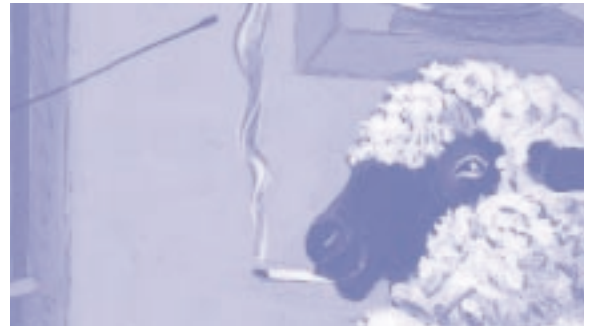


Patterns of Drug-Related Mortality in Maine, 1997-2002

by Marcella H. Sorg

Margaret Greenwald



Since 1997, the number and rate of drug-related deaths in Maine have risen dramatically. Contrary to what much of recent popular media coverage suggests, prescription medications and not illicit drugs are involved in the majority of these deaths, and many of these prescription medications are used by people from all walks of life. In this article, Drs. Sorg and Greenwald summarize the results of a recent statewide study to determine the characteristics of those in Maine who have died from drug-related causes over the past five years. They find that Maine's substance abuse problem continues to be largely an alcohol abuse problem. Further, they find that drug deaths and, by implication, drug abuse problems are found in all areas of the state, both rural and urban. 🐏

Drug deaths in Maine have been rising.¹ In recent years, both the number and rate of drug-related mortalities have increased dramatically. Since 1997, the total annual number of drug deaths has more than quadrupled, and accidental drug-related fatalities have risen more than sixfold. This rapid increase has given rise to media coverage, public concern and political debate. All counties in Maine have been affected. As we shall describe, the prevalence and rate of increase in drug deaths in Maine parallels patterns found in other rural states.

Substantial increases in mortality or mortality risk potentially require public policy intervention. However, in order to make good decisions about changes in public policy that may be needed, it is necessary to have accurate and timely data on emergent public health and criminal justice problems such as drug-related deaths, the subject of this article. Data from the research reported here are being used for a range of purposes: to inform statewide strategic planning for the public health response to rising opiate abuse; to evaluate state policies on take-home dosing in methadone clinics for opiate addiction; to underscore the need for a statewide electronic prescription monitoring program; and to provide data on rural drug-related mortality to federal agencies which regulate opiate addiction treatment.

Attention and public concern in Maine has focused on heroin deaths in Cumberland County, OxyContin abuse in Washington County, and the operation of methadone clinics around the state. Are these the only dangerous drugs used in Maine? What are the characteristics of the people who die from drug-related causes? Do the geographic patterns publicized in the media relate to one another? With questions such as these in mind, Maine's Office of Chief Medical Examiner undertook an analysis of all drug deaths occurring in the state from the beginning of 1997 to the end of June 2002.² The study's findings provide a comprehensive snapshot of one population of drug users—those for whom drug use has gone tragically awry—and therefore offer an essential perspective on substance abuse in the state of Maine.

THE BODY OF EVIDENCE

All deaths for which drug involvement is suspected are referred to Maine's Office of Chief Medical Examiner, which has statutory authority to investigate all suspicious, accidental, and unintended deaths, in order to certify their cause and manner. This death investigation includes a scene visit whenever practicable. An autopsy and full toxicology screen are routine in suspected drug deaths. The medical examiner may obtain hospital or other medical records upon request, and may utilize the services of consultants with special expertise. The Maine Office of Chief Medical Examiner currently has two full-time forensic pathologists.

For each death investigated, a medical examiner is responsible for completion of a death certificate, which includes:

- Demographic information about the decedent (including age, sex, marital status, military veteran status, birthplace, place of residence, race, ethnicity, education, and occupation);
- Information on the processing and disposition of the body (including whether it was viewed by the medical examiner after death, autopsied or embalmed; the method [burial, cremation, etc.] and place of disposition; identification of the investigating medical examiner; and funeral practitioner involved);
- Information on the death event (time, place, how the injury or activity leading to death occurred);
- The manner of death (natural, accident, suicide, homicide or undetermined);

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- The medical cause of death (up to four levels of causation may be specified, as well as significant conditions which contributed to the death).

Defining Drug-Related Deaths

This article reports on a study of all the cases investigated by the Office of Chief Medical Examiner (often referred to simply as “medical examiner cases”) from 1997 through 2002 in which the use or abuse of a drug was determined to be either a cause (primary or underlying) or a significant contributing factor. Deaths caused by drugs are, in medical examiner parlance, poisoning deaths. However, not all poisoning deaths were considered drug-related fatalities. Two categories were excluded: deaths due to the inhalation of carbon monoxide and deaths caused by chronic alcohol abuse in which no other drugs were implicated. Death in which both alcohol and drugs were causal or contributing factors have been included.

Even when drugs are not the primary cause of death, they may be an important component of the overall causal sequence.

Deaths caused directly or indirectly by drugs may involve illicit substances (such as heroin or cocaine) or prescription drugs. Abuse occurs when drugs are intentionally taken by a legitimate prescription holder in a manner other than prescribed, or when these drugs are diverted (by sale, gift or theft) from prescription holders to others. A drug-related death also may be an unintended consequence of drug use. These unintended consequences may result from drug interactions, such as cases where multiple medical practitioners independently prescribe for one individual, or from adverse individual reactions to particular drugs or particular doses. When legitimate prescription holders are involved, it is not always easy after death to distinguish use from abuse.

Even when drugs are not the primary cause of death, they may be an important component of the overall causal sequence. For example, a medical examiner may determine that lack of oxygen to the brain (brain anoxia) was the immediate cause of death, but that brain anoxia was due to methadone toxicity. In that case, methadone would be listed as an underlying (secondary) cause on the certificate of death.

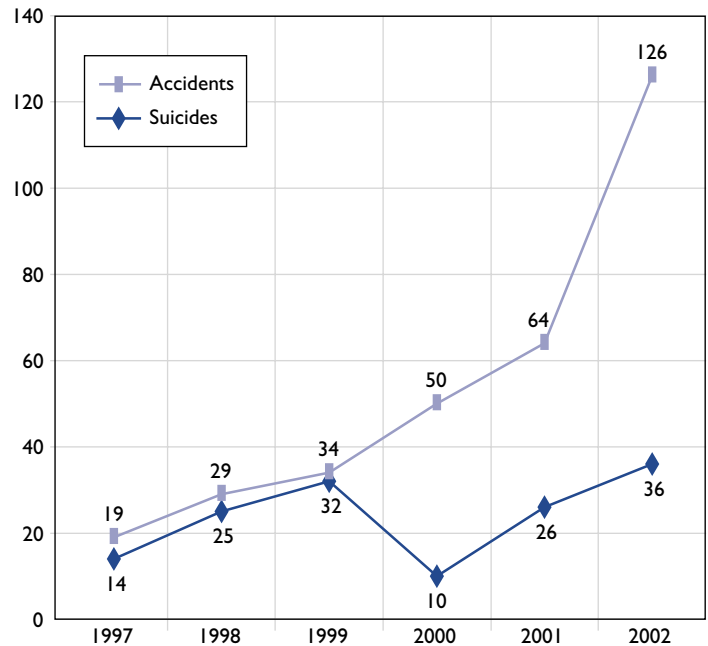
In other cases, where death occurs as a direct consequence of disease rather than drugs, drug use or abuse may be a significant factor in the victim’s failure to survive the disease. For example, in certain dosages or under certain circumstances, a tricyclic antidepressant may increase the potential for a cardiac arrhythmia. In a case such as this, death may result from underlying heart disease, but the drug exacerbates the cardiac malfunction. So the death certificate would list cardiac disease as the cause of death but the antidepressant might be listed as a significant contributing factor. Circumstances such as these provide one reason why an autopsy is generally necessary. A microscopic examination of the major organs also may be needed to diagnose or exclude certain diseases.

Toxicology Testing

The investigation of drug deaths in Maine routinely includes full toxicology testing. A comprehensive toxicology screen is designed to detect a wide range of drugs, including “analgesics, anticonvulsants, antihistamines, antidepressants, hypnotics, narcotics, sedatives, stimulants [and] tranquilizers” in amounts as small as 0.001 mg/L (Central Valley Toxicology, Inc., www.cvtox.com).⁵ Though toxicology reports may yield a wealth of information, using this information to help determine cause and manner of death requires considerable expertise.

The toxicology report includes a list of all drugs in the victim’s system at the time of death, but their presence does not necessarily mean they were a causal or contributing factor. For example, if a cardiac patient on methadone maintenance had taken over-the-counter drugs for a cold, and then died of an accidental digoxin overdose, the toxicology report would include methadone, digoxin, and perhaps antihistamine and an analgesic such as acetaminophen. However,

FIGURE 1: **Number of Suicidal and Accidental Drug-related Deaths in Maine, 1997-2002**



only digoxin would be listed as a cause of death on the death certificate.

In some cases, use of a drug must be inferred from the presence of a metabolized form identified by the toxicology test. Some drugs metabolize quickly, even after death. Breakdown of chemicals may be more extensive if there is a delay in discovering the death. This complicates the determination of deaths due to heroin, for example, which quickly metabolizes to morphine in the body. Once metabolization has occurred, prescription morphine and heroin cannot be differentiated. The medical examiner must consult the victim's medical history and police reports of the circumstances surrounding the death in order to interpret the toxicology results.

The relationship between drug levels provided in the toxicology report and the cause of death is not always straightforward. Toxic drug levels sometimes overlap with therapeutic levels, as in the case of methadone. Further, there may be a large range of individual variation in tolerance for a given drug; doses needed in a person with high tolerance may be lethal for a person with low tolerance. Drugs may interact with one another in dangerous ways. It is possible for an otherwise benign drug taken at a therapeutic dose to be toxic in combination with other drugs.

The toxicology report is an essential component of any drug death investigation, but the interpretation requires knowledge, experience, care, and caution. For this reason, our analysis gives more weight to the medical examiner's determination of cause of death than to the raw data in the toxicology report.

Determining Manner of Death

Some deaths classified as natural do involve drugs. These include deaths resulting from known effects of accepted medical treatment, such as digitalis toxicity from treatment of congestive heart failure. It is important to note that when death is due to a consequence of chronic (long-term) substance abuse—such as withdrawal seizures from chronic alcoholism or cardiac inflammation (endocarditis) due to chronic intravenous drug use—the manner is ruled natural as well (Hanzlick 1997). Unless a drug is listed by the medical examiner as an underlying cause or a contributing factor on the

death certificate, natural deaths with positive drug toxicology findings are not included in our analysis.

Homicidal poisonings are very rare in Maine. None occurred during the period covered by our study. Not all homicides (death at the hands of another) are legally classified as murders (intentionally taking a life).

Deaths may be classified as suicide in Maine only if there is a "preponderance of evidence" that the victim intended to cause his or her own death. Such evidence might include a suicide note or history of previous attempts. Although drug abuse in and of itself carries with it an inherent risk of overdose and death, engaging in risky or reckless behavior is not generally considered sufficient evidence of suicidal intent. Medical examiners are bound by these legal guidelines.

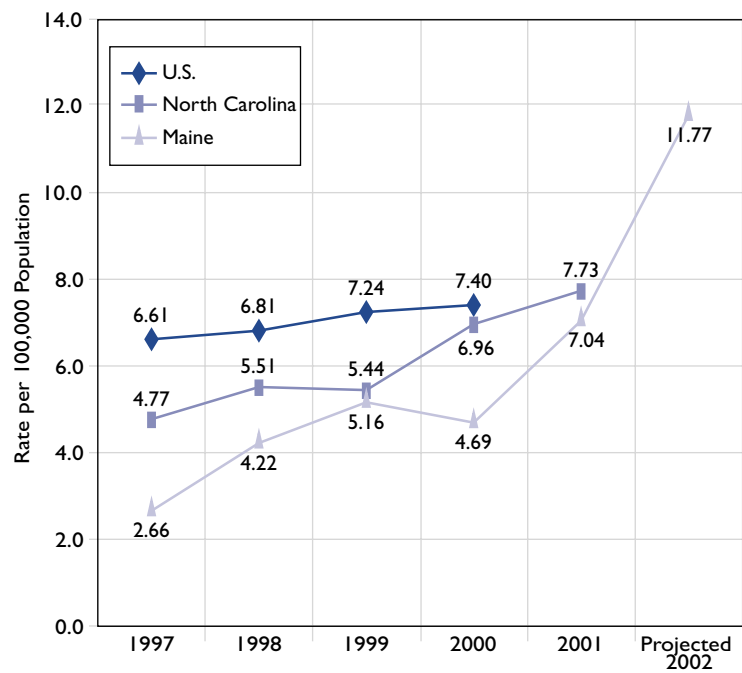
Maine's strict guidelines for what can be judged suicide means that medical examiners classify as accidents all drug deaths directly due to the unintended or unexpected, acute (sudden or short-term) toxic effects of a drug or poison.⁴ Accidental deaths thus comprise something of a composite category; deaths under this rubric may be the result of a range of heterogeneous drug uses.

TABLE 1: Distribution of Maine Drug-related Deaths by County, 1997-2002

County	No. Drug Deaths	% of State-wide Drug Deaths	County's % of Maine Population	County	No. Drug Deaths	% of State-wide Drug Deaths	County's % of Maine Population
Androscoggin	19	5.1%	8%	Oxford	10	2.7%	4%
Aroostook	12	3.2%	6%	Penobscot	46	12.3%	11%
Cumberland	126	33.7%	21%	Piscataquis	3	0.8%	1%
Franklin	12	3.2%	2%	Sagadahoc	2	0.5%	3%
Hancock	10	2.7%	4%	Somerset	12	3.2%	4%
Kennebec	37	9.9%	9%	Waldo	5	1.4%	3%
Knox	17	4.5%	3%	Washington	8	2.1%	3%
Lincoln	4	1.1%	3%	York	51	13.6%	15%
				State Total	374	100.0%	100%

*County population percentages computed from Census 2000 data.

FIGURE 2: Comparison of Death Rates from Intentional and Unintentional Poisonings in Maine, North Carolina, and Nationally



In our study, as in much of the published literature on drug deaths, we often combined accidents and suicides for statistical purposes. When suicides and accidents are statistically different in some respect, we reported them separately.

MORTALITY RATES

The total annual number of drug deaths occurring in Maine has more than quadrupled since 1997. During the same period accidental drug-related fatalities have risen more than sixfold; recent increases are particularly dramatic. Figure 1 shows the total number of suicidal and accidental deaths by year.

Drug deaths have been rising across the country. The prevalence and rate of increase in Maine deaths involving drugs parallels those found in other rural states. Likewise, Maine's drug deaths—and by inference, drug abuse—are spread throughout the state, and thus are not a strictly urban phenomenon (see Table 1).⁵

Drug deaths have occurred in every county of the state in proportions roughly equivalent to the population as a whole. For example, Penobscot County, with 11% of Maine's population according to the 2000 census, was the site of 12.3% of its drug deaths. Within counties, deaths occur in towns large and small. Though the largest disproportion occurs in Cumberland County (home to 21% of the state's population but site of 33.7% of its drug-related mortalities), these statistics

believe the nearly exclusive media focus on Cumberland and Washington counties.

The overall proportionality of drug deaths relative to total population is based on computations for the period of study as a whole. It masks a very steep rise in the rate of these deaths over the course of these five and a half years. Recent studies enable us to compare Maine's increase to both the United States as a whole and to North Carolina (a more populous and racially diverse but still largely rural state) through use of what is termed the "Crude Death Rate" (CDR). (See Figure 2.)⁶ The CDR for drugs is the number of deaths per 100,000 of population due to intentional and unintentional overdose. The U.S. National Vital Statistics System has published national rates for drug-induced deaths among non-Hispanic whites through 1999 (Minino et al. 2002). Statistics from unintentional drug overdoses in North Carolina from 1997 through 2001 also have been compiled (Sanford 2002).

While the national drug death rate shows a small but steady increase, Maine's rise is precipitous. In 1997 Maine's rate was only 40% of the national rate. Two years later it had risen to 70% of the national rate. Even more dramatic increases in the years since make it likely that Maine's drug death rate has now exceeded the national rate. North Carolina's increase is roughly comparable to Maine's. It is clear that drug deaths are not confined to major metropolitan areas of the United States. Risky drug use seems to be on the increase in smaller cities, small towns, and rural areas. Who takes these risks, and under what circumstances?

DECEDENTS

Some victims of drug-related mortality in Maine are people most Mainers would characterize as marginal—without a stable place to live or a stable work history, perhaps with histories of mental illness or of serious substance abuse problems. Others, however, are well-educated homeowners, employed at responsible jobs in a variety of skilled occupations. Aside from being (like most Mainers) overwhelmingly Caucasian, the population of those who die of drug-related causes is surprisingly diverse. Both men and women of all ages (15-92) are included.

TABLE 2: **Demographic Characteristics of Drug-death Victims, 1997-2002, Compared to Maine's 2000 U.S. Census Population**

	Drug-death Victims	Maine 2000 Census
Males	62%	48%
Born in Maine	58%	67%
Married	24%	58%
Single/divorced	71%	36%
Education high school or greater	79%	85%

TABLE 3: **Demographic Characteristics of Drug-death Victims: Suicides and Accidents, 1997-2002**

	All Victims	Accident Victims	Suicide Victims
Age			
Mean (range)	40 (15-92)	38 (15-92)	45 (16-91)
Sex			
Male	62%	68%	49%
Female	38%	32%	51%
Race			
Caucasian	96%	95%	98%
Marital Status			
Married	24%	20%	33%
Never married	39%	31%	32%
Divorced	32%	44%	29%
Education (ages 15+)			
High school	50%	51%	50%
Beyond high school	29%	25%	37%
Nativity			
Born in Maine	58%	60%	54%

Compared to averages for Maine's population as a whole, drug-death victims are more likely to be male, slightly less likely to have been born in Maine, much less likely to be married, and a bit less educated.

Accident victims are on average slightly younger than those who commit suicide, more likely to be male and less likely to be married. The mean age of all drug-

TABLE 4: **Location of Death, by Sex, 1997-2002**

	Males	Females	All
Hospital	51 (22.2%)	45 (31.3%)	96 (25.7%)
Residence	144 (62.6%)	89 (61.8%)	233 (62.3%)
In open	7 (3.0%)	2 (1.4%)	9 (2.4%)
Motor vehicle	2 (0.9%)	0 (0.0%)	2 (0.5%)
Nursing home	2 (0.9%)	1 (0.7%)	3 (0.8%)
Other	24 (10.5%)	7 (4.9%)	31 (8.3%)
Total	230 (100.0%)	144 (100.0%)	374 (100.0%)

TABLE 5: **Drug-death Victims with Chronic Conditions Identified as a Cause or Contributing Factor on the Death Certificate, 1997-2002***

as percentage of 374 total drug-death cases

	Primary or Secondary Cause	Contributing Factor
Respiratory disease	2 (0.5%)	7 (1.9%)
Liver disease	0 (0.0%)	5 (1.3%)
Heart disease	13 (3.5%)	9 (2.4%)
Brain disease (seizure disorder)	1 (0.8%)	7 (1.9%)
Substance abuse history	0 (0.0%)	9 (2.4%)
Obesity	0 (0.0%)	9 (2.4%)
Total	16 (4.3%)**	46 (12.3%)

* Note that more than one drug may be mentioned in a single case.

**Column percent does not add due to rounding.

death victims for our period of study was 40. More than half (57%) of these decedents were aged 35-55.

Most drug-death victims died at a residence, their own or someone else's. More women than men died in a hospital. More men than women died in the open or in a motor vehicle. These statistics may reflect stronger social networks for women decedents. Knowing where drug deaths occur is important for designing prevention strategies as well as interventions for living victims.

Like many middle-aged Mainers, the drug death victims had chronic medical problems, including heart, lung and liver diseases, as well as obesity. Conditions such as these play a role in drug-related deaths by reducing physical capacity. For instance, liver diseases, such as hepatitis or cirrhosis, can reduce the ability of the liver to detoxify blood. This reduced ability plays a role in keeping blood drug levels dangerously high. Chronic obstructive pulmonary disease (COPD), on the other hand, reduces lung capacity, which can enhance the respiratory depression produced by high levels of opiates. Obesity can obstruct the airway, particularly in some body positions, thus potentially increasing the risk from respiratory depression caused by opiates. Cardiovascular disease further increases risks from respiratory depression by reducing the capacity of the heart and lungs to process oxygen. Witnesses to the circumstances of overdose deaths often describe the

TABLE 6: **Drugs Most Frequently Mentioned on Death Certificates as a Cause or Contributing Factor, 1997-2002***

	All Drug Deaths No. (% of 374 cases)	Accidents No. (% of 248 cases)	Suicides No. (% of 123 cases)		All Drug Deaths No. (% of 374 cases)	Accidents No. (% of 248 cases)	Suicides No. (% of 123 cases)
Polydrug **	87 (23.3%)	53 (21.4%)	34 (27.6%)	Cocaine	20 (5.3%)	19 (7.7%)	0 (0.0%)
Methadone	66 (17.6%)	64 (25.8%)	2 (1.6%)	Propoxyphene	16 (4.3%)	7 (2.8%)	9 (7.3%)
Ethanol	57 (15.2%)	38 (15.3%)	19 (15.4%)	Fentanyl	18 (4.8%)	16 (6.5%)	2 (1.6%)
Morphine/heroin	73 (19.5%)	69 (27.8%)	4 (3.3%)	Diazepam	12 (3.2%)	9 (3.6%)	3 (2.4%)
Oxycodone	26 (7.0%)	17 (6.9%)	9 (7.3%)	Hydrocodone	11 (2.9%)	7 (2.8%)	4 (3.3%)
Amitriptyline	24 (6.4%)	14 (5.6%)	10 (8.1%)				

*Note that more than one drug may be mentioned in a single case.

** One polydrug case is undetermined manner and one cocaine case is a natural death.

victim as “sleeping” and “snoring” heavily just before death, an unrecognized sign of respiratory distress.

Decedents may have been taking medications prescribed legitimately for conditions such as pain. These medications sometimes have dangerous side effects if taken at high doses. They may interact dangerously with one another, or with alcohol or other drugs of abuse. Tricyclic antidepressants such as elavil or aventyl, for example, can interfere with the electrical function of the heart in some individuals and at some doses. Methadone is legitimately prescribed for treatment of pain or for narcotic dependency. Some medications prescribed for anxiety or depression, if taken in conjunction with methadone, can boost the blood levels—hence the toxic effects—of both drugs (Mikolaenko et al. 2002).

Maine currently has no system of centralized prescription registration or monitoring, although there is a bill proposed for electronic prescription monitoring. The certificate of death does not code for histories of mental illness or substance abuse. To try to clarify the relationship of prescription drugs to drug deaths, we examined all 2001 case files for evidence of histories of mental illness (including depression) and drug or alcohol abuse, as well as for information about prescription involvement. Since this information is not collected systematically, it must be gleaned from the medical examiner’s report, medical records, or police reports.

The files revealed that at least 55% of all 2001 drug-death victims had a known history of mental illness. The percentage was higher for suicide (72%) than for accident victims (42%). About half (50%) of all victims had a documented history of substance abuse. In this case, the percentage was higher for victims of accidental death (73%) than for those who committed suicide (16%).

Information on prescriptions could be found in the files of 96% of the 26 drug-related suicides that occurred in 2001, but for only 52% of the accidental deaths. Of the cases for which prescription information is available, decedents in 88% of the suicides and 52% of the accident cases had a prescription for at least one drug identified as a cause of death. Prescription drugs accounted for the cause of 63% of accidental deaths during the study period and of 94% of the suicides.

Common Name and Drug Class for Frequently Occurring Drugs

Drug	Common/Brand Name	Drug Class
Amitriptyline	Elavil	Antidepressant
Diazepam	Valium	Anti-anxiety agent
Diphenhydramine	Benadryl	Antihistamine
Ethanol	Alcohol	Depressant
Fentanyl	Duragesic	Narcotic analgesic
Fluoxetine	Prozac	Antidepressant
Hydrocodone	Vicodin	Narcotic analgesic
Methadone	Methadone	Narcotic analgesic
Morphine/heroin	Morphine/heroin	Narcotic analgesic
Nortriptyline	Aventyl	Antidepressant
Oxycodone	OxyContin	Narcotic analgesic
Propoxyphene	Darvon	Narcotic analgesic

TABLE 7: **Drugs Mentioned in the Death Certificate as Cause of Death Combined with Those Found in Toxicology of “Polydrug” Cases, 1997-2002***

	No.	(% of 374 cases)
Methadone	86	(23.0%)
Ethanol	77	(20.6%)
Morphine/heroin	86	(23.0%)
Oxycodone	42	(11.2%)
Amitriptyline	36	(9.6%)
Cocaine	28	(7.5%)
Propoxyphene	31	(8.3%)
Fentanyl	23	(6.1%)
Fluoxetine	29	(7.8%)
Hydrocodone	22	(5.9%)

* Categories of drugs are not mutually exclusive and only the major drug causes are included here; thus, the column does not sum to 100%.

DRUGS

Of the drugs specifically listed on death certificates as either cause or contributing factor, three classes predominate: narcotics (including for example methadone,

TABLE 8: Top Five-ranked Drugs Found in Toxicology Screen and Frequency of Occurrences, 1997-2002*

ACCIDENTS		SUICIDES		ALL DRUG DEATHS	
Rank	Frequency (n= 248)	Rank	Frequency (n= 123)	Rank	Frequency (n= 374)
1. Methadone	181 (32.7%)	1. Ethanol	29 (23.5%)	1. Methadone	88 (23.5%)
2. Morphine/heroin	79 (31.9%)	2. Amitriptyline	19 (15.4%)	2. Morphine/ heroin	85 (22.7%)
3. Diazepam	58 (23.4%)	2. Propoxyphene	19 (15.4%)	3. Ethanol	83 (22.2%)
4. Ethanol	53 (21.4%)	3. Oxycodone	18 (14.6%)	4. Diazepam	75 (20.1%)
5. Oxycodone	45 (18.1%)	3. Diphenhydramine	18 (14.6%)	5. Oxycodone	63 (16.8%)
		4. Diazepam	17 (13.8%)		
		5. Fluoxetine	15 (12.2%)		

*Note that some drugs share a rank.

morphine/heroin,⁷ oxycodone, hydrocodone, and others), antidepressants (most frequently amitriptyline) and anti-anxiety agents (especially diazepam and alprazolam). Alcohol (a depressant) and cocaine (a stimulant) are also frequently listed.

As is seen in most other medical examiner jurisdictions, victims in Maine typically have more than one drug in their system. Drugs co-occur in many combinations, making it difficult to isolate a single drug as the cause of death. In fact, in about one-quarter (23%) of all drug deaths, medical examiners have noted “polydrug” or “mixed drug” as the cause of death. In general, the toxicology findings for these cases reflect the frequency distribution of drugs implicated in cases where the specific drug has been listed on the death certificate. The drugs most frequently encountered are (in rank order) methadone, ethanol (alcohol), and morphine/heroin. These are the drugs most frequently implicated in Maine drug deaths overall in 1997-2002. By contrast, the Drug Abuse Warning Network (DAWN) lists the three drugs most frequently implicated in overdose deaths in urban areas in 2000 as (in order) heroin, cocaine, and alcohol (Mortality Data 2002).

Toxicology Test Results

Because toxicology tests provide a record of all drugs in a decedent’s system, regardless of cause of death, they provide broader insights into patterns of drug consumption than do the certificates of death. The findings regarding narcotics are illustrative. Of the 267 Maine decedents who tested positive for narcotics,

81% had toxicology results that included more than one drug. For 26% of these, two or more narcotics were involved. The most frequently occurring narcotic-narcotic combinations were: morphine/heroin-codeine (10 cases), methadone-oxycodone (10 cases), and morphine/heroin-methadone (seven cases).

Of the 267 narcotic-related deaths, 80% were accidental deaths, and 20% were suicides. Drug distributions for these two classes of narcotic-related deaths were markedly dissimilar. The two narcotics found most frequently in the toxicology results for accident victims—methadone and morphine/heroin—are not even among the top seven drugs found in suicide victims’ toxicology tests.

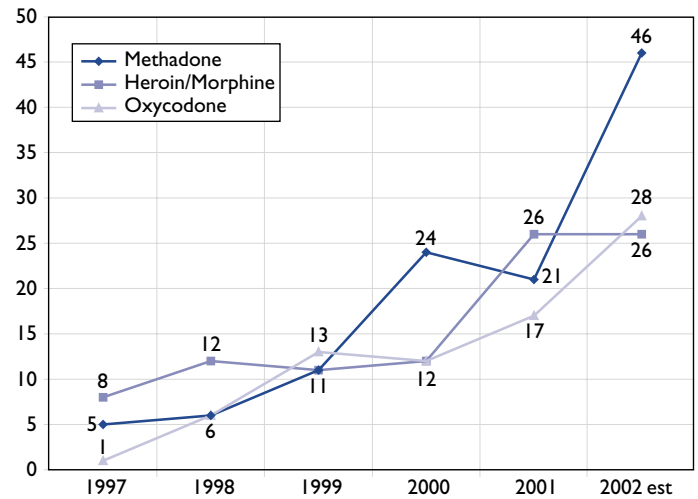
Ethanol, diazepam, and oxycodone appear on both lists. Other drugs commonly found among suicides—amitriptyline, propoxyphene, and fluoxetine—appear much less frequently among accident victims.

Narcotics

The narcotic analgesic class of drugs includes the naturally occurring opiates (morphine, heroin, and codeine) and synthetic opioids (including methadone, oxycodone, hydrocodone, fentanyl, and propoxyphene). Except for heroin, which is illicit, these drugs are frequently prescribed for pain relief (analgesia).

Narcotics comprise the class of drugs most commonly implicated in Maine drug deaths. One or more narcotic drugs are identified as a cause of death for 198 (53%) of the 374 cases in our study. Toxicology tests reveal that, regardless of cause of

FIGURE 3: **Number of Cases in Which Key Drugs Were Identified by Toxicology, 1997-2002**



death, 71% of Maine's drug death victims had one or more narcotics present in their system when they died. Narcotics most frequently involved, measured either by cause of death on death certificates or toxicology reports, were methadone, morphine/heroin, and oxycodone. Rates of occurrence for all three rose sharply during the period of study. (See Figure 3.) These three drugs have been a particular focus of media attention and public concern.

Methadone. Methadone is a synthetic opioid with two distinct primary uses. Because it is long-acting, without the same euphoric "high" as heroin, it has long been used in the treatment of opiate addiction. Methadone maintenance clinics distribute the drug in liquid, powder or wafer form (opiate agonist therapy). More recently, methadone has gained favor as a cost-effective treatment for chronic pain. Pain clinics and private physicians prescribe it in tablet form. Toxicology tests cannot discriminate between these various forms.

Methadone pharmacology is particularly complex. Tolerances vary widely from one individual to another. The range of blood levels for therapeutic effect overlaps with the toxic range. People can die of fairly low, theoretically safe doses, often when alcohol or other drugs are present, or if the individual has low tolerance. An individual's tolerance can also change with circumstance. Tolerance is reduced for regular users who, for one reason or another, stop receiving regular doses. When they resume taking dosages to which they had been accustomed, they are at greater risk for fatal overdose.

The slow onset of methadone's effects may prompt some users to take more methadone, with fatal effect. Use or abuse of other drugs in combination with methadone may increase its toxicity or alter its metabolic effect. Alcohol and benzodiazepines (such as diazepam or alprazolam) are often taken along with methadone. This can increase the risk of respiratory depression, the most common adverse effect of all narcotics and the one most likely to prove fatal. Recent research also suggests an association between methadone and cardiac arrhythmias in some individuals (Krantz et al. 2002; Martell et al. 2003).

It should come as no surprise that methadone was found in the toxicology results of 24% of Maine drug

deaths during the study period, with rates increasing sharply in recent years. Methadone was the drug most frequently found in the toxicology findings for accidental overdoses, but was infrequently found in the toxicology reports of those who had committed suicide.

All Maine counties except Piscataquis, Sagadahoc, and Washington had some drug deaths for which methadone appears in the toxicology report during the period of study. Cumberland, York, and Penobscot counties taken together account for 75% of these methadone cases. However, in all counties but Cumberland, the percentage of drug deaths with a toxicology finding that includes methadone is roughly proportional to the population as a whole.

It is important to note that methadone therapy for opiate dependence has been used for over 30 years. It is only recently that methadone-associated deaths have increased. Thus, it is likely that other factors, such as its newer use for treating pain, may be associated with the increase.

Because public concern has focused on the possible involvement of methadone maintenance clinics in methadone deaths, records of methadone deaths for 2001-2002 were analyzed to try to determine the source of the methadone involved. These numbers may under-represent the number of legitimate methadone users involved in drug-related fatalities. Medical examiners

make every effort to contact maintenance clinics and physicians who may have been involved. But there are no special restrictions on prescribing methadone for pain. In cases where medical records are incomplete, especially where the decedent sought treatment out of state, records may be lacking for prescriptions that do exist.

Morphine/Heroin. Heroin is an illicit drug. Morphine sulfate may be legally prescribed as an analgesic. Because heroin metabolizes rapidly to morphine, the two drugs are indistinguishable in toxicology tests and nearly indistinguishable in autopsy. However, evidence of intravenous injection along with morphine in toxicology is taken as a sign of heroin abuse. Because heroin is an illegal substance, there is no standard dose and purity is impossible to regulate. Therefore, it is not surprising that morphine/heroin was the second most frequent drug found in the toxicology reports of accidental drug death victims in Maine during the period of study. However, it was seldom found in the toxicology results for suicides. (See Table 8.)

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Drug deaths for which morphine/heroin appeared in the toxicology report were unevenly distributed around the state. During the period of study, Aroostook, Lincoln, Sagadahoc and Washington counties had none. Cumberland, Franklin and Penobscot counties had a disproportionate share.

Oxycodone. Oxycodone is a synthetic opioid often prescribed for pain. Since 1995 it has been marketed in the long-acting form OxyContin. Media attention has focused on OxyContin abuse, particularly in Washington County. Once metabolized, however, OxyContin and other forms of oxycodone are indistinguishable. Oxycodone is listed as a cause of death on

only 7% of death certificates for drug-related cases during 1997-2002. It is listed on 17% of toxicology tests for drug-related deaths during this period: 15% of suicides and 18% of accident victims.

All Maine counties except Piscataquis had at least one case for which oxycodone appeared in the toxicology findings. In most counties, the percentage of oxycodone deaths was roughly proportional to the percentage of the state's population as a whole. In four counties the rate was higher: Aroostook, Cumberland, Penobscot, and Washington.

CONCLUSION

Substance abuse is a critical problem facing Maine state and local governments and the communities they serve. Death is only the most dramatic consequence of a behavior pattern associated with crime, increased accidents, lost time at work, serious health problems, and untold anguish for family and loved ones. In our legitimate concerns about this serious social problem, we often focus on its most exotic elements—illegal drugs such as heroin or cocaine, or legal drugs such as methadone that seem to be used primarily by a definable “addict” population. Discussion tends to focus on whether it is more effective to imprison addicts, enroll them in drug treatment programs, or even make overdose antidotes more easily accessible. Yet the problem is much more complex.

Study of Maine's medical examiner files on all those involved in drug-related deaths from 1997 through June 2002 indicates that substance abuse and legitimate drug use in Maine exist along a complex series of continua. Use of illegal drugs by socially marginal people is only one extreme of a large, interrelated set of behavior patterns. Prescription medications are involved in the majority of Maine drug deaths. Many of these prescription medications are used by people from all walks of life. It is not easy to distinguish legitimate use from abuse, even when that use results in death. To reduce the risk of drug-related fatalities, policy initiatives must address this complexity of drug use. Here we make a few points not often made in policy debates on substance abuse issues, simply by way of example:

- Prescription drugs are involved in the overwhelming majority of drug deaths in Maine. Some of these deaths may be due to drug diversion. Some may be due to misuse. Others may be due to adverse interactions of drugs unforeseen by multiple providers acting independently of one another. Without some system of prescription registration or monitoring, it will be difficult to get accurate estimates of any of these dimensions of the problem.
- Alcohol ranked third of the substances listed on death certificates as either cause of death or contributing factor of drug-related deaths in Maine, 1997-2002. Maine's substance abuse problem is very largely an alcohol abuse problem.
- Because chronic medical problems were a factor in many drug deaths, efficacious public health measures addressing these underlying conditions might reduce the risk of drug-related mortality. These measures might include weight reduction, smoking cessation, exercise programs, and the like.
- Better public education on signs of respiratory distress might save lives. Unwitting witnesses to drug deaths frequently mistake respiratory distress for snoring and fail to summon medical assistance.

Our study, though comprehensive in scope, was preliminary. We hope its findings will prompt further study of drug users in Maine. Public policy initiatives that effectively address problems of drug use and abuse in Maine must be based on a more detailed understanding of the circumstances and risks of those use patterns. 🐉



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Please turn the page for endnotes and article references.

ENDNOTES

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2. The Maine Drug-Related Mortality Patterns project was a collaborative effort of the Office of Chief Medical Examiner, the Office of Attorney General, the Office of Substance Abuse, and the Margaret Chase Smith Center for Public Policy at the University of Maine. Funding for the project was provided the Maine Justice Assistance Council (Edward Byrne Memorial Grant) and the Office of Substance Abuse. Direct project support was provided by the Office of Chief Medical Examiner, the Office of Attorney General, and the University of Maine. Analysis of the data was performed by forensic anthropologist Marcella H. Sorg and Maine Chief Medical Examiner Margaret Greenwald.
3. Central Valley Toxicology, Inc. of Clovis, California is one of the toxicology laboratories whose services have been employed by Maine's Office of Chief Medical Examiner.
4. This designation is consistent with guidelines recently published by the National Association of Medical Examiners (Hanzlick et al. 2002) for determining the manner of death when drugs are involved. Jurisdictions outside Maine may use different criteria.
5. Although the total number of drug-related deaths in 2002 is provisionally known, the analysis of demographic and toxicology findings for deaths occurring July-December 2002 has not yet been completed. As of this time, there are four cases still pending from 2002.
6. Maine's data are compiled directly from the certificate of death, medical examiner report, and toxicology report. The North Carolina and U.S. data are based on vital records statistics on particular "ICD-9" or "ICD-10" categories (for intentional and unintentional poisoning deaths) in which a Department of Health

nosologist has coded information on the death certificate using the International Code of Diseases. There are minor systematic differences. For example, the North Carolina data include inhalation deaths, such as carbon monoxide; the Maine data do not.

7. Since heroin is toxicologically indistinguishable from morphine when metabolized, they are grouped together.

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