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Predictors of participant engagement and naloxone utilization in a community-based naloxone distribution program

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Abstract

Aims—To describe characteristics of participants and overdose reversals associated with a community-based naloxone distribution program and identify predictors of obtaining naloxone refills and using naloxone for overdose reversal.

Design—Bivariate statistical tests were used to compare characteristics of participants who obtained refills and reported overdose reversals, versus those who did not. We fitted multiple logistic regression models to identify predictors of refills and reversals; zero-inflated multiple Poisson regression models were used to identify predictors of number of refills and reversals.

Setting—San Francisco, California, U.S.A.

Participants—Naloxone program participants registered and reversals reported from 2010-2013.

Measurements—Baseline characteristics of participants and reported characteristics of reversals.

Findings—2500 participants were registered and 702 reversals were reported from 2010-2013. Participants who had witnessed an overdose [AOR=2.02(1.53-2.66); AOR=2.73(1.73-4.30)] or used heroin [AOR=1.85(1.44-2.37); AOR=2.19(1.54-3.13)], or methamphetamine [AOR=1.71(1.37-2.15); AOR=1.61(1.18-2.19)] had higher odds of obtaining a refill and reporting a reversal, respectively. African American [Adjusted Odds Ratio=0.63(95%CI=0.45-0.88)] and Latino [AOR=0.65(0.43-1.00)] participants had lower odds of obtaining a naloxone refill whereas Latino participants who obtained at least one refill reported a higher number of refills [Incidence Rate Ratio=1.33(1.05-1.69)].

Declarations of Interest

Authors declare no conflicts.

Conclusions—Community naloxone distribution programs are capable of reaching sizeable populations of high-risk individuals and facilitating large numbers of overdose reversals. Community members most likely to engage with a naloxone program and use naloxone to reverse an overdose are active drug users.

INTRODUCTION

Drug related deaths increased 92.7% worldwide between 1990 and 2013 (1), and drug overdose has been the largest cause of injury-related death among U.S. adults since 2008 (2-4), a trend driven by increased opioid overdose mortality (5). Naloxone, a short-acting mu-opioid antagonist with no abuse potential, is recommended by the World Health Organization and others as a key strategy to reduce mortality related to opioid overdose (6-13). Naloxone has been distributed to heroin users to facilitate lay reversal of opioid overdoses since the mid-1990s (6, 9, 14). As of 2010, there were at least 188 naloxone distribution programs in the U.S. but no programs in 19 of the 25 states with drug overdose death rates above the 2008 median, indicating a critical need to expand community access to naloxone. (6)

Extant literature demonstrates that drug users accept lay naloxone provision and frequently utilize naloxone successfully to reverse opioid overdoses (9). Multiple studies also demonstrate reductions in opioid overdose temporally associated with introduction and expansion of naloxone programming, including an interrupted time-series analysis demonstrating a relative reduction in opioid overdose in communities that distributed naloxone compared to those that did not distribute naloxone. (15, 16) Cohort and programmatic data from naloxone programs have described demographics as well as rates and characteristics of reversals (9). Generally, 10-20% of substance users given naloxone will passively report a reversal event (17-19); however, it is unclear what predicts reversals and what happens to the majority of naloxone kits. Understanding who is continuing to access naloxone programs and who effectively utilizes naloxone in the community would identify programming strengths and gaps and inform the cost-effective expansion of community naloxone distribution.

To address these gaps, we analyzed data from the Drug Overdose Prevention Education Project (DOPE), a San Francisco County overdose prevention and naloxone distribution program in operation since 2003. DOPE was the first naloxone distribution program in the U.S. to be sanctioned and supported by a health department, the San Francisco Department of Public Health, and a prior study reported on participant demographics and refill and reversal characteristics between 2003 and 2009 (18). Utilizing more comprehensive data collection from 2010 onward to understand who engages with a community naloxone program, we attempted to (1) describe DOPE participants and reversal events between 2010 and 2013, (2) compare demographic characteristics among subgroups based on whether or not they had returned to a DOPE site to obtain a refill of naloxone (henceforth referred to as a refill) or used naloxone to reverse an overdose (henceforth referred to as a reversal), (3) identify predictors of obtaining refills and reporting reversals, and (4) identify predictors of the numbers of refills obtained and reversals reported.

METHODS

Data Collection and Measures

DOPE Participants—DOPE provides brief (5-10 minute) training for anyone who might witness or experience an opioid overdose in how to recognize and respond to overdose and dispenses 2-dose intranasal or injectable naloxone kits. Services are provided at needle exchange sites, re-entry programs, pain management clinics, opioid substitution treatment programs, and single room occupancy hotels (SROs). All participants complete a brief questionnaire during enrollment, linked to a unique identifier based on personal information that can be easily recalled on return to the program. Data collected include birthdate, race/ethnicity, gender, housing status, use of specific substances in the preceding 30 days, and history of prior overdose, witnessing of an overdose, naloxone administration, witnessing of naloxone administration.

Naloxone Refill and Reversal Events—Participants returning to obtain a new naloxone kit completed a separate questionnaire in which they indicated whether the refill was due to use or loss of their previous kit. If the participant had used the naloxone, they were asked about the individual to whom the naloxone was administered (e.g., relationship to recipient, substances used) as well as the setting and result of the naloxone administration.

Analysis

Due to more comprehensive data collection since 2010, we limited analysis to participants registered since 2010 and reversals performed since 2010. All data were analyzed using STATA version 12 (College Station, TX). This study was approved and deemed exempt from review by the University of California San Francisco Committee on Human Research (IRB study ID 12-09877).

DOPE Participants—All participants were categorized into subgroups according to whether or not they had obtained a refill or reported an overdose reversal using naloxone. We calculated the mean age and frequencies of demographic and behavioral measures for all participants and those in each subgroup.

Demographic and behavioral characteristic comparisons between those who obtained a refill and those who did not, as well as between those who reported a reversal and those who did not, were conducted using unpaired Student's t-tests and Fisher's exact tests. We excluded any records of clinical registration (n=9) and refills (n=10) where a single unique identifier was given to multiple individuals at initial registration and that unique identifier was associated with at least one refill. Additionally, we excluded from analysis any records of refills (n=183) where no unique identifier could be linked to an existing clinical registration.

We also conducted a subgroup analysis among participants who obtained refills, in which we compared characteristics of those who did and did not report a reversal (please see Supplemental Online Appendix, Table S1)

Naloxone Administration Events—We calculated frequencies of circumstantial measures for all naloxone administration events occurring between January 1, 2010, and

December 31, 2013, regardless of when the participant underwent initial clinical registration or whether their unique identifier could be linked to an existing clinical registration.

Multiple Regression Analyses—We used multiple logistic regression models to examine the relationship between demographic (e.g., age, gender, race, housing status) and behavioral characteristics (e.g., prior experience of overdose, prior witnessing of overdose, substance use) of participants trained from 2010-2013 and whether or not participants obtained naloxone refills or reported reversals in the same timeframe (see Table 3 for complete list of predictors). In sensitivity analyses, we fitted logistic regression models described above, but with measures on baseline history of naloxone administration and witnessing of naloxone administration, instead of baseline history of witnessing an overdose; these predictors were not fitted simultaneously to avoid collinearity. We also conducted a subgroup analysis examining predictors of refills and reversals restricted to opioid users.

We conducted an exploratory analysis assessing potential synergistic effects between demographic characteristics (age, race, and gender) and specific behavioral characteristics (heroin use, meth use, and history of witnessing an overdose), in separate multiple logistic regression models predicting odds of obtaining a naloxone refill. We used likelihood ratio tests to assess the joint statistical significance of the independent contributions of each set of interaction terms. Jointly significant interaction terms ($p < 0.05$) were summarized qualitatively in the results due to the exploratory nature of the analyses.

We used zero-inflated multiple Poisson regression models to examine the relationship between demographic and behavioral characteristics of participants trained from 2010-2013 and counts of both refills and reversals in the same timeframe. Models included the same covariates as the multiple logistic regression models as well as an offset for time of follow-up for each participant, calculated from date of initial registration to December 31, 2013. The zero-inflated Poisson model rests on the assumption that in an unobservable subset of the population, the count outcome is always (structurally) zero, while in a second, complementary subset, it arises from a standard Poisson distribution (including the expected proportion of random zeroes). These models estimate covariate effects on both sub-population membership as well as the mean of the Poisson distribution in the second population subset.

We conducted additional subgroup analyses limiting the logistic regression and Poisson regression models to those who had obtained refills, which is included in the appendix (Tables S2 and S3).

RESULTS

DOPE Participants

DOPE trained and prescribed naloxone to 2500 participants from 2010 to 2013. The majority of participants were male (60.5%), of European background / white (58.8%) and homeless or unstably housed (56.1%), with a mean age of 38.6 (Table 1). Most participants (73.9%) engaged in some illicit substance use in the 30 days prior to initial registration;

50.7% used opioids. Roughly one-third of participants had overdosed (32.5%) and nearly twice as many (63.7%) had witnessed at least one overdose. About one-third (32.0%) had witnessed naloxone administration and 10.8% had used naloxone on another individual prior to their initial training.

Among participants who obtained at least 1 refill, the median number of refills was 1 (IQR 1-3). The differences between participants who obtained at least one refill compared to those who did not return for any refills are summarized in Table 1. Those who received refills were significantly more likely to be male, of European background, homeless or unstably housed or to have previously overdosed, witnessed an overdose, used naloxone on another individual, or witnessed the use of naloxone on another individual. Additionally, participants who obtained refills were more likely to use any drugs, multiple drugs, heroin, other opioids, or methamphetamine.

Correlates were similar for those who reported at least one reversal (median overdose reversals reported was 1 [IQR 1-2]). Compared to those who did not report any reversals, those who reported at least one reversal were younger, more likely to be of European background and homeless or unstably housed, or to have overdosed, witnessed an overdose, used naloxone on another individual, or witnessed the use of naloxone on another individual. Additionally, participants who reported reversals were more likely to use any drugs, multiple drugs, heroin, or methamphetamine.

Comparisons between participants who did and did not report reversals among those who obtained refills are presented in Table S1.

Naloxone Administration Events

DOPE recorded 702 naloxone administration events between 2010 and 2013 (405 reported by participants initially registered from 2010-2013, 270 by participants registered before 2010, and 27 by participants whose unique identifier was not linkable to a registration record). The most common setting was a private residence (40.5%), followed by a SRO (29.6%). Naloxone was mostly used on companions or acquaintances of participants (74.6%) and 95.7% of recipients were known to have survived. Of 10 reported deaths (1.4% of reversals), in 6 cases participants reported that they arrived too late but administered naloxone anyway. Heroin was the most commonly reported substance consumed by the person reversed by naloxone (90.3%). Roughly one-quarter (27.4%) of reversal attempts also involved a call to emergency medical services (Table 2).

Multiple Regression Analyses

The results of multiple logistic regression analyses evaluating predictors of obtaining at least one refill and reporting at least one reversal are summarized in Table 3. With regard to refills, African American and Latino participants had lower odds of obtaining a refill. Participants of mixed or other race and those who had witnessed an overdose, used heroin, or used methamphetamine had higher odds of obtaining a refill. In a subgroup analysis examining only opioid using participants, African American participants also had lower odds of obtaining a naloxone refill [AOR 0.59 (95% CI, 0.39-0.90)].

In the exploratory models addressing the interaction effects between demographic and behavioral predictors, those with history of overdose had differential odds of obtaining a refill depending on the race of the participant, with a stronger effect among African Americans and participants of other / mixed race compared to participants of European background. There were no other significant interaction effects in these models.

With regard to reversals, participants who used alcohol had lower odds of reporting a reversal while participants who had witnessed an overdose, used heroin, or used methamphetamine had higher odds of reporting a reversal. In a subgroup analysis examining only opioid-using participants, African American participants had lower odds of reporting a reversal [AOR, 0.50 (0.26-0.95)].

In sensitivity analyses, both prior naloxone administration [AOR 1.37 (1.01-1.88); AOR 2.49 (1.73-3.59)] and previously witnessing naloxone being administered [AOR 1.85 (1.47-2.32); AOR 2.67 (1.94-3.67)] were associated with higher odds of obtaining a refill and reporting a reversal, respectively.

Table 4 summarizes the results of the zero-inflated multiple Poisson regression models evaluating predictors of the number of naloxone refills and number of overdose reversal events among those who obtained at least one refill and reported at least one reversal, respectively. With regard to refills, Latino participants who had obtained at least one refill had a greater average number of refills than participants of European background. Participants who were homeless, had experienced an overdose, used heroin, or used methamphetamine also had a greater average number of naloxone refills. Those who used methadone had a lower number of refills than those who did not use methadone. With regard to reversal events, participants of mixed or other race reported a greater average number of reversals than participants of European background, and those who used heroin or methamphetamine reported a greater average number of reversal events than those who did not use these substances.

Results of subgroup analyses assessing the odds of reporting a reversal and the number of reversals among participants who had obtained refills are reported in the appendix. For the multiple logistic regression analysis among this subgroup, those who had witnessed an overdose or used heroin had higher odds of reporting a reversal (Table S2). For the zero-inflated multiple Poisson regression analysis among this subgroup, female participants reported a greater average number of reversals than male participants and African American participants and those of mixed / other race reported a greater average number of reversals than participants of European background. Participants who had a prior overdose, used heroin, or used methamphetamine also reported greater average numbers of reversals. Participants who used cocaine or crack reported a lower average number of reversals (Table S3).

DISCUSSION

We identified unique demographic and behavioral characteristics associated with continuous engagement in a naloxone distribution program. Specifically, we observed that participants

who were of European background, had prior experiences with overdoses, and used heroin or methamphetamine were more likely to return for refills and those who had prior experiences with overdoses and used heroin or methamphetamine were more likely to report reversals. To our knowledge, these findings are the first to analyze predictors of obtaining naloxone refills and of reporting reversals. These results emphasize the impact, with regard to utilization of this medication, of directly reaching drug users with lay naloxone programming.

DOPE participants were mostly of European background, homeless or unstably housed, and used multiple substances, while about one-third drank alcohol and one-third reported a prior personal overdose. These findings are highly consistent with other research on overdose identifying European background, homelessness, use of multiple substances, use of alcohol, and having experienced a prior overdose as risk factors for a subsequent overdose (20-23). These results suggest that naloxone distributed through DOPE is reaching very high risk individuals and, based on the multiple logistic regression analyses, that these high-risk individuals are also the most likely to utilize this intervention in an overdose scenario.

Additionally, multiple logistic regression analyses revealed that witnessing an overdose was significantly associated with greater odds of both obtaining a refill and reporting a reversal. This relationship is supported by the Information-Motivation-Behavior Skills (IMB) model of behavior change, which posits that behavior change occurs when individuals have information about a target behavior, motivation to prevent future outcomes and skills to prevent or reverse outcomes (24, 25). DOPE offers information on overdose management, having witnessed an overdose may provide the motivation to prepare for future overdoses, and DOPE provides participants with tools to address overdose. Our findings suggest that those who are at high risk for overdose are also likely to witness an overdose, consistent with other data, and that the most efficient approach to getting naloxone at the scene of overdose events is to put it in the hands of those at greatest risk for overdose themselves (26).

We also reported several unique findings that merit further exploration. Participants who used methadone obtained fewer refills; if methadone use was in a maintenance program, participants may be using illicit opioids less frequently and thus be less likely to visit a DOPE site or witness an overdose (27). Participants reporting methamphetamine use had higher odds of obtaining a refill and reporting a reversal. We assessed and found a significant bivariate association between methamphetamine use and polydrug use, suggesting that methamphetamine users may be more likely to use multiple substances, highlighting the importance of engaging drug users broadly, and not just opioid users, as part of naloxone distribution programs.

With regard to race/ethnicity, African Americans constitute only 6.1% of San Francisco County residents yet made up 23.9% of accidental drug-related deaths in 2010-2011, including those related to opioid overdose (28, 29), and 20% of DOPE participants, again suggesting that DOPE is effective in reaching at-risk populations. Moreover, Latino participants who reported obtaining refills on average obtained greater number of refills and, among participants who obtained refills, African Americans who reported at least one

reversal on average reported more reversals (Table S3), suggesting that some participants of racial/ethnic minority groups were heavily engaged in naloxone programming. This is further supported by our assessment of statistical interaction between race and prior witnessing of an overdose, in which the association between witnessing of an overdose and odds of obtaining a refill was stronger in African Americans and participants of mixed / other race compared to participants of European background. Regardless of these findings on number of refills and number of reversals, both African American and Latino participants had lower odds of any obtaining refills. Even among the subgroup of only-opioid using participants, African Americans were less likely to both obtain refills and report any reversals, suggesting that this finding is robust and not mediated by drug of choice. The discrepancy between lower early engagement with naloxone programming and the potential for higher subsequent engagement among racial/ethnic minority participants reveals an important opportunity to further engage these populations through outreach efforts and services that are both culturally sensitive and relevant. These findings also highlight the need for further research, including the use of qualitative methods, to better understand the underlying causes of these racial/ethnic trends.

DOPE has documented a substantial increase in reported annual reversals with naloxone since 2003 (from 5 in 2003 to 252 in 2013) which has paralleled a substantial decline in heroin-related overdose mortality in San Francisco (18, 28, 30, 31). Moreover, our results show that 90.3% of the naloxone administrations have targeted overdoses that involved heroin. The tendency of participants to use naloxone primarily to reverse heroin-related overdoses, the growing number of reversals, and the declining number of deaths from heroin overdose suggest that the DOPE Project and naloxone distribution may be having an effect on population-level overdose mortality among heroin users. As heroin-related overdose mortality has decreased in San Francisco, however, there has been a corresponding rise in deaths and emergency room visits related to opioid analgesics (28, 30-32). Opioids besides heroin were used by a minority of DOPE participants and were involved in only a small minority of reversed overdoses, suggesting that DOPE activities are not sufficiently reaching the population of opioid analgesic users at risk for overdose. The finding that the use of heroin is associated with greater odds of obtaining a refill of naloxone or reporting a reversal, as shown in our multiple logistic regression analyses, is likely because most DOPE activities are based at needle exchange program sites, highlighting the need to explore alternative naloxone distribution streams to reach other populations at risk. Efforts are underway in San Francisco to achieve this by identifying patients receiving opioid analgesics through primary care for naloxone prescription (NIDA R21 DA036776).

This study has several limitations. All information is self-reported by participants and may be subject to social desirability and/or recall bias. Additionally, reversals were only reported by participants who visited a DOPE site to obtain a refill of naloxone (i.e., “passive surveillance”), which excludes reversals that may have been performed by participants who did not obtain refills. Thus, the reversal analyses may be subject to collider-stratification bias, if obtaining a refill is a common effect of our predictors and the reversals analyzed. Behavioral characteristics of participants, many of which are subject to changes over time, are only collected during initial registration, precluding the analyses from accounting for the

effects of recent changes in characteristics such as housing status, substance use, and overdose experience.

In conclusion, we have identified demographic and behavioral characteristics associated with subsequent engagement with naloxone programming and utilization of naloxone to reverse overdoses. Our results reaffirm the success of community-based naloxone distribution in reaching the most at-risk populations and identify opportunities for service expansion to reach or re-engage other populations in need.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Baseline characteristics of DOPE Project participants registered 2010-2013 by refill and reversal status

Demographic and Behavioral Characteristics*	All Participants		Participants Who Obtained a Refill†		Participants Who Did Not Obtain a Refill		Participants Who Reported a Reversal†		Participants Who Did Not Report a Reversal	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
N	2500		613	(24.5)	1887	(75.5)	257	(10.3)	2243	(89.7)
Mean Age[b] (SD)	38.6	(12.7)	38.0	(12.1)	38.8	(12.9)	37.1	(12.3)	38.8	(12.7)
Gender[a]										
Male	1513	(60.5)	403	(65.7)	1110	(58.8)	170	(66.1)	1343	(59.9)
Female	929	(37.2)	199	(32.5)	730	(38.7)	81	(31.5)	848	(37.8)
Transgender/Other gender	55	(2.2)	11	(1.8)	44	(2.3)	6	(2.3)	49	(2.2)
Missing	3	(0.1)	0	(0.0)	3	(0.2)	0	(0.0)	3	(0.1)
Race[a, b]										
European background / white	1471	(58.8)	403	(65.7)	1068	(56.6)	181	(70.4)	1290	(57.5)
African American	505	(20.2)	79	(12.9)	426	(22.6)	26	(10.1)	479	(21.4)
Latino	224	(9.0)	41	(6.7)	183	(9.7)	16	(6.2)	208	(9.3)
Mixed/Other race	264	(10.6)	79	(12.9)	185	(9.8)	28	(10.9)	236	(10.5)
Missing	36	(1.4)	11	(1.8)	25	(1.3)	6	(2.3)	30	(1.3)
Housing Status[a, b]										
Stably housed	1007	(40.3)	197	(32.1)	810	(42.9)	86	(33.5)	921	(41.1)
Homeless/Unstably housed	1403	(56.1)	391	(63.8)	1012	(53.6)	156	(60.7)	1247	(55.6)
Missing	90	(3.6)	25	(4.1)	65	(3.4)	15	(5.8)	75	(3.3)
Overdose[a, b]										
Prior overdose	813	(32.5)	256	(41.8)	557	(29.5)	120	(46.7)	693	(30.9)
No Prior overdose	1505	(60.2)	296	(48.3)	1209	(64.1)	111	(43.2)	1394	(62.1)
Missing	182	(7.3)	61	(10.0)	121	(6.4)	26	(10.1)	156	(7.0)
Witness of Overdose[a, b]										
Witnessed an overdose	1592	(63.7)	464	(75.7)	1128	(59.8)	210	(81.7)	1382	(61.6)
Never witnessed an overdose	747	(29.9)	97	(15.8)	650	(34.4)	27	(10.5)	720	(32.1)

Demographic and Behavioral Characteristics*	All Participants		Participants Who Obtained a Refill†		Participants Who Did Not Obtain a Refill		Participants Who Reported a Reversal†		Participants Who Did Not Report a Reversal	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Missing	162	(6.5)	52	(8.5)	110	(5.8)	20	(7.8)	142	(6.3)
Naloxone Administration[a, b]										
Administered naloxone	270	(10.8)	100	(16.3)	170	(9.0)	68	(26.5)	202	(9.0)
Never administered naloxone	2016	(80.6)	451	(73.6)	1565	(82.9)	166	(64.6)	1850	(82.5)
Missing	214	(8.6)	62	(10.1)	152	(8.1)	23	(8.9)	191	(8.5)
Witness of Naloxone Administration[a, b]										
Witnessed naloxone administration	800	(32.0)	280	(45.7)	520	(27.6)	147	(57.2)	653	(29.1)
Never witnessed naloxone administration	1484	(59.4)	270	(44.0)	1214	(64.3)	87	(33.9)	1397	(62.3)
Missing	216	(8.6)	63	(10.3)	153	(8.1)	23	(8.9)	193	(8.6)
General Substance Use in Last 30 Days[a, b]										
Any substance use	1847	(73.9)	508	(82.9)	1339	(71.0)	216	(84.0)	1631	(72.7)
No substance use	265	(10.6)	19	(3.1)	246	(13.0)	9	(3.5)	256	(11.4)
Missing	388	(15.5)	86	(14.0)	302	(16.0)	32	(12.5)	356	(15.9)
Polydrug Use in Last 30 Days[a, b]										
Polydrug use	1144	(45.8)	371	(60.5)	773	(41.0)	171	(66.5)	973	(43.4)
No polydrug use	968	(38.7)	156	(25.4)	812	(43.0)	54	(21.0)	914	(40.7)
Missing	388	(15.5)	86	(14.0)	302	(16.0)	32	(12.5)	356	(15.9)
Specific Substance Use in Last 30 Days										
Any opioids[a, b]	1267	(50.7)	399	(65.1)	868	(46.0)	177	(68.9)	1090	(48.6)
Heroin[a, b]	892	(35.7)	318	(51.9)	574	(30.4)	151	(58.8)	741	(33.0)
Methadone[a, b]	584	(23.4)	193	(31.5)	391	(20.7)	82	(31.9)	502	(22.4)
Benzodiazepines[a, b]	497	(19.9)	174	(28.4)	323	(17.1)	87	(33.9)	410	(18.3)
Other opioids[a, b]	612	(24.5)	206	(33.6)	406	(21.5)	95	(37.0)	517	(23.0)
Cocaine/Crack[a, b]	687	(27.5)	219	(35.7)	468	(24.8)	93	(36.2)	594	(26.5)
Alcohol	864	(34.6)	221	(36.1)	643	(34.1)	90	(35.0)	774	(34.5)
Methamphetamine/Speed[a, b]	776	(31.0)	268	(43.7)	508	(26.9)	122	(47.5)	654	(29.2)

Demographic and Behavioral Characteristics*	All Participants		Participants Who Obtained a Refill†		Participants Who Did Not Obtain a Refill		Participants Who Reported a Reversal†		Participants Who Did Not Report a Reversal	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Other substances	371	(14.8)	107	(17.5)	264	(14.0)	48	(18.7)	323	(14.4)

*All characteristics were assessed at baseline during initial registration between January 1, 2010 and December 31, 2013.

†All considered refills and reversals occurred between January 1, 2010 and December 31, 2013.

[a]P < 0.05 for Fisher exact or t-test comparing participants who did and did not obtain refills

[b]P < 0.05 for Fisher exact or t-test comparing participants who did and did not report reversals

Table 2

Characteristics of reported reversal events reported 2010-2013 by DOPE Project participants

	Reversals by All Participants' regardless of Initial Registration Date		Reversals by Participants Initially Registered 2010 - 2013	
	N	(%)	N	(%)
N	702		405	
Setting				
Private residence	284	(40.5)	154	(38.0)
Single room occupancy hotel (SRO)	208	(29.6)	120	(29.6)
Public park	58	(8.3)	39	(9.6)
Public toilet	27	(3.8)	15	(3.7)
Other	102	(14.5)	70	(17.3)
Missing	23	(3.3)	7	(1.7)
Recipient Relationship				
Companion (friend, partner, family member)	524	(74.6)	295	(72.8)
Stranger	139	(19.8)	91	(22.5)
Self	34	(4.8)	17	(4.2)
Missing	5	(0.7)	2	(0.5)
Result				
Reversed, all reasons	673	(95.9)	390	(96.3)
Reversed due to participant administering naloxone	658	(93.7)	385	(95.1)
Reversed following EMS response	15	(2.1)	5	(1.2)
Death	10[†]	(1.4)	9	(2.2)
Unknown	9	(1.3)	1	(0.2)
Missing	10	(1.4)	2	(0.5)
General Substance Use Details				
Single substance	416	(59.3)	246	(60.7)
Multiple substances	286	(40.7)	159	(39.3)
Missing	18	(2.6)	9	(2.2)
Specific Substance				
Heroin	634	(90.3)	363	(89.6)
Heroin alone	379	(54.0)	222	(54.8)
Heroin with other substances	255	(36.3)	141	(34.8)
Benzodiazepine	107	(15.2)	57	(14.1)
Alcohol	109	(15.5)	56	(13.8)
Other Opioids	90	(12.8)	58	(14.3)
Meth	86	(12.3)	53	(13.1)
Cocaine/Crack	54	(7.7)	30	(7.4)
Methadone	37	(5.3)	20	(4.9)
Other Drugs	14	(2.0)	8	(2.0)
Other Measures Taken				

	Reversals by All Participants' regardless of Initial Registration Date		Reversals by Participants Initially Registered 2010 - 2013	
	N	(%)	N	(%)
Sternum rub	243	(34.6)	136	(33.6)
Call 9-1-1	192	(27.4)	118	(29.1)
Rescue breathing	364	(51.9)	209	(51.6)
Missing	3	(0.4)	1	(0.2)

† Of 10 deaths, victim was already deceased in 2, respondent reported arriving “too late” in 4 others.

Table 3

Multiple logistic regression models predicting naloxone refills and reversals among DOPE Project participants registered 2010-2013 (N = 1972)

	Refill†			Reversal†		
	AOR	**95% CI**	**P-Value**	**AOR**	**95% CI**	**P-Value**
Age	1.01	(1.00, 1.02)	0.125	1.00	(0.99, 1.02)	0.620
Gender						
Male	-	-	-	-	-	-
Female	0.81	(0.64, 1.02)	0.073	0.96	(0.70, 1.33)	0.825
Transgender/other	0.76	(0.32, 1.81)	0.533	1.27	(0.42, 3.84)	0.666
Race						
European background / white	-	-	-	-	-	-
African American	0.63*	(0.45, 0.88)	0.007	0.62	(0.37, 1.03)	0.063
Latino	0.65*	(0.43, 1.00)	0.050	0.58	(0.31, 1.09)	0.091
Mixed/other race	1.51*	(1.07, 2.11)	0.018	1.13	(0.70, 1.82)	0.614
Homeless	1.14	(0.90, 1.44)	0.280	0.95	(0.69, 1.30)	0.734
Prior overdose	1.03	(0.82, 1.31)	0.775	1.14	(0.83, 1.57)	0.411
Witnessed overdose	2.02*	(1.53, 2.66)	<0.001	2.73*	(1.73, 4.30)	<0.001
Use heroin	1.85*	(1.44, 2.37)	<0.001	2.19*	(1.54, 3.13)	<0.001
Use methadone	1.22	(0.96, 1.56)	0.109	0.99	(0.71, 1.37)	0.934
Use benzodiazepines	1.14	(0.87, 1.51)	0.340	1.35	(0.94, 1.94)	0.108
Use other opioids	1.18	(0.92, 1.52)	0.201	1.25	(0.89, 1.75)	0.203
Use cocaine/crack	0.15	(0.92, 1.52)	0.187	1.04	(0.74, 1.46)	0.833
Use alcohol	0.82	(0.65, 1.03)	0.094	0.72*	(0.52, 1.00)	0.049
Use methamphetamine	1.71*	(1.37, 2.15)	<0.001	1.61*	(1.18, 2.19)	0.003
Use other drugs	1.00	(0.75, 1.32)	0.978	0.97	(0.66, 1.43)	0.875

† All considered refills and reversals occurred between January 1, 2010 and December 31, 2013.

* $P \leq 0.05$

Table 4

Zero-inflated multiple Poisson regression models predicting naloxone refill and reversal counts among DOPE Project participants registered 2010-2013 (N = 1972)

	Refill Countt			Refill Count Inflate Componentt		
	IRR	**95% CI**	**P-Value**	**Coefficient**	**95% CI**	**P-Value**
Age	0.98*	(0.98, 0.99)	<0.001	−0.03*	(−0.04, −0.01)	<0.001
Gender						
Male	-	-	-	-	-	-
Female	1.11	(0.97, 1.28)	0.132	0.29*	(0.01, 0.57)	0.040
Transgender/other	0.90	(0.48, 1.68)	0.745	0.32	(−0.79, 1.43)	0.577
Race						
European background / white	-	-	-	-	-	-
African American	0.97	(0.75, 1.26)	0.831	0.62*	(0.20, 1.05)	0.004
Latino	1.33*	(1.05, 1.69)	0.019	0.67*	(0.19, 1.15)	0.006
Mixed/other race	0.84	(0.69, 1.03)	0.095	−0.60*	(−1.06, −0.15)	0.010
Homeless	1.24*	(1.07, 1.45)	0.005	0.06	(−0.24, 0.35)	0.711
Prior overdose	1.22*	(1.07, 1.41)	0.004	0.05	(−0.23, 0.33)	0.732
Witnessed overdose	0.96	(0.81, 1.15)	0.683	−0.70*	(−1.02, −0.38)	<0.001
Use heroin	1.30*	(1.09, 1.54)	0.003	−0.62*	(−0.93, −0.31)	<0.001
Use methadone	0.83*	(0.71, 0.96)	0.013	−0.30	(−0.61, 0.01)	0.055
Use benzodiazepines	0.93	(0.80, 1.09)	0.389	−0.28	(−0.62, 0.06)	0.110
Use other opioids	1.05	(0.90, 1.22)	0.535	−0.16	(−0.47, 0.15)	0.321
Use cocaine/crack	1.09	(0.94, 1.27)	0.240	−0.08	(−0.39, 0.23)	0.601
Use alcohol	0.93	(0.80, 1.07)	0.298	0.21	(−0.08, 0.49)_	0.158
Use methamphetamine	1.83*	(1.57, 2.13)	<0.001	−0.36*	(−0.64, −0.08)	0.011
Use other drugs	0.79*	(0.66, 0.95)	0.012	−0.10	(−0.46, 0.25)	0.563

	Reversal Count†			Reversal Count Inflate Component†		
	IRR	**95% CI**	**P-Value**	**Coefficient**	**95% CI**	**P-Value**
Age	0.99	(0.98, 1.01)	0.432	−0.01	(−0.03, 0.00)	0.133
Gender						
Male	-	-	-	-	-	-
Female	1.31	(0.95, 1.81)	0.105	0.20	(−0.20, 0.61)	0.328
Transgender/other	0.92	(0.28, 2.97)	0.884	−0.20	(−1.60, 1.19)	0.776
Race						
European background / white	-	-	-	-	-	-
African American	1.49	(0.83, 2.65)	0.180	0.88*	(0.23, 1.53)	0.008

	Reversal Count†			Reversal Count Inflate Component†		
	IRR	**95% CI**	**P-Value**	**Coefficient**	**95% CI**	**P-Value**
Latino	1.56	(0.93, 2.61)	0.094	0.91*	(0.19, 1.63)	0.013
Mixed/other race	1.75*	(1.16, 2.65)	0.008	0.25	(−0.31, 0.81)	0.383
Homeless	0.84	(0.61, 1.16)	0.297	0.00	(−0.41, 0.41)	0.994
Prior overdose	1.29	(0.94, 1.76)	0.114	0.01	(−0.40, 0.42)	0.955
Witnessed overdose	1.33	(0.82, 2.15)	0.248	−0.86*	(−1.44, −0.29)	0.003
Use heroin	1.61*	(1.05, 2.47)	0.028	−0.62*	(−1.11, −0.13)	0.013
Use methadone	0.96	(0.70, 1.30)	0.789	0.08	(−0.35, 0.50)	0.727
Use benzodiazepines	1.00	(0.68, 1.47)	0.996	−0.40	(−0.89, 0.08)	0.105
Use other opioids	1.07	(0.76, 1.51)	0.701	−0.23	(−0.68, 0.22)	0.312
Use cocaine/crack	0.81	(0.58, 1.14)	0.230	−0.12	(−0.57, 0.32)	0.589
Use alcohol	0.84	(0.61, 1.16)	0.295	0.27	(−0.15, 0.69)	0.203
Use methamphetamine	1.61*	(1.18, 2.19)	0.003	−0.31	(−0.71, 0.09)	0.132
Use other drugs	0.85	(0.57, 1.25)	0.412	−0.06	(−0.57, 0.45)	0.816

† All considered refills and reversals occurred between January 1, 2010 and December 31, 2013.

* $P \leq 0.05$