

## ORIGINAL ARTICLE

# The Estimation of Pesticide Retrieved by Gastric Lavage in Acute Organophosphorus Poisoning

INDIRA M<sup>\*1</sup>, USHANAGADEVI CS<sup>1</sup>, AKHILA PRASAD<sup>1</sup>, SREEJITH PN<sup>1</sup>, ANDREWS MA<sup>2</sup>

<sup>1</sup>Department of Medicine, Government Medical College, Thrissur, Kerala, India.

<sup>2</sup>Department of Medicine, PK Das Institute of Medical Science, Palakkad, Kerala, India.

## Abstract

**Objective:** There is insufficient evidence on the effectiveness of gastric lavage in organophosphorus poisoning. This study was done to quantitate the level of chlorpyrifos and quinalphos retrieved in gastric lavage fluid.

**Methods:** Patients presenting within six hours of ingesting quinalphos or chlorpyrifos with International Program on Chemical Safety Poison Severity Score (IPCS PSS) grade 2 or more were included in the study. After the stabilisation of patients, gastric lavage was performed with aliquotes of 200 ml of normal saline till aspirate became clear. Quantification of the pesticide was done in the first 10 ml of lavage fluid aspirated out and in blood with gas chromatography with triple quadruple mass spectrometer (GC-MSMS).

**Results:** There were six patients in each pesticide group. Mean time for reaching hospital after the ingestion of pesticide was  $2.8 \pm 1.1$  (range 1.25-6) hours. Median quantity of chlorpyrifos in the lavage fluid was 10.24 (IQR 14.36)  $\mu\text{g/L}$  and in quinalphos, it was 1360.62 (IQR 1691.2)  $\mu\text{g/L}$ . Other compounds detected in lavage fluid and confirmed in blood were endosulfan, diazinon, pirimiphos, pyridafenthion, pyrazophos, pirimiphos ethyl, and azinphos.

**Conclusion:** Chlorpyrifos and quinalphos are detected in lavage fluid after one hour of ingestion and few milligrams are retrieved by gastric lavage. The presence of other pesticides including endosulfan were confirmed in lavage fluid.

**Keywords:** Organophosphate Poisoning, Chlorpyrifos, Quinalphos, Gas Chromatography

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## INTRODUCTION

Suicide death in India was calculated as 187000 in 2010 and was among the highest suicide death rates in the world. Pesticide self-poisoning remains the major cause of suicide in India, mainly organophosphorus (OP) pesticides [1]. Easy availability of highly hazardous pesticides in the market and lack of good critical care settings in many parts of the country increase the mortality in pesticide poisoning in India [2,3].

To bring down the mortality, the standardisation of treatment protocols, the availability of antidotes, and infrastructure development are the most significant requirements [4]. Treatment protocols followed in Indian hospitals are in agreement with the internationally accepted protocols except in the widespread use of gastric lavage for management of poisoning [5,6]. As per Indian penal code, the collection of stomach sample is one of the medicolegal duties of the treating physician [7]. The idea of removing poison from stomach by gastric lavage seems to be an option for further reduction of poison absorption and hence the disease severity. Because of these two reasons, gastric lavage is routinely done in India in the management of poisoning unless contraindicated as in corrosive or hydrocarbon ingestions [8].

There were many adverse events reported following gastric lavage like aspiration pneumonia, electrolyte imbalance, and cardiac arrhythmias [9]. However, there is lack of good quality evidence for the beneficial effects of gastric lavage in the management of poisoning. Position statement on gastric lavage states that gastric lavage should not be done routinely and if at all, lavage is to be done, it should be advised by an expert in the procedure [10]. These conclusions were mainly based on animal and volunteer studies done in tablet ingestion.

Since organophosphates cause high mortality in India, poisoning with OP pesticides become one of the situations where gastric lavage may be indicated as per position paper statement [11]. But the time period up to which OP pesticides remain in stomach and the amount that can be retrieved by gastric lavage are not well documented. This study was done to determine whether Chlorpyrifos and Quinalphos were present in the stomach after 1 hour of ingestion and to quantitate the level of pesticides retrieved in gastric lavage fluid. Chlorpyrifos and Quinalphos were chosen because they were the commonly identified organophosphorus pesticides used for deliberate self-poisoning in our area and are fatal. The novelty of the study is that there is no published study on estimation by gas chromatography of organophosphorus pesticide retrieved by gastric lavage.

\*Correspondence to: Indira M, M.D, Associate Professor, Department of Medicine, Government Medical College, Thrissur, Kerala, India. Pin – 680596  
Tel: +91 9446542120, Email: drindirarun76@gmail.com

## METHODS

The study was conducted in an 1800-bedded tertiary care centre in South India since June 2019 to December 2019. Consecutive patients admitted with alleged history of ingesting Chlorpyrifos or Quinalphos and presented within six hours of ingestion were included in the study. Patients presented after six hours of ingestion were excluded as most of the guidelines say lavage will be effective within one hour of ingestion and may be beneficial up to four hours [12,13]. The ingestion of compounds were further confirmed by the presence of cholinergic signs, from the bottle of pesticide and/or from reference letter. The severity of poisoning was assessed by the scoring system IPCS PSS at presentation and those with score of 2 or more were included in the study in order to confirm significant poisoning [14]. Informed consent was obtained from all patients or immediate relatives (if patient was unconscious). Ethical clearance was obtained from Institutional review board. In India, gastric sample is collected from all poisoned patient for toxicological analysis as a part of medicolegal procedure. This procedure is performed with or without gastric lavage. Other gastric decontamination methods like ipecac, cathartics, and whole bowel irrigation are not used in our centre.

It is essential to note that all patients were given standard treatment. After stabilizing their general condition and administering atropine to dry up secretions, gastric lavage was done through a nasogastric tube (NGT). Intubation was done in patients with GCS 8 or less to secure the airway. Gastric contents were aspirated out if there was free flow or after giving 200 mL normal saline through NGT. Initial 10 mL sample was taken for analysis. Further aliquots of 200 mL of saline were given and the liquid was drained by gravity or aspirated out repeatedly till the infused quantity was aspirated out. This cycle was repeated till the aspirate was clear and free of smell of pesticide. Activated charcoal (1 gm/Kg body weight) was given through NGT after the completion of gastric lavage. A blood sample was also taken for the confirmation of exposure.

Sample preparation and analysis were done by gas chromatography with triple quadruple mass spectrometer (GC MSMS) for pesticide residues as per AOAC 2007.1. Ten ml lavage sample was treated with MgSO<sub>4</sub> and NaCl (4:1 by weight) to remove the water content and vortexed well for five minutes. Acetonitrile (3 ml) was added to this solution and centrifuged. One ml of supernatant was transferred to tubes, which was deep freeze at -80 degree till analysis. Gas chromatograph details were as follows: TG-5MS (30 meters), Oven temperature : 60 to 280 degree Celsius, run time 24.34 minute and injection volume 1 microlitre. GC MSMS machine was programmed to quantitate 12 organophosphorus compounds and 16 organochlorine compounds (Table 1). Among these pesticides, Chlorpyrifos and Quinalphos are commonly used for deliberate self-poisoning. Co-ingested compounds other than programmed could not be identified. The effectiveness of lavage was defined as the presence of identifiable quantity of pesticide in lavage fluid by GC MSMS.

Patient details and estimation results were entered into Microsoft excel and analysed using Epi info version 7.

**Table 1. Pesticides detected by GC MSMS**

Organophosphorus compounds	Organochlorine compounds
Diazinon	Hexachlorobenzene
Isazophos	α Lindane, β Lindane, γ Lindane
Chlorpyrifos-methyl	Heptachlor
Fenitrothion	Aldrin
Pirimiphos-methyl	Heptachlor epoxide
Quinalphos	Trans-chlordane
Pyridafenthion	Cis-chlordane
Phosmet	pp-DDE
Azinphos-methyl	Endosulfan I
Pyrazaphos	Dieldrin
Azinphos-ethyl	op-DDT
Phosalone	Endrin
	op-DDD
	Endosulfan II
	pp-DDT
	Endosulfan sulfate

## RESULTS

A total of 12 patients were included in the present study of which there were six patients in each pesticide group. Study participants were two women (16.7%) and ten men (83.3%). Mean age of study population was 54.08 ± 12.08 years. Median volume of pesticide ingestion was 50 (IQR 25) ml. The number of patients in each pesticide group is presented in table 2.

Six patients (50%) received prior treatment and lavage before reaching our hospital. No patient presented within one hour of ingestion. Nine patients presented between one and four hours. Three patients presented between four and six

**Table 2. Number (%) of patients in each pesticide group**

	Chlorpyrifos	Quinalphos
Males	5 (83.33%)	5(83.33%)
Females	1(16.7%)	1(16.7%)
Mean age (±SD) in years	49.8 ± 16.4	58.8 ± 3.3
Lag time * less than 1 hour	0	0
(1-4 hours)	4(66.67%)	5(83.33%)
(4-6 hours)	2(33.33%)	1(16.7%)
IPCC PSS grade 2	3	0
Grade 3	3	6
Mechanical ventilation	5(83.33%)	6 (100%)
Survival	3 (50%)	1 (16.7%)
Prior lavage	4 (66.67%)	2 (33.33%)

\*Lag time: time taken to reach our hospital after pesticide ingestion

**Table 3. Details of each pesticide group**

	Chlorpyrifos	Quinalphos
Median (range) quantity ingested	50 (25-100) ml	62.5 (50-100)ml
Median (IQR) quantity of pesticide in lavage	10.24 (14.36)µg/L	1360.62(1691.2) µg/L
Median quantity (lag time <4hours)	9.22(55.17) µg/L	1698.72 (1438.57) µg/L
Median quantity (lag time more than 4 hours)	15.32 (12.31) µg/L	1.24 (0)µg/L
Median quantity of pesticide (with prior lavage)	14.29 µg/L	7040.51 µg/L
Median quantity of pesticide (with no prior lavage)	10.24 µg/L	1234.31 µg/L

**Table 4. The quantity of pesticides retrieved in each case**

Serial number	Lag time in minutes	No of cycles of lavage	Quantity of pesticide	Outcome	Other compound detected
Chlorpyrifos					
1	360	3	21.475 µg/L	expired	Diazinon (18.685 µg/L)
2	360	3	9.168 µg/L	Survived	Pirimiphos ethyl (204.5 µg/L), Pyridafenthion(23.76 µg/L)
3	75	3	7.12 µg/L	Survived	nil
4	120	3	11.32 µg/L	survived	Endosulfan II (679 µg/L)
5	190	3	110.78 µg/L	Expired	Nil
6	210	3	4.635 µg/L	expired	Endosulfan I (4.573 µg/L)
Quinalphos					
1	205	4	2461.095 µg/L	Expired	Pyrazophos (9.901 µg/L)
2	120	5	13058.49 µg/L	survived	Chlorpyrifos (7.15 µg/L), Endosulfan II (509.6 µg/L)
3	120	3	1698.712 µg/L	Expired	nil
4	80	3	1022.534 µg/L	Expired	Diazinon (176.451 µg/L), Pirimiphos ethyl (132.338 µg/L), Azinphos ethyl (7.463 µg/L)
5	180	3	769.9 µg/L	Expired	Nil
6	300	3	1.242 µg/L	Expired	Diazinon (7.273 µg/L), Endosulfan II (1254.4 µg/L)

hours of ingestion. Mean time taken to reach our hospital after ingestion of pesticide (lag time 1) was  $2.8 \pm 1.1$  hours. Three patients were grade 2 and nine patients were grade 3 at presentation according to IPCS PSS grading system. Mean time taken for lavage sample collection after ingestion (lag time 2) was  $3 \pm 1.4$  hours. Blood samples collected simultaneously confirmed the presence of pesticides in blood.

In the study group, eight patients (66.67%) expired. All patients received ICU care and 11 patients required mechanical ventilation. Three out of 12 patients (25%) developed aspiration pneumonia.

Pesticide was detected in all lavage samples including those received gastric lavage from outside (Table 3). The details of quantification of pesticide is provided in Table 4.

## DISCUSSION

The study was conducted to document the amount of OP pesticide removed by gastric lavage. 12 patients were recruited with alleged history of Chlorpyrifos or Quinalphos ingestion with moderate to severe cholinergic features. Both Chlorpyrifos and Quinalphos are diethyl OP compound and

belong to WHO class II pesticides [15]. Both are lipophilic compounds and likely to remain in stomach for more time than hydrophilic compounds [16].

Most of the patients in our study were middle aged and elderly and were in high grade clinical severity at presentation according to IPCS PSS. Mean time taken to reach our hospital was 2.8 hours, but fifty percent of patients were referred, who received initial care from nearby hospital. All referred patients received atropine and gastric lavage from first point of care. This denotes that emergency care is rapidly available in our area [17] and gastric lavage is also considered as one of the emergency treatment at first point of care.

All patients presented after one hour of ingestion and there was the presence of pesticide in stomach of all patients at presentation as evidenced by lavage fluid analysis. Likewise, there was the presence of pesticide in lavage fluid after four hours of ingestion. The quantity of pesticide detected after four hours of ingestion was lower compared to early lavage, but the difference was not statistically significant. There was detectable amount of pesticide in those who received prior lavage before reaching our hospital. This shows that lavage

done at local centers did not decontaminate stomach thoroughly and could be due to lack of expertise or poor technique [18].

The concentration of Chlorpyrifos was lower in the lavage fluid compared to Quinalphos. The highest concentration of Chlorpyrifos was seen in a patient after 190 minutes of ingestion, whereas the lowest concentration was seen at 75 minutes of ingestion and both were referred cases after gastric lavage. The highest concentration of Quinalphos was seen in a patient after 120 minutes of ingestion and the lowest concentration at 300 minutes of ingestion. Other than time since ingestion, many other factors like dose of atropine received, which can cause gastroparesis and co-ingestion of food and alcohol can play a role in gastric absorption and emptying [19].

Chlorpyrifos removed by lavage was expressed as micrograms per liter. Accordingly, the maximum amount removed by the initial lavage of 200ml was calculated in few grams. The ingested amount of Chlorpyrifos 20% EC ranged from 5 grams to 20 grams. The highest amount removed in initial lavage cycle was calculated as 0.02 milligrams. In case of Quinalphos 25% EC, the ingested amount ranged from 12.5 to 25 grams. The highest amount removed by initial lavage was calculated as 2.6 milligrams. So, overall clinical benefit in removing such small quantity may be minimal. Since we did not include patients not receiving lavage in this study, definite opinion regarding benefit by lavage is not possible [20].

The name of the pesticide on the container was recorded as Quinalphos 25% EC or Chlorpyrifos 20% EC and no other compound was specified. But, on analysis few other OP compounds were detected in equal or higher concentration of alleged compound. The banned compound Endosulfan was also detected in some lavage samples and corresponding blood samples. The combination of organophosphorus and pyrethroid compounds are available in the market and are reported to be highly toxic than individual compounds. Our machine was not programmed to identify pyrethroid compounds [21].

The presence of multiple pesticides in one container may be one cause of high fatality in pesticide poisoning. As per our study, the presence of multiple organophosphorus and organochlorine compounds are not recorded over the container. Also it demonstrates poor regulation of manufacturing and sale of pesticide in the country [22]. Pesticide regulation in India comes under the Insecticide act 1968 and the Insecticides rules 1971. National-wise and state-wise regulations were issued in the country from time to time, but there are no much surveillance data available regarding the effect of regulations [23].

Moreover, in the current study, it was observed that three patients developed aspiration pneumonia. Since all patients with GCS less than 8 were intubated before lavage, the chance of aspiration during lavage was less likely. There is a possibility of aspiration during transport to hospital in unconscious state or ventilator associated pneumonia exist in all three patients [9]. Other complications of gastric lavage were not observed during or after lavage.

Outcome analysis was not done in the small study sample, but it was observed that those with relatively high pesticide concentration in stomach survived, while those with negligible concentration in stomach did not survive. This may be due to good absorption of pesticide prior to lavage and its effect on various systems [24]. The outcome of pesticide poisoning depends on many factors like clinical severity at presentation, early antidote administration, hazard level of pesticide, and good critical care setting for management [25]. All our patients received atropine at first point of care itself and all of them were provided with ICU care. Both Chlorpyrifos and Quinalphos are available 100 or 250ml bottles. Our patients brought bottles of 100ml Chlorpyrifos and Quinalphos. Easy availability of such highly hazardous pesticides and their large volume ingestions are likely to cause poor outcome despite prompt treatment [26,27].

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### LIMITATION

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The volume of pesticide ingested was calculated from subjective statements given by the patients or relatives and this may not be accurate. The quantification of pesticide in each cycle of lavage was not done and whether pesticide disappeared from stomach once aspirate turned clear was not documented. Sample size calculation was not done for this study as we could not find any published studies of similar kind.

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### CONCLUSION

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Chlorpyrifos and Quinalphos are detected in lavage fluid up to 6 hours after ingestion and few milligrams are retrieved in first cycle of lavage. So Gastric lavage is effective in removing identifiable amount of Chlorpyrifos and Quinalphos in moderate to severe poisoning up to six hours of ingestion. However, the utility of removing minute quantity by lavage in the overall outcome of OP poisoning may be minimal. Further studies with larger samples are required for confirmation. The presence of other pesticides including Endosulfan were confirmed in lavage fluid probably from commercially available Chlorpyrifos and Quinalphos preparations. The combination of multiple organophosphorus and organochlorine compounds including banned Endosulfan in a single container possibly increase the hazard level of pesticides and increase the fatality in self-harm.

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