

# Profile and outcome of patients presenting with agrochemical poisoning to the emergency department

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## ABSTRACT

**Background:** Deliberate self-harm (DSH) is one of the leading causes of mortality and morbidity in India. Agrochemicals are the most commonly used compounds for DSH. The spectrum of Agrochemicals in use varies from region to region and time period with newer compound being regularly introduced into the market. **Methodology:** This retrospective cohort study included patients presenting with agrochemical poisoning to the ED during January 2017 to December 2018. Patient data was retrieved from the ED triage registry software and clinical workstation, following which their hospital outcome was determined. **Results:** During the study period, 1802 patients presented with DSH among which Agrochemical poisoning comprised 33.5% (604/1802). The mean age was 31 years and incidence of agrochemical poisoning was found to be higher in young adults (16–30 years–55.8%). The prevalence was more common in males (62.4%). The common agrochemical compounds consumed were insecticides (91%), herbicides (4.3%), fungicides (1.5%), fertilizer (1.5%), and plant growth regulators (1.5%). Majority (80.96%) of the patients were discharged alive from the hospital, 17% left against medical advice due to bad prognosis and 12 patients (2%) died in the hospital. **Conclusion:** Insecticides (mainly Organophosphates) are the most common agrochemicals used for DSH. Their management is better understood leading to better outcomes compared to other chemicals. The proportion of agrochemical use in DSH has reduced over the last decade. Imidacloprid (Insecticide) and Plant growth regulators are the new compounds for which appropriate management is not yet established and more research is needed.

**Keywords:** Agrochemical poisoning, deliberate self-harm, insecticide, organophosphorus

## Introduction

Agrochemical poisoning is one of the major causes of morbidity and mortality in our country and around the world.<sup>[1–6]</sup> The strength of our community is agriculture, which has remained the main pillar and source of income to the majority. To sustain livelihood with agriculture, advancement in education use of chemicals has been on the rise increasing

crop yields and productivity. They are used as fertilizers, pesticides and preservatives, storage. There has been pitfall of its use on human health and the ecosystem as they are misused. Their accessibility and availability has resulted in intentional self-poisoning as well as accidental poisonings. The accidental poisonings occur in all age groups as pesticides are mistaken for water or food products with children being the most vulnerable population. In the suicidal group, our farmers, geriatric age group in the community are at high risk due to their financial burden and high debt rates. They seek to kill themselves to end their agony and find agrochemicals the easy means for intentional suicide.<sup>[7–9]</sup>

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There is no proper regulation on availability and use of pesticide in agriculture. In India pesticides have been in production from early 1950s and we are second largest manufacturer of pesticides in Asia. As per 'The World Health Organization' reports there are 3 million pesticide poisonings every year and that 200,000 deaths globally are a result of agrochemical poisonings.<sup>[10,11]</sup> There has been in a rise in Global pesticide pollution too. Insecticides are the largest sub-segment of agrochemicals followed by herbicides in India.<sup>[12]</sup>

There is a wide variation of availability of agrochemicals around the country and it is important to know the spectrum of compounds available in our geographic territory in order to better understand the lethality and be well equipped to handle these emergencies. Hence, we conducted this study in our department to find the type of poisoning compound, emergency department (ED), and hospital outcome so that we could improve physician awareness of the same.

## Materials and Methods

### Study design

This was a retrospective study on patients presenting with deliberate self-harm. In our study, we recruited patients who had presented with agrochemical poisoning in 2017–2018.

### Setting

The study was conducted in the ED of Christian Medical College and Hospital, Vellore, which is a large tertiary care hospital in South India. The ED is a 50-bed department and tends to about 300 patients per day including trauma and non-trauma patients.

### Participants

We recruited all patients presenting with Agrochemical poisoning to our ED during the study period. We reviewed a total of 604 patient's charts over a period of 2 years (January 2017 to December 2018).

### Variables

The charts were reviewed, and the relevant details of history, clinical findings and treatment were documented in the study form. The management and outcome of the patients with regards to admission, discharge, leaving against medical advice and death were documented.

### Outcome variable

Hospital admission, ICU admission, Use of Inotropes and Death.

### Bias

This is a retrospective cohort study, and therefore we could not control exposure or outcome assessment, and instead relied on others for accurate record keeping.

### Study size

Based on a previous study by Jegaraj *et al.*, sample size with an estimated prevalence of 46% and a precision of 4% was

calculated to be 580 patients. Therefore, we recruited patients over a 2-year study period.<sup>[9]</sup>

### Statistical analysis

Data was analyzed using Statistical Package for Social Sciences for Windows (SPSS Inc. Released 2007, version 23.0. Armonk, NY, USA). Continuous variables are presented as mean (standard deviation). Categorical and nominal variables are presented as percentages. The factors associated with bad outcome were determined by bivariate followed by multivariate logistic regression analysis and their 95% confidence intervals were calculated. For all tests a two-sided *P* less than 0.05 was considered statistically significant.

### Ethical considerations

This study was approved by the Institutional Review Board prior to the commencement of the study (IRB Min no: 12269 dated 25.09.2019). Patient confidentiality was maintained using unique identifiers and by password protected data entry software with restricted users.

## Results

During the total retrospective cohort analysis, 1802 patients presented with deliberate self-harm (DSH) to our ED and among them 604 were using Agrochemicals [Figure 1]. The mean age was 31 years and majority of patients were males (62.4%). Young adults (16-30 years) are more prone (55.8%) to attempt DSH compared to the other age groups. The further details of baseline characteristics are shown in Table 1.

The common Agrochemical compounds consumed were Insecticides (91%), Herbicides (4.3%), Fungicides (1.5%), Fertilizer (1.5%), and Plant growth regulators (1.5%). Among Insecticides, Organophosphorus compounds (36%) are the most commonly consumed followed by Pyrethroids [Figure 2].

Most of the patients (71.7%) who presented to the ED were admitted. Majority (80.96%) of the patients were discharged alive from the hospital either from ED or ward. Significant number of patients (17%) had left against medical advice mainly due to poor prognosis or lack of beds. Out of the patients who visited ED, 1 patient died in the ED itself whereas 11 more patients had died either in the intensive care area or ward [Table 2].

For analysis, death, and leaving against medical advice due to poor prognosis were taken as bad outcome. Bivariate and

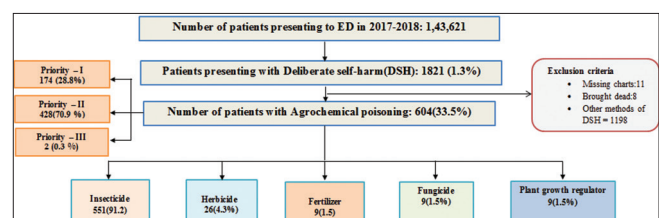


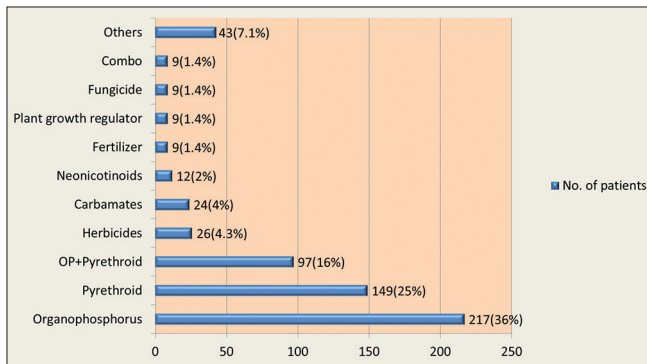
Figure 1: STROBE diagram

**Table 1: Baseline Characteristics**

Characteristics	Number (%)
Mean age (SD)	31 (13)
Male	377 (62.4%)
Female	227 (37.6%)
Age group	
16 - 30 years	337 (55.8)
31 - 45 years	157 (26)
46 - 60 years	84 (13.9)
More than 60 years	26 (4.3)
Triage priority	
Priority 1	174 (28.8)
Priority 2	425 (70.4)
Priority 3	5 (0.8)
Referred from outside hospital	478 (79)
K/C/O Psychiatric illness	7 (1.1)
Previous DSH history	15 (2.4)
Under the influence of alcohol	102 (16.9)

**Table 2: Emergency department and Hospital outcome**

Characteristics	Number (%)
Emergency department outcome (n=604)	
ICU/Ward admission	433 (71.7)
Discharged stable	87 (14.4)
Dead in ED	1 (0.2)
LAMA	83 (13.7)
Hospital outcome (n=433)	
Discharged stable	402 (92.8)
Dead	11 (2.5)
LAMA	20 (4.6)

**Figure 2: Spectrum of Agrochemicals**

multivariate analysis was done to determine the factors associated with bad outcome. Multiple factors such as age (OR 2.653, 95% CI 1.440–4.890) saturation at presentation (OR 2.653, 95% CI 2.661–7.807), low sensorium at presentation (OR 5.352, 95% CI 2.733–10.480), intubation (OR 4.698, 95% CI 2.738–8.059), cardiac arrest (OR 21.573, 95% CI 4.099–113.544), oxygen requirement (OR 5.302, 95% CI 3.063–9.177) and use of inotropes (OR 12.701, 95% CI 5.913–27.283) were found to be significant factors associated with bad outcome on bivariate analysis [Table 3].

## Discussion

India has the second largest population in the world but is first when it comes to suicide rates in the Southeast Asia region according to WHO estimates 2016.<sup>[13]</sup> The suicide rates have increased by a staggering 40% over a period of 26 years (1990–2016). Suicide is the ninth leading cause of death in India in 2016. Suicide ranks as the leading cause of death in age groups 15–29 and 15–39 years in India.<sup>[14]</sup> Suicide rates in Southern India are higher than Northern India despite the better education. Tamil Nadu reported the second highest number of suicides in India.<sup>[15]</sup>

In our population, Agrochemicals were the most common mode of DSH whereas hanging was the most common mode of suicide followed by consumption of Poison in India.<sup>[15]</sup> In the developed countries the most common mode of DSH was self-injury followed by poisoning with drugs. The use of Agrochemicals for DSH was rare in developed countries.<sup>[16,17]</sup>

Compared to the previous study done in our institute, there is a decrease in use of agrochemicals by approximately 13%, yet agrochemical poisoning (33.5%) was the primary mode of DSH.<sup>[9]</sup> Organophosphorus compounds were the main agrochemicals consumed by the patients in our population which was in accordance to other studies on DSH.<sup>[10,18-22]</sup> The widespread use of OP compounds has resulted in the clinician being more aware of their management compared to other substances in India. This improved awareness may be the reason why our study showed a lower chance of bad outcome with OP poisoning on both bivariate and multivariate analysis. The subset of patients who presented with consumption of more than one compound had severe presentation probably due to synergistic effect. The countries which have restricted the access to highly toxic pesticides as recommended by WHO, have shown decline in the rate of suicides.<sup>[23,24]</sup> If the Indian government can take steps to curb the easy availability of dangerous chemicals to personnel not involved in agriculture by use of a license/other proof, the incidence of Agrochemical poisoning may decline to a great extent.

Our study had a male: female ratio of which was in accordance to the national data with males being the majority.<sup>[15,25]</sup> The age group with most DSH was 16–30 years in our study which was similar to most other studies.<sup>[10,20,21,26]</sup> This is a worrying trend as this age group represents the student and working population who are vital in the progress of any nation and needs immediate attention.

Imidacloprid was a new compound with increasing usage in our population. Imidacloprid (Nicotine analogue) is an emerging systemic insecticide, which is used in pesticides and pet products. It was classified as moderately toxic compound by WHO however there are numerous case reports of severe systemic manifestations.<sup>[27,28]</sup> There are no specific antidotes making the management more challenging. Plant growth regulators are also new compounds regarding which data is limited and needs further research.

**Table 3: Bivariate and multivariate logistic regression analysis of factors associated with bad outcome**

Variable	Bad outcome* n=67	Good outcome n=537	Bivariate analysis		Multivariate analysis	
			P	Unadjusted OR (95%CI)	P	Adjusted OR (95%CI)
Age (>50)	17 (25.4%)	61 (11.4%)	0.001	2.653 (1.440-4.890)	0.208	1.646 (0.758-3.573)
Insecticides	54 (80.6%)	497 (92.6%)	0.001	0.334 (0.168-0.664)	<0.001	0.182 (0.079-0.417)
SpO <sub>2</sub>	30 (45.5%)	83 (15.5%)	<0.001	4.558 (2.661-7.807)	0.326	1.496 (0.669-3.345)
GCS (<8)	16 (28.1%)	35 (6.8%)	<0.001	5.352 (2.733-10.480)	0.447	1.444 (0.560-3.722)
Intubation	30 (45.5%)	80 (15.1%)	<0.001	4.698 (2.738-8.059)	0.057	2.520 (0.974-6.516)
Cardiac arrest	5 (7.5%)	2 (0.4%)	<0.001	21.573 (4.099-113.544)	0.243	3.128 (0.461-21.235)
Oxygen	46 (68.7%)	157 (29.2%)	<0.001	5.302 (3.063-9.177)	0.113	1.982 (0.850-4.623)
Inotropes	17 (25.4%)	14 (2.6%)	<0.001	12.701 (5.913-27.283)	0.347	1.709 (0.559-5.225)

\*Bad outcome: Includes patients who died in the hospital and those who left against medical advice due to poor prognosis

Emergency physicians are involved in management of acute conditions, stabilization, and referral of patients to appropriate specialty for further management and follow up. Hence, emergency physicians are primary care physicians with limited resources for further care and follow up. Knowledge of spectrum of agrochemical poisons in their region would help the primary care physicians to impart prompt and appropriate management of accidental or intentional poisoning. Primary care physicians should propagate public awareness on harmful effects of pesticides in their community.<sup>[29]</sup> We suggest similar studies should be carried out in each hospital to help identify the common modes of poisoning which will enable the primary care physicians to anticipate the course of poisoning and improvise their management plan.<sup>[30]</sup>

Our study has certain limitations. Being a single medical center study there may have been a patient selection and referral pattern bias. Missing charts and incomplete data were another limitation of our retrospective study. Nonetheless our study sheds light on the changing trends of agrochemical poisoning used by victims of DSH.

## Conclusion

Our study shows Organophosphorus compounds are the most common agrochemicals used for DSH. Over the years there have been improved outcomes due to better understanding of this compounds compared to other chemicals. There has been a significant reduction of agrochemical use in DSH over the last decade. Pesticide ingestion remains an independent factor for bad outcome. Newer compounds like Imidacloprid (Insecticide) and Plant growth regulators need further research for better management.

## Research quality and ethics statement

The authors of this manuscript declare that this scientific work complies with reporting is IRB Min no: 12269 dated 25<sup>th</sup> September 2019. We also certify that we have not plagiarized quality, formatting and reproducibility guidelines set forth by the EQUATOR Network. The authors also attest that this clinical investigation was determined to require Institutional Review Board/Ethics Committee review, and the corresponding

protocol/approval number the contents in this submission and have done a Plagiarism Check.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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