**Trend of poisoning cases reported to Poison Information Centre, Ahmedabad, India: A three-year observational study**

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**Abstract**

**Background:** Morbidity and mortality with pesticide poisoning is a major public health issue, especially in lower and middle income countries including India. Timely understanding of the trend of poisoning is required for its prevention. The objective of the present study was to analyze the trend of poisoning cases in Ahmedabad for last three years.

**Methodology:** Detailed history, including personal data, circumstances, agents involved and occupational influence were collected for poisoning cases reported to the poison information center, Ahmedabad for last three years. Cholinesterase activity and HPTLC method for detection of sanguinarine in urine were used to investigate the agents of poisoning.

**Results:** A total 1373 poisoning cases were investigated. The incidence and fatality rate was found to be higher in men compared to females (M/F ratio 1.89:1). About 91.62% of the poisoning were through the oral route. Erythrocyte cholinesterase activity assay results indicated that 41.29% of the cases were due to organophosphorus/carbamate poisoning. Insecticides were found to be the agent of poisoning in 26.29% cases and 11.07% of all the cases were agricultural workers. Poisoning with medications and household pesticides and chemicals were also reported. Few cases of food poisoning with sanguinarine were detected, indicating adulteration of edible oil with argemone seeds.

**Conclusions:** The data presented here suggest that pesticides used for agriculture are the major source of poisoning. Implementation of usage guidelines, educating farmers and vulnerable population and finding novel alternatives for highly toxic chemicals may be helpful to bring down the poisoning cases to the least possible level.

**Keywords:** trend of poisoning, pesticide poisoning, organophosphorus, suicide

**Introduction**

Morbidity and mortality due to pesticide poisoning is a major public health issue, especially in lower and middle income countries.1 According to national crime records bureau of India, the official estimate of suicides resulted from insecticide poisoning was 10.4% of the total suicide cases in the year 2014.2 This estimate is more likely to be less than the actual number because of under-reporting of suicide cases and exclusion of poisoning cases due to rodenticides, fungicides and herbicides.1 An estimate of 11.3% of total suicide cases due to insecticide poisoning was also reported in lower and middle income countries of South-East Asia region.1 In 2010 there was reports of incidence of 38.8% of suicide by pesticide ingestion in India.3 Among the Indian states, Gujarat accounts for 5.4% of the suicide cases and this is above the national average of the country.4

To date considerable efforts have been taken by the World health organization (WHO) and different countries to reduce the incidence of poisoning cases. One of such initiative is an IPCS INTOX program by WHO in 1988, which promote chemical safety by establishing poison information centers, which is a global endeavor to promote chemical safety by the introduction and support of poison information centers. The program aimed to harmonize the collection of poisoning data, training and sharing of information related to poisoning within member countries.5 As per this program, India has six poison information centers. The Central Insecticides Board & Registration Committee, under the Department of Agriculture and Co-operation, Govt. of India is engaged with registration of pesticides used in agriculture in the country, banning the pesticides and chemicals that are hazardous to health and the environment, guidelines for registration of new pesticides, minimum infrastructure requirements for pesticide manufacturing and export and import of pesticides.6 Still, morbidity and mortality from poisoning continue to be a major public health concern in the country.

The incidence of poisoning depends on several factors like socioeconomic elements, culture and religion, educational status, agricultural practices and knowledge of pesticides and other poisonous substances, extent of industrialization and geographical conditions.7 Consequently, the epidemiology of poisoning cases may vary depending on place and prompt understanding of the pattern and trend of poisoning in a particular area is necessary for efficient design and implementation of control strategies for prevention of poisoning incidences in future. A Previous study conducted in Delhi, India, identified that household chemicals followed by drugs, agricultural pesticides and industrial chemicals are the major agents of poisoning.8 The objective of this study was to understand the trend of the poisoning cases arising from human exposure to different poisons including pesticides, in last three years and to understand the possible preventive measures that may help to reduce future incidence of poisoning cases. The present article describes the trend of poisoning cases reported to a poison information center at Ahmedabad, Gujarat in the last three years.

**Materials and Methods**

**Fatality rate due to poisoning:** In order to understand the annual mortality trend due to poisoning, the rate of fatality due to poisoning was studied. It was calculated from the number of fatality due to poisoning and total number of poisoning cases reported.

**Collection of epidemiological data:** A detailed history of poisoning cases was taken for each of the poisoning cases reported to the poison information center for last 3 years, from 01/01/2015 to 31/12/2017. The necessary ethical committee approval was obtained from institutional ethics committee. Informed oral consent was obtained from each patient/their guardians for the use of poisoning data in the present work. The proforma for patient history included patient’s personal data such as age, sex, marital status, education and geographical area. Occupation of the patient was noted to know any relationship between the incidence and workplace. The poison severity score (none, minor, moderate or severe) as per Persson et al., 19989 was documented at the time of admission to the hospital. Efforts were taken to document information on the chemical nature of the poison. Other information like chronicity of poisoning, route of poisoning, such as oral, inhalation, dermal exposure, etc. were obtained from the attending physician. Information such as the consciousness of the patient at the time of admission and requirement of ventilator support were also documented for each patient.

**Estimation cholinesterase activity:** Cholinesterase activity was used as the diagnostic tool for acute organophosphorus poisoning. Plasma and/or RBC cholinesterase activity was measured using modified *Ellman’s* spectrophotometric method.10 Briefly, plasma was added and mixed with 5,5’-dithiobis-(2-nitrobenzoic acid) reagent (Sigma) and acetyl thiocholine substrate (Sigma) was added to the mixture. The yellow color developed was measured at 410nm using a spectrophotometer (Cary 100 Bio, Varian) and cholinesterase activity was expressed in Units per liter of plasma. The value of cholinesterase activity was then compared with biological reference range generated in-house.

**Detection of sanguinarine:** Sanguinarine in urine samples of poisoning cases were detected by HPTLC method according to Shenolikar et al.11 Briefly, sanguinarine in urine samples were extracted with 1% acetic acid in chloroform and spotted onto TLC plates (Sigma) along with standard and developed with butanol-acetic acid-water in the ratio 63:10:27 by volume. The plates were then observed under ultraviolet light and the golden-yellow fluorescent band in line with standard sanguinarine spot was identified and evaluated as sanguinarine in the sample.

**Statistical Analysis:** Non-parametric tests such as Chi-square test and Mann Whitney U Test was applied to test statistical significance between the groups. All statistical tests were carried out at 5% level of significance.

**Results**

A total of 1373 poisoning cases was reported to poison information center with the highest number in the year 2016 (480 cases). Although the fatality rate due to poisoning in the Ahmedabad showed an increasing trend annually (Table-1), however, it was not statistically significant. The male to female ratio was 1.4, 1.8 and 2.7 in the years 2015, 2016 and 2017 respectively, indicating the increasing trend of incidence of poisoning in men. Also, the fatality rate was significantly high in men compared to females. The distribution of poisoning cases with respect to the age of patients12 represented as young (age ≤35 years), middle age (36-55 years) and older (age ≥56) are shown in Figure-1A. The highest level of incidence was observed in young age group. Figure-1B shows the education status of the patients. The educational status of 136 patients was not known. The trend was similar in all the three years of the study.

The poison severity score at the time of admission to the hospitals revealed that 338 cases were severe which constitute 24.61% percent of the total cases and 51.42% cases were of moderate severity. Figure-2A shows 3-year trend of severity at admission indicating the similar trend in the last 3 years. 289 (21.04%) poisoning cases needed ventilator support during the course of treatment. A total of 47 patients suffered from limb paralysis due to poisoning in last 3 years. The route of exposure was oral in majority of the cases. The trend was same in throughout the study period with 89.5%, 91.6% and 93.7% cases with the route of poisoning through oral ingestion in the years 2015, 2016 and 2017 respectively. A total of 23 poisoning cases were reported due to poisoning through inhalation of toxic agent. Four cases of poisoning through dermal exposure was also documented. Figure-2B illustrates the trend of various chemical agents used for poisoning in last 3 years. The trend was similar in all 3 years, except the occurrence of 7 edema cases due to contaminated edible oil in the year 2015, followed by one case in 2016. There were no edema cases reported in the year 2017. The chemical nature of the poison was not known to the investigators in 52.5% of the cases. Agricultural insecticides were found in 26.29% cases followed by household chemicals like phenyl, rodenticides, mosquito repellents and bleaching powder together comprising about 12.31% of the poisoning cases.

The trend in relation to circumstances of poisoning cases reported is shown in Fig. 3A. Most of the cases were of suicidal in nature (73.4%, 75.2% and 88.8% in the years 2015, 2016 and 2017 respectively) with intentional oral intake of poison at home. Agricultural chemicals stored in home were found to be the poisoning agent in 28.18% of the suicide cases. Chemically they were acephate, phorate, adrin, carbofuran, celphos, chlorophos, chorpyriphos, cypermethrin, DDT, gamexin, dimethoate, imidochloprid, malathion and monocrotophos. The list also includes some insecticides with local trade names whose chemical composition was not clear. Analysis of cholinesterase activity in these patients revealed 571 (52.57%) cases with reduced plasma cholinesterase activity and 428 (39.41%) cases with reduced RBC cholinesterase activity, indicating the widespread use of organophosphorus chemicals for intentional poisoning. Plasma/serum cholinesterase activity and RBC cholinesterase activity reduced in 49.67% and 41.29% of all the cases. The cholinesterase values of poisoning cases due to agricultural pesticides where significantly less than that of poisoning due to causes other than agricultural pesticides (*p* value <0.05) as shown in Fig.3B.

Thirteen cases were homicidal in nature (1, 10 and 2 cases in the year 2015, 2016 and 2017 respectively). Six of them had reduced RBC cholinesterase activity with normal level of plasma cholinesterase activity and another 2 cases had very low level of plasma cholinesterase activity. Since the organophosphorus chemicals are infamous for its homicidal potential the possibility of organophosphorus poisoning cannot be excluded.

About 55 cases of food poisoning and 35 cases of accidental poisoning were recorded in the study period. The number of food poisoning cases showed a decreasing trend with 38, 16 and 1 cases in the year 2015, 2016 and 2017 respectively. Paralysis of both limbs of the patients were present in 18 food poisoning cases reported in 2015. Among these, 8 were suspected cases of argemonium oil consumption and HPTLC analysis of urine sample of the patients revealed the presence of sanguinarine in 3 cases. About 38.18% of the food poisoning cases showed reduction in the plasma cholinesterase activity and 65.45% showed reduced RBC cholinesterase activity. Therefore, organophosphorus poisoning might be accounted for a significant number of food poisoning cases. Fourteen cases were found in the category of abuse of toxic substances. Four of them were with Bhang, a locally available cannabinoid substance and one case with local made alcohol. 3 patients showed reduced plasma/RBC cholinesterase activity indicating the possibility of organophosphorus poisoning.

Twenty eight cases were reported with poisoning in occupational circumstances. All of these were acute poisoning cases, out of which 16 cases were from inhalation of toxicant and 11 cases were of oral poisoning. At least 21 of them had reduced plasma cholinesterase activity and 15 cases had reduced RBC cholinesterase activity indicative of organophosphorus poisoning in occupational settings. Fig. 3C shows the trend of poisoning with respect to the occupation of patients. In all the 3 years’ house wives constituted the highest number of poisoning cases (21.2%), followed by laborers (11.2%), agricultural workers (11.0%) and industrial workers (7.7%). The number of industrial workers exposed to poison at workplace was 19, 29 and 56 in the years 2015, 2016 and 2017 respectively. Except this, the trend was similar in all 3 years of the study.

**Discussion**

This study presents the trend of poisoning cases reported to poison information center, Ahmedabad in last 3 years. The fatality rate due to poisoning was found to be similar from 2015 to 2017 underlining the importance of the poisoning as a public health concern. This rate may be an underestimate because of under-reporting of deaths due to poisoning. The incidence and fatality due to poisoning was more in men showing that men are more prone to poisoning (Table-1). A similar study conducted in a tertiary hospital in Karnataka state, India also reported higher incidence (75.4%) of poisoning among males compared to females.13 However, there are studies that reported higher incidence in females14 as well as comparable incidence in men and women.15 This might be attributed to the difference in the cultural, lifestyle, occupational and socioeconomic nature of the population studied.

In the present study, 11.07% of the population comprised of agricultural workers and in 26.29% of the reported cases the poisoning was with insecticides used in agriculture sector. This is a matter of concern in the context of recent reports of occupational poisoning and death of 45 agricultural workers in the Bt-cotton plantations of Maharashtra state.16 A similar method of cotton cultivation is being practiced in Gujarat too.17 Though Bt-cotton plants are supposed to be resistant against the insect cotton ballworms, new reports are suggestive of development of resistance in ballworm.18 This leads to heavy insecticide use in Bt-cotton plantations and results in occupational poisoning in agricultural workers and higher incidence of suicide. A notable study among 127 acute poisoning cases in Maharashtra, have reported 48.8% cases in agriculture workers.19 The cause of higher incidence of poisoning cases among farmers of Vidarbha region of Maharashtra was identified as a complex interplay of social, political and environmental factors. Relief packages, implementation of mental health programs at the regional level to offer support and counselling to vulnerable population may prevent the incidence of poisoning cases in future.20 Similarly, the use of personal protective equipment and safety guidelines in the use of pesticides may also aid in reducing the occupational poisoning especially in workers who spray the insecticide solution. Proper training in integrated pest management has been proven as an effective strategy in reducing the number of poisoning cases in farm workers of South India.21

Organophosphorus pesticides are the most common cause of poisoning in agricultural workers and other unskilled workers.22 Currently cholinesterase activity in serum/plasma/RBC is used as most reliable tests for organophosphorus poisoning.23 This study revealed reduced cholinesterase activity in plasma of victims exposed to agricultural pesticides compared to cases due to other means of poisoning (Fig. 3B) emphasizing the prevalence of poisoning with pesticides such as organophosphorus chemicals/carbamates in the community. This observation warrants the need for replacing highly poisonous organophosphorus chemicals with less toxic chemicals, their highly regulated supply, implementation of usage guidelines and banning of highly toxic pesticides.

Poisoning with alcohol is relatively less in Gujarat.24 In this study, we came across 11 alcohol poisoning cases that comprises only 0.80% of total poisoning cases reported. This might be because of the Bombay prohibition bill passed in 1949 and subsequent amendments by the state government, according to which liquor is prohibited by law in Gujarat state.25 However, previous studies on the drunkenness at Ahmedabad civil hospital have reported some episodes of alcohol poisoning and the alcohol prohibition by law has not changed the behavior of people towards the usage of alcohol.24

Eight cases of poisoning through contaminated edible oil was reported. Out of this, the presence of sanguinarine, a toxic alkaloid present in *Argemone mexicana* seeds was detected in the urine of 3 patients, suggestive of edema (epidemic dropsy) in the year 2015. Edema usually occur in the form of an epidemic affecting a population that consume edible oil adulterated with *Argemone mexicana* oil.26 In the year 2012, thirteen cases of edema were reported from panchmahal district of Gujarat.27 Hence, even though a small incidence of the disease was reported to the poison information center in the year 2015, the data points towards the need of active toxicovigilance and anti-food adulteration activities. Moreover, the toxicology laboratories have to be strengthened for timely detection and diagnosis of edema in future.

Household chemicals like insecticides, rodenticides, phenyl, bleaching powder and mosquito repellents constituted 12.31% of the poisoning cases. Previous studies also reported a higher incidence (44%)of poisoning due to such household chemicals.8 This difference in the trend of poisoning might be attributed to the differences in the culture, education status and availability of other toxicants for suicide purpose. The probability of poisoning is inversely proportional to the education level.28 The education status of patients in this study also showed that, the poisoning incidence is high among the uneducated or less educated population (Figure-1B). Therefore, increasing the awareness on poisonous substances may be effective in reducing the number of poisoning cases in future.

According to WHO, pesticide poisoning accounts for the most of the global suicides and majority of them occurs in lower and middle income countries.29 The present study also shows that agriculture pesticides are the major means of poisoning and related fatality. A multifaceted approach with legislation to ban highly toxic pesticides, improvements in medical management of poisoning cases, awareness and storage guidelines may help to reduce the incidence of poisoning as found effective in Srilanka.30 More effective toxicovigilance by the regulatory agencies also can contribute to bring down the poisoning cases to minimum level.31

In this study only poisoning cases reported to the poison information center were included. There might be cases that are not reported to the PIC and hence were not included in the study. The availability and nature of particular antidotes were also not documented in this study. These are very important for assessment of health resources required to deal with poisoning cases in a particular region. Therefore, future epidemiological studies will be carried out by strengthening of the reporting of poisoning cases to the poison information center and special attention to availability of antidotes.

**Conclusions**

Poisoning with toxic chemicals continue to be a major health concern in Gujarat and poison information center play a crucial role in reducing the prevalence of poisoning incidences through epidemiological studies. The data presented in this paper suggest that pesticides used in agriculture was a major source of poisoning in last 3 years. Implementation of usage guidelines, educating farmers and vulnerable population and finding novel alternatives for highly toxic pesticides may be helpful to bring down the poisoning cases to the least possible level. Highly toxic chemicals used in agriculture should be either banned or given to farmers with strict usage guidelines and documentation. Most of the poisoning cases reported here were suicidal in nature, indicating the need for effective measures to prevent the suicidal tendency in the community. The epidemiological trend of poisoning cases presented in this paper may be helpful in reducing the incidence of poisoning cases in future.

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**Table 1.** Data on poisoning cases reported to poison information center

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **2015** | **2016** | **2017** | **total** |
| No. of cases | 447 | 480 | 446 | 1373 |
| Males | 262 | 310 | 326 | 898 |
| Females | 185 | 169 | 120 | 474 |
| Male to female ratio | 1.42 | 1.83 | 2.72 | 1.89 |
| Third gender | 0 | 1 | 0 | 1 |
| % of fatal rate | 6.04% | 8.75% | 9.64% | 8.15% |
| No. of fatal | 27 | 42 | 43 | 112 |
| No. of fatal (male) | 19 | 30 | 36 | 85 \* |
| No. of fatal (Female) | 8 | 12 | 6 | 26 |

\* Indicates significant difference when compared with number of fatal in females at 5% significance (P value=0.010, chi-squire statistic 6.6098).

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Fig. 1: The Pie chart showing the number of poisoning incidence in young, middle and older aged subjects (A), and educational status of the patients (B) during last 3 years.

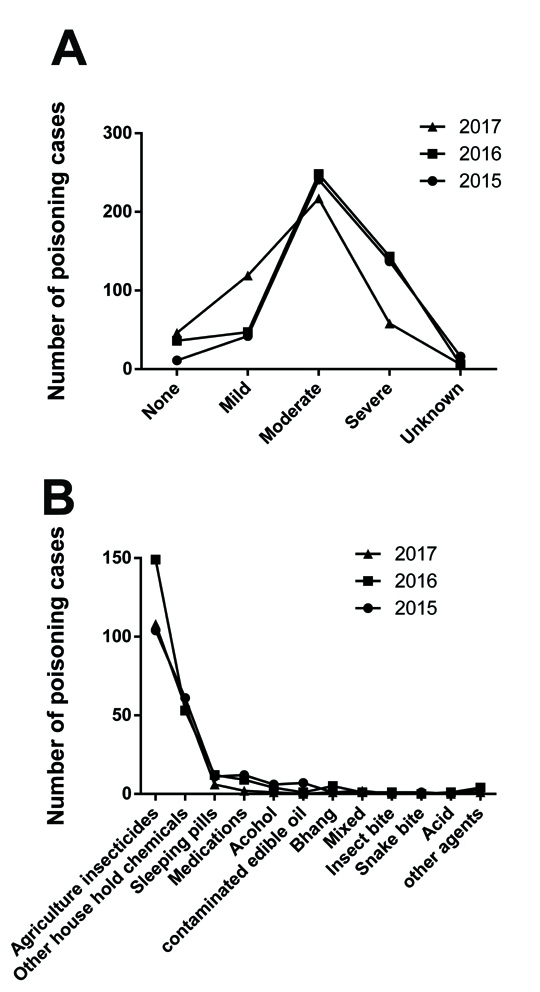


Fig. 2: The annual trend of poisoning cases in relation to the severity of cases at the time of admission to hospital (A) and the agents involved in poisoning (B) for last 3 years.

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Fig. 3: The trend of poisoning in last 3 years in relation to the circumstances of poisoning (A), the box plot showing plasma cholinesterase activity in victims of poisoning due to agricultural pesticides in comparison to other known causes (B), and the occupation of patients (B).