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Original Research Article

Comparative Analysis of Clinical Profiles and Outcomes in Organophosphorus Poisoning: Identifying Predictive Factors for Prognosis

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Abstract: ***Background:*** A OP poisoning is a major public health issue, mainly in developing countries where OP is a common insecticide. Early hospital admission and appropriate initial treatment are two factors that have brought reduced morbidity and mortality. The present study discusses the clinical profiles, complications, and prognostic factors influencing patient outcomes. ***Methods:*** A prospective observational study was conducted on 100 patients admitted with OP poisoning at VIMSAR, Burla, between November 2017 and October 2019. Data regarding demographics, clinical presentation, time to hospitalization, atropinization status, need for mechanical ventilation, biochemical parameters, and outcomes were analyzed using appropriate statistical methods. ***Results:*** The mean age of affected patients was 28.55 ± 10.98 years, with males predominating (male-to-female ratio: 1.56:1). Early admission within two hours had a 100% recovery rate. However, beyond six hours from the onset, mortality was markedly increased at 57.6%. Lack of atropinization before admission was associated with a higher mortality rate at 28.4%. Respiratory failure was the most common fatal complication at 76.1% of the deaths. A significantly poorer prognosis was observed among patients requiring mechanical ventilation, at a mortality rate of 55%. ***Conclusion:*** Timely hospital admission, early atropinization, and adequate respiratory support play a crucial role in improving survival rates in OP poisoning. Respiratory failure remains the leading cause of mortality, emphasizing the need for aggressive supportive care. Public awareness, preventive strategies, and improved emergency response systems are essential in reducing fatalities associated with OP poisoning.

Keywords: Organophosphorus poisoning, prognosis, atropinization, respiratory failure, mortality, time to hospital admission.

INTRODUCTION

The use of chemicals, pharmaceuticals, and insecticides during increased production has significantly contributed to poisoning cases in developing countries. Among the poisonous compounds, OP compounds have become one of the most used insecticides over the last four decades. These compounds are widely used in agriculture because of their effectiveness in pest control, but the ease of access and improper handling have led to a high incidence of both accidental and intentional poisonings [1].

Acute organophosphorus poisoning has become a major public health concern, especially in low- and middle-income countries, where regulatory measures and safety awareness are often inadequate. The frequency of poisoning cases has been steadily increasing, making OP compounds one of the most frequently encountered toxic substances in clinical

toxicology. In India, pesticide poisoning accounts for the majority of reported cases, with organophosphates being the predominant agents involved. These further compound the problems of negligent use, ease of availability, weak legal restrictions and the role of socio-economic distress, which so often leads to deliberate self-poisoning. The burden is particularly severe in the Asia-Pacific region, causing an estimated 200,000 deaths annually from OP poisoning. Mortality in cases of OP poisoning is variable and can be between 10% and 20%, based on the nature of the compound involved, the time at which treatment is administered, and the treatment protocol followed [2-3].

The main mechanism of toxic action of OP compounds is their strong inhibition of carboxylic esterase enzymes, specifically acetylcholinesterase and pseudocholinesterase. This inhibition leads to excessive accumulation of acetylcholine at nerve synapses, resulting in overstimulation of the autonomic nervous system. Consequently, affected individuals develop a range of muscarinic, nicotinic, and central nervous system manifestations. The clinical presentation varies based on the severity of poisoning, with muscarinic symptoms including nausea, vomiting, diarrhea, excessive salivation, lacrimation, bradycardia, and miosis. The nicotinic effects include muscle weakness, fasciculations, paralysis, convulsions, and coma. In some extreme cases, OP poisoning leads to lethal complications such as ARDS aspiration pneumonitis, sudden cardiac death, or IMS, a condition of delayed onset paralysis. Chronic complications arising may also occur, such as polyneuropathy, anxiety, depression, and persistent neurological deficits [4-5].

A few factors determine the prognosis of OP poisoning, namely the type of compound ingested, the duration of time passed before medical intervention, the severity of initial symptoms, and the adequacy of respiratory management. The correlation of these factors will be crucial for determining patient outcomes and guiding the treatment strategies meant to reduce mortality. Early recognition and prompt initiation of treatment improve survival rates. The mainstays of treatment include rapid resuscitation with oxygen therapy, airway protection, intravenous fluids, administration of atropine to counteract muscarinic effects, and pralidoxime (PAM) to reactivate acetylcholinesterase [6-7].

With increasing incidence and severe morbidity and mortality associated with OP poisoning, an objective analysis of its clinical profiles and outcomes is warranted. Early identification of high-risk patients may be possible with understanding the patterns of poisoning, identifying common clinical presentations, and predictive factors for poor prognosis. This study is basically on the clinical and biochemical aspects in OP poisoning, an assessment of its outcome, and whether specific clinical findings could be used as reliable prognostic markers. Such information will be extremely helpful in upgrading the treatment protocols and implementing preventive strategies to minimize the burden of OP poisoning, which is more evident in developing countries [8].

II. METHODS

Source of Data

This study was conducted on patients admitted with organophosphorus (OP) poisoning in the Postgraduate Department of Medicine at VIMSAR, Burla, over a two-year period from November 2017 to October 2019. The study aimed to analyze the clinical profiles and outcomes of OP poisoning cases while identifying predictive factors for prognosis.

Study Design and Data Collection

A total of 100 patients were included in the study, selected using a simple randomization method. Data collection involved obtaining detailed patient histories from attendants, which included demographic details such as age, sex, and occupation. Additional information regarding the mode of exposure, type of OP compound involved, and the duration between exposure and hospitalization was also recorded.

The diagnosis of OP poisoning was based on a combination of factors, including a definite history of exposure to insecticides, clinical presentation consistent with OP poisoning, and laboratory confirmation through reduced serum acetylcholinesterase (AChE) levels. Improvement of symptoms following treatment with atropine and pralidoxime (PAM) further supported the diagnosis. OP poisoning was confirmed biochemically when serum cholinesterase activity was found to be below 50% of the laboratory's minimum reference value of 4850 U/L.

Inclusion Criteria for Patients

All patients aged 15 years and above with confirmed diagnosis of OP poisoning based on clinical features and laboratory findings were included in the study. The study excluded all patients who had a history of alcohol or drug intake, cases of poisoning involving mixed substances, and patients with non-OP poisoning. Patients who died within a few hours of admission were excluded, as their acute deterioration did not provide an opportunity to assess clinical progression and treatment response adequately.

Clinical Severity Rating

The Peradeniya Organophosphorus Poisoning (POP) Score was used to classify the severity of poisoning. This scoring system based on clinical parameters evaluates the muscarinic, nicotinic, and central nervous system effects of acute cholinergic toxicity, like the size of pupils, respiratory rate, heart rate,

fasciculations, level of consciousness, and seizure activity. Patients were classified into three groups according to their initial POP score: mild poisoning (score 0–3), moderate poisoning (score 4–7), and severe poisoning (score 8–11). Scores were assigned at presentation before any medical intervention was instituted, thus providing an objective measure of poisoning severity.

Treatment Protocol and Monitoring

On arrival to the emergency care unit, all patients received immediate resuscitation and atropine according to a standardized protocol. Initiation of atropinization started with an IV bolus dose of 1.8–3 mg followed by repeated dosing at five-minute intervals. The dose was doubled each time until full atropinization was achieved. The adequacy of atropinization was determined based on clinical signs that included drying of secretions, pupil dilation, and an increase in heart rate to approximately 110–120 beats per minute. Once atropinization was attained, a maintenance dose equivalent to 20–30% of the total atropinization dose was continuously infused intravenously for the next two to three days, with gradual tapering as the patient's condition stabilized.
Aside from atropine therapy, the PAM infusion was administered at a high dose according to WHO. In patients, an initial loading dose of 30 mg/kg body weight would be given as IV bolus, followed by a continuous IV infusion at 8 mg/kg/hour. The regimen was maintained in the acute phase of the poisoning to help in reactivating cholinesterase.

Vital signs such as changes in blood pressure and pulse rate were closely monitored during the period of hospital stay. The electrocardiographic changes were also assessed to observe the cardiac complications due to OP toxicity.

Laboratory Investigations

Baseline laboratory investigations included serum cholinesterase measurement, which was performed using the Butyrylthiocholine Potassium Hexacyanoferrate (III) method. The normal reference range for pseudocholinesterase levels in the laboratory was between 4850 and 12000 U/L. OP poisoning was confirmed in cases where serum cholinesterase levels were below 50% of the lower reference limit.

Serum electrolyte measurements, such as sodium (Na^+), potassium (K^+), and calcium (Ca^{2+}), were recorded at entry. These serum electrolytes levels were reassessed as needed at any time of the hospital stay and at time of discharge. Hypokalemia was said to be diagnosed when serum K^+ falls below 3.5 mmol/L and appropriate correction implemented when necessary.

Outcome Measurement and Statistical Analysis

Duration of hospital stay and final patient outcome were recorded. SPSS version 25.0 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5 were used for statistical analysis, with numerical variables represented as means and standard deviations, and categorical variables as counts and percentages.

For comparisons concerning numerical data, independent-sample t-tests were used to compare the difference between means, and within-group comparison was done using paired t-tests to improve the statistical power. For categorical variables, the contingency tables were analyzed using the Chi-square test (χ^2) where the frequencies are expected to be high; otherwise, Fisher's exact test was used.

The p-values were calculated using Student's t-distribution with a threshold value of $p \leq 0.05$ to consider statistically significant. When the calculated p-value was below this threshold, the null hypothesis was rejected in favor of the alternative hypothesis, pointing out there is a considerable association between the studied variables and patient outcomes.
This study intended to give an overall analysis of OP poisoning, based on the clinical presentation, severity, treatment response, and outcomes. By identifying key predictive factors, refinement of treatment protocols and improvement of prognosis may be possible, particularly in regions where OP poisoning is a major public health concern.

RESULTS

The demographic and clinical characteristics of patients admitted due to OP poisoning are listed in *Table 1*. Affected individuals were of a mean age of 28.55 ± 10.98 years, with most of them falling in the age group of 15-30 years (70%), followed by 15% in the age group of 31-40 years, 10% in the age group of 41-50 years, and 5% in the age group of 51-60 years. The incidence of poisoning was higher in males, with a male-to-female ratio of 1.56:1, indicating a predominance of male cases. This data provides crucial insights into the population most vulnerable to OP poisoning, which can help guide preventive measures and targeted interventions.

Table 1: Demographic and Clinical Characteristics of Patients Admitted Due to Organophosphorus Poisoning

Characteristics	Values
Mean Age (years)	28.55 ± 10.98
Age Group	15-30 years (70%), 31-40 years (15%), 41-50 years (10%), 51-60 years (5%)
Male:Female Ratio	1.56:1

Graph 1: Age Distribution of Patients Admitted Due to Organophosphorus Poisoning

A pie chart illustrating the age distribution of patients admitted due to organophosphorus poisoning.

Table 2 depicts the relationship between the time lapse to hospital admission and patient outcomes in organophosphorus poisoning. Early hospital admission within less than 2 hours was associated with a 100% recovery rate, while delays beyond 6 hours significantly increased mortality, with 57.6% of deaths occurring in this group. Patients admitted within 2-6 hours had a lower mortality rate of 4.7%, thus emphasizing the critical importance of timely medical intervention in improving survival outcomes.

Table 2: Association Between Time Interval to Hospital Admission and Patient Outcomes

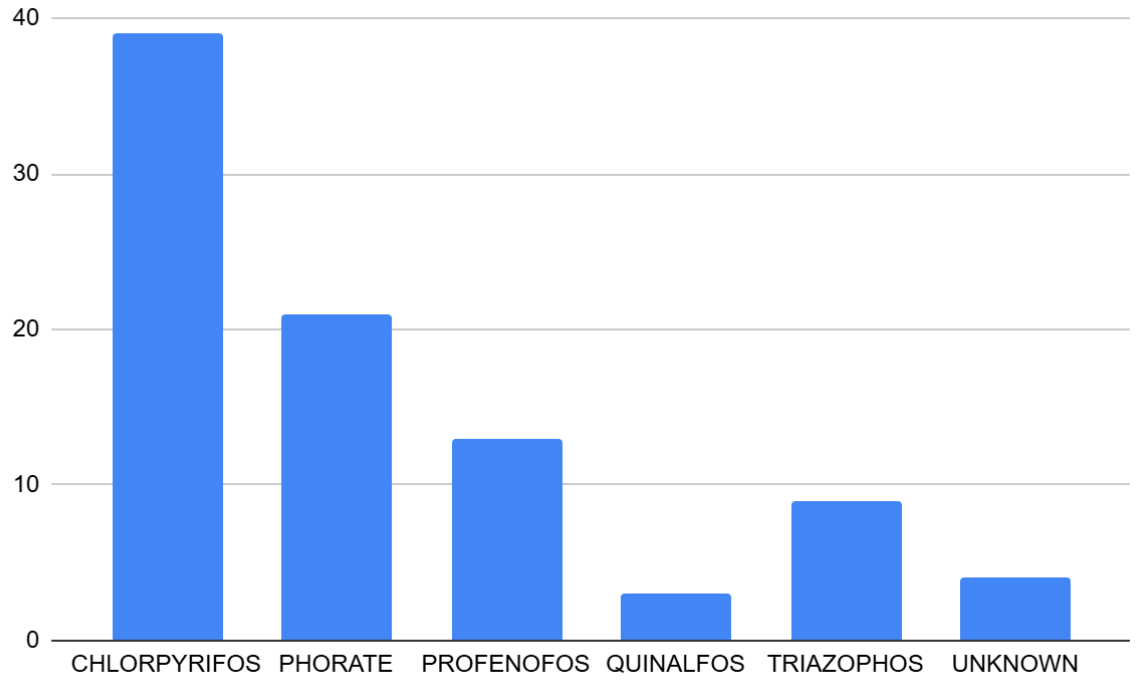
Time Interval	Death	Recovered	Total
<2 - hours Row % Col %	0 0.0 0.0	24 100.0 30.4	24 100.0 24.0
2-6 hours Row % Col %	2 4.7 9.5	41 95.3 51.9	43 100.0 43.0
>6 - hours Row % Col %	19 57.6 90.5	14 42.4 17.7	33 100.0 33.0
Total Row % Col %	21 21.0 100.0	79 79.0 100.0	100 100.0 100.0

Table 3 Comparative analysis of major clinical predictors of mortality in organophosphorus poisoning cases Mechanics of ventilation used was a strong predictor of higher mortality, with 55.0% of the ventilated patients dying from the poisoning. Lack of atropinization before hospitalization strongly correlated with higher mortality, with 28.4% dying compared to only 6.1% of those who had been atropinized early in their course. Among the complications, the most fatal was respiratory failure accounting for 76.1% of deaths, followed by pulmonary edema,

at 14.3%, intermediate syndrome, at 4.8%, and aspiration pneumonia, at 4.8%. These findings highlight the critical role of early atropinization and respiratory support in improving patient outcomes.

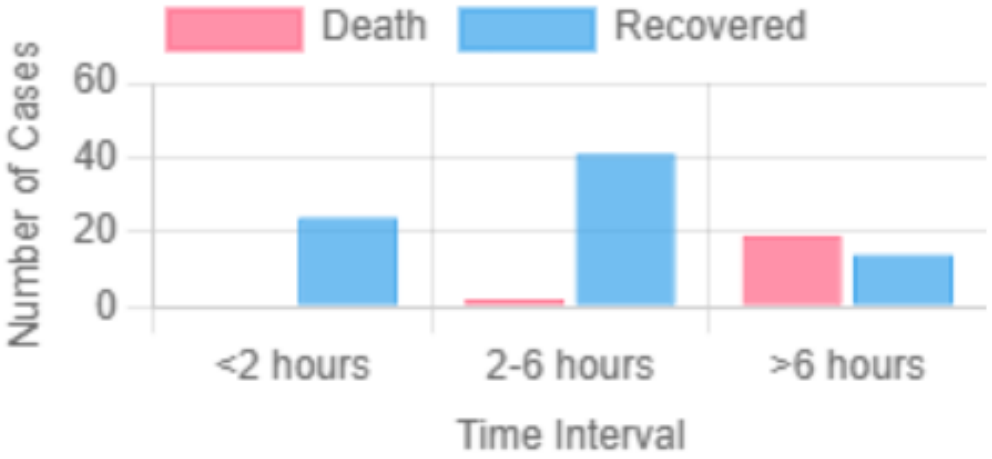
Table 3: Comparative Analysis of Clinical Predictors of Mortality

Factor	Death (n, %)	Recovered (n, %)	Total (n, %)
Mechanical Ventilation			
No	10 (12.5%)	70 (87.5%)	80 (100.0%)
Yes	11 (55.0%)	9 (45.0%)	20 (100.0%)
Atropinization Before Hospitalization			
No	19 (28.4%)	48 (71.6%)	67 (100.0%)
Yes	2 (6.1%)	31 (93.9%)	33 (100.0%)
Complications	***No. of Cases***	***No. of Deaths (%)***	
Respiratory Failure	21	16 (76.1%)	
Pulmonary Edema	8	3 (14.3%)	
Intermediate Syndrome	4	1 (4.8%)	
Aspiration Pneumonia	2	1 (4.8%)	



Graph 2: Mortality Rates by Organophosphorus Compound Type table 25

Graph 2. Mortality Rates by Type of Organophosphorus Compound Figure 2. Mortality Rates by Type of Organophosphorus Compound Differences in toxicity levels and patient outcomes suggest that some compounds are worse than others. This information may be useful in tailoring treatment approaches and focusing early interventions on high-risk exposures.



Graph 3: Survival Analysis Based on Time to Hospital Admission

The time to hospital admission survival analysis by organophosphorus poisoning has been graphically represented in Graph 3. It was indicated that there exists a clear connection between the initiation of medical therapy and improved chances of survival in such patients. Patients treated early within the hours had the greatest survival rate while delayed admissions resulted in high levels of mortality particularly after 6 hours. All these point toward the crucial value of hospital admission within time that can significantly impact fatal outcomes in such patients.

Table 4 shows the spectrum of fatal complications in organophosphorus poisoning. Respiratory failure was the most common and fatal complication and accounted for 76.1% of the deaths. Pulmonary edema accounted for 14.3% of deaths, and intermediate syndrome and aspiration pneumonia each caused 4.8% of deaths. Thus, the conclusion is that the survival in affected patients would depend on early respiratory support and careful management of pulmonary complications.

Table 4: Distribution of Fatal Complications in Organophosphorus Poisoning

Complications	No of Cases	No of Death(%)
Respiratory Failure	21	16(76.1%)
Pulmonary Edema	8	3(14.3%)
Intermediate Syndrome	4	1(4.8%)
Aspiration Pneumonia	2	1(4.8%)

The results of this study have identified major determinants of outcome for patients with OP poisoning. Younger victims, aged 15-30 years, were more predominantly affected by this poisoning with a male preponderance, and timely hospital admission ensured survival as those admitted within two hours had 100% recovery while delayed admission beyond six hours exposed the victim to a significantly increased risk of death. The need for mechanical ventilation and absence of early atropinization were strong predictors of poor outcomes, further putting a spotlight on the need for early medical management. Among complications, respiratory failure was the highest cause of mortality, followed by pulmonary edema, intermediate syndrome, and aspiration pneumonia. These findings highlight the need for early identification, transport to the hospital as quickly as possible, and aggressive supportive management, atropinization, and respiratory support to improve survival.

DISCUSSION

The findings of this study offer important insights into the demographic patterns, clinical characteristics, and key predictors of mortality in organophosphorus (OP) poisoning cases. Results indicate that the most affected individuals are those belonging to the age group 15-30 years, accounting for 70% of cases. This demographic trend indicates that OP poisoning is a significant problem in the younger age group, probably due to factors like occupational exposure, impulsive suicidal attempts, or accidental ingestion.

The male preponderance with a male-to-female ratio of 1.56:1 matches other studies showing that more males are affected than females, perhaps because of the higher involvement of males in agricultural activities and better access to OP compounds [9].

The critical importance of timely medical intervention in OP poisoning is revealed from the time intervals to hospital admission and patient outcomes. Among the patients admitted within two hours, a notable 100% survival rate was seen, reiterating the urgency of swift emergency care. The mortality rates increased significantly with the delay of hospital admission beyond six hours; in fact, 57.6% of the deaths fell within this category. This delay likely worsens the poisonous effects of OP compounds and ultimately facilitates a severe cholinergic crisis with life-threatening complications. The only 4.7% mortality involved those patients admitted within two to six hours, which further points to the fact that even a minor delay in medical care greatly affects survival rates. These findings make for increased public awareness campaigns and emergency response strategies that could ensure speedy transportation of OP poisoning cases to healthcare [10-11].

The clinical predictors of death further emphasize the significance of early atropinization and mechanical ventilation in determining the outcome. A strong predictor of poor prognosis was the necessity of ventilatory support, which occurred in 55% of patients who died due to poisoning while on mechanical ventilation. This indicates the severity of respiratory compromise in OP poisoning, where excessive bronchial secretions, diaphragmatic weakness, and neuromuscular failure contribute to hypoxia and respiratory arrest. Patients who were not atropinized before hospitalization had a much higher mortality rate of 28.4% as compared with only 6.1% mortality among those who were atropinized early. This confirms the well-established role of atropine in counteracting the cholinergic effects of OP poisoning and highlights the need for immediate administration in suspected cases, even before hospital arrival [12].

Complications associated with OP poisoning were another critical factor influencing mortality. Respiratory failure emerged as the leading cause of death, accounting for 76.1% of fatal cases. High incidence of respiratory failure can be ascribed to excessive bronchial secretions, neuromuscular paralysis, and central respiratory depression that are characteristic of severe OP poisoning. Pulmonary edema contributed to 14.3% of deaths and therefore fluid accumulation in the lungs further compromised oxygenation in the critically ill. Intermediate syndrome, characterized by delayed muscle weakness and respiratory insufficiency, accounted for 4.8% of deaths, and it was felt that these patients needed to be monitored for a longer period than the acute cholinergic crisis. Aspiration pneumonia accounted for 4.8% of deaths, and it was felt that airway protection and early respiratory support were important in preventing further complications [13].

As illustrated in the survival analysis, variation in mortality rates based on different OP compounds further suggests that certain OP agents have higher levels of toxicity and worse prognostic outcomes. Such information could be instrumental in tailoring treatment approaches, particularly identifying high-risk exposures that require more aggressive management strategies. Differences in toxicity may be related to differences in lipid solubility, metabolism, and binding affinity of different OP compounds to acetylcholinesterase, all factors that affect the severity and duration of poisoning effects [14].

The survival analysis further supports the positive correlation of time from hospital admission to the patient's survival. Survivals were highly improved among patients who received early medical intervention compared to delayed admissions, for which survival exhibited a stepwise decrease after six hours. These findings underscore the critical need for early recognition and transport of cases to medical facilities to avoid unnecessary fatalities due to OP poisoning [15].

In general, the study gives an overall assessment of the major factors that determine OP poisoning outcomes. The fact that most patients involved were relatively younger and predominantly male points to specific prevention measures and public education campaigns about the danger of OP compounds and strict availability. The outcome is a significant indication of an early hospital admission, timely atropinization, and intensive respiratory support measures for better survival rates. In addition, high mortality due to respiratory complications calls for close respiratory monitoring, ventilatory support, and intensive care management in the severe cases. The results do stress the imperative to have improved pre-hospital care, public health initiatives, and healthcare infrastructure to minimize the morbidity and mortality related to OP poisoning.

V. CONCLUSION

This study stresses the need for early medical intervention, timely atropinization, and respiratory support in managing patients with organophosphorus poisoning to yield better outcomes. The findings underscore that the susceptibility is higher in younger patients, especially males. Delayed admission to hospital had a high increase in mortality rates. The mechanical ventilation and the lack of pre-hospital atropinization were the significant predictors of a poor prognosis. Thus, early and aggressive management is crucial. Respiratory failure became the major cause of death, which makes it imperative to closely monitor

and provide intensive care support. With the significant role of time to treatment in survival, public education, improvement in emergency response systems, and ensuring timely medical treatment are critical interventions in reducing fatalities due to OP poisoning.

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