

Workplace Toxic Exposures Involving Adolescents Aged 14 to 19 Years

One Poison Center's Experience

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Background: While many previous reports describe injuries to adolescents in the workplace, few focus on toxic substance exposures among such injuries. Yet low-skill, entry-level jobs pose a particular hazard of toxic exposure owing to the frequent use of cleaning agents, solvents, and/or other chemicals in carrying out assigned tasks.

Objective: To analyze the types and severity of adolescent occupational toxic exposures.

Design: Secondary analysis of calls to a single regional poison control center (PCC).

Setting: Massachusetts PCC poisoning consultations between 1991 and 1996.

Subjects: Children aged 19 years or younger reporting toxic exposures occurring in the workplace.

Results: Of 7024 occupational toxic exposures recorded by the PCC in the 6 years of study, 269 incidents (3.8%) involved adolescents aged 14 to 19 years (median age, 18 years; 124 aged 14-17 years and 145 aged 18-19 years; 65% were male). The most frequently in-

involved agents were cleaning compounds (27.8%); paints, solvents, and glues (9.0%); caustics (8.7%); hydrocarbons (8.7%); and bleaches (7.3%). Of 88 cases (32.7%) in which a worksite was identified, food services (30.7%), automotive services (14.8%), and general retail stores (12.5%) were the most common locations. One hundred fifty-six patients (58.0%) were triaged to an emergency department; 7 were hospitalized. Forty-three subjects (16.0%), 18 who were between the ages of 14 and 17 years and 25 who were aged 18 or 19 years, were judged to have moderate to severe injuries. There were no deaths.

Conclusions: This study confirmed the usefulness of PCC surveillance as a source of information about adolescent toxic exposures occurring in the workplace. The occupational toxic exposures reported here most commonly involved cleaning agents, solvents, paints, caustics, and bleach used in those entry-level jobs most frequently filled by adolescents. We conclude that occupational toxic exposures are an underrecognized adolescent injury, and that PCC experience can be used to fill a gap in the surveillance of such workplace-associated events.

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Editor's Note: Now these are classic examples of poisoning adolescents against work.

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AS MANY as 4 million children and adolescents are legally employed in the United States; an additional 1 to 2 million are suspected to be employed in violation of the Fair Labor Safety Act.¹ A recent report from the Institute of Medicine (Washington, DC) on adolescent work injuries observed that as many as 80% of high school students hold jobs during some part of the school year.² Injuries suffered by children and adolescents in the work-

place have long been recognized as an important public health problem. As many as 64 000 work-related injuries among children and adolescents are treated in emergency departments annually, which projects to an estimated 200 000 such injuries occurring in the United States.³

In reviewing adolescent workplace injury types, many authors cite a theoretical risk to adolescents of exposure to toxic agents such as solvents, hot liquids, and grease (from fast-food or full-service restaurants),⁴ benzene, lead and pulmonary sensitizers (from gas stations and automobile repair shops),⁵ or pesticides and nicotine (used in agricultural jobs).^{5,6} Yet there are few data defining the number of incidents involving youth exposed to toxins in the workplace. There are anecdotal reports of adolescent deaths from toxic ex-

MATERIALS AND METHODS

We analyzed computer-coded telephone records of toxic exposures reported to the Massachusetts Poison Control System, Boston, from 1991 to 1996. Only those records involving adolescents aged 14 to 19 years and in which the site of the toxic exposure was coded as the worksite were included. Cases were excluded if the written record could not be found. Because we were interested only in those toxic injuries specific to a worksite, if the record indicated that this was a suicide attempt, then the case was excluded. Each medical record was retrieved and reviewed for information regarding the patient's age and sex, the toxin involved, the site, time, and circumstances (if available) of the exposure, any related symptoms or signs of toxic effects, triage to health care, disposition, and medical outcome. In cases in which the type of worksite was not noted, but the correct telephone number of the worksite was recorded, sites were called to classify the type of worksite.

For certain analyses, toxins implicated in the exposure were classified into 14 larger descriptive categories. **Table 1** gives examples of how individual products and chemicals were sorted into these 14 categories. Medical records were reviewed for notations about the circumstances of the poisoning. Worksites were classified into 10 industry sectors (**Table 2**). Medical outcomes defined previously by the American Association of Poison Control Centers²⁰ include the following:

- No effect: The patient developed no symptoms as a result of the exposure.
- Minor effect: The patient exhibited some symptoms, but they were minimally bothersome. The symptoms resolved rapidly.
- Moderate effect: The patient exhibited symptoms that were more pronounced, more prolonged, or more systemic in nature than minor symptoms but were not life-threatening. Usually some form of treatment was indicated.
- Major effect: The patient exhibited some symptoms that were life-threatening or resulted in significant residual disability or disfigurement.
- Not followed up, judged as nontoxic exposure: The patient was not followed up because the substance was judged to be nontoxic.
- Not followed up, no or minimal medical effects possible: The patient was not followed up because the exposure was likely to result in only minimal toxic effects.
- Unable to follow up, judged as a potentially toxic exposure: The patient was lost to follow-up and the exposure was significant and may have resulted in toxic manifestations with a moderate, major, or fatal outcome.

This research was approved by the Committee on Clinical Investigation at Children's Hospital, Boston, Mass.

posures in the workplace.⁷⁻⁹ In a review of North Carolina medical examiners' cases between 1981 and 1989, Dunn and Runyan¹⁰ reported that 5 of 71 childhood deaths on the job were related to poisoning. An analysis of the

Table 1. Toxins Involved in Accidents in the Workplace Among Adolescents

Category	Examples
Cleaners (not including bleach)	Industrial cleaners, disinfectants (nonbleach), ammonia cleaners, drain cleaners, glass cleaners, bathroom cleaners
Caustics	Corrosives (alkaline), potassium hydroxide, sodium hydroxide, hydrofluoric acid, muriatic acid, battery acid
Automotive products	Antifreeze, oil, ethylene glycol
Pesticides/herbicides/fertilizers	Insecticides, fertilizers, garden fungicide
Bleach	Hypochlorite bleaches
Paints, glues, and solvents	Adhesives, paints (including lead paint), paint thinner, wood sealer, turpentine
Miscellaneous chemicals	Copper, bromine, chlorine, radium, mercury
Biologicals	Fish stings, spider bites, mold, spoiled food
Building and construction products	Fiberglass, asphalt, tar, fluorescent lightbulbs
Hydrocarbons	Gasoline, kerosene, xylene, diesel fuel
Refrigerants	Freon, refrigerants
Drugs	Caffeine, nicotine, acetaminophen, aspirin
Cosmetics	Nail polish remover, nail glue, aloe vera
Unknown/miscellaneous	Other chemicals, no substance found

National Traumatic Occupational Fatalities surveillance system from 1980 to 1989¹¹ discovered 20 deaths from poisoning in male adolescents aged 16 or 17 years, a rate of 0.28 deaths per 100 000 full-time equivalents.

A few studies of morbidity related to adolescent occupational injuries refer obliquely to toxic exposures. In a Massachusetts investigation of 2551 adolescent workers' compensation claims, 29 claims were related to chemical burns.¹² A similar New York study of 9656 workers' compensation claims included 49 adolescents with chemical burns and 17 cases of poisoning.¹³ Several studies of adolescent workers presenting to emergency departments with injuries sustained on the job include numerous cases of chemical burns and scalds from grease, deep fat fryers, or hot water.¹⁴⁻¹⁶ In a study of 1361 work-related injuries suffered by adolescents and treated in one emergency department in Dunedin, New Zealand, during 1990 to 1993, there were 27 cases of chemical burns to the eye.¹⁷ Among 37 405 adolescent injuries reported by emergency departments to the Consumer Product Safety Commission's National Electronic Injury Surveillance System (Washington, DC) in a 6-month period, there were 4629 burns, 3553 of which were sustained in the service industry. Of these 3553 burns, 14.8% were from exposure to caustic liquids.¹⁸

The databases currently recommended for surveillance with regard to adolescent workplace injuries include workers' compensation records, the Annual Survey of Occupational Injuries and Illnesses, hospital discharge data, the Census of Fatal Occupational Injuries, the National Electronic Injury Surveillance System, and the National Traumatic Occupational Fatalities System.¹⁹ All of these sources of data are likely to

Table 2. Workplace Injuries Categorized by Industry Sector

Site	No. of Injuries by Age Group, y			Categories of Toxins
	14-17	18-19	14-19 (%)	
Food services	17	10	27 (30.1)	12 Cleaning products 3 of Each: bleach, hydrocarbons 1 of Each: automotive products, miscellaneous chemicals, construction products, drugs, refrigerants 4 Miscellaneous/unknown
Automotive services	5	8	13 (14.8)	5 Hydrocarbons 4 Automotive products 1 of Each: caustics, cleaners, paints, and glues 1 Miscellaneous/unknown
Retail trade-general merchandise	4	7	11 (12.5)	2 of Each: biological, caustics, drugs 1 of Each: cleaners, pesticides, refrigerants 2 Miscellaneous/unknown
Miscellaneous/unknown	4	5	9 (10.2)	3 Hydrocarbons 1 of Each: biologic, paints, and glues 4 Miscellaneous/unknown
Health services	1	7	8 (9.1)	5 Cleaners 1 of Each: drug, pesticide 1 Miscellaneous/unknown
Recreational services	3	4	7 (8.0)	1 of Each: biologicals, bleach, cleaners 4 Miscellaneous/unknown
Retail trade-food/bakery/dairy	2	4	6 (6.8)	2 Cleaners 1 of Each: miscellaneous chemicals, hydrocarbons, pesticide 1 Miscellaneous/unknown
Construction/painting	1	2	3 (3.4)	3 Paints, glues, and solvents
Agriculture	1	2	3 (3.4)	1 of Each: construction products and hydrocarbons 1 Miscellaneous/unknown
Hotel services	0	1	1 (1.1)	1 Caustic
	38	50	88 (100)	

undercount toxic exposure involving adolescents because (1) death from an occupational toxic exposure is very rare, (2) many injured adolescents do not self-refer to the emergency department, (3) many adolescents are not eligible for or will not file a claim for workers' compensation, (4) small businesses (or private residences) where adolescents often work may not be required to report such injuries, (5) businesses that are required to report injuries may not enforce this rule, or (6) a toxic exposure in the workplace may not be recognized as the cause of an adolescent's symptoms or death.

The objective of the current study was to define the frequency, circumstances, and medical severity of adolescent occupational poisonings and toxic exposures occurring in Massachusetts by using a novel database. If such incidents are detectable as "sentinel events," then it might be possible to use the existing health care network not only to manage cases, but also to define high-risk groups and direct population-based preventive interventions.

RESULTS

Of 7024 occupational exposures reported to the poison center in the 6-year study period, we identified 313 poison center cases involving adolescents aged 14 to 19 years (**Figure 1**). Of these, 44 cases did not meet our inclusion criteria (in 33 cases, no medical record could be found, 2 cases were duplicates, and 9 cases were misclassified and no drug or toxin was involved). Thus, 269 cases (3.8%) of occupational toxic exposures and poi-

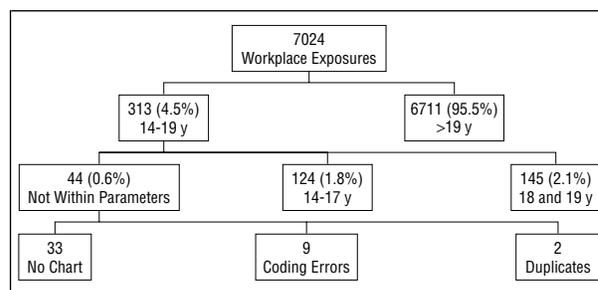


Figure 1. Flow diagram of data collection results.

sonings among adolescents aged 14 to 19 years were entered into the analysis. Of those adolescents, 124 were younger (aged 14-17 years) and 145 were older (aged 18 or 19 years).

Figure 2 gives the age and sex distribution of the 269 cases. The median age was 18 years old; 66% of the victims were male.

TOXIC AGENTS

There were 288 individual toxic agents (in 19 of the cases, the adolescent was exposed to more than 1 substance) involved in these exposures. **Figure 3** presents the relative frequencies of exposures to different types of toxins, subdivided by route of exposure. Nonbleach cleaning products (27.8%) were most commonly involved; many of these contained upper-airway irritants such as ammonia. Other common substances included paints,

glues, and solvents (9.0%), caustics (8.7%), hydrocarbons (8.7%), and bleach (7.3%).

WORKSITE

In one third of the cases (n = 88), the worksite was identified and was confirmed by a follow-up telephone inquiry. Table 1 identifies the worksites involved in these exposures. Food services had the most toxic exposures (30.7%); more than half of the food service sites were fast-food restaurants. Automotive services and other retail stores were other common sites of exposure.

SYMPTOMS AND SIGNS OF TOXIC EFFECTS

Figure 3 shows frequency of these poisonings defined by the category of toxin involved as well as the route of exposure (inhalation, ocular, dermal, or a combination of routes). The most common routes of exposure included inhalations (27.5%), ocular splashes (27%), skin contamination (21.1%), and ingestions (18.2%). Symptoms often included irritation of the eyes and throat, in cases of exposure to simple irritants such as bleach, ammonia, and cleaning agents. Patients also complained of temporarily impaired vision, nausea, and/or dizziness related to exposure to solvents, bleach, or cleaning agents. Skin burns were frequently the result of exposure to caustics.

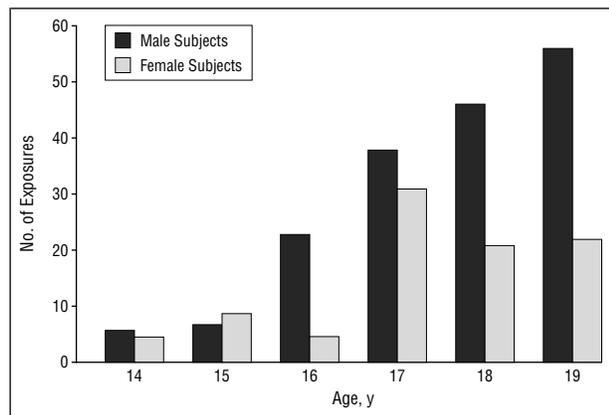


Figure 2. Age and sex of 269 subjects who reported toxic exposures that occurred at the worksite.

SEVERITY AND OUTCOME

One hundred fifty-six (58%) of these adolescents referred themselves to a health care facility or were triaged there by the poison center for further evaluation of their injuries. Forty-three incidents (15.9%) involving 48 separate toxins were coded by a poison center staff member as having had an injury outcome of moderate or major severity. As **Figure 4** shows, almost half of these severe injuries involved caustics or cleaning compounds. However, only 7 (2.6%) of 269 adolescents required short periods of hospitalization for observation and there were no deaths.

COMMENT

This study confirms that toxic exposures occur with some frequency among adolescents aged 14 to 19 years working in a variety of occupational experiences; 3.8% of all toxic exposures in the workplace reported to one poison control center in a 6-year period involved children aged 19 years or younger. Almost half of the injuries involved cleaners, bleaching agents, or caustics. It is likely that both food and health service establishments use strong cleaning agents such as bleach or ammonia to sanitize workspaces and equipment, and adolescents come into contact with these substances during

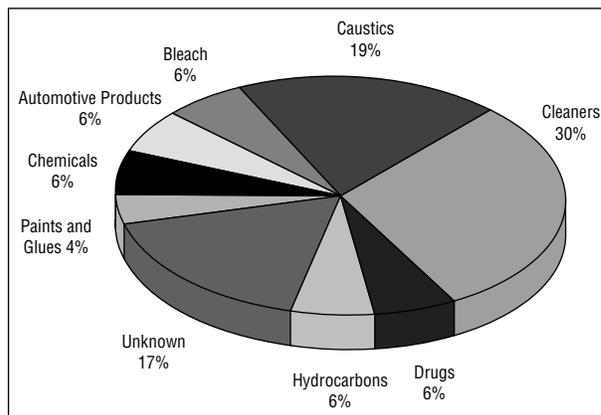


Figure 4. Forty-eight toxins producing 43 injuries rated in severity of medical outcome as either moderate or severe.

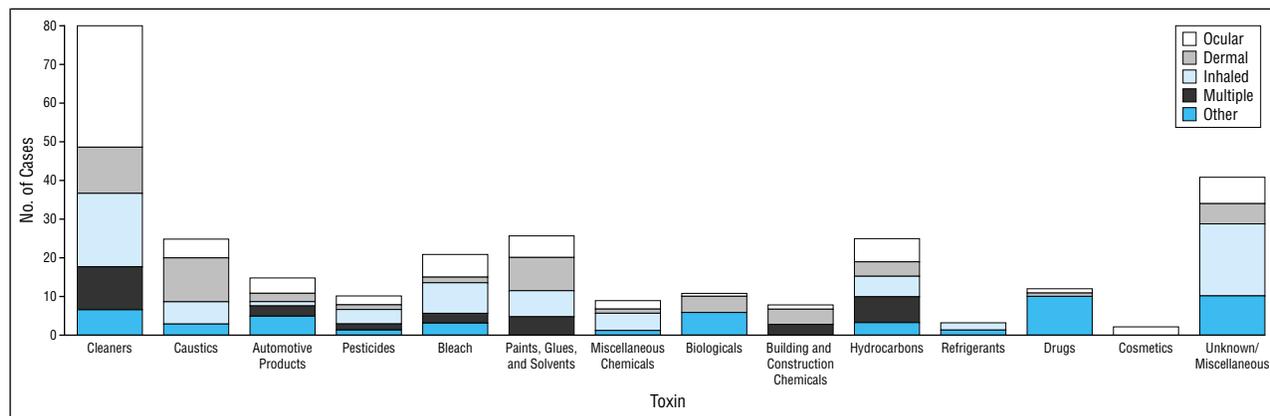


Figure 3. Chemical agents involved in 288 adolescent toxic exposures, by route of exposure. The category "miscellaneous" is not further defined in the dataset.

routine cleaning tasks. Other frequently involved substances included automotive products, paints, and glues. Adolescents find often work in automobile repair shops, which commonly use hydrocarbon-based solvents, oil, benzene-containing gasoline, and degreasers in their operations. Part-time work for painting or remodeling contractors can account for the exposure of adolescents to paints, thinners, and other toxic chemicals such as asbestos. Such work may also inadvertently expose them to contact with lead-containing dust from older painted surfaces.

Why are these adolescents at high risk for injury from a toxic exposure on the job? Entry-level jobs with minimal skill requirements are those most commonly secured by adolescents. Such jobs pose a particular hazard of toxic exposure owing to the frequent use of cleaning compounds, solvents, caustics, and/or other chemicals in carrying out assigned tasks. Because many of these jobs may be in small businesses or homes, they may not be carefully regulated by governmental agencies. Adolescents involved in part-time or seasonal work may not be adequately trained for the tasks they do and may not receive important safety information about toxic solvents, pesticides, or cleaners they are using. Although parents and adolescents are warned by such child advocacy groups to carefully consider safety issues when securing work, such issues are likely to be assigned a lower priority in the family's decision-making when jobs for which the youth can qualify are limited. Risk-taking behaviors within the context of adolescent perceptions of personal safety may influence vulnerability to workplace injuries. Further, adolescents may be motivated by their achievement of an "adult status" activity (ie, employment) and disregard their personal safety to please an employer.

Many of the cases reported here included children younger than 18 years whose work experience falls under the regulations of the Fair Labor Safety Act. There have been recent increases in detected child labor violations and a general relaxation in the enforcement of child labor laws.^{1,21-24} Violation of the restriction on total working hours per week may contribute to an adolescent's fatigue, making him or her more susceptible to making a mistake when working with hot oil, a corrosive compound, or another agent.²⁴ Whether any of the toxic exposures described in this report occurred in violation of the Fair Labor Safety Act is unknown.

There are limitations in this study and the results should be interpreted cautiously. Poison control centers remain a voluntary reporting system; therefore one cannot derive population-based injury rates from such a database and it is likely that our data underestimate the true incidence of adolescent occupational toxic exposures and poisonings. Similarly, it is difficult to assess how much risk may be age-related. While the frequency of such injuries among children aged 14 years was low, the average number of months on the job for this group is probably much lower than that of older adolescents.

In some cases, the nature of the toxic product involved in the event was incompletely characterized. This could have led to a misclassification bias related to prod-

uct category. For example, if the substance involved was described only as a "cleaner" and its major ingredient (sulfuric acid) was not identified, then the exposure would have been categorized as a "cleaner" when it also could have been classified as a "caustic." While we created exclusive categories for the toxins, some overlap exists—for example, an automobile engine cleaner containing both a corrosive and a hydrocarbon-based solvent could be classified in 4 different categories.

The retrospective nature of the data also constrained our ability to discover details about the circumstances of the injury. Time-motion studies of adolescents in the workplace have been recommended by others²³ and could uncover exactly how adolescents are working with chemicals and what precautions they commonly take.

While it was assumed that many of the exposures resulted in no injury or medically trivial effects, not all calls were followed up to verify this. The amount of time lost from school or work owing to these injuries was not available in the poison control center records. Finally, the results of this study may not be generalizable to other parts of the United States. Massachusetts is largely a manufacturing and technology-oriented state, and injuries to adolescents from pesticides and other agricultural toxins are less likely here than in other states.

The recent Institute of Medicine report recommended that the National Institute for Occupational Safety and Health (Washington, DC) develop and implement a plan for monitoring work-related injuries among workers younger than 18 years.² Poison control center data could help achieve such a worthy objective. In some instances, even if the acute injury to the adolescent is medically trivial, these sentinel events may expose unsafe work practices or the use of hazardous chemicals that may be outmoded and unnecessary to the performance of the job. Toxic exposures with latent manifestations, such as reproductive effects, would likely not be uncovered by this surveillance, which emphasizes largely acute symptoms and signs.

These findings should encourage further research into adolescent occupational exposures. Prospective studies could better define the determinants underlying these injuries such that preventive regulations or interventions could be guided by more informed public policy. It seems evident that many of the poisonings we described could have been prevented with prior training, attention to the hazards inherent in some of these products, use of appropriate protective gear, and a better orientation at the worksite. Adolescents should be notified of potentially hazardous substances they are being asked to work with and should be trained to use the products safely. Proper supervision of the employee in the setting in which the hazardous chemical is being used is also of utmost importance.

CONCLUSIONS

Adolescent occupational exposures to toxins are an important but underrecognized injury category; poison control center data can be used to fill in gaps in surveillance for this type of workplace-associated injury.

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