



# Clinical Epidemiology and Treatment Outcome of Monocrotophos Poisoning: A Seven Year Prospective Study

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## KEYWORDS

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## ABSTRACT:

### Background

Monocrotophos is classified in the WHO Class Ib and considered as highly toxic pesticide. Monocrotophos is an organophosphorus compound used for protection of rice, banana, cotton, citrus and vegetables from wide spectrum of insects. Monocrotophos is toxic in all routes of exposure, it is cheap and easily available, so the risk of exposure and toxicity is high. Published systematic study on the clinical epidemiology and treatment outcome of monocrotophos poisoning is scarce.

### Methodology

This patient record based cross-sectional study was carried out in 34 patients with monocrotophos poisoning to find out the outcome of treatment expressed as duration of stay in hospital, disability and death. International Programme on Chemical Safety (IPCS) poison severity score was used to find out the severity of poisoning at the time of admission.

### Results

The poisoning due to monocrotophos constituted 2.95% of the poisoning cases and 5.26% of organophosphorus poisoning during the study period. The mean age of patients in monocrotophos poisoning was  $35.26 \pm 12.86$  years with a range of 18 to 65 years. There was male predominance. Majority of the patients were agricultural workers and farmers by occupation (18, 52.94%). The mean duration of stay in hospital is  $10.53 \pm 5.60$  days. Out of 34 patients, 26 (73.52%) recovered and 8 (26.47%) succumbed. Monocrotophos poisoning along with alcohol was associated with a higher odds of mortality (OR 42, 95% CI 4.05-435.03).

### Conclusion

Monocrotophos is a highly toxic compound, the consequences of poisoning being fatal.

## Introduction

Monocrotophos, chemically known as 4-(methylamino)-4-oxobut-2-en-2-yl ester of dimethyl phosphate is commercially available as reddish-brown solid [1]. As per WHO Recommended Classification of

Pesticides by Hazard and the Guidelines to Classification, monocrotophos is classified in the WHO Class Ib and considered as highly toxic pesticide [2]. Agriculture is major component of Indian economy and is major livelihood of major portion of Indian



population. Increased production of food grain is priority for hunger of expanding population in India. Various pesticides with varying degree of toxicity are used for reducing crop damage by pest and increase the yield. Monocrotophos is an organophosphorus compound used for the protection of rice, banana, cotton, citrous and vegetables from wide spectrum of insects. It is toxic in all routes of exposure, cheap and easily available, so the risk of exposure is high. The acute oral LD50 is 15 mg/kgbw. U.S. Environmental Protection Agency has reported that probable oral lethal dose to humans 5-50 mg/kg or between 7 drops and 1 teaspoon for a 70 kg (150 lb.) person [3, 4]. In addition to its typical organophosphate poisoning effect, it is also reported to be neurotoxic [5].

Uncontrolled application of monocrotophos in farming has led to the contamination of surface and groundwater, causing neurotoxicity, genotoxicity, hyperglycaemic and stressogenic effects on different organisms [6]. Monocrotophos poisoning is associated with accidental and self-harm intent. In a case report from Gujarat, India mass poisoning due to monocrotophos have been reported due to accidental ingestion of contaminated millet flour (so called bavta) [7]. In another report, Chhapra, Bihar, India, 23 children died and more than 48 were hospitalized due to poisoning consequent upon the consumption of a freely provided lunch cooked with oil contaminated with monocrotophos [8, 9]. *Bodwal J et al* have reported fatal accidental monocrotophos poisoning in an adult female by dermal exposure while sleeping [10].

Although it is a toxic compound, but there is no systematic study published on the clinical epidemiology and treatment outcome of monocrotophos poisoning except for a few case reports. With this background the present study was carried out to find the clinical epidemiology and treatment outcome of monocrotophos poisoning.

## Methodology

This is a patient record based cross-sectional study conducted by the Department of Clinical Pharmacology, Konaseema Institute of Medical Science and Research Foundation, Amalapuram, Andhra Pradesh India during a period from May 2012 to April 2021.

### *Study setting and representativeness*

Patients of all age group and either gender confirmed with monocrotophos poisoning as evidenced by empty

container or photograph of empty container of drug consumed were enrolled for this study. The case records of the patients admitted during the study period with organophosphorus poisoning were screened and 34 patients with monocrotophos poisoning were included in this study. The demographic and clinical findings were recorded in a pre-designed Case Record Form. Age, gender, occupation, marital status, socio-economic status, region, amount of poison consumed as informed by the patient or the attendant, the intention of poisoning, and time elapsed for the first visiting a hospital was recorded. Biochemical and haematological parameters like complete blood counts, urea, creatinine, liver function test, serum electrolyte were recorded at time of admission and on the third day of poisoning were also recorded. Plasma choline esterase level was estimated at time of admission. Outcome of treatment was expressed as duration of stay in hospital, disability and death. International Programme on Chemical Safety (IPCS) poison severity score was used to calculate severity of poisoning [11]. The data were analysed using GraphPad Prism trial version 7.0. Descriptive statistics was used to present the data. Mean $\pm$ standard deviation was used to represent continuous data. Frequency and percentage was used for the presentation of categorical data. Chi square test and odds ratio were used to find out the association between the independent and outcome variables. Paired sample t test was used to test the significance of difference in continuous variables. A p value of  $\leq 0.05$  was considered as statistically significant. The study was approved by the Institutional Ethics Committee, Konaseema Institute of Medical Science, Amalapuram India.

## Results

There were 34 cases of monocrotophos exposures in a period of seven years. This accounted for the 5.26% of all organophosphorous poisoning cases and 2.95% of the total pesticide poisoning cases during the period. The mean age of patients was  $35.26 \pm 12.86$  years with a range from 18 to 65 years. There was a male predominance 30 (88.23%). Most of the patients were agricultural workers or farmers by occupation 18 (52.94%). Students constituted 8 (23.52%) patients and 3 (7.89%) were homemakers. Majority (20, 58.82%) patients were married. Poisoning was intentional in all the patients. The mean time elapsed for the first visit to the hospital was  $244.61 \pm 76.09$  minutes. The mean



amount of poison consumed was  $65.83 \pm 50.36$  ml. The IPCS poison severity score at the time of admission was zero in 5.88% patients, one in 41.17% patients, two in 17.64% patients, three in 11.76% and four in 23.52%. The mean duration of stay in hospital is  $10.53 \pm 5.60$  days. Out of 34 patients, 9 (26.47%) died, rest of the patients recovered without any disability. [Table 1]

Analysis of clinical presentation showed that, 18 (52.49%) patients presented with vomiting, 10 (29.41%) cases had diarrhoea, 14 (41.47%) had increased salivation. Pain abdomen was presenting symptom in 8 (23.52%) patients. Dyspnoea was seen in 8 (23.52%) patients. Palpitation was observed in 6 (17.64%) patients where as tremor was seen in 2 (5.88%). 4 (11.76%) and 9 (26.47%) patients had bradycardia and tachycardia respectively. Seizure was observed in 2 (5.88%) patients. 3 (8.88%) patients were unconscious at the time of admission. ECG changes was present in 11.76% patients, crepitation was present in 17.76% patients and 11.76% patients have muscle weakness. [Table 2]

Mean TWBC count was  $10.6 \pm 2.61 \times 10^9$  cells per liter at the time of admission and  $11.17 \pm 2.77 \times 10^9$  cells per liter after 72 hours of admission. Mean TRBC count was  $4.46 \pm 0.38 \times 10^{12}$  cells per liter at the time of admission and  $4.28 \pm 0.48 \times 10^{12}$  cells per liter after 72 hours of admission. The mean platelet count was  $2.87 \pm 0.66 \times 10^{11}$  per liter at the time of admission and  $2.74 \pm 0.47 \times 10^{11}$  per liter after 72 hours of admission. But the difference in TWBC, TRBC, platelet count was statistically not significant. The difference in the values of the hepatic and renal profile of patient at the time of admission and after 72 hours of admission was not statistically significant. Serum electrolyte concentration was comparable to each other at the time of admission and after 72 hours after admission. [Table 3]

Analysis of the relationship between number of patients with IPCS poison severity score and time elapsed for the first visit to the hospital showed that, 19 patients were brought to hospital within 2 hours of consumption of poison and out of them 2 patients had IPCS score zero. IPCS score was 4 in 2 patients. Time elapsed for first visit to hospital ranged between 2 to 4 hours in 8 patients and IPCS severity score was 4 in two of these patients. 8 patients were brought to hospital after 4 hours, IPCS severity score was 4 in four of these patients. In present study, in 15 patients volume of poison consumed was less than 20 ml and IPCS score

was 2 in 12 patients. Volume of poison consumed was 21 ml to 100 ml in 10 patients. Among them IPCS score was 1 in two patients, 2 in 5 patients, 3 in 2 patients and 4 in 1 patient. Volume of poison consumed was more than 100 ml in 9 patients, among them IPCS score was 4 in seven such patients. [Table 4] It was observed that 12 patients had consumed alcohol with monocrotophos, among them 8 died. Further, 22 patients had consumed monocrotophos without mixing in alcohol and among them only one patient died. The association between monocrotophos consumption with alcohol and mortality was statistically significant ( $p \leq 0.05$ ). The odds of mortality in monocrotophos poisoning with alcohol was 42 ( $p = 0.0017$ , 95% CI 4.05-435.03). [Table 5] After psychiatric assessment it was found that 26 (76.47%) patients were impulsive, 4 (11.76%) had depression, stress in 2 (5.88%) and anxiety was diagnosed in 2 (5.88%) patients. [Table 6]

### Discussion

Organophosphorus poisoning is major health emergency in developing countries where agriculture is major means of livelihood. There are various types of organophosphorus compounds used for pest control with different grade of toxicity. Use of a particular type of compound depends upon the crop cultivated and nature of pest attacking. Monocrotophos is an organophosphorus compound used for protection of rice, banana, cotton, citrous and vegetables from wide spectrum of insects [13, 14]. In present 34 patients with monocrotophos poisoning were included. The mean age of patients was  $35.26 \pm 12.86$  and most of the patients were between 26 to 50 years of age with male predominance. Most of them were farmer by occupation and married. All patients consumed poison with a suicidal intent. In a study by *Dash SK et al* done in the state of Odisha, India they have also reported that organophosphorus poisoning was common in young people with a male predominance and in 97% patient it was of suicidal intent [15]. *Banday TH et al* in their study done in Karnataka have reported that 80% of the cases were young people less than 40 years of age and were predominantly males [16]. In the study by *Banerjee I et al*, they have reported that females outnumbered males and majority of the patients were housewives (42%) followed by farmers (33.99%) [17]. This finding is not in agreement with our study. The differences may be due to different socio-demographic



profile of the study populations. It was observed that the mean duration of time elapsed for first visit to the hospital was  $244.61 \pm 76.09$  minutes. *Rajesh Kumar M et al* in a study done in Nellore, Andhra Pradesh has reported that the mean amount of poison consumed was  $65.83 \pm 50.36$  ml and the mean time elapsed to receive treatment was  $5.2 \pm 7.4$  hours (range 1-48 h) [18]. *Abdel Baseer, K.A. et al*, in their study done in Egypt have reported that mean time (in hours) from poisoning exposure to presentation in emergency unit was  $6.06 \pm 3.12$  (range 1-36 hours) [19]. These difference in the time elapsed for visiting a hospital in different studies may be due to varied health infrastructure and awareness of people about poisoning in different study settings. In the present study the mean amount of poison consumed was  $65.83 \pm 50.36$  ml. *Banday TH et al* have reported that the amount of organophosphorous compound consumed in their study ranged from 10 ml to 200 ml with a mean 77.5 ml which is along the observations of the present study is in agreement with our study [16]. Vomiting and salivation were the most common symptoms. Tachycardia was more common than bradycardia. *Banday TH et al* have also made a similar observation [16]. There was no significant change in biochemical and metabolic profile in patients exposed to monocrotophos in our study. This is similar to the observation in the study by *Patel et al* done in Gujarat India [7]. Patients brought late to the hospital and who had consumed large amount of poison had a higher IPCS score. *Boedeker, W et al* and *Davies JO et al* also had a similar observation [20, 21].

Regarding consumption of monocrotophos mixed with alcohol, it was observed that 12 patients were consumed monocrotophos poison along with alcohol and among them 66.67% died. We did not find any literature to support the effect of co-ingestion of alcohol with monocrotophos. *Warriner RA 3<sup>rd</sup> et al* have reported that co ingestion of alcohol with organophosphorus compound increases the duration of hospital stay [22]. *Dhanarisi HKJ et al* have reported that alcohol consumption, old age are independently associated with worse outcome in patients' self-poisoned with profenofos [23]. *Eddleston M et al* have reported that alcohol co-ingestion is associated with higher plasma concentrations of dimethoate and increased risk of death [24]. *Lee, Y.H et al* in their multi-centric study have reported that blood alcohol concentration of more than 173 mg/dL during organophosphorous poisoning is a

major risk factor for mortality [25]. These findings indirectly support the observations of the present study. The mean duration of stay in hospital was  $10.53 \pm 5.60$  years. Out of 34 patients 26 (73.52%) recovered and 8(26.47%) died. Monocrotophos is a highly toxic compound and multiple incidences of accidental poisoning death has been reported from various part of India [7, 8, 9, 10]. On psychiatric assessment it was found that 26 (76.47%) patients were impulsive, 4(11.76%) had depression and stress was diagnosed in 2 (5.88%) cases. These findings were similar to the observations made in the study by *Christine L et al* [26].

## Conclusion

Monocrotophos is used for the protection of commonly grown crops from a wide variety of pests. It causes poisoning through all routes of exposure resulting in significant mortality and hospital stay. A population based study in contrast to the hospital based study is essential to reveal the actual problem of poison exposure, intoxication and treatment outcome. Since, male agricultural workers belonging to younger age group are predisposed to suicidal poisoning; safe handling and limiting access to the pesticide, sensitization, counselling through mental health programs are needed to be targeted towards this vulnerable group.

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### Tables

**Table 1: Demographic profile of patients with monocrotophos poisoning**

Variable		Number (%)
Age (years)	Less than 25	10 (29.41)
	26 to 50	16 (47.05)
	More than 50	8 (23.52)
Gender	Male	30 (88.23)
	Female	4 (11.76)
Occupation	Student	8 (23.52)
	Housewife	3 (7.89)
	Farmer	18 (52.94)
	Others	5 (14.70)
Marital status	Unmarried	14 (41.17)
	Married	20 (58.82)
Intent of poisoning	Suicidal	34 (100)
	Accidental	0 (0)
	Homicidal	0 (0)
Time elapsed from first visit to the hospital(in minutes)		244.61±76.09
Amount of poison consumed in ml (Mean ± SD)		65.83±50.36
IPCS poison severity score	0	2 (5.88)
	1	14 (41.17)
	2	6 (17.64)
	3	4 (11.76)



	4	8 (23.52)
Treatment outcome	Recovered	25(73.52%)
	Death	9(26.47%)
	Disability	Nil

Table 2: Clinical presentation of patients with monocrotophos poisoning

Presentations		Number (percentage)
Vomiting		18(52.49)
Diarrhoea		10(29.41)
Increased salivation		14(41.47)
Pain abdomen		8(23.52)
Dyspnoea		8(23.52)
Palpitation		6(17.64)
Tremor		2(5.88)
Change in heart rate	Bradycardia	4(11.76)
	Tachycardia	9(26.47)
Loss of consciousness		3(8.82)
Seizure		2(5.88)
Stupor		2(5.88)
ECG changes		4(11.76)
Crept in chest		6(17.64)
Muscle weakness		4(11.76)

Table 3: Biochemical and Haematological parameters of patients with monocrotophos poisoning

Variables		At Admission	After 72 Hours	p value (paired sample t test)
TWBC (in $\times 10^9$ cells per liter)		10.6 $\pm$ 2.61	11.17 $\pm$ 2.77	.33
TRBC (in $\times 10^{12}$ cells per liter)		4.46 $\pm$ .38	4.28 $\pm$ 0.48	.29
Platelet count (in $\times 10^{11}$ per liter)		2.87 $\pm$ .66	2.74 $\pm$ .47	.30
Serum bilirubin (in mg/dl)		1.11 $\pm$ .34	1.02 $\pm$ 0.21	.25
AST (in units/liter)		51.3 $\pm$ 14.73	49.80 $\pm$ 13.16	.37
ALT (in IU/liter)		60.41 $\pm$ 12.46	56.12 $\pm$ 13.16	.14
ALP (IU/liter)		83.05 $\pm$ 16.56	81.55 $\pm$ 17.67	.39
Serum creatinine (in mg/dl)		.97 $\pm$ .11	1.02 $\pm$ .15	.10
Serum urea (in mg/dl)		28.12 $\pm$ 4.21	29.87 $\pm$ 3.98	.45
Electrolyte	Serum sodium (in mEq/L)	140.21 $\pm$ 5.41	138.21 $\pm$ 4.12	.64
	Serum potassium (in mmol/L)	3.80 $\pm$ .47	3.63 $\pm$ 0.49	.14



	Serum chloride (in mEq/L)	106.55±4.37	106.2±3.48	.39
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**Table 4: Relation between number of patients with IPCS poison severity score, time elapsed from the first visit to the hospital and amount of monocrotophos poison consumed**

			IPCS* poison severity score				
			0	1	2	3	4
<b>Time elapsed from 1<sup>st</sup> visit to hospital</b>	Less than 2 hours	Number of patients	2	10	4	1	2
	2 to 4 hours		0	4	1	1	2
	More than 4 hours		0	1	1	2	4
<b>Amount of poison consumed</b>	Less than 20 ml	Number of patients	2	12	1	0	0
	21ml to 100 ml		0	2	5	2	1
	More than 100 ml		0	0	0	2	7

\*IPCS = International Programme on Chemical Safety

**Table 5: Association between consumption of monocrotophos with alcohol and outcome**

	Death	Survived	Yates' chi square & p value Odds ratio
Monocrotophos consumption with alcohol (n=12)	8	4	12.369 p ≤ 0.05  OR = 42 (95% CI 4.05-432.03)
Monocrotophos consumption without alcohol (22)	1	21	

**Table 6: Psychiatric assessment of the patient with monocrotophos poisoning**

Types of disorder		Number(%)
Impulsive		26(76.47)
Non impulsive	Depression	4(11.76)
	Anxiety	2(5.88)
	Stress	2(5.88)
	Other psychiatric illness	0