

Adolescent's suicide using pesticides: risk factors and outcome prediction

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Abstract

Background: In several countries, suicide is one of the leading causes of mortality and morbidity among adolescents, making it a major public health problem. Suicide can be prevented with accurate and prompt evaluation of mental illness and successful care, as well as informed media reporting of suicide and environmental monitoring of risk factors.

Objective: This study was designed to assess the predictive value of the Poisoning Severity Score ((PSS) IPCS/EAPCCT)) in the outcome of suicide by pesticides in adolescents and provide data on risk/precipitating factors.

Methods: Observational prospective surveys were conducted on 100 adolescent patients presented with acute suicidal pesticides poisoning within a six-month period and met the inclusion criteria.

Results: Most of the patients (96.0%) reported adverse life events and recent stressors, 77.0% of the patients were diagnosed with anxiety, 52.0% were diagnosed with depression, and 29.0% were diagnosed with personality disorders. Significant higher total PSS was found in patients who died (2.22 ± 0.24) compared to those admitted to ICU (1.47 ± 0.23); $p=0.001$ and the total PSS for the patients admitted to ICU (1.47 ± 0.23) was significantly higher than those admitted to Alexandria Poison Center (0.64 ± 0.26) $p<0.001$. Analysis of the ROC curve for the total poisoning severity score (PSS) as a predictor of mortality revealed that the area under the curve (AUC) was 0.991 with high sensitivity (94.74%) and specificity (98.77%) for PSS >2 and P-value was highly significant ($p<0.001$).

Conclusion: Aluminum phosphide, organophosphorus, and zinc phosphide are the most used pesticides for committing suicide in adolescence by this order in Alexandria. In the present study, the presence of major life events, recent stressors, diagnosis with depression, and diagnosis of anxiety were associated with the suicide event. Finally, Poisoning Severity Score can be used as a predictor to provide the families with the possible outcome/prognosis for their patients and to have the medical team prepared for specific medical attention needed by the patients, especially in PSS 3 and 4.

Keywords: Adolescent's suicide, pesticides, risk factors, precipitating factors, Poisoning Severity Score (PSS)

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INTRODUCTION

Pesticides are substances or mixtures of substances that are widely used in agricultural countries, and they are freely available in the market. Pesticides have been associated with accidental and suicidal intoxication as well as the environmental pollution that occurs secondary to their excessive agricultural use (1,2).

Pesticide self-poisoning accounts for 110 000 to 168 000 deaths globally every year and up to 20% of global suicides. More than 90% of adolescent suicide victims met the criteria for a psychiatric disorder before their death. Key risk factors found were mental disorders, previous suicide attempts, specific personality characteristics, genetic loading, and family problems in combination with triggering psychosocial

stressors, exposure to inspiring models, and availability of means of committing suicide (3,4).

Poisoning Severity Score (PSS) is a standardized and generally applicable scheme for grading the severity of poisoning. It allows a qualitative evaluation of morbidity and facilitates comparability of data (5). According to Mohammed S (6) study, in the last years in Alexandria poison center -one center at the main university hospital- suicide constituted 31.77% (2400 out of 7552) up to 36.8% (2273 out of 6171). (6) It represents 1.4- 2% of total deaths by pesticides globally.

This study was designed to assess the predictive value of the Poisoning Severity Score ((PSS) IPCS/EAPCCT)) in the outcome of suicide by pesticides in adolescents and provide data on risk/precipitating factors.

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METHODS

The study was conducted over a six-month period between October 2018 and March 2019. It consisted of 100 patients aged 10 to 19 who presented with acute pesticide poisoning to the Emergency Medicine Department of Alexandria Main University Hospital. Only those admitted within 24 hours of a suicidal attempt were included in the study. Patients with co-ingestion of other substances and those with claimed homicide or accidental ingestion were excluded from the study.

The sample size was calculated using G power analysis, at a level of significance of 0.05, a power of 0.8, a sensitivity of 0.66, a specificity of 0.88, and a 15% mortality (7).

A prospective observational survey was conducted as follows:

Time zero: once the patients presented to the emergency department, they were subjected to:

1- Detailed history taking, which included demographic data (age, sex, occupation, residency), type of pesticide, time of toxin exposure or intake, history of medical diseases, history of recreational drugs, and drug history with stress on psychiatric medications.

2-Psychiatric interview carried out by one of the research team -after training in the psychiatry and neurology department- for the presence of psychiatric illness and to assess the precipitating factors to the suicidal attempt, including depression, anxiety, personality disorder, and adverse life events and stressors (there were no other psychiatric issues present) (8).

3-Clinical examination.

4- Poison Severity Score (IPCS/EAPCCT) calculations (5)

5- Patients were followed up clinically in the poison center and the ICU to assess the clinical outcome according to the following checklist:

- 1- Treated in the emergency department and discharged.
- 2- Admitted to Alexandria Poison Center (APC).
- 3- Admitted to ICU.
- 4-Death.

Conduction of the present study was approved by the Ethical Committee of the Faculty of Medicine. Informed consent was taken from patients or their relatives before starting to collect data after a full explanation of the study's purpose and aims. (IRB NO: 00007555 - -FWA NO: 00018699)

Data was analyzed using SPSS, version 20. Data was presented as numbers and percentages for categorical variables as well as means, medians, and standard deviations (SD) for continuous variables. The Kruskal Wallis test was used for non-normally distributed quantitative variables, and the chi-square and Monte Carlo tests were used for testing associations between qualitative variables. ROC curve analysis was performed for the predictive value of PSS for mortality. All results were interpreted at the 5% level of significance.

RESULTS

The study consisted of 23 males and 77 females. Their age ranged from 10 to 19 years with a mean of 16.01 ± 2.61 years. 60% of them aged above 15 years and 40% aged 15 years or less. (age of 15 was chosen as a round figure between 10-19 years). In regard to the patient's residence, 41.0% reported living in rural areas, and 59.0% lived in urban regions.

The pesticides used were aluminum phosphide in 35% of the patients, organophosphorus in 30%, zinc phosphide in 25%, boric acid, and carbamate each in 5% .

Psychiatric interviews were carried out by one of the research team who had previous training in the psychiatry and neurology department. Patients were evaluated using a psychiatric interview format where (96.0%) reported adverse life events and recent stressors, 77.0% of the patients were diagnosed with anxiety, 52.0% were diagnosed with depression, and 29.0% were diagnosed with personality disorders.

Early stabilized patients accounted for 43% were admitted to Alexandria Poison Center (APC) ward. On the other hand, 38.0% of patients needed either ventilators and/or vigorous interventions; thus, they were admitted to the ICU, and 19.0%

Table 1. Distribution of the studied cases according to poisoning severity score (n = 100)

Poisoning Severity Score (PSS)	None		Minor		Moderate		Severe		Fatal	
	No.	%	No.	%	No.	%	No.	%	No.	%
GI-tract	1	1.0	17	17.0	23	23.0	47	47.0	12	12.0
Respiratory system	2	2.0	30	30.0	23	23.0	33	33.0	12	12.0
Nervous system	5	5.0	30	30.0	25	25.0	29	29.0	11	11.0
Cardiovascular system	13	13.0	22	22.0	30	30.0	33	33.0	2	2.0
Metabolic balance	11	11.0	25	25.0	19	19.0	33	33.0	12	12.0
Liver	56	56.0	24	24.0	13	13.0	7	7.0	0	0.0
Kidney	58	58.0	28	28.0	11	11.0	1	1.0	2	2.0
Blood	64	64.0	32	32.0	2	2.0	2	2.0	0	0.0
Muscular system	48	48.0	40	40.0	9	9.0	3	3.0	0	0.0
Local effects on skin	71	71.0	22	22.0	5	5.0	2	2.0	0	0.0
Local effects on eye	84	84.0	16	16.0	0	0.0	0	0.0	0	0.0
Total score										
Min. – Max.					0.18 – 2.55					
Mean \pm SD.					1.25 \pm 0.65					
Median					1.32					

of patients died in the emergency room.

The distribution of the studied cases according to their poisoning severity score (PSS) is illustrated in table 1.

As shown in table 2, there was statistically significant higher total PSS in patients who died (2.22 ± 0.24) compared to those admitted to ICU (1.47 ± 0.23); $p=0.001$ The total PSS of patients admitted to ICU (1.47 ± 0.23) was also significantly higher than those admitted to APC (0.64 ± 0.26) with $P\text{-value}<0.001$.

The relation between the outcome of the patients and the underlying psychiatric diagnosis is demonstrated in table 3. Among patients diagnosed with depression, 44.2% and 21.2% respectively were admitted to ICU and died compared to 31.2% and 16.7% of patients with no reported depression. However, these differences were not statistically significant ($P=0.208$). About a quarter (24.7%) of patients diagnosed with anxiety died compared to none of the patients with no reported

anxiety, which was statistically significant ($p=0.015$). A higher percentage (31%) of patients with a diagnosis of personality disorder died compared to 14.1% of patients with no reported personality disorders but not at a statistically significant value ($p=0.107$). Among patients who reported adverse life events and recent stressors, 39.9% were admitted to the ICU, and 19.8% died compared to none of the patients who had not reported a recent history of stressors, but these differences were not statistically significant.

Table 4 demonstrates the ROC curve analysis for the total poisoning severity score (PSS) as a predictor of mortality. The results revealed that the area under the curve was 0.991 with high sensitivity (94.74%) and specificity (98.77%) for $PSS >2$ to predict mortality and $p\text{-value} <0.001$ (Figure 1).

DISCUSSION

In the present study, the females (77) outnumbered the

Table 2. Relation between outcome and total scores

Total score	Outcome			Test of Sig.	P
	APC (n = 43)	ICU admission (n = 38)	Death (n = 19)		
Poisoning severity score (PSS)					
Mean \pm SD.	0.64 ± 0.26	1.47 ± 0.23	2.22 ± 0.24	H = 81.403*	<0.001*
Significance between groups.	$p_1<0.001^*$, $p_2<0.001^*$, $p_3=0.001^*$				

H: H for Kruskal Wallis test, Pairwise comparison between each 2 groups were done using Post Hoc Test (Dunn's for multiple comparisons test)

p: p value for comparison of the three categories

p_1 : p value for comparison APC and ICU admission

p_2 : p value for comparison APC admission and Death

p_3 : p value for comparison ICU admission and Death

*: Statistically significant: $p \leq 0.05$

Table 3. Relation between patients' outcome and underlying psychiatric diagnosis

Psychiatric interview	Outcome						χ^2	P
	APC admission		ICU admission		Death			
	No.	%	No.	%	No.	%		
Depression								
No (48)	25	52.1	15	31.2	8	16.7	3.142	0.208
Yes (52)	18	34.6	23	44.2	11	21.2		
Anxiety								
No (23)	10	43.5	13	56.5	0	0.0	8.374*	0.015*
Yes (77)	33	42.8	25	32.5	19	24.7		
Personality disorder								
No (71)	34	47.9	27	38.0	10	14.1	4.473	0.107
Yes (29)	9	31.9	11	38.0	9	31.0		
Life event								
No (4)	4	100.0	0	0.0	0	0.0	4.023	$^{MC}p=$ 0.104
Yes (96)	39	40.6	38	39.6	19	19.8		

χ^2 : Chi square test MC: Monte Carlo

p: p value for comparison of the three categories

Table 4. Results of ROC curve analysis for PSS as a Mortality predictor

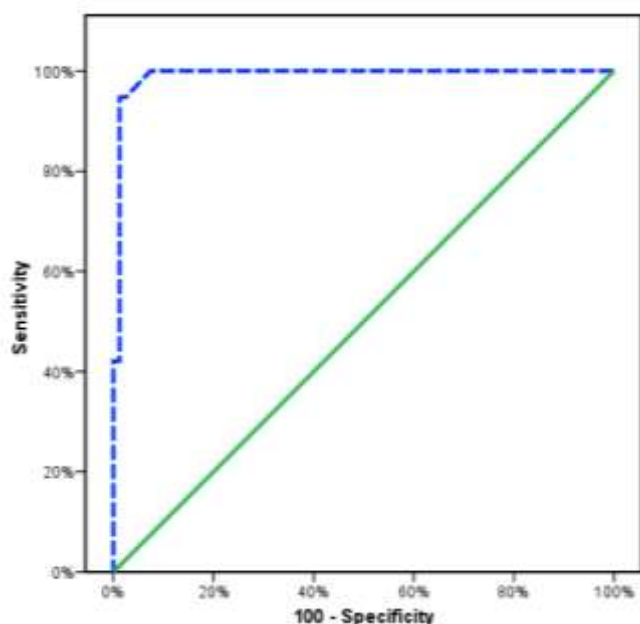
	AUC	p	95% C.I		Cut off [#]	Sensitivity	Specificity	PPV	NPV
			LL	UL					
Poisoning severity score (PSS)	0.991*	<0.001*	0.976	1.006	>2	94.74	98.77	94.7	98.8

AUC: Area under the curve

CI: Confidence Interval

NPV: Negative predictive value

PPV: Positive predictive value

*: Statistically significant at $p \leq 0.05$ #Cut off was choose according to Youden index - *: Statistically significant: $p \leq 0.05$ **Figure 1. ROC curve for PSS as a predictor of mortality**

males (23). This was consistent with the results found by Spiller et al. (2019) (9). In contrast, the previous studies in hospital settings (hospitals were chosen to unify this factor when comparing the age of studied subjects) showed that males outnumbered females, and death rates were also higher among males. (10,11)

Pawar KS et al. (10) carried out a study on 200 patients in a single center after poisoning by anticholinesterase pesticide, and the statistics showed that males outnumbered females. Gunnell D, Eddleston M study (11) identified 27 studies undertaken in 16 countries -5 low-income or middle-income countries (Bangladesh, Colombia, India, Jordan, and Sri Lanka), and 11 high-income countries (Denmark, Finland, Germany, Greece, Hungary, Ireland, Japan, South Korea, Taiwan, UK, and USA)- with the males outnumbering the females due to the easier use of pesticides by men for suicide.

The patients were mainly from an urban area (59.0%) which is in accordance with Jayashree K et al. (12), who stated that depression and anxiety were high among pre-graduation Institutes in the city of Mangaluru. Co-existing anxiety and female gender are significantly associated with depression

among them. The study included 201 participants; ages ranged from 15 to 18 years; mean age being 16.3 years (standard deviation: 0.71). Among them, 135 (67.2%) study participants resided in urban areas, 66 (32.8%) were from rural areas.

The psychiatric assessment in the present study reported that 96.0% had adverse life events and recent stressors, 77.0% of the patients were diagnosed with anxiety, 52.0% were diagnosed with depression, and 29.0% were diagnosed with personality disorders. There were similar findings regarding the relationship between psychiatric disorders and adolescent suicide conducted with Bang et al. (13), who assessed 1196 participants for psychiatric disorders. They indicated that adolescents with a history of stress were more likely to be diagnosed with depression and were significantly associated with suicide attempts even after adjusting for demographic characteristics, depression, and psychosis. Moreover, Pelkonen et al. (14) reported that less than half of young people who commit suicide receive psychiatric treatment, and teenagers are vulnerable to environmental stress. There are several risk factors of suicide, e.g., depression, substance abuse, divorce, previous suicide in the family, bad contact with parents, and mental health issues.

Albert, in 2015, explained the higher prevalence of depression in females due to genetic influence and proposed its accountability for a higher incidence of suicidal behaviors in females. This may explain the results of the present study, where females represented 77% of the total cases (15).

Pesticide suicidal poisoning is considered a burden on the health care system due to numerous requests for laboratory investigation, prolonged hospital stays, psychological assessments, and ICU bed occupation (16). Furthermore, due to their wide availability and easy accessibility, pesticides are commonly used for suicide. (17) Jaga and Dharmani (18) stated that OP poisoning is highly prevalent in agricultural communities, where it is more common to be used by females due to depression and other sociodemographic risk factors. This is consistent with the findings of the current study, where females outnumbered males (77%).

In the current study, all the types of pesticides were recorded, where aluminum phosphide was used in 35% of the patients, organophosphorus in 30%, zinc phosphide in 25%, boric acid and carbamate each in 5%. A similar result regarding the use of Aluminum phosphide followed by organophosphates in self-poisoning was found by Qureshi et al. (19). They stated that among the 110 studied patients, 94(85.45%) belonged to the younger age group (12-30 years), and 65(59.1%) of cases that used Aluminum Phosphide

poisoning were females & 45(40.9%) were males. They found that Aluminum Phosphide with suicidal intent was reported in 82(79.6%) of their cases.

Another study in Iran carried out between 2006 to 2013 reported that aluminum phosphide was widely used as a suicide poison due to its high toxicity potential and easy availability. A total of 51.8% of studied cases were female. Most of the patients were between 10 and 40 years old. The manner of death was self-poisoning in 85% of cases (20).

The Poisoning Severity Score (PSS) was used to grade the severity of poisoning, provide the families with the possible outcome/prognosis for their patients, and have the medical team prepared for any specific medical attention needed by the patients, especially in PSS 3 and 4.

In the present study, the total PSS was calculated and ranged between 0.18 – 2.55. The clinical outcomes of the patients determined by their total PSS scores were presented as 43% admission to Alexandria Poison Center (grade 1 and 2), and 38% to the ICU (grade 3), 19 %death (grade 4). 47.3% of the last group died in the emergency resuscitation room and the rest after ICU admission. Similar to the present results, were the results of Chandrasekhar et al. 2017(21) - who studied the distribution of poison severity score on 100 patients- showed that 45 cases were of grade 1 poisoning, 26 cases of grade 2 poisoning, 23 cases of grade 3 poisoning and 6 cases of grade 4 poisoning (death within first 24 hours). The increased score in the present study may be due to the late arrival of the patient because the APC is considered as a tertiary care unit, and usually, relatives of the patients started with nearby primary or secondary care units. A similar death rate was reported by Shaikh et al. (22), which came up to 17.39% (84 deaths in 483 patients, excluding those referred to Karachi).

In the current research, the PSS predicted poor outcomes accurately in the patients at the cutoff value of >2. Analysis of the ROC curve for the total poisoning severity score (PSS) as a predictor of mortality revealed that the area under the curve (AUC) was 0.991 with high sensitivity (94.74%) and specificity (98.77%) for PSS >2 with a significant P-value ($p<0.001$). Like our study, Shrestha et al. analyzed the outcome of OP poisoning use (PSS) and found that 35.56% of cases with PSS grade 3 didn't survive, and it was significant ($p<0.005$) to predict the outcome (7). Also, Chandrasekhar et al. found a significant association between poison severity score within the first 24 hours and the outcome of OP poisoning ($p\leq 0.001$) (21).

Among patients diagnosed with depression, 44.2% and 21.2% were admitted to ICU (grade 3 according to PSS) and died, respectively, compared to 31.2% and 16.7% of patients with no reported depression (table 3). Keyes KM et al. stated that depressive symptoms are increasing among teens, especially among girls, consistent with increases in depression and suicide after a study search on 512,283 adolescent students in the USA. This may explain the severity of the cases suffered from depression in the current research, they were intended to kill themselves and most of them were females (23).

About a quarter (24.7%) of patients diagnosed with anxiety died compared to the zero deaths in patients with no

diagnosis of anxiety, which was statistically significant ($p=0.015$). Mary E et al. reported that rates of depression, anxiety, non-suicidal self-injury, suicidal ideation, and suicide attempts markedly increased over the college students from 2007 to 2018 (24).

A higher percentage of patients diagnosed with personality disorders died (31%) compared to the patients without personality disorders. Among patients who experienced adverse life events and recent stressors, 39.9 % and 19.8% respectively were admitted to ICU and died, compared to none of the patients with no reported recent history of stressors. Paris J stated that borderline personality disorder is associated with suicidal behaviors and self-harm. Up to 10% of BPD patients will die by suicide (25).

Several studies claimed that people exposed to pesticides have symptoms of psychological distress as well as diagnoses of depression and suicidal ideation. Wesseling C et al. worked on 130 non-poisoned employees chosen at random as a control and 78 banana workers in Costa Rica who had received medical attention 1-3 years previously for occupational pesticide poisoning (OP and carbamate) (26). They reported that organophosphate poisoned workers showed more depression symptoms than non-poisoned workers. Somatization, obsessive-compulsiveness, interpersonal sensitivity, depression, and anxiety increased with increased exposure to poisoning. The odds ratios (ORS) for suicidal thoughts were 3.58 in all poisoned workers. Beseler C et al. examined 32,347 spouses of pesticide applicators enrolled in a study between 1993 and 1997 in Iowa and North Carolina (27). Among them, those with a history of pesticide poisoning were significantly associated with self-reported physician-diagnosed depression after controlling for other risk factors. It showed that ORs for depression were 1.11 (CI 1.01, 1.22) among those mixing or applying pesticides for up to 225 days, 1.22 (CI 1.02, 1.45) for greater than 225 days, and 3.97 (CI 2.18, 7.21) among those reporting a history of pesticide poisoning. Depression was significantly associated with the use of insecticides, fumigants, fungicides and nearly significant for herbicides.

Peter JV et al. examined Two-hundred and fifty-one patients exposed to class I, II, or III organophosphate compound. They stated that because of the linear association between WHO danger class and mortality in acute OP poisoning, the restriction of pesticides' sale should become mandatory (28).

In conclusion, aluminum phosphide, organophosphorus, and zinc phosphide are the most used pesticides for committing suicide in adolescence in this order in Alexandria. The presence of major life events, recent stressors, diagnosis with depression, and diagnosis of anxiety were associated with the suicide event. Finally, Poisoning Severity Score can be used as a predictor to provide the families with the possible outcome/prognosis for their patients and to have the medical team prepared for specific medical attention needed by the patients, especially in PSS 3 and 4.

Recommendations: 1- It is important to initiate a suicide prevention program during childhood and adolescence and follow-up all those who attempted suicide.

2- Interventions that reduce common, multiple risk factors

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will maximize impact.

3- Survey for agriculture workers and their families, including children and adolescents, to determine the prevalence of psychiatric changes and precipitating risk factors of attempted suicide as a result of exposure to pesticides.

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