Suzanne M. Froede,[1] *M.A.; James M. Byers, III,*[2] *M.D.; Grushenka H. I. Wolfgang,*[3] *M.S.; Richard C. Froede,*[4] *M.D.; Allen M. Jones,*[5] *M.D.; and Thomas E. Henry,*[5] *M.D.*

An Analysis of Toxic Deaths, 1982 to 1985, Pima County, Arizona

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ABSTRACT: Toxic deaths in Pima County, Arizona, were studied over a four-year period. The deaths were analyzed according to cause and manner of death, toxic substance, and demographic data. The age group 40 to 49 years had the highest rate of suicide from toxic substances. The accident death rate was highest for ages 20 to 29 years. Carbon monoxide was most often found to be the cause of deaths in this study. The most prevalent drugs were narcotics followed by antidepressants, cocaine, and barbiturates. Comparisons are made with similar studies.

KEYWORDS: toxicology, demography, suicides, accidents

Rapid population growth, proximity to an international border, a developing chemical industry, and the use of environmental toxic substances for agriculture and industry combine to make Pima County, Arizona a unique area in which to study deaths from toxic substances. All toxic deaths are medicolegal cases and fall under the jurisdiction of the Pima County Medical Examiner. Toxic death cases in the Pima County Medical Examiner's Office for a four-year period (1982 to 1985) were analyzed in two ways: a demographic analysis of all deaths attributed to toxic substances and an investigation of changes in toxic substance incidence. These patterns of toxic death in Pima County were compared to other studies and similarities and differences noted. This analysis pointed to certain areas in which death prevention programs might be developed by the community.

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[1]Tucson, AZ.

[2]Associate professor of pathology, College of Medicine, University of Arizona, Tucson, AZ.

[3]Department of Pharmacology and Toxicology, University of Arizona, Tucson, AZ.

[4]Professor of pathology and chief of forensic sciences, College of Medicine, University of Arizona, Tucson, AZ; chief medical examiner, County of Pima, Tucson, AZ.

[5]Both clinical assistant professors of pathology, College of Medicine, University of Arizona, Tucson, AZ; chief deputy medical examiner and deputy medical examiner, respectively, County of Pima, Tucson, AZ.

Materials and Methods

The Sample

Pima County, Arizona, has an area of 9 188 square miles (23 889 km^2) and shares 126 miles (201 km) of its southern border with Mexico. The population of the county has increased during the four years of the study from 565 000 in 1982 to 619 000 in 1985 [*1*]. Fifty-one percent of the population is female and forty-nine percent male [*2*]. Pima County has an ethnic distribution of 72.4% Anglo (white other than those of Hispanic heritage), 21% Hispanic, 2.9% black, 2.8% American Indian, and 0.9% Oriental (none in the study) [*2*]. The age breakdown of the population is depicted in Table 1.

Data

All deaths from chemical substances (drugs, licit and illicit; ethanol) and environmental toxins (for example, carbon monoxide) from 1982 to 1985 were included. Law enforcement records were used for supplemental data.

Methods

Complete postmortem examinations including comprehensive toxicologic studies were done on all suspected toxic deaths.

Autopsy—The postmortem examinations used in this series were performed in accordance with systematic medicolegal investigations and consisted of a description of the circumstances of death, the evaluation of any preexisting medical records, identification procedures, and the gross autopsy, which included radiographs and photographs. At the time of the complete internal examination of the head and trunk, toxicologic specimens, required microbiologic specimens, and pertinent evidentiary material were obtained. Vitreous, blood, urine, bile, liver, and gastric contents were the toxicologic specimens collected.

Toxicology—The primary method of substance detection was thin-layer chromatography (Toxilab®). Urine was the specimen of choice, though in some cases gastric contents or liver were utilized. Syva immunoassay techniques (EMIT®) were used for confirmation. Roche Abu-screen® antibody based methods as well as gas chromatography were used for most quantitative assays. Other techniques used included high-pressure liquid chromatography and spectrophotometry. All the qualitative and quantitative analytical data were reported to the Medical Examiner for determination of the cause and manner of death.

Results

Demographic Observations

Two hundred and ten toxic deaths were found. The manner of death was ruled accidental in ninety-nine of these deaths, suicidal in ninety-four and undetermined in the remaining seventeen cases.

Table 2 gives the percentages of toxic accidents to total accidents as well as of toxic suicides to total suicides.

While the suicide pattern has remained stable, the toxic accidents account for a steadily increasing percentage of total accidents in Pima County. When the percentages of total toxic deaths are determined for the toxic accidents and toxic suicides each year, the profile seen in Table 3 emerges.

When only the toxic deaths are considered, the percentage of toxic accidents increased, while that of toxic suicides decreased during the four-year study.

TABLE 1—*Age distribution of Pima County population* [1].

	Age in Years							
	<5	5-14	15-19	20-29	30-39	40-49	50-64	65+
Percent of total population	8.1	13.5	6.9	19.2	16.5	10	13.2	12.6

TABLE 2—*Percent of all accidents/suicides represented by toxic accidents/suicides.*

Type	1982	1983	1984	1985
All accidents	199	226	229	247
Toxic accidents	14	19	28	38
Toxic percent of total accidents	7	8.4	12.2	15.4
All suicides	98	100	111	111
Toxic suicides	24	26	20	24
Toxic percent of total suicides	24.5	26	18	21.6

TABLE 3—*Toxic deaths by percent accident, suicide, and undetermined.*

Type of Death	1982	1983	1984	1985
Accident	31.8	38	56	57.6
Suicide	54.6	52	40	36.4
Undetermined	13.6	10	4	6

Table 4 illustrates the number of toxic accidents each sex would be expected to have on the basis of its percent of total population, as well as the actual number observed. Table 5 depicts similar figures for the number of toxic suicides each year.

While the number of suicides are approximately what would be expected on population proportion alone, this is not the case with the toxic accidents. The males in this study have higher ratios of observed to projected accidents, though the 1985 figures show a trend toward what would be expected on the basis of population.

American Indians had no toxic suicides during the years of the study and blacks had only one (1982). Table 6 demonstrates the ratio of observed to expected suicides on the basis of percent of total population for Anglos and Hispanics.

The Anglo ratios show no change through the four-year period while the Hispanic ratios show a decrease. The ethnic distribution of toxic death accidents seen in Fig. 1 is the reverse of that seen in suicides. Neither American Indians nor blacks had toxic death accidents in every year of the study; nevertheless, their four-year totals were greater than expected.

Figure 2 depicts the age distribution of total toxic death accidents for the 4-year period. The 20-to-29 age group and those under 5 years old show the largest ratios of observed to expected numbers of toxic death accidents, while the 5-to-14 age group shows the lowest. In Fig. 3, the age distribution of toxic suicides is shown. The 40-to-49 age group has the highest

TABLE 4—*Toxic accidents by sex.*

Accidents	1982 (M/F)[a]	1983 (M/F)	1984 (M/F)	1985 (M/F)
Accidents projected[b]	6.9/7.1	9.3/9.7	13.7/14.3	18.6/19.4
Accidents observed	12/2	12/7	21/7	22/16
Radio of observed to projected	1.7/0.3	1.3/0.7	1.5/0.5	1.2/0.8

[a]M = male; F = female.
[b]Number of toxic accidents that would be expected on the basis of the percentage of each sex in the total population (49% males; 51% females).

TABLE 5—*Toxic suicides by sex.*

Suicides	1982 (M/F)[a]	1983 (M/F)	1984 (M/F)	1985 (M/F)
Suicides projected[b]	11.8/12.2	12.7/13.3	9.8/10.2	11.8/12.2
Suicides observed	12/12	14/12	10/10	14/10
Ratio of observed to projected	1/1	1.1/0.9	1/1	1.2/0.8

[a]M = male; F = female.
[b]Number of toxic suicides that would be expected on the basis of the percentage of each sex in the total population (49% males; 51% females).

TABLE 6—*Toxic suicides for Anglos and Hispanics.*

Suicides	1982 (A/H)[a]	1983 (A/H)	1984 (A/H)	1985 (A/H)
Suicides projected	17.4/5	18.8/5.5	14.5/4.2	17.4/5
Suicides observed	20/3	23/3	18/2	23/1
Ratio of observed to projected	1.2/0.6	1.2/0.6	1.2/0.5	1.3/0.2

[a]A = Anglo; H = Hispanic.

ratio of observed to expected toxic suicides, followed by the 50-to-64 age group and the 30-to-39 age group. Neither toxic death accidents nor suicides varied annually in age distribution during the 4-year period.

The toxic suicides were not clustered in any month or season. In the 4-year study the month of September had the highest total, 10 deaths, an average of 2.5 deaths per year. January, April, June, July, August, and November each averaged 2.3 deaths per year. May and December followed with an average of 2.0 deaths and February and October each averaged 1.3 deaths per year. March, with an average of only 1 death each year, had the least number of deaths.

Substance Group Analysis

A total of 78 different chemical substances were found in the 210 toxic deaths studied. These substances were separated into major drug classes similar to those used by the National Institute on Drug Abuse (NIDA) (1984) [3] and are listed in Table 7. When a single

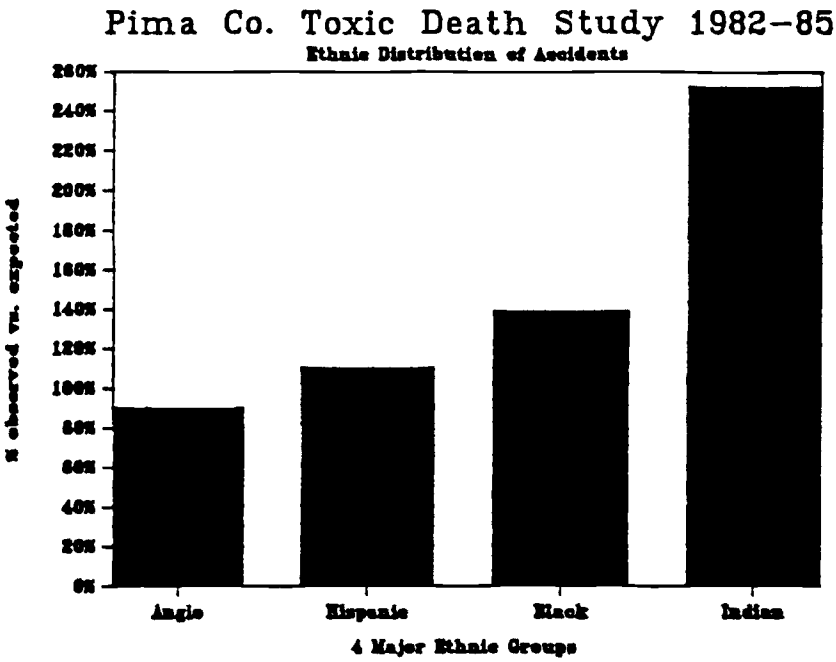

FIG. 1—*Percentage of the number of observed toxic accident deaths divided by the number of such deaths expected on the basis of population percentage of each of the four ethnic groups: Anglo 65/71.7, Hispanic 23/20.8, black 4/2.87, Indian 7/2.77.*

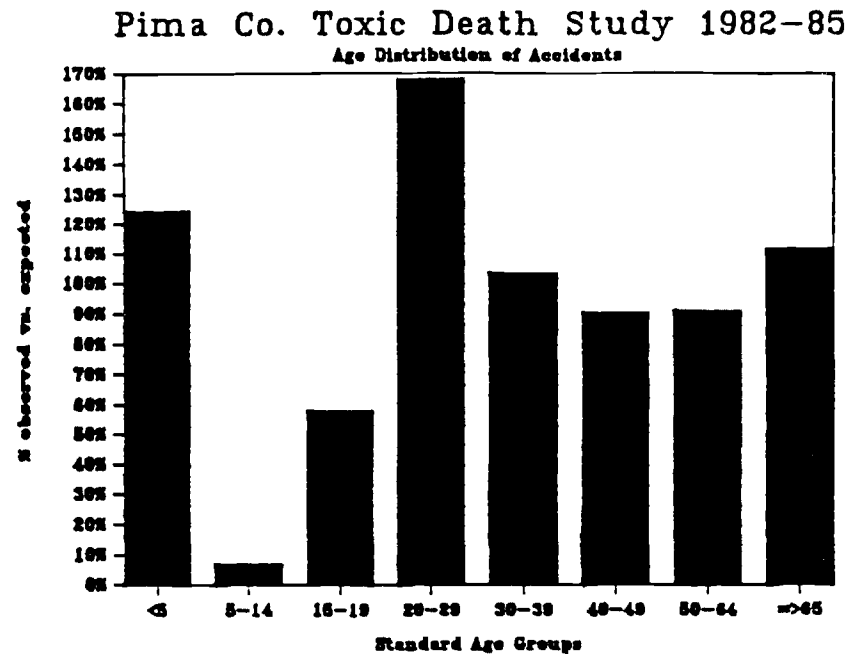

FIG. 2—*Percentage of the number of observed toxic accident deaths divided by the number of such deaths expected on the basis of population percentages of each of the standard age groups: <5 years, 10/8; 5–14 years, 1/13.4; 15–19 years, 4/6.8; 20–29 years, 32/19; 30–39 years, 17/16.3; 40–49 years, 9/9.9; 50–64 years, 2/13.1; ≥65 years, 14/12.5.*

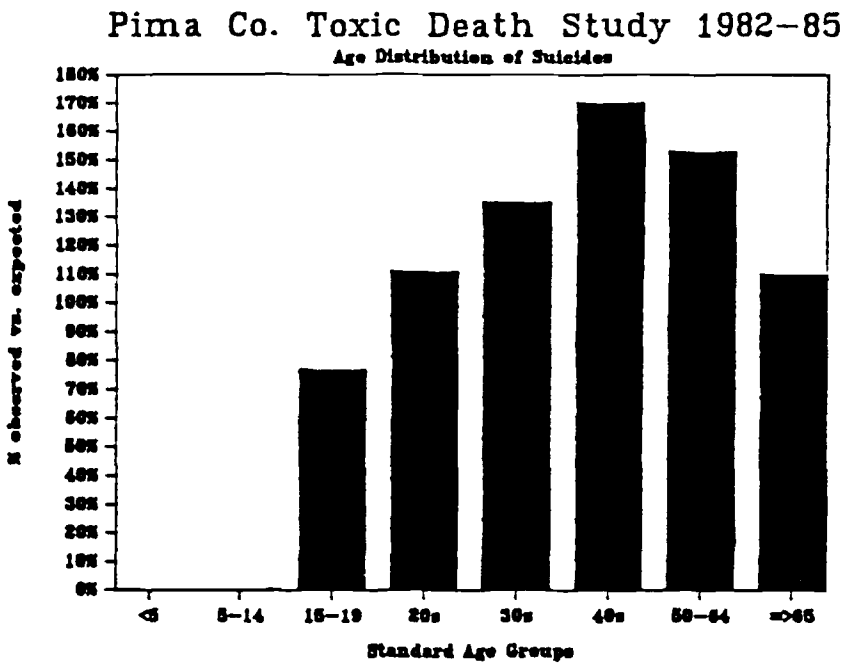

FIG. 3—*Percentage of the number of observed toxic suicides divided by the number of toxic suicides expected on the basis of population percentages of each of the standard age groups: <5 years, 0/7.6; 5-14 years, 0/12.7; 15-19 years, 5/6.5; 20-29 years, 20/18; 30-39 years, 21/15.5; 40-49 years, 16/9.4; 50-64 years, 19/12.4; ≥65 years, 13/11.8.*

agent was considered the primary cause of death, it is listed under Primary Agent column. Cases where either multiple agents were the cause of death or where additional agents, besides the primary causal agent were found, are listed in the Occurrence column. The Incidence column is the total of these two.

Ethanol (85 cases), narcotics (73 cases), carbon monoxide (63 cases), non-narcotic analgesics (62 cases), and tranquilizers (54 cases) were the toxic substances most often detected.

Carbon monoxide, narcotics, antidepressants, cocaine, barbiturates, and ethanol were responsible for the majority of the deaths and were selected for further analysis. Figure 4 depicts the total number of accidents and suicides for five of these groups: carbon monoxide, narcotics, cocaine, barbiturates, and antidepressants.

Table 8 lists these substance groups, each responsible for more than ten deaths during the four-year period, by year and number of deaths. When the data presented in Table 8 is separated into toxic accidents and suicides, as in Tables 9 and 10, annual changes in the numbers of deaths by these toxic substances are seen.

Carbon monoxide deaths show an increase in both accidents and suicides. There is also an increase in narcotic, antidepressant, and cocaine accidental deaths, but a decrease in the barbiturate accidents. Barbiturate and antidepressant suicides both show a decreasing trend.

Discussion

The demographic data, age, sex, and ethnicity used in the following discussion were obtained from review of the investigative reports.

TABLE 7—*Substances detected in toxic deaths, Pima County, Arizona, 1982–1985.*

Toxic Substance	Primary Agent	Occurrence	Incidence
Amphetamines and sympathomimetic amines:			
amphetamine	0	2	2
ephedrine	0	4	4
methamphetamine	1	2	3
phentermine	0	1	1
phenylpropanolamine	0	5	5
Antidepressants:			
amitriptyline, nortriptyline	15	5	20
amoxapine	1	0	1
desipramine, imipramine	6	1	7
doxepine	9	1	10
trazodone	0	1	1
trimipramine	1	0	1
Antipsychotics:			
haloperidol	1	0	1
phenothiazines	4	9	13
Barbiturates:			
amobarbital	1	2	3
butabarbital	1	0	1
pentobarbital	1	3	4
phenobarbital	9	4	13
secobarbital	3	2	5
Narcotic analgesics:			
meperidine	0	2	2
methadone	3	5	8
opiate	30	19	49
oxycodone	1	1	2
pentazozine	0	1	1
propoxyphene	8	3	11
Nonbarbiturate sedatives:			
ethchlorvynol	0	4	4
flurazepam	0	8	8
glutethimide	1	1	2
meprobamate	0	3	3
triazolam	1	0	1
trichlorethanol (chloral hydrate metabolite)	0	2	2
Non-narcotic analgesics:			
acetaminophen	0	34	34
butalbital	1	5	6
salicylate	2	20	22
Solvents:			
acetone	0	4	4
isopropanol	0	3	3
methanol	1	0	1
Tranquilizers:			
chlordiazepoxide	0	6	6
demoxepam	0	6	6
diazepam	0	33	33
oxazepam	0	8	8
temazepam	0	1	1
Other:			
benztropine	0	2	2
caffeine	1	8	9
cannabinoids	0	3	3
carbon monoxide	58	5	63
cimetidine	0	1	1
cocaine	18	7	25
colchicine	1	0	1
cyanide	3	16	19
digoxin	2	2	4
dilantin	0	7	7
diphenhydramine	0	4	4
ethanol	13	72	85
ethylene glycol	1	0	1
miscellaneous heart medications	0	7	7
natural gas	1	0	1
orphenadrine	0	1	1
phencyclidine	1	0	1
procainamide	1	1	2
theophylline	2	1	3

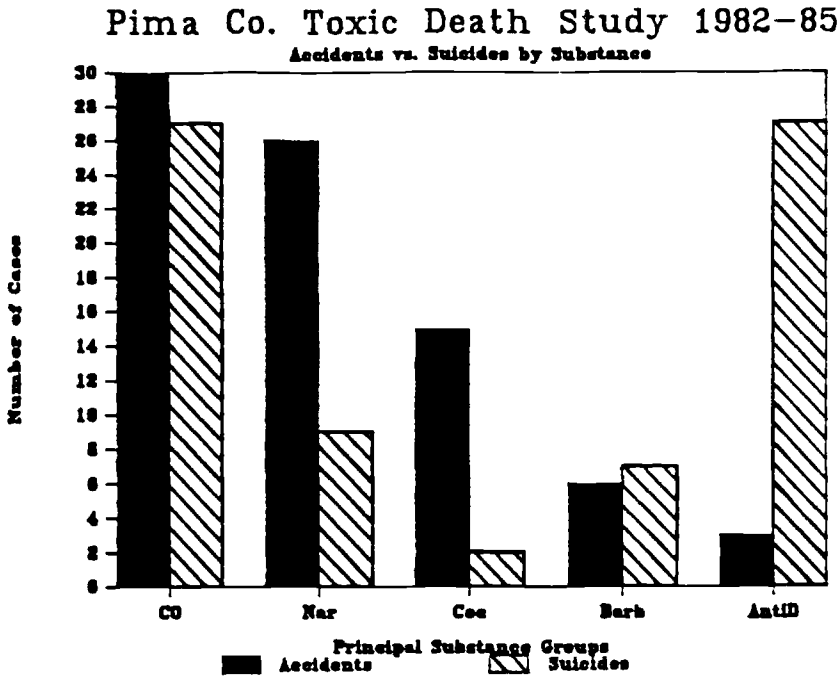

FIG. 4—*Accidents versus suicides by the five toxic substance groups most often the cause of death: carbon monoxide (CO), cocaine (Coc), barbiturates (Barb), and antidepressants (AntiD).*

TABLE 8—*Number of deaths by substance group and year.*

	1982	1983	1984	1985	Percent Total Toxic Deaths
Total Toxic Deaths	44	50	50	66	
Carbon monoxide	11(25)[a]	8(16)	15(30)	24(36)	27.6%
Narcotics	10(23)	9(18)	9(18)	14(21)	20.0%
Antidepressants	9(20)	10(20)	7(14)	6(9)	14.8%
Cocaine	0	4(8)	9(18)	5(8)	8.6%
Barbiturates	6(14)	2(4)	3(6)	4(6)	7.1%
Ethanol	1(2)	5(10)	4(8)	3(5)	6.2%

[a]Number in parentheses is the percent of toxic deaths annually.

Observations

The most significant observation was the increasing number of toxic accidents and their increasing percentage of the total accidents for the county, as well as their increasing percentage of the total toxic deaths. Table 9 shows that an increase in carbon monoxide, narcotic, and antidepressant accidents accounts for the increase in total toxic deaths. Cocaine deaths are also a contributing factor.

The corresponding decrease in the proportion of toxic deaths due to suicide is depicted in Table 10. A decreasing number of barbiturate and antidepressant suicides through the four years is noted.

TABLE 9—*Toxic accident deaths by year and substance.*

	1982	1983	1984	1985
Total Toxic Deaths	44	50	50	66
Carbon monoxide	6(14)[a]	4(8)	7(14)	13(20)
Narcotics	4(9)	5(10)	6(12)	11(17)
Antidepressants	0	0	0	3(4.5)
Cocaine	0	2(4)	9(18)	4(6)
Barbiturates	2(5)	2(4)	1(2)	1(2)
Ethanol	1(2)	4(8)	4(8)	2(3)

[a]Number in parentheses is percent of toxic deaths annually.

TABLE 10—*Toxic suicides by year and substance.*[a]

	1982	1983	1984	1985
Total Toxic Deaths	44	50	50	66
Carbon monoxide	5(11)[b]	4(8)	8(16)	10(15)
Narcotics	2(5)	2(4)	2(4)	3(5)
Antidepressants	9(20)	9(18)	7(14)	2(3)
Cocaine	0	1(2)	0	1(2)
Barbiturates	3(7)	0	1(2)	3(5)
Ethanol	0	1(2)	0	1(2)

[a]Totals of Tables 9 and 10 do not always equal figures in Table 8 due to undetermined deaths.

[b]Number in parentheses is percent of toxic deaths annually.

While the increasing number of toxic accidents among females (Table 4) is of interest, there was no single significant cause. There were no accidental deaths as a result of narcotics or cocaine for females until 1983. It was not until 1985 that there were any accidental deaths for females from antidepressants or ethanol.

Carbon Monoxide

Carbon monoxide (CO) is the leading cause of death in the study and was responsible for 27.6% of the cases. CO, a colorless, odorless, tasteless gas, is derived from the incomplete combustion of carbon compounds. Primary sources in these cases were motor vehicle exhaust and fires. The fire related cases included are those in which high CO concentrations were measured in the blood of the decedents. CO, not thermal injuries, was determined to be the cause of death in all instances.

CO was responsible for 30 accidental deaths (23 fire related, 7 not fire related), 27 suicides, and 1 undetermined death in the 4-year period. The accidental CO deaths, which were primarily due to fires, increased from 6 in 1982 to 13 in 1985 and claimed 19 males and 11 females. Nine fire related deaths were children 10 years or younger, and 7 were 70 years of age or older, those least able to care for themselves in such situations. Nineteen were Anglo, 5 Hispanic, 3 black, and 3 American Indian. Ratios of observed deaths to the number expected on basis of percent of population indicate that blacks suffered 3.5 times as many accidental CO deaths as expected and American Indians 3.6 times as many.

The number of suicides as a result of CO increased from 5 in 1982 to 10 in 1985. There were 8 females and 19 males who committed suicide by CO poisoning and all but 2 by motor vehicle exhaust. One Anglo female attempted to set herself on fire with gasoline and another burned coals in a grill indoors. Though more than twice as many males as females used CO to commit suicide, the number of females doing so increased during the study from none in 1982 to 4 in 1985. CO suicides ranged from age 16 years old to 74 years old. The 2 Hispanic suicides were only 0.4 of the number expected on basis of population.

Narcotics

Narcotics are the second ranking cause of toxic death and were responsible for 20% of the deaths. This percentage remained stable through the four-year period. The natural opiate analgesics (morphine, codeine), the semisynthetics (heroin), and the synthetic narcotics are included in this group.

Use of narcotics caused twenty-six accidental deaths over the four-year period and nine suicides and seven undetermined. Eight Anglo males in their twenties and thirties accounted for most narcotic accidents followed by five Hispanic males also in their twenties and thirties. Four of the suicides were Anglo females, one of whom was fifteen years old, one eighty-four years old, and the other two in their sixties. All four ethnic groups were represented in narcotic deaths as well as all age groups over fifteen years.

The number of accidental narcotic deaths among Hispanics was 1.8 times greater than expected on basis of their percent of the population and the black suicides 3.9 times greater. However, the two Hispanic suicides were only 0.3 times the number expected.

Opiates accounted for 14.3% of the toxic deaths and ranked third in incidence in this study, being detected in 49 cases. Propoxyphene was the primary cause of death in 8 cases (4% of total toxic deaths) as was detected in 11 cases (5% of total toxic deaths). Methadone, which has minimal but long lasting euphorigenic properties, was responsible for 3 deaths during the 4-year period.

Antidepressants

Antidepressants are the third ranking cause of death and were responsible for 14.8% of the cases. There were 27 suicides using antidepressants in the study, but only 3 antidepressant deaths were ruled accidental and 2 were undetermined.

Tricyclic antidepressants are widely used in the treatment of major depression. Lethal doses are often available to patients with a high risk of suicide. In the cases studied, if one of these drugs was detected, most often it was the cause of death (32 of 40 cases or 80% of the time).

The number of suicides as a result of antidepressants decreased from 20% of all toxic deaths in 1982 to 3% of all toxic deaths in 1985 (Table 10). Fifteen of the suicides were Anglo females and two were Hispanic females. These two Hispanic suicides were only 0.35 times the number expected on basis of population. Anglo males accounted for the remaining ten suicides.

Two Anglo males (age 16 and 50 years) and one 34-year-old Anglo female had the three accidental deaths.

Cocaine

Cocaine was the primary cause of 18 deaths, 8.6% of total toxic deaths, and was detected in a total of 25 toxic deaths. Cocaine usage had the most dramatic increase seen in the study. No deaths as a result of cocaine alone occurred in 1982, but there were four in 1983, nine in 1984, and five in 1985.

Cocaine is unique among local anesthetics because of its euphorigenic and reinforcing properties [4]. Cocaine, whose effects are similar to amphetamines, is a central nervous system stimulant and affects the cardiovascular and respiratory systems. Cocaine is rapid acting, which usually precludes any emergency treatment of overdose victims.

Of these deaths 15 were classified as accidental, 2 as suicide and 1 as undetermined. Nine Anglo males, four Hispanic males, 4 Anglo females, and 1 Hispanic female died from cocaine. A 19-year-old, a 44-year-old, and a 66-year-old were in the group, but the remaining 15 were all in their 20s or 30s.

Barbiturates

The percent of toxic deaths as a result of barbiturates has decreased over the period of the study from 14% in 1982 to 6% in 1985. Phenobarbital was the primary agent responsible for the majority of barbiturate deaths (nine cases), followed by secobarbital (three cases).

In 9 of the 15 cases (60%) where barbiturates were the primary agent of death, blood ethanol was detected in amounts greater than 10 mg/dL. Of these ethanol related cases 7 were male; the remaining 2 were female. All age groups over 20 years were represented, but there were 4 in the 30- to-39-year group and only 1, a male, in the 65 years or older group.

There was a total of six accidental deaths, seven suicides, and two undetermined deaths. Four males and two females had accidental deaths, but five females and two males used barbiturates to commit suicide. With the exception of one Hispanic male accidental death and one Hispanic female suicide, all barbiturate deaths were Anglo. Four of the females were over sixty-five years of age and two were in fifty-to-sixty-four-year-old category. Males were represented in all age categories over twenty years.

Ethanol

Ethanol is the toxic substance most commonly encountered by the forensic toxicologist because of its widespread use and the legal constraints on conduct under its influence [5]. Acute toxic effects are due to central nervous system depression which progresses to coma and respiratory depression. Deaths from chronic alcohol abuse and the resulting medical complications were not included in this study.

Acute ethanol intoxication was the primary cause of death in thirteen cases in this 4-year study accounting for 6.2% of the total toxic deaths. Eleven cases were ruled accidental. One case was a 34-year-old Hispanic female, but the remaining ten were male: five Anglos, two Hispanics, and three American Indians. The three American Indian deaths as a result of ethanol are 9.7 times greater than the number expected on the basis of their proportion of the population. The two suicides were both Anglo in their fifties; one male and one female.

Ethanol was the most common toxic substance detected in the deaths included in this study. Out of 210 cases, 85 (40%) showed a blood ethanol concentration of 10 mg/dL or greater. Of these, 47 had a blood ethanol concentration above the legal limit of 100 mg/dL. Table 11 incorporates the data of blood ethanol concentrations.

Other Toxic Substances

Tranquilizers were detected in 54 cases, but in no instance were benzodiazepines the primary agent of death. Non-narcotic analgesics resulted in only 3 deaths, but were detected in 62 cases. Only 1 death resulted from amphetamines, and despite its popularity in recent years, PCP was responsible for only 1 death.

TABLE 11—*Blood ethanol concentrations greater than 10 mg/dL.*

Concentration Range, mg/dL	Number of Cases	Percent of Total Toxic Death Cases	Percent of Total Cases at or Above Each Range	Other Agents Detected	Ethanol Cause of Death
<100	38	18.1	40.5	38	0
100-199	26	12.4	22.4	25	1
200-299	9	4.3	10.0	6	3
300-399	6	2.9	5.7	5	2
≥400	6	2.9	2.9	0	6(7)[a]
Totals	85	40.5	...	...	13

[a]One case had no blood recovered, but vitreous ethanol was >400 mg/dL.

Cyanide is often present in fires because of the combustion of synthetic materials such as urethane and plastics and was detected along with carbon monoxide in a number of fire related deaths. Cyanide was also the toxic substance primarily responsible for three deaths in this study. A miner was unintentionally exposed to cyanide and hydrochloric acid while working and died. In addition, there were two suicides by cyanide ingestion.

Therapeutic drugs, such as digoxin, procainamide, and theophylline, were responsible for five deaths.

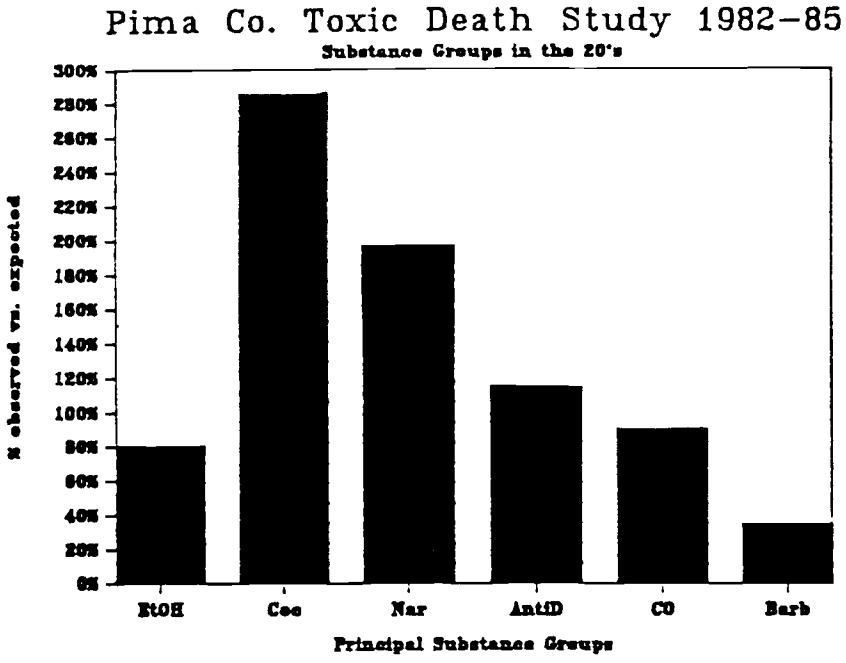

FIG. 5—*Deaths in the 20-29 age group as a result of the six toxic substance groups most often the cause of death. The percentage of the number of observed deaths divided by the number of deaths expected on the basis of the population percentage of the 20-29 age group is represented: ethanol (EtOH) 2/2.5; Coc 10/3.5; Nar 16/8.1; AntiD 7/6.1; CO 10/11.1; Barb 1/2.9.*

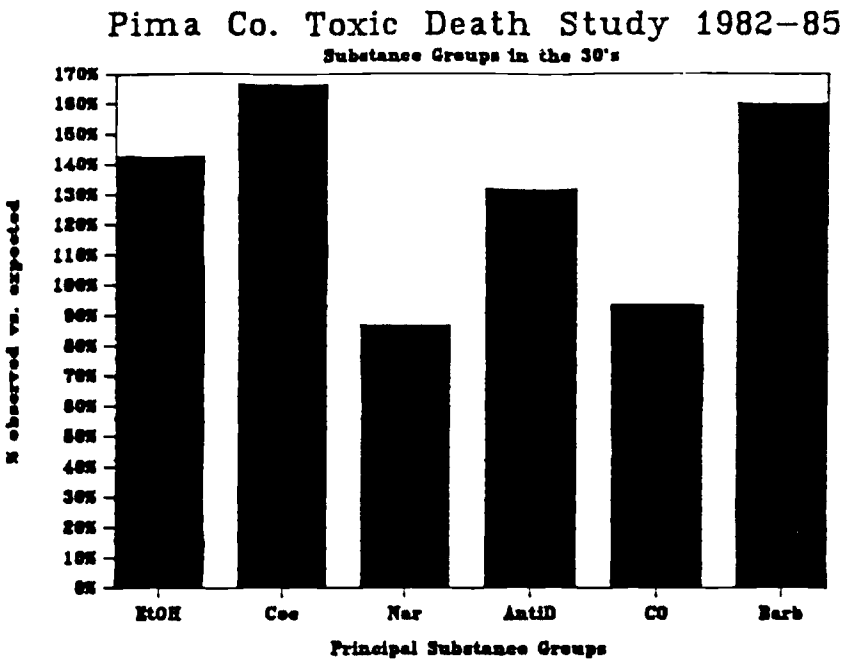

FIG. 6— *Deaths in the 30–39 age group due to the six toxic substance groups most often the cause of death. The percentage of the number of observed deaths divided by the number of deaths expected on the basis of the population percentage of the 30–39 age group is represented: EtOH 3/2.1; Coc 5/3; Nar 6/6.9; AntiD 7/5.3; CO 9/9.6; Barb 4/2.5.*

Age Studies

Figures 5 through 9 illustrate the percent of observed cases to expected cases on the basis of population percentages caused by each of the six toxic substance groups that were found to cause the greatest number of deaths in the 5 age groups from 20 to 65 years and greater. The toxic substances responsible for most deaths in each age group varies. In the 20-to-29 age group, cocaine and narcotics were the most frequent cause of toxic death. In the 30-to-39 age group cocaine, barbiturates, and alcohol caused the most toxic deaths, while narcotics and antidepressants were the leaders for the 40-to-49 age group. Barbiturates, antidepressants, alcohol, and carbon monoxide were responsible for more deaths than would be expected in the 50-to-64 age group, but this is the 1 age group in the over-20s not having any deaths as a result of cocaine. Barbiturates and alcohol were the 2 toxic substance groups responsible for more deaths in the 65 years and greater group than would be expected; however, in only 1 case in this age group were they found in combination.

Community Programs

Education is suggested as the most effective method for the community to prevent toxic deaths. Young adults are either unaware or ignore the fact that cocaine and narcotics are sometimes lethal. Physicians should warn patients of the dangers of overdoses of prescription drugs, in particular elderly patients taking barbiturates. This analysis demonstrates the extra danger house fires hold for the young and the elderly in this community, and special emphasis should be given to educating those responsible for their care in the proper procedures in case of fire.

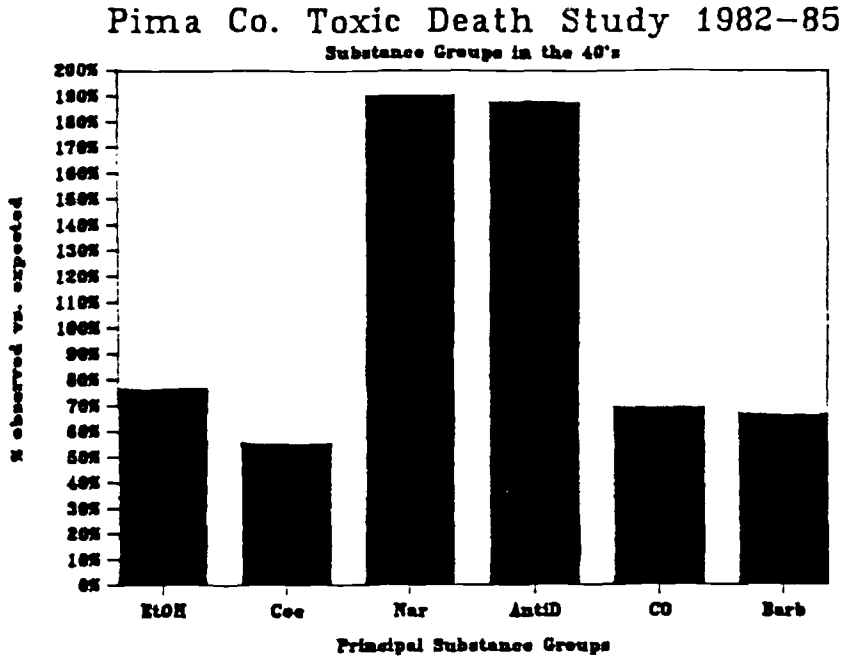

FIG. 7—*Deaths in the 40–49 age group as a result of the six toxic substance groups most often the cause of death. The percentage of the number of observed deaths divided by the number of deaths expected on the basis of the population percentage of the 40–49 age group is represented: EtOH 1/1.3; Coc 1/1.8; Nar 8/4.2; AntiD 6/3.2; CO 4/5.8; Barb 1/1.5.*

Comparative Studies

Many of the observations in this study were not unexpected. The facts that young males have large numbers of accidental deaths due to toxic substances and that whites (term used in cited references) commit the most suicides have been reported previously [*6, 7*]. Also, toxic suicide victims in Pima County reflect the sex division of the population (51% female, 49% male), which corresponds to the nationwide suicide-by-poisoning statistics [*7*]. Carbon monoxide has been listed as the leading cause of toxic deaths [*6, 8*], and increasing cocaine deaths have been reported [*9*].

However, in this study the 40-to-49 age group has the largest ratio of observed suicides to projected suicides (on basis of population percentage). This differs from Gowitt and Hanzlick's report that drug related suicides were most prevalent in elderly and 15-to-19-year-old females [*10*].

Comparisons with other studies are difficult because of differences in categorizing the deaths. However, Table 12 compares the 15 toxic substance groups with the highest incidence rate in our study with their rank in the NIDA (1984) listing of drugs mentioned most frequently by medical examiners in 1984 [*3*].

Phencyclidine was detected in only one case in this study, but ranked ninth in the NIDA (1984) list of drugs mentioned most frequently by medical examiners. Glutethimide, ranking thirteenth in the NIDA (1984) list, was detected in only two cases. Quinine, ranking fifth, was not detected in this study.

In Pima County from 1982 to 1985, it was found that CO was the leading cause of toxic deaths (27.6%), followed by narcotics (20%), antidepressants (14.8%), cocaine (9.5%),

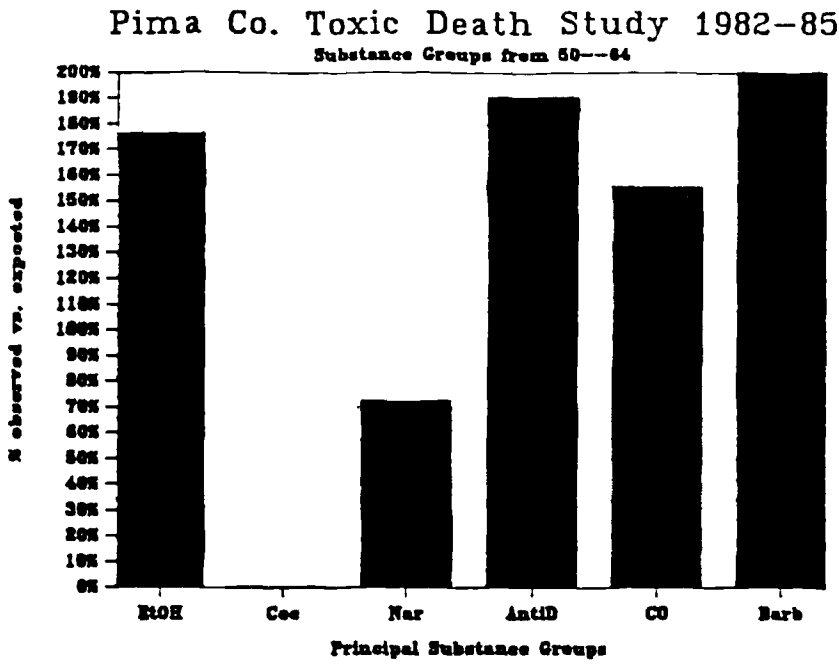

FIG. 8—*Deaths in the 50–64 age group as a result of the six toxic substance groups most often the cause of death. The percentage of the number of observed deaths divided by the number of deaths expected on the basis of the population percentage of the 50–64 age group is represented: EtOH 3/1.7; Coc 0/2.4; Nar 4/5.5; AntiD 8/4.2; CO 12/7.7; Barb 4/2.*

barbiturates (7.1%), and ethanol (6.2%). Caplan et al. in their study from Maryland (1975 to 1980) report CO as the leading cause of toxic deaths at 36.7%, a percentage higher than our 27.6% [*6*]. In contrast, Garriott et al. found CO in only 19% toxic deaths in Dallas [*8*].

The CO deaths in this study were almost evenly divided between accidents (30 cases) and suicides (27 cases). This finding differs from Garriott et al., who report 2 CO suicides for every CO accident [*8*].

In contrast to Fulton County, Georgia where there were no CO suicides among the elderly, there were 2 Anglo males over 70 years who chose this method (car exhaust) in our study [*10*].

Blood ethanol was detected in 30% of the accidental CO deaths. This includes 2 of the 6 victims over 70 years old. This percentage is lower than the 47% reported by Reddick and Luke for fire deaths in the Washington, DC area [*11*].

The increase in antidepressant deaths reported by Garriott et al. [*8*] and Caplan et al. [*6*] did not occur in this four-year study. While the percent of antidepressant deaths in all toxic deaths remained steady, the number of suicides decreased and were replaced by accidents.

Barbiturates were responsible for 7.1% of the toxic deaths, though Table 8 shows a slight decrease during the 4-year period. This is in contrast to 36% of all toxic deaths as a result of barbiturates reported by Campbell and Mason for Edinburgh in 1974 to 1978, where they were the most common drug causing death [*12*]. While barbiturates and also ethanol were leading toxic substances causing death for the over-65 age group, there was no evidence that the 2 substances were linked in deaths in this age group.

Ethanol accounted for 13 deaths (6.2%) in this study, and 6 of the victims were over 50 years of age. This percentage is higher than the 3.5% reported by Campbell and Mason and the 4.8% reported by Poklis and Gantner in their 1977 to 1979 St. Louis study [*12,13*]. On

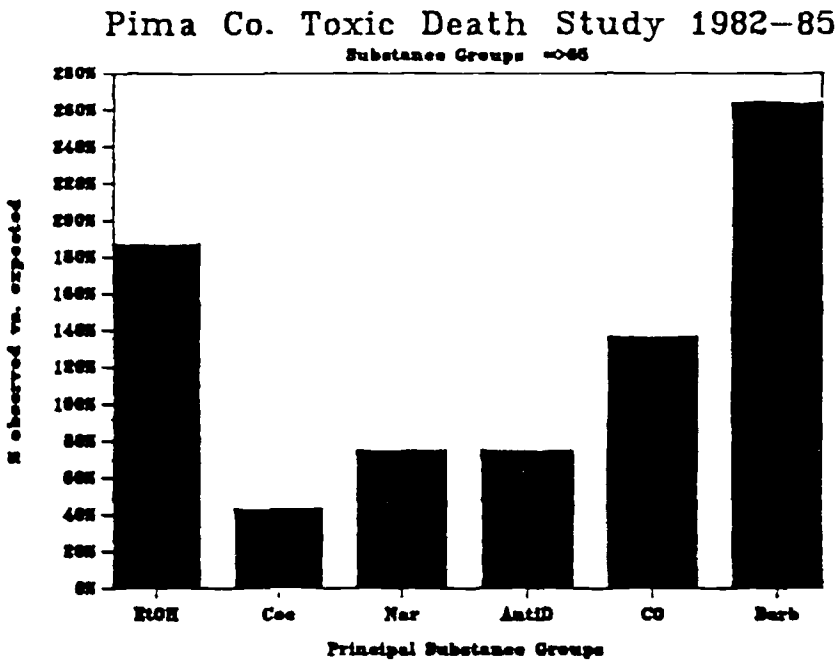

FIG. 9—*Deaths of the ≥65 age group as a result of the six toxic substance groups most often the cause of death. The percentage of the number of observed deaths divided by the number of deaths expected on the basis of the population percentage of the ≥65 age group is represented: EtOH 3/1.6; Coc 1/2.3; Nar 4/5.3; AntiD 3/4; CO 10/7.3; Barb 5/1.9.*

TABLE 12—*Comparison of toxic substance incidence.*

Substance	Incidence Rank Toxic Substance Pima County, AZ (1982-1985)	Incidence Rank Drugs NIDA (1984)
Ethanol	1	1
Carbon monoxide	2	...
Opiate[a]	3	2
Acetaminophen	4	10
Diazepam	5	7
Cocaine	6	3
Salicylate	7	14
Amitriptyline	8	6
Cyanide	9	...
Phenobarbital	10	12
Propoxyphene	11	8
Doxepine	12	15
Caffeine	13	26
Methadone	14	11
Flurazepam	14[b]	25

[a]Includes codeine ranking No. 4 in NIDA (1984).
[b]Methadone and flurazepam were each detected in eight cases.

the other hand, it is less than the 9.1% reported by Caplan et al. for Maryland or the 8% reported by Garriott et al. for Dallas [*6,8*].

In this analysis, 40.5% of the 210 toxic deaths had blood ethanol concentrations greater than 10 mg/dL. This figure is consistent with the 38.6% reported by Caplan et al. and the 36% for female toxic deaths reported by Campbell and Mason [*6,12*]. NIDA (1984) lists alcohol-in-combination as the drug mentioned in 31.24% of the episodes reported by medical examiners [*3*].

Non-narcotic analgesics were detected in 62 (29.5%) cases, but caused only 3 (1.4%) deaths. This is similar to the report by Poklis and Gantner where common analgesics were found in 20% of their St. Louis cases but caused only 4 (2.7%) deaths [*13*]. Campbell and Mason found these drugs to be the second most important group associated with death. The concern expressed by Campbell and Mason concerning the ease of obtaining these preparations is supported [*12*].

Summary

Toxic accidents have shown a steadily increasing percentage of all accidents in Pima County (7% in 1982, 8.4% in 1983, 12.2% in 1984 and 15.4% in 1985). Toxic accidents have also increased from 31.8% to 57.6% of all toxic deaths during the four years of the study.

Males and females have the numbers of toxic suicides that would be projected on the basis of their proportion of the population (51% females, 49% males). Toxic accidents show a trend over the four years from an overrepresentation of males to the numbers expected on the basis of population proportion.

The 20-to-29-years age group and those under 5 years of age show the largest ratios of observed to projected (or expected) numbers of toxic death accidents. The 40-to-49-years age group shows the highest ratio of observed to projected toxic suicides.

Ethanol (85 cases), narcotics (73 cases), carbon monoxide (63 cases), non-narcotic analgesics (62 cases), and tranquilizers (54 cases) were the toxic substances most often detected.

Carbon monoxide (58 cases), narcotics (42 cases), antidepressants (32 cases), cocaine (18 cases), barbiturates (15 cases), and ethanol (13 cases) were the substances responsible for the majority of toxic deaths.

Carbon monoxide was responsible for 27.6% of the toxic deaths and showed a significant increase in the number of deaths from 1982 to 1985.

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Address requests for reprints or additional information to
James M. Byers, M.D.
Department of Pathology
Arizona Health Sciences Center
1501 N. Campbell Avenue
Tucson, AZ 85724