Objective: To describe the epidemiological features of poisoning deaths in adolescents in the United States.

Design: Descriptive analysis of poisoning deaths in persons aged 10 to 19 years in the United States from January 1, 1979, to December 31, 1994, based on national mortality data.

Study Population: Adolescents whose cause of death was identified as poisoning using International Classification of Diseases, Ninth Revision codes.

Main Outcome Measure: Nature of injury (accident vs suicide).

Results: There were 4129 suicides and 3807 accidental deaths due to poisoning. Victims were most frequently male and white. However, poisoning was more often the method of suicide in adolescent girls than in boys (28.0% vs 8.7%). The number of deaths (7138 vs 798) and death rate (2.36 vs 0.28 per 100,000 population) were higher in 15- to 19-year-olds vs 10- to 14-year-olds. The distribution of substances involved was different for 10- to 14-year-olds compared with 15- to 19-year-olds and for suicides compared with accidents. Among 10- to 14-year-olds, drugs other than alcohol accounted for 232 (85.3%) of 272 suicides but only 118 (22.4%) of 526 accidental deaths. Gases and vapors played an important role in accidental deaths and suicides in 15- to 19-year-olds and in accidents in 10- to 14-year-olds.

Conclusions: The rates of suicides and accidental poisoning deaths were lower in 10- to 14-year-olds compared with 15- to 19-year-olds. Areas where injury-prevention efforts might have an influence on adolescent fatalities include management of depression, substance abuse education, and use of carbon monoxide detectors or shutoff switches.


Editor’s Note: I was very surprised to see the substantial number of males involved in poisonings until I noted CARbon monoxide listed as a gaseous poison. Whatever the vehicle, the waste of young lives is tragic.

Catherine D. DeAngelis, MD

ACCIDENTAL INJURIES are the leading cause of death in 10- to 19-year-olds, and suicides are the third and fourth leading cause of death in 15- to 19-year-olds and 10- to 14-year-olds, respectively. The proportion of accidental injuries and suicides due to poisoning has not been systematically investigated in adolescents. Of 2,155,952 poison exposures reported to poison centers in 1996, 158,663 occurred in people aged 13 to 19 years. Unintentional exposures accounted for 51.2% of reported cases in this age group. Of 38 deaths in 13- to 19-year-olds, 34 resulted from intentional exposures and 2 from unintentional exposures. In 2 cases, the reason for the exposure could not be determined. Most poisoning deaths are not reported to poison centers for a number of reasons, including the fact that many of these deaths occur outside the hospital or very soon after arrival at the hospital, that poisoning is not suspected until the medical examiner’s investigation, or lack of awareness of the poison center.

To further our understanding of poisoning deaths in adolescents, we used national mortality data to evaluate these deaths. We examined the characteristics of the victims and compared accidental poisoning deaths with suicides in this population.

RESULTS

There were 7936 poisoning deaths in adolescents, including 3807 accidental deaths and 4129 suicides. The mortality rate for
accidental poisonings remained relatively stable during the 16 years, whereas the suicide rate showed a downward trend in the 1990s compared with the middle to late 1980s (Figure 1). Victims were more frequently male, with a male-female ratio of 1.8:1. Breakdown by race reveals that most deaths occurred in white adolescents (6985 deaths [rate, 1.47 per 100 000 population] vs 687 deaths among black adolescents [rate, 0.78 per 100 000 population]) and 264 deaths among those of other races [rate, 1.21 per 100 000 population]). Of the 5032 fatalities in boys, 2661 (52.9%) were accidents. For girls, 1758 (60.5%) of 2904 deaths were suicides. The number of deaths (7138) and mortality rate (2.36 per 100 000 population) was different between both groups. Accidental drug-related fatalities occurred more frequently in 15-to 19-year-olds than in 10- to 14-year-olds. Overall, accidental drug-related deaths were due to analgesics and antipyretics in 328 cases, central and autonomic nervous system drugs in 54 cases, and other drugs in 613 cases. Of 162 alcohol-related accidental deaths, 151 occurred in 15-to 19-year-olds. The alcohols involved were ethanol (n = 85), methanol (n = 8), isopropyl alcohol (n = 2), and unspecified alcohol (n = 67). For accidental

Table 1. Accidental and Suicidal Poisoning Deaths in Adolescents by Race and Sex*

<table>
<thead>
<tr>
<th>Age, y</th>
<th>All</th>
<th>Male</th>
<th>Female</th>
<th>White</th>
<th>Black</th>
<th>Other</th>
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<tbody>
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<td></td>
<td>Accidents</td>
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<tr>
<td>10-14</td>
<td>0.18</td>
<td>0.23</td>
<td>0.13</td>
<td>0.18</td>
<td>0.15</td>
<td>0.35</td>
</tr>
<tr>
<td>15-19</td>
<td>1.12</td>
<td>1.50</td>
<td>0.65</td>
<td>1.14</td>
<td>0.88</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>Suicides</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-14</td>
<td>0.09</td>
<td>0.05</td>
<td>0.14</td>
<td>0.09</td>
<td>0.08</td>
<td>0.10</td>
</tr>
<tr>
<td>15-19</td>
<td>1.28</td>
<td>1.49</td>
<td>1.05</td>
<td>1.43</td>
<td>0.43</td>
<td>1.28</td>
</tr>
</tbody>
</table>

*Death rates are per 100 000 population.

Table 2. Accidental and Suicidal Deaths in Adolescents by Substance

<table>
<thead>
<tr>
<th>Age, y</th>
<th>All</th>
<th>Drugs</th>
<th>Nondrug†</th>
<th>Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accidents‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-14</td>
<td>526</td>
<td>118</td>
<td>140</td>
<td>268</td>
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<tr>
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<td>3281</td>
<td>1367</td>
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<td>1440</td>
</tr>
<tr>
<td></td>
<td>Suicides§</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-14</td>
<td>272</td>
<td>232</td>
<td>7</td>
<td>33</td>
</tr>
<tr>
<td>15-19</td>
<td>3857</td>
<td>1751</td>
<td>122</td>
<td>1984</td>
</tr>
</tbody>
</table>

†Indicates other solids and liquids; includes alcohols.
‡\(x^2 = 47; P < .001\);
§\(x^2 = 17; P < .001\).
Injury is a major cause of morbidity, mortality, and health care costs in children. Increases in suicides and self-poisoning in adolescents have been demonstrated in the United States and other countries. In the United States, suicide rates in 15- to 19-year-olds increased from the 1950s to the 1970s and then leveled off, except in white boys, for whom rates continued to increase in the 1980s. A comparison of methods of suicide in adolescents found that most suicides resulted from firearms and hanging. Poisoning was responsible for 12.4% and 16.1% of suicides in 10- to 14-year-olds and 15- to 19-year-olds, respectively. In our study, poisonings accounted for 7.2% and 13.0% of suicides in 10- to 14-year-olds and 15- to 19-year-olds, respectively.

Adolescents at highest risk for suicide are predominantly white males aged 15 to 19 years, who generally account for 72.2% of suicides. In our study, poisoning death rates due to accidents and suicides were higher in 15- to 19-year-olds than in 10- to 14-year-olds. The poisoning death rates were higher in boys than in girls for both age groups for accidental deaths and for suicides in the 15- to 19-year-olds. The suicide death rate in girls was higher than in boys in 10- to 14-year-olds. A sex difference was noted with regard to the proportion of all suicides due to poisoning. Of the girls who committed suicide, 28.0% used poisoning as their method compared with only 8.7% of the boys. This is consistent with the fact that women tend to use less violent methods of suicide. Studies in the United States and other countries have shown that girls and women in general have a significantly higher rate of suicide attempts, which are usually intended to gain attention. This finding is further substantiated by an analysis of poisoning hospitalizations in 2273 teenagers aged 13 to 19 years, in whom the rate of hospitalization for females (15.0 per 100 000 population) was similar to that for males (15.3 per 100 000 population) for accidental poisoning, but for suicide attempts, the female rate (89.5 per 100 000 population) was more than twice the male rate (36.6 per 100 000 population). Poisoning is one of the primary methods in attempted suicides and is the second leading method of completed suicide in women.

The death rate was higher in white than in black adolescents. The race disparity was most evident in the suicide death rate in 15- to 19-year-olds, in whom the suicide rate was approximately 70% lower in black than in white youths or those of other races. Although suicide death rates for other races were similar to those for white adolescents, the accidental poisoning rates for other races were lower in 15- to 19-year-olds and higher in 10- to 14-year-olds. Other studies have shown that, in general, black youths have suicide rates approximately 50% of those of white youths and youths of other races. Theories explaining the lower suicide rates in black youths include cultural taboos, internal cohesion within the black community, strong connections with black community institutions, and methodological issues resulting in biases in classifying deaths in black youths as suicides.

The distribution of use of solids or liquids vs gases or vapors was similar for suicides and accidental deaths (Figure 2). However, the solid or liquid substance was more frequently a drug, and the gas was more frequently carbon monoxide for suicides compared with accidental deaths. The distribution of substances was different for the 10- to 14-year-olds and 15- to 19-year-olds. In 10- to 14-year-olds, drugs were agents for most suicides but for a much smaller proportion of accidental deaths. In 15- to 19-year-olds, the contribution of drugs and gases were similar for suicides and accidental deaths. Alcohol was the agent for 162 accidental adolescent deaths, most of which occurred in 15- to 19-year-olds. Ethanol was the alcohol involved in 52.5% of the deaths. Although the exact alcohol was not specified in 41.4%, it is likely that ethanol was the primary alcohol, and that this alcohol is more easily accessible by older adolescents. The distribution of substances involved in poisoning fatalities is most likely different from those involved in nonlethal poisonings. In a study of adolescents.
cent poisonings, antidepressants and stimulants, analgesics, and sedatives and hypnotics were implicated in 75% of the adolescent deaths, but only 20% of the hospitalizations. A 1-year retrospective analysis of 1879 exposures in 13- to 17-year-olds reported to a regional poison center in which 47.6% of poisonings were accidental found that most accidental exposures involved nonpharmaceuticals (63.5%), whereas most intentional exposures involved pharmaceuticals (82.5%).

In our study, the fluorinated hydrocarbon refrigerant (Freon) was responsible for 149 accidental deaths, and solvents were responsible for 171 accidental deaths. We cannot determine the circumstances of the exposure from this database, but presumably some of these deaths resulted from inhalant abuse. Abuse of inhalants is a well-recognized form of substance abuse in teenagers. Inhalants are popular because of their easy accessibility; they are inexpensive, easy to conceal and to use, and difficult to detect. Serious toxic effects and death can occur with frequent or even 1-time use. Experimentation with inhalants may lead to habitual abuse or experimentation with other substances. Among the large number of volatile substances abused, the major categories are fuel gases, solvents, and propellants. Volatile substance abusers are generally adolescent boys and young men aged 14 to 22 years. A recent case series of 165 inhalant abusers reported to 2 regional poison centers found that 61% of cases involved spray paint (which contains toluene and gasoline). The adverse environmental effects of widespread fluorocarbon use led to a phaseout of certain forms of refrigerant from 1992 to 1996. The impact of this regulation on accidental teen deaths due to refrigerant exposure should be assessed once these data become available.

Carbon monoxide poisoning is a leading cause of accidental deaths and suicides in the United States. Causes of accidental carbon monoxide poisoning include faulty oil and gas heating units, fires, and poor ventilation of buildings (eg, garages) near residences. Suicides most often result from the purposeful inhalation of motor vehicle exhaust. In our study, 3034 adolescent deaths (38.2%) were due to carbon monoxide inhalation, of which 65.1% were suicides. Motor vehicle exhaust gas accounted for 65.6% and 84.8% of carbon monoxide-related accidents and suicides, respectively.

There are several limitations to our study. Poisoning deaths of undetermined reason and poisoning homicides were excluded. Our results are based on an analysis of data concerning underlying cause of death; analysis of multiple-cause data might provide additional insight into contributing factors. Analysis of substances involved in suicides is restricted to broad categories because of lack of detail in E-codes. Misclassification of the cause of death by physicians and coroners may result in underreporting (particularly for adolescent suicides) or overreporting. Because inference and judgment play a role in classifying cause of death, misclassification can occur as a result of insufficient information and lack of standardization of criteria used to rule a death a suicide.

The goals of injury control are to prevent injuries from occurring and to minimize the associated morbidity and mortality. Areas that we identified where injury prevention efforts might have an impact on adolescent fatalities include management of depression, substance abuse education, and technological devices to prevent carbon monoxide poisoning.

Strategies for prevention of suicides in adolescents include recognizing suicide attempts, referring adolescents at risk to appropriate professionals, and limiting access to lethal materials. Identifying adolescents at risk for suicide is a critical first step in suicide prevention. Mood disturbances, somatic complaints, eating and sleeping disorders, and changes in school performance or peer relationships may be presenting signs of depression. Pediatricians and other health professionals can help to educate parents, peers, teachers, and guidance counselors regarding the warning signs of adolescent depression and suicidal behavior. Health care professionals can provide direct services to these troubled adolescents or referrals to appropriate community resources. Intervention should be immediate and aggressive for attempted adolescent suicides, to prevent future suicide attempts. Management of depression in adolescents may be more complicated, in part because evidence of the effectiveness of antidepressants is not as compelling in adolescents as in adults. Demonstrating the efficacy and delineating the role of serotonin reuptake inhibitors in managing adolescent depression are important, since these drugs have lower inherent toxic effects in overdose than cyclic antidepressants or monoamine oxidase inhibitors.

Inhalant abuse is a serious problem facing adolescents. Pediatricians should be aware of this growing form of substance abuse and its potentially serious consequences. Adolescents requiring medical care for acute or chronic manifestations of inhalant abuse should also receive immediate social work and psychological interventions. Educational programs that describe the dangers of inhalant abuse without arousing curiosity or inadvertently teaching how to obtain these substances are needed, with education regarding the warning signs of inhalant abuse and community resources to help adolescents discontinue psychoactive substance abuse.

With 38.2% of all deaths in our study due to carbon monoxide inhalation, technological devices such as carbon monoxide detectors in homes or detection shut-off switches for motor vehicles might significantly decrease deaths due to carbon monoxide inhalation in adolescents. Considering the fact that 78.1% of deaths due to carbon monoxide inhalation were due to motor vehicle exhaust, carbon monoxide detection shut-off switches would be most effective. Carbon monoxide detectors in garages and residences might prevent some accidental poisonings due to motor vehicle exhaust in poorly or improperly ventilated garages or other structures adjacent to residences.

Adolescent deaths due to accidental and suicidal poisonings are public health problems requiring intervention. As with all types of injury, for each death there are many more adolescents who experience poisonings and survive. Analysis of the fatality data allows identifi-
cation of high-risk groups and potential intervention strategies.

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Announcement

1999 Certifying Examinations of the American Board of Pediatrics

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Pediatric Endocrinology Subspecialty examination:

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