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Evaluation of Clinical and Biochemical Parameters in Organophosphorus Poisoning

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ABSTRACT

Background: Organophosphorus (OP) poisoning is a significant health issue in developing countries like India due to the easy availability and low cost of OP compounds, leading to a rise in suicidal and accidental poisonings. With agriculture contributing substantially to the Indian economy, the use of OP compounds is extensive, making up 22% of the GDP and employing nearly 70% of the workforce. This study addresses the pressing need to understand factors influencing the morbidity and mortality associated with OP poisoning.

Methods: A study was conducted, including 100 consecutive patients admitted to the PG Dept. of Medicine at SCB Medical College between December 2020 and November 2021 with documented organophosphorus poisoning. Parameters were examined, such as the type and quantity of OP compounds consumed, the time between exposure and gastric lavage, clinical severity grading, and their correlations with mechanical ventilation, complications, and mortality.

Results: Chlorpyriphos (29%), Phorate (26%), and Dimethoate (13%) were the most common OP compounds used. Complications included pulmonary edema (31.8%), aspiration pneumonia (22.7%), respiratory failure (27.2%), and intermediate syndrome (18.3%). Non-survivors had a significantly higher mean poison consumption (116.66ml) compared to survivors (42.92ml).

Conclusion: The study concludes that the mean amount of poison consumed is indicative of complications and mortality in OP poisoning. Additionally, the time interval between ingestion and gastric lavage is a valuable indicator for assessing the severity of poisoning, predicting complications, and estimating the need for ventilator support and mortality risk. These findings contribute to refining management strategies for OP poisoning cases.

Key-words: Organophosphorus, OP poisoning, POP scale, Clinical parameters, Biochemical parameters

INTRODUCTION

Organophosphorus (OP) compounds are insecticides widely used in agriculture to control weeds, diseases, and pests. Given that agriculture is the primary driver of India's economy, the significance of pesticides is evident. Approximately 70% of the workforce nation's workforce is employed in it, generating 22% of the GDP. One of the most prevalent forms of poisoning in developing countries like India is OP poisoning since it is affordable and readily available [1]. Consequently, there is a surge in accidental poisoning occurrences and suicidal thoughts, which raise the rate of morbidity and death. Suicidal people typically absorb drugs through the stomach mucosa, which organophosphates can cross. Although the liver is the final organ in the body to activate and detoxify organophosphate chemicals, the kidneys ultimately eliminate them [2]. At neuromuscular junctions

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and nerve terminals, the OP compounds block the acetylcholine esterase enzyme, causing overstimulation of acetylcholine receptors. The main source of poisoning signs and symptoms is overstimulation of muscarinic, nicotinic, and central nervous system (CNS) receptors. [3] Bradycardia, muscarinic hypotension, nicotinic tachycardia, increased salivation/lacrimation, excessive sweating, nausea, vomiting, diarrhea, stomach discomfort, and fecal and urine incontinence are the two primary types of clinical symptoms associated with muscarinic and nicotinic disorders. CNS symptoms include anxiety, restlessness, seizures, miosis, insomnia, coma, Cheyne-Stokes breathing, respiratory failure, and cardiovascular failure [4,5]. Most deaths from OP poisoning are caused by cardiovascular and pulmonary failure. A laboratory evaluation is necessary to establish whether poisoning is present, locate the initial acute organ damage, and calculate the overall poisoning. Measurements of plasma pseudocholinesterase levels in a laboratory setting are required for the most accurate diagnosis of OP poisoning. [6,7] Decreases in pseudocholinesterase activity are linked with the severity of acute OP poisoning. In addition to clinical symptoms, low blood cholinesterase levels were a good predictor of the need for mechanical ventilation in patients with OP poisoning. However, plasma choline esterase is not a good measure of achievement [8,9]. The optimal course of treatment can be identified by monitoring erythrocyte cholinesterase activity, as opposed to plasma cholinesterase activity, in conjunction with clinical symptoms.[10] On the other hand, RBC cholinesterase estimation is a difficult test to do technically and is not widely accessible in India. One well-known biochemical trait associated with OP poisoning is hyperamylasemia, which may result from an overstimulated cholinergic response in the pancreas. An increase in intraductal pressure and the exocrine pancreatic flow rate lead to fluid extravasation.[11] Several studies have evaluated serum amylase's predictive usefulness in cases of OP poisoning. [12,13] Amylase elevation in serum is less specific and sensitive. Therefore, serum lipase estimation may be helpful for an early diagnosis of pancreatitis in patients with increased amylase levels. A patient's chance of dying from OP poisoning increases if they consume 50–100 ml or more of the OP compounds; eating more than 100 ml has the highest death rate. [14], when post-poisoning care begins [15], which patients require mechanical breathing [16], and how long ventilator support is needed [17]. Longer automatic breathing times are also needed for those with extended lag periods. [17] This study aims to investigate potential correlations between the amount of poison consumed, the time interval between the poisoning and gastric lavage, and various biochemical parameters such as serum choline esterase, serum amylase, serum lipase, serum urea, and serum creatinine values, and the severity, complications, ventilator requirement, and mortality in cases of OP poisoning. The kind and amount of OP compound consumed, the interval between exposure to the poison and the time of gastric lavage, the clinical severity as determined by the Peradeniya OP poisoning scale, the need for and length of time spent on mechanical ventilation, complications, and death from OP poisoning are among the variables that need to be looked into.

MATERIALS AND METHODS

In this prospective study conducted at the Department of Medicine, SCB Medical College, and Cuttack from December 2020 to November 2021, 100 patients diagnosed with OP poisoning were enrolled following approval from the Institute Ethical Committee. The study design included all OP poisoning cases, with specific exclusion criteria applied. The participants' demographic and clinical information were collected through established medical examinations and laboratory tests. Ethical considerations were addressed with IEC approval, ensuring participant confidentiality and well-being. Statistical analysis was conducted to analyze the collected data. The study aimed to comprehensively investigate OP poisoning, utilizing a rigorous methodology to derive meaningful insights.

Inclusion criteria- The study included all the OP poisoning cases diagnosed by history, circumstantial evidence of consumption, characteristic clinical features, and basic laboratory investigations.

Exclusion criteria

- Patients less than 15 years.
- Poisoning with substances other than organophosphorus compound or OP compound mixed with other substances.
- Patients who have chronic alcoholism

- Patients with a history of pancreatitis or disease of the salivary gland
- Patients with history of any disease that may adversely affect the outcome in case of op poisoning.

Statistical Analysis- In this study, a comprehensive approach was employed to evaluate and manage patients with OP poisoning. Detailed histories were obtained from the patient's relatives, covering the type of OP compound and treatment history. A thorough clinical examination focused on vital parameters, pupil size, and assessments of the central nervous, respiratory, cardiovascular, and gastrointestinal systems. The Peradeniya OP poisoning scale was applied at admission to grade the severity of OP poisoning. Diagnosis relied on clinical features, exposure history, and low plasma pseudocholinesterase levels. Standard protocols, including atropine, pralidoxime, and supportive measures, were administered. Baseline investigations were performed, such as complete blood count, plasma pseudocholinesterase, blood urea, serum creatinine, amylase, and lipase. Follow-up assessments included the reassessment of certain parameters on days 3 and 5. Arterial blood gas and chest X-rays were conducted in ventilated patients, while ultrasound examinations were performed in cases showing signs of pancreatitis or renal failure. Data analysis encompassed age, gender, amount of OP consumed, time intervals, ventilatory support, hospital stay, complications, and outcomes. Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) software, ensuring the integrity and completeness of the collected data.

Ethical approval- The patients and their attendants were informed about the study objectives, procedures, risks and benefits related to the study. In addition, they were told that participation was optional, and will not affect the treatment outcome during their stay in the hospital.

RESULTS

The mean age of presentation for patients in this study was 37.57±16.19 years for males and 34.28±13.44 years for females. Most cases were in the younger age group, with 28 out of 100 patients falling between 21 and 30 years of age, followed by 15 patients in the 15–20-year range. Distribution across other age groups included 25, 11, and 12 cases in the 31-40-, 41-50-, and 51–60-year ranges, respectively. Only 9 patients were over 60, as highlighted in Table 1. This demographic breakdown provides insight into the age distribution of patients presenting with organophosphate poisoning in the study population.

Table 1: Age distribution

Age (Yrs)	Males		Females	
	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)
<20	07	13	08	17.4
21 to 30	16	29.6	12	26.1
31 to 40	11	20.4	14	30.4
41 to 50	05	9.3	06	13.0
51 to 60	09	16.7	03	6.5
>60	06	11.1	03	6.5
Total	54	100	46	100

The study findings reveal that chlorpyriphos was the predominant organophosphate (OP) compound used in cases of poisoning, accounting for 29 out of 100 instances. Phorate followed closely, comprising 26% of the cases, while dimethoate was associated with 13% of poisonings. Other OP compounds identified included dichlorvos, profenofos, monocrotophos, diphos, and acephate. Notably, in 8% of the cases, the specific poison compound could not be determined, as detailed in Table 2 and Fig 1. This information underscores the distribution of various OP compounds responsible for poisoning incidents in the study population, with chlorpyriphos being the most prevalent.

Table 2: Types of compounds consumed

Type of compound consumed	Frequency (N)	Percentage (%)
Chlorpyriphos	29	29
Diphorate	06	6
Monocrotophos	04	4
Phorate	26	26
Malathion	02	2
Dimethoate	13	13
Profenofos	03	3
Acephate	01	1
Diphos	03	3
Unknown	08	8
Total	100	100

Table 3: Presenting features

Clinical features	Males (%)	Females (%)	Total
Sludge*	49 (90.7)	43 (93.5)	92 (92)
Miosis	41 (75.9)	32 (69.6)	73 (73)
Tachypnea	40 (74.1)	29 (63.)	69 (69)
Bronchorrhea	36 (66.7)	26 (56.5)	62 (62)
Bradycardia	35 (64.8)	27 (58.7)	62 (62)
Tachycardia	02 (3.7)	04 (8.7)	06 (6)
Fasciculation	07 (13.)	01 (2.2)	08 (8)
Altered sensorium	39 (72.2)	27 (58.7)	66 (66)
Seizure	05 (9.3)	02 (4.3)	07 (7)
Coma	07 (13.)	03 (6.5)	10 (10)

During the study of symptoms and signs at the time of admission and hospitalization, SLUDGE* (salivation, lacrimation, urination, diarrhoea, GI upset and emesis) was the most common symptom present in 92% of the cases, while miosis (73%), tachypnoea (69%), altered sensorium (66%), bronchorrhea (62%) and bradycardia (62%) were common presenting signs followed by Coma (10%), fasciculation (8%) and seizure (7%), Tachycardia (6%).

Table 4: Complications

Complications	Frequency (N)	Percentage (%)
Pulmonary edema	14	31.8
Aspiration pneumonia	10	22.7
Respiratory failure	12	27.2
Intermediate syndrome	08	18.3
Total	44	100

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Among the 100 patients in the study, 44 presented with various complications during the research. Pulmonary edema was identified as the most prevalent complication, constituting 31.8% of cases with a total of 14 instances. Other complications included aspiration pneumonia, observed in 22.7% (10 cases), respiratory failure in 27.2% (12 cases), and intermediate syndrome in 18.3% (8 cases). This data highlights the diversity of complications associated with organophosphate poisoning, with pulmonary edema being the most frequently observed complication in the study population.

Table 5: Amount of poison consumed

Amount consumed (mL)	Frequency (N)	Percentage (%)
<25	33	33
26 to 50	30	30
51 to 75	16	16
76 to 100	09	9
>100	12	12
Total	100	100

The mean consumption of poison in males was 52.77ml, while in females, it was 60.21ml. Most cases (63%) consumed less than 50ml of the poison.

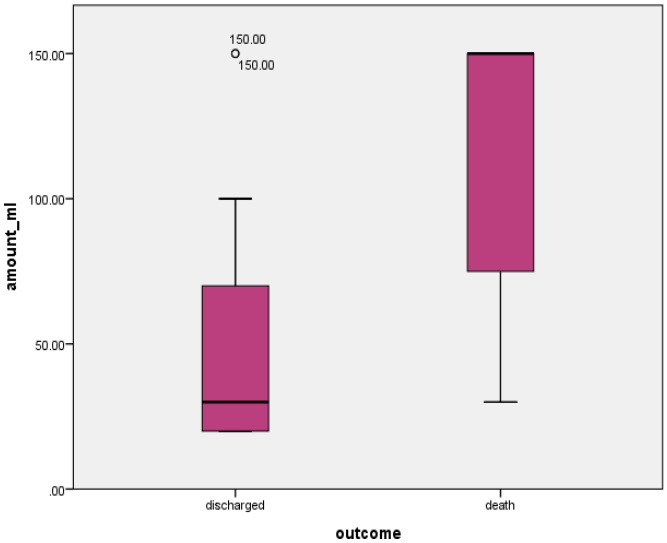

Fig. 1: Amount of poison consumed v/s outcome

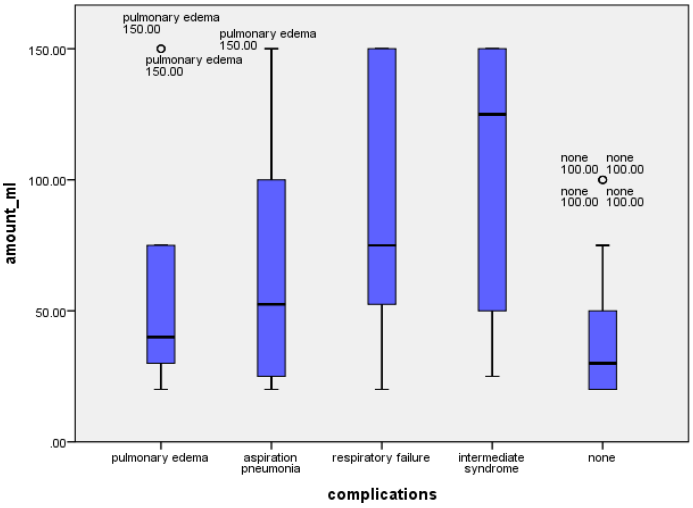

Fig. 2: Amount of poison consumed v/s complications observed during study

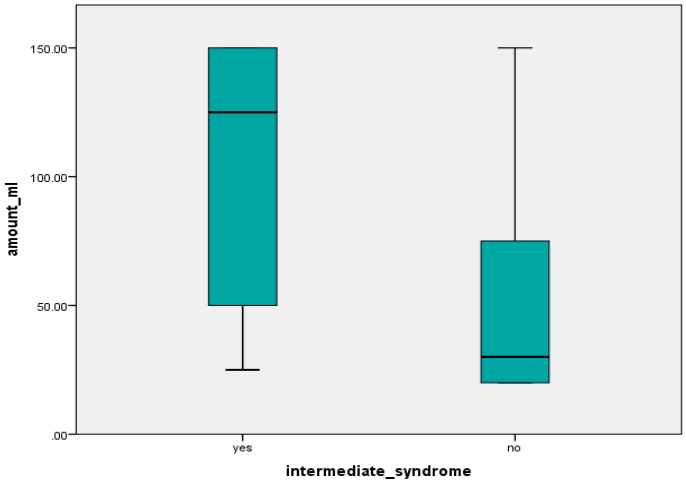

Fig. 3: Amount of poison consumed v/s occurrence of IMS during study

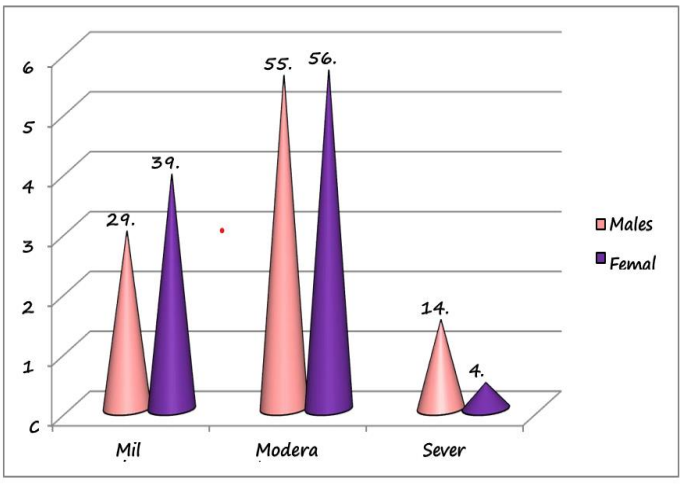

Fig. 4: Distribution of patients according to severity of op poisoning based on pop scale

Table 6: Severity of POP score Vs mean interval of presentation

Time interval (Hrs)	POP score			p-value	Pearson's Chi-square (χ)
	Mild (%)	Moderate (%)	Severe (%)		
<1	10 (29.4)	02 (3.6)	01 (10)	<0.001	97.769
1 to 2	17 (50.0)	01 (1.8)	00		
2 to 3	01 (2.9)	28 (50)	01 (10)		
3 to 4	06 (17.6)	21 (37.5)	01 (10)		
>5	00	04 (7.1)	07 (70)		
Total	34 (100)	56 (100)	10 (100)		

Among the patients presented with mild poisoning (34), in 27 cases (79.4%), gastric lavage was done before 2 hours, while only in 7 (20.5%) cases gastric lavage was done after 2 hours. Among the moderate poisoning cases (56), in 49 cases (87.5%), gastric lavage was done between 2-4 hours, while in 3(5.4%) and 4 (7.1%) cases, gastric lavage was done before 2 hours and after 4 hours respectively. Among 10 patients with severe poisoning, in 7 (70%) patients, gastric lavage was done after 4 hours; in the rest, 3 (30%), it was done before 4 hours. The time interval between ingestion of poison and gastric lavage has a highly significant association with the severity of poisoning, as indicated by p-value <0.001.

DISCUSSION

The study sample consisted of 100 patients, with a mean age of presentation of 34.28±13.44 years for females and 37.57±16.19 years for males. Twenty patients were in the age range of twenty to twenty, and fifteen patients fell into the fifteen to twenty age range. These patients made up the bulk of those in the younger age group. There were 25 cases in the age ranges of 31–40, 41–50, and 51–60 years, respectively. There were also 11 cases and 12 cases. The number of patients above sixty was just nine. The younger age groups were, therefore, more likely to suffer from OP poisoning and contemplate suicide because of their emotional immaturity and inability to cope with stressful events such as romantic relationships and exams. Rangaswamy *et al.* [18] and Logaraj *et al.* [19] presented similar findings from their experiments in 2017.

In our investigation, male cases accounted for 54% of all cases; the male-to-female ratio was 1.17. Men encounter stress in their lives more often than women, which could make them less skilled at managing it. This could help to clarify things. Studies by Vikram *et al.* [20] and Shobha *et al.* [21] provided evidence in favor of it. However, the findings of Bag *et al.* [22] analysis differed. Suicidal tendencies characterized most poisoning cases in our sample, which is consistent with research by Vikram *et al*. [23] and Bhattarai *et al*. [24]. Due to their easy availability of these chemicals and propensity to act on suicidal impulses, farmers are more prone to suffer from suicide poisoning. Based on epidemiological distribution, 76% of the population resided in rural areas. This outcome was consistent with the findings of Gupta *et al.* [25].

Op chemicals are commonly used in agriculture, which could explain why this group is more likely to come across them in rural areas and make them easier to purchase there. Out of the 100 compounds studied, chlorpyriphos was the most frequently used type of substance (29 instances); it was closely followed by dimethoate (13%) and phenol (26%). In addition, acephate, phorate, dichlorvos, profenofos, diphos, and monocrotophos were consumed as OP compounds. Of the patients, 8% had an unknown dangerous chemical. 30.17% of cases in the Zanjad and Nanadkar [26] study is attributed to monocrotophos. Quinolphos and methyl parathion follow monocrotophos in the percentage of instances, with 18.96% and 28.44%, respectively.

On average, men drank 52.77 ml of poison, while women drank 60.21 ml. Less than 50 milliliters of the poison were consumed in 63% of the instances. Survivors consumed 42.92 ml of poison on average, while non-survivors ingested 116.66 ml. The p-value of 0.006 indicates that there is a significant difference between them. Therefore, there may be a positive correlation between the mean amount consumed and the outcome in the case of op poisoning. On the Peradeniya OP poisoning scale, the majority of patients in our study (56%) were classified as moderately poisoned, followed by the mild group (34%) and the severe group (10%). Bhattacharya et al. discovered similar outcomes in their study. In Prakash *et al.* [27] study, the bulk of patients were categorized as mild, and this group had a higher frequency of unintended ingestion.

Seven of the 34 patients (79.4%) who had mild poisoning had stomach lavage performed after two hours, while the other 27 (79.4%) had it done sooner. Of the fifty-six patients with mild poisoning, forty-nine (87.5%) underwent gastric lavage within the two to four-hour timeframe; four (7.1%) and three (5.4%) underwent gastric lavage before the two-hour interval. Of the ten patients who experienced severe poisoning, three (30%) and seven (7%), respectively, had gastric lavage performed earlier and later than four hours later.

There was a statistically significant correlation ($p<0.001$) between the degree (as measured by the POP scale) and the amount of time that passed between swallowing the toxin and performing a stomach lavage. During the hospital stay, 92% of the patients experienced SLUDGE (salivation, lacrimation, urine, diarrhoea, GI upset, and emesis) as their most often observed symptom when symptoms and signs were evaluated at admission. Other prevalent presenting symptoms were tachypnea (69%), altered sensorium (66%), miosis (73%), bronchorrhea (62%), and bradycardia (62%). 10% of patients are in a coma, 8% have fasciculations, 7% have seizures, and 6% have tachycardia. A similar tendency was described by Goel *et al.* [28].

CONCLUSIONS

The study draws significant conclusions regarding organophosphate (OP) poisoning. It suggests that the mean amount of poison consumption can serve as a predictor for the occurrence of complications and mortality in OP poisoning cases. Additionally, the time interval between poison ingestion and gastric lavage is valuable for assessing the severity of poisoning, predicting complications, determining the need for ventilator support, and estimating mortality risk. The severity of poisoning, as per the Peradeniya OP poisoning scale, is found to have a significant positive association with the occurrence of intermediate syndrome, the duration of hospitalization, the need and duration of ventilator support, and mortality in OP poisoning cases.

These findings contribute valuable insights into the factors influencing the outcomes and complications associated with OP poisoning, aiding in better understanding, and managing this condition.

CONTRIBUTION OF AUTHORS

Research concept- Srikant Kumar Behera, Purna Chandra, Dash, Sunita Sethy, Suresh Kumar Rout

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Critical review- Sunita Sethy, Suresh Kumar Rout

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Final approval- Suresh Kumar Rout

REFERENCES

[1] Kumar V, Fareedullah MD et al. Current review on Organophosphorus poisoning. Arch Appl Sci Res., 2010; 2: 199–215.

[2] Eddleston M. Patterns and problems of deliberate self-poisoning in the developing world. QJM, 2000; 93: 715–31.

[3] Pore NE, Pujari KN, Jadkar SP. Organophosphorus poisoning. J Pharma Biosci., 2011; 2: 604–12.

[4] Lotti M, Moretto A. Cholinergic symptoms and Gulf War syndrome. Nat Med., 1995; 1: 1225–26.

[5] Singh G, Khurana D. Neurology of acute organophosphate poisoning. Neurol India, 2009; 57: 119–25.

[6] Anormallikleri L. Emergency laboratory abnormalities in suicidal patients with acute organophosphate poisoning. Türk Biyokimya Dergisi., 2010; 35(1): 29-34.

[7] Mehta AB, Shah AC, Joshi LG, Kale AK, et al. Clinical features and plasma acetylcholinesterase activity in poisoning with insecticidal organophosphorus compounds. J Assoc Physicians India, 1991; 19: 181–84.

[8] Goswamy R, Chaudhuri A, Mahashur AA. Study of respiratory failure in organophosphate and carbamate poisoning. Heart Lung, 1994; 23: 466–72.

[9] Senthilnathan NK, Allen Binny. Biochemical abnormalities in OPC poisoning and its prognostic significance, IOSR-JDMS, 2017; 16(7): 116-19.

[10] Oxford text book of medicine 5th edition, 2012- David A Warell, Timmothy Cox, John d Firth. Available at: https://academic.oup.com/ije/article/42/5/1524/620847.

[11] Dressel T, GoodaleJr R, Arneson M, Borner J. Pancreatitis as a complication of anticholinesterase insecticide intoxication. Annals of surgery. 1999; 189(2):199.

[12] Matsumiya N, Tanaka M, Iwai M, Kondo T, et al. Elevated amylase is related to the development of respiratory failure in organophosphate poisoning. Hum Exp Toxicol., 1996; 15: 250–53.

[13] Lee HS. Acute pancreatitis and organophosphate poisoning. A case report and review. Singapore Med J., 1999; 30: 599–601.

[14] Banday TH, Tathineni B, Desai MS, Naik V. Predictors of Morbidity and Mortality in Organophosphorus Poisoning: A Case Study in Rural Hospital in Karnataka, India. N Am J Med Sci., 2015; 7(6): 259-65. doi: 10.4103/1947-2714.159331.

[15] Suleman MI, Jibran R, Rai M. The analysis of organophosphate poisoning case treated at Bhawal Victoria Hospital, Bahawalpur 2000-2003. Pak J Med Sci., 2006; 22: 244–49.

[16] Hussain AM, Sultan ST. Organophosphorus insecticide poisoning: Management in surgical intensive care unit. J Coll Physicians Surg Pak., 2005; 15: 100–02.

[17] Wadia RS. Treatment of organophosphate poisoning. Indian J Crit Care Med., 2003; 17: 85–87.

[18] Rangaswamy, M S Bharath. A study of cardiac involvement in organophosphorus poisoning. IJSS, 2018; 5(10): 38-40.

[19] Logaraj M, Ethirajan N, Felix JW, Roseline FW. Suicidal attempts reported at a medical college hospital in Tamilnadu. Indian J Comm Med., 2005; 30(4): 136-37.

[20] Vikram P, Arun M, Saralaya KM, Bhoopendra S. Spectrum of organophosphorous poisoning in Manipal. Ind Medica-Medicolegal Update, 2005; 5(2): 55-57.

[21] Shobha TR, Prakash O. Glycosuria in organophosphate and carbamate poisoning. J Assoc Physicians India, 2000; 48(12): 1197-99.

[22] Bag A, Ghosh K., Bhattacharya A, Ghosh S. A study of changes in liver function, pancreatic enzyme levels, and creatine phosphokinase level in cases of acute organophosphorus poisoning. Toxicol Int., 2015; 22(3): 70-75.

[23] Vikram P, Arun M, Saralaya KM, Bhoopendra S. Spectrum of organophosphorous poisoning in Manipal. Ind Medica-Medicolegal Update, 2005; 5(2): 55-57.

[24] Bhattarai N, Rewniyar A, Chaudhry D, Jaiswal S, Banthia P, Rana BB. Patterns of organophosphorus poisoning attending a teaching hospital. J Nepal Med Assoc., 2006; 45(162): 228-32.

[25] Gupta B, et al. Organophosphorus poisoning facts and myths. Med Update, 1999; pp. 1345–48.

[26] Zanjad NP, Nanadkar SD. Study of sudden unexpected deaths in medicolegal autopsies. J Ind Acad Forensic Med., 2006; 28(1): 27-30.

[27] Prakash M, Ram O, et al. Acute Organophosphorus Poisoning and Clinical Admission Score Association Among Patients Admitted In Emergency Ward Of A Tertiary Teaching Hospital Of Medical College. J Pharm Biomed Sci., 2012; 17(8): 1-5.

[28] Goel A, Joseph S. Dutta TK. Organophosphate poisoning: predicting the need for ventilatory support. JAPI, 1998; 46: 786-90.