EVALUATION OF ORGANOPHOSPHOROUS INSECTICIDES POISONING IN POISON UNIT AT EMERGENCY HOSPITAL, MANSOURA UNIVERSITY

BY

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ABSTRACT

Pesticides present a special interest in our daily life either as pests control or as environmental hazards. The organophosphates are the most widely used pesticides in industry, agriculture and houses. This study intends to evaluate organophosphate poisoning among insecticides cases of different localities presented to Poison Unit at Emergency Hospital, Mansoura University during the period from July 2003 to January 2005 (18 months period). A total number of 614 inhabitant blood samples were collected consecutively from patients (447 adults and 167 children) clinically diagnosed pesticides poisoning and analyzed for plasma cholinesterase level (PChE) and red blood cells acetyl cholinesterase activity (AChE). The pesticides were identified using thin - layer chromatography (TLC) and gas chromatography-mass spectrometry (GC-MS). A significant 361 cases of parathion poisoning constituting about 58.79% of the total distributed as 310 adult cases (85.87%) and 51 children cases (14.13%). The mode of poisoning was accidentally by inhalation and skin contact [no. 217 (60%)] and intentional intake [no. 144 (40%)]. The overall mean level of plasma cholinesterase level (PChE) for the total significant cases were categorized as severe poisoning (185.617 ± 61.945), moderate poisoning (714.773 ± 104.314) and mild poisoning (1497.9 ± 52). The mean levels of red blood cells acetyl cholinesterase activity (AChE) were categorized as mild degree poisoning (8.628 ± 0.515), moderate degree poisoning (6.225 ± 0.853) and severe degree poisoning (3.898 ± 0.598). The level of AChE corresponded with the clinical picture of the patients more than PChE. So, the total significant cases were categorized according to AChE activity into mild degree poisoning (23.55%), moderate degree poisoning (54.02%) and severe degree poisoning (22.43%).

INTRODUCTION

Pesticides are a group of substances with heterogeneous toxicity whose desired activity is the killing of unwanted living organisms, in a more or less specific manner. There are a number of possible ways in which humans can be exposed to

pesticides, thus the toxic effects of pesticides may have consequences for consumers of food as well as farmers and other applicators. Moreover, pesticides used domestically as household insecticides may be important sources of exposure of the general public. Further more, pesticides may enter the water supply. It should also be remembered that the more acutely toxic pesticides have been used for suicide and murder (Marrs and Dewhurst, 2000).

The World Health Organization estimates that approximately 3 million pesticide poisonings occur annually worldwide and cause more than 220.000 deaths (Karalliedde, 1999). 95% of fatal pesticide poisonings occur in developing countries. Serious cases of pesticide poisoning are more likely to occur in adults than in children (Schonwald et al., 2001).

Pesticide exposures have acute, chronic and long-term health effects. Besides the classical organophosphate/carbamate cholinesterase inhibition caused illness, other health concerns include dermatitis, pulmonary injury, carcinogenesis, renal disease, liver disease, reproductive toxicity, neurologic and neurobehavioral toxicity. The pesticides most frequently implicated in acute field exposures have been the organophosphates and carbamates. These pesticides exert their primary and acute toxic effect by inhibiting acetylcholinesterase (John et al., 2001). A 60% inhibition in cholinesterase activity can produce relativity mild nonspecific symptoms, such as vertigo, nausea, anxiety, vomiting, diarrhea, asthma like tightness of the chest, increased sweating, increased salivation, wheezing and shortness of breath, increased lacrimation, constriction of the pupils, and malaise (Padilla, 1995).

Greater inhibition of cholinesterase activity may produce pulmonary edema, unconsciousness, respiratory failure, and even death (Khan and Ali, 1993). The benefit of early otolaryngological consultation for the prevention and treatment of airway obstruction in patients with suspected organophosphate poisoning was shown by Thompson and Stocks, (1997). Effects on the gastrointestinal system and bradycardia have also been associated with poisoning by pesticides that inhibit cholinesterase activity (Grace et al., 2000).

Two groups of anticholinesterases, the organophosphates (OPs) and the carbamates, are widely used as agricultural insecticides and veterinary medicines (Marrs, 1996). Vertebrates have two different enzymes that hydrolyze acetylcholine (ACh); the acetylcholinesterase (AChE) in the RBCs and the nervous tissue. The other cholinesterase is present in plasma and is called butyrylcholinesterase (BChE) or

pseudocholinesterase (plasma cholinesterase). Inhibition of the activity of erythrocyte AChE is reasonably well correlated with the severity of poisoning. BChE (plasma cholinesterase) is the most sensitive to inhibitors (Iotti, 1995). So that plasma cholinesterase inhibition can be taken only as a marker of exposure. (Mason et al., 1993).

Organophosphate compounds can be classified as direct and indirect AChE inhibitors. Direct inhibitors are effective without further metabolic modification, whereas indirect inhibitors undergo biotransformation in the body to be effective. The insecticide dichlorvos is a direct inhibitor and parathion is an indirect inhibitor of the AChE (Jeyaratnam and Maroni, 1994). These indirect inhibitors organophosphates may present with delayed clinical toxicity.

Organophosphate insecticides are esters, amides, or thiol derivatives of phosphoric, phosphonic, phosphorothioic, or phosphonothioic acids (Bey et al., 2001).

Aim of the work

The aim of the present work is to evaluate organophosphate poisoning among insecticides cases presented to Poison Unit at Emergency Hospital, Mansoura University during the period from July 2003 to January 2005.

MATERIAL AND METHODS

A total number of 614 patients (447 adults and 167 children) were presented with insecticides poisoning admitted to poison unit at Emergency Hospital, Mansoura University over 18 months period (July 2003 to January 2005).

Diagnosis of acute organophosphate poisoning by complete history, evidence of exposure to organophosphate, signs or symptoms of cholinergic excess and improvement with atropine plus toxogonine therapy.

Diagnosis of suspected organophosphate poisoning was confirmed by laboratory investigations; pseudocholinesterase level (PChE) which was analyzed by spectrophotometry according to Ellman et al., (1961) and acetyl cholinesterase (AChE) activity according to Crane et al., (1970).

Thin layer chromatography and gas chromatography - mass spectroscopy (GC.MS) were done for detection of organophosphate insecticides after blood samples extraction.

Method for identification the organophosphorous insecticides using GC-MS (Flanagan et al., 1995):

Extraction of blood samples:

- The pH of 10 ml of sample is adjusted

to about 7 by sodium bicarbonate.
- The sample is extracted with 5 ml of methyl tertiary ether for 5 minutes using a rotary mixer.
- Allow to stand for 5 minutes, then the upper ether layer is taken off and re-extracted with a 5 ml of ether.
- The two extracts are combined, filtered into a clean tube and evaporated to dryness under a stream of air, 1µl of the extract was injected into GC-MS (Hewlett Packard 6890 series) of NP (nitrogen-phosphorous) detector and examined in pesticides library.

GC/MS conditions:

Column Hp^{-1} (ultra-1) Ion source temperature 200oC, Ionization voltage 70 ev, Initial oven temperature 70°C, Final oven temperature 250°C, Injection port temperature 250°C, Initial time 3.00 min, Final time 3.00 min, Equilibration time 0.50 min, Rate 8°C/min, Carrier gas Helium, Flow rate 13.5 ml/min.

Method for Thin-layer chromatography (Moffat, 1986):

The residue of the extracts was dissolved in 0.5 ml ethanol. The dissolved residues were spotted on precoated silica gel plates (20 x 20 cm) with standard parathion solution (1000 ppm) and developed in TLC glass tank. The mobile phase was hexane : acetone : chloroform (70 : 25 : 5). The plates were sprayed with palladium chloride reagent (Stevens, 1986) and then photographed using a digital camera.

Statistical analysis:

Mean ± SD was used to describe quantitative data. These tests were run on an IBM compatible personal computer using the Statistical Package for Social Scientists (SPSS) for windows 13 (SPSS Inc., Chicago, IL, USA).

RESULTS

614 patients (447 adults and 167 children) presented to Emergency hospital, Mansoura University with signs of insecticide poisoning (salivation, diaphoresis, vomiting, diarrhea, miosis, weakness and agitation). Those patients received both attention and complete treatment.

Thin layer chromatography examination revealed 361 (58.79%) positive organophosphorous cases; Fig. (1-a) shows a photographic picture of a TLC plate of positive organophosphosphorus cases. Yellow spots of the standard and the samples were observed at the same R_f value (0.81).

Fig. (1-b) shows a photographic picture of a TLC plate of negative organophosphorous cases. Examination by GC-MS indicates that there were significant 361 cases of parathion toxicity (diethyl 4-nitro phenyl phosphoro-thioate) of molecular weight 291 and chemical formula

$C_{10}H_{14}NO_5PS$), fig. (2). These toxic cases constituting about (58.79 %) of the total, distributed as 310 (85.87%) adults and 51 (14.13%) children. The mode of poisoning was accidentally in 217 cases (60%) by inhalation and skin contact and suicidal in 144 cases (40%), table (1). The poisoning cases of children were of mild poisoning. The degrees of poisoning for adults according to plasma cholinesterase level were severe poisoning in 201 cases with plasma cholinesterase level (<500 U/L), moderate poisoning in 76 cases with plasma cholinesterase level (500 - 1000 U/L), mild poisoning was found in 33 cases with plasma cholinesterase level (1000 - 1500 U/L), Table (2). Also the degree of poisoning for children were mild poisoning in all cases (51) with plasma cholinesterase activity (1000 - 1500 U/L), Table (2). Also the degree of poisoning for children were mild poisoning in all cases (51) with plasma cholinesterase activity (1000-1500 U/L), table (3). The overall mean levels of cholinesterase enzyme for the total significant cases were categorized as severe poisoning (185.617 ± 61.945 U/L), moderate poisoning (714.773 ± 104.314U/L) and mild poisoning (1497.9 ± 52 U/L) , Table (4). Table (5) and Fig. (3) show frequency for each degree of poisoning in children and adult patients according to plasma cholinesterase level.

Table (6). shows Mean values ± std. deviation of red blood cell acetyl cholinesterase (AChE) activity which ranged from minimum 2.30 to maximum 9.80 μ moles/min/ml red cells. The total significant cases were divided according to these levels into mild degree inhibition [n. 85 (23.55%)] of which 51 children cases (14.13%) and 34 adult cases (9.42%) with mean acetyl cholinesterase level 8.628 ± 0.515, moderate degree inhibition [n.195 (54.02%)] with mean acetyl cholinesterase level 6.225 ± 0.853 and severe poisoning cases [n.81 (22.43%)] with mean acetyl cholinesterase level 3.898 ± 0.598.

Table (7) and fig. (4). show frequency for each degree of poisoning in the total significant cases according to red cell cholinesterase activity. The greatest percentage (54.02%) was of moderate degree inhibition all of adult cases, then 23.55% of mild degree inhibition (14.13% children cases and 9.42% adult cases) and the least percentage (22.43%) was of severe degree inhibition (all of adult cases).

Table (8). shows degree of poisoning in the total significant cases according to clinical picture, time of response to treatment and number of atropine and toxogonine ampoules.

DISCUSSION

Hundreds of organophosphate compounds are currently available to use as

insecticides (Bardin et al., 1994). They are irreversible cholinesterase inhibitors, causing accumulation of acetylcholine at synapses and overstimulation of nicotinic and muscarinic receptors (Mortensen, 1986). The mode of exposure to organophosphorus insecticides varies, including dermal, gastrointestinal, inhalational and intravenous routes (Guven et al., 1997). Poisoning occur as a result of agricultural use, accidental exposure, suicide and rarely, homicide (Midtling et al., 1985).

The mortality rate of organophosphate poisoning is high due to a delay in diagnosis or an improper management (Murat and Muhammed, 2001). The Environmental protection Agency (1992), reported that over 80% of all hospitalization from pesticide poisoning was due to organophosphate insecticides.

In this study, the cases of organophosphate poisoning among cases presented to Poison Unit at Emergency Hospital, Mansoura University during the period (July 2003 to January 2005) represented 361 cases (58.79%) as revealed by thin layer chromatography and GC/MS (Fig. l-a) and fig. (2), of which 310 adults cases (85.87%) and 51 children cases (14.13%). These finding are nearly similar to Jeyaratnam et al., (1982); Karalliede and Senanayake, (1988) and Goonasekera et al., (1999) who revealed that organophosphates account for 50% of all cases of acute poisonings.

Fig. (2) shows that all these cases are of parathion insecticide by G.C/MS. analysis. This coincides with Bey et al., 2001 who recognized that parathion is one of the most widely used organophosphate insecticide owing to its insecticidal activity and physiochemical profile. In contradiction, Grace et al., 2000 revealed that the most often used organophosphate insecticide were malathion and dimethoate in Kenya.

The most frequent signs of these cases are miosis, vomiting, abdominal pain, respiratory distress and muscle fasciculation, which coincides with Murat and Muhammed, 2001 findings.

Regarding to the degree of poisoning acoording to pseudo cholinesterase level (PChE) in adults. There are 201 cases (45%) of severe poisoning degree with plasma cholinesterase level <500 (U/L) 76 cases (17%) of moderate poisoning with plasma cholinesterase level 500 - 1000 (U/L) and 33 (7.4%) mild poisoning cases with plasma cholinesterase level 1000-1500 (U/L). The children poisoning cases [n. 51 (30.5%)] were of mild degree. This may be due to the low exposure incidence, time and early hospital arrival. The overall mean levels of cholinesterase enzyme for the total significant cases were categorized

as severe degree poisoning (185.617 ± 61.945 U/L) [n.201 (32.7%], moderate degree poisoning (714.773 ± 104.314 U/L) [n.76 (12.4%)] and mild degree poisoning (1497.9 ± 52.00 U/L) [n.84 (13.7%)].

Our study revealed that the degree of poisoning in children was of mild degree [n.51 (30.5%)] but in adults cases, the majority lie in severe poisoning degree [201 cases (45%)].

These findings don't correlate with the severity of the clinical picture of the patients. This coincides with Olga et al., (1999) who reported that PChE is not specific as AChE activity because it may be depressed owing to genetic deficiency or medical illness.

As regards to red cell AChE activity, the total significant cases were categorized into mild degree poisoning (23.55%), moderate degree poisoning (54.02%) and severe degree poisoning (22.43%). All children cases were of mild degree inhibition (14.13%). This was attributed to the low exposure time and incidence. The majority of adult cases were of moderate degree inhibition (54.02).These findings correlate with the severity of the clinical picture of patients as regard duration and response to treatment. These coincide with the results of Grace et al., (2000) who revealed that there was relation between AChE activity and clinical picture of subjects exposed to insecticides especially eye, respiratory and central nervous system symptoms.

The severity and number of poisoning cases among adults are more than children. This is attributed to occupational exposure, the widespread use of organophosphates in spraying and the lack of protective measures.

In conclusion, results of our study revealed the presence of a relation between AChE activity and the degree of poisoning clinically, the widely used insecticides in Dakhlia are the organophosphorus insecticides specifically parathion insecticide, and the prevalence of insecticides intoxication in adults which is explained by occupational exposure, lack of knowledge, unsafe attitudes, faulty sprayers, lack of protective equipments, and non existent first-aid provisions.

The lack of information at all levels may be one of the most important causative factors of insecticides intoxications.So, development efforts are critically needed in behaviors correction on dealing with insecticides, in safety devices, availability of free first aid measures, and in assessment of workers in the insecticides field by multiple monitoring of them by cholinesterase levels (pre exposure and post exposure) and removal of the worker from the work and not return until the enzyme level re-

turn to 80% of baseline. Insecticides must be kept out of the reach and sight of children and never be stored in food or beverage containers.

On the other hand, we must pay attention to the magnititude of suicide problem by pesticides use. There must be a limitation in easy access of pesticides purchase to anyone. Psychiatric assessment and follow up of these patients are of worthy value in reducing this problem.

Table (1): Distribution of cases of acute organophosphate poisoning presented to Emergency Hospital, Mansoura University according to circumstances of poisoning.

Accidental		Suicidal		Total	
No.	%	No.	%	No.	%
217	60%	144	40%	361	100%

Table (2): Degree of poisoning in adults according to plasma cholinesterase level (U/L).

Mild Poisoning		Moderate Poisoning		Severe Poisoning	
No.	Cholinesterase level (U/L)	No.	Cholinesterase level (U/L)	No.	Cholinesterase level (U/L)
33	1000-1500	76	500-1000	201	<500

Table (3): Degree of Poisoning in children according to plasma cholinesterase level (U/L).

Mild Poisoning	
No.	Cholinesterase level (U/L)
51	1000-1500

Table (4): Overall mean values ± Standard Deviation (S.D.) of plasma Cholinesterase level (U/L) in the total significant cases.

	Mild poisoning	*Moderate Poisoning*	*Severe Poisoning*
	Mean ± S.D	Mean ± S.D	Mean ± S.D
	1497.9 ± 52	714.773 ± 104.314	185.617 ± 61.945
No.	84	76	201
Total	*361*		

Table (5): Frequency for each degree of poisoning in children and adult patients according to plasma cholinesterase level (U/L).

		Degree of poisoning				*Total*
		Negative	Mild	Moderate	Severe	
Childre n	No.	116.0	51.0	0.0	0.0	167.0
	%	69.5	30.5	0.0	0.0	100.0
Adult	No.	137.0	33.0	76.0	201.0	447.0
	%	30.6	7.4	17.0	45.0	100.0
Total	No.	253.0	84.0	76.0	201.0	614.0
	%	41.2	13.7	12.4	32.7	100.0

Table (6): Statistical data of red blood cell acetyl cholinesterase (AChE) activity* in the total significant cases (n.: 361).

	No.	Mean	S.D	Minimum	Maximum
Mild	85	8.628	0.515	8.00	9.80
Moderate	195	6.225	0.853	5.00	7.90
Severe	81	3.898	0.598	2.30	4.90
Total	361	6.269	1.767	2.30	9.80

* Normal red blood cell cholinesterase activity 10.20 μ moles/min./ml. red cells.

Table (7): Frequency for each degree of poisoning in the total significant cases according to red blood cell acetyl cholinesterase (AChE) activity.

		Degree of poisoning			Total
		Mild	Moderate	Severe	
Children	No.	51	0.0	0.0	51
	%	14.13	0.0	0.0	100.00
Adult	No.	34	195	81	310
	%	9.42	54.02	22.43	100.00
Total	No.	85	195	81	361
	%	23.55	54.02	22.43	100.00

Table (8): Degree of poisoning in the total significant cases according to clinical picture, time of response to treatment and number of atropine and toxogonine ampoules.

	Mild	Moderate	Severe
Manifestations	- Vomiting - Abdominal colic Salivation - Miosis	- Vomiting - Abdominal colic Salivation - Miosis - Chest crepitations	- Vomiting - Abdominal colic - Salivation, Sweating - Miosis - Chest crepitations - Bradycardia - Arrhythmias - Pulmonary oedema
Times of response to treatment	2 hours	5 hours	10 hours
Number of atropine ampoules given to patients	24	60	120
Number of toxogonine ampoules	____	3	3

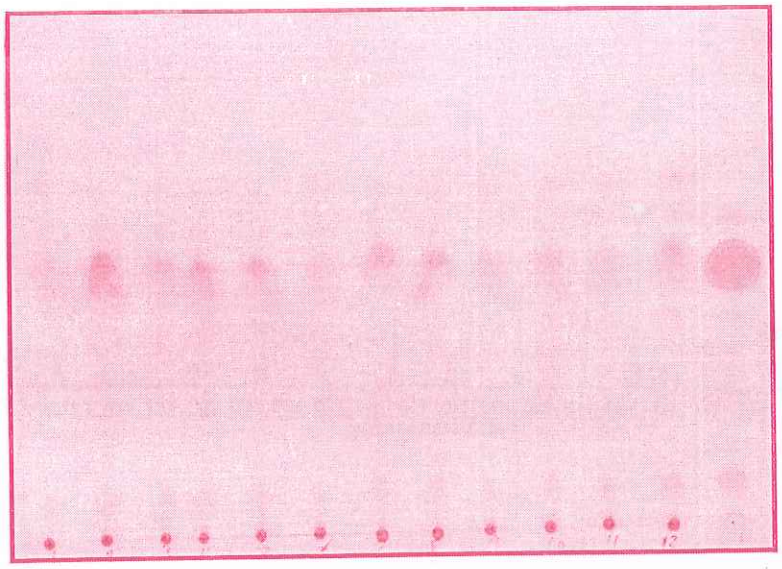

Fig. (1-a) shows a photographic picture of a TLC plate of positive organophosphorus poisoning cases.

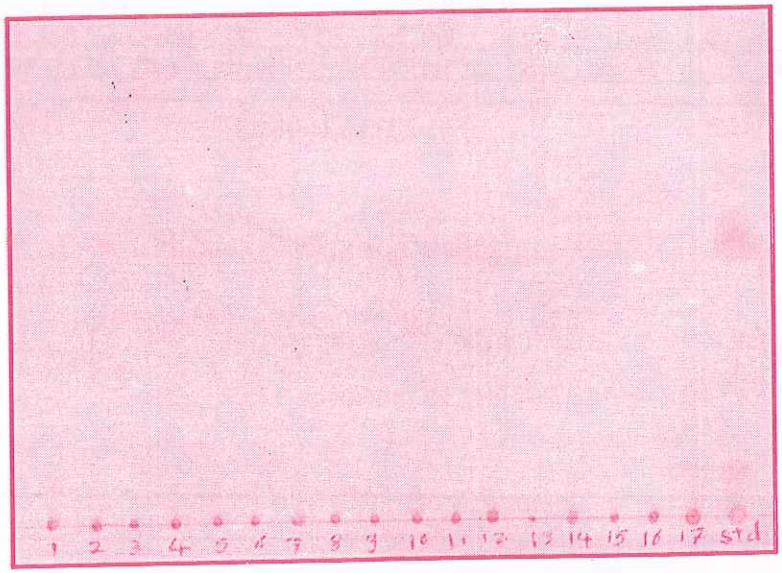

Fig. (1-b) shows a photographic picture of a TLC plate of negative organophosphorus poisoning cases.

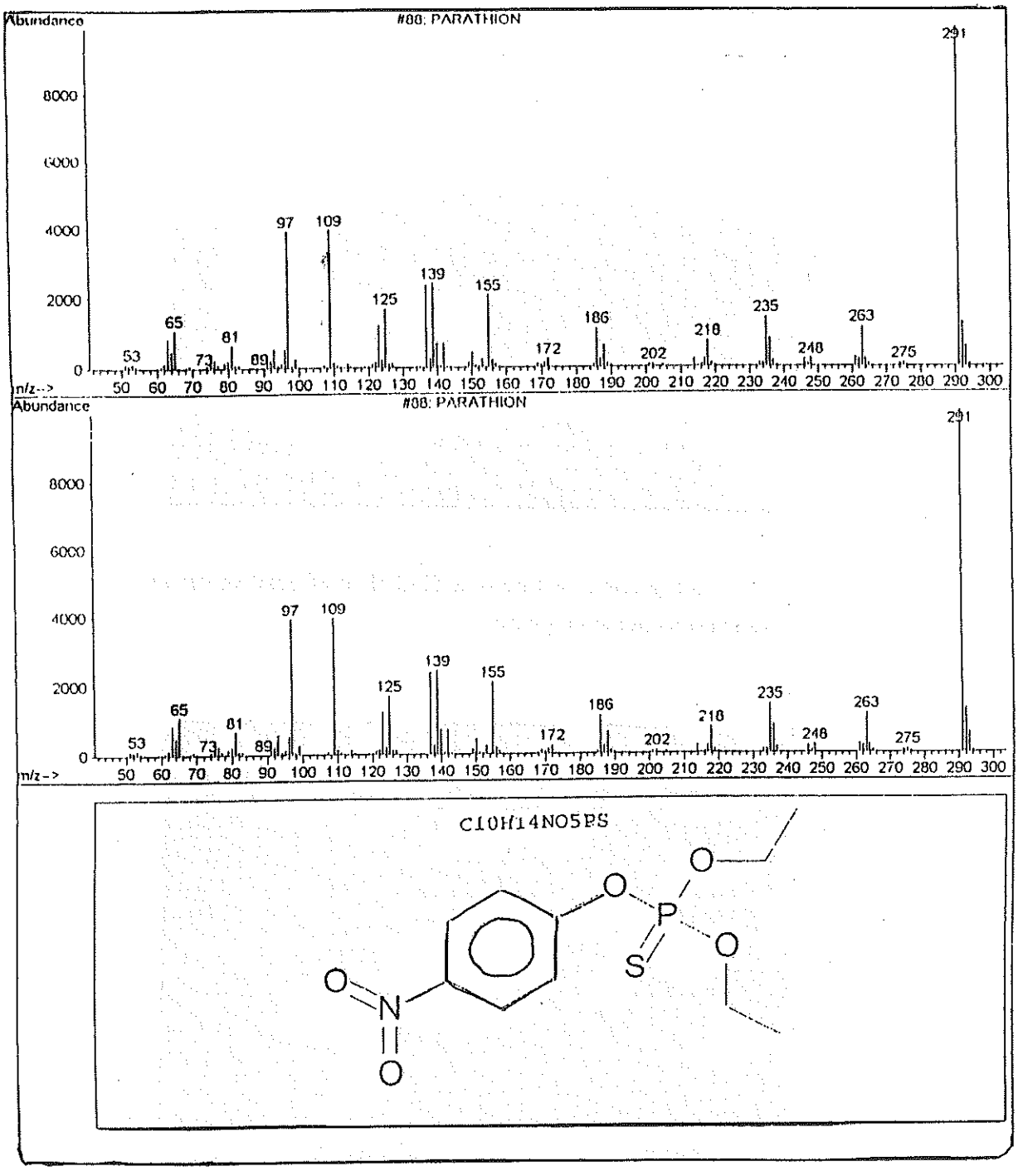

Fig. (2) : Spectra and structure of parathion.

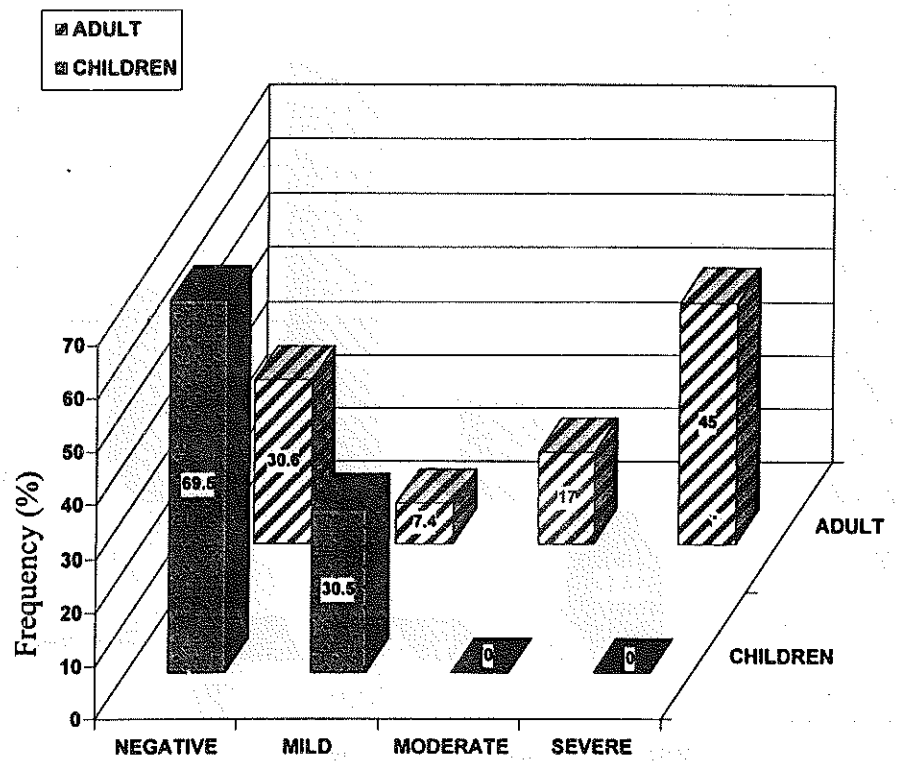

Fig. (3) : Frequency for each degree of poisoning in children and adult patients according to plasma cholinesterase level (U/L).

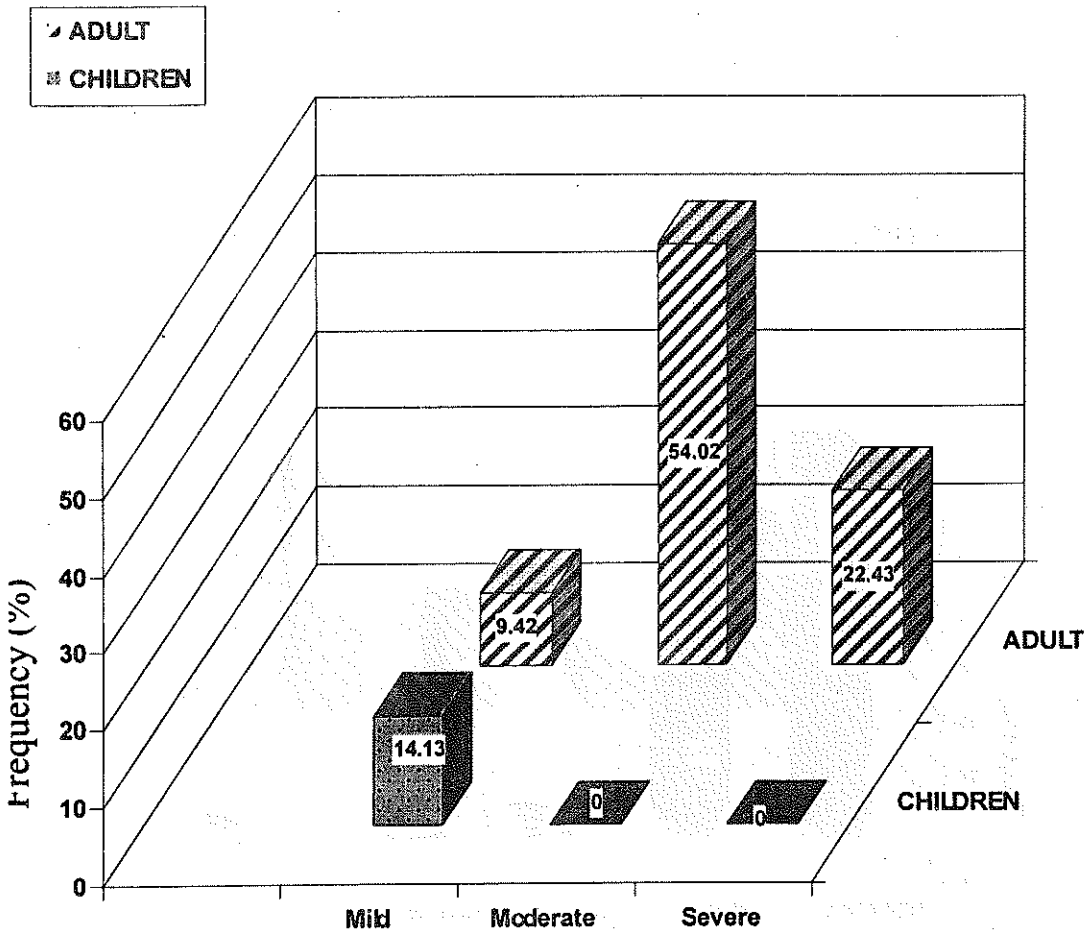

Fig. (4) : Frequency for each degree of poisoning in the total significant cases according to red blood cell acetyl cholinesterase (AChE) activity.

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تقييم التسمم بالمبيدات الحشرية الفوسفورية العضوية فى وحدة السموم - فى مستشفى الطوارىء - جامعة المنصورة

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تحتل المبيدات الحشرية إهتماماً خاصاً فى حياتنا اليومية من حيث كبح الحشرات أو كأخطار بيئية، المبيدات الفسفورية العضوية من أكثر المبيدات الشائعة الإستعمال فى الصناعة والزراعة والمنازل، لذا تهدف هذه الدراسة إلى تقييم حالات التسمم بالمبيدات الحشرية الفوسفورية العضوية فى مستشفى الطوارىء - جامعة المنصورة خلال فترة ثمانية عشر شهراً من يوليو ٢٠٠٣م إلى يناير ٢٠٠٥م وقد أجريت هذه الدراسة على عدد ٦١٤ مريض (٤٤٧ حالة من الكبار، ١٦٧ حالة من الأطفال) أدخلوا جميعاً وحدة السموم بمستشفى الطوارىء وتم تشخيصهم إكلينيكياً كتسمم بالمبيدات الحشرية، وتم تحليل إنزيم الكولين إستراز فى البلازما، وفى كرات الدم الحمراء، وتم تحديد المبيدات باستعمال جهاز التحليل الكروماتوجرافى بالطبقة الرقيقة والكروماتوجرافى بمطياف الكتلة، وقد أظهرت النتائج وجود ٣٦١ حالة من الحالات الكلية (٣١٠ حالة من الكبار و٥١ حالة من الأطفال) تسمم بالمبيد الحشرى الفوسفورى العضوى (الباراثيون)، وقد تم التسمم عرضياً عن طريق الاستنشاق والتلامس بالجلد (٢١٧ حالة (٦٠٪))، وانتحارياً (١٤٤ حالة (٤٠٪)).

وصنفت الحالات تبعاً لمستوى البلازما كولين إستراز إلى شديدة السمية بتركيز الكولين إستراز ١٨٥,٦١٧، ومتوسط السمية بتركيز الكولين إستراز ٧١٤,٧٧٣، وبسيط السمية بتركيز الكولين إستراز ١٤٩٧,٩.

وتم تصنيف الحالات تبعاً لمستوى الكولين إستراز فى كرات الدم الحمراء إلى شديدة السمية بتركيز الكولين إستراز ٣,٨٩٨ ومتوسط السمية بتركيز الكولين إستراز ٦,٢٢٥، وبسيط السمية بتركيز الكولين إستراز ٨,٦٢٨

وقد توافق مستوى الكولين إستراز فى كرات الدم الحمراء مع الحالة الإكلينيكية للمرضى أكثر من مستوى الإنزيم فى البلازما، ولذلك صنفت الحالات الإيجابية تبعاً لمستوى الكولين إستراز فى كرات الدم الحمراء إلى بسيطة السمية (٢٣,٥٥٪)، ومتوسطة السمية (٥٤,٠٢٪)، وشديدة السمية (٢٢,٤٣٪).