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A Study of Predicting Outcomes in Acute Organophosphate Poisoning Using Poisoning Severity Score, Glasgow Coma Scale and Corrected QT Interval

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ABSTRACT

Acute organophosphate poisoning is a significant worldwide health issue, especially in areas with limited access to healthcare resources. Rapid diagnosis of the severity of poisoning is essential for devising therapeutic options and determining patient outcomes. The study evaluated the prognostic significance of the Poisoning Severity Score, Glasgow Coma Scale and Corrected QT Interval in determining the severity and predicting the outcomes of acute OP poisoning. A retrospective analysis of 61 patients admitted to Shri B M Patil Medical College and Research Center, Vijayapura, over 18 months from August 2022 to January 2024, was conducted. The data collected included demographics, clinical features, ECG findings, treatment modalities and patient outcomes, focusing on organophosphate substance intake or exposure. The study involved 61 patients, 52.5% male and 47.5% female, with a majority aged 20-39. The most common opioid (OP) component was unidentified, followed by Malathion and Acephate. Most patients had mild to moderate PSS scores, with Grade 1 representing 40.9% of responses and Grade 2 accounting for 27.9% and 17. Grade 3 represented 31.1% and Grade 4 18.0%, respectively. GCS scores indicated mild to moderate impairment (19.6%). Significant ECG findings included patients with prolonged QTc intervals, which showed a higher association with mechanical ventilation but was statistically insignificant in determining outcomes. A significant proportion of patients who did not survive had PSS Grade 3, suggesting higher PSS grades are strongly associated with lesser outcomes. The study highlights the importance of PSS, GCS and QTc interval in predicting outcomes in acute OP poisoning, emphasizing the need for early assessment and intervention to improve patient prognosis and reduce mortality and calls for further research in QTc.

INTRODUCTION

Organophosphate is a widely used insecticide worldwide, with one million major unintentional poisonings and two million hospital admissions for pesticide-related suicide attempts each year. These cases are more common in underdeveloped nations where harmful compounds are more accessible and pesticide use is often less strictly regulated. In households and farming settings, organophosphate (OP) are mainly used as pesticides, leading to millions of people suffering from acute organophosphate poisoning every year[1]. India's economy is primarily based on agriculture, with farmers making up about 60% of the population[2]. The most common kind of unintentional intoxication from using these substances as agricultural insecticides is the OP compound. These chemicals are also used in suicidal and homicidal thoughts and intentions. In 2020, poisoning was a contributing factor in 25% of India's 153,052 officially documented suicides[3]. Organophosphate toxicity can cause severe acute poisoning, leading to convulsions, muscle twitching, respiratory trouble and even death[4]. In poor nations, organophosphate compound poisoning is a significant cause of illness and death, with 1 million major unintentional poisonings from pesticides and 2 million suicide poisonings worldwide[5]. Mortality rates in Indian research vary from 4-30%, with respiratory failure being the most frequent consequence of organophosphate poisoning. Early identification and ventilatory support increase the likelihood of survival[6]. Organophosphate toxicity can range significantly in severity, depending on the exposure route, dose and prompt medical attention. Clinical evaluation tools must be integrated to manage and predict outcomes in these patients efficiently. This study investigates the predictive value of the Poisoning Severity Score (PSS), Glasgow Coma Scale (GCS) and Corrected QT Interval (QTc) as tools for treatment procedures and patient outcomes. By using these resources, medical professionals can more effectively manage the intricacies of organophosphate poisoning and promptly deliver therapies based on each patient's clinical status and toxicity level[2,5]. The PSS is a categorization system for acute poisonings in adults and children, considering the entire clinical progression and severity rating based on the most severe symptoms or signs observed. This system is typically a backward-looking procedure that requires subsequent examination of cases[7]. The severity rating is calculated based on the most severe symptoms or signs observed, without assessing risks or hazards based on factors like quantity consumed or serum/plasma concentrations[8]. The system uses signs and symptoms provided in each grade as illustrations to determine the severity of the condition. Treatment measures are not assigned a specific grade, but symptomatic and supportive treatment can indirectly help assess the severity. Proactive administration of antidotes should not affect the grading, but it should be acknowledged when data is presented[8,9]. Long-term disabilities or deformities warrant a high severity grade and severe cases leading to death are classified separately in the scoring system to provide a more precise representation of data. A standardized grading scale for assessing poisoning severity allows for a qualitative assessment of the harm caused by poisoning, facilitating accurate identification of actual dangers and enhancing data comparability[9]. There are four PSS grades: 0 for no symptoms, 1 for mild, transient and spontaneously resolving symptoms, 2 for pronounced or prolonged symptoms, 3 for severe or life-threatening symptoms and 4 for death[9,10]. Studies have shown that QT prolongation is crucial in organophosphate poisoning, and its severity is directly linked to QTc intervals. PSS and GCS are useful in evaluating poisoning and neurological conditions. Up to 70% of individuals with organophosphate poisoning have a prolonged QTc interval and a significant incidence of respiratory failure. An electrocardiogram (ECG) quantifies the duration of ventricular depolarization and repolarization. Prolonged QTc intervals are associated with cardiac issues and the severity of poisoning. The Corrected QT Interval (QTc) is a measurement in cardiology that assesses the duration of the QT interval on an electrocardiogram (ECG), adjusting for the individual's heart rate. The application of GCS has been explored to predict the severity of organophosphate poisoning. The Glasgow Coma Scale (GCS) is utilized to assess and quantify a patient's level of consciousness. The GCS evaluates responses according to three criteria: best eye-opening (maximum 4 points), best verbal response (maximum 5 points) and best motor reaction (maximum 6 points). The points are aggregated to yield a final score that ranges from 3-15. A consciousness assessment instrument for individuals experiencing acute brain injury, including toxicity-related conditions. The GCS scores range from 3, indicating deep unconsciousness, to 15, signifying full alertness and awareness. These findings highlight the importance of QT prolongation in predicting organophosphate poisoning[11-13].

MATERIALS AND METHODS

Data is collected from patients admitted to Shri B M Patil Medical College and Research Center, Vijayapura, who have a history of organophosphate substance intake or exposure for 18 months from August 2022 to January 2024 and who are seen in the outpatient department. The data is collected using Pro-forma, including detailed history, clinical examination and necessary investigations for patients meeting inclusion criteria, as illustrated in (Fig. 1). The study uses routine standard procedures, including electrocardiography, random blood sugar, chest X-ray PA view, complete

blood count, artificial blood gas analysis, liver function test, renal function test, urine routine and serum acetylcholinesterase. Several formulas are used to calculate QTc, such as Bazett's (QTcB) and others.
Bazett's formula: QTcB = QT / v(RR interval in seconds)

Inclusion for the Study: This study aims to identify patients with acute organophosphate poisoning, including those with a confirmed diagnosis, history of exposure to organophosphorus insecticide and clinical manifestations of poisoning. Exclusion criteria include non-organophosphate poisoning, known long QT syndrome, or co-ingestion of other drugs with organophosphorus compounds. No animal experiment was involved.

Fig. 1: Collection of Data

Statistical Analysis: The study employs Microsoft Excel for data recording and SPSS for statistical analysis. The findings consist of graphs, counts, percentages, mean and standard deviation. The dissimilarities between two groups are assessed by an independent sample t-test, Mann-Whitney U test for variables that are not normally distributed, Fisher's exact or Chi-square tests for categorical variables and ANOVA for situations involving more than two groups. A p-value below 0.05 signifies statistical significance. The data will be analyzed using statistical software such as SPSS, Stata and R. Exposure and demographic data will be summarized using descriptive statistics, while categorical variables will be analyzed using either Fisher's exact test or Chi-square test. For continuous variables, either the Mann-Whitney U test or independent t-tests will be employed. The logistic regression model will be employed to identify factors that are associated with complications and mortality. Additionally, the Kaplan-Meier survival analysis will be utilized to assess the probability of survival. The study seeks to offer significant insights into the elements that influence the duration of event outcomes.

RESULTS AND DISCUSSIONS

The sample of 61 individuals shows that the age group distribution is as follows: those under 20 are represented by 12.7%, those between 20 and 29 by 32.8%, those between 30 and 39 by 36.1%, those between 40 and 49 by 6.6% and those above 50 by 4.92%. Gender with 32 males and 29 females, aged 15-80. The average age ranged from 15-80, with a mean of 29.5 years. The minimum age was 15 years, and the maximum was 80 years. The mean value was 29.5 as tabulated in (Table 1).

Table 1: Gender Wise Analysis

Gender	Frequency	Percent	Minimum	Maximum	Mean
Female	29	47.5			
Male	32	52.5	15	80	29.5
Total	61	100			

The majority of unknown compounds (36.1%) require improved detection and identification methods. The prevalence of Malathion (27.9%) and Chlorpyrifos (14.8%) underscores the need for safety and regulatory measures. Enhanced detection methods, regulatory review and increased public awareness are necessary to address these issues. Investing in better diagnostic tools and training is crucial for accurate identification. The majority of OP compound exposures (98.4%) occurred through ingestion, with inhalation and contact being less common routes. Ingestion is the primary exposure route, while inhalation and contact are less common, indicating that these routes are less common in OP compound incidents. The majority of occupational compound exposures are intentional self-harm cases, with 93.4% of incidents classified as such. Accidental exposure accounts for 4.9% of incidents, posing a significant risk. Occupational exposures are rare but present, accounting for only 1.6%. The high prevalence of suicidal incidents underscores a critical mental health and public safety issue that requires immediate attention. Despite less frequent exposures, ongoing vigilance and preventive measures are necessary. (Table 2) displays the distribution of Glasgow Coma Scale (GCS) scores upon admission and the corresponding outcomes of the patients under study. The GCS score is the most reliable indication for assessing the severity and mortality of patients with OP poisoning in emergencies. It is a straightforward, efficient and time-saving method.

Table 2: GCS Score Analysis

GCS score	Frequency	Percent
3	7	11.5
6	2	3.3
7	4	6.6
8	2	3.3
9	2	3.3
10	1	1.6
11	1	1.6
12	2	3.3
13	2	3.3
14	4	6.6
15	34	55.7
Total	61	100

PSS Grade 1 represents 40.9% of the total responses, with a frequency of 25. PSS Grade 2 Accounts for 27.9% of the responses, with a frequency of 17. PSS Grade 3 Represents 31.1% of the responses, with a frequency of 19. PSS Grade 4 Accounts for 18.0% of the

responses, with a frequency of 12. The total includes 61 responses, summing up to 100.0% (Table 3).

Table 3: PSS Grades

PSS grade	Frequency	Percent
1	25	40.9
2	17	27.9
3	19	31.1
4	12	18
Total	61	100

The majority of patients (44%) were hospitalized within 3 - 6 hours after exposure to OP poisoning, with 39% being hospitalized within the first three hours. Less common periods were 6-12 hours, with 10% experiencing delays of 6-12 hours, suggesting potential barriers to immediate medical care. Only 7% experienced delays of more than 12 hours, indicating a rare but concerning situation. The majority of patients (83%) were hospitalized within six hours, emphasizing the importance of rapid medical response in mitigating OP poisoning effects. Delays over six hours may increase the risk of complications and worse outcomes. Approximately 48% of patients necessitate a moderate duration of hospitalization, while 43% of cases necessitate shorter stays. Merely 7% necessitate prolonged stays, showing the presence of more severe illnesses or consequences. Merely 3% of cases necessitate hospitalization over 16 days, indicating that extended stays in hospitals are infrequent. Approximately 91% of patients were admitted to the hospital for 10 days or fewer, which is consistent with the usual length of treatment for exposure to OP compounds. Prolonged hospital stays, lasting more than 10 days, are infrequent but can suggest more serious instances of poisoning or consequences that necessitate extended medical attention. The majority of cases with OP exposure have mild GCS scores (65.6%), indicating mild or fully conscious patients. A quarter (24.6%) has severe scores, indicating a significant neurological impact. A smaller fraction (9.8%) has moderate scores (9-12). The majority of cases has mild effects or respond well to initial treatment. Severe cases highlight the need for rapid medical intervention to manage severe neurological impacts and improve outcomes. The presence of severe cases underscores the importance of effective medical intervention. The study found that (52.5%) of cases had QTc intervals less than 0.4400 seconds, indicating normal QTc intervals. Nearly half of the cases (47.5%) had intervals of 0.4400 seconds or more, suggesting prolonged QTc intervals, which can increase the risk of cardiac arrhythmias. The difference in QTc intervals is not statistically significant at the 0.05 threshold, suggesting a weak association between OP compound exposure and prolonged intervals. The presence of prolonged QTc intervals in nearly half of the cases suggests a potential cardiac risk, but the statistical significance is marginal. Continuous monitoring of QTc intervals is recommended to detect and manage potential cardiac complications.

Table 4: Descriptive Statistical Analysis of Different Parameters

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	61	15	80	29.5	11.21
QTc interval (sec)	61	.3300	.5600	.440397	.0480937
Serum Cholinesterase	61	157	8114	3262.60	2699.628
GCS score	61	3	15	12.00	4.317
Hospitalization Period (in days)	61	1	20	6.33	3.682

The individuals in the dataset range from 15-80 years, with an average age of approximately 29.5 years and a standard deviation of 11.21, indicating a notable spread around the mean. The QTc interval values, averaging around 0.440397 seconds, range from 0.3300-0.5600 seconds and show a tight clustering around the mean with a standard deviation of 0.0480937. Serum Cholinesterase levels range from 157-8114, with a mean of 3262.60 and a large standard deviation of 2699.628, indicating significant variability. GCS scores range from 3-15, with an average of 12.00 and a standard deviation of 4.317, reflecting considerable variation in consciousness levels. Hospitalization periods vary from 1-20 days, averaging 6.33 days, with a standard deviation of 3.682, indicating moderate variability in hospital stay length as mentioned in (Table 4).

Table 5: Comparative Analysis of QTc Interval with Incubation, Status, GCS Score and PSS Grade

		QTc interval (sec)		
		< .4400	.4400+	p-value
Intubation	Yes	6 (28.6%)	15 (71.4%)	
	No	26 (65%)	14 (35%)	0.076
Status	Improved	28 (57.1%)	21 (42.9%)	
	Dead	4 (33.3%)	8 (66.7%)	0.131
GCS score	<=8	4 (26.7%)	11 (73.3%)	
	9 to 12	3 (50%)	3 (50%)	0.002
	13+	25 (62.5%)	15 (37.5%)	
PSS Grade	1	24 (96%)	1(4%)	
	2	4(23.5%)	13 (76.5%)	
	3	4(21.1%)	15 (78.9%)	0.042
Total	32 (52.5%)	29 (47.5%)		

Table 6: Comparative Analysis of PSS Grade vs Status and Intubation

		PSS GRADE			
		1	2	3	p-value
STATUS	Improved	24 (49%)	17 (34.7%)	8 (16.3%)	<0.001
	Dead	1 (8.3%)	0 (0%)	11(91.7%)	
INTUBATION	Yes	1(4.8%)	1(4.8%)	19 (90.5%)	<0.001
	No	24 (60%)	16 (40%)	0 (0%)	
Total	25 (41%)	17 (27.9%)	19 (31.1%)		

The study found a significant association between patient status and PSS grade in (Table 5,6), with higher PSS grades correlating with increased mortality rates. The majority of patients improved (49%), with a low mortality rate (8.3%). Intubation was also found to be a significant factor, with very few patients requiring it (4.8%). The study suggests that intensive monitoring and treatment are necessary for patients with higher severity scores. The importance of preparing for respiratory support in severe OP poisoning cases is underscored by the association between higher PSS grades and the need for intubation. Recommendations include enhanced monitoring for patients with higher PSS grades, implementation of rapid response protocols for patients with higher PSS grades and

resource allocation for effective management of patients with higher PSS grades. The study found that 42.9% of intubated patients improved, while 57.1% died, while all non-intubated patients improved and none died, indicating a strong statistical significance, indicating no chance-based difference tabulated in (Table 7).

Table 7: Comparative Analysis of Intubation vs Status

		Intubation			
		Yes	No	Total	p-value
STATUS	Improved	9 (42.9%)	40 (100%)	49 (80.3%)	<0.001
	Dead	12 (57.1%)	0 (0%)	12 (19.7%)	
Total	21 (100%)	40 (100%)	61 (100%)		

The study analyzed the distribution of serum cholinesterase levels across different PSS grades in 61 patients. Grade I had 9 patients (36%), Grade II had 6 patients (35%) and Grade III had 12 patients (63%). Grades 2000 to 4000 had 2 patients (8%), Grades 4000 to 6000 had 7 patients (28%), Grades 4000-6000 had 5 patients (26%) and Grades 6000-2000 had 7 patients (28%). The total number of patients was 61. The p-value of 0.648 indicates no significant difference in the distribution of serum cholinesterase levels across different PSS grades, indicating no significant variation between the different grades in the sample as shown in (Table 8).

Table 8: Comparative Analysis of PSS Grade vs Serum Cholinesterase

	PSS Grade			
Serum Cholinesterase	**Grade - I**	**Grade - II**	**Grade - III**	**p- Value**
< 2000	9 (36%)	6 (35%)	12 (63%)	0.648
2000 to 4000	2 (8%)	2 (12%)	1 (5%)	
4000 to 6000	7 (28%)	7 (41%)	5 (26%)	
> 6000	7 (28%)	2 (12%)	1 (5%)	
Total	25 (100%)	17 (100%)	19 (100%)	

The study aims to assess the study of organophosphorus (OP) poisoning in individuals presenting to the Emergency Service. The sample comprised 61 individuals, with a notable predominance of those aged 20-39, or 89% of the overall population. The results corroborated earlier research by Natin Bagat *et al.,* Baruch Brenner *et al.,* Okhan Akdure *et al.* and Michael Eddleston about OP poisoning[14,15,18]. The predominant organophosphate compound ingested by patients was Malathion, succeeded by Chlorpyrifos. In contrast to the study conducted by Okhan Akdure[14] Dichlorvos, Diazinon and methyl parathion were the most prevalent organophosphate chemicals ingested by patients. The majority of instances pertained to ingestion, whereas inhalation and touch were infrequent. A majority of patients (83%) received medical attention within six hours prior to hospitalization. No statistical link exists between the pre-hospitalization duration and PSS. The mean length of hospitalization was 6.7 days. The severity of the poisoning is expected to escalate with duration, as the toxin may induce irreversible tissue damage if treatment is postponed. The majority of cases were suicides, with a minority being accidental or occupational. Scoring systems are employed to evaluate the severity of diseases and to manage patients according to clinical characteristics. Upon admission, individuals were predominantly classified as PSS Grade 1, subsequently transitioning to Grade 3 and Grade 2. A total of twelve patients progressed to Grade 4 (mortality). Approximately two-thirds of patients had a mild Glasgow Coma Scale (GCS) score (>13), while the majority of fatalities (75%) transpired among individuals with severe GCS grades. Grmec *et al.* suggest that the GCS may assist in prognostic evaluation and complication prevention in instances of OP poisoning. Davies et al. and Nouira S *et al.* Patients with a Glasgow Coma Scale (GCS) score on the lower end necessitate vigilant monitoring and assertive medical treatment[16,17]. The average age of the fatal cases was elevated. A significant finding of the inquiry was the link between ECG readings and instances of OP poisoning. The predominant aberrant ECG finding in the study's subjects was QTc prolongation, followed by non-specific ST-T alterations and extra systole, which prolonged PR intervals in that sequence compared to study of Nouira[18]. The prolonged QTc interval was the most often seen ECG abnormality in instances of organophosphate poisoning. Patients exhibiting a QTc interval $\geq$0.4400 seconds demonstrated a stronger correlation with intubation and adverse outcomes compared to those with a QTc interval <0.4400 seconds. No statistically significant correlation was identified between QTc prolongation and patient outcomes compared to the studies of Nouira, S., *et al.* and Persson[18,19]. The study determined that ECG data in cases of OP poisoning cannot exclusively predict the prognosis of patients poisoned by organophosphorus compounds.

CONCLUSION

Overall, this study provides insights into the demographics, clinical associations and outcomes of OP poisoning patients. The study has found that the Glasgow coma scale and Poisoning severity score can be used as necessary tools to assess and manage the organophosphorus compound consumption patients effectively. ECG abnormalities such as prolonged QTc intervals were observed in higher frequency in OP poisoning patients, but they were statistically insignificant in predicting outcomes. Further research is required in this QTc interval aspect of OP poisoning patients, to get firmer beliefs about their reliability in accurately predicting outcomes.

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