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Individual and social network correlates of responding to multiple overdoses among a cohort of people who use drugs

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Abstract

Background: The purpose of this study was to identify characteristics of people who respond to two or more overdoses (i.e., multiple overdose responders; MOR) compared to those who respond to zero or one, and the association between MOR status and changes in network size.

Methods: Secondary analysis of data from a randomized trial among 199 PWUD in Baltimore, MD (2016–2019). We used cross-tabulation, χ^2 , and ANOVA models to identify cross-sectional associations between overdose response and demographic, drug use, and network size; and ANCOVA models to examine the relationship between baseline MOR status and change in network size.

Results: From the cohort of 199, 185 people provided data on overdose response at baseline; 197 provided data at 6-month follow-up. At baseline, 27.6% of participants were classified as MORs (ever). Correlates of MOR status included homelessness; age; injecting drug use; quality of interactions with police (respectful vs. not); and use of powder cocaine, prescription opioids, and heroin. MORs had larger networks and their network size decreased more over time, but the

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Contributors

We use the CRediT Taxonomy to describe authorship contributions:

KDW: Conceptualization, Methodology, Supervision, Writing

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CL: Conceptualization, Funding Acquisition, Supervision, Writing

OOF-N: Conceptualization, Writing

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Conflict of Interest

None to declare.

CRediT authorship contribution statement

Karla D. Wagner: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Charles Marks:** Formal analysis, Methodology, Writing – review & editing. **Marisa Felsher:** Formal analysis, Methodology, Writing – review & editing. **Carl Latkin:** Conceptualization, Funding acquisition, Supervision, Writing – review & editing. **Oluwaseun O Falade-Nwulia:** Conceptualization.

association was not statistically significant. At follow-up, 16% were classified as MORs (past 6 months); correlates of follow-up MOR status were similar to those at baseline.

Conclusions: Overdose prevention interventions rely on PWUD to respond to overdoses. Identifying factors associated with MOR status could increase intervention efficiency and providing MORs with support could increase sustainability. Our findings suggest that PWUD experiencing homelessness, using cocaine and heroin, and demonstrating increased salience of overdose in their lives would benefit from targeted programs.

Keywords

Naloxone; Overdose prevention; People who use drugs; Social networks; Baltimore

1. Introduction

Overdose education and naloxone distribution programs (OEND) provide training about overdose prevention, recognition, and response for people who use drugs (PWUD) and can reduce opioid overdose mortality (Albert et al., 2011; Walley et al., 2013). The success of OEND programs depends upon PWUD's willingness to provide emergency medical treatment for overdose victims in the form of administering naloxone, calling 911, and providing rescue breathing until help arrives (Faulkner-Gurstein, 2017). Getting naloxone into the hands of trained people who are most likely to encounter someone experiencing an overdose is an enduring challenge of naloxone training and distribution programs.

Correlates of carrying and using naloxone to respond to overdoses include being female (Tobin et al., 2018), current opioid use (Buresh et al., 2020), homelessness (Reed et al., 2019), using a syringe access program (Buresh et al., 2020; Reed et al., 2019), and having recent encounters with police (Reed et al., 2019). Those with recent involvement in substance use disorder treatment had higher odds of possessing and administering naloxone in one Baltimore, MD-based study (Buresh et al., 2020), though qualitative work in San Diego, CA suggests that people living at sober living facilities may be hesitant to carry naloxone due to its symbolic link to a drug-using identity (Bowles et al., 2021). Substance use stigma has also been identified as a barrier to carrying naloxone in other qualitative work (Bennett et al., 2020).

While existing data provide some hint about the characteristics of PWUD who carry and use naloxone, much less is known about the characteristics of those who *continue* to serve in the role of overdose responder over time. Between 5% – 40% of PWUD trained to respond to overdoses report responding to multiple overdoses over relatively short periods of time (Dettmer et al., 2001; Spear et al., 2018; Strang et al., 2008). Several attributes might characterize people who take up the role of multiple overdose responder (MOR). They may have greater exposure to overdoses via experiences of homelessness, have larger networks, or live in geographic areas with a large number of PWUD (Bennett et al., 2020 ; Bowles and Lankenau, 2019; Reed et al., 2019). Assuming roles or identities such as needle sellers or hit doctors (i.e., those who help others inject) could also increase risk for responding to multiple overdoses. (Bowles and Lankenau, 2019; Fairbairn et al., 2006) Finally, personal experiences such as experiencing a non-fatal overdose or responding to a close friend's

overdose may increase the importance of overdose response for some individuals (Bowles et al., 2020; Wagner et al., 2014; Wagner et al., 2019; Wagner et al., 2021). Positive effects of OEND training and overdose response such as empowerment and pride may provide reinforcement for responders to continue in that role (McAuley et al., 2018; Wagner et al., 2014; Wagner et al., 2010). However, responding to overdoses and losing friends to overdose death can also result in stress, burnout, grief, and trauma, causing other individuals to withdraw from their role as an overdose responder (Bardwell et al., 2019; Dechman, 2015; Kolla and Strike, 2019; McAuley et al., 2018; Shearer et al., 2018; Wagner et al., 2014). In addition, having (or fearing) negative interactions with law enforcement at the scene of an overdose may result in some PWUD refusing to continue in the role or cutting ties with people who overdose frequently to reduce their own exposure to overdoses and resulting law enforcement interventions (Bowles et al., 2020).

Because the life-saving potential of OEND programs requires that people most likely to witness overdoses (i.e., PWUD) are present and willing to help when an overdose occurs, identifying those who respond to multiple overdoses could bolster program sustainability by ensuring that the most appropriate people within drug using networks are trained and equipped with naloxone. Using existing data from a cohort study of PWUD, the primary purpose of this study was to identify characteristics of people who respond to multiple overdoses. Based on previous qualitative research suggesting that overdose responders cut social ties with people who overdose frequently to protect themselves from negative emotional and legal repercussions of responding to multiple overdoses (Bowles et al., 2021; Bowles et al., 2020; Wagner et al., 2013), a secondary purpose was to quantitatively examine the association between being a MOR at baseline and changes in social network size over the follow-up period.

2. Methods

2.1. Setting

Baltimore, MD is a large city characterized by high rates of heroin use and opioid overdose. In 2018, Baltimore City had the highest overdose death rate in the US (Dayton et al., 2021). Naloxone distribution began in 2004, through the Staying Alive program offered by the Baltimore City Health Department (Tobin et al., 2008). Since 2015, the city has a standing order facilitating jurisdiction-wide naloxone distribution.

2.2. Study Design and Sample

Data come from two consecutive observations spaced six months apart from a prospective randomized trial to enhance hepatitis C and HIV prevention and care among PWUD residing in impoverished neighborhoods in Baltimore, MD. Participants were recruited through street-based outreach, word-of-mouth, flyers, advertisements in local newspapers, and community agency referrals. Study participants were recruited from December 2016 to March 2019 (Dayton et al., 2019). PWUD were included if they were 18 years or older, had a positive HCV antibody test, had a lifetime history of injection drug use (i.e., ever injected), and provided informed consent to enroll in the trial. Participants were encouraged to recruit network members who were drug use and/or sexual partners to join

the study. Participants completed interviews at baseline and six months follow-up, and were compensated \$20 for each interview. The study itself did not provide OEND training or naloxone. The institutional review board at Johns Hopkins University provided approval of all study procedures.

2.3. Measures

2.3.1. Individual-level measures—We defined baseline MOR status using data from the baseline visit. This was assessed with the question, “How many times have you used Narcan to reverse an opiate overdose?” Participant responses were categorized as 0, 1, or 2 + overdose responses. At follow-up, participants were asked how many times they had used Narcan to reverse an opiate overdose in the past six months. We defined follow-up MOR status as 0, 1, or 2 + overdose responses reported at follow-up.

At baseline, participants reported sociodemographic information such as: sex assigned at birth (male or female), race (Black, White or Other), age (in years), education (categorized as did not complete high school, high school/GED equivalent, or some college or more) and whether or not they are currently homeless.

At baseline and 6-month follow-up, we also assessed the number of ODs experienced and witnessed over the respondent’s lifetime (baseline) and past six months (follow-up). Participants also reported drug use information including: frequency of injecting drugs alone (response options included *never*, *rarely*, *sometimes* or *always*); how worried they are about overdosing (response options included *not worried at all*, *just a little worried*, *quite a bit worried*, or *very worried*); and how worried they are about a peer overdosing (response options included *not worried at all*, *just a little worried*, *quite a bit worried*, or *very worried*). Participants reported whether they had used prescription opiates, heroin, crack, or cocaine in the past 6 months *to get high* (response options: *no* or *yes*). Lastly, participants reported how often they carried naloxone (response options included *never*, *rarely*, *sometimes*, *often*, *always*), and whether they had been trained to use naloxone (response options *no* or *yes*). While none of the study assessments included a measure of recent interactions with law enforcement, participants reported degree of agreement with the statement “police treat me with respect” (response options *police treat me with respect*, *neutral*, *police do not treat me with respect*; dichotomized as *police treat me with respect/neutral* vs. *police do not treat me with respect*). We include this measure as a general proxy for positive and negative experiences with law enforcement.

2.3.2. Social network-level measures—At baseline and the 6-month follow-up surveys, participants listed the first names of network members who provided them advice, who pitched in to help do things, who loaned them money, to whom they entrusted with their money, and with whom they socialized, in the past 6 months. Participants were then asked to indicate if they had used drugs with any of the listed network members in the past 6 months. Network size was calculated as the total number of network members listed by survey respondents at baseline and at 6-month follow up, in terms of both the overall network and the sub-network of drug use partners. We calculated changes in network size

between baseline and follow up by subtracting the measure at follow up from the measure at baseline.

2.4. Analysis

The total sample for the parent study was 199 people. These analyses were restricted to participants who provided complete information for all variables of interest on both the baseline and follow up surveys, yielding an analytic sample of 185 at baseline and 197 at follow-up (overdose response behavior data were missing for 12 people at baseline and non-missing for those individuals at follow-up). All analyses were performed using R version 3.6.1. To identify personal characteristics of being a MOR, we used cross-tabulation, χ^2 , and ANOVA to identify bivariate associations between baseline and follow-up MOR status and demographic factors, drug use, and network size.

To test our hypothesis that being an MOR is associated with prospective changes in network size, we examined the relationship between baseline MOR status (0 [referent], 1, and 2+) and change in personal social network size over the follow-up period, using two outcomes in this analysis: 1) change in overall network size from baseline to follow-up; and 2) change in drug network size from baseline to follow-up. We fit two ANCOVA models corresponding to each outcome, specifying the dependent variable as network size at follow-up, the primary independent variable as baseline MOR status, and including baseline network size as a covariate.

3. Results

3.1. Demographics, drug use, and law enforcement experiences associated with baseline overdose response

One hundred and ninety-nine people were enrolled in the study. Of those, 185 participants provided data about their history of overdose response at baseline. Table 1 shows demographics, drug use, overdose response behavior, and network characteristics at baseline, comparing those who reported responding to 0 (never responders), 1 (one-time responders), or 2+ overdoses in their lifetime (MORs). Just over one-quarter (27.6%) of participants were classified as lifetime MORs, 12% as one-time responders, and 60% as never responders. The mean number of overdose responses in the MOR group was 4.53 (sd 3.58), the median number was 3, and the maximum number of reported responses was 20.

Bivariate comparisons demonstrated statistically significant associations with several demographic, drug use, and law enforcement experience variables. The prevalence of recent homelessness at baseline was over 60% among the one-time and MOR groups, compared to 44% of the never responder group ($p = 0.055$). Baseline one-time responders were younger (40.5 years old) than never responders (49.3 years old) or MORs (47 years old; $p = 0.001$). At baseline, MOR and one-time responder groups reported more injection drug use (78.3% & 78.4% vs 55%; $p = 0.005$), powder cocaine use (73.9 & 58.8 vs 30.0; $p < 0.001$), prescription opioid use (26.1% & 25.5% vs 12.7%; $p = 0.08$), and heroin use (82.6% & 88.2% vs 67.6%; $p = 0.012$) in the prior six months compared to never responders. Approximately half of the MOR and one-time responder groups reported that they felt that

police treated them with respect, compared to 69.1% of the never responder group ($p = 0.048$).

3.2. Naloxone and overdose at baseline

Baseline MORs had, on average, witnessed more overdoses in their lifetime (12.3) than both one-time responders (7.3) and never responders (8.9), though this association was not statistically significant ($p = 0.581$). People in the baseline MOR and one-time responder groups reported personally overdosing 4.4 times in their lifetimes, compared to 2.4 times by people in the never responder group ($p = 0.022$). Nearly 59% of the baseline reported “Often” or “Always” carrying naloxone compared to 43.5% of the one-time responders and 4.5% of the never responders ($p < 0.001$). Everyone in the baseline one-time responder group and 83.0% in the baseline MOR group reported knowing how to help someone who was overdosing, compared to just 48.6% of those in the never responder group ($p < 0.001$). Relatedly, 96.1% of the baseline MOR group and 82.6% of the one-time responder group reported ever being trained to use naloxone compared to 44.1% of the never responder group ($p < 0.001$).

3.3. Network size

People in the baseline MOR group had a larger average network size (8.2 people) than people in both the one-time responder (6.5 people) and never responder groups (6.9 people; $p = 0.078$). The baseline MOR group also reported the largest average drug network size (3.0 people), followed by the one-time responder group (2.7 people), and the never responder group (1.8 people; $p = 0.003$). From baseline to follow-up, the baseline MOR group reported that, on average, their overall network size decreased by 1.00 person and their drug network size decreased by 1.3 person. The baseline one-time responder group reported that, on average, their overall network size decreased by 0.04 people while their drug network size decreased by 0.74 people. The baseline never responder group reported that their overall network size increased, on average, by 0.13 people while their drug network size shrunk by 0.49 people. After adjusting for baseline network size, baseline MOR status was not significantly associated with changes in overall network size ($F(2,181) = 0.92, p = 0.4$) nor drug network size ($F(2,181) = 0.36, p = 0.69$) at follow-up.

3.4. Demographics, drug use, and law enforcement experiences associated with overdose response at follow-up

Table 2 shows factors associated with responding to overdoses at follow-up. Twelve individuals who did not provide baseline overdose response data did report follow-up overdose response data, increasing the sample size for these analyses to 197. Thirty-two people (16.2%) were categorized as MORs during the 6-month follow-up period, 24 (12.2%) as one-time responders, and 141 (71.6%) as never responders. Nearly half of the people characterized as MORs at baseline (20/51; 40%) were also categorized as MORs at follow-up, suggesting that a meaningful share continued to engage in overdose responses over time. Importantly, 21.7% of baseline one-time responders and 6.4% of baseline never responders ($p < 0.001$; data not shown) responded to multiple overdoses during the follow-up period.

The only demographic factor associated with any overdose response behavior at follow-up was education: 14.9% of never-responders had more than a high school education, compared to 29.2% of one-time responders and 21.9% of MORs. Similar to findings at baseline, use of powder cocaine ($p = 0.056$) and heroin ($p = 0.032$) was associated with overdose response behavior, though injecting drug use and prescription opioids was not. The measure of experiences with law enforcement achieved a marginally statistically significant association with overdose response behavior at follow up ($p = 0.065$).

3.5. Naloxone and overdose at follow-up

In terms of naloxone and overdose measures, statistically significant correlates of overdose response behavior at follow-up included frequency of carrying naloxone ($p < 0.001$), knowing how to help ($p = 0.003$), and reporting more experiences of administering naloxone in one's lifetime ($p = 0.003$). All associations operated in the same direction as baseline overdose response behavior.

4. Discussion

The purpose of this study was to identify characteristics of people who respond to multiple overdoses. At baseline, MORs had a higher prevalence of homelessness and larger overall social networks and drug networks compared to never responders. People who are experiencing homelessness and living in street-based communities, shelters, or other similar settings and people with larger social networks may simply have a higher probability of witnessing overdoses and be available to respond more often. MORs were similar to one-time responders, but differed from never responders, in their higher prevalence of powder cocaine, heroin, and prescription drug use, and prevalence of injecting drug use. This suggests different drug use patterns, which may also indicate the extent to which MORs are embedded in drug-using networks where overdoses occur. These findings reinforce the imperative that naloxone distribution is targeted towards those most likely to witness overdoses, and suggest that people who are homeless, have larger networks, and use injection drugs (especially heroin and stimulants) should be prioritized for initial distribution and consistent refills when naloxone is used (Kinnard et al., 2021). Since most of our respondents at both baseline and 6-month follow-up were characterized as 'never' responders, these findings also suggest a need for more research to understand their reasons for not responding, and additional efforts to ensure that PWUD who want to be trained as overdose responders are afforded the opportunity to do so.

MORs also more frequently reported being trained in overdose response and carrying naloxone, experienced more overdoses themselves, and appeared more worried about their friends overdosing. Nearly half of those who had responded to more than two overdoses at baseline responded to two or more during the next six months. These findings suggest that overdose response may have more personal salience for some people, which translates into more frequent response to witnessed overdoses. Of note, the correlates do not consistently demonstrate a trend from 0 to 1 to 2+ responses. On some variables, one-time responders appeared more similar to never responders (e.g., age), while on others (e.g., homelessness) they appeared more similar to MORs. One-time responders also had the highest prevalence

of cocaine use across the three groups. This suggests that there might be unique experiences among people who respond to only one overdose (and then do not do it again) that should be investigated to determine whether opportunities exist to re-engage them in overdose response after their initial experience.

Relatedly, identifying those who continue to respond in the role of MOR could bolster the capacity of networks to respond. However, given the growing body of literature quantifying the burden of grief and trauma among those who respond to overdoses (Bardwell et al., 2019; Dechman, 2015; Kolla and Strike, 2019; McAuley et al., 2018; Shearer et al., 2018; Wagner et al., 2014), MORs should be prioritized for social and emotional support to ensure their continued wellbeing. These programs could take the form of trauma-informed care programs and support for those who witness and respond to overdoses, and realistic training scenarios that allow sufficient time for practicing overdose response and priming trainees for potential negative experiences (Wagner et al., 2014). This recommendation is bolstered by the broader literature on peer-support interventions, which suggests that peers are rendered vulnerable to negative outcomes as a result of their work, and require both emotional and financial support to continue in this important role (Kennedy et al., 2019; Miler et al., 2020).

We also examined the relationship between MOR status and changes in network size, motivated by prior research suggesting that MORs “cut ties ” with people who overdose frequently (Bowles et al., 2021; Bowles et al., 2020; Wagner et al., 2013). While we found initial differences in network size, after adjusting for baseline network size these differences did not persist, possibly because we were underpowered to detect an association. Given the suggestion from qualitative data that PWUDs who respond to overdose deliberately change their social networks, future research should endeavor to more accurately characterize this phenomenon. One avenue for future research is to more accurately characterize network turnover as a result of overdose deaths, incarceration, changes in drug use, or initiation of substance use disorder treatment.

Importantly, providing social and emotional support for PWUD who voluntarily assume the role of MOR should not be a substitute for structural reforms. PWUD who respond to overdoses fear the legal and social consequences that can be incurred by calling 911. 911 Good Samaritan Laws have failed to ameliorate this concern (J. Bowles et al., 2020; Koester et al., 2017), and newer policies such as drug induced homicide laws, which prosecute individuals who sell or deliver drugs linked to an overdose death, appear to be further deterring PWUD from responding to overdoses (Carroll et al., 2021). Our analyses showed that being treated with respect by police was associated with overdose response behaviors in a manner that is consistent with these observations. Policy changes such as expanding 911 Good Samaritan laws to protect people against more significant charges, restricting the use of drug-induced homicide laws, and separating law enforcement from emergency medical response will be required to ensure that communities are protected from opioid overdose deaths and the collateral harms associated with managing them from within.

4.1. Limitations

Our findings should be considered in light of some limitations. This cohort, which comprised HCV-antibody positive people with a history of injecting drug use, was

recruited in Baltimore, MD. Baltimore has had a robust naloxone distribution infrastructure since 2004 and communitywide standing orders facilitating naloxone access since 2015. Therefore, not only have PWUDs in Baltimore had a longer exposure to naloxone (and therefore a longer amount of time to respond to overdoses using naloxone), the social and policy environment is likely quite different than in communities where OEND programs are more recently introduced. Generalizability of our findings may therefore be limited. Finally, our data were collected from 2016 – 2019, during a time when fentanyl adulteration of the illicit heroin market was emerging. We only assessed self-reported heroin use and have no data on the prevalence of illicitly manufactured fentanyl adulterants that may have been consumed by our participants.

Ours was a secondary analysis of data collected for different purposes, therefore some measures employed here were not optimal for our purposes. For example, the measure of drug and network size were elicited using name generators that asked for people who provide support, then we asked behaviors with those people. Therefore, people's whole drug using networks could be larger than what was reported here, if they had drug use partners who were not named as support providers. Our measure of overdose response specified "responded with naloxone", which may have under estimated the true number of overdose responses by undercounting those in which naloxone was not administered, but other rescue attempts were made. Also, the measure of overdose response at baseline assessed lifetime overdose responses, while the measure at follow-up only included responses in the past 6 months, which is a relatively short amount of time. We do not have the dates when the overdoses occurred; it is possible that the overdoses reported at baseline happened many years ago, possibly before naloxone was widely available and potentially long enough ago that the event is no longer salient for our respondents. Future research should examine both the long-term and more proximal effects of responding to overdoses. Nonetheless, our findings present some preliminary evidence for differences among PWUD that could help tailor OEND interventions to identify and support those most likely to engage in lifesaving overdose responses.

5. Conclusions

OEND is an intervention that relies on networks of PWUD to witness and respond to overdoses among their members. Identifying factors associated with responding to multiple overdoses over time could increase the efficiency of OEND interventions, while providing those individuals with sufficient support could increase their sustainability. Our findings suggest that PWUD experiencing homelessness, using cocaine and heroin, and demonstrating increased salience of overdose in their lives would benefit from targeted programs that provide initial OD response training and sustained support for those who continue responding.

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Abbreviations:

OEND	Overdose Education and Naloxone Distribution
PWUD	People Who Use Drugs
OD	Overdose
MOR	Multiple Overdose Responder

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Baseline characteristics stratified by number of overdoses responded to with naloxone at baseline (*n* = 185).

Table 1

	Ever responded to OD with naloxone at Baseline			p
	Never 111 (60.0%)	Once 23 (12.4%)	2+ 51 (27.6%)	
Demographic Characteristics				
Sex: Male (ref: female)	69 (62.7)	12 (52.2)	31 (62.0)	0.634
Age (years, mean (SD))	49.3 (9.4)	40.5 (9.1)	47.0 (11.1)	0.001
Race				
Black or African American	72 (65.5)	10 (43.5)	26 (52.0)	0.152
White	36 (32.7)	13 (56.5)	22 (44.0)	
Other or mixed or multi-racial	2 (1.8)	0 (0.0)	2 (4.0)	
Education				
Didn't Graduate High School	52 (46.8)	10 (43.5)	21 (41.2)	0.938
High School/GED	41 (36.9)	8 (34.8)	20 (39.2)	
More Than High School	18 (16.2)	5 (21.7)	10 (19.6)	
Homeless (past 6 months)	49 (44.1)	14 (60.9)	32 (62.7)	0.055
Currently in a relationship	31 (27.9)	8 (34.8)	16 (31.4)	0.771
Has health Insurance	102 (92.7)	19 (82.6)	48 (94.1)	0.214
Drug Use Information				
Past 6 months drug use to get high (check all that apply)				
Cannabis	51 (45.9)	13 (56.5)	26 (51.0)	0.605
Crack	76 (68.5)	13 (56.5)	34 (66.7)	0.543
Powder Cocaine	33 (30.0)	17 (73.9)	30 (58.8)	<0.001
Rx Opioids	14 (12.7)	6 (26.1)	13 (25.5)	0.08
Heroin	75 (67.6)	19 (82.6)	45 (88.2)	0.012
Buprenorphine	7 (6.3)	3 (13.0)	5 (9.8)	0.489
Injection Drug Use past 6 months	61 (55.0)	18 (78.3)	40 (78.4)	0.005
How Often Inject Alone past 6 months				
Never	11 (18.0) ^a	1 (5.6)	6 (15.0)	0.176
Rarely	7 (11.5)	4 (22.2)	9 (22.5)	
Sometimes	6 (9.8)	4 (22.2)	7 (17.5)	

	Ever responded to OD with naloxone at Baseline				p
	Never III (60.0%)	Once 23 (12.4%)	2+ 51 (27.6%)		
Often	24 (39.3)	6 (33.3)	13 (32.5)		
Always	13 (21.3)	1 (5.6)	2 (5.0)		
Law Enforcement Measure					
Police Treat Me with Respect/neutral (ref: do not treat me with respect)	76 (69.1)	11 (47.8)	27 (52.9)		0.048
Baseline Naloxone and Overdose Measures					
How Many of the People That You Know Ever Overdosed					
Less Than Half	79 (74.5)	14 (66.7)	30 (60.0)		0.176
At Least Half	27 (25.5)	7 (33.3)	20 (40.0)		
Frequency of carrying naloxone					
Never	75 (67.6)	7 (30.4)	4 (7.8)		< 0.001
Rarely/Sometimes	31 (27.9)	6 (26.1)	17 (33.3)		
Often/Always	5 (4.5)	10 (43.5)	30 (58.8)		
Frequency of talking with others about OD					
Never	11 (9.9)	0 (0.0)	7 (13.7)		0.197
Rarely	34 (30.6)	5 (21.7)	12 (23.5)		
Sometimes	40 (36.0)	12 (52.2)	14 (27.5)		
Often	26 (23.4)	6 (26.1)	18 (35.3)		
# of ODs Witnessed Lifetime (mean (SD))	8.9 (29.6)	7.3 (11.1)	12.3 (9.2)		0.581
# of ODs Experienced Lifetime (mean (SD))	2.4 (4.02)	4.4 (7.26)	4.4 (4.76)		0.022
Know How to Help someone having an OD (ref: doesn't know)	51 (48.6)	23 (100.0)	39 (83.0)		< 0.001
Wants to be able to help someone having an OD (ref: doesn't want to be able help or neutral)	108 (97.3)	23 (100.0)	49 (96.1)		0.629
Ever Trained to Use Narcan	49 (44.1)	19 (82.6)	49 (96.1)		< 0.001
How Many Times Used Narcan Lifetime	0.0 (0.0)	1.0 (0.0)	4.5 (3.6)		< 0.001
Worried Friends Will OD					
Not at all worried	9 (8.3)	4 (19.0)	0 (0.0)		0.097
Just a little worried	13 (11.9)	3 (14.3)	9 (18.8)		
Quite a bit worried	34 (31.2)	3 (14.3)	16 (33.3)		
Very worried	53 (48.6)	11 (52.4)	23 (47.9)		
Baseline Network Size and Change in Network Size at Follow-Up					
Baseline Network Size (mean (SD))	6.90 (3.56)	6.52 (3.55)	8.22 (4.24)		0.078

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	Ever responded to OD with naloxone at Baseline			p
	Never 111 (60.0%)	Once 23 (12.4%)	2+ 51 (27.6%)	
Baseline Drug Network Size (mean (SD))	1.80 (1.88)	2.70 (2.95)	3.02 (2.42)	0.003
Change in Network Size (mean (SD))	0.13 (3.11)	-0.04 (2.60)	-1.00 (3.51)	0.109
Change in Drug Network Size (mean (SD))	-0.49 (1.86)	-0.74 (1.89)	-1.27 (2.81)	0.103

^aDenominator is number of people who reported injection drug use in previous 6 months.

Baseline characteristics stratified by number of overdoses responded to with naloxone over the six-month follow-up period (*n* = 197).

Table 2

	Responded to OD with naloxone Over Follow-Up				p
	No 141 (71.6%)	Once 24 (12.2%)	2+ 32 (16.2%)		
Demographic Characteristics (Baseline)					
Sex: Male (ref: female)	89 (63.1)	13 (54.2)	20 (62.5)		0.704
Age (mean (SD))	48.7 (10.5)	44.6 (11.34)	48.0 (9.1)		0.202
Race					
Black or African American	92 (65.2)	10 (41.7)	19 (59.4)		0.179
White	46 (32.6)	14 (58.3)	12 (37.5)		
Other or mixed or multi-racial	3 (2.1)	0 (0.0)	1 (3.1)		
Education					
Didn't Graduate High School	75 (53.2)	8 (33.3)	7 (21.9)		0.009
High School/GED	45 (31.9)	9 (37.5)	18 (56.2)		
More Than High School	21 (14.9)	7 (29.2)	7 (21.9)		
Homeless (past 6 months)	64 (45.4)	15 (62.5)	19 (59.4)		0.148
Currently in a relationship	40 (28.4)	4 (16.7)	13 (40.6)		0.142
Has health insurance	128 (90.8)	24 (100.0)	29 (93.5)		0.281
Drug Use Information at Follow-up					
Past 6 month drug use to get high (check all that apply)					
Cannabis	62 (44.0)	15 (62.5)	17 (53.1)		0.195
Crack	93 (66.0)	19 (79.2)	21 (65.6)		0.429
Powder Cocaine	54 (38.6)	13 (54.2)	19 (59.4)		0.056
Rx Opioids	26 (18.6)	6 (25.0)	6 (18.8)		0.759
Heroin	98 (69.5)	21 (87.5)	28 (87.5)		0.032
Buprenorphine	11 (7.8)	4 (16.7)	0 (0.0)		0.066
Injection Drug Use past 6 months	85 (60.3)	16 (66.7)	25 (78.1)		0.158
How Often Inject alone past 6 months					
Never	12 (8.5)	3 (12.5)	3 (9.4)		0.200
Rarely	13 (9.2)	0 (0.0)	6 (18.8)		
Sometimes	15 (10.6)	4 (16.7)	1 (3.1)		

	Responded to OD with naloxone Over Follow-Up			P
	No 141 (71.6%)	Once 24 (12.2%)	2+ 32 (16.2%)	
Often	27 (19.1)	7 (29.2)	10 (31.2)	
Always	12 (8.5)	2 (8.3)	4 (12.5)	
Law Enforcement Measure (Baseline)				
Police Treat Me with Respect/neutral (ref: do not treat me with respect)	47 (33.6)	14 (58.3)	13 (40.6)	0.065
Naloxone and Overdose Measures (Baseline)				
How Many People Know That OD'd at baseline				
Less Than Half	94 (70.7)	20 (83.3)	20 (62.5)	0.235
At Least Half	39 (29.3)	4 (16.7)	12 (37.5)	
Frequency of carrying naloxone at baseline				
Never	69 (53.5)	9 (39.1)	7 (21.9)	<0.001
Rarely/Sometimes	39 (30.2)	8 (34.8)	8 (25.0)	
Often/Always	21 (16.3)	6 (26.1)	17 (53.1)	
Frequency of talking with others about OD at baseline				
Never	11 (7.8)	6 (25.0)	3 (9.4)	0.288
Rarely	39 (27.7)	5 (20.8)	9 (28.1)	
Sometimes	54 (38.3)	7 (29.2)	10 (31.2)	
Often	37 (26.2)	6 (25.0)	10 (31.2)	
# of ODs Witnessed Lifetime (mean (SD)) at baseline	9.43 (26.90)	7.21 (6.04)	8.72 (6.54)	0.906
# of Times OD Lifetime (mean (SD)) at baseline	3.11 (4.86)	3.71 (5.42)	2.31 (3.20)	0.530
Know How to Help someone having an OD (ref: doesn't know)	73 (53.7)	14 (66.7)	26 (86.7)	0.003
Wants to be able to help someone having an OD (ref: doesn't want to be able help or neutral)	137 (97.2)	23 (95.8)	32 (100.0)	0.565
Ever Trained to Use Narcan	74 (57.4)	16 (69.6)	25 (78.1)	0.072
How Many Times Used Narcan Lifetime	1.0 (2.5)	1.7 (3.3)	2.8 (2.8)	0.003
Worried Friends Will OD				
Not at all worried	13 (10.0)	0 (0.0)	2 (6.5)	0.797
Just a little worried	17 (13.1)	4 (16.7)	5 (16.1)	
Quite a bit worried	39 (30.0)	8 (33.3)	10 (32.3)	
Very worried	61 (46.9)	12 (50.0)	14 (45.2)	
Network Size (Baseline)				
Baseline Network Size (mean (SD))	7.04 (3.73)	6.83 (3.12)	7.81 (4.33)	0.530

	Responded to OD with naloxone Over Follow-Up			P
	No 141 (71.6%)	Once 24 (12.2%)	2+ 32 (16.2%)	
Baseline Drug Network Size (mean (SD))	2.16 (2.35)	2.33 (2.01)	2.41 (1.85)	0.819
Overdose Response Variables at Follow-Up				
Frequency of carrying naloxone in the past 6 months				
Never	78 (55.3)	4 (16.7)	4 (12.5)	<0.001
Rarely	13 (9.2)	8 (33.3)	3 (9.4)	
Sometimes	28 (19.9)	4 (16.7)	4 (12.5)	
Often	11 (7.8)	4 (16.7)	6 (18.8)	
Always	11 (7.8)	4 (16.7)	15 (46.9)	
Witnessed an overdose in the past six months	36 (25.5)	19 (79.2)	29 (90.6)	<0.001

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