PREDICTORS OF MAJOR OUTCOME IN ACUTE ORGANOPHOSPHORUS POISONED CASES

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ABSTRACT

Introduction: Organophosphorus poisoning (OP) continues to be a significant cause of morbidity and mortality with no definite predictors of outcome have been identified yet. **The present study aimed** to find parameters that could be used as predictors of major outcomes in acute OP poisoning. **Patients and methods:** This prospective, cohort study was carried out from the start of August 2019 to the end of July 2020 on cases with acute OP poisoning admitted to Tanta University Poison Control Center. All cases were subjected to history taking, clinical examination, assessment of poison severity score (PSS), laboratory investigations, electrocardiography, and assessment of outcome. **Results and conclusion:** One hundred and sixty-two cases were included. Their ages ranged from 18 to 74 years old. Males accounted for 55.6% of the cases. Most cases were intoxicated in suicidal attempts through ingestion of OP compounds. Statistically significant differences were found between cases that needed and didn't need intensive care unit (ICU) admission, mechanical ventilation (MV), and between survivors and non-survivors regarding GCS, O_2 saturation, PSS, pH, bicarbonate level, and serum cholinesterase enzyme (SChE) level. Multivariate regression analyses revealed that the low GCS and the low O_2 saturation were the independent risk factors for the need for ICU admission. Low O_2 saturation was the sole risk factor for the need for MV. While the low O_2 saturation and the low SChE level were the independent risk factors for mortality. **Recommendations:** It is recommended to assess the GCS, monitor the O_2 saturation, and measure the level of SChE in all cases of OP poisoning at admission.

KEYWORDS: Organophosphorus; Intensive care unit; Mechanical ventilation; Mortality; Poison severity score; Serum cholinesterase enzyme

INTRODUCTION

Organophosphorus (OP) poisoning is a major health problem in both developing and western countries. Based on hospital records, about half of acute poisoning admissions are due to OP poisoning **(Datla et al., 2020)**. Globally, it is stated that more than 3 million people are exposed to OP poisoning each year, with up to 300,000 fatalities **(Robb and Baker, 2021)**. In addition, OP poisoning is responsible for 80% of hospital admissions caused by pesticide poisoning **(Mohamed et al., 2018)**.

Toxicity of OP compounds occurs due to inhibition of true cholinesterase and pseudocholinesterase enzymes, which results in the accumulation of acetylcholine at synapses and neuromuscular junctions. This leads to overstimulation of muscarinic,

nicotinic, and central nervous system receptors **(Khurana and Prabhakar, 2000; Sinha and Sharma, 2003; Afify et al., 2016)**.

Clinical manifestations of OP poisoning depend on the type of OP compound, the amount consumed, and the delay time between exposure and hospital admission **(Sert et al., 2018)**. Common clinical manifestations of OP poisoning include bradycardia, miosis, bronchospasm, bronchorrhea, salivation, lacrimation, diarrhea, urination, muscle weakness, and fasciculation. Furthermore, other presentations include hypotension, central nervous system (CNS) depression with impaired neurological function and cognition, convulsions, and respiratory failure **(Blain, 2011; Majidi et al., 2018)**.

Although OP poisoning continues to be a significant cause of morbidity and mortality, unfortunately, no definite predictors of outcome have been identified yet. Prediction of severity at admission may assist in decision-making, especially in places with limited resources **(Muley et al., 2014; Moussa et al., 2018)**. Therefore, the aim of the present study was to find parameters that could be used as predictors of major outcomes in acute OP poisoning cases.

PATIENTS AND METHODS

Study design and settings

This prospective, cohort study was carried out from the start of August 2019 to the end of July 2020 on cases with acute OP poisoning admitted to Tanta University Poison Control Center (TUPCC).

Ethical considerations

Ethical approval was obtained from the Research Ethics Committee of the Faculty of Medicine, Tanta University (approval code: 34076). After receiving detailed information about the study, each case or legal guardian (if the case was unable to participate in the consent process) was asked to sign an informed written consent. The confidentiality of the patients' data was maintained by using coding numbers.

Subjects

Inclusion criteria:

All cases (of both genders) older than 18 years with acute OP poisoning during the study period were included. The diagnosis of acute OP poisoning was based on history, clinical picture (symptoms and signs), improvement of signs and symptoms after treatment with atropine and oximes (toxogonin), and a decreased serum cholinesterase enzyme (SChE) level.

Exclusion criteria:

Cases younger than 18 years old, cases with exposure to other substances in addition to OP, and/or cases with chronic diseases (liver, kidney, and heart diseases) were excluded from the study. Furthermore, cases with any accompanying condition, such as significant head trauma or cases referred from other medical facilities with previous intervention, were also excluded.

Methods of the study

All cases were subjected to:

1. History taking:

- Sociodemographic data (age, gender, and residence).
- Toxicological history, including route of exposure, mode of poisoning, and delay time between exposure and hospital admission.

2. Clinical Examination:

- Vital signs (heart rate, blood pressure, respiratory rate, and temperature).
- Assessment of the consciousness level by the Glasgow coma scale (GCS).
- Systemic examination.

3. Evaluation of the poison severity score (PSS): According to **Persson et al. (1998)**, this score grades the severity of poisoning into the following:

- None (0): no symptoms or signs related to poisoning.
- Minor (1): symptoms that are mild, transient, and resolve spontaneously.
- Moderate (2): pronounced or long-lasting symptoms.
- Severe (3): severe or life-threatening symptoms.
- Fatal (4): death.

4. Laboratory investigations:

- Arterial blood gas (ABG) analysis.

- Measurement of SChE level according to **Blawen et al. (1983)**.

5. An electrocardiography (ECG) recording was done shortly after admission. Electrocardiographic changes were graded according to PSS into:

- Minor (grade 1): isolated extrasystoles.
- Moderate (grade 2): sinus bradycardia (heart rate (HR): 40-50 in adults) or sinus tachycardia (HR: 140-180 in adults), frequent extrasystoles, atrial fibrillation/flutter, atrioventricular (AV) block I-II, prolonged QRS and QTc-time, repolarization abnormalities, myocardial ischemia.
- Severe (grade 3): severe sinus bradycardia (HR: <40 in adults) or severe sinus tachycardia (HR: >180 in adults), life-threatening ventricular dysrhythmias, AV block III, asystole, myocardial infarction.

6. Assessment of major outcomes, including the need for ICU admission, the need for mechanical ventilation (MV), and in-hospital mortality.

Statistical analysis

To conduct the statistical analysis, data were collected in an excel datasheet and then imported into the Statistical Package for Social Sciences (SPSS Statistics) for Windows, version 22. Categorical variables were summarized as frequencies and associations between them were tested using either Pearson's Chi square test for independence, or Fisher's exact test as indicated. For numerical variables, the Shapiro-Wilk test was used to test their normality. Variables with an abnormal distribution were conveyed as median and interquartile range (25^{th}- 75^{th} percentiles) and were compared using the Mann-Whitney U test. For each outcome, the statistically significant variables in the univariate analysis were entered into a multivariable logistic regression analysis (backward method) to determine the significant independent predictors. A p-value of < 0.05 was considered statistically significant.

RESULTS

One hundred and sixty-two cases of acute OP poisoning were included in the present study. The demographic and toxicological characteristics of the studied cases are demonstrated in table (1). The age of the studied cases ranged from 18 to 74 years old, with a median of 26 years. More than half of them were males (55.6%), from rural areas (67.9%) and in the age group from 18 to 30 years (59.9%). Most cases were intoxicated during suicidal attempts (69.2%) and through OP compound ingestion (67.9%). The median delay time was 4 hours.

Table (1): Demographic and toxicological characters of the studied cases with acute OP poisoning (n= 162)

Variables		n= 162	%
Gender	Male	90	55.6%
	Female	72	44.4%
Age	Minimum- Maximum	18.0-74.0	
	Median (IQR)	26.0 (19.0-42.0)	
Residence	Urban	52	32.1%
	Rural	110	67.9%
Route	Ingestion	110	67.9%
	Inhalation	26	16.0%
	Dermal	3	1.9%
	Combined	23	14.2%
Mode	Suicidal	112	69.2%
	Accidental	50	30.8%
Delay time (hours)	Median (IQR)	4.0 (2.0-6.0)	

n: number; OP: organophosphate; IQR: interquartile range; %: percentage.

The clinical findings of the studied cases are shown in table (2). The current study revealed that 40.7% of the cases suffered from variable degrees of disturbed consciousness level (DCL) and 25.3% had low O_2 saturation. Concerning vital signs, 37.7% of the cases had tachycardia, 34.0% had hypertension, and 39.5% of them had tachypnea. In addition, 42.6% of the studied cases had minor toxicity (grade 1) according to PSS. Meanwhile, more than half of the cases (64.2%) had abnormal ECG findings, of which 91.3% were graded as PSS-ECG grade 2.

Table (2): Baseline clinical characteristics of the studied cases with acute OP poisoning (n= 162)

Variables		n= 162	%
GCS	Norma	96	59.3%
	Mild DCL	26	16.0%
	Moderate DCL	10	6.2%
	Severe DCL	30	18.5%
Oxygen saturation (%)	Normal	121	74.7%
	Low (≤90%)	41	25.3%
Pulse (Beat/minute)	Normal	79	48.8%
	Tachycardia	61	37.7%
	Bradycardia	22	13.6%
Blood pressure (mmHg)	Normal	88	54.3%
	Hypertension	55	34.0%
	Hypotension	19	11.7%
Respiratory rate (Cycle/minute)	Normal	96	59.3%
	Tachypnea	64	39.5%
	Bradypnea	2	1.2%
Temperature (°C)	Normal	120	74.1%
	Hyperthermia	14	8.6%
	Hypothermia	28	17.3%
PSS	Grade1	69	42.6%
	Grade 2	51	31.5%
	Grade 3	42	25.9%
ECG findings	Normal ECG	58	35.8%
	Abnormal ECG	104	64.2%
ECG grading[#]	Grade1	1	1.0%
	Grade 2	95	91.3%
	Grade 3	8	7.7%

n: number; OP: organophosphate; GCS: Glasgow Coma Scale; DCL: disturbed consciousness level; ECG: electrocardiograph; PSS: poisoning severity score; %: percentage; [#]: of abnormal ECG in 104 cases

Table (3) demonstrates the results of laboratory investigations recorded in this study. In addition, table (3) represents that 25.3% of the cases needed ICU admission, 24.1% needed MV, and 13.6% of them died.

Table (3): Acid base disturbances, level of cholinesterase enzyme and major outcome of the studied cases with acute OP poisoning (n= 162)

Variables		n= 162	%
Acid-base disturbances	Normal	39	24.1%
	Metabolic acidosis	40	24.7%
	Metabolic alkalosis	7	4.3%
	Respiratory acidosis	20	12.3%
	Respiratory alkalosis	43	26.5%
	Mixed disorder	13	8.0%
Serum cholinesterase level (U/L)	Median (IQR)	2415.0 (953.0-4235.0)	
Hospital stay duration (hours)	Median (IQR)	42.0 (15.0-50.0)	
The need for ICU admission		41	25.3%
The need for MV		39	24.1%
In-hospital Mortality		22	13.6%

n: number; OP: organophosphate; IQR: interquartile range; %: percentage; ICU: intensive care unit; MV: mechanical ventilation.

The current study revealed statistically significant differences between cases who needed and didn't need ICU admission (Table 4), MV (Table 5) and between survivors and non-survivors (Table 6) regarding GCS, O_2 saturation, PSS, pH, bicarbonate level, and serum cholinesterase levels ($p < 0.001$).

Table (4): Comparison between cases of acute OP poisoning who needed and didn't need ICU admission regarding some clinical and laboratory variables

		Groups				Tests of significance	
		Not needed ICU admission n=121		Needed ICU admission n=41		Statistical test	P value
GCS	Median (IQR)	15.0 (15.0-15.0)		6.0 (3.0-11.0)		8.974a	<0.001*
	Mean rank	99.61		31.0			
Oxygen saturation	Median (IQR)	98.0 (96.0-99.0)		76.0 (62.0-84.0)		8.595a	<0.001*
	Mean rank	99.86		27.32			
PSS	Grade1	68	56.2%	1	2.4%	110.08b	<0.001*
	Grade 2	47	38.8%	4	9.8%		
	Grade 3	6	5.0%	36	87.8%		
ECG grading[#]	Grade1	1	1.0%	0	0.0%	2.935c	0.182
	Grade 2	62	59.6%	33	31.7%		
	Grade 3	3	2.9%	5	4.8%		
pH	Median (IQR)	7.42 (7.37-7.46)		7.30 (7.21-7.45)		3.866a	<0.001*
	Mean rank	89.79		57.04			
PCO_2	Median (IQR)	36.8 (31.0-42.0)		35.0 (30.0-41.5)		0.056a	0.955
	Mean rank	81.62		81.15			
HCO_3	Median (IQR)	23.01 (22.0-24.4)		19.0 (15.0-23.5)		3.871a	<0.001*
	Mean rank	89.76		57.12			
Serum cholinesterase levels (U/L)	Median (IQR)	3512.0 (2090.0-4444.0)		458.0 (189.0-838.0)		8.508a	<0.001*
	Mean rank	99.75		27.63			

n: number; OP: organophosphate; GCS: Glasgow Coma Scale; PSS: poisoning severity score; ECG: electrocardiograph; IQR: interquartile range; pH: potential of hydrogen; PCO_2: partial pressure of carbon dioxide; HCO_3: bicarbonate; %: percentage; ICU: intensive care unit; a: Mann-Whitney U test; b: Chi-Square test; c: Fisher Exact test; [#]: of abnormal ECG in 104 cases; *significant at $p<0.05$.

Table (5): Comparison between cases of acute OP poisoning who needed and didn't need MV regarding some clinical and laboratory variables

		Groups				Tests of significance	
		Not needed MV n=123		Needed MV n=39		Statistical test	P value
GCS	Median (IQR)	15.0(15.0-15.0)		6.0(3.0-8.0)		9.983a	<0.001*
	Mean rank	99.91		23.42			
Oxygen saturation %	Median (IQR)	98.0 (96.0-99.0)		72.0 (60.0-80.0)		9.437a	<0.001*
	Mean rank	101.0		20.0			
PSS	Grade1	69	56.1%	0	0.0%	146.76b	<0.001*
	Grade 2	51	41.5%	0	0.0%		
	Grade 3	3	2.4%	39	100.0%		
ECG grading[#]	Grade1	1	1.0%	0	0.0%	2.764c	0.189
	Grade 2	61	58.7%	34	32.7%		
	Grade 3	3	2.9%	5	4.8%		
pH	Median (IQR)	7.42 (7.37-7.46)		7.28 (7.19-7.35)		5.361a	<0.001*
	Mean rank	92.62		46.44			
PCO_2	Median (IQR)	37.0 (31.0-42.0)		35.0 (29.4-41.5)		0.357a	0.721
	Mean rank	82.24		79.17			
HCO_3	Median (IQR)	23.0 (22.0-24.5)		17.0 (14.0-23.4)		4.607a	<0.001*
	Mean rank	91.01		51.51			
Serum cholinesterase levels (U/L)	Median (IQR)	3512.0 (2098.0-4444.0)		430.0 (189.0-670.0)		9.385a	<0.001*
	Mean rank	100.98		20.08			

n: number; OP: organophosphate; GCS: Glasgow Coma Scale; PSS: poisoning severity score; ECG: electrocardiograph; IQR: interquartile range; pH: potential of hydrogen; PCO_2: partial pressure of carbon dioxide; HCO_3: bicarbonate; %: percentage; MV: mechanical ventilation; a: Mann-Whitney U test; b: Chi-Square test; c: Fisher Exact test; [#]: of abnormal ECG in 104 cases; *significant at $p<0.05$.

Table (6): Comparison between survivors and non-survivors of acute OP poisoning regarding some clinical and laboratory variables

		Groups				Tests of significance	
		Survivors n=140		Non-survivors n=22		Statistical test	P value
GCS	Median (IQR)	15.0 (14.0-15.0)		7.0 (3.0-11.0)		6.637a	<0.001*
	Mean rank	90.12		26.66			
Oxygen saturation %	Median (IQR)	97.0 (95.0-99.0)		67.0 (52.0-76.0)		6.877a	<0.001*
	Mean rank	91.50		17.84			
PSS	Grade1	69	49.3%	0	0.0%	64.17b	<0.001*
	Grade 2	50	35.7%	1	4.5%		
	Grade 3	21	15.0%	21	95.5%		
ECG grading[#]	Grade1	1	1.2%	0	0.0%	4.337c	0.124
	Grade 2	77	93.9%	18	81.8%		
	Grade 3	4	4.9%	4	18.2%		
pH	Median (IQR)	7.41 (7.35-7.46)		7.29 (7.19-7.37)		3.642a	<0.001*
	Mean rank	86.82		47.66			
PCO_2	Median (IQR)	36.9 (31.0-42.0)		35.1 (32.0-40.0)		0.169a	0.866
	Mean rank	81.75		79.93			
HCO_3	Median (IQR)	23.0 (22.0-24.1)		17.5 (14.0-23.0)		3.726a	<0.001*
	Mean rank	86.91		47.05			
Serum cholinesterase levels (U/L)	Median (IQR)	2898.5 (1635.0-4335.5)		340.0 (176.0-560.0)		6.664a	<0.001*
	Mean rank	91.24		19.55			

n: number; OP: organophosphate; GCS: Glasgow Coma Scale; PSS: poisoning severity score; ECG: electrocardiograph; IQR: interquartile range; pH: potential of hydrogen; PCO_2: partial pressure of carbon dioxide; HCO_3: bicarbonate; %: percentage; a: Mann-Whitney U test; b: Chi-Square test; c: Fisher Exact test; [#]: of abnormal ECG in 104 cases; *significant at p<0.05.

The construction of prediction models for the studied outcomes was carried out using multivariate logistic regression analysis. The choice of predictors was based on scientific relevance and the results of univariate analysis (Table 7).

For the prediction of the need for ICU admission, GCS and O_2 saturation contributed significantly to the prediction model (p = 0.002). The model significantly predicted the outcome (x2 = 126.283, p<0.001), with an accuracy of 94.4%, a sensitivity of 82.9%, and a specificity of 98.3%. As well, the model explained 79.9% (R2) of the outcome prediction.

Only the O_2 saturation contributed considerably to the prediction model of the requirement for MV (p = 0.001), and the model accurately anticipated the outcome (x2 = 154.97, p<0.001). This model showed an accuracy of 96.9%, a sensitivity of 94.9%, and a specificity of 97.6%. It explained 92.1% (R2) of the outcome prediction.

Prediction model for mortality consisted of O2 saturation and SChE level. It significantly predicted the outcome (x2 = 78.87, p<0.001). The accuracy, sensitivity, and specificity of this model were 94.4%, 77.3%, and 97.1% respectively. It explained 78.87% (R2) of the outcome prediction.

Table (7): Multivariable binary logistic regression analysis for prediction of the studied outcomes in cases with acute OP poisoning (n= 162)

	Odds ratio	95% CI odds ratio	P value	Accuracy %	Sensitivity %	Specificity %	R^2 %	X^2	P value
The need for ICU admission									
GCS	0.637	0.479-0.846	0.002*	94.4	82.9	98.3	79.9	126.283	<0.001*
O_2 saturation	0.860	0.782-0.946	0.002*						
The need for MV									
O_2 saturation	0.573	0.442-0.742	<0.001*	96.9	94.9	97.6	92.1	154.97	<0.001*
Mortality									
O_2 saturation	0.902	0.843 to 0.965	0.003*	94.4	77.3	97.1	70.3	78.870	<0.001*
SChE level	0.998	0.996 to 1.0	0.026*						

n: number; OP: organophosphate; GCS: Glasgow Coma Scale; ICU: intensive care unit; MV: mechanical ventilation; SChE: serum cholinesterase enzyme; *significant at p<0.05.

DISCUSSION

Globally, OP compounds are among the most frequent causes of human toxicity as they are easily available and of low cost **(Abass et al., 2019; Abdel Baseer et al., 2021)**. Organophosphorus poisoning is a dangerous clinical entity that has a significant morbidity and mortality. Assessment of the severity of OP poisoning and prediction of its outcome have been extensively studied. Unfortunately, the results of these studies are inconclusive **(Hiremath et al., 2016; Majidi et al., 2018)**. For this reason, the present study aimed to find parameters that could be used as predictors of major outcomes in acute OP poisoning cases.

The epidemiological data of the present study are comparable to those in other studies **(Abd El Al et al., 2016; Amin et al., 2018; Amir et al., 2020; Gagarin and Rajagopal, 2020; Reddy et al., 2020)**.

Data obtained from the current study showed that most of the cases were intoxicated in suicidal attempts through the ingestion of OP compounds. These results are in partial accordance with those reported by previous studies **(El-Gharbawy and Emara, 2015; Elagamy and Gabr, 2019)**. In contradiction to our findings, **Abd El-moneim et al. (2019)** recorded that most of their cases were accidentally poisoned with insecticides.

The delay time in this study ranged from 2 to 6 hours, with a median of 4 hours. This is in line with the results demonstrated by **Lee et al. (2019a)** and **Tefera and Teferi (2020)**. Shorter delay times were reported in other studies **(Oreby and El-Madah, 2017; Liu et al., 2020)**.

The present study demonstrated that 40.7% of the cases suffered from variable degrees of DCL. This is in partial agreement with studies done by **Coskun et al. (2015)**

and **Elagamy and Gabr (2019)**. In addition, 25.3% of the cases had different degrees of hypoxia. This finding disagrees with **Shama et al. (2020)**, who reported hypoxia in 12% of their cases. This discrepancy could be explained by the difference in the severity of the cases included in each study. Organophosphorus-induced hypoxia is caused by a combination of peripheral acute cholinergic effects and central apnea **(Hulse et al., 2014)**.

Concerning the vital signs, more than one third of the cases in the current study had tachycardia and tachypnea. These findings are in line with the results of **Laudari et al. (2014)** and **Abd El-moneim et al. (2019)**, who demonstrated that tachycardia and tachypnea were more frequent in their studies. On the other hand, **Elagamy and Gabr (2019)** reported that 56.19% of their OP poisoned cases had bradycardia.

Hypertension was more common than hypotension in this study (34% and 11.7% of cases, respectively). A similar result was reported by **El-Gendy et al. (2017)**. But, **Abd El-moneim et al. (2019)** reported that hypotension was more common than hypertension in their study. The increased incidence of tachycardia, tachypnea, and hypertension in the present study could be explained by the predominance of nicotinic effects of OP compounds.

Normal body temperature was detected in 74.1% of the cases in the current study. Hypothermia was more frequent than hyperthermia in the remaining cases (17.3% and 8.6%, respectively). In their case series, **Moffatt et al. (2010)** reported that half of the cases had normal body temperature and the other half had hypothermia. The effect of OP compounds on the hypothalamus can explain the occurrence of hypothermia during the first 48 hours after their ingestion **(Gordon, 1996; Muthu et al., 2014)**. Conversely, **Khodeary and Elkholy (2018)** observed that 60% of their study cases had normal body temperature and 28% had hyperthermia. While **Abd El-moneim et al. (2019)** found that 80% of their cases had normal body temperature and the remaining cases had hyperthermia.

Regarding PSS, 42.6% of the studied cases had minor OP toxicity and 31.5% had moderate OP toxicity. These results could be attributed to the short delay time and rapid transfer of patients to TUPCC. Similar results were reported by **Chandrasekhar et al. (2017)** and **Raveendra et al. (2020)**. Furthermore, **Elagamy and Gabr (2019)** demonstrated that according to the Peradeniya Organophosphorus Poisoning (POP) scale; 55.2% of their cases were graded as mild and 24.26% were graded as moderate.

Respiratory alkalosis was present in 26.5% of the cases and could be explained by the high incidence of tachypnea that leads to increased CO_2 wash. In addition, metabolic acidosis was recorded in 24.7% of the cases and could result from the OP-induced hypoxia. These results are comparable to those of other studies **(Bai et al., 2014; Pergulwar et al., 2016)**.

It is well known that OP compounds irreversibly inhibit the cholinesterase enzyme, resulting in an accumulation of acetylcholine at synapses and neuromuscular junctions **(Gagarin and Rajagopal, 2020)**. In this study, SChE was decreased, recording a median of 2415 U/L. This finding is in line with the findings of **Abd El-moneim et al. (2019)**, **Shahin and Hafez (2020)** and **Sagah and Elhawary (2021)**, who revealed that the mean and median SChE level in their patients were 2281.76± 1109.39, 2631 and 2411U/L respectively. A higher mean level of 3383± 2847 of SChE was reported by **Amin et al. (2018)**.

The current study demonstrated that the median hospital stay duration was 42.0 hours. This is partially similar to the hospital stay duration reported in **Amir et al. (2020)** study with a mean of 2.17± 1.8 days and in **Shahin and Hafez (2020)** with a median of 2 days. On the other hand, **Oreby and El-Madah (2017)** reported a longer median duration of 14 days. They attributed this long duration to

their inclusion criteria, as they selected only severely poisoned patients.

In-hospital mortality in the present study was 13.6%. Rapid transfer of the cases to TUPCC and the availability of atropine and oximes could contribute to this low mortality rate. Furthermore, 25.3% of the patients in this study needed ICU admission and 24.1% required mechanical ventilation (MV). These results coincide with the findings of **Kothiwale et al. (2019)**, who reported that the mortality rate in their study was 15.29% and that 25.88% of their cases required ventilator support. Meanwhile, **Gagarin and Rajagopal (2020)** recorded a higher mortality rate (25%) and a higher need for MV (40%).

In the current study, the univariate analysis demonstrated that the median of GCS, O_2 saturation, pH, HCO_3, and SChE were significantly lower in the cases who needed ICU admission, MV, and in the non-survivors than in the cases who didn't need ICU admission, MV, and the survivors. Meanwhile, the percentage of severe OP poisoning cases (PSS = 3) was significantly higher in the cases who needed ICU admission, MV, and non-survivors.

These results are comparable with the results of other studies in the literature. **Oreby and El-Madah (2017)** reported that the GCS was significantly lower in non-survivors of their study, and mortality could be predicted with a sensitivity of 100% in patients who had a GCS ≤ 9. Similarly, **Shahin and Hafez (2020)** reported that the median GCS was significantly lower in patients who needed MV than those who didn't need it and in non-survivors than in survivors. Organophosphorus poisoning induces neuropathy (resulting in CNS hypoperfusion) and hemodynamic changes that may both cause a decrease in GCS value **(Grmec et al., 2004)**.

Muley et al. (2014) reported that O_2 saturation was significantly lower in patients who needed MV than those who didn't need it and in non-survivors than in survivors. They added that the need for MV was found to be significantly linked to O_2 saturation of less than 85%.

The present study demonstrated that both lower pH and HCO_3 values are associated with poor outcomes. In accordance with these findings, **Lee et al. (2019b)** found that non-survivors of their study had a significantly lower pH and HCO_3. In addition, **Subikshavarthni and Selvan (2019)** concluded that acidosis (mainly metabolic acidosis) is associated with an increased risk of longer ICU stay duration and mortality. Organophosphorus poisoning contributes to a variety of cardiac manifestations, including ECG changes and respiratory insufficiency. These may result in hypotension, hypoperfusion, and electrolyte imbalance. These factors might be the primary causes of acidosis in acute OP poisoning **(Lee et al., 2018)**.

In agreement with the current study result, **Muley et al. (2014)** and **Amin et al. (2018)** found that the level of SChE was significantly lower in patients who needed MV and in non-survivors when compared with patients who didn't need MV and survivors. They concluded that levels of SChE <1000 IU/L and < 1800 IU/L, respectively, are significantly associated with morbidity and mortality. Furthermore, **Kothiwale et al. (2019)** discovered that SChE levels of 2500 IU/L on the first day and decreasing levels on subsequent estimations are associated with longer hospital stay duration, increased need for MV, and a higher risk of mortality. On the other hand, **Chandrasekhar et al. (2017)** reported that there was no statistical association between SChE levels and the mortality of OP poisoned patients. In addition, **Twayana et al. (2019)** discovered a non-significant correlation between low SChE levels and the need for MV.

In the present study, severe OP poisoning (PSS = 3) was associated with a higher risk of need for ICU admission, MV, and mortality. In accordance with this result, **Yuan et al. (2018)** found that non-survivors

had significantly higher values of PSS than survivors and concluded that PSS could predict the prognosis of patients with OP poisoning. Similarly, **Raveendra et al. (2020)** noted that among patients with PSS = 3, 100% needed MV and 65% died. **Shama et al. (2020)** reported a significantly higher PSS among cases who needed ICU admission and MV when compared with cases who didn't need them. But they found a non-significant difference between survivors and non-survivors concerning the PSS.

Multivariate regression analyses revealed that low GCS and low O_2 saturation were the independent risk factors for the need of ICU admission. **Elagamy and Gabr (2019)** revealed that severe degree of POP classification, presence of hypoxia (PO2< 50mmHg), convulsions and severe affection of SChE activity were significant predictors for the need of ICU admission. The independent risk factors for the need for MV included low O_2 saturation alone. **Kolandai Samy et al. (2019)** reported that by using the multivariate regression analysis, it was found that low serum paraoxonase 1 and SChE levels and high serum amylase, lipase and creatine kinase-total levels were associated with ventilation assistance requirement and mortality. Furthermore, the low O_2 saturation and low SChE level were the independent risk factors for mortality in the current study. In a study done by **Liu et al. (2012)**, it was found that hypotension, respiratory failure, coma, and QTc prolongation were the significant risk factors for mortality. The presence of heart rate, respiratory rate abnormalities and low GCS were the predictors of mortality detected by **Moussa et al. (2018)**. While **Abdel Baseer et al. (2021)** revealed that the delay time, the necessity for MV, leukocytosis, a lower GCS, a lower PaO_2 and a higher cumulative dose of pralidoxime were the independent risk factors of mortality in their study.

CONCLUSIONS& RECOMMENDATIONS

From the results of the present study, it could be concluded that low GCS and low O_2 saturation might be used in the prediction of the need for ICU admission in OP poisoned cases. Low O_2 saturation might be used in the prediction of the need for MV. While low O_2 saturation with low SChE level could predict the risk of mortality in these cases. Therefore, it is recommended to assess the GCS, monitor the O_2 saturation, and measure the level of SChE in all cases of OP poisoning at admission.

LIMITATIONS

The current study's most significant limitations are the small sample size of studied cases and the fact that it is a one-centered study. On the other hand, the present study is a prospective one, which could be considered an important strength point as it avoided errors and missed data that can result from dependence on the previous records.

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الملخص العربي

المتنبئات بمقاييس النتائج الرئيسية في حالات التسمم الحاد بالمواد العضوية الفسفورية

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مقدمة: لا يزال التسمم بالمواد العضوية الفسفورية سببا هاما للمرض والوفيات مع عدم وجود متنبئات محددة لنتيجة هذا التسمم حتى الآن. **الهدف من الدراسة:** هدفت هذه الدراسة إلى إيجاد عوامل يمكن استخدامها كمتنبئات لمقاييس النتائج الرئيسية في التسمم الحاد بالمواد العضوية الفسفورية. **المرضى والأساليب:** أجريت هذه الدراسة الحشدية المستقبلية من بداية أغسطس 2019 حتى نهاية يوليو 2020 على الحالات التي تعاني من التسمم الحاد بالمواد العضوية الفسفورية والتي تم قبولها بمركز طنطا الجامعي لعلاج حالات التسمم. وقد خضعت جميع الحالات لأخذ التاريخ، والفحص السريري، والتحقيقات المختبرية، وتخطيط القلب الكهربائي، وتقييم النتائج. **النتائج والاستنتاج:** تضمنت الدراسة مئة واثنان وستون حالة. تراوحت أعمارهم بين 18 و 74سنة. وشكل الذكور 55.6% من الحالات. تسممت معظم الحالات في محاولات انتحارية من خلال ابتلاع مركبات المواد العضوية الفسفورية. تم العثور على اختلافات ذات دلالة إحصائية بين الحالات التي تحتاج و التي لا تحتاج إلى دخول وحدة العناية المركزة و التنفس الصناعي و بين الناجين وغير الناجين فيما يتعلق بمستويات مقياس جلاسكو للوعي (GCS)، ونسبة تشبع الدم بالأوكسجين، ومقياس شدة التسمم، ودرجة حموضة الدم، ومستوى البيكربونات بالدم، ومستوى إنزيم السيرم كولينستراز (SChE) . وكشفت تحليلات الانحدار المتعددة المتغيرات أن انخفاض مستوى GCS وانخفاض نسبة تشبع الدم بالأوكسجين هما عاملا الخطر المستقلان للتنبؤ بالحاجة إلى دخول وحدة العناية المركزة. وكان انخفاض نسبة تشبع الدم بالأوكسجين هو عامل الخطر الوحيد للتنبؤ بالحاجة إلى التنفس الصناعي. في حين أن انخفاض نسبة تشبع الدم بالأوكسجين وانخفاض مستوى SChE كانا عوامل الخطر المستقلة للتنبؤ بالوفيات. **التوصيات:** لذلك، يوصى بتقييم GCS، ورصد نسبة تشبع الدم بالأوكسجين وقياس مستوى SChE في جميع حالات التسمم بالمواد العضوية الفسفورية عند دخول المستشفى.