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Trends of Fatal Poisoning in Northern India: A Ten-year Autopsy Analysis

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Abstract: Knowledge of poisons, their clinical manifestations, remedial measures, etc. and the causing of death by poisoning, has been prevalent all over the world since time immemorial. But the present day poisoning scenario is altogether different due to rapid development in the field of science and technology and vast growth in the industrial and agricultural sectors. The ups and downs in the incidence of poisoning have been reported from time to time both in the developed and the developing world. Toxicology became a specialized branch of medicine in early 1950s in the developed countries in response to the proliferation and use of chemicals in every day life. The first Poison Information Center started functioning in America in the mid fifties and by the early eighties there were nearly 400 such centers in USA. Many countries of Europe and Asia Pacific Region have established poison information center facilities. In India, a Toxicology Laboratory was setup at the Medicolegal Institute Bhopal, in 1984, following Bhopal Gas Tragedy. In 1994, National Poison Information Center was setup at All India Institute of Medical Sciences New Delhi followed by the establishment of Poison Information Centers at National Institute of Occupational Health at Ahmedabad and Mahatma Gandhi Institute of Medical Sciences Sevagram in 1996. However, the spurt in the number of intentional as well as unintentional poisoning and poisoning deaths continues to be a cause for concern.

Key words: Poison, poisoning, agrochemicals, insecticides, pesticides, rodenticides, poison information center

INTRODUCTION

A Poison is any substance, which when administered to the body through any route, produces ill health, disease or death while Poisoning refers to the damaging physiologic effects of ingestion, inhalation, or other exposure to a range of pharmaceuticals, illicit drugs and chemicals, including pesticides, heavy metals, gases/vapors and common household substances, such as bleach and ammonia. Death due to poisoning has been known since time immemorial and poisoning continues to be a major problem all over the world although its type and the associated morbidity and mortality vary from country to country or even place-to-place in the same country (Sharma and Singh, 2003). The influence of scientific and technical progress, social factors and personal lifestyles is hardly more apparent in any other area of medico legal activity than in the specialist field of forensic toxicology. For example, the use of heavy metals for the purpose of homicide is very rarely found these days (Sharma *et al*., 2002). In their place toxic chemicals have moved into the foreground and so is the misuse of pharmaceutical drugs or the abuse and addictive use of narcotic drugs. Deliberate self-poisoning is one of the methods, commonly used in suicides and suicide attempts (Rogde *et al*., 1996; Borna *et al*., 2001; Carlsten *et al*., 1999; Ohberg *et al*., 1995).

Agrochemicals (insecticides, pesticides, rodenticides, etc.) are a group of chemicals used predominantly in agriculture and against insects, vectors, rodents etc. It is evident that agrochemicals

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are used for the variety of benefits it provides to mankind. But in so doing there are certain undesirable and unwanted effects of their usage, which cannot be ignored. Man may be exposed to these agrochemicals in a variety of ways; at different dose levels and for varying periods of time, but what is most important is that each country or region must identify the mode of exposure and resultant hazard which is most important to its own circumstances. For instance, in the industrialized world the problem of acute agrochemical poisoning has largely been controlled and the main focus of attention is on the possible health effects arising from exposure to low levels of insecticides and pesticides over a long period of time. Such exposures usually arise from environmental contamination as well as from agrochemical residues in food, whereas the situation is quite the reverse in the countries of the developing world. In these countries the main health problem arising from agrochemicals is that due to acute poisoning. No doubt the concerns of long-term exposure to low levels of insecticides and /or pesticides also obtain attention in these countries, but they should not be considered a priority health issue as they are in the countries of the industrialized world.

Any figures concerning the extent of acute agrochemical poisoning on a global scale are largely based, by necessity, on estimates. The first such estimate was made in 1973 by the World Health Organization (WHO Technical Report, 1973) which suggested that 500,000 cases of acute serious pesticide poisoning occurred annually. This estimate included only hospitalized cases of unintentional poisoning (excluding suicide attempts). At that time it was considered to be an unacceptably large problem, requiring efforts to substantiate this estimate as well as to control the problem. In 1982, a national study of hospital cases of acute pesticide poisoning demonstrated that Sri Lanka, a country with a population of 12 million, had approximately 10,000 persons admitted to hospitals for acute pesticide poisoning annually, resulting in almost 1000 deaths (Jeyaratnam *et al*., 1982). The public health importance of this figure was highlighted by the fact that the deaths due to acute pesticide poisoning for that particular year were almost twice the total number of deaths due to malaria, poliomyelitis, whooping cough, diphtheria and tetanus, the traditional public health problems of developing countries. These figures included suicides attempts and suicides, which comprised about two-thirds of the hospitalized poisonings (Jeyaratnam *et al*., 1987; WHO, 1985). The equivalent annual figures at a global level in 1985 were estimated at approximately 3 million cases hospitalized and approximately 220 000 deaths (Jeyaratnam *et al*., 1987).

Suicides have been incriminated as a major factor in the causation of acute agrochemicals poisoning. They contribute to approximately two-thirds of all causes of acute poisoning. The herbicide paraquat is extensively used as an agent for suicides and is a major problem in Malaysia particularly, with 73.4% of such poisonings due to suicides, 13.8% to accidents and only 1.07% to occupational accidents (Jeyaratnam, 1988). Suicide in any society is a social problem, which requires attention from many disciplines. The reason for the extensive use of agrochemicals as an agent for suicide in developing countries could be the ready availability of extremely toxic substances. A study reported that 11 million cases of pesticide intoxications occur annually in Africa, concluding that in the developed countries, pesticides are responsible for only a small percentage of all poisonings, whereas in the developing countries they are a major contributor to poisoning (Kritalugsana, 1988).

Furthermore, in making global estimates, there are a variety of pitfalls, which are likely to give rise to inaccurate estimates of the extent of the problem. The main issues, which distort the picture, are the following:

- Misdiagnosis of acute poisoning at different health-care levels;
- Some studies are confined to hospital cases while others to minor poisoning or mere pesticide exposure;
- Most studies are confined to a limited region and not nationally representative;

- Incomplete compilation of data, as for example, in Indonesia, although the officially-collected records do not indicate a problem, local studies estimate that there are 30,000 cases of pesticide poisoning annually, of whom approximately 2400 require hospitalization. In Thailand, the epidemiological surveillance report records 2,094 cases of pesticide poisoning with no deaths for the year 1985, while the data collected by the National Environmental Board record a fatal of 4 046 cases resulting in 289 deaths, indicating the great variation even in official records (International Labor Organization, 1980).

Given this situation, there is an urgent need to collect accurate data on the different aspects of acute poisoning, particularly in the countries of the developing world. Such data should not merely be looked upon as data to establish the extent of the problem, but rather as the starting point for programs for the control of acute agrochemical poisoning. Further, such data are necessary to monitor and evaluate the efficacy of different intervention programs that may be implemented for the control of acute agrochemical poisoning.

MATERIALS AND METHODS

The present study was conducted at the department of Forensic Medicine and Toxicology, Govt. Medical College Hospital, Chandigarh, a tertiary care hospital and referral center for the adjoining states of Punjab, Haryana, Himachal Pradesh and Jammu and Kashmir. The subjects of our study were 712 cases of poisoning out of a total number of 3178 cases of unnatural deaths subjected to medicolegal autopsy during the period 1996-2005. Autopsy records of those cases, whose test samples of body tissues, organs and fluids were examined for chemical analysis at the Forensic Science Laboratory/Chemical Examiner's laboratory, were included in the study. Type of the poison consumed was verified from the reports furnished by the Forensic Science Laboratory/Chemical Examiner. Information regarding age, gender, marital status, demographics, socio-economic status and type and manner of poison consumed was collected from the Hospital records and documented versions of relatives of the victim and the investigating officer at the time of autopsy.

RESULTS

The present study reveals that out of a total 3178 medicolegal autopsies conducted, poisoning was responsible for 712 (24%) of the unnatural deaths in Northern India. The percentage of the poisoning deaths remained steady around 19% during the period 1996-2000 followed by an abrupt increase to 27% in 2001 and 31% in 2002. This was followed by a decrease to 25% in 2004 and 24% in 2005. Overall, there was a steady increase in the incidence of poisoning from 18% in 1996 to 24% in 2005 (Table 1).

Table 1: Annual poisoning deaths in comparison to total unnational deaths

Year	Total Auto	Poisoning cases
1996	226	42
1997	264	49
1998	287	53
1999	303	58
2000	352	67
2001	372	100
2002	288	89
2003	338	71
2004	369	92
2005	379	91

Table 2: Age and gender distribution of total poisoning cases

Age group	Males	Females
0-10 years	3	0
11-15 years	11	3
16-20 years	74	61
21-25 years	130	80
26-30 years	82	35
31-40 years	75	34
41-50 years	54	18
51-60 years	32	13
>60 years	3	4

Table 3: Types of poison consumed

Poison	No. of cases
Aluminum phosphide	359
Insecticides	169
Alcohol	45
Corrosives/irritants	9
Diazepam	3
Cyanides	2
Nitrobenzene	2
Report pending	53
No definite opinion	70

Table 4: Marital status of rural and urban cases

Gender	Married	Unmarried
Rural male	172	119
Urban male	79	94
Rural female	98	37
Urban female	84	29

Young adults belonging to the age group 21 to 25 years constituted the majority 210 (30%) of victims, followed by the age groups 16 to 20 years (19%), 26 to 30 years (16%) and 31 to 40 years (15%). A significant decrease in the higher age groups 41 to 50 years (10%), 51 to 60 years (6%) and above 60 years (1%) was observed. Males outnumbered the females, the male: female ratio being 2: 1 (Table 2).

Aluminum Phosphide in 359 cases was the poison responsible for maximum number of fatalities, followed by insecticides in 169 cases. Alcohol in 45, corrosives and irritant in 9 and pharmaceuticals in 7 cases were reported to be responsible for the death. In 70 cases, who were admitted to the hospital and treated for more than three days as a case of poisoning and whose blood / urine and/or vomitus sample tested positive for poison during admission, the reports of chemical analysis of viscera on autopsy did not report any poison. 53 (7%) reports of the chemical analysis were pending at the time of writing this paper, however, in these cases also the blood / urine/vomitus had been tested positive for poison (Table 3).

60% Victims were from rural background of which 68% were males. In the rural category, 39.72% males and 23.59% females were married whereas among the urban victims 27.82% males and 29.58% females were married (Table 4).

History recorded at the time of admission to hospital or at the time of autopsy revealed that 669 (94%) of the deaths were suicidal in nature, followed by industrial / occupational accidents, 38 (5%) cases. Homicide accounted for 5 (1%) deaths.

DISCUSSION

The incidence of poisoning, intentional or accidental is on the rise despite the best efforts of legislative, punitive, social and educational machinery to combat this menace (Sharma *et al*., 2001). An increase in the percentage of deaths due to poisoning from 18.59% in 1996 to about 25% in 2004 and

the maximum incidence (48.45%) in the age group of 16-25 years noticed in our study are in conformity with the reports of other workers (Bhullar *et al*., 1996; Meena *et al*., 1994; Singh, 1999; Sharma, 1996; Bajaj and Wasir, 1988). The reasons for this trend may be that the younger age group is most susceptible to the lure of riches-the modern society's yardstick of success, as well as, frustration caused by the inability to cope with the highly competitive, indifferent and materialistic society. Some of the other important reasons are failure in exams or love affair, scolding/humiliation by peers and parents, inability to live up to the expectations of others etc.

In contrast to the findings of our study, deaths from acute poisoning, in England and Wales, have decreased over the last 20 years particularly because this period follows the substitution of 'natural gas' for 'town gas', which led directly to a fall in carbon monoxide deaths from nearly 4000 in 1963 to just over 1000 per annum 10 years later (Meredith *et al*., 1984). Studies have also reported very substantial changes in the agents responsible. Those due to barbiturates and non-barbiturate hypnotics have fallen (Crowe, 1989), whilst those due to analgesics and psychotropic agents have risen (Meredith and Vale, 1984). Increasing numbers of young men (14-24 years) in the United Kingdom have been reported committing suicide, with car exhaust fumes containing carbon monoxide (Hawton and Fagg, 1992).

In a study to describe trends in poisoning deaths, the US health professionals analyzed vital statistics data for 1990-2001 in 11 states. Trends were examined for the following categories: 1) all poisonings, 2) unintentional poisonings, 3) suicides, 4) homicides and 5) poisonings of undetermined intent. It was reported that during 1990-2001, the death rate from poisoning in the United States increased 56%, from 5.0 per 100,000 population in 1990 to 7.8 in 2001 while 14,078 (63%) of 22,242 poisoning deaths, in 2001, were unintentional (CDC, 2003).

According to the report, death rates attributed to unintentional and undetermined poisoning increased in all 11 states, with an average increase of 145% (range: 28-325%); poisoning homicide rates were stable and poisoning suicide rates declined. Nine states (Colorado, Delaware, Florida, Kentucky, New Mexico, North Carolina, Oregon, Washington and Wisconsin) reported increases in unintentional poisoning deaths; Massachusetts and Utah reported increases in undetermined poisoning deaths. The largest percentage increases in poisoning deaths were in Florida (325%), Kentucky (252%) and Massachusetts (228%). In Colorado (125%), Massachusetts and Washington (108%), death rates began to increase during 1991-1992. The death rates in Florida, Kentucky, North Carolina (80%) and Wisconsin (123%) were stable during 1990-1996 but increased thereafter. In contrast, the rates in Delaware (186%), New Mexico (105%), Oregon (28%) and Utah (183%) increased substantially during 1990-1998, but declined thereafter. In all 11 states, the increases in unintentional and undetermined poisoning death rates were greatest for persons aged 45-54 years (average increase: 359%; range: 139-710%) and persons aged 35-44 years (average increase: 195%; range: 14-910%). Among persons aged >65 years, the rate declined an average of 28%. Sex-specific unintentional and undetermined poisoning death rates also increased for males (average increase: 126%; range: 11-339%) and females (average increase: 203%; range: 95-486%) (CDC, 2003).

Countries in the developed and developing world seem to have different priorities in dealing with the public health problem of poisoning. Yet both seem to be making slow progress and ignoring common links. These common links indicate that the collaboration would be of immense benefit to both and that its lack is a needless wasted opportunity. Western nations are most concerned about terrorist use of chemicals. A major concern is the organophosphate chemical weapons or nerve gases, such as sarin, tabun and VX, which were developed in the middle of the 20th century (Lee, 2003). They are extremely toxic, with some causing death within minutes of exposure. The proportion of people who die in any future attack will depend on the gas used and the form and level of exposure. Meanwhile the developing world is coping with a largely hidden tragedy. Poisoning is seldom mentioned as a priority for health research in the developing world. Yet, in some Asian countries, poisoning is a leading cause

of premature death (Eddleston *et al*., 1998). Every year, hundreds of thousands of people are dying from pesticide poisoning (Eddleston, 2000; Phillips *et al*., 2002). Millions more are being treated in overstretched health services and a substantial number are left with long-term disability. Research or programs to tackle the problem of poisoning in developing countries has been insufficient, particularly for pesticides (Buckley *et al*., 2004). Organo-phosphate poisoning has been reported as an important issue for developing countries, accounting for most deaths and disability after exposure to pesticides (Eddleston *et al*., 1998).

It was observed in the present study that 60% of victims were from rural background with lesser resources available to them than their urban counter parts. This compounded by the usually large family size, high illiteracy, ignorance and superstitions, complete dependence on the fate of their crop-both in the field and in the market etc may be responsible for the trend observed in our study. An early marriage in the rural community, along with its added familial responsibilities, social customs, limited resources etc may be the factors responsible for married males (59%) outnumbering unmarried males in the rural population (41%). Conversely, a continuous hunt for a suitable placement/employment (a mandatory pre-requisite for marriage), associated disillusionment and frustrations etc leading to depression may be attributed to the reverse trend in urban population i.e., unmarried males (54%) outnumbering the married (45%). In case of females the percentage of married victims was almost similar in rural (73%) and urban (74%) in our study. This indicates that woes of the married female have no rural or urban barriers. Dowry, cruelty by the in- laws, family quarrels, mal-adjustments in married life, low level of education, infidelity, unemployment, dependence of the women on husband/in-laws etc are some of the important factors contributing towards the preponderance of fatal suicidal poisoning among the married women in both the rural and urban communities (Sharma *et al*., 2002).

Studies from the USA have reported that Narcotics and Psychodysleptics accounted for 51% of all poisoning deaths. The substances associated most frequently with poisoning deaths were cocaine (15%), alcohol (8%), heroin (7%), antidepressants (5%), benzodiazepines (5%) and methadone (5%) (CDC, 2003). Conversely, the studies from developing agricultural countries, report that agrochemicals (cholinesterase inhibitors, organochlorines and other pesticides) are more commonly used to commit suicide (Fernando, 1990). It has been estimated that globally pesticides account for one million serious unintentional poisonings and two million hospitalized suicide attempts annually, predominantly in developing countries (Jeyaratnam, 1990). A point to note is that the mortality rate from poisoning is to some extent determined by the lethality of the agent(s) involved and that this, in turn, results in regional differences in mortality rates. Thus, compared with Western Europe and North America, Sri Lanka has a low incidence of self-poisoning but a much higher mortality rate because of the frequency with which toxic agrochemicals, such as organophosphates and paraquat, rather than pharmaceuticals are involved (Hettiarachchi and Kodithuwakku, 1989). A similar picture emerges in our study also, where maximum number of deaths was due to ingestion of aluminum phosphide (50.42%). This compound has emerged as Poison of choice for suicides in northern India. Easy availability of aluminum phosphide as rodenticide for crop protection in the agriculture-based states, unavailability of any antidote, the certainty of death by ingestion of just a single tablet etc., have all contributed to the maximum deaths due to this compound. This finding in our study is in conformity with those of other workers from this region (Bhullar *et al*., 1996; Sagar *et al*., 1993; Lall *et al*., 1994).

Suicide was the most common mode of poisoning (94%). This endorses our views that the inability to cope up with the demands put forth by the standards set by the materialistic modern society is the main factor responsible for fatal poisoning in this region. Different workers in this field have also found similar results in their studies (Sagar *et al*., 1993; Lall *et al*., 1994; Singh *et al*., 1995). The relative significance of suicide in the incidence of pesticide poisoning has been projected as a point of international contention. Reports from other Asian countries (Jeyaratnam *et al*., 1982, 1987;

Malik *et al*., 1998) also identify suicide as the main circumstance for poisoning with pesticides, while equivalent data from countries in the America (Wesseling *et al*., 1993; Cole *et al*., 1988; Murray, 1994) point to occupational causes as the priority. However, the specific link between suicide and the agrochemicals, which is significant in rural areas in general and in Asian countries, in particular is perhaps less well understood and demands further studies in different cultures and regions.

Few health care professionals would deny that poisoning, accidental or deliberate, is a common problem in most countries throughout the world. Yet it is remarkably difficult to obtain meaningful statistics on the absolute morbidity or mortality resulting from poisoning, even in those countries with comparatively advanced systems for collection of population health data on account of a number of reasons: 1) A tendency to rely unduly on statistics compiled by poisons information centers for information on the incidence of poisoning and the resultant morbidity because many of those are suspected or potential cases of poisoning rather than true poisoning and few centers have the resources to obtain reliable follow-up data. Therefore, although information derived from enquiries made to poisons information centers provides a valuable guide to trends in poisoning (e.g., newly identified causes, changes in population groups affected, etc.,), it should not be used as the sole basis for making observations on either the incidence of poisoning. 2) When hospital activity data are used to determine the number of cases. Not all cases of poisoning, or suspected poisoning are referred to hospital and not all cases referred are admitted (CDC, 2003), even if true poisoning has occurred. The number of deaths recorded by hospitals can be equally misleading, because the many fatalities from poisoning may occur outside hospital without intervention by health care professionals.

In view of the magnitude of this problem, its impact and its relative neglect so far, three WHO departments (Mental Health and Substance Abuse, Injuries and Violence Prevention and the Program on the Promotion of Chemical Safety) recently joined forces to produce an action proposal entitled The impact of pesticides on health: preventing intentional and unintentional deaths from pesticide poisoning. This initiative has already received strong support from civil society and some of the governments (WHO, 2006).

CONCLUSIONS

Agrochemical poisoning is a major public health problem in developing countries particularly in settings of low education and poor regulatory frameworks. Agrochemical usage, both agricultural and non-agricultural, has increased substantially in the recent past and so has increased its misuse to commit suicide. Key to the control of agrochemicals-related morbidity and mortality is the need for accurate, timely and effective surveillance systems that is effective and can demonstrate usefulness of the data generated at different levels of policy planning. Appropriate action at different levels – administrative, social, health-care and research needs to follow reporting of the data.

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