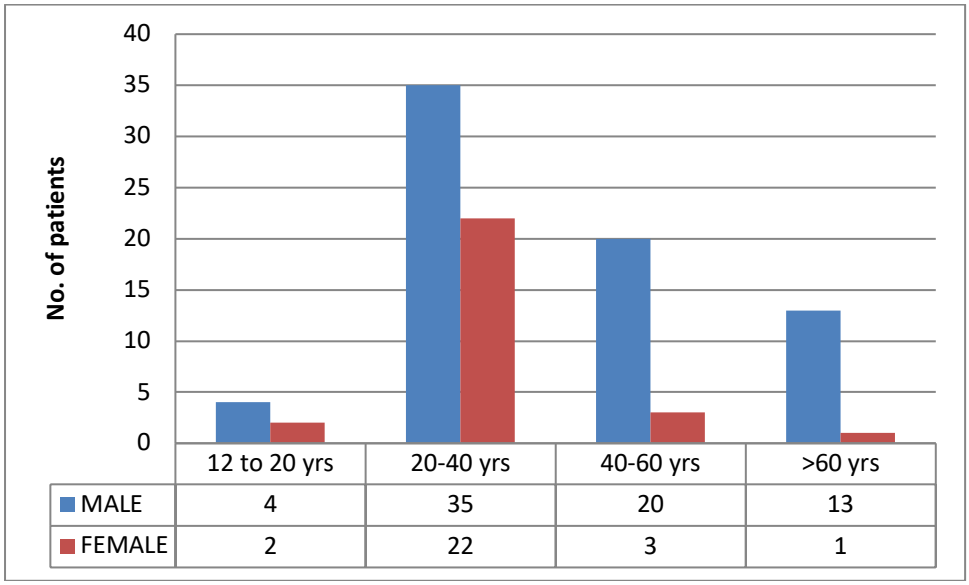

Figure 1: Age wise distribution

Dichlorvos had an equal distribution, with two alive and two dead, totalling four cases. Dimethoate had a substantially bigger impact, with 37 living and four dead, totalling 41 instances. Methyl parathion has four survivors and no documented fatalities, for a total of four. The "OTHERS" category contains nine cases: eight living and one deceased. Finally, phorate is responsible for 34 alive and 8 dead, totalling 42 cases. Overall, dimethoate and phorate appear to have the most dramatic impacts, while methyl parathion causes no fatalities (Table 2).

Table 2: Test of significance between compound and death

Compound name	Alive	Death	Grand Total	
Dichlorvos	2	2	4	
Dimethoate	37	4	41	**P Value =0.17**
Methyl Parathion	4	0	4	
Others	8	1	9	
Phorate	34	8	42	

Out of a total of 100 patients, 74 lived without respiratory failure, with only one succumbing to their illness.

In contrast, 11 of the 25 patients who encountered respiratory failure survived, while 14 did not. This suggests that the existence of respiratory failure has a major impact on mortality, since individuals affected have a significantly shorter survival rate than those without the illness (Table 3).

The correlation between respiratory failure at presentation or after admission and outcome is statistically significant (p=0.012, <0.05).

Table 3: Test of significance between ventilatory support and outcome

Respiratory Failure	Alive	Death	
No	74	1	P value=0.012
Yes	11	14	
Grand Total	85	15	

Among the 100 patients, those exposed to inhalational toxicity did well, with all six surviving. In comparison, the oral route revealed a more worrying trend, with 79 out of 94 patients surviving but 15 not. This implies that whereas inhalational poisoning has a reduced risk of death, oral poisoning has a much higher risk, emphasizing the crucial need for rapid care in cases of oral poisoning (Table 4), which is not statistically significant (p=0.44, >0.05).

Table 4: Test of significance between route of poisoning and outcome

Route Of Poisoning	Alive	Death	
Inhalational	6	0	P value= 0.44
Oral	79	15	
Grand Total	85	15	

The mean CPK level for survivors is 28.68, which is within a pretty normal range, whereas those who did not survive had a significantly higher mean CPK level of 1024.66.

The standard deviation for survivors is 282.4, indicating a broad range of values among living patients, while non-survivors also exhibit significant variation, with a standard deviation of 288.88. The minimum CPK level for survivors is 18, whereas non-survivors have a substantially higher minimum of 659, with a maximum CPK level of 1593 among those who died (Table 5).

These data imply that elevated CPK levels are associated with higher mortality, highlighting CPK's potential function as a crucial biomarker in determining patient prognosis. The correlation between serum CPK and mortality is statistically significant (p=0.015, <0.05)

Table 5: Test of significance between CPK at presentation and outcome

CPK level	Alive	Death	
Mean	28.68	1024.66	P value =0.015
Std.dev	282.4	288.88	
Min	18	659	
Max	1504	1593	
Count	85	15	

The average albumin level in the 15 patients who died was 3.16, while survivors had a higher mean of 3.94. The standard deviation for non-survivors is 0.32, showing rather stable albumin levels in this group, whereas the survivors exhibit significantly greater fluctuation, with a standard deviation of 3.92. Notably, the maximum albumin level for non-survivors is 4, whereas the maximum for survivors is much higher, at 40. The minimum albumin level for the deceased is 2.8, while the lowest level for the surviving is 3 (Table 6). This data suggests that lower albumin levels may be associated with increased mortality, yet the wide range among survivors highlights the complexities of individual patient circumstances. There is a statistically significant link between serum albumin at initial presentation and outcome in organophosphorus chemical poisoning (p=0.04, <0.05).

Table 6: Test of significance between albumin level and outcome

Albumin Level	Death	live	
Count	15	85	P value= 0.04
Mean	3.16495	3.935443	
Standard deviation	0.318748	3.922406	
Max	4	40	
Min	2.8	3	
Range	1.2	37	

Among the 85 survivors, 21 had hypoalbuminemia (levels less than 3.5 gm), while the majority, 62, had normoalbuminemia (3.5-5 gm). Only two survivors had hyperalbuminemia (levels above 5 gm). In contrast, 13

of the 15 patients who did not survive had hypoalbuminemia, demonstrating a link between low albumin levels and mortality. Only two of the patients who died had normal albumin levels, and none had hyperalbuminemia.

Table 7: Albumin level and outcome

	Hypoalbuminemia (<3.5 gm)	Normoalbuminemia (3.5 to 5)	Hyperalbuminemia (>5 gm)
Alive	21	62	2
Death	13	2	0

For patients classified as having severe diseases, the mean enzyme level for survivors is 676.61 IU/L, but those who did not survive have a much higher mean of 1024.26. In the moderate category, survivors had an average of 257.57 IU/L, compared to a worrying 82.06 IU/L for non-survivors. There are no known levels of moderate instances in either group. These findings point to a clear trend: higher enzyme levels are associated with an increased risk of mortality. Patients with severe and mild illnesses who survive have lower enzyme levels than those who die. This emphasizes the possible relevance of enzyme levels as crucial markers for determining the severity of a patient's disease and forecasting outcomes.The results on albumin levels in connection to various forms of pesticide exposure show clear trends. Dimethoate is the most commonly used medication among patients with hypoalbuminemia (levels <3.5 gm/dl), accounting for 10 cases, followed by phorate, with 11. Dichlorvos and other drugs have lower numbers, with two cases apiece. Dimethoate is the most common cause of normoalbuminemia (3.5 to 5 gm/dl), with 31 cases, demonstrating a strong link to this exposure. Phorate and other drugs follow with 29 and 5 cases, respectively. Notably, there are no incidences of hyperalbuminemia (>5 g/dl) among patients exposed to dichlorvos, dimethoate, or other drugs, although phorate is responsible for two cases. These data indicate that different pesticides have variable effects on albumin levels, with dimethoate and phorate related with both hypo- and normoalbuminemia (Table 8). This emphasizes the significance of monitoring albumin levels in patients exposed to certain pesticides as a potential signal of their clinical condition. The individual compound is connected with serum albumin level at the time of presentation in organophosphorus chemical poisoning, although no statistical significance was discovered (p=0.21, >0.05).

Table 8: Albumin category correlation with individual compound

	Dichlorv Os	Dimethoat E	Phorate	Methyl Parathio N	Other S
Albumin <3.5 gm/dl	2	10	11	2	4
3.5to5 gm/dl	2	31	29	2	5
>5gm/dl	0	0	2	0	0

Table 9 shows that there is a substantial difference in serum CPK levels between organophosphate poisoning survivors and non-survivors 48 hours after exposure.

Patients who survived had an average CPK level of 289.35 IU/L, but those who died had a significantly higher level of 1571.73 IU/L. The statistically significant p-value of 0.038 strengthens the link between raised CPK levels and poor outcomes, implying that higher CPK levels may indicate greater tissue damage and a higher chance of mortality in these individuals.

The range and variability of CPK levels between the two groups highlight the need of monitoring this biomarker in clinical practice to determine prognosis. The blood CPK level at 48 hours and outcome linked with the student T test, which was statistically significant (p=0.038).

Table 9: Serum CPK level at 48 hrs correlated withoutcome

CPK48hrs	Alive	Death	
Mean	289.35	1571.73	
Std.dev	285.54	52.34	
Min	10	856	P value=0.038
Max	1689	2786	
Range	1679	1930	
Count	85	15	

Table 10 shows the relationship between blood CPK levels at 96 hours and patient outcomes in cases of organophosphate poisoning. The survivors had a mean CPK level of 251.43 IU/L, which was significantly lower than the non-survivors' mean level of 1885.66 IU/L. The statistically significant p-value of 0.02 suggests a substantial link between raised CPK levels and increased mortality risk. The standard deviation results reveal significant heterogeneity in CPK levels, particularly among non-

survivors, indicating the degree of tissue damage. The minimum and highest numbers further demonstrate the range of CPK levels, with survivors having a smaller range than those who did not survive. This study emphasizes the value of CPK monitoring as a prognostic tool in clinical settings, demonstrating its potential to help assess patient outcomes and guide treatment methods.

Table 10: CPK level at 96 hrs correlated with outcome

CPK96hrs	Alive	Death	
Mean	251.43	1885.66	
Std.dev	243.34	480.72	
Min	14	907	P value =0.02
Max	1318	2596	
Range	1304	1689	
Count	85	15	

Discussion

The outcomes of this study highlight the significance of creatine phosphokinase (CPK) levels as a prognostic indicator in organophosphate poisoning. Our findings suggest that greater CPK levels are substantially associated with increased mortality, which is consistent with previous research that has highlighted the link between muscle injury and systemic toxicity.

The relevance of CPK levels as a prognostic indication in organophosphate poisoning has received more attention in recent years. Our findings are consistent with earlier research, which suggests that increased CPK levels are associated with poorer outcomes in patients facing severe toxicity. This finding was in line with research by Kumar A et al., who found that among the patients admitted to their separate study populations, chlorpyrifos was the most prevalent OPC toxin [8].

In the current investigation, among 100 patients with acute organophosphorous poisoning, 72 (72%) were males and 28 (28%) were females, and as in most other studies, males outnumbered females [9, 10]. The bulk of cases, 35 (57%), were between the ages of 20 and 40. This suggests an increase in the incidence of organophosphorous chemical poisoning among young people.

These findings are consistent with prior investigations [11, 12]. We linked the POP scale with serum CPK values and discovered a strong positive connection between CPK and poisoning severity. Bhattacharyya et al. and Sen R et al. [13, 14] revealed a link between initial CPK levels and poison severity. Patients with acute organophosphorus poisoning are often monitored by measuring serum acetylcholinesterase levels, which are expected to decrease. It is not specific, has no correlation with the degree of poisoning, and cannot be utilized as a prognostic factor [15]. CPK levels may be easily estimated, and they are elevated both in the acute phase and in the intermediate condition, most likely due to muscle fiber necrosis. It has been observed that high serum CPK levels represent the severity of acute muscular necrosis and are the best and most sensitive indicators of muscle injury [16]. The greater muscular injury necessitates the necessity for early ventilator treatment. Repeating CPK levels after 48 hours can identify persistent muscle injury, need early ventilator treatment, and improve prognosis. CPK levels were significantly lower in patients who had completely recovered than in those who had died. We found a substantial negative connection between serum CPK and serum acetylcholinesterase. Similar findings were reported in another investigation [17]. Our findings add to the growing body of research suggesting that high CPK levels are a key prognostic factor in organophosphate poisoning. Comparisons with other studies confirm the biomarker's usefulness, while also advocating for more research into its clinical uses and potential intervention thresholds. Integrating CPK monitoring into standard assessment processes may improve patient care and outcomes in cases of organophosphate toxicity.

Conclusion

This study emphasizes the significance of CPK levels as a prognostic predictor in organophosphate poisoning. Elevated CPK levels were strongly associated with increased mortality, implying that larger concentrations represent greater muscle injury and systemic toxicity. These findings provide support for routine CPK monitoring in clinical settings to aid in early risk assessment and treatment decisions. While our findings are consistent with previous research, more prospective studies are needed to clarify the therapeutic application of CPK and create defined thresholds. Finally, incorporating CPK monitoring into practice may improve care and survival rates in cases of organophosphate poisoning.

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