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## Circumstances and witness characteristics associated with overdose fatality

Amy S.B. Bohnert, Ph.D.<sup>1,2</sup>, Melissa Tracy, M.P.H.<sup>3</sup>, and Sandro Galea, M.D., Dr.P.H.<sup>3,4</sup>

<sup>1</sup> VA National Serious Mental Illness Treatment Research & Evaluation Center, Ann Arbor, MI

<sup>2</sup> Department of Psychiatry, University of Michigan, Ann Arbor, MI

<sup>3</sup> Department of Epidemiology, University of Michigan School of Public Health, Ann Arbor, MI

<sup>4</sup> Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor, MI

### Abstract

**Objective**—Emergency physicians have an opportunity to provide overdose fatality prevention interventions to individuals at risk for experiencing or witnessing an overdose to reduce fatality. The present study uses data about the most recent overdose observed by a sample of inner-city drug users to determine the circumstances of overdose that are associated with overdose fatality.

**Methods**—Participants (n = 690), age 18+, were recruited using targeted street outreach. All participants had used heroin and/or cocaine in the prior 2 months, and had witnessed at least one overdose. Survey data included the circumstances of the last overdose witnessed, including actions taken, drug use behavior, the location of the event, and whether or not the overdose was fatal (the outcome measure).

**Results**—152 (21.7%) of the witnessed overdoses were fatal. Witness powder cocaine use (Adjusted Odds Ratio [AOR] = 1.64, 95% Confidence Interval [CI] 1.03–2.60) and injection drug history (AOR = 0.55, 95% CI 0.32–0.90) were associated with the last witnessed overdose being fatal. Witnessed overdoses that occurred in public or abandoned buildings, compared to homes, were more likely to be fatal (AOR = 1.90, 95% CI 1.03–3.02), as were overdoses where witnesses sought outside medical help (AOR = 1.46, 95% CI 1.01–2.13).

**Conclusions**—Future prevention interventions may fruitfully target users of powder cocaine, drug users without a history of injecting, and individuals who use drugs in public or abandoned buildings for brief interventions on responding when witnessing an overdose to reduce mortality.

### Keywords

drug overdose; fatality; emergency medical services

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Address for Reprints: Amy. S.B. Bohnert, Ph.D.; VA Ann Arbor SMITREC (11H), 2215 Fuller Road, Ann Arbor, MI 48105; Voice: 734-232-0185; Fax: 734-845-3249; amybohne@med.umich.edu.

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## Introduction

### Background

Accidental overdose is second only to motor vehicle accidents as a leading cause of accidental death in the United States among adults, and over 700,000 emergency room visits in 2006 were attributed to accidental overdoses.<sup>1</sup> Among drug users, drug overdose is a leading cause of mortality.<sup>2</sup> While the health consequences of non-fatal overdoses are considerable,<sup>3</sup> fatality due to overdose presents a crucial target for prevention efforts.

Zinberg<sup>4</sup> identified three categories of factors that are associated with the effect of a drug, and consequently the risk of overdose and overdose fatality. First are the characteristics of the drug (s) used, such as purity<sup>5</sup> or particular combination of drugs.<sup>6,7</sup> The second category is the characteristics of the drug user, such as physiological attributes like a lowered tolerance after a period of abstinence.<sup>8</sup> Finally, the third category is characteristics of the setting in which the drug use occurs, such as the type of location in which the overdose occurs.<sup>9</sup> The first category of factors associated with overdose and overdose fatality, characteristics of the drug itself, have been studied extensively using medical examiner reports, death records, and data from emergency room settings.<sup>6,9-14</sup> In these studies, toxicology reports provide much of the information available about the circumstances surrounding the overdose. Consequently, less is known regarding settings associated with overdose and overdose fatality. We sought to extend prior research on overdose fatality by examining how characteristics of the setting in which the overdose occurred are associated with whether or not the overdose is fatal.

### Importance

As many individuals who use drugs do so with others, overdose often occurs in the presence of witnesses.<sup>12,15</sup> The actions taken by the witnesses may be important determinants of whether the overdose victim survives. Prior research has found that witnesses of an overdose often do take action to prevent fatality,<sup>16-18</sup> but there has been limited research that has explored how the characteristics and actions of these witnesses relate to overdose fatality.

Individuals who have experienced a non-fatal overdose are more likely to witness drug overdoses,<sup>18</sup> and drug users often have contact with medical providers. Consequently, the contact emergency medical professionals have with drug users provides an opportunity to communicate messages on appropriate responses when witnessing an overdose to reduce fatality.

### Goals of this Investigation

We used data that includes information on the situation surrounding the overdose in connection to the main outcome of fatality to identify circumstances of overdoses most likely to result in death. Specifically, we included information on the characteristics of the overdose witness, whether witnesses sought medical help, and the location of the overdose in a multivariable logistic model of overdose fatality. Identifying circumstances related to overdose fatality can inform the development of targeted interventions to prevent fatality once an overdose has occurred.

## Methods

### Study Design

The present study used cross-sectional observational data of a sample of current heroin and/or cocaine users in the Central Harlem and the South Bronx neighborhoods of New York City (NYC). The New York Academy of Medicine Institutional Review Board approved the study protocol and all participants gave oral consent at the time of the interview.

## Study Setting

In NYC, drug overdose is a significant problem; in 2007 death due to drug use and accidental overdose was the third leading cause of death among residents age 15–34, and fourth leading cause of death among residents age 35–54.<sup>19</sup> The drugs most commonly responsible for overdose deaths in NYC are cocaine and heroin, often in combination with alcohol.<sup>6</sup> Among black men in NYC, the most common cause of overdose deaths is cocaine alone, while cocaine and opiates together were the most common cause among white and Latino men.<sup>6</sup> The rate of drug-related hospitalizations and deaths in the neighborhoods in the recruitment area are historically higher than for NYC as a whole,<sup>20–23</sup> with roughly 1,200–2,400 or more drug-related hospitalizations per 100,000 residents per year for these neighborhoods, compared to a NYC-wide average of ~600.

## Selection of Participants

Trained outreach workers (who were residents of the same communities as participants) recruited participants using targeted sampling with street outreach techniques<sup>24–26</sup> from November 2001 to February 2004. Recruiters approached individuals in public areas in the target neighborhoods that were identified by ethnographic research as areas where drug users congregated. Recruiters engaged potential participants in conversation, assessed eligibility through structured questions, and escorted eligible and interested individuals to the study office located in the neighborhood. To participate, respondents were required to be 18 years of age or older and to have used heroin or cocaine via any route of administration in the two months prior to the interview. The present report includes only those participants who reported having ever witnessed an overdose.

## Data Collection

Data collection for the study has been described in detail elsewhere.<sup>18,27,28</sup> In-person interviews were conducted in English or Spanish by trained interviewers. Identifying data were kept in separate files from responses to the study questionnaire. Participant responses were protected by a federal certificate of confidentiality, and all interviews took place in private and behind a closed door, either in a study research storefront or a study-owned mobile van. All study records were double-entered and stored on password-protected computers with data encrypted, and hard copies of data were destroyed at the end of the study. Respondents received a nominal incentive to participate in the parent study. All participants were offered referrals to substance use treatment as appropriate and clinical staff affiliated with the study facilitated referral for participants who wished to pursue referral.

## Methods of Measurement

Domains covered in the questionnaire included demographic characteristics, drug use behavior, overdose experiences, and experiences witnessing the overdose of others. For the purposes of the study, “overdose” was defined as “someone who collapses, has blue skin color, convulsions, difficulty breathing, loses consciousness, cannot be woken up, or has a heart attack or dies while using drugs”.<sup>29,30</sup> Participants were asked the location of the most recent overdose that they witnessed, with the choices of a private residence (including their own or someone else’s), a shooting gallery (based on the respondent’s knowledge that it is a location where injection drug users know to go to use), an open public space (such as a street, schoolyard, or parking lot), a public or abandoned building (including bars, stores, hotel rooms, etc.), or other. Interviewers asked participants how many overdoses they had ever witnessed, if they had ever known someone who died of an overdose, and how many overdoses they had heard about in the past year. Interviewers additionally asked those participants who reported having witnessed at least one overdose questions regarding the last overdose they witnessed, including the recency, what drugs the overdose victim was using at the time, what actions were taken by the

respondent and other witnesses, and whether the overdose victim lived or died as a result. Seeking medical assistance for the overdose victim was defined as witnesses calling an ambulance or taking the overdose victim to the hospital.

## Data Analysis

The primary analytic goal of the study was to create a multivariable logistic regression model with the outcome of fatality for the most recent witnessed overdose for all participants who reported witnessing at least one overdose. We selected covariates for modeling based on theoretical plausibility and prior empirical findings. We hypothesized that getting help for the overdose victim would be associated with fatality, per the findings of Davidson and colleagues.<sup>9</sup> Tracy and colleagues<sup>18</sup> found that overdose location was associated with witnesses calling for help, and Davidson and colleagues<sup>17</sup> found that witness race was related to getting help for an overdose victim. We hypothesized that those witnesses who sought outside help would also be more likely to intervene in other ways that would reduce the risk of fatality for an overdose victim. Consequently we hypothesized that location and witness race may have an association with overdose fatality beyond that which is explained through witnesses seeking outside help. As existing prevention efforts targeting actions taken by overdose witnesses have been administered through needle exchange programs or have targeted heroin users,<sup>31,32</sup> we included witness drug use type and injection history. As it has been suggested that drug users at older ages may engage in drug use patterns that impart more risk for overdose,<sup>13</sup> and age may be associated with types of drug used (due to relative popularity of drugs by age cohort) and drug use location, we included witness age as a potentially important control variable. In total, these variables use 14 degrees of freedom.

In order to create a more parsimonious model, we removed variables that did not have a relationship with fatality after adjustment for other covariates ( $p > 0.05$ ). After each removal from the multivariable model we considered if the variable was an important confounder based on the effect its removal had on the other covariates in the model, and retained the variable if this was found to be the case.<sup>33</sup> A variable was considered a potentially important confounder if its removal resulted in changes greater than 10% in the estimates ( $\beta$ ) for retained variables. We also tested an interaction between overdose location and getting medical attention. We conducted all analyses using Stata 9 (Statacorp, 2005).

## Results

Study staff approached 1,228 participants who met initial eligibility criteria and gave informed consent; 44 were later determined to not be eligible. Of the 1,184 respondents who completed the survey, 797 (67.3%) reported having witnessed at least one overdose. Among those who had witnessed an overdose, 554 (71.0%) knew at least one person who died of an overdose, and 523 (67.1%) reported hearing about an overdose in the past year, with the mean number of overdoses heard about being 4.7 (S.D. = 7.5). Of those who reported ever witnessing an overdose, 35.2% reported witnessing an overdose in the prior 6 months, the mean number witnessed over the lifetime was 11.8 (S.D. = 20.9) and the median number of witnessed overdoses was 5.

The outcome (fatal or not fatal) was known for 721 of the 797 (90.5%) last overdoses witnessed. Of the 721 overdoses with a known outcome, 163 (22.5%) were fatal. The majority of witnesses who knew the outcome of the last overdose they witnessed were Hispanic ( $n = 433$ , 60.1%), male ( $n = 534$ , 74.5%), never married ( $n = 444$ , 61.6%), had ever injected drugs ( $n = 611$ , 85.9%), had used heroin in the past year ( $n = 644$ , 89.3%), had ever experienced homelessness ( $n = 632$ , 87.8%), and were between the ages of 25 and 44 years ( $n = 510$ , 70.7%). The victim used heroin ( $n = 613$ , 89.1%) and injected drugs ( $n = 632$ , 90.4%) in the majority of the most recent witnessed overdoses with a known outcome reported.

Witnesses called for an ambulance or took the victim to the hospital for 313 (44.0%) of all witnessed overdoses with a known outcome reported. Among the 399 witnessed overdoses where medical attention was not sought, 75 (18.8%) resulted in fatality. Among those overdose victims where witnesses did seek outside help, 83 (26.5%) died as a result of the overdose.

For the 721 witnesses who knew the fatality outcome of the last overdose s/he witnessed, 31 (4.3%) were not able to be included in modeling due to missing data. Table 1 reports the sample description for the analytic sample (i.e., the 690 individuals without missing data).

Observations not included were not different from those included in terms of age group, history of injection drug use, location of witnessed overdose, witness use of crack cocaine or powder cocaine, or likelihood of seeking outside help for the overdose victim. Those witnesses with missing data were more likely to be African American (50.0 vs. 24.9%,  $\chi^2(1) = 9.40, p = 0.002$ ) but not Hispanic (36.7 vs. 61.2%,  $\chi^2(1) = 7.19, p = 0.007$ ) and were less likely to have used heroin in the past year (61.3 vs. 90.6%,  $\chi^2(1) = 26.7, p < 0.001$ ).

As shown in model 1 in table 2, the witness not having a history of injection drug use and seeking medical attention for the victim as well as the overdose taking place in a public or abandoned building compared to a private home were significantly associated (the 95% confidence interval did not include 1.00) with a higher likelihood of the witnessed overdose being fatal. We created a second multivariable logistic model by removing variables which were not significant (95% confidence interval included 1.00) one at a time, considering their potential role as an important confounder for other covariates. Witness race/ethnicity, crack cocaine use, and heroin use did not act as confounders of the relations of other covariates with the outcome, as the changes in estimates ( $\beta$ ) for retained variables before and after the removal of these variables were less than 10%. Consequently, we did not retain these variables in model 2. When age was removed from the model, the value of the estimates for injection drug use history and the overdose occurring in a public or abandoned building changed by 16 and 11% respectively; consequently, we retained age as a control variable. There was no significant interaction between overdose location in a public or abandoned building and getting medical attention. For model 2 shown in table 2, the witness being a user of powder cocaine, the witness not having a history of injection drug use, the overdose taking place in a public or abandoned building compared to a private home, and witnesses seeking medical attention were associated with a higher likelihood of the witnessed overdose being fatal, as indicated by 95% confidence intervals that did not include 1.00. Both the full model and the parsimonious model had acceptable local and global fit, as indicated by the Hosmer-Lemeshow and Likelihood Ratio tests.

## Limitations

There are several limitations to the present study. We used retrospective cross-sectional data, which is subject to errors and biases in recall. Given the recruitment methods, the sample may not be representative of all drug users in terms of their experiences with witnessing overdoses. Specifically, because the sample was composed of chronic drug users, the frequency of witnessing overdoses may be overestimated. Recruitment methods do not allow for a count of persons who did not wish to participate. While these methods are standard in studies that aim to recruit high risk participants,<sup>18,28,34–35</sup> we were unable to calculate the percent of eligible participants who consented and completed the survey. Furthermore, this study was conducted in a large city on the east coast of the U.S. Characteristics associated with witnessing a fatal overdose may be quite different in other parts of the country, particularly rural areas and regions with different trends in drug use. Additionally, the effect sizes found in multivariable modeling were relatively small (Odds Ratios ranging between 0.54 and 1.90). Prior evidence suggests that many fatal overdoses occur when the overdose victim is alone,<sup>9</sup> and no witnesses are

present to act; however, overdoses that were not witnessed were outside the scope of this study, and the percent of overdoses that were fatal may under-represent the true proportion.

Despite these limitations, the present study extended prior knowledge of factors associated with overdose fatality by using data collected from witnesses of overdoses, rather than hospital or death records. We found that 56% of overdose witnesses reported that they did not seek medical attention for the victim, consistent with other studies that have found that medical care is sought for roughly half of overdose victims.<sup>16,17</sup> Findings from studies using hospital records may be subject to selection biases based on differences in which witnesses are more likely to seek medical treatment for the victim.

## Discussion

In a study of urban chronic heroin and/or cocaine users, we found that 67.3% had witnessed at least one overdose. Among those who had witnessed an overdose, 22.5% of the most recent witnessed overdoses were fatal. We found that characteristics of both the witness and the situation in which an overdose takes place are associated with whether or not the overdose is fatal. Those witnesses who use powder cocaine were more likely to report that the last overdose they observed was fatal than witnesses who do not use powder cocaine, controlling for their history of injection drug use. In contrast, those witnesses with a history of injection drug use were only about half as likely to report that the last overdose they observed was fatal compared to witnesses without a history of injection drug use. In regards to the location of the overdose, we found that overdoses in public or abandoned buildings were almost twice as likely to be fatal than overdoses in a private home. Overdose situations where the witnesses called an ambulance or took the overdose victim to the hospital were also more likely to be fatal.

While over 90% of the sample reported recent heroin use, other aspects of the drug use history of the witness were associated with overdose fatality. Injection drug users were less likely to report the last witnessed overdose as fatal, while powder cocaine users were more likely to report the last witnessed overdose as fatal. Needle exchange programs (NEPs) are increasingly providing overdose prevention programs.<sup>31</sup> Additionally, in a large community sample of drug users, those who had injected drugs reported greater willingness to treat someone who they witnessed overdosing.<sup>36</sup> Our findings suggest that injection drug users may have greater knowledge of how to react to an overdose due to contact with NEPs and more past experiences with overdose, compared to those who do not use injection drugs, and that this may result in a lower risk of fatality for an overdose when an injection drug user is present.

Prior literature has shown that overdoses where witnesses sought emergency medical services were more likely to result in a fatality.<sup>17</sup> This is consistent with our finding that witnesses taking the overdose victim to the hospital or calling for an ambulance was associated with a greater likelihood of the overdose being fatal. This likely reflects that witnesses seek medical attention when an overdose is more severe and the victim could not be revived.

The setting of the overdose was also an important correlate of fatality. One possible explanation for the finding that overdoses that occur in a public or abandoned building are more likely to be fatal than those in a private residence is that those witnesses in a public or abandoned building felt less responsible to take action than they would if the overdose occurred in their own or a friend's home. However, the location of the overdose was still associated with fatality in multivariable models that included seeking medical help, and we found no evidence for an interaction between the location of the overdose and seeking medical attention.

This study has important implications for intervention. Several studies have demonstrated the feasibility and effectiveness of network-based overdose prevention programs.<sup>32,37-39</sup> These studies have focused primarily on heroin overdose, in large part due to the availability of

naloxone as an effective antidote that can be administered by trained laypersons. Our findings suggest that individuals who use powder cocaine (and who may or may not use heroin) are less equipped to intervene when they are witnessing an overdose. Surveillance for the National Vital Statistics Reports suggests that the number of overdose deaths (regardless of intent) where cocaine is mentioned in the death certificates has increased by 62.5% between 1999 and 2005, while heroin has only increased in mentions by 2.4%.<sup>40</sup> Furthermore, cocaine was the most commonly mentioned narcotic during that period.<sup>40</sup> Future efforts at developing interventions to reduce fatality among overdose victims by educating drug users on actions to take in the event of overdose should adapt proven interventions and target cocaine users and other non-injection drug users. Given the findings of the present study, such interventions should also target drug users who frequently use drugs in public or abandoned buildings.

Emergency physicians are well-positioned to provide brief interventions to drug users when seeking care for non-overdose and overdose-related emergencies. Those witnesses who bring an overdose victim to the Emergency Department may also be fruitfully involved in intervention. Based on proven interventions for overdose harm reduction,<sup>32,39</sup> the intervention could take the form of an educational session on how to quickly recognize an overdose and on providing first aid in the event of witnessing an overdose again in the future. Findings from the present study indicate characteristics of drug users who may be more likely to have been missed by existing, community-based harm reduction efforts to prevent overdose fatality in urban settings, and who may be well-served by overdose-related education beyond that which is provided in usual care when seen in Emergency Departments.

## Conclusions

Witnessing an overdose is a common experience among chronic drug users in inner city locations, and witnesses play an important role in determining if an overdose is fatal. Study findings suggest that drug users in urban locations who use powder cocaine are less prepared to respond when they witness an overdose compared to drug users who do not use powder cocaine, controlling for history of injection drug use. Overdoses that occur in public or abandoned buildings were also more likely to result in fatality than overdoses in a private home. Future prevention interventions should educate urban drug users who use powder cocaine and use drugs in public or abandoned buildings to take actions to reduce the risk of fatality when witnessing an overdose. Emergency physicians, when involved in the treatment of drug users in urban locations, have the opportunity to target individuals with these characteristics, who may be missed by other community-based interventions, for overdose fatality prevention education.

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**Table 1**  
Witness and overdose characteristics by fatality of the last witnessed overdoses.

Variable	Last Witnessed Overdose		
	Sample (n = 690) %	Fatal (n = 152) %	Non-Fatal (n = 538) %
<i>Witness Characteristics</i>			
Race			
-Hispanic	61.2	54.0	63.2
-African American	24.9	29.6	23.6
-White/Other	13.9	16.5	13.2
Female gender	24.6	25.7	24.3
High school education	51.0	53.0	50.4
Age			
-18–24	7.0	5.9	7.3
-25–34	30.3	24.3	32.0
-35–44	41.0	46.7	39.4
-45+	21.7	23.1	21.3
Drug Use, past year			
-Heroin	90.6	88.2	91.3
-Crack cocaine	63.0	69.1	61.3
-Powder cocaine	75.8	80.3	74.5
-Injected drugs (ever)	86.2	79.0	88.3
<i>Circumstances of Overdose</i>			
Location			
-Private residence	37.5	33.6	38.7
-Shooting gallery	17.3	14.5	18.0
-Open public area	21.7	21.1	21.9
-Public or abandoned building	10.4	13.8	9.5
-Other	13.0	17.1	11.9
Witnesses called an ambulance or took to hospital	43.5	51.3	41.3

**Table 2**  
Multivariable models of overdose fatality among last witnessed overdose (n = 690).

Variable	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
	Adjusted Odds Ratio	95% Confidence Interval	Adjusted Odds Ratio	95% Confidence Interval
<i>Witness Characteristics</i>				
Race				
-Hispanic	1.00	--		
-African American	1.16	0.71, 1.90		
-White/Other	1.45	0.84, 2.47		
Age				
-18–24	0.71	0.31, 1.60	0.69	0.31, 1.54
-25–34	0.64	0.40, 1.04	0.66	0.41, 1.05
-35–44	1.00	--	1.00	--
-45–54	0.91	0.56, 1.48	0.92	0.57, 1.49
Drug Use, past year				
-Crack cocaine	1.25	0.83, 1.88		
-Powder cocaine	1.57	0.98, 2.51	1.64	1.03, 2.60
-Heroin	1.04	0.54, 2.02		
-Injected drugs (ever)	0.55	0.32, 0.97	0.54	0.32, 0.90
<i>Circumstances of Overdose</i>				
Location				
-Private residence	1.00	--	1.00	--
-Shooting gallery	1.17	0.65, 2.11	1.08	0.61, 1.92
-Open public area	1.19	0.71, 1.99	1.13	0.68, 1.88
-Public or abandoned building	1.95	1.06, 3.60	1.90	1.03, 3.49
-Other	1.74	0.98, 3.09	1.71	0.97, 3.02
Witnesses called an ambulance or took to hospital	1.46	1.00, 2.25	1.46	1.01, 2.13
Model Diagnostics				
Likelihood Ratio	$\chi^2 (14) = 28.40; p = 0.013$		$\chi^2 (10) = 24.98; p = 0.005$	
Hosmer-Lemeshow	$\chi^2 (8) = 4.29; p = 0.83$		$\chi^2 (8) = 7.51; p = 0.48$	

<sup>a</sup>Model 1 includes all variables selected *a priori* for analyses.

<sup>b</sup>Model 2 initially included the same variables as Model 1 but eliminates variables that were not significant after adjustment and were not important confounders to other variables.