STATE OF MAINE

Maine Drug-Related Mortality Patterns: 1997-2002

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Executive Summary

Drug deaths have been increasing in Maine. Reports on this increase by the media and the police have raised public concern. The Office of Chief Medical Examiner, Office of Attorney General, and Office of Substance Abuse have responded by launching a review and analysis of drug deaths that occurred during the past five years. This report summarizes the findings of that study, which focuses on medical examiner cases from 1997 through June 2002. The analysis includes both suicidal and accidental overdoses. In particular, it addresses a rising problem with prescription drug abuse.

Both the rate and number of drug deaths have increased substantially in the past five years, rising from 34 in 1997 to 90 in 2001. The projected number for 2002 is 161, over four times the 1997 number (Figure 1). The rise in drug deaths is due primarily to a rise in accidental, not suicidal, overdoses. The increased incidence of drug deaths is part of a national trend now affecting rural states.

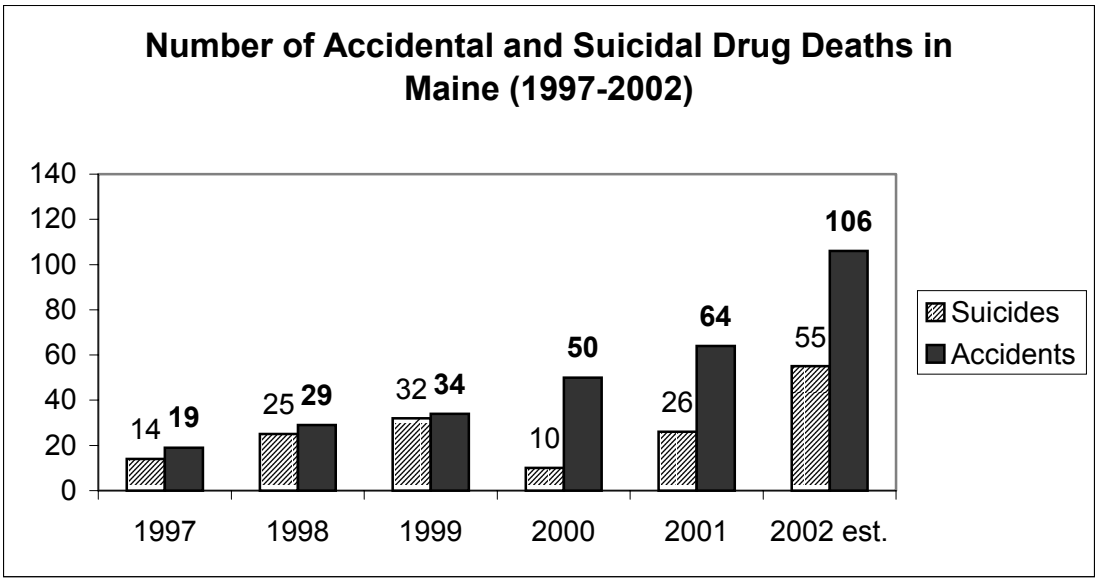

Figure 1. Number of accidental and suicidal drug deaths in Maine, 1997-2002 (2002 is projected)

In general, the number of deaths in each county mirrors the geographical distribution of the Maine population, with most cases occurring in the southern part of the state. However, all counties are affected (Table 1).

This study includes all medical examiner cases in which a drug or toxic substance caused the death. Each of these cases was investigated by the Office of Chief Medical Examiner. Overdose cases routinely receive an autopsy and a complete toxicology test. About 26% of victims die in the hospital and 62% at home; 12% die in other locations. When the death occurs outside the hospital, the police routinely conduct a scene investigation.

Table 1. Number and percent of confirmed drug deaths by county, 1997-2002

Number	*(Percent)*	*County*
19	(5.1%)	Androscoggin
12	(3.2%)	Aroostook
126	(33.7%)	Cumberland
12	(3.2%)	Franklin
10	(2.7%)	Hancock
37	(9.9%)	Kennebec
17	(4.5%)	Knox
4	(1.1%)	Lincoln
10	(2.7%)	Oxford
46	(12.3%)	Penobscot
3	(0.8%)	Piscataquis
2	(0.5%)	Sagadahoc
12	(3.2%)	Somerset
5	(1.3%)	Waldo
8	(2.1%)	Washington
51	(13.6%)	York
374	(100.0%)	TOTAL

The increase in drug deaths is largely a problem with prescription drugs, particularly those frequently prescribed for pain, anxiety, and depression. Prescription drugs cause 63% of accidental deaths and 94% of suicidal deaths. Table 2 lists the most common drugs implicated in Maine's drug deaths. An overwhelming majority involve narcotics (opiates and opioids) prescribed for pain, including methadone, oxycodone, fentanyl, and others. In 53% of all drug deaths, narcotics are mentioned as a cause of death. Prescription narcotics, including methadone, comprise 65% of the narcotic deaths. Heroin, an illicit narcotic opiate, is mentioned as a cause of death in 37% of the narcotic related deaths. The narcotic drugs are frequently taken in combination with each other and with other prescription medications, such as antidepressants and antianxiety medications. Death results from a range of factors, including self-medication for opiate dependence, "recreational abuse," intentional overdose, and unforeseen drug interactions.

Detailed examination of the 2001 case files reveals information about the prescription status of the drugs causing the deaths. Information was available for 96% of the 26 suicides, but for only 52% of the 64 accidents. Of those with prescription information, 88% of suicide victims and 52% of accident victims had a prescription for at least one drug that was listed in the cause of death.

Methadone and heroin are the individual drugs most frequently identified in toxicology tests, each present in about a quarter of all cases. For the year 2001, fewer than half of the deaths involving methadone had a documented prescription. Prescriptions include those from a methadone maintenance clinic, a pain clinic, or a private physician. Wide variance in individual tolerance makes methadone abuse risky. Doses that are safe in one person can be fatal in another with reduced tolerance due to abstinence or individual characteristics. The risks for both liquid methadone and heroin use are increased because the user may not know for sure the potency of the drug.

Table 2. Drugs most commonly identified as the cause of death, 1997-2002

Drug or drug class *	***Percent of 374 Cases***	***Common names***	***Drug class***
Polydrug combinations	23%	N/A	
Morphine/heroin	20%	Morphine/heroin	Narcotic analgesic
Methadone**	18%	Methadone	Narcotic analgesic
Prescription narcotic analgesics* (except methadone)	17%	N/A	
Ethanol	15%	Alcohol	Depressant
Amitriptyline	6%	Elavil	Antidepressant
Cocaine	5%	Cocaine	Stimulant
Diazepam	3%	Valium	Anti-anxiety agent
Fluoxetine	2%	Prozac	Antidepressant
Prescription narcotic analgesics* (except methadone)			
-Oxycodone	7%	OxyContin, Percocet, Tylox	Narcotic analgesic
-Propoxyphene	4%	Darvon	Narcotic analgesic
-Fentanyl	5%	Duragesic	Narcotic analgesic
-Hydrocodone	3%	Vicodin, Lorcet	Narcotic analgesic
-Codeine	1%	Codeine	Narcotic analgesic

** Percentages add to more than 100%, because more than one drug may be identified as causative in a single death. The percentage for the prescription narcotic category is calculated on an unduplicated count of all deaths caused by <u>any</u> prescription narcotic, except methadone. Polydrug is the term used for cause of death when no one drug is identified individually on the death certificate.*

*** Methadone is a prescription narcotic analgesic used to treat pain in some patients and addiction in others.*

Drug death victims, both for accidents and for suicides, have a broad range of ages. About two-thirds of decedents are between 30 and 50, with a mean age of 40. Sixty-eight percent of accidental overdoses and 49% of suicides are male.

Selected demographic comparisons between overdose victims and the general (Maine 2000 Census) population include the following notable statistics. Compared to the general population, among victims, there are 14% more males, 9% fewer Maine natives, and 34% fewer who are married. About 6% fewer victims have earned at least a high school diploma. (Table 3):

Table 3. Highlighted demographic characteristics for all drug related deaths, 1997-2002, compared to the Maine 2000 Census population

	Drug Overdose 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%

Those who die of overdose are likely to have other medical problems, as documented in the autopsy and by medical history. About 55% have a history of mental illness, including depression. More mental illness is reported among suicides (72%) than accidents (42%). About 50% of overdose victims have a history of drug abuse. This proportion is much higher among accidental overdoses (73%) than suicides (16%). Many decedents have other physical conditions, such as cardiovascular disease, lung disease, obesity, or chronic pain. These underlying conditions may increase vulnerability to fatal drug overdose, either due to reduced capacity (for example, of lungs or heart) or because medications prescribed for the conditions may interact dangerously with drugs of abuse.

Death certificates and narrative information gathered during the death investigation reveal details about the death event. Statistically, females are more likely (31%) than males (22%) to die in a hospital. Conversely, males are more likely (14%) than females (7%) to die away from a residence and outside the hospital. A commonly repeated description of the circumstances surrounding deaths includes comments about the person "sleeping" and snoring heavily just prior to death, likely an unrecognized sign of respiratory distress. Other investigative information shows that the location of death may be "sanitized" (by removing illegal drugs) before calling for help, or victims may be moved by companions to a neutral location from which to call 911, or placed where the body will be readily discovered by others.

In summary, the dramatic rise in overdose deaths in Maine is due mainly to a rise in accidental overdoses, primarily involving illicit and prescription narcotics in combination with other prescription drugs and alcohol. The most common drugs seen are narcotic pain medications (including methadone) and heroin. Medications prescribed for pain, depression, and anxiety all appear frequently as causes of death, often co-occurring. These overdose trends parallel those seen nationally. The picture of this population that emerges suggests that increased risk of death may be associated with a history of substance abuse, underlying natural disease, and use or abuse of multiple prescription medications. Legitimate prescriptions and diverted prescription medications are both important factors in drug fatalities and should be addressed, along with attention to illicit drug use.

Background

Substance abuse is a critical problem facing Maine state and local government and the communities they serve. It is associated with many types of crime, increased accidents, lost time at work, serious health problems, social dysfunction, and death. Within the last several years, problems related to drug abuse in Maine have received increased attention from the media, law enforcement, the justice system, and local communities.

Rates of substance abuse, particularly associated with heroin, methadone, and other synthetic opiates are increasing dramatically, as reflected in emergency medical care encounters, substance abuse treatment admissions, drug-related arrests, and drug-related deaths. Problems with OxyContin in Washington County have received national media attention. There is continuing public debate regarding the opening of methadone clinics. Recently, media attention has been focused on Cumberland County as overdose deaths increase.

The ability of Maine state government to generate effective and appropriate public policy responses to drug-related problems depends on having valid and reliable data. With this need in mind, the Office of Chief Medical Examiner sought funding from the Maine Justice Assistance Council to analyze medical examiner data concerning drug-related deaths.[1] The goal of the Maine Drug-Related Mortality Patterns project is to provide an immediate, comprehensive review and analysis of the drug-induced and drug-related deaths in the State of Maine from 1997 through the first two quarters of 2002. The data are compared with published national data on drug deaths, data from the 2000 U.S. Census, as well as available analyses from other states.

The project represents a collaborative effort between the Office of Chief Medical Examiner (OCME) and its project partners, the Office of Attorney General (OAG), the Office of Substance Abuse (OSA), and the Margaret Chase Smith Center for Public Policy at the University of Maine (MCSC). Funding for the project was provided by the Maine Justice Assistance Council (Edward Byrne Memorial Grant) and the OSA. Direct project support was provided by the Office of Chief Medical Examiner, the Office of Attorney General, and the University of Maine.

Methods

Study Population and Data Sources

All drug-related deaths are medical examiner cases.[2] Investigation of these cases includes medical examination and toxicological testing, and frequently also involves law enforcement investigation of the circumstances surrounding the death. Medical examiner files provide the primary source of data for this study. These records are the most complete and systematic source of information about victims of drug overdose.

The study population includes all closed cases of drug-related deaths from January of 1997 through June 2002. All cases in which drug toxicity appeared as a cause or contributing factor on the death certificate are included. All drug-related cases from 1997 through 2001 have been closed; but, at the time of this report, the first six months of 2002 still had open cases, where the cause and manner of death were pending.

The primary data sources are the death certificate, toxicology report, autopsy report, and medical examiner report. The death certificate includes:

- Demographic information about the decedent (age, marital status, occupation, race, ethnicity, place of residence, birthplace, military status)
- Information about the death event (time and place)
- Information about whether an autopsy was performed
- A determination of medical cause and the manner of death (natural, accident, suicide, homicide, undetermined)

The medical examiner report and the autopsy report were used to reconstruct details about decedent history, when such information was available, for 2001 cases, including: (1) history of substance abuse; (2) history of mental illness; (3) whether there was evidence the decedent had a prescription for drugs listed on the death certificate as causing the death, including therapeutic methadone for pain or opiate addiction.

Defining Drug-Related Deaths

Drug-related deaths include any deaths where the drug is either a direct cause of the death or a significant underlying factor. They may involve illicit drugs, such as heroin or cocaine. They may involve *drug abuse*, for example, when prescription drugs have been (1) diverted from legitimate prescription holders to other individuals, or (2) intentionally taken in a manner other than as prescribed. A drug-related death may also be an unintended consequence of *drug use,* for example, (1) prescription interactions, including cases where multiple medical providers have been prescribing for one individual, or (2) adverse individual responses to particular drugs or particular doses.

In some drug-related deaths, the immediate cause of death may not be the drug itself, but may be a consequence of the drug's presence. For example, the immediate cause of death may be noted as lack of oxygen to the brain (brain anoxia), but this may be due to methadone toxicity. Methadone would then be an underlying cause. In other cases, multiple drugs may have caused the death. In multiple drug cases, each drug may be identified on the death certificate. However, the roles of mixed drugs may be too complex to reconstruct. In these cases the medical examiner may list "polydrug" or "mixed drug" toxicity as the cause, and not specify a drug name. Some deaths occur as a direct consequence of disease, but drug use or abuse may be a significant factor

in the victim's inability to survive the disease. For example, in certain dosages or circumstances, a tricyclic antidepressant may increase the potential for a cardiac arrhythmia. Death may be due to underlying heart disease, but the drug adds to the cardiac malfunction. In such cases, cardiac disease is the cause of death, but that specific drug may be listed as a significant factor on the death certificate.

In this study we include all cases in which the use/abuse of a substance was a primary or underlying cause of death, or in which the use/abuse of a substance was noted as a significant factor contributing to the death. Cases in which alcohol, but not drugs, caused the death are not included here. However, we do include deaths where alcohol was implicated in combination with drugs. Although inhalation of carbon monoxide is sometimes grouped with other poisoning deaths, we have excluded those cases from this study.

Determining Manner of Death

The Maine Office of Chief Medical Examiner classifies as accidents drug deaths directly due to the unintended or unexpected, acute (sudden or short-term), toxic effects of a drug or poison. These include natural disorders if caused by an acute exposure to a drug, such as a stroke that results from acute cocaine intoxication. 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.

Deaths resulting from the known toxic effects of accepted medical treatment, such as digitalis toxicity from treatment of congestive heart failure, are ruled natural. When death is a consequence of chronic (long-term) substance abuse, such as withdrawal seizures from chronic alcoholism, or cardiac inflammation (endocarditis) due to chronic intravenous drug abuse, the manner is ruled natural as well.

Deaths may be classified as a suicide in Maine only if there is a "preponderance of evidence" that the person intended to cause their own death. An example of intent would be a suicide note or previous suicide attempts. Although drug abuse in and of itself carries an inherent risk of overdose and death, engaging in risky or reckless behavior is not generally considered sufficient evidence of suicidal intent.

In this report we often combine accidents and suicides statistically, as is done in much of the published literature about drug deaths. However, when the characteristics being discussed differ between suicides and accidents, we report them separately.

Toxicology Testing

All drug deaths routinely include toxicology testing. The resulting report includes all drugs identified in a person's system at the time of death. The interpretation of toxicology findings is often complex and includes details about the victim's autopsy, medical history, and the circumstances surrounding the death. In some cases, the drug chemicals break down in the body and only their less specific metabolites can be found. For example, heroin metabolizes quickly to morphine in the body. Once that occurs, prescription morphine and heroin cannot be differentiated. With certain drugs, breakdown of chemicals may be more extensive if there is a delay in discovering the death.

The relationship between drug levels in the toxicology report and the cause of death is not always straightforward. Toxic drug levels sometimes overlap with therapeutic levels, as they do for methadone. Multiple drugs may interact with each other in dangerous ways. It is possible for an otherwise benign drug at therapeutic levels to be toxic in combination with other drugs.

Not all drugs identified in the toxicology report are related to the cause of death. For example, a person may be on methadone maintenance, but die due to an insulin overdose. Methadone would appear in the toxicology findings, but not be connected to the death. In such a case, although the toxicology report identifies methadone, it is not included in the cause of death. The toxicology report may include prescription medications the victim was taking or medications administered by emergency medical providers for resuscitation.

"Mixed Drug" and "Polydrug" Cases

In some cases with multiple drugs present, the possibilities for drug interaction are too numerous and complex to implicate specific drugs, and the cause listed is "mixed drug" or "polydrug" toxicity. In these cases, we refer to the toxicology report for details regarding the presence of specific drugs, focusing on the major drugs of abuse. We have counted all instances where morphine/heroin, for example, was found in the toxicology screen of polydrug cases. However, it is important to point out that not all drugs identified in a "polydrug" toxicology screen may have actually caused the death. For example, acetaminophen and cannabis are frequently identified by toxicology, yet these drugs would normally not be implicated in the death.

Two Sources of Data about Drug Involvement: Death Certificate and Toxicology

We use two approaches to analyze which drugs are involved with these deaths. Data from the death certificate and data from the toxicology report reflect different aspects of drug morbidity and mortality. The death certificate specifies which drugs are implicated as causing or significantly contributing to the death. Those drugs are physiologically the most important with regard to mortality patterns and risk. However, in the many cases that have "polydrug" causes, the death certificate does not specify which particular substances are toxic.

Accordingly, we also examine drug involvement by analyzing all toxicology reports, including those of the polydrug cases. This approach has the advantage of revealing comprehensive drug involvement for every case. However, it draws analytical attention to all drugs present, including those that may be used or abused, but may not necessarily have caused death. This method reveals more about the overall available supply of drugs, both legitimate and illicit, than it does about risk. That is, it demonstrates which drugs are commonly used in the community, in both therapeutic situations and on the street.

Autopsy

An autopsy is a postmortem examination performed to determine cause of death. If a death seems to be drug-related, an autopsy is routinely done. A microscopic examination of the major organs may be necessary to diagnose or exclude diseases. Once all the results of the autopsy are available, an autopsy report is generated, which lists all of the findings.

Vulnerability to drug toxicity may be increased due to the presence of underlying disease. Conversely, vulnerability to underlying disease may be enhanced by drug toxicity. Knowing more about typical patterns of underlying disease in drug fatality victims may be useful in designing public health programs for risk reduction. We report the frequencies for associated disease found at autopsy and noted on the death certificate for the entire study population.

Projection for 2002

This study includes all cases received in the Office of Chief Medical Examiner through June, 2002 and confirmed as of September 15th. Some suspected drug cases from January through June of 2002 still remained open. In order to project the total deaths for 2002, the number of confirmed cases for the first six months was doubled: (70 x 2 =140). This is a minimum estimate, since cases were still pending.

To project a maximum number, the number of cases still open (21) was doubled (42) and added to the minimum (140 + 42 = 182) to calculate a maximum figure. Since not all open cases will be confirmed as drug deaths, the midpoint between the minimum and maximum range has been used as a projected mid-range total (161).

The five-year average of 34% suicides and 66% accidents has been used to project the suicide/accident estimates for 2002. Thus, projected total deaths are estimated at 140-182. Of these, 48-62 are likely to be suicides and 92-120 are likely to be accidental overdoses.

Results

Increase in Maine Drug-Related Deaths

The annual rate of all drug deaths in Maine has more than quadrupled since 1997 (Table 4; Figure 1); but accidental drug deaths have risen six-fold. In the five-year span between 1997 and June 2002 there have been 374 confirmed drug deaths, about one-third (123) suicides and two-thirds (248) accidental overdoses. Drugs played a contributing role in two cases ruled as natural deaths and one ruled as undetermined manner.

In the first year of the series, 1997, there were 34 total drug related deaths; in 2001 that number had risen to 90. During the first six months of 2002, 70 drug deaths have already been confirmed, with 21 more possible drug deaths awaiting final determination of cause and manner. Of these 70 deaths, 52 are accidental overdoses and 16 are suicides.

The number of suicidal drug deaths in Maine has varied during the last five years between a low of 10 deaths in 2000 and a high of 32 in 1999. The fluctuation is not unexpected given the small numbers. Suicide totals have not risen steadily as have the accidental deaths. The current year's projected number of suicides is 48-62.

Accidental drug deaths have risen every year of the five-year study period, beginning at only 19 in 1997. The projected number of accidental drug deaths for 2002 is 92-120. It is the accidental overdose deaths, not suicides, which have fueled the dramatic increase in overall drug deaths.

Table 4. Number of drug deaths by manner of death, 1997-2002

	1997	1998	1999	2000	2001	2002 Jan-June*	Total Confirmed No. (%)	Projected Totals for 2002
Accidents	19	29	34	50	64	52	248 (66.3%)	92-120
Suicides	14	25	32	10	26	16	123 (33.9%)	48-62
Natural	0	0	0	0	0	2	2 (0.5%)	0
Undetermined	1	0	0	0	0	0	1 (0.3%)	0
TOTAL	34	54	66	60	90	70	374 (100.0%)	140-182

**Totals for the period January – June 2002 are incomplete, due to pending cases.*

Drug Deaths by County

Overall, the number of deaths in each county mirrors the geographic distribution of the Maine population, with most cases occurring in the southern part of the state. Nevertheless, all counties are affected (Table 5). (See Appendix A for a breakdown by county of specific drugs identified in toxicology tests. Appendix B summarizes the frequency by year for the three counties with the highest proportion of drug deaths: Cumberland, York, and Penobscot.)

Media reports have focused public attention on the incidence of overdose deaths in the southern, more urban part of the state, Cumberland and York Counties. Cumberland County has 21% of Maine's population and 34% of all drug deaths (35% of the accidents and 30% of the

suicides). Together, Cumberland and York Counties have 36% of Maine's population and 47% of the drug deaths.

Washington County has received significant media attention regarding problems with opiate addiction, specifically OxyContin (oxycodone). However, the Washington county drug deaths do not show drug death numbers out of proportion with the population. Washington County has 3% of the Maine population and 2% of the drug deaths. Five Washington County deaths involve oxycodone: 3 in 1999, 1 each in 2001 and 2002.

Table 5. Frequency of drug deaths by county, 1997-2002, compared with Maine 2000 Census population

County	Accidents	Suicides	Natural	Undetermined	All Drug Deaths	Maine 2000 Census Population
Androscoggin	16 (6.5%)	3 (2.4%)			19 (5.1%)	103,793 (8%)
Aroostook	3 (1.2%)	9 (7.3%)			12 (3.2%)	73,938 (6%)
Cumberland	87 35.1%)	37 (30.1%)	2 (100.0%)		126 (33.7%)	265,612 (21%)
Franklin	11 (4.4%)	1 (0.8%)			12 (3.2%)	29,467 (2%)
Hancock	6 2.4%)	4 (3.3%)			10 (2.7%)	51,791 (4%)
Kennebec	19 (7.7%)	18 (14.6%)			37 (9.9%)	117,114 (9%)
Knox	10 (4.0%)	7 (5.7%)			17 (4.5%)	39,618 (3%)
Lincoln	3 (1.2%)	1 (0.8%)			4 (1.1%)	22,616 (3%)
Oxford	7 (2.8%)	3 (2.4%)			10 (2.7%)	54,755 (4%)
Penobscot	33 (13.3%)	13 (10.6%)			46 (12.3%)	144,919 (11%)
Piscataquis	3 (1.2%)	0 (0%)			3 (0.8%)	17,235 (1%)
Sagadahoc	2 (0.8%)	0 (0%)			2 (0.5%)	35,214 (3%)
Somerset	6 (2.4%)	6 (4.9%)			12 (3.2%)	50,888 (4%)
Waldo	3 (1.3%)	1 (0.9%)		1 (100.0%)	5 (1.4%)	36,280 (3%)
Washington	6 (2.4%)	2 (1.6%)			8 (2.1%)	33,931 (3%)
York	33 (13.3%)	18 (14.6%)			51 (13.6%)	186,742 (15%)
TOTAL	248 (100.0%)	123 (100.0%)	2 (100.0%)	1 (100.0%)	374 (100.0%)	1,274,923 (100%)

Where Deaths Occur

The death certificate records the location of death, as Tables 6 and 7 summarize. About 26% of victims die in the hospital and 62% at a residence; 12% die in other locations. Death locations for accident and suicide victim deaths are very similar, differing by only a few percentage points. There are, however, differences between males and females. More females die in the hospital than males (31% compared to 22%). Conversely, more males are than females die in a place other than the hospital or a residence, such as a motor vehicle or in the open (14% compared to 7%).

Table 6. Location of death by manner of death

	Accidents	Suicides	Undetermined And Natural	All
Hospital	67 (27.0%)	27 (22.0%)	2 (67.0%)	96 (25.7%)
Residence	151 (60.9%)	81 (65.9%)	1 (33.0%)	233 (62.3%)
In open	6 (2.4%)	3 (2.4%)	0 (0.0%)	9 (2.4%)
Motor vehicle	2 (0.8%)	0 (0.0%)	0 (0.0%)	2 (0.5%)
Nursing home	3 (1.2%)	0 (0.0%)	0 (0.0%)	3 (0.8%)
Other	19 (7.7%)	12 (9.8%)	0 (0.0%)	31 (8.3%)
TOTAL	248 (100.0%)	123 (100.0%)	3 (100.0%)	374 (100.0%)

Table 7. Location of death by sex

	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%)

Drugs Involved in the Deaths

A total of 80 different drugs appear as a cause or contributing factor in the 374 death certificates in this study. Three drug classes predominate: narcotics, antidepressants, and anti-anxiety agents. Most of these drugs are available by prescription and most deaths involve two or more drugs in combination. About a quarter of the deaths list "polydrug" or "mixed drug" toxicity as a cause, rather than indicating a specific drug. We use two data sources to analyze the array of drugs involved in the deaths, (1) drugs appearing in the toxicology findings, and (2) drugs specifically mentioned in the death certificate.

Drugs Found by Toxicology

As discussed, all drugs found in the toxicology screen may not contribute equally to the cause of death. However, they are an indication of the underlying medication "load," and the overall supply of drugs. Table 8 presents the drugs that appear most frequently in the toxicology findings over the entire study period, ranked by number of occurrences. Table 9 provides the common name and drug class of the drugs listed in Table 8. The toxicology test does not identify the different forms of methadone (liquid, tablets) or, in most cases, distinguish morphine (the pain medication) from heroin (the illicit drug), or OxyContin from other forms of oxycodone.

Other than alcohol, the most common drugs found in the toxicology screens on the accidental deaths are narcotic analgesics (methadone, morphine/heroin, oxycodone, hydrocodone), anti-anxiety drugs (diazepam, alprazolam) antidepressants (most frequently amitriptyline) and cocaine. Methadone and heroin occur most frequently in toxicology results

overall, and are much more likely to be found in accidental, rather than suicidal cases. Methadone and heroin each occur in about a quarter of all drug deaths and in about a third of all accidental deaths (Table 8). They may occur together.

Toxicology screens from suicidal overdoses tend most frequently to include alcohol, antidepressants (most frequently amitriptyline, fluoxetine), anti-anxiety medications (diazepam), some narcotic analgesics (oxycodone, propoxyphene) and one antihistimine (diphenhydramine). Methadone and heroin are much less frequent in suicides, occurring in about 5% of cases.

Table 8. Top five-ranked drugs found in toxicology screen 1997-2002 and frequency of occurrences*

ACCIDENTS		SUICIDES		ALL DRUG DEATHS	
Rank	**Frequency (n=248)**	**Rank**	**Frequency (n=123)**	**Rank**	**Frequency (n=374)**
1. Methadone	81 (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*

Table 9. 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

Drugs Mentioned on the Death Certificate

Tables 2, 10, and 11 report the drugs most frequently mentioned on death certificates as a cause or contributing factor. Table 10 displays the variation between suicides and accidents, and Table 11 shows the changes over time. The medical examiner's determination of the cause of death is based on an interpretation of the toxicology findings, in association with the other autopsy findings and the circumstances of death. Thus the cause of death findings reflect the toxicology findings, but focus only on key drugs causing the fatality. Mortality Data from the Drug Abuse Warning Network (DAWN) for the year 2000 indicate that, for urban areas in their sample, the three drugs most frequently mentioned were heroin, cocaine, and alcohol, accounting for about two-thirds of the drugs mentioned. In Maine the pattern is slightly different, with more

emphasis on opiates: the top three drugs mentioned were methadone, alcohol, and morphine/heroin. Cocaine is prevalent, but does not rank among the top five in Maine.

Table 10. Drugs most frequently mentioned on the death certificates as a cause or contributing factor 1997-2002*

Drug Mentioned	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%)
Methadone	66 (17.6%)	64 (25.8%)	2 (1.6%)
Ethanol	57 (15.2%)	38 (15.3%)	19 (15.4%)
Morphine/heroin	73 (19.5%)	69 (27.8%)	4 (3.3%)
Oxycodone	26 (7.0%)	17 (6.9%)	9 (7.3%)
Amitriptyline	24 (6.4%)	14 (5.6%)	10 (8.1%)
Cocaine	20 (5.3%)	19 (7.7%)	0 (0.0%)
Propoxyphene	16 (4.3%)	7 (2.8%)	9 (7.3%)
Fentanyl	18 (4.8%)	16 (6.5%)	2 (1.6%)
Diazepam	12 (3.2%)	9 (3.6%)	3 (2.4%)
Hydrocodone	11 (2.9%)	7 (2.8%)	4 (3.3%)

**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.*

Table 11. Top ten substances listed as cause of death by year, 1997-2002

Drug	1997	1998	1999	2000	2001	2002*	TOTAL
Polydrug	7 (8.0%)	22 (25.2%)	19 (21.8%)	12 (13.8%)	17 (19.5%)	1 0 (11.5%)	87 (99.8%)**
Methadone	4 (6.1%)	4 (6.1%)	7 (10.6%)	19 (28.8%)	14 (21.2%)	18 (27.3%)	66 (100.1%)**
Ethanol	7 (12.3%)	7 (12 3%)	11 (19.3 %)	6 (10.5%)	15 (26.3%)	11 (19.3%)	57 (100.0%)
Morphine/ Heroin	6 (8.2%)	12 (16.4%)	9 (12.3%)	10 (13.7%)	23 (31.5%)	13 (17.8%)	73 (99.9%)**
Oxycodone	0 (0.0%)	3 (11.5%)	7 (26.9%)	2 (7.7%)	5 (19.2%)	9 (34.6%)	26 (99.9%)**
Amitriptyline	5 (20.8%)	4 (16.7%)	5 (20.8%)	2 (8.3%)	5 (20.8%)	3 (12.5%)	24 (99.9%)**
Cocaine	3 (15.0%)	6 (30.0%)	2 (10.0%)	2 (10.0%)	5 (25.0%)	2 (10.0%)	20 (100.0%)
Propoxyphene	3 (18.8%)	5 (31.3%)	2 (12.5%)	1 (6.3%)	4 (25.0%)	1 (6.3%)	16 (100.2%)**
Fentanyl	1 (5.6%)	1 (5.6%)	4 (22.2%)	3 (16.7%)	6 (33.3%)	3 (16.7%)	18 (100.1%)**
Diazepam	6 (50.0%)	3 (25.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (25.0%)	12 (100.0%)
Hydrocodone	1 (9.1%)	3 (27.3%)	0 (0.0%)	3 (27.3%)	3 (27.3%)	1 (9.1%)	11 (100.1%)**

**The numbers for 2002 in this table are confirmed deaths for first 6 months, not a projection for entire year.*
***Rounding error.*

Multiple Drug Involvement: "Polydrug" Cases and Their Toxicology Findings

Most deaths involve more than one drug. However, the proportion of deaths where only one drug is implicated in the cause of death has more than doubled from 24% in 1997 to 46% in 2001, and 59% for the partial 2002 year.

As is seen across U.S. medical examiner jurisdictions, drugs typically co-occur in many combinations, making it difficult to isolate a single drug as the cause of death. The "polydrug" cause is one of the most frequent causes mentioned (87 cases, 23%). The drugs identified in the polydrug case toxicology tests mirror the frequency distribution found overall. For example, methadone and heroin are the most prevalent.

Table 12 displays the toxicology findings for the polydrug cases, focusing on the frequency of major drugs of abuse in these toxicology test results. We have placed the drugs

most frequently mentioned in the cause of death into the same table with the polydrug toxicology results. Although these outcomes (cause of death and toxicology finding) are not the same, they are related. The right-most column adds these instances together in order to estimate the proportional importance of major drugs in this study.

Table 12. Frequency distribution of drugs mentioned in the death certificate combined with drugs found in toxicology of "polydrug" cases*

Drug	Drugs Mentioned in Cause of Death No. (%) Of 374 Cases With Specific Drug Mentioned in Cause of Death	Drugs Identified in Toxicology of Polydrug Cases No. (%) Of 87 Polydrug Cases With Specific Drugs in Toxicology Findings	Drugs Mentioned in Cause of Death or Present in Polydrug Case Toxicology No. (%) Of 374 Cases
Polydrug	87 (23.3%)	******	******
Methadone	66 (17.6%)	20 (23.0%)	86 (23.0%)
Ethanol	57 (15.2%)	20 (23.0%)	77 (20.6%)
Morphine/heroin	73 (19.5%)	13 (14.9%)	86 (23.0%)
Oxycodone	26 (7.0%)	16 (18.4%)	42 (11.2%)
Amitriptyline	24 (6.4%)	12 (13.8%)	36 (9.6%)
Cocaine	20 (5.3%)	8 (9.2%)	28 (7.5%)
Propoxyphene	16 (4.3%)	15 (17.2%)	31 (8.3%)
Fentanyl	18 (4.8%)	5 (5.7%)	23 (6.1%)
Fluoxetine	12 (3.2%)	17 (19.5%)	29 (7.8%)
Hydrocodone	11 (2.9%)	11 (12.6%)	22 (5.9%)

**Categories of drugs are not mutually exclusive and only the major drug causes are included in this table, thus the columns do not sum to 100%.*

Prescription Drug Involvement

Drug-related deaths are very often due to prescription drugs, whether suicides or accidental overdoses. The prescription drugs are primarily from the categories of narcotic pain analgesics, antidepressants, and anti-anxiety medications. The deaths may be due to misuse of prescriptions, unforeseen interactions, intentional overdose, or a combination of these factors.

In order to clarify the relationship of prescription drugs to drug deaths, all 2001 case files were examined for investigative information about prescription involvement. Such information is frequently found in the narrative portions of police or medical examiner reports. In some cases the prescription drugs were specifically inventoried by law enforcement officers at the location of death or by the OCME staff at the time of autopsy. We coded all these cases according to whether or not there was any evidence that the drug (or drugs) causing the death had been prescribed for the decedent (see Table 13). There was evidence of prescription information for 96% of the 26 suicides, but for only 52% of the 64 accidents. Of those cases for which we had prescription information, 88% of the suicide and 52% of the accident victims had a prescription for at least one drug identified as the cause of death.

Table 13. Prescription status for drugs implicated in cause of death, 2001, among cases with prescription evidence

	Suicides	Accidents
Decedents with prescription for at least one drug implicated in the cause of death	22 (88%)	17 (52%)
Decedents with no prescription for any drugs that caused death	3 (12%)	16 (48%)
Total cases with prescription information	25 (100%)	33 (100%)

Frequently Abused Narcotic Analgesics

The narcotic analgesic class of drugs includes the naturally occurring opiates (morphine, heroin, and codeine), and the synthetic opiates ("opioids," including oxycodone, hydrocodone, fentanyl, and propoxyphene). Except for heroin, which is illicit, these drugs are frequently prescribed for pain relief (analgesia). Narcotic analgesics are prevalent in Maine drug deaths. Toxicology tests reveal that 267 (71%) of the 374 victims in this case series have one or more narcotics present in their system. Similarly, one or more narcotic drugs are identified as a cause of death for 198 (53%) drug death cases.

Both death certificate and toxicology analyses conclude that the top two drugs involved in Maine drug deaths are methadone and heroin (Figure 2). The third most involved drug in both distributions is alcohol (classed as a depressant, not a narcotic), frequently associated with both narcotic and non-narcotic deaths.

Of the 267 victims with narcotics, 81% involve a combination of drugs. Twenty-six percent (69 cases) include two or more narcotics. The most frequently occurring narcotic-narcotic combinations are heroin-codeine (10 cases, 14% of combination cases), methadone-oxycodone (10 cases, 14%), and heroin-methadone (7 cases, 10%).

Of the narcotic-related deaths, 80% (213 cases) are accidental overdoses and 20% (54 cases) are suicides. Drug distributions for accidental and intentional deaths are markedly dissimilar. Toxicology screens reveal that methadone and morphine/heroin, the drugs ranked first and second in frequency among the accidental deaths, are not among the top five drugs in suicides (see Table 8). However, two other narcotics are identified among the top five drugs in suicides: oxycodone and propoxyphene. (See Appendix A for a breakdown of toxicology findings by county and Appendix B for a breakdown by year for three counties.)

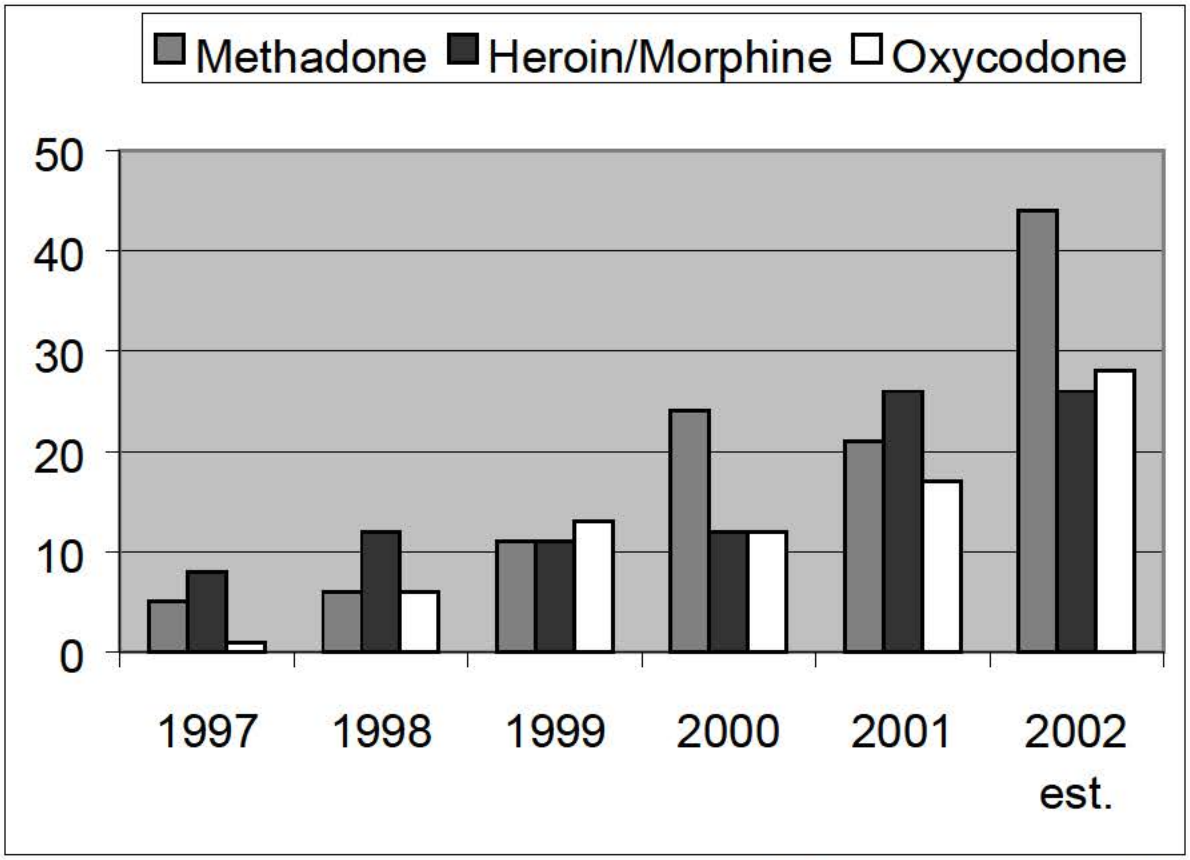

Figure 2. Number of cases in which key drugs were identified, based on toxicology, 1997-2002

Methadone

Methadone is a synthetic opiate prescribed for pain and for treatment of heroin addiction. It is long acting, with a sedative effect and does not produce the same "euphoric high" as heroin. In Maine it is prescribed by methadone maintenance clinics in liquid, powder, or wafer form, or in tablet form by pain clinics and private physicians. Toxicology screening cannot discriminate between these various forms of the drug. Based on our analysis of toxicology results, methadone is identified in 88 (24%) of the total 374 cases (or 33% of the 267 cases with narcotics in the toxicology findings). Methadone ranks first in frequency among accidental death victims, but is infrequent in suicide toxicology findings.

Methadone toxicology is complex. The range of blood levels for therapeutic effect overlaps with the toxic range. That fatalities occur with fairly low blood levels has been repeatedly noted in the medical literature. This is thought to be due primarily to widely varying individual tolerance and to interaction with other drugs and alcohol. Use or abuse of other drugs in combination with methadone may increase its toxicity or alter its metabolic effect. The most common and potentially fatal adverse effect of all opiate or opioid drugs, including methadone and heroin, is respiratory depression. Alcohol and benzodiazepines, commonly taken along with methadone, can increase the likelihood of respiratory depression.

Tolerance can change within one individual depending on circumstances. Persons who have been abstinent, such as those in substance abuse treatment programs or in prison, experience a reduction in tolerance. Persons with reduced tolerance are at greater risk for fatal overdoses when they attempt to take dosages to which they were previously tolerant. The slow onset of effects of methadone may lead abusers to take more methadone or use additional drugs in potentially dangerous combinations.

Most people who died from methadone toxicity were not involved in methadone maintenance programs. In a preliminary analysis of 23 methadone-related deaths from Cumberland County in 2001 and 2002, only 3 (13%) decedents were documented in methadone maintenance clinics; 2 others (9%) had prescriptions for methadone for pain.

Similarly, in 14 methadone-related cases statewide in 2001 (where methadone was a cause of death or contributing factor), 3 (21%) were being treated at a methadone maintenance clinic and 3 (21%) others were found to have a prescription for methadone from a pain clinic. It should be noted that more victims may have had prescriptions from a pain clinic than our records reflect. The medical examiners contact all methadone maintenance clinics and whatever physicians they can find. They may not find all physicians or pain clinics. Further, some victims may have seen practitioners in other states, increasing the difficulty of tracking down their medication histories.

Deaths in which methadone is identified on the death certificate (66 cases) or found in the toxicology results (88 cases) have increased in frequency (see Table 11 for death certificate data. See Table 8 and Appendix A for toxicology data). Table 11 reveals only four deaths in 1997, rising to 19 in 2000 and 14 in 2001. In the first six months of 2002, 18 cases have already been confirmed. For most of the 66 confirmed methadone deaths in the past five years, methadone is the primary or secondary causal factor noted on the death certificate (58 of 66 deaths); in eight of the cases, methadone is listed as a significant contributing factor. In 20 additional cases, methadone is one of multiple drugs implicated in the cause of death (polydrug deaths). In 2 other cases, methadone appears in the toxicology findings, but is not identified as a cause of death or a contributing factor.

Based on toxicology, the projected minimum number of deaths in which methadone will be identified for 2002 is 34-44, calculated by assuming they will comprise about 24% of the projected 140-182 total drug deaths.

Deaths with methadone toxicology findings have affected nearly all counties since 1997. (Exceptions are Piscataquis, Sagadahoc, and Washington.) Cumberland, Penobscot, and York Counties have had the most cases in which methadone is identified: 44, 10, and 12 respectively (Appendix B). These three counties have had 66 (75%) of the cases with methadone toxicology findings. In comparing the distribution of deaths to the population distribution, most counties are within plus or minus 5% of their expected share of the methadone toxicology findings, based on their population numbers. The only county with an excess of such deaths (more than 5% above census percentage) is Cumberland, which has 28% of the state's methadone toxicology findings compared with 21% of Maine's population.

Cumberland County, with a total of 44 cases in which methadone is identified by toxicology over the five-year period, had only a few deaths per year until 2000, when the number rose to 10, and stayed at 10 in 2001. The projected number for Cumberland County in 2002, however, is about 30.

Penobscot County, with 10 deaths in which methadone is identified over the five-year period based on toxicology findings, experienced a spike (5 deaths) in 2000, and subsequent decline. Only 2 deaths in which methadone is identified are projected for Penobscot County for 2002.

York County, with only 12 deaths in which methadone is identified for the five-year period based on toxicology findings, increased by one death each year, reaching 4 in 2001. In 2002, 4 deaths in which methadone is identified are projected for York County.

In terms of statewide patterns, deaths identifying methadone in toxicology doubled between 1999 and 2000, and then leveled off through 2001. The rate has recently increased significantly. Based on projections, the total for 2002 is likely to be more than double that of 2001.

Heroin/Morphine

Heroin and morphine are narcotics, nearly indistinguishable in the autopsy. However, evidence of intravenous injection strongly suggests heroin use. Heroin is the illicit form and morphine sulfate is the prescription form. Heroin/morphine-related deaths in Maine have increased along with methadone, although with a slightly different pattern. Based on the death certificate determinations, the number per year has fluctuated between 1 and 11 cases. Based on toxicology findings, however, heroin identified in the overdose deaths has gradually increased from 8 to 26 cases. There was an initial increase from 8 to 12 in 1997-98, little change through 2000, and another increase from 12 to 26 between 2000 and 2001. The total projected for 2002 is about 26.

Heroin rapidly metabolizes to morphine in the body. Once that occurs, it cannot be distinguished in toxicology tests from morphine given as a prescription pain medication. Hence, in those tables summarizing toxicology results, it is referred to as "heroin/morphine." Heroin/morphine ranks second in frequency among accidental death victims, but is infrequent in suicide toxicology findings.

There is substantial variation in deaths with heroin toxicology by county. Aroostook, Lincoln, Sagadahoc, and Washington Counties have had no such deaths. Cumberland County has had 37% of these deaths, disproportionately more than its 21% of the population. Other counties with a larger than expected share based on population distribution are Franklin (with 8 deaths --10% of all drug deaths, compared to 2% of Maine's population), and Penobscot (with 12 deaths --15% of all drug deaths, compared to 11% of Maine's population).

Oxycodone

Oxycodone is a synthetic opiate, a narcotic prescribed for pain. Marketed since 1995 in a long-acting form, OxyContin, this drug is taken orally, and sometimes injected. Oxycodone is implicated as the cause of death on 7% (26 cases) of death certificates over the five-year study period. It is identified in 17% (63 cases) of drug death toxicology tests overall, 15% of suicides and 18% of accidents.

Based on toxicology results, oxycodone-related cases began in 1997 with only 1, increased to 6 in 1998, to 13 in 1999, and to 17 in 2001 (Figure 2). So far, there are 14 confirmed cases in the first half of 2002. Of these, 8 deaths with oxycodone toxicology have occurred in Cumberland and 1 in Washington County.

Washington County has been thought to have a high prevalence of oxycodone abuse. There have been a total of 5 deaths with oxycodone toxicology findings in Washington County, 3 in 1999, 1 in 2001, and 1 in the first half of 2002. These comprise 8% of Maine oxycodone toxicology findings, compared with Washington County's 3% share of Maine's population.

Cumberland County has had 18 oxycodone toxicology deaths, or 29% of all Maine oxycodone toxicology findings, compared with 21% of Maine's population. There was 1 death in 1997, 0 in 1998, then 3 in each year 1999-2001. There have been 8 deaths in which there was oxycodone confirmed in the first half of 2002.

All counties in Maine except Piscataquis County have had deaths with oxycodone toxicology findings. Most counties have the same or fewer of these deaths than expected by population. Two counties besides Washington and Cumberland have more; Aroostook has 5 (8%) of deaths and 6% of population, and Penobscot has had 9 (14%) of deaths and has 11% of population.

Demographic Characteristics

All Manners of Death Combined

Demographically, Maine overdose victims are more often male (62%), single (71%), middle-aged (57% aged 35-55), Caucasian (96%), born in Maine (58%) and have at least a high school education (79%). However, victims range widely in all characteristics but race. They have an average age of 40 (range 15-92), with women (average age 43) older than men (average age 38). In terms of ethnicity, about 15% of drug-related death victims were reported to be of French descent, 0.3% African, and 1% Hispanic. Fewer overdose victims are married than in the general (Maine 2000 Census) population (Table 3). In the general population only 36% are never married or divorced; among decedents in this study, the percentage is 71%. The education of decedents in this study generally mirrors the Maine general population. About 79% of decedents above the age of 25 have had 12 or more years of school, compared with 85% in the general population. In the Maine general population 67% of those 15 and older are born in Maine, whereas 58% of decedents were born in Maine.

Accidental overdose and suicidal overdose victims differ demographically and are considered separately in the discussion that follows (see Table 14).

Accidental Overdose Victims

Compared to suicide victims, accident victims are more often male, younger, less educated, born in Maine, and unmarried. About two-thirds (68%) of accidental overdose victims are male. The average age of accidental overdose victims is 38, with only three 65 or older. Male accidental overdose victims are younger than women (average age 36 and 40 respectively) with about twice as many males as females under the age of 25. Conversely, about twice as many female as male accident decedents are between the ages of 35 to 39. About 76% of victims have a high school education or greater. Accidental deaths included 95% Caucasian decedents, slightly less than the census population. Among all accident victims, 60% were born in Maine, with females more orten Maine natives than males (65% compared to 59%).

Table 14. Demographic characteristics of drug death victims, comparing suicides and accidents

Demographic Characteristic	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%

Suicidal Overdose Victims

The mean age of suicidal overdose victims is 45, averaging slightly less for males (44) than for females (46). The age range for all suicides is 16-91, and 11 (9%) of the 123 decedents are 65 and over. The sex distribution in suicidal overdoses is 49% male and 51% female, mirroring the Maine general population. The racial composition of victims of suicidal deaths also reflects that of the state, 98% Caucasian. In terms of marital status, 33% of suicide victims are married, 32% divorced, and 29% never married. The proportion of those that are divorced or never married (61%) is higher than in the general population (36%). The educational status of suicide victims is generally higher than for accident victims, with 87% having at least a high school education. Among all suicide victims, 54% were born in Maine; females are slightly less often Maine natives than males (52% compared to 57%).

Medical Characteristics

As mentioned earlier, the autopsy and medical history of decedents reveals a number of underlying conditions, both physical and mental, that may have increased their risk of overdose fatality (Table 15). We coded information about existing history of mental illness (including depression) and substance abuse for all of the 2001 cases. About 55% have a known history of mental illness, more among suicides (72%) than among accidents (42%). About half (50%) of overdose victims have a history of drug abuse, with more among accidents (73%) than among suicides (16%).

Many decedents have chronic physical conditions that played a role in their death, including heart, lung, and liver disease, as well as obesity. These conditions may reduce physical capacity. For example, chronic obstructive pulmonary disease (COPD) reduces lung capacity, which can interact dangerously with the respiratory depression produced by high levels of opiates. Obesity can obstruct the airway, particularly in some body positions, increasing the risk from respiratory depression caused by opiates. Liver disease, such as hepatitis, or cirrhosis

from chronic alcoholism, can reduce the ability of the liver to detoxify the blood, thus keeping blood drug levels dangerously high. Cardiovascular disease can reduce the capacity of the heart and lungs to process oxygen, again increasing risk from respiratory depression.

Victims may have been taking medications prescribed legitimately for pain, depression, anxiety, or other conditions. These may have dangerous side effects if taken at high doses. They may interact with each other, or with drugs of abuse. For example, tricyclic antidepressants prescribed for depression can interfere with the electrical function of the heart in some individuals and at some doses. Other medications prescribed for anxiety or depression and taken with methadone (prescribed for treatment of pain or opiate dependency) can boost the blood levels (and toxic effects) of both drugs.

Table 15 presents the frequency of chronic conditions mentioned in the death certificates of the study population, either as a cause of death or contributing factor. A total of 62 cases (16.6%) identified a chronic condition, usually listed as a contributing factor. Contributing factors include a range of conditions, such as respiratory conditions, liver conditions, heart conditions, seizure disorders, substance abuse, and obesity. Heart disease is the most frequently mentioned as a primary or secondary cause (3.5%).

Table 15. Frequency of associated chronic conditions identified as a cause or contributing factor on the death certificate, with percent of 374 total drug death cases*

Condition	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 cases	16 (4.3%)*	46 (12.3%)

** Column percent does not total due to rounding*

Comparing Maine's Drug Death Rate to Other Populations

The number of drug deaths in Maine is high. More important, the rate of increase in drug deaths from year to year is very high, starting in 1997-98 when the number increased by 59%. The increase between 2001 and 2002 (using projected totals) may be as high as 102%.

Comparisons can be drawn between Maine and other populations through the use of the crude death rate (CDR), that is, the number of deaths per 100,000 people due to intentional and unintentional overdose. The most recent rate published by the U.S. National Vital Statistics System (Minino et al., 2002) for drug-induced deaths among non-Hispanic whites covers the years 1999 (CDR = 6.9) and 2000 (CDR = 7.4). In Table 16 the Maine CDR 1997-2002 for intentional and unintentional poisoning in this study is compared to the U.S. rate and the rate for North Carolina (a rural state). Whereas the Maine rate began at 40% of the national rate in 1997, the rate in 1998-2000 was 60-70% of the national rate. By 2001 the Maine rate had risen to 95% of the 2000 national rate. But by 2002, the Maine rate is projected to be 159% of the 2000

national rate. North Carolina, another rural state, shows a similar, steady climb, beginning at 72% the national rate in 1997, and in 2001 at 104% of the national 2000 rate (Sanford, 2002).

Table 16. Crude Death Rate (CDR) for intentional and unintentional poisonings in the U.S., in Maine, and in North Carolina 1997-2002

	1997	1998	1999	2000	2001	Projected 2002
U.S. CDR	6.61	6.81	7.24	7.40	******	******
Maine CDR	2.66	4.22	5.16	4.69	7.04	11.77
N. Carolina CDR	4.77	5.51	5.44	6.96	7.73	******

Comparable data to contrast with Maine comes from Connecticut, a primarily urban population of 3.406 million. Using toxicology findings from medical examiner cases and focusing on opiate deaths alone, Heimer et al. (2002) have shown that the death rate from opiates in Connecticut 1998-2001 is lower than Maine and has remained stable while Maine's rate has risen (Figure 3). Analysis reveals that Connecticut's rate is about a third that of Maine in 2001.

The two populations are very different. Maine is less densely populated and is removed from the northeast megalopolis. Maine's poor are mostly rural, whereas Connecticut's poor are mostly urban. Connecticut has a long history of opiate use and treatment. Heroin use and methadone maintenance treatment has been common in that state for about 30 years. Maine opiate abuse began to emerge in the 1990's and methadone treatment programs opened first in 1995. Connecticut opiate drug abusers are primarily injecting heroin, Maine opiate abuse is primarily (oral) ingestion of prescription medications. The victims of opiate overdose are about the same age on average, but Connecticut decedents are 77% male, compared to 65% in Maine.

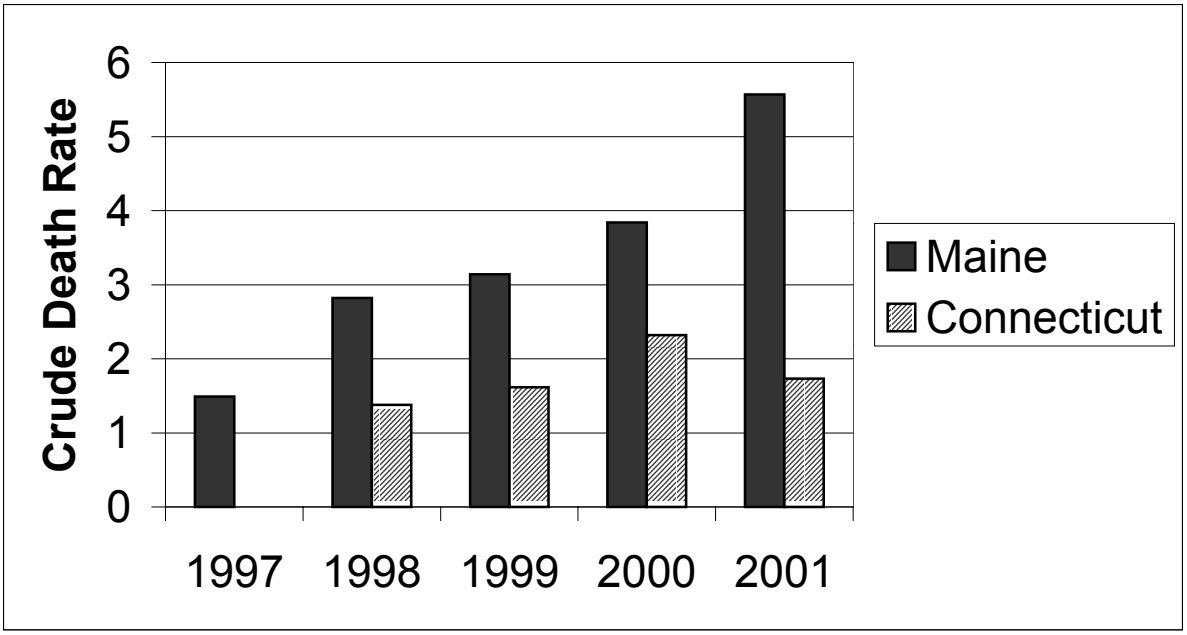

Figure 3. Crude death rate of opiate toxicology in drug related deaths (deaths per 100,000) in Connecticut and Maine, 1997-2001 (courtesy R. Heimer)

CONCLUSION

The annual rate of drug deaths in Maine has been rising rapidly, particularly in the last year. These deaths are caused by a mix of drugs, both prescription and illicit. Opiate drugs are the most prevalent, primarily prescription narcotic analgesics (including methadone) and heroin, but the most frequent pattern involves combinations of drugs. Narcotic analgesics are often combined with antidepressants and anti-anxiety agents. Alcohol is frequently present.

Mortality patterns are the tip of a very large iceberg that includes drug trafficking, addiction treatment, and related societal problems. The pattern of toxicology findings in decedents is an indicator of the supply of drugs, legally prescribed, illicit or diverted. The population at risk for mortality and morbidity from drug abuse is diverse, but most persons dying from drugs are middle aged and, in many ways, representative of the general population.

Solutions to the drug mortality problem are complex. Systematic attention to prescription drug availability and refinements to drug death investigation protocols are important components. Further research on the medical history of decedents as it involves emergency medical encounters and patterns of prescription availability would benefit decision makers engaged in treatment, law enforcement, and the legislative process, and ultimately benefit persons at risk.

Notes

[1] The term drug-related is used as an umbrella to include all instances in which drugs were listed on the death certificate as a cause (drug-induced) or a significant contributing factor. This type of case, often referred to in epidemiology as intentional and unintentional poisonings, generally includes inhalation deaths due to substance abuse (e.g., butane) as well as carbon monoxide poisoning. However, we excluded carbon monoxide cases from consideration in this series.

[2] The Office of Chief Medical Examiner in Maine has statutory authority to investigate all suspicious, accidental, and unattended deaths in order to certify both the cause and the manner of death. The medical examiner produces a Certificate of Death, a document that ultimately provides data for vital statistics. The death certificate specifies the cause and manner of death. It also includes the time, date, and place of death, as well as demographic information about the decedent.

The cause of death section in the death certificate follows guidelines recommended by the World Health Association. The medical cause of death is defined as "the disease or injury that initiated the train of morbid events leading directly to death." The section dealing with cause of death has two parts. Part 1 itemizes a sequence of up to four events leading to the death; Part 2 allows the medical examiner to note the other significant factors contributing to the death.

The manner of death is determined from among the following: natural, accident, suicide, homicide, pending, or undetermined.

In nearly all drug-related deaths, the body is brought in for autopsy and toxicology testing. Autopsies are performed at the Office of Chief Medical Examiner morgue. Toxicology samples are sent to a private laboratory for analysis. Microscopic study is done internally. Current staffing includes two forensic pathologists, one histology technician, and an increasing caseload. Most drug deaths require several months before a death certificate can be issued.

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Appendices

Appendix A. Number and percent of deaths by county and by drug, based on toxicology findings

	AND	ARO	CUM	FRA	HAN	KEN	KNO	LIN	OXF	PEN	PIS	SAG	SOM	WAL	WAS	YOR	TOT
METHADONE	4	2	44	1	2	4	4	0	3	10	0	0	1	2	0	12	89
HEROIN/MORPHINE	5	0	30	8	3	6	3	0	1	12	1	0	1	1	0	11	82
ETHANOL	4	2	25	2	5	6	6	1	0	12	0	0	2	1	2	13	81
DIAZEPAM	2	3	19	3	4	5	6	2	2	10	0	0	5	0	2	9	72
OXYCODONE	2	5	18	1	1	4	2	2	2	9	0	1	2	2	5	7	63
AMITRIPTYLINE	1	0	12	1	2	9	2	0	1	4	0	0	3	1	0	8	44
ALPRAZOLAM	2	1	16	1	1	3	2	1	2	3	1	1	1	1	0	7	43
PROPOXYPHENE	2	1	13	1	1	7	2	1	1	5	0	1	2	0	2	2	41
DIPHENHYDRAMINE	3	2	8	0	0	4	1	3	1	5	0	0	0	0	1	7	35
FLUOXETINE	1	0	5	1	1	6	4	2	0	6	0	0	2	1	0	4	33
COCAINE	4	0	11	1	2	2	1	1	2	3	0	0	1	0	0	4	32
HYDROCODONE	1	2	9	2	0	2	2	1	1	5	1	1	1	1	0	3	32
PAROXETINE	0	3	11	1	1	1	0	2	1	4	1	1	0	2	0	3	31
TEMAZEPAM	0	1	7	0	1	2	2	1	1	3	0	0	3	0	2	3	26
FENTANYL	1	1	7	0	1	4	1	1	2	4	0	0	0	0	1	2	25
CODEINE	2	0	7	3	0	2	2	0	0	3	0	0	1	0	0	3	23
MIRTAZEPINE	3	5	2	0	0	2	3	0	2	4	0	0	0	0	0	2	23
VENLAFAXINE	1	1	6	1	0	2	1	0	3	4	0	1	0	1	0	2	23
TRAZODONE	3	0	6	0	0	1	3	0	0	3	0	0	0	0	1	4	21
	AND	ARO	CUM	FRA	HAN	KEN	KNO	LIN	OXF	PEN	PIS	SAG	SOM	WAL	WAS	YOR	TOT
PERCENT OF MAINE POPULATION	8%	6%	21%	2%	4%	9%	3%	3%	4%	11%	1%	3%	4%	3%	3%	15%	100%
METHADONE	4%	2%	28%	2%	6%	7%	7%	1%	0%	13%	0%	0%	2%	1%	2%	15%	100%
HEROIN/MORPHINE	6%	0%	37%	10%	4%	7%	4%	0%	1%	15%	1%	0%	1%	1%	0%	13%	100%
ETHANOL	5%	2%	31%	2%	6%	7%	7%	1%	0%	15%	0%	0%	2%	1%	2%	16%	100%
DIAZEPAM	3%	4%	26%	4%	6%	7%	8%	3%	3%	14%	0%	0%	7%	0%	3%	13%	100%
OXYCODONE	3%	8%	29%	2%	2%	6%	3%	3%	3%	14%	0%	2%	3%	3%	8%	11%	100%
AMITRIPTYLINE	2%	0%	27%	2%	5%	20%	5%	0%	2%	9%	0%	0%	7%	2%	0%	18%	100%
ALPRAZOLAM	5%	2%	37%	2%	2%	7%	5%	2%	5%	7%	2%	2%	2%	2%	0%	16%	100%
PROPOXYPHENE	5%	2%	32%	2%	2%	17%	5%	2%	2%	12%	0%	2%	5%	0%	5%	5%	100%
DIPHENHYDRAMINE	9%	6%	23%	0%	0%	11%	3%	9%	3%	14%	0%	0%	0%	0%	3%	20%	100%
FLUOXETINE	3%	0%	15%	3%	3%	18%	12%	6%	0%	18%	0%	0%	6%	3%	0%	12%	100%
COCAINE	13%	0%	34%	3%	6%	6%	3%	3%	6%	9%	0%	0%	3%	0%	0%	13%	100%
HYDROCODONE	3%	6%	28%	6%	0%	6%	6%	3%	3%	16%	3%	3%	3%	3%	0%	9%	100%
PAROXETINE	0%	10%	35%	3%	3%	3%	0%	6%	3%	13%	3%	3%	0%	6%	0%	10%	100%
TEMAZEPAM	0%	4%	27%	0%	4%	8%	8%	4%	4%	12%	0%	0%	12%	0%	8%	12%	100%
FENTANYL	4%	4%	28%	0%	4%	16%	4%	4%	8%	16%	0%	0%	0%	0%	4%	8%	100%
CODEINE	9%	0%	30%	13%	0%	9%	9%	0%	0%	13%	0%	0%	4%	0%	0%	13%	100%
MIRTAZEPINE	13%	22%	9%	0%	0%	9%	13%	0%	9%	17%	0%	0%	0%	0%	0%	9%	100%
VENLAFAXINE	4%	4%	26%	4%	0%	9%	4%	0%	13%	17%	0%	4%	0%	4%	0%	9%	100%
TRAZODONE	14%	0%	29%	0%	0%	5%	14%	0%	0%	14%	0%	0%	0%	0%	5%	19%	100%

Appendix B. Frequency of drug deaths by year and by drug for highest frequency counties

	1997	1998	1999	2000	2001	2002	TOTAL
CUMBERLAND							
METHADONE	3	2	4	10	10	15	44
HEROIN/MORPHINE	4	3	4	6	10	3	30
ETHANOL	2	2	5	3	6	7	25
DIAZEPAM	3	4	4	1	5	2	19
OXYCODONE	1	0	3	3	3	8	18
PENOBSCOT							
METHADONE	1	1	2	5	0	1	10
HEROIN/MORPHINE	0	1	3	3	4	0	12
ETHANOL	1	2	3	2	3	1	12
DIAZEPAM	0	1	4	1	3	1	10
OXYCODONE	0	1	3	2	2	1	9
YORK							
METHADONE	0	1	2	3	4	2	12
HEROIN/MORPHINE	1	1	1	2	5	1	11
ETHANOL	1	2	4	1	3	1	13
DIAZEPAM	1	2	2	2	1	1	9
OXYCODONE	0	1	2	2	1	1	7