Articles

Underreporting of Fatal Cases to a Regional Poison Control Center

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We assessed fatal drug overdose and poisoning case surveillance by a regional poison control center, comparing it with medical examiner determinations of death by poisoning over the same 2-year period and from the same catchment area. We studied 358 fatal cases of poisoning or drug overdose reported by a medical examiner and 10 fatal cases of poisoning or drug overdose reported by a poison control center, analyzing demographics and other case-associated factors with possible successful poison control center case surveillance. Of the medical examiner cases, 245 (68%) were prehospital deaths. Of the remaining 113 emergency department or hospital cases, only 5 (4.4%) were also reported to the poison control center. Compared with cases involving illicit drugs, other narcotics, and sedative drugs, those that involved other prescription drugs (relative odds, 30.6; 95% confidence interval, 2.7 to 351) and over-the-counter products and other substances (odds ratio, 18.9; 95% confidence interval, 1.4 to 257) were significantly more likely to be reported to the poison control center. Most fatal cases of poisoning and drug overdose are not detected through poison control center surveillance. For prevention and treatment, health planners and policy makers should recognize the implications of case underreporting.

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Poisoning and drug overdose is a leading cause of injury deaths. A recent report on injury-related morbidity in San Francisco, California, identified poisoning and overdose as the single greatest cause of fatal injuries in that county.[1] The direct and indirect economic costs of poisoning are staggering, estimated to be greater than $8 billion annually nationwide.[2(p50)]

Over recent years, a network of poison control centers in the United States has provided an important and widely cited source of incidence data for poisoning and drug overdose through the American Association of Poison Control Centers.[3]* There is, however, a paucity of other reliable epidemiologic data on poisoning and drug overdose. For this reason, little is known about cases that never reach poison control center consultation. For example, we recently found that among 533 cases of poisoning and drug overdose presenting to an emergency department, fewer than 1 in 4 were reported to the regional poison control center that directly served the reporting hospitals.[4] Reporting rates may be even poorer from sites more remote from a regional poison control center. Moreover, there were few deaths in our previous emergency department series, which makes those findings difficult to extrapolate to the reporting of cases of fatal poisoning.

We analyzed a series of fatalities that were determined by a medical examiner's investigation to be causally related to poisoning or drug overdose and compared them with deaths reported by a poison control center in the same jurisdiction. Our goal was to determine the proportion of medical examiner cases that would also appear in poison control center reporting. We also wished to identify factors that are associated with a more successful poison control center case surveillance.

Cases and Methods

We studied all fatalities investigated by the San Francisco City and County Medical Examiner's office in which poisoning and drug overdose was attributed to be the principal cause of death. We also studied all cases with a fatal outcome over a matching time period in the same geographic jurisdiction reported to the San Francisco Bay Area Regional Poison Control Center (PCC). The study was carried out retrospectively and covered a two-year period between July 1, 1988, and June 30, 1990. We identified eligible cases from a computerized database listing all cases during that time period for the med-

*See also the editorial by Toby Litovitz, MD, "Listen, Ye Legislators, Our Children Need You!" on pages 552-553 of this issue.

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ABBREVIATIONS USED IN TEXT

CI = confidence interval
OR = relative odds (odds ratio)
PCC = San Francisco Bay Area Regional Poison Control Center

ical examiner and from a file of all fatal cases maintained by the PCC.

The medical examiner's determination of death is carried out only after a detailed case investigation. In cases where poisoning or drug overdose is suspected, the investigation routinely includes toxicologic testing of blood and other tissue specimens using gas chromatography and mass spectroscopy. A core panel of substances tested includes barbiturates (amobarbital, phenobarbital, secobarbital), benzodiazepines (chlordiazepoxide, diazepam, nordiazepam), amphetamine and methamphetamine, antihistamines, phencyclidine, cocaine and benzoylecgonine, narcotics and opiates (methadone, morphine, codeine, propoxyphene, norpropoxyphene), antidepressants (fluoxetine, clomipramine, doxepin, amitriptyline, nortriptyline, imipramine, desipramine), phenothiazines, salicylate, and phenytoin. In addition, other specific toxins may be evaluated according to the clinical history.

We extracted from the case record the final medical examiner assessment of the specific drug or toxin responsible for the poisoning death or whether the case was attributed to "polydrug" overdose. The medical examiner's attribution of cause of death frequently does not identify a single toxin as the primary cause of death in fatal overdoses that involve several drugs. We also extracted from the medical examiner case record the identification and number of different toxins found in toxicologic testing. We categorized toxins into one of the following three broad groups:

- Illicit drugs, narcotics, or sedative-hypnotic drugs with abuse potential—including cocaine, amphetamines, heroin or other narcotics, benzodiazepines, and barbiturates;
- Other prescription medications—such as antidepressants, theophylline, or digoxin; and
- Over-the-counter medications and other toxins—including aspirin, acetaminophen, and carbon monoxide.

The categories were not mutually exclusive as toxicologic testing could identify substances from more than one broad category. We did not analyze medical examiner toxicologic data on ethanol detection among these cases.

In addition to the medical examiner's attribution of cause of death and toxicologic data, we also extracted from the medical examiner case record demographics, location of death (prehospital, emergency department, or hospital inpatient), and attribution of intention (suicide, nonintentional, or intentionality unknown).

From the PCC file of fatal cases, we extracted demographics, toxicity data, and the PCC determination of whether the death was related to the reported exposure. This determination was made by the PCC in connection with data reporting to the American Association of Poison Control Centers and is not dependent on the medical examiner's case reporting.

We analyzed the data employing a standard computerized statistical package (SAS Institute, Cary, North Carolina). We tested the differences in case characteristics by location of death using the χ^2, Fisher's exact test, or, for the continuous variable of age, by analysis of variance. Excluding prehospital deaths, we analyzed factors associated with case reporting to the PCC, calculating the relative odds or odds ratio (OR) and 95% confidence intervals (95% CI) about those estimates. This was a bivariate analysis, except for toxin type, where we estimated the OR including prescription medications and other products in the same model.

Results

We identified 358 medical examiner cases of drug or toxin-attributed fatalities over the 24-month study period (Table 1). Of these, 245 (68%) were prehospital cases in which the victim was found dead and was not brought for evaluation to a hospital emergency department. Demographically, the study group was largely male (78%), with a mean age of 39 years.

As shown in Table 1, the substances most frequently involved were illicit drugs, narcotics, or sedative-hypnotics, identified by toxicologic testing in 317 (89%) cases. Of the 317 cases involving such drugs, the medical examiner attributed the primary cause of death to a single toxin in the following distribution: heroin, 97 (31%); cocaine, 53 (17%); amphetamines, 14 (4%); codeine or derivatives, 7 (2%); and benzodiazepines and barbiturates, 4 (1%) each. Deaths from other prescription medications, over-the-counter products, and other substances where the cause was attributed to a single toxin included 11 due to cyclic antidepressants, 7 due to carbon monoxide exposures, and 1 each attributed to acetaminophen, salicylate, digoxin, and theophylline. Among all deaths, cyclic antidepressants were identified by toxicologic testing as present in 43 (12%) of the cases.

When analyzed by site of death, cases differed significantly by three locations: prehospital victims found dead and not taken to an emergency department, those declared dead on arrival or dying in an emergency department, or victims surviving at least until hospital inpatient admission (Table 1). The proportion of fatalities determined by the medical examiner to be due to suicide (as opposed to nonintentional or of undetermined intent) differed significantly by site of death, being most common among those admitted to a hospital (9 [25%] of 36 cases) and least common among emergency department deaths (4 [5%] of 77 cases). The proportion of drug-related fatalities where illicit drugs, other narcotics, or sedative-hypnotics were detected toxicologically also differed significantly by site of death, being most common among the emergency department cases. In contrast, deaths involving other prescription medications were significantly less frequent for the emergency department location. The median length of stay until death among the 36 cases

TABLE 1.—*Medical Examiner Drug- and Toxin-Attributed Cases Over 24 Months by Site of Death*

Case Variables	Site of Death: Prehospital (n = 245)	Emergency Dept (n = 77)	Hospital (n = 36)	All Cases (n = 358)
Age, years, mean ± SD	39 ± 11	39 ± 10	40 ± 13	39 ± 11
Sex, male, No. (%)	198 (81)	57 (74)	24 (67)	279 (78)
Nonwhite or Hispanic, No. (%)*	75 (31)	34 (44)	16 (44)	125 (35)
Suicidal intent, No. (%)*	42 (17)	4 (5)	9 (25)	55 (15)
Drug or toxin types, No. (%)†				
Illicit drugs, narcotics, sedatives*	217 (89)	74 (96)	26 (72)	317 (88)
Other prescription medications*	43 (17)	3 (4)	8 (22)	54 (15)
Over-the-counter and other substances	29 (12)	5 (6)	4 (11)	38 (11)
Multiple drugs or toxins identified	97 (40)	26 (34)	16 (44)	139 (39)

SD = standard deviation

*$P < .05$, differences by site of death.
†Multiple categories of drug or toxin type are possible.

admitted to a hospital was 3.5 days (interquartile 25% to 75% range, 1 to 5 days).

Over the same 24-month study period, 15 fatal case consultations were reported to the PCC that were geographically under the jurisdiction of the San Francisco medical examiner (approximately 15% of all deaths reported to this PCC). We excluded five cases from further analysis. These were cases for which the PCC consultation concluded that the death was unrelated to drug or chemical exposure. Among these five excluded unrelated deaths, the medical examiner's office had either "cleared" the case on initial reporting (n = 2) or had no record of the case (n = 3).

The remaining ten cases are listed in Table 2. For five cases, there was concurrence between the assessment of the PCC and the medical examiner. In one case in which the medical examiner attributed the cause of death to theophylline overdose, the PCC assessment was that of an unrelated fatality. In two cases of PCC assessment of drug-attributed death, the medical examiner's conclusion was that of an unrelated cause of death. The two other PCC cases had been "released" by the medical examiner and therefore were not evaluated further. These discordant cases, which are detailed in Table 2, are heterogeneous in relation to both exposure and intent.

Altogether, 6 (1.7%) of 358 medical examiner cases were reported to the PCC. These 6 included only 1 (0.4%) of the 245 prehospital deaths compared with 5 (4.4%) of the 113 emergency department or hospital fatalities ($P = .01$). We further studied factors associated with PCC reporting of deaths that were also attributed by the medical examiner to be toxin-related, limiting analysis to the 113 emergency department or hospitalized fatalities (Table 3). Of these medical examiner cases, 5 (4%) also involved PCC consultations. Of the 36 cases admitted to a hospital, 4 (11%) were reported to the poison control center. Survival until hospital admission as compared with emergency department death was strongly associated with PCC consultation (OR = 9.5; 95% CI, 1.02 to 88). Among those admitted, length of stay was unrelated to PCC consultation (OR = 1.1 per 5 days of stay). Suicidal intent as compared with unintentional or undetermined intentionality was also strongly associated with PCC consultation, demonstrating an OR of 14.7 (95% CI, 2.2 to 99).

Cases involving prescription medications other than narcotics, benzodiazepines, or barbiturates (OR = 31) and cases involving over-the-counter products or other substances (OR = 19) were significantly more likely to have been reported to the PCC. Nonetheless, even among the 13 deaths among emergency department or hospitalized cases where no illicit drugs, narcotics, or sedative-hypnotics were detected, only 3 (23%) were indeed reported to the poison control center. Cases in which multiple drugs or toxins were detected were no more likely to have been reported to the poison control center.

Discussion

We found that poison control center reporting is far less comprehensive than medical examiner case detection of fatal poisoning and drug overdose. Even when the analysis is limited to cases presenting to emergency departments or admitted to a hospital, only 1 in 20 medical examiner-reported poisonings had also led to a poison control consultation. Among those surviving until hospital admission, the poison control consultation rate increased to 11%. Poison control center surveillance was disproportionately weighted toward suicides and to cases that did not involve illicit drugs or other narcotics or sedatives.

Two recent studies from the northeastern United States have also compared medical examiner- and poison control center-reported cases. A retrospective study of a two-year incidence of poisoning deaths in the State of Massachusetts (1986 to 1987) compared medical examiner and poison control center reporting after excluding prehospital deaths (which accounted for 77% of their cases).[5] Of 95 medical examiner-reported cases, 49 (52%) had also been reported through the poison control center system. That study also analyzed death certificates, a source that we did not examine in our study. It is interesting to note that of 43 death certificate-identified poisoning deaths that were not medical examiner cases, only 3

TABLE 2.—*Drug-Related Fatalities in San Francisco City and County Reported to the San Francisco Bay Area Regional Poison Control Center (PCC) Over 24 Months**

Case	Drug	Site of Death	Intention	Age, yr	Gender	ME Report	PCC Report
1	Acetaminophen, codeine, ibuprofen	Hospital	Suicide	85	Female	Related	Related
2	Trichloroethane	Prehospital	Suicide	47	Male	Related	Related
3	Maprotiline, dextromethorphan	ED	Suicide	17	Female	Related	Related
4	Theophylline	Hospital	Unintended	77	Male	Related	Unrelated
5	Amitriptyline	Hospital	Suicide	25	Female	Related	Related
6	Heroin, cocaine	Hospital	Unintended	37	Male	Related	Related
7	Colchicine	Hospital	Unintended	70	Male	Unrelated	Related
8	Amphetamine	Hospital	Unintended	51	Male	Unrelated	Related
9	Procainamide	Hospital	Unintended	83	Male	NA	Related
10	Aspirin	Hospital	Unintended	61	Female	NA	Related

ED = emergency department, ME = medical examiner, NA = not ME-investigated case

*Not included: Five PCC case consultations over study period for deaths assessed as unrelated to exposure. Two of these were ME cases also determined to be unrelated. Three others were not ME-investigated.

(7%) were also reported through a poison control center. Moreover, 25 additional cases in that series were detected solely through poison control center surveillance. In comparison, our PCC series identified 4 of 9 cases (excluding 1 prehospital death) as poisoning-related deaths in which the medical examiner either did not concur or had not evaluated the case.

Another retrospective study of a four-year incidence of fatal poisoning and drug overdose in Rhode Island (1986 to 1989) identified 230 (62%) prehospital deaths among 369 studied.[6] Of 139 non–prehospital cases, 33 (24%) were also reported to the regional poison control center. There were 8 other poison-related deaths reported to the poison control center that did not appear as medical examiner-reported poisoning cases.

Important differences and similarities exist between our study and these other series. Most striking are differences in the incidence of medical examiner-reported poisonings, as shown in Table 4.[5-7] These data are based on crude rates, unadjusted for age or other demographic variables, but comparable in the exclusion of prehospital cases. In contrast to the differences in medical examiner-derived incidence data, PCC-based poisoning fatality rates are similar among the three locations, reflecting the counterbalancing effect of varying PCC and medical examiner case overlap. All of the studies employed similar retrospective designs in states with comparable medical examiner reporting requirements and with regional poison control centers meeting the same national American Association of Poison Control Center performance standards. Based on our data, we cannot assess whether the observed differences in medical examiner incidence reflect a true higher incidence of poisoning deaths in San Francisco or, alternatively, whether more complete medical examiner investigations occur in that area.

Other important differences exist in the study populations. The leading specific toxin cause of death in each of the other two series was carbon monoxide, which was relatively uncommon among our cases, where drugs of abuse predominated. In addition to regional differences with the northeastern United States, our study catchment area was entirely urban rather than a statewide rural-urban mix. Of note, an important shortcoming shared by our study and the previous investigations is a relative lack of pediatric fatalities, a group for which poison control reporting may indeed be effective compared with medical examiner surveillance. The ability to generalize our data is tempered by all of these geographic and case-mix considerations.

Although the number of cases we analyzed after excluding prehospital deaths was similar to that in these studies, the small number of cases reported to the PCC limits our ability to identify other than strong statistical associations such as those we observed for drug type or

TABLE 3.—*Factors Associated With Report of Poisonings to a Regional Poison Control Center (PCC) for 5 Among 113 Non–Prehospital Medical Examiner (ME) Cases*

Factors Studied	PCC Reporting* Relative Odds	95% CI
Age ≤ 35 yr	2.7	0.4-17
Sex, female	4.1	0.7-26
White, non–Hispanic	3.3	0.4-31
Survival to hospital admission	9.5	1.02-88
Suicidal intent	14.7	2.2-99
Multiple drugs or toxins identified	0.4	0.04-3.8
Substances identified by toxicology testing		
Illicit drugs, narcotics, sedatives (referent)	1.0	--
Other prescription medications	30.6	2.7-351
Over-the-counter substances or other	18.9	1.4-257

CI = confidence interval

*All analyses are bivariate except for "substances identified," which included the categories "other prescription medications" and "over-the-counter substances or other" as 2 predictors in a multiple logistic regression.

TABLE 4.—*Medical Examiner (ME) and Poison Control Center (PCC) Poisoning Incidence Excluding Prehospital Deaths: Current Study Compared With Previously Published Data**

Incidence Measures, %	Study Locations† San Francisco City and County	Rhode Island Statewide	Massachusetts Statewide
ME annual cases/ 10^5 catchment population	7.5	3.6	0.8
ME annual cases/ 10^3 deaths, all causes	7.1	3.7	0.9
ME annual cases/ 10^3 hospital beds	9.2	6.4	1.2
Annual PCC deaths/ 10^5 catchment population	0.6	1.1	0.7
ME cases reported by PCC, %	4.0	24.0	52.0
PCC cases reported by ME, %	56.0	80.0	64.0

*From US Census Bureau[7]; catchment population data current for 1986, total number of deaths for 1984, and total number of hospital beds for 1985. No age or sex adjustments have been made.

†San Francisco locations comprise current study, 1988 to 1990; Rhode Island study period, 1986 to 1989 (Linakis and Frederick[6]); and Massachusetts study period, 1986 to 1987 (Soslow and Woolf[5]).

suicidal intention. For example, although among fatalities female cases were more than four times more likely to be reported to the PCC, our 95% confidence intervals about this estimate were wide and did not exclude unity. The small number of PCC-reported medical examiner cases also precluded multivariate analysis or stratification that could address the potential relationship between demographics, intention, and toxic substances identified. Moreover, as shown in Table 1, the association between both suicidal intent and certain toxin types on the one hand and PCC case reports on the other may be confounded by survival to hospital admission. These statistical limitations should be kept in mind when interpreting our findings.

Our study confirms and amplifies the principal finding of other studies: fatal poisonings frequently do not receive poison control center evaluation and consultation. The implication is twofold. Among those surviving to receive medical care, reducing morbidity and mortality is the focus of PCC consultation. This can be viewed as a secondary prevention goal. Among the 113 cases reaching emergency departments (of whom 36 survived to hospital admission), 96% did not receive the possible benefit of PCC consultation. It is generally accepted that poison control consultation leads to improved outcome, particularly when regional as opposed to local centers are used.[8] Our findings suggest that poison control centers may need to improve awareness among health professionals of the possible benefits of such consultation. Even though we found that PCC reporting was marginally more frequent, after excluding prehospital deaths, the type of cases reported appear heavily skewed by toxin type and suicidal intent and likely reflect demographic biases as well. This being said, it must be emphasized that our data demonstrate that most poisoning and drug overdose deaths occur before the victims reach medical care. For prehospital deaths, primary rather than secondary prevention strategies are paramount. The principal role of poison control centers in primary prevention is in public education. They clearly have a narrow role "postmortem," although consultations are sometimes sought to clarify clinicopathologic correlations. Nonetheless, poison control centers are likely to remain an ineffective tool for the passive collection of surveillance data on such prehospital deaths.

It is crucial to recognize the shortcomings in poison control center fatality reporting. These shortcomings highlight the critical need for improved primary prevention of those cases of overdose that never survive to receive medical intervention and for improved secondary prevention through poison control case consultation for those patients who do receive physician treatment.

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