

Published in final edited form as:

*Addiction*. 2008 June ; 103(6): 979–989. doi:10.1111/j.1360-0443.2008.02182.x.

## Distinguishing signs of opioid overdose and indication for naloxone: an evaluation of six overdose training and naloxone distribution programs in the United States

Traci C. Green, Robert Heimer, and Laretta E. Grau

Department of Epidemiology and Public Health, Yale University School of Medicine, New Haven, CT and Yale Center for Interdisciplinary Research on AIDS, New Haven, CT, USA

### Abstract

**Aims**—This study assessed overdose and naloxone administration knowledge among current or former opioid abusers trained and untrained in overdose–response in the United States.

**Design and participants**—Ten individuals, divided equally between those trained or not trained in overdose recognition and response, were recruited from each of six sites ( $n = 62$ ).

**Setting**—US-based overdose training and naloxone distribution programs in Baltimore, San Francisco, Chicago, New York and New Mexico.

**Measurements**—Participants completed a brief questionnaire on overdose knowledge that included the task of rating 16 putative overdose scenarios for: (i) whether an overdose was occurring and (ii) if naloxone was indicated. Bivariate and multivariable analyses compared results for those trained to untrained. Responses were also compared to those of 11 medical experts using weighted and unweighted kappa statistics.

**Findings**—Respondents were primarily male (72.6%); 45.8% had experienced an overdose and 72% had ever witnessed an overdose. Trained participants recognized more opioid overdose scenarios accurately ( $t_{60} = 3.76$ ,  $P < 0.001$ ) and instances where naloxone was indicated ( $t_{59} = 2.2$ ,  $P < 0.05$ ) than did untrained participants. Receipt of training and higher perceived competency in recognizing signs of an opioid overdose were associated independently with higher overdose recognition scores. Trained respondents were as skilled as medical experts in recognizing opioid overdose situations (weighted kappa = 0.85) and when naloxone was indicated (kappa = 1.0).

**Conclusions**—Results suggest that naloxone training programs in the United States improve participants' ability to recognize and respond to opioid overdoses in the community. Drug users with overdose training and confidence in their abilities to respond may effectively prevent overdose mortality.

### Keywords

Cocaine; harm reduction; injection drug use; naloxone distribution; opioids; overdose

## BACKGROUND

Overdose is a frequent consequence of heroin and pharmaceutical opioid abuse. It is the single greatest cause of mortality among injecting drug users (IDU) in the United States [1],

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Correspondence to: Traci Craig Green, Yale School of Public Health, 60 College Street, PO Box 208034, New Haven, CT 06520-8034, USA. traci.c.green@yale.edu.

far exceeding deaths attributable to acquired immunodeficiency syndrome (AIDS), hepatitis and other morbidities [2]. Moreover, the incidence of drug overdose has been increasing in the United States since the 1990s [3–5]. History of non-fatal opioid overdose ranges from 41% [6] in Baltimore IDUs to 48% in San Francisco IDUs [7]. Much of the substantial mortality and morbidity is avoidable. Fatal overdose is usually not instantaneous; it occurs over a period of 1–3 hours [8]. Given the relatively long window of opportunity in which to intervene and the fact that the vast majority of overdoses occur in the presence of others [1,9–12], efforts to mobilize immediate medical intervention are optimal, i.e. rescue breathing and/or administration of naloxone hydrochloride (hereafter naloxone), a short-acting opioid antagonist. Appropriate responses by bystanders require training in overdose recognition and rescue breathing, as well opioid overdose victim [13].

If injected soon after an opioid overdose, naloxone prevents or reverses the effects of opioids on the brain and restores breathing. When given intramuscularly (i.m.), the onset of action is approximately 2 minutes. In the absence of the agonist effects of opioids, naloxone exhibits essentially no pharmacological activity. The US Food and Drug Administration approved naloxone in 1971 for complete or partial reversal of narcotic depression. It is an inexpensive, non-scheduled drug available by prescription only through medical professionals (i.e. physicians, physician assistants, dentists, advanced practice registered nurses, podiatrists), and is routinely carried by emergency medical technicians. Many states and localities are trying to expand access to naloxone to other first-line responders (e.g. police, firefighters) and, as a public health intervention for reducing overdose deaths, to IDUs and their peers. To do so, several states (i.e. New Mexico, New York, Illinois, Maryland, Oregon, California, Massachusetts, Connecticut) have legal pilot or established programs for naloxone distribution among drug users and claim impressive declines in their overdose mortality numbers, 17–20% in some cases [14–17]. Additionally, a number of states have initiated ‘good Samaritan’ laws to protect from legal recourse citizens who carry and administer naloxone and medical professionals who prescribe it (e.g. Connecticut, Illinois, New York).

Scientific research into the practice of overdose prevention training and naloxone distribution for opioid abusers is limited, and few well-designed studies have evaluated interventions. In addition, critics often claim that non-medical professionals may use naloxone inappropriately, even when trained, which may result in high costs to society [18]. Lives may be lost if naloxone is not administered appropriately, and misuse of naloxone in non-overdose situations could translate to wasted resources. There are also concerns about consistency and safety of the curriculum, the trainee’s retention of information and liability in the event of an adverse event or misuse of the medication. These issues and concerns often impede adequate funding for implementation, evaluation and expansion of naloxone programs [19].

In an effort to add to the literature on naloxone distribution, this study sought to assess overdose and naloxone administration knowledge among current and former opioid abusers trained and untrained by six naloxone distribution programs across the United States. The premise underlying this study is that appropriate response to an overdose requires sufficient knowledge to recognize when an overdose is occurring, to differentiate between opioid versus non-opioid overdose and non-overdose situations, and to respond appropriately. The ability to distinguish signs of an opioid overdose quickly, to which the bystander can respond actively and directly by performing rescue breathing and/or administering naloxone, from a non-opioid overdose or a non-overdose situation where use of naloxone would be inappropriate, could mean the difference between life and death for the victim. The goals of naloxone training programs, therefore, are to maximize the appropriateness of the reaction and minimize the time to overdose recognition and response.

## METHODS

### Evaluation sites

Six sites were selected for this evaluation to include both new and established programs, with varied geographic representation. Site liaisons were program directors and project managers, while those recruiting the participants in this study were peer trainers and site staff. The training programs at three sites were new (Baltimore, Citiwide and Positive Health Project in New York) and three were well established (Chicago, New Mexico, San Francisco). More detail on the projects is included in an appendix (<http://www.harmreduction.org/article.php?id=700>; <http://cira.med.yale.edu/addiction/>; <http://www.anypositivechange.org/Appendix.pdf>).

### Summary of training programs

Generally, the six training programs followed similar outlines for content with differences arising in delivery, setting and several topics covered in the curriculum (Table 1). Trainings were brief and took place in diverse settings ranging from syringe exchange programs to street corners to private homes (Fig. 1). Training curricula tended to include both didactic and interactive components (e.g. use of resuscitation dummy, instructor demonstration, practice rousing a victim). All sites covered opioid overdose symptom recognition and response, some focusing more upon immediate administration of naloxone, others concentrating more heavily upon rescue breathing, but all incorporating contacting 911 (the US emergency medical service) at some point in the response sequence.

Of note, all programs included content that addressed explicitly differentiating an opioid overdose from a 'heavy nod', and four programs required some form of evaluation to verify participant comprehension of the training curriculum. Only two programs addressed explicitly the identification and response to non-opioid (e.g. stimulant) overdoses. Site-specific curriculum and program overviews are detailed in an appendix (<http://www.harmreduction.org/article.php?id=700>; <http://cira.med.yale.edu/addiction/>; <http://www.anypositivechange.org/Appendix.pdf>); the site liaisons provided all data.

### Study procedure

Staff from sites that conducted overdose prevention training were approached at a national conference on opioid overdose; all agreed to take part in the study. Each site was asked to recruit five participants who had been trained in their program and five participants who had not been trained in their program. Recruitment of both groups could be accomplished at the same site, as training sites were co-located within programs where former and active drug users congregate (e.g. needle exchanges, drop-in sites). Study staff explained the procedures and administered informed consent. Participants completed independently a hard copy of the study instrument, although site staff were available for questions or to administer it if literacy posed a problem. Participants were remunerated \$10 for study participation.

### Evaluation tool

Sixteen unique experiences that IDUs described as an overdose experience were used as the 'cases' evaluated by study participants. A complete description of the development and validation of the evaluation tool can be found elsewhere [20]. Briefly, the 16 cases were selected from a pool of 60 unique experiences reported by IDUs as part of a study on public injecting [21]. Eleven medical experts in overdose recognition and treatment were asked to designate each case as either: (i) opioid overdose; (ii) non-opioid overdose; (iii) not an overdose; or (iv) not enough information/unsure, and whether naloxone was indicated. Collapsing the non-opioid overdose and non-overdose categories and using latent class analysis [22,23], agreement among the experts was calculated to arrive at collectively

agreed-upon designations. These assignments became the 'gold standard' and comprised the evaluation tool: nine cases were deemed opioid overdoses and seven were deemed non-opioid or non-overdose scenarios. All opioid overdose cases required naloxone; non-opioid or non-overdose scenarios did not. Possible scores for overdose recognition and naloxone indication knowledge each ranged from 0 to 16.

In addition to the 16 scenarios, the instrument included items pertaining to participants' gender, background (e.g. volunteer, current/former drug user, outreach worker), history of overdose recognition and response training and self-rated expertise in overdose recognition and response (1, low to 5, high). To preserve participant anonymity and minimize response burden, no data were gathered on age, race, ethnicity or drugs used.

### Data analysis

Descriptive statistics (means, medians, standard deviations) were conducted to characterize the sample's drug use and overdose experiences. Kappas, weighted kappas and their 95% confidence intervals (CIs) were calculated to compare agreement among overdose and naloxone recognition codes assigned by medical experts, trained and untrained participants. Bivariate analyses ( $t$ -tests,  $\chi^2$  tests and, when appropriate, non-parametric Kruskal–Wallis and Mann–Whitney  $U$ -tests) were conducted to compare trained to untrained participants on all demographic and outcome variables. Multivariable regression analyses (linear, logistic) were conducted to explore variables associated with knowledge (i.e. opioid overdose, naloxone indication and overall overdose scores) and having responded to overdose. In all models, non-automated backward and stepwise modeling techniques were employed. Due to small sample size, and drawing upon recommendations from the literature for analyses in such situations [24–26], models considered only variables yielding significant bivariate associations with outcomes, resulting in four or fewer possible independent variables. Sufficient power ( $> 0.8$ ) to detect at least one significant independent regression variable was achieved, based on expected effect sizes [25,27]. However, sample size precluded a more comprehensive and conclusive test of associations with additional variables or smaller effects; regression findings are necessarily presented as exploratory in nature.

This study was approved by the Human Investigations Committee of Yale University School of Medicine.

## RESULTS

Sixty-two respondents took part in the study between October 2005 and July 2006 (Table 2). Respondents were predominantly male (72.6%), and current or former drug users (85.5%). Fourteen (22.6%) were syringe exchange staff. Approximately half ( $n = 30$ ) had been trained in responding to drug overdose, a median of 8 months (range 1–80 months) prior to evaluation. History of experiencing an overdose was common (45.8%,  $n = 27$ ), with respondents reporting a median of three previous overdoses [interquartile range (IQR) = 4]. History of witnessing an overdose was also reported by 72% ( $n = 44$ ) of respondents, witnessing a median of 7.5 (IQR = 11) overdoses. Having responded to an overdose (e.g. calling 911, administering naloxone, injecting with milk, etc.) was reported by 62.3% of all respondents ( $n = 38$ ) and by 86.4% of those who reported witnessing an overdose. Of those reporting having ever responded to an overdose, they had done so a median of four times (IQR = 4), with half ( $n = 19$ , 50%) occurring within the past year. Trained and untrained respondents did not differ in demographics or overdose experience. They differed, however, in their self-rated level of expertise in identifying symptoms of opioid overdose ( $t_{60} = 2.14$ ,  $P < 0.05$ ) and identifying when to use naloxone ( $t_{60} = 5.03$ ,  $P < 0.0001$ ), with trained respondents having higher perceived competency in recognizing and responding to opioid

overdoses (Table 3). The groups did not differ in self-rated level of expertise in identifying non-opioid overdose symptoms ( $t_{58} = 0.59, P = 0.56$ ).

### Overdose and naloxone knowledge

Knowledge of opioid overdose symptoms was significantly higher among trained compared to untrained respondents (Table 3: 7.1 of nine situations recognized versus 5.2,  $t_{60} = -3.76, P < 0.001$ ). However, trained and untrained respondents had similar indecision in recognizing non-overdose and non-opioid overdose situations (4.6 versus 4.3 of seven situations,  $t_{60} = -0.81, P = 0.42$ ). Overall, overdose knowledge was high for trained respondents who scored 85.2% correct compared to the 68.3% correct among untrained respondents (11.7 versus 9.5 of 16 correct,  $t_{48.93} = -3.24, P < 0.005$ ). Trained respondents showed greater aptitude in recognizing when naloxone was indicated (13.5 versus 11.1 of 16,  $t_{59} = -4.38, P < 0.0001$ ). There were no significant differences in knowledge scores by site.

### Naloxone response: ‘missed opportunities’, ‘wasted resources’

Fewer (2.1 versus 3.2) opioid situations that required naloxone administration were missed by trained respondents compared to those untrained ( $t_{59} = -2.20, P < 0.05$ ). That is, of the opioid overdose situations, untrained respondents were more likely than trained respondents to miss the opportunity to respond appropriately with naloxone. In a similar vein, trained participants were less likely to recommend administration of naloxone in situations where it was not indicated (i.e. in non-overdose and non-opioid overdose events): 0.4 versus 1.7 of seven situations ( $t_{38.32} = -3.43, P < 0.001$ ). Hence, resources—measured in response time and naloxone—were less likely to be wasted by trained respondents than by untrained respondents.

### Multivariable analyses

Table 4 presents results from exploratory multivariable analyses of the knowledge and reported overdose–response outcomes. In a multiple linear regression, the only statistically significant independent predictor of greater opioid overdose knowledge was receipt of training in overdose response ( $\beta_{st}$ , standardized beta = 0.41,  $P < 0.001$ ). For the outcome of overall overdose knowledge score (opioid or non-opioid overdose), the independent predictors were receipt of training ( $\beta_{st} = 0.47, P < 0.001$ ) and self-rated level of expertise in recognizing signs of opioid overdose ( $\beta_{st} = 0.24, P < 0.05$ ). Having ever responded to overdose of any kind was predicted independently by self-rated level of expertise in recognizing signs of opioid overdose [adjusted odds ratio (AOR): 2.06 (95% CI: 1.05, 4.03)] and, more strongly, expertise in recognizing signs of non-opioid overdose [AOR: 2.6 (95% CI: 1.31, 5.21)]. Only receipt of overdose training was associated independently with higher naloxone knowledge scores ( $\beta_{st} = 0.51, P < 0.001$ ).

### Responses to overdose situations and time since training

Untrained participants were significantly more likely to report having never responded to an overdose (Fig. 2, 48.4% versus 27.6%,  $\chi^2_3 = 8.62, P < 0.05$ ). A linear trend indicated that trained participants were more likely to have responded recently than those who had not been trained (trained: 37.9%  $\leq$  1 year ago, 31.0% 1–5 years ago versus untrained: 25.8% and 9.7%, respectively,  $\chi^2_1$  linear trend = 3.94,  $P < 0.05$ ). People who had been trained over 1 year prior to assessment were as likely to report having responded to an overdose that occurred within the past year as to an overdose that occurred 1–5 years ago [53.8% versus 50% past year responded, 38.5% versus 50% 1–5 years ago responded,  $\chi^2_2 =$  not significant]. These data suggest a continued level of involvement in overdose–response for those who had been trained. Additionally, people trained within the past year appeared to be

applying their training: the highest proportion of last overdoses responded to for this group occurred in the past year (38.9%).

### Witnessing and responding to overdose

More recently witnessing an overdose was associated marginally with having been trained in overdose recognition and response [OR: 2.71 (95% CI: 0.95, 7.71)]. Among those who had recently witnessed an overdose, trained participants also reported having responded to a median of four overdoses compared to only 1.5 overdoses among the untrained participants (Mann–Whitney  $U = 119.5$ , Wilcoxon's  $W = 329.5$ ,  $Z = -2.00$ ,  $P < 0.05$ ).

### Comparison of participants to medical experts

Examining the 962 raw ratings, 43.9% ( $n = 422$ ) were assigned to opioid overdose, 39% ( $n = 375$ ) to not an overdose/non-opioid overdose and 17.2% ( $n = 165$ ) to unsure/not enough information. Compared to the medical experts, trained respondents assigned a comparable proportion of opioid overdose ratings (47.7 versus 51.7,  $\chi^2_1 = 0.842$ ,  $P = 0.36$ ) to the same 16 putative overdose scenarios. The medical experts and trained respondents assigned differing proportions of codes to the non-opioid/non-overdose category and to the unsure/not enough information category. Notably, the medical experts assigned approximately 10% more codes to the 'don't know/unsure/not enough information' category, compared to trained respondents (25.6% versus 16.0% of codes). Weighted kappas for the three overdose rating categories comparing medical examiners to trained respondents were high: 0.85 (weighted kappa 95% CI: 0.72, 0.98), whereas those comparing medical experts to untrained respondents [weighted kappa: 0.48 (95% CI: 0.18, 0.77)], and trained to untrained respondents [weighted kappa: 0.56 (95% CI: 0.22, 0.89)] were lower, with larger variances.

There was perfect agreement (kappa = 1.0) between the medical experts and trained respondents in their recommendations for administration of naloxone. In contrast, agreement between the untrained respondents and medical experts or trained respondents, the kappa was 0.75 with a wide confidence interval (0.44, 1.0).

## DISCUSSION

This study is the first multi-site evaluation of overdose training and naloxone distribution programs in the United States. It is also the first study to employ a psychometrically valid instrument to measure improvements in overdose recognition and naloxone administration knowledge. We found that people trained in overdose recognition and naloxone administration were comparable to medical experts in identifying situations in which an opioid overdose was occurring and when naloxone should be administered. Training programs improved recognition and response to opioid overdoses significantly, so that fewer opioid overdoses would be missed and fewer overdoses would be responded to inappropriately by trained participants.

Our findings suggest that non-opioid overdose knowledge is low, even among people who have been trained to recognize and respond to overdose situations. A review of training curricula at each site (see appendix mentioned previously) found that most of the training programs (four of six) do not address explicitly identification and responding to non-opioid overdoses, so the low non-opioid overdose knowledge scores in this study may be expected. Several recent studies have highlighted the role that cocaine plays in opioid overdose deaths [28–30]. Overdoses with cocaine and heroin in combination, cocaine-only and cocaine, heroin and alcohol combinations are often experienced by drug users, yet their epidemiology is not well understood [29,31]. Areas that have historically reported high abuse of cocaine and other stimulants such as the US eastern seaboard [32], California [33] and Canada [34–



36] may find muted effects of naloxone training programs on the prevalence of fatal drug overdose in their community. Curricula to recognize and respond to non-opioid overdose, especially cocaine intoxication, should be incorporated into naloxone trainings. For example, curricula could include explicitly addressing and practicing recognition of signs of cocaine/stimulant overdoses and a clear directive to call 911 in such circumstances.

The association between more recently witnessing an overdose and having been trained in overdose recognition and response may indicate that the people being trained by the programs are those exposed to settings in which the risk of overdose is high. In other words, the programs appear to be reaching their target population. Given relatively high knowledge scores among untrained participants, the association is less likely due to inability to recognize an overdose when it takes place. Among those who had recently witnessed an overdose, the greater median number of overdoses responded to by trained participants may not be due to success of training but rather to a reluctance of untrained participants to do anything that could potentially be harmful to the victim. Further evaluation studies pairing witnessed overdose and their specific response might elucidate this point.

It is important to note the relatively high opioid overdose symptom knowledge amongst untrained participants. While this may reveal a diffusion of knowledge from trained to untrained members in the community, it may also reflect the drug user community's awareness of, concern about and organic efforts to educate others about overdose risk. Programs for overdose recognition and response often arise directly from or are built upon such cumulative foundations, influencing program mobilization and thus their efficacy. Further, diffusion of public health messages from those trained to those untrained increases program effectiveness and overdose risk minimization within the community.

Finally, this study found that people who have been trained in overdose-response techniques and who feel confident in their ability to recognize an opioid overdose may effectively prevent overdose mortality. Self-efficacy, or one's perceived ability to engage in a specific behavior, is a prominent predictor of behavior change and action [37–39]. The finding that perceived competency (i.e. self-efficacy) in recognizing opioid overdose was associated independently with greater knowledge of overdose recognition suggests that mechanisms to improve confidence in one's abilities such as attending trainings and practicing newly acquired skills exert an influence on knowledge, a key mediator of behavior change. Moreover, self-efficacy to recognize both opioid and non-opioid overdoses were associated independently with ever responding to overdose, suggesting links between self-efficacy and behavior. For drug users, there may be a sense of empowerment and other important psychosocial benefits gained through receipt of overdose recognition and naloxone training. Future studies should further explore these potential benefits.

Cost-effectiveness of health interventions such as diagnostic screening is a function of the prevalence of the problem being alleviated, the frequency and cost of a false positive, and the frequency and cost of a false negative [40–42]. In the case of naloxone training programs, the prevalence of opioid overdose is high among drug users but may differ by location depending on, among other things, accessibility to drugs other than opioids. This study demonstrated that the frequency of a false positive (i.e. 'wasted resources') and the frequency of a false negative (i.e. 'missed opportunity') were minimized with training. The cost of a false positive could range from the cost of the naloxone dose (\$1.75–3.10 per 1 mg dose wholesale; Safetyworks: <http://www.1800safety2.com>) to death, if the case was a non-opioid overdose. The cost of a false negative could range from nothing to death. Mitigating the influence of these costs is the capacity to train drug users and people who spend time around drug users in overdose recognition and response. This study provides key evidence,

without having to conduct a large, costly, multi-site study or a complex cost-effectiveness analysis, that naloxone training programs are effective and probably cost-effective.

This study has several important limitations. Sample size was small, and power was insufficient to test for site-specific differences. For the main knowledge outcomes, however, the large effect sizes (Cohen's  $d = 0.97$  for overdose knowledge,  $d = 1.1$  for naloxone indication knowledge) were detected with confidence using this sample size. Nevertheless, a larger scale evaluation could examine site and program-specific effects more thoroughly, provide adequate power for multivariable regressions to test hypotheses generated by our exploratory models and return results with greater external validity than our small study provides. This study is observational in nature and thus is open to the limitations of such designs including self-report and reporting bias. Moreover, the non-random sampling strategy employed to recruit subjects at each site may have introduced bias. We made every effort to convey the importance of recruiting a random sample of participants trained and untrained at each site. In all cases, the programs' time and staff constraints would have made orchestration of a non-random selection-biased recruitment effort unlikely. Another limitation pertains to the lack of specificity in the data obtained, namely that the overdoses witnessed were not necessarily the same overdoses that were responded to by participants (i.e. unpaired overdose situations). Instead, interpretation is restricted to associations between participants' reports of witnessing and responding to overdoses in general. Finally, due to time and space constraints at the sites, the evaluation instrument collected limited demographic variables. Thus, residual confounding may have influenced the findings.

In conclusion, this study reports initial evidence of the effectiveness of overdose training and naloxone distribution programs in opioid overdose recognition and response. People trained through these programs identify opioid overdoses and indications for naloxone as well as medical experts and consistently scored higher in knowledge of overdose and naloxone indication scenarios than their untrained counterparts. Efforts to develop and incorporate curricula for recognizing and responding to non-opioid overdoses, especially cocaine intoxication, are needed. Expansion of overdose training and naloxone distribution programs for drug-using populations is warranted.

## Acknowledgments

The authors are grateful to Jeannette Ickovics for support of this research, to Min Kim for his assistance in organizing and analyzing data, to Mark Kinzly for assisting with pilot testing the evaluation tool and liaising with sites and to Darlene Palmer, Karina Lavoie, Melissa Prevost and Catherine Hankins for assistance in obtaining overdose scenarios. We are especially thankful to study participants and staff of the evaluation sites: Pete Morse, Emalie Hurliaux (DOPE Project, San Francisco); Susan Sherman, Monique Rucker (Johns Hopkins School of Public Health and the City of Baltimore); Bernie Lieving, Phillip Fiuty, Diana McCague (New Mexico Department of Health); Sharon Stancliff, Jason Farrell (Harm Reduction Coalition, Positive Health Project, New York); Dan Bigg, Suzanne Carlberg-Racich, Big John (Chicago Recovery Alliance); and Dahlia Heller, Rafi Toruella (Citiwide Harm Reduction Services, New York). We acknowledge with appreciation the 11 medical experts who took part in this study: Phillip Coffin, Brian Edlin, Niels Tangherlini, Sharon Stancliff, Bernie Lieving, R. Douglas Bruce, Sarz Maxwell, Karl Sporer, Josh Bamberger, Dan Ciccarone and one expert who preferred to remain anonymous. This evaluation was conducted with support from an institutional training grant for T. C. G.: NIMH 5T32MH020031.

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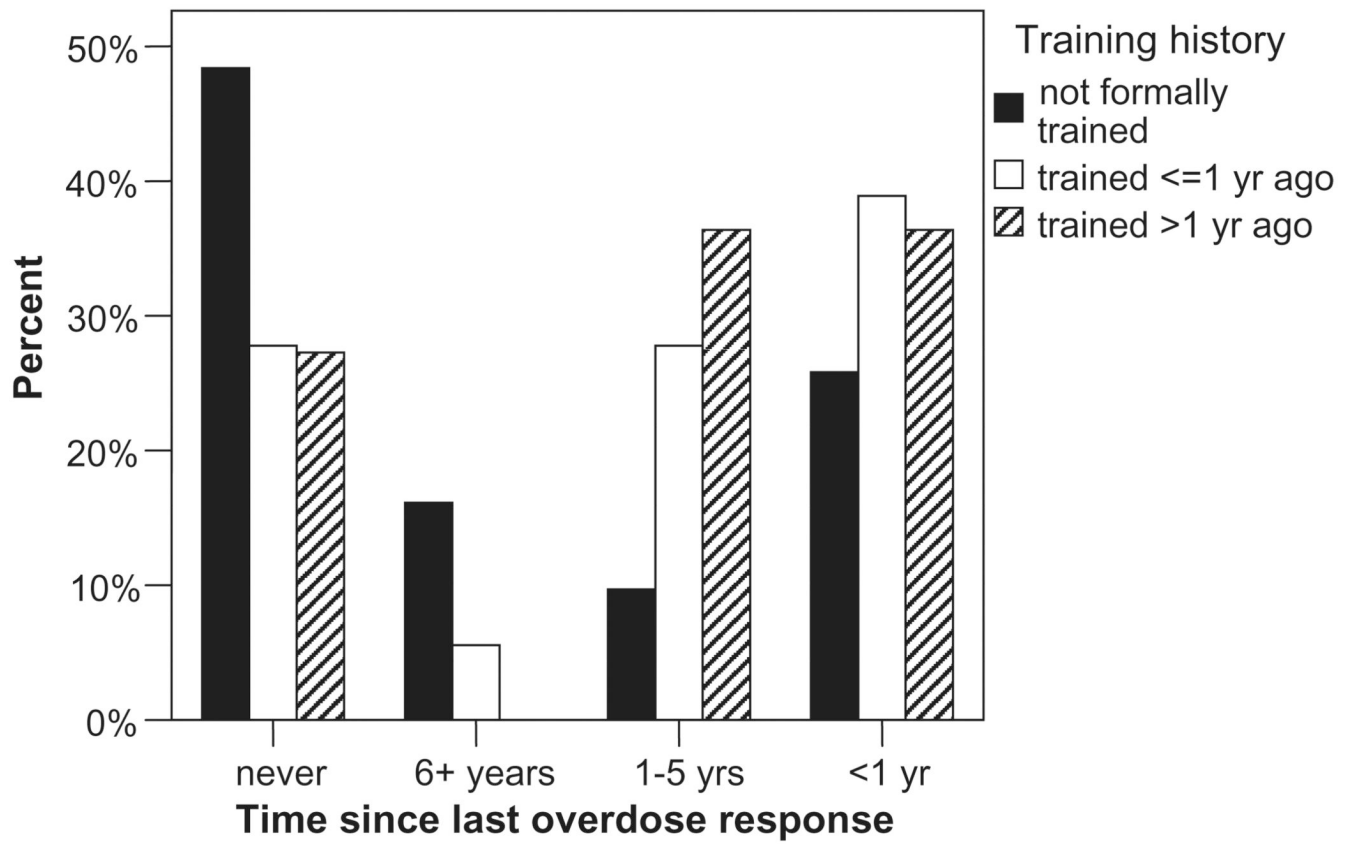


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**Figure 1.** One of many community-based naloxone distribution and overdose prevention training programs held across the state of New Mexico. Photo courtesy of Philip Fiuty



**Figure 2.**  
Time since last reported overdose–response by participants’ overdose–response training history

Table 1

Program and curriculum components of six study sites: overdose prevention and response programs.

Site	Training setting	Training type	Participant remuneration	Average estimated length of training (minutes)	Aspects of overdose recognition curriculum		
					Non-opioid (e.g. stimulant) overdose covered	'Heavy nod' versus overdose differentiation	Evaluation/ knowledge test
Chicago, Illinois	Needle exchange, mobile van, street	One-on-one, pairs; DVD	None	15-30 (15-20: training, 10: DVD)	Partial	Yes	After training
State of New Mexico	Drug treatment centers, needle exchanges, peer's homes, street settings	One-on-one, classroom	\$5-10	20-30 (one-on-one), 120 (classroom)	No	Yes	No
San Francisco, California	SRO hotels*, needle exchange programs	One-on-one	None	15	Explicitly	Yes	No
Baltimore, Maryland	Needle exchange, community centers, mobile unit	One-on-one in mobile unit; Classroom	None	20-30 (mobile), 90 (classroom)	Explicitly	Yes	After training
New York, New York (Positive Health Project)	Multi-service facility	Classroom	\$4 metro card	30-45	No	Yes	After training
New York, New York (Citwide)	Street, hotel room, drop	One-on-one, classroom	\$4 metro card	15-20 (one-on-one), 60 (classroom)	Partial	Yes	After training

\* SRO hotels = single room occupancy hotels.



**Table 2**

Study population socio-demographics and overdose experience, by training history.

Variable	Trained n (%)	Untrained n (%)	Test statistic, P-value
Site			
Chicago	6	5	1.43, $P = 0.96$
Baltimore	4	6	
New York City: Citiwide	5	6	
New York City: Positive Health Project	5	5	
New Mexico	5	5	
San Francisco	5	5	
Total sample	30	32	
Male	22 (73.3)	23 (71.9)	0.02, $P = 0.90$
Respondent's background <sup>†</sup>			
Medical professional	0	1 (3.1)	<sup>‡</sup> $P = 1.0$
Needle exchange program employee	9 (30.0)	5 (15.6)	1.83, $P = 0.18$
Outreach worker	2 (6.7)	1 (3.1)	<sup>‡</sup> $P = 0.61$
Current or former drug user	25 (83.3)	28 (87.5)	0.22, $P = 0.64$
Other (client)	0	2 (6.3)	<sup>‡</sup> $P = 0.49$
Trained in responding to drug overdose	30 (100)	3 (9.4)*	$P < 0.0001$
History of overdose	14 (50)	13 (41.9)	0.38, $P = 0.53$
Number of overdoses experienced (median, IQR)	2 (4)	3 (3)	1.14, $P = 0.25$
Last overdose experienced			
Within past year	4 (28.6)	4 (36.4)	0.65, $P = 0.72$
1–5 years ago	6 (42.9)	3 (27.3)	
6+ years ago	4 (28.6)	4 (36.4)	
History of witnessing an overdose	22 (75.9)	22 (68.8)	0.38, $P = 0.54$
Number of overdoses ever witnessed (median, IQR)	9 (12)	7 (8)	1.09, $P = 0.28$
History of responding to a drug overdose	21 (72.4)	17 (53.1)	2.41, $P = 0.12$
Number of overdoses ever responded to (median, IQR)	4.5 (6)	2 (5)	1.21, $P = 0.23$

\* Three respondents who were not trained by the recruiting program stated that they had received training in overdose symptom recognition and response (one during professional CPR training, one at a long-term drug treatment facility, one in Vancouver, British Columbia). Because these trainings were not aimed specifically at overdose recognition and response or they occurred more than 9 years ago, these respondents were considered as untrained participants in our analyses.

<sup>†</sup> More than one response was possible.

<sup>‡</sup> Fisher's exact test applied. IQR: interquartile range.

**Table 3**

Overdose and naloxone knowledge scores by training status.

Scores	Trained n = 30 Mean (SD)	Untrained n = 32 Mean (SD)	Test statistic, P-value
Self-rated level of expertise			
Identifying opioid overdose symptoms	3.77 (.94)	3.22 (1.07)	$t_{60} = 2.14, P < 0.05$
Identifying when to use naloxone	3.83 (.91)	2.63 (.98)	$t_{60} = 5.03, P < 0.0001$
Identifying non-opioid overdose symptoms (e.g. cocaine intoxication)	3.39 (1.13)	3.22 (1.16)	$t_{58} = 0.59, P = 0.56$
Overdose symptom recognition			
Correctly identified as opioid overdose (nine items)	7.13 (1.38)	5.18 (2.55)	$t_{60} = -3.76, P < 0.001$
Correctly identified as not an overdose/non-opioid overdose (seven items)	4.63 (1.40)	4.28 (1.94)	$t_{60} = -0.81, P = 0.42$
Total score (16 items)			
Average percentage correct: recognition of overdose	11.77 (1.92)	9.47 (3.48)	$t_{48.93} = -3.24, P < 0.005$
Naloxone indication			
Correctly indicated for opioid overdose (nine items)	6.93 (1.76)	5.77 (2.30)	$t_{59} = -2.20, P < 0.05$
Correctly <i>not</i> indicated for opioid overdose (seven items)	6.60 (0.72)	5.32 (1.94)	$t_{38.32} = -3.43, P < 0.001$
Total score (16 items)	13.53 (1.96)	11.09 (2.32)	$t_{59} = -4.38, P < 0.0001$
Average percentage correct: naloxone indication	84.6%	69.3%	

SD: standard deviation.

**Table 4**

Predictors of knowledge of overdose recognition, naloxone administration and history of response: multiple linear and logistic regressions.

<b>Outcome</b>	<b>Receipt of training</b>	<b>Perceived competency in recognizing signs of an opioid overdose</b>	<b>Perceived competency in recognizing signs of a non-opioid overdose</b>
Knowledge of opioid overdose symptom recognition	$\beta_{st} = 0.41, P < 0.001$	–	–
Knowledge of naloxone indication	$\beta_{st} = 0.51, P < 0.001$	–	–
Overall overdose knowledge (opioid, non-opioid, non-overdose) recognition	$\beta_{st} = 0.47, P < 0.001$	$\beta_{st} = 0.24, P < 0.05$	–
History of ever treating or responding to an overdose	–	AOR 2.06 (95% CI: 1.05, 4.03), $P < 0.05$	AOR 2.6 (95% CI: 1.31, 5.21), $P < 0.001$

AOR = adjusted odds ratio; 95% CI = 95% confidence interval;  $\beta_{st}$  = standardized beta.