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Human Poisonings and Rodenticides: Evaluation of Incidents Reported to the American Association of Poison Control Centers

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Abstract: Accidental human exposure to pesticide products is a major concern of the U.S. Environmental Protection Agency (EPA). One condition of product reregistration is the submission of product-specific incident report summaries from the American Association of Poison Control Centers (AAPCC) Toxic Exposure Surveillance System (TESS). Between 1986 and 1998, the AAPCC received a total of 22,921,827 incident reports from telephone calls and physician reports. The total number of incident reports per year more than doubled between 1986 and 1998, with 2,241,082 incidents in 1998. While the total number of incidents increased each year, the reporting per year rate remained constant at approximately 9 reports per 1,000 individuals. Rodenticide related incident reports increased from 8,705 in 1986 to 20,300 in 1998. However, the yearly reporting rate for rodenticide incidents remained constant at approximately 8 reports per 100,000 individuals. Since 1990, anticoagulants have consistently accounted for 82% to 89% of all rodenticide exposures and "long-acting" anticoagulants (i.e., 2nd generation compounds such as brodifacoum) have accounted for 83% to 91% of all anticoagulant incidents. Although there was variation between years, there were approximately 150 incident reports each year for both strychnine and zinc phosphide. "Unintentional" exposures accounted for approximately 85% of all incidents reported to the AAPCC. With the exception of strychnine, unintentional exposure to rodenticides was slightly higher, at 90%. In the case of zinc phosphide, nearly all exposures (>97%) were unintentional. The majority of exposures involved children less than 6 years old. However, adults were reported to be involved more than 50% of the strychnine incidents. Despite the high number of exposures, very few cases resulted in more than minor symptoms.

Key Words: anticoagulant, poison, primary poisoning, rodenticide, strychnine, zinc phosphide

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INTRODUCTION

The U.S. Environmental Protection Agency (EPA) issued Reregistration Eligibility Decisions (RED) for strychnine and zinc phosphide rodenticides in 1996 and 1998, respectively (U.S. EPA 1996, 1998). Included in the REDs were Generic Data Call-In (GDCl) notices requiring all registrants to submit human poisoning incidents received by the American Association of Poison Control Centers (AAPCC) and housed in the AAPCC's Toxic Exposure Surveillance System (TESS). The EPA requested these data be submitted for strychnine for the 6-year period 1990 through 1995. The EPA also requested yearly data submissions for zinc phosphide for the 11-year period between 1999 and 2009. This EPA request was the result of the growing concern for accidental exposure among children less than 6 years old. Additionally, the EPA was concerned with the rate of incidents resulting in death or noticeable symptoms. In this paper, incidents reported to the AAPCC between 1986 and 1998, involving rodenticides are examined in relation to the type and registration status of the material involved, the age of the victim, the location of exposure, and the severity of symptoms. The general characteristics of rodenticide incidents are compared to those of all incidents reported to the AAPCC. This examination will identify sets of circumstances or groups of individuals that may be at higher risk of rodenticide exposure and assist registrants and regulators in evaluating the real risk

of compounds when considering product modifications or regulatory actions.

METHODS

Five databases were queried to collect information for this report. The AAPCC's TESS database was queried for product-specific information on poisoning incidents involving strychnine and zinc phosphide during 1990-1992 and 1996-1998, respectively (Litovitz, unpubl. data). The current registration status of products identified in the TESS database was obtained from the EPA's Reference File System (REFS), the National Pesticide Information Retrieval System (NPIRS), and the Pesticide Product Label System (PPLS). Finally, annual reports of the AAPCC were used to obtain information on historical incidents rates (Litovitz et al. 1986 through 1999). Each zinc phosphide and strychnine incident identified in the TESS database was evaluated for the following information: registration status of the identified product, location and nature of the incident, route and frequency of exposure, age and sex of the exposed individuals, severity of symptoms, medical attention requirements, and the medical outcome.

The AAPCC considers product-specific information within the TESS database confidential business information. The AAPCC will only release product-specific information to the owner of identified products. Therefore, with approval of all respective consortium

members, product-specific data was purchased for strychnine and zinc phosphide. Consequently, the registration status of products identified in incidents and information surrounding individual incidents could only be determined for strychnine and zinc phosphide products.

RESULTS

A total of 524 incidents involving strychnine were reported in the 1990-1992 AAPCC annual reports. The AAPCC's TESS data summary reported approximately 35% fewer incidents than the annual reports. Dr. Toby Litovitz of AAPCC (pers. comm.) explained that prior to releasing the data requested by the Strychnine Consortium, a rematching, checking, and cleaning of the data set eliminated 29 incorrectly entered products (185 individual incidents that were not related to strychnine-based rodenticides). However, these incidents remained in the annual reports.

Between 1986 and 1998, the AAPCC received a total of 22,921,827 incident reports via telephone calls and physician reports on such varied incidents as suicide attempts, accidental ingestion of rodenticides, eye irritations caused by cosmetics, children ingesting toothpaste, and fishing lure injuries. The total number of incident reports received per year by the AAPCC more than doubled between 1986 and 1998, with 2,241,082 incidents reported in 1998. While the total number of incidents increased each year, the rate at which incidents were reported remained constant at approximately 9 reports per 1,000 individuals serviced by a poison control center. During the same period, the number of rodenticide incidents increased from 8,705 to 20,300 per year. However, the rate at which rodenticide incidents

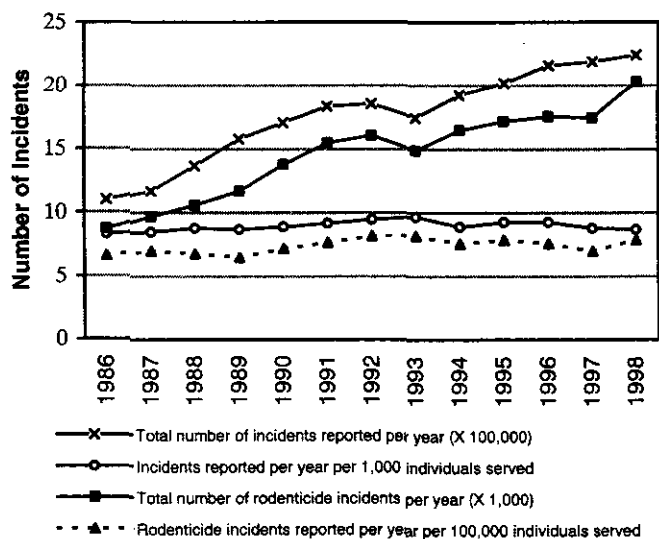


Figure 1. Total number of incidents reported to the AAPCC and the number of incidents per 1,000 individuals serviced by poison control centers (1986 through 1998).

were reported has remained constant at approximately 8 reports per 100,000 individuals (Figure 1) (Litovitz et al. 1986 through 1998).

As Figure 2 clearly indicates, most rodenticide incidents were attributed to anticoagulant rodenticides. In 1987, the AAPCC began categorizing anticoagulant-related incidents as "Anticoagulant: long-acting" (2nd generation compounds) and "Anticoagulant: standard" (1st generation compounds). Since 1990, anticoagulants have consistently accounted for 82% to 89% of all rodenticide exposures and "long-acting" anticoagulants have accounted for 83% to 91% of all anticoagulant incidents. In 1988 "standard" anticoagulants accounted for 43% of the total number of rodenticide incidents. In 1991, the number of "standard anticoagulant" incidents significantly dropped and since that time has averaged around 1,500 incident reports per year or 7% of all rodenticide related reports. Although there was slight variation between years, there were consistently about 150 incidents reported per year for both strychnine and zinc phosphide.

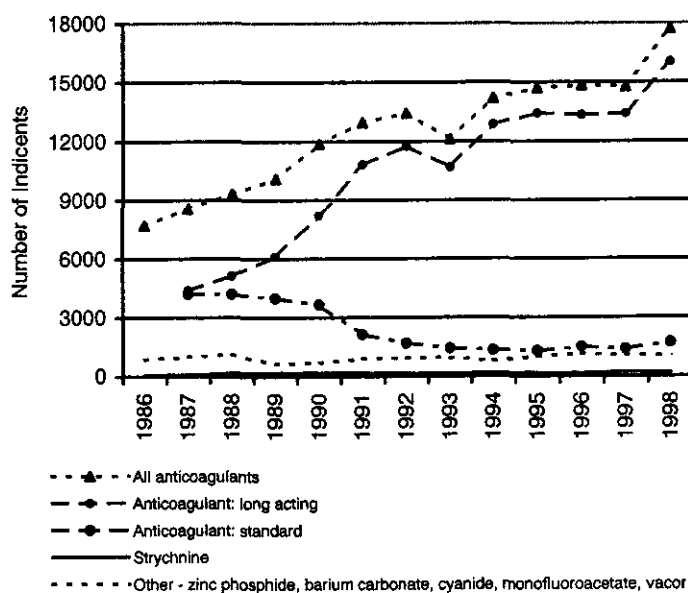


Figure 2. Human poisoning incidents involving rodenticides reported to the AAPCC (1986 through 1998).

Product Registration Status

A total of 415 zinc phosphide incidents were reported to the AAPCC between 1996 and 1998. These incidents involved 23 identified products and a general "zinc phosphide" group. Eleven currently registered General Use products accounted for 260 (62.7%) of all zinc phosphide incidents. A single product accounted for 174 (41.9%) of all zinc phosphide incidents. The generic "zinc phosphide" group accounted for 118 (28.4%) of poisoning incidents. Restricted use products accounted for 4.6% of the zinc phosphide incidents.

Strychnine was implicated in 336 incidents between 1990 and 1992 and involved 41 identified products and a general "strychnine" group. This generic group accounted for the greatest number of cases (n=202), or 60.0% of all strychnine-related incidents. Products known to be, or assumed to be, canceled accounted for 26.2% (n=88). Five currently registered General Use products accounted for 29 reported incidents. Currently registered Restricted Use products were cited in 17 poisoning incidents. Therefore, of the 336 strychnine incidents, only 14% resulted from products that are currently registered.

Because of differences in the way the AAPCC presents data in its annual reports, changes in the annual report format, and what the AAPCC provides when product-specific data is purchased, data could not be uniformly analyzed. Results presented below for exposure and medical outcome of exposures involving "rodenticides" will not include age-specific or route-of-exposure details. Additionally, most data presented below are for 1996 through 1998, with the exception of TESS strychnine, which is for 1990 through 1992. Trends in strychnine exposures were compared between 1990-1992 and 1996-1998. No significant differences were found. Therefore, 1996 through 1998 annual reports are used to evaluate strychnine trends.

Exposure

"Unintentional" incidents accounted for approximately 86% of all incidents reported to the AAPCC. With the exception of strychnine, unintentional rodenticide incidents were slightly higher at 90%. The most common site for all incidents was at a residence (91%), with more than 88% of these occurring at the patient's home. The most common routes of exposure reported in poisoning incidents were ingestion (74%), dermal (8%), inhalation (7%), and ocular (6%). Children less than 6 years old were involved in over half of all incidents reported to the AAPCC. Adults older than 19 were involved in 32% of incidents and 72% of these were unintentional. More than 86% of the rodenticide incidents involved children.

Nearly all zinc phosphide incidents (>96%) were unintentional. Incidents most commonly occurred at a residence (85%) with 95% of these occurring at the patient's residence. Zinc phosphide incidents most commonly involved ingestion (60%). However, inhalation and dermal exposure were specified in 26% and 11% of reports, respectively. Children less than 6 years old accounted for over half of all zinc phosphide incidents. Adults older than 19 years old were involved in 39% of the incidents and 91% were unintentional. Unintentional incidents at the workplace accounted for 7% of the adult cases.

Unlike trends observed for other rodenticides, during the 3-year period between 1996 and 1998, only 50% of strychnine incidents were unintentional exposures. According to the TESS database, there were 272

unintentional incidents (81%) during 1990 and 1992. During this period, the most common location was at a residence (77%). Ingestion was the most common route of exposure (57%), followed by dermal (16%) and inhalation (14%) and ocular (<1%). Adults older than 18 were the most frequently reported age group, accounting for nearly 55% of all reported strychnine incidents of which 30% were intentional. Children less than 6 years of age accounted for 29% of strychnine incidents.

Health Care Requirements

The AAPCC attempts to track exposed individuals to determine the outcome of poisoning incidents. One aspect reported for each tracked incident is the rate at which patients required treatment at a health care facility (HCF). Approximately 22% of all incidents reported to the AAPCC involve treatment at a HCF (Figure 3). Of those examined at a HCF, 57% were treated and released. Approximately 27% were admitted for further treatment. Sixteen percent of those examined at a HCF were lost to follow-up. Rodenticide exposure patients were treated at a HCF in 35% of the incidents.

When the incident involved zinc phosphide, 35% of all patients were treated at a HCF (Figure 3). Approximately 8% of all patients evaluated at HCFs were admitted for further treatment. Eighty percent of the patients evaluated were treated and released. These rates are similar for children. However, children were nearly twice as likely (21%) to be taken to a HCF as adults (13%). Twelve percent of the patients were "lost to follow-up."

More than 55% of the patients exposed to strychnine either go to or are referred to a HCF (Figure 3). Twenty-one percent of strychnine incident patients were hospitalized for further treatment. Forty percent of the patients evaluated were treated and released and did not require hospitalization. Forty percent of the patients were "lost to follow-up." When children were involved, 61% were taken to a HCF.

Medical Outcome

Cases for which symptoms or outcome were known were categorized based upon the severity of the symptoms and health care received. The following terms were used in this classification:

No Effect: patient displayed no signs or symptoms.

Minor Effect: patient displayed some symptoms from exposure but they were rapidly resolved.

Moderate Effect: definite symptoms from exposure were noted, usually requiring treatment or medical attention, not life-threatening.

Major effects: life-threatening symptoms.

Death: death due to effects of exposure.

The medical outcome of the individuals exposed in all AAPCC exposures and rodenticides exposures was unknown for 50% and 44% of the incidents, respectively. Of the 6,589,122 incidents occurring during 1996 through 1998, less than 5% fell within the scope of EPA's

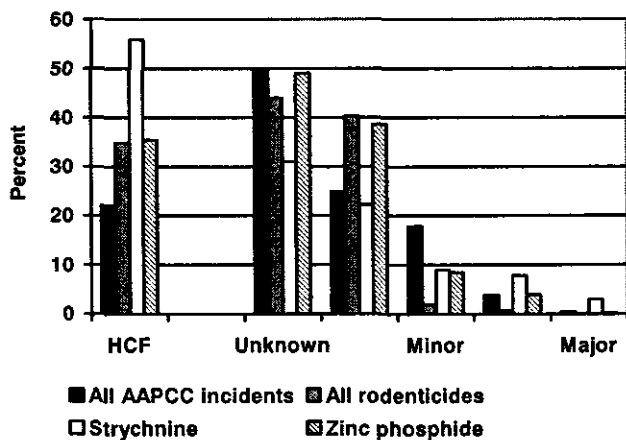


Figure 3. The relative severity of incidents reported to the AAPCC and the percentage of patients seeking treatment at a health care facility (1996 through 1998).

concerns, moderate (3.9%) or major symptoms (0.5%), or death (<0.03%) (Figure 3). Only 0.8% of the children involved in all incidents exhibited symptoms more severe than minor. This included 70 deaths. Symptoms in less than 1% of the incidents attributed to rodenticides were more severe than minor. This includes 19 deaths.

The medical outcome of the individuals exposed to zinc phosphide was unknown for nearly 49% of the 415 incidents occurring between 1996 and 1998. "Moderate" and "Major" outcomes accounted for 3.9 and 0.2% of all incidents, respectively (Figure 3). Only 4 children exhibited moderate to major symptoms. No children died from zinc phosphide exposure. Unrelated symptoms were noted in 10% of the incidences. Incidents where the outcome was unknown or patients were lost to follow-up accounted for an additional 25 incidents (6.0%).

According to the TESS data for strychnine (1990-1992), the medical outcome of the exposed individuals was unknown for 31% of the incidents. Nineteen percent of the patients exhibited unrelated symptoms. During 1996 through 1998, 8% of the patients exhibited symptoms more severe than minor, including 7 deaths. TESS data indicate children were involved in 29% of all strychnine incidents. The majority of incidents involving small children (81%) were assessed as asymptomatic. Less than 10% showed related symptoms.

Between 1996 and 1998 the AAPCC reported a total of 2,236 fatalities, of which 1,738 were intentional exposures, and 1,181 were successful suicide attempts. During the same period, rodenticides were implicated in 19 deaths. Eight deaths were attributed to anticoagulants, 7 of which were suicides. Three of the suicides involved only anticoagulants. Four others involved concomitant material such as aspirin, acetaminophen, and marijuana. All of the victims were over 17 years old. Strychnine was implicated in 7 deaths, 5 of which were suicide. All of the victims were older than 35 years old. Concomitant materials including ethanol, arsenic, cyanide, and cocaine

were involved in 6 of the 7 strychnine-related deaths. Only one death, a 38-year old suicide victim, was related to zinc phosphide during this period.

CONCLUSIONS

Incidents reported to the AAPCC involving rodenticides have increased in proportion to the rate of increase in the general population. The total number of incidents reported to the AAPCC each year has steadily increased by approximately 170,000 per year. However, when the increase is adjusted for the growth of the population in areas served by poison control centers, the reporting rate has remained constant at approximately 9 reports per 1000 individuals. The same trend is evident for rodenticides. Rodenticide incident reports are increasing by 900 incidents per year, but again, the reporting rate has remained constant at approximately 8 reports per 100,000 individuals. Since the number of strychnine and zinc phosphide incidents has remained steady at approximately 175 per year during the last decade, the reporting rate for these two compounds may actually be decreasing.

"Long-acting" anticoagulant rodenticides (brodifacoum, etc.) are driving the reporting of incidents on rodenticides to the AAPCC. There is a steady increase in the total number of rodenticide incidents reported to the AAPCC each year. The AAPCC data clearly indicate that anticoagulants are responsible for nearly all of the rodenticide incidents, and since 1990 "long-acting" anticoagulants have consistently accounted for 85% of all rodenticide incidents. This is likely due to the increased use of "long-acting" anticoagulants in rodenticide products purchased by homeowners for commensal rodent control.

Strychnine incidents are not typical of other rodenticide incidents in that the victim is more often an adult and the exposure was more likely intentional. Fifty-five percent of strychnine incidents were adults over 17 years old and 30% of these were intentional exposures. On the other hand, adults accounted for less than 40% of zinc phosphide incidents and only 9% of these were intentional exposures. Because strychnine is more often intentionally ingested, one might expect a higher rate of severe symptoms. In fact, strychnine exposures resulted in a slightly higher rate (8%) of moderate to major symptoms than rodenticides in general (1%) and victims of strychnine exposure were nearly twice as likely to be examined at a health care facility. In addition, the number of incidents where the symptoms were unknown was approximately 13% less than for rodenticides in general.

With the exception of strychnine, rodenticide incidents most often involve children. However, very few of the exposed children exhibit more than minor symptoms.

Children are being exposed to rodenticides at a significantly higher rate than all other incident types reported to the AAPCC (86% vs. 53%, respectively). Incidents involving children were far more likely to be

treated at a health care facility than those not involving children. However, few (<1%) rodenticide-related incidents resulted in moderate or major symptoms. No deaths occurred for children for any type of rodenticide during the period of this analysis. No matter what product is involved, nearly 100% of the incidents involving children were accidental and occurred at a residence, usually the child's own home.

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* Editors' Note: For ease of reference, the citations by Litovitz et al. are listed in chronological order rather than by alphabetically by co-authors.