International Journal of Research in Medical Sciences
Paratel TR et al. Int J Res Med Sci. 2025 Jun;13(6):2493-2498
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20251641

Original Research Article

Estimation of serum potassium levels as a prognostic marker in acute organophosphorus poisoning in a tertiary care center

Tilottama R. Parate[1]*, Nitin H. Bhure[1]*, Ramesh U. Parate[2]

[1]Department of General Medicine, Indira Gandhi Government Medical College, Nagpur, Maharashtra, India
[2]Department of Radiology, Government Medical College, Nagpur, Maharashtra, India

Received: 11 April 2025
Revised: 11 May 2025
Accepted: 21 May 2025

***Correspondence:**
Dr. Nitin H. Bhure,
E-mail: bhurenitin008@gmail.com

ABSTRACT

Background: Organophosphorus compound poisoning is primarily a problem of the developing countries. Its widespread use and easy availability have increased the likelihood of poisoning with these compounds. Serum cholinesterase levels are easier to estimate and usually depressed after OP poisoning. Peradeniya OP poisoning scale has not been studied much in Indian scenario. Hypokalaemia is one of the most common electrolyte abnormalities associated with organophosphorus poisoning It could be a simple and effective system to determine the need for ventilatory support early on in the course. The data are scarce especially in central India regarding the OP poisoning and the consequent role of serum potassium in assessing the severity. Hence this study was undertaken to assess the severity of organophosphorus compound poisoning clinically by estimating serum potassium levels.
Methods: A prospective study was performed among 100 cases of OP poisoning, from September 2022 to September 2024. On patient's fulfilling inclusion criteria were investigated with serum Potassium at the time of admission and estimation of serum acetylcholinesterase were done on the day of admission.
Results: Serum potassium levels were significantly low in subjects who required mechanical ventilation compared to those with normal potassium levels serum potassium levels and Potassium levels were significantly low in patients who developed respiratory failure and thus strongly correlated with clinical severity.
Conclusions: Serum potassium levels show a strong degree of positive correlation with the severity of poisoning and can be used as a predictor of outcome in organophosphorus poisoning.

Keywords: Acetylcholinesterase, Organophosphorus, Respiratory failure, Serum potassium

INTRODUCTION

Organophosphorus compound (OPC) poisoning has assumed alarming proportions with an annual incidence of over 3 million patients in 1990. Organophosphorus compound poisoning is primarily a problem of the developing countries.[1] Organophosphorus compound poisoning is the most common medico toxic emergency in India. Acute organophosphorus compound poisoning is an important indication for emergency admission in most hospitals throughout India.[2] Organophosphorus compounds were first developed by Schrader shortly before and during the Second World War. They were first used as an agricultural insecticide and later as potential chemical warfare agents.[2]

Organophosphorus (OP) compounds are used as pesticides, herbicides, and chemical warfare agents in the form of nerve gases.[2] Its widespread use and easy availability has increased the likelihood of poisoning with these compounds. Although poisoning can result from occupational exposure or accidental ingestion, in most cases there is suicidal intent. Their common availability renders OP insecticide poisoning a worldwide health

problem affecting millions of patients. India is a tropical country where agriculture forms the backbone of the nation.[3] The WHO estimates that approximately 3 million pesticide poisonings occur annually worldwide and cause more than 220,000 deaths. Developing countries like India and Srilanka report alarming rates of toxicity and death.[4]

Potassium plays an important role at the cellular level. Its functions relate mainly to the heart and skeletal muscle contraction, nerve conduction, and glomerulo-tubular renal function.[5] It is seen that hypokalaemia is one of the most common electrolyte abnormality associated with organophosphorus poisoning which has already been demonstrated by Tripathy et al.[6,7] He also demonstrated cardiac comorbidities associated with hypokalaemia in organophosphorus poisoning.[7] It is also seen that hypokalaemia is associated with a ten-fold mortality risk among hospitalized patients due to adverse effects on cardiac rhythm, blood pressure and cardiovascular mortality.[7] Associated hypokalaemia reinforces the muscle weakness. Hence, hypokalaemia can be considered as an important factor for intensifying the poisoning. Estimation of serum potassium is economical and levels are usually deranged. Serum potassium can be used as a low budget, easily available prognostic marker for acute organophosphorus poisoning.[6]

Organophosphorus poisoning constitutes a major health hazard in central India and constitutes a sizeable number of hospital admissions in emergency situations. There is a paucity of literature regarding the clinico-pathological profile of organophosphorus poisoning and its association with serum potassium levels, in India. The data are scarce especially in central India regarding the OP poisoning and the consequent role of serum potassium in assessing the severity. Hence the present study was conducted to evaluate the role of hypokalaemia in OP poisoning in our tertiary care centre.

METHODS

A cross-sectional prospective study was performed among 100 cases of OP poisoning, from September 2022 to September 2024 at Department of General medicine in a tertiary care institute-Indira Gandhi Government Medical College Nagpur who fulfilled the inclusion and exclusion criteria. Institutional ethical committee clearance obtained before commencement of study.

Inclusion criteria

Patients who had allegedly consumed organophosphate poison and admitted to hospital within 24 hrs. of ingestion in Males and females of age >12 years.

Exclusion criteria

Patient with multiple poisoning with other drugs such as opioids, diazepam, etc. Diseases that can modify serum potassium levels like liver dysfunction, chronic renal failure. Patients with history of respiratory disease including bronchial asthma, cardiac diseases, neuromuscular disease like myasthenia gravis or muscular dystrophy. All conditions causing of hypokalaemia-alkalosis, diuretic use, beta agonist use, etc and pregnant patients.

Type of poisoning was ascertained by containers brought by relatives in setting of clinical and biochemical features of OP compound poisoning. Peradeniya organophosphorus poisoning scale was calculated and patients were classified. Serum Cholinesterase was estimated on the day of admission and serum Potassium will be done on the day of admission. Along with the biochemical analysis, patient was followed up for clinical outcome like complete recovery, respiratory failure, and death.

Statistical analysis

Data was coded and analysed in statistical software SPSS version 26. Quantitative data was expressed in mean and standard deviation along with Categorical variables was expressed. Inferential statistics included chi square test and test of significance (p-value) and appropriate test were applied to analyse data.

RESULTS

In our study the majority of participants (42%) are between the ages of 21 and 30, followed by 22% aged 31 to 40. The youngest age group (≤20) constitutes 9% of the subjects, while those aged 41 to 50 make up 14%. Participants aged 51 to 60 accounts for 10% The mean age of the study subjects is 34.09 years. A significant majority (77%) of the participants were male, while females constitute 23%, Jallad was the most commonly used compound, accounting for 48% of the subjects.

Table 1: Distribution of study subjects according to age.

Age groups (years)	Frequency	Percentage
≤20	09	9.00
21-30	42	42.00
31-40	22	22.00
41-50	14	14.00
51-60	10	10.00
61-70	03	3.00
Total	100	100.00
Mean±SD	34.09±12.37	
Range	13-70	

Chlorpyriphos and monocrotophos were each used by 12% of participants according to the peradeniya organophosphorous poisoning grading (POP). 58% of the subjects fell under the mild category, while 42% are classified as moderate Most subjects (60%) had normal potassium levels. Mild hypokalaemia was observed in

30% of subjects, moderate hypokalaemia in 7%, and severe hypokalaemia in 2%. Only 1% of the subjects exhibited hyperkalaemia.

Table 2: Distribution of study subjects according to sex.

Sex	Frequency	Percentage
Female	23	23.00
Males	77	77.00
Total	100	100.00

According to the proudfoot classification, 42% of subjects were in the mild category (2001 IU-4500 IU), 40% in the moderate category (1001 IU-2000 IU), and 6% in the severe category (0-1000 IU). In the mild hypokalaemia group, 46.67% of the subjects died, while 53.33% were discharged. For subjects with moderate hypokalaemia, 42.86% died, and 57.14% were discharged. Subjects with normal potassium levels had a death rate of 11.67%, with 88.33% being discharged. In the severe hypokalaemia group, 100% deaths were recorded.

Table 1 shows the age distribution of the study subjects. The majority of participants (42%) are between the ages of 21 and 30, followed by 22% aged 31 to 40. The youngest age group (≤20) constitutes 9% of the subjects, while those aged 41 to 50 make up 14%. Participants aged 51 to 60 account for 10%, and the oldest group (61-70) represents 3% of the total. The mean age of the study subjects is 34.09 years, with a standard deviation of 12.37 years, and the age range is from 13 to 70 years.

Table 2 illustrates the gender distribution among the study subjects. A significant majority (77%) of the participants were male, while females constitute 23% of the total sample size of 100 subjects.

Table 4 shows the serum potassium levels among the study subjects after 24 hours. Most subjects (60%) had normal potassium levels. Mild hypokalaemia was observed in 30% of subjects, moderate hypokalaemia in 7%, and severe hypokalaemia in 2%. Only 1% of the subjects exhibited hyperkalaemia.

Table 3: Distribution of study subjects according to organophosphrous compound used.

OP compound	Frequency	Percentage
Chlorpyriphos	12	12.00
Cypermethrin	10	10.00
Fenthion	02	2.00
Jallad	48	48.00
Monocrotophos	12	12.00
Monophos	02	2.00
Profenophos + cypermethrin	05	5.00
Propoxur	02	2.00
Others	07	7.00
Total	100	100.00

Table 3 lists the various organophosphorous compounds used by the study subjects. Jallad was the most commonly used compound, accounting for 48% of the subjects. Chlorpyriphos and monocrotophos were each used by 12% of participants, while Cypermethrin is used by 10%. Other compounds like Profenophos + cypermethrin, monophos, propoxur, and fenthion were used less frequently, representing 5%, 2%, 2%, and 2% respectively. Other unspecified compounds make up 7% of the total.

Table 4: Distribution of study subjects according to serum potassium levels.

Serum potassium levels at 24 hours	Frequency	Percentage
Hyperkalaemia	01	1.00
Mild hypokalaemia	30	30.00
Moderate hypokalaemia	07	7.00
Severe hypokalaemia	02	2.00
Normal levels	60	60.00
Total	100	100.00

Table 5: Association between POP grading and serum potassium levels.

POP grading	Hyperkalaemia N (%)	Mild hypokalaemia N (%)	Moderate hypokalaemia	Normal N (%)	Severe hypokalaemia N (%)	Total N (%)	Fischer's exact P value
Mild	01 (100%)	07 (23.33%)	03 (42.86%)	47 (78.33%	00 (00%)	58 (58%)	0.0000*
Moderate	00 (00%)	23 (76.67%)	04 (57.14%)	13 (21.67%	02 (100%)	42 (42%)	
Total	01 (100%)	30 (100%)	07 (100%)	60 (100%)	02 (100%)	100 (100%)	

***statistically significant**

Table 5 examines the relationship between POP grading and serum potassium levels. A significant association (p=0.00001) is found between the two. Subjects with mild POP grading mostly had normal potassium levels, whereas those with moderate POP grading were more likely to have mild or moderate hypokalaemia.

Table 6 assesses the association between serum potassium levels and the outcome of the study subjects. A chi-square test reveals a significant association (p=0.003). Subjects with normal potassium levels have the highest discharge rate (69.74%). Mild hypokalaemia was also associated with a higher discharge rate (21.05%). Severe hypokalaemia was less common and observed only in a small percentage (2.63%) of discharged subjects. Hyperkalaemia was rare, and there are no deaths associated with it.

Table 6: Association between potassium levels and outcome of study subjects.

Serum potassium levels	Outcome		Total N (%)	Chi square P value
	Death N (%)	Discharged N (%)		
Hyperkalaemia	00 (00)	01 (1.32)	01 (1)	0.003*
Mild hypokalaemia	14 (58.33)	16 (21.05)	30 (30)	
Moderate	03 (12.50)	04 (5.26)	07 (7)	
Normal potassium levels	07 (29.17)	53 (69.74)	60 (60)	
Severe hypokalaemia	00 (00)	02 (2.63)	02 (2)	
Total	24 (100)	76 (100)	100 (100)	

*statistically significant

Table 7: Association between POP grading and outcome of study subjects.

POP grading	Outcome		Total N (%)	Chi square P value
	Death N (%)	Discharged N (%)		
Mild	02 (8.33)	56 (73.68)	58 (58)	0.000001*
Moderate	22 (91.67)	20 (26.32)	42 (42)	
Total	24 (100)	76 (100)	100 (100)	

*statistically significant

Table 8: Association between mechanical ventilation requirement and serum potassium levels and outcome of study subjects.

Mechanical ventilation	Serum potassium levels					Total N (%)	Chi square P value
	Hyperkalaemia N (%)	Mild hypokalaemia N (%)	Moderate hypokalaemia N (%)	Normal	Severe hypokalaemia N (%)		
No (n=57)	01 (1.75)	09 (15.79)	02 (3.51)	45 (78.95)	0 (0)	57 (100)	0.001*
Yes (n=43)	0 (0)	21 (48.84)	05 (11.63)	15 (34.88)	02 (4.65)	43 (100)	

*statistically significant

Table 7 evaluates the association between POP grading and the outcome of the study subjects. A significant association (p=0.000001) was noted. Subjects with mild POP grading have a high discharge rate (73.68%), while those with moderate POP grading have a higher mortality rate (91.67%).

Table 8 outlines the association between the requirement for mechanical ventilation and serum potassium levels among study subjects, along with their outcomes.

Among those who did not require mechanical ventilation (n=57), 1.75% had hyperkalemia, 15.79% had mild hypokalemia, 3.51% had moderate hypokalemia, and a majority of 78.95% had normal potassium levels, with no cases of severe hypokalemia observed. In contrast, for those who required mechanical ventilation (n=43), none had hyperkalemia, 48.84% had mild hypokalemia, 11.63% had moderate hypokalemia, 34.88% had normal potassium levels, and 4.65% had severe hypokalemia. The chi-square analysis revealed a statistically significant association between serum potassium levels and the requirement for mechanical ventilation, with a p-value of 0.001.

DISCUSSION

OP poisoning is a major health problem worldwide and one of the commonest causes for morbidity and mortality, particularly in developing countries. The prognosis depends on time lag between exposure and the onset of management. With increase in use of this compound for industrial and agricultural purposes and due to easy accessibility and low cost, they are becoming major source of health hazard. Early identification, diagnosis, appropriate management are vital to reduce the mortality. This study is undertaken to analyse the biochemical abnormalities in organophosphate poisoning and to assess their prognostic significance.

In our study, vomiting, reported by 97% of subjects, is the most common symptom, reflecting the gastrointestinal distress caused by these compounds. Sweating (78%) and fasciculation (75%) are also highly prevalent, indicating significant autonomic and neuromuscular effects. Tachypnea (54%) and miosis (59%) further emphasize the respiratory and ocular manifestations of poisoning. Bladder incontinence (49%), lacrimation (46%), and loose stools (39%) are additional common symptoms, suggesting widespread cholinergic effects

Jallad is the most commonly used, accounting for 48% of cases. This high percentage indicates the widespread availability and application of Jallad in the study area. This finding is corroborated by Eyer et al, who highlighted that certain organophosphorous compounds, like Jallad, are widely used due to their effectiveness and availability.[8] Chlorpyriphos and monocrotophos, each used by 12% of participants, are also significant contributors to exposure. Cypermethrin, used by 10%, is another common pesticide.

The POP grading categorizes the severity of poisoning, with 58% of subjects classified as mild and 42% as moderate.

60% of subjects had normal potassium levels, while 30% exhibited mild hypokalemia. Moderate and severe hypokalemia were observed in 7% and 2% of subjects respectively, and hyperkalemia was rare (1%). Hypokalemia is a common electrolyte disturbance in organophosphorous poisoning and requires careful monitoring and correction to prevent complications. The high percentage of subjects with normal potassium levels suggests that with proper management, many patients can maintain stable electrolyte balances. The observed serum potassium levels and their association with clinical outcomes are corroborated by research from Roberts and Aaron et al, which highlights the importance of electrolyte monitoring in organophosphorous poisoning management.[9]

This is consistent with the findings of Wadia et al, who observed hypokalemia in patients with organophosphate poisoning due to excessive sweating and gastrointestinal losses.[10] Gawarammana and Buckley et al also reported similar electrolyte disturbances in their study on organophosphate poisoning cases.[11]

Difoesa et al observed hypokalaemia among 28% out of the total 100 organophosphorus poisoning patients admitted whereas 72 % (72 patients) were having normal serum potassium levels and no one had hyperkalaemia among the study population.[12] Umamaheshwari S et al found 14% of the study population with mild hypokalaemia at the time of presentation and 2% of population had moderate hypokalaemia. In rest of the patients, serum potassium levels were normal and there is no hyperkalaemia.

The proudfoot classification of serum cholinesterase levels is used to gauge the extent of cholinesterase inhibition. 42% of subjects were in the mild category (2001-4500 IU), 40% in the moderate category (1001-2000 IU), and 6% in the severe category (0-1000 IU). 12% of subjects had normal cholinesterase levels (>4500 IU). a significant number of subjects experiencing moderate to mild inhibition. This observation aligns with Eddleston et al, who found that serum cholinesterase activity is a reliable biomarker for the severity of organophosphate poisoning.[13] He et al further supported this, noting that lower cholinesterase levels correlate with more severe poisoning and poorer outcomes.[14]

Subjects with normal potassium levels had better outcomes, which is consistent with the findings of Adinew et al, who noted that electrolyte balance plays a crucial role in recovery from organophosphate poisoning.[15] Additionally, subjects with mild serum cholinesterase reductions had higher discharge rates, similar to the outcomes reported by Balali-Mood and Saber in their comprehensive review of organophosphate poisoning management.[16]

Our study also showed the association between the need for mechanical ventilation and serum potassium levels. The data suggest that patients with mild to moderate hypokalemia were more likely to require mechanical ventilation compared to those with normal potassium levels. This is supported by a study conducted by Krogager et al which found that hypokalemia was a predictor of the need for invasive mechanical ventilation in acutely ill patients.[17] The study concluded that maintaining optimal potassium levels could reduce the likelihood of respiratory complications that necessitate mechanical support.

The significant p-values in both tables indicate that these associations are not due to chance, reinforcing the clinical relevance of serum potassium levels in determining both the immediate need for mechanical intervention and overall patient outcomes. This is in line with the findings of Brotfain et al who emphasized that dyskalemias are common in critically ill patients and are associated with poor outcomes, including increased mortality and prolonged mechanical ventilation.[18]

Limitations

Sample size: The study had a relatively small sample size (n=100), which may limit the generalizability of the findings to broader population. A larger sample size would provide more robust conclusions. Single center study: If the study was conducted in a single center or hospital result may not be representative of different regions or health care settings, which might have different exposure patterns, treatment protocols, or patient demographics.

CONCLUSION

The association between serum potassium levels and clinical outcomes revealed that subjects with normal potassium levels had the highest discharge rate while cases with hypokalemia have higher mortality rates as compared to others. POP grading showed a significant association with clinical outcomes with subjects having mild grading exhibiting a high discharge rate while those with moderate grading had a higher mortality rate. The chi-square analysis revealed a statistically significant association between serum potassium levels and the requirement for mechanical ventilation showing hypokalemic cases required mechanical ventilation. Serum potassium shows a strong degree of positive correlation with the severity of poisoning and can be used as a predictor of outcome in organophosphorus poisoning.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Mogda KM, Kashoury A, Rashed MA. Oxidative and biochemical alterations induced by profenofos insecticide in rats. Nat Sci. 2009;7(2):1-15.
2. Claudia B. Genotoxicity of pesticides: a review of human biomonitoring studies. Mut Res. 2003;543:251-72.
3. Taylor P. Anticholinesterase agents. In: Goodman and Gilman's The Pharmacological Basis of Therapeutics. Ed. Hardman J G, Limbird L E, Molinoff P B, Ruddon R W. 9th ed.; 1996:161-76.
4. World Health Report 2004. WHO, Geneva; 2004. Available at: https://iris.who.int/bitstream/handle/10665/42891/924156265X.pdf. Accessed on 25 March 2025.
5. Tetzlaff JE, O'Hara JF, Walsh MT. Potassium and anaesthesia. Can J Anaesth 1993;40(3):227-46.
6. Mount DB. Fluid and electrolyte disturbances. In: Kasper D, Fauci A, Hauser S, et al, eds. Harrison's principles of internal medicine. Vol. 1. New York: McGraw-Hill Education; 2018:304-306.
7. Tripathy SK, Rout PK, Debta N. Study of clinical profile of organophosphorus poisoning with special reference to electrocardiographic changes and electrolyte derangement. Int J Adv Med. 2018;5(1):50-6.
8. Eyer P. The role of oximes in the management of organophosphorus pesticide poisoning. Toxicol Reviews. 2003;22(3):165-90.
9. Roberts DM, Aaron CK. Management of acute organophosphorus pesticide poisoning. BMJ. 2007;334(7594):629-34.
10. Wadia RS, Sadagopan C, Amin RB, Sardesai HV. Neurological manifestations of organophosphorous insecticide poisoning. J Neurol Neurosurg Psychiatry. 1974;37(7):841-7.
11. Gawarammana IB, Buckley NA. Medical management of paraquat ingestion. Br J Clin Pharmacol. 2011;72(5):745-57.
12. Difoesa B, Sharma DJ, Hari S. Significance of serum potassium level at admission in organophosphorus poisoning and impact on outcome – a hospital- based study from north east India. J Evid Based Med Healthc. 2021;8(36):3282-7.
13. Eddleston M. Patterns and problems of deliberate self-poisoning in the developing world. QJM. 2000;93:715–31.
14. He F, Wang S, Tang X, Xia H, Zhao X. Clinical manifestation and diagnosis of acute pyrethroid poisoning. Arch Toxicol. 1989;63(1):54-8.
15. Adinew GM, Wubie M, Azazh A, Mehta R, Tullu KD. Clinical profile and outcome of organophosphate poisoning patients at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia: a cross-sectional study. BMC Pharmacol Toxicol. 2017;18(1):35.
16. Balali- Mood M, Saber H. Recent advances in the t reatment of organophosphorous poisonings. Iran J Med Sci. 2012;37(2):74-91.
17. Krogager ML, Torp-Pedersen C, Mortensen RN, et al. Short-term mortality risk of serum potassium levels in hypertensive patients: A retrospective cohort study. Eur Heart J. 2017;38(2):104-12.
18. Brotfain E, Koyfman L, Toledano R. Risk factors associated with the need for mechanical ventilation and mortality in critically ill patients with dyskalemias. Crit Care Resusc. 2017;19(2):143-9.

Cite this article as: Parate TR, Bhure NH, Parate RU. Estimation of serum potassium levels as a prognostic marker in acute organophosphorus poisoning in a tertiary care center. Int J Res Med Sci 2025;13:2493-8.