

Factors Associated With Calling 911 for an Overdose: An Ethnographic Decision Tree Modeling Approach

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Objectives. To identify factors that influence when people who use drugs (PWUDs) call 911 for an overdose.

Methods. We conducted 45 qualitative interviews and 180 surveys with PWUDs who had recently witnessed overdoses in Southern California from 2017 to 2019. We used conditional inference tree and random forest models to generate and validate a model to predict whether 911 would be called.

Results. Our model had good in- (83%) and out-of-sample (84%) predictive accuracy. Three aspects of the social and policy environment influenced calling 911 for an overdose: the effectiveness of response strategies employed, the behavior of other bystanders, and whether the responder believes it is their responsibility to call.

Conclusions. Even in the presence of policies that provide some protections, PWUDs are faced with difficult decisions about calling 911 and must weigh their own safety against that of an overdose victim. Potential interventions include strengthening training and safety planning for PWUDs, bolstering protections for PWUDs when they call 911, and separating law enforcement response from emergency medical response to overdoses. (*Am J Public Health.* 2021;111(7):1281–1283. <https://doi.org/10.2105/AJPH.2021.306261>)

Opioid overdose is a leading cause of death among people who use drugs (PWUDs).¹ Best practices for layperson opioid overdose response includes calling 911, giving rescue breathing, and administering naloxone.^{2,3} However, PWUDs often fear calling 911, particularly if law enforcement officers routinely attend overdoses.^{4,5} In the United States, “911 Good Samaritan Laws,” which provide nominal protections to 911 callers for minor drug-related offenses, have failed to overcome this barrier.^{4,6} As part of a larger study, we used ethnographic decision tree modeling⁷ to identify factors that predict when PWUDs call 911 for an overdose, with the goal of identifying intervention targets.

METHODS

Between February 2017 and May 2018, we conducted qualitative interviews with 45 PWUDs who had seen an overdose, recruited from San Diego County, California, using outreach, referrals, and flyers. Respondents were compensated \$40. Interviews were conducted in locations chosen by the respondents and used a semistructured guide to ask about the context of the most recently witnessed overdose. Interview transcripts were reviewed by 4 analysts, who created “decision trees” illustrating the events described in each interview using a series of branching if-then decision points. The trees were used to

develop a quantitative survey with 74 “yes or no” questions that captured each of the decision points, demographics, and circumstances related to overdoses. From February to December 2019, the survey was administered to 180 PWUDs who had recently been present at an overdose.

We applied a conditional inference tree (CTree⁸) model to accurately classify whether 911 would be called in 177 cases with complete survey data (R version 3.6.3 “ctree” function from “partykit” package [version 1.2-9; R Foundation for Statistical Computing, Vienna, Austria]). The top of the tree is based on the variable with the most significant bivariate association with calling 911; if the *P* value

is small, then CTree creates 2 lower nodes based on the answer. CTree next calculates bivariate P values among respondents within each bottom node and uses the same criterion ($P < .05$) to determine if a bottom node should be split again. CTree repeats this until no additional splits can be made. Finally, the tree breaks the sample into distinct subgroups, and 911 calls are predicted based on the proportion in the sample who called 911 within each subgroup. Almost everyone (94%) tried at least 1 method of waking up the victim, by giving naloxone, doing cardiopulmonary resuscitation or rescue breathing, injecting them with a stimulant or milk or water, or giving Suboxone (buprenorphine and naloxone). At least 1 of these things worked in 67% of cases. So, we combined the questions asking if respondents did any of these things and the questions asking whether it worked into a single independent variable representing whether “something was tried and worked” to wake the person. Missing data were ignored when building the tree and imputed when making predictions.

Because single trees often give predictions with large variability and can be inaccurate when used to predict outside the sample, we used an ensemble of classification trees (i.e., random forests⁹), which decreases variability and increases the accuracy of out-of-sample predictions compared with a single tree. We used a random forest algorithm (“randomForest” function in the R package “randomForest” version 4.6-14) to estimate the out-of-bag (OOB) accuracy, which provides an unbiased estimate of the expected predictive accuracy outside the sample. We present the results from this model along with 2 subanalyses that split the decision tree into additional subgroups based on larger P value cutoffs.

These subgroup analyses do not affect the in-sample predictive accuracy of the overall model, but they do identify additional variables that increase the random forest OOB accuracy and help explain cases in which 911 was not called.

RESULTS

In 43 of 177 (24.3%) cases, 911 was called (see Table A for descriptive statistics; available as a supplement to the online version of this article at <http://www.ajph.org>). Respondents were 68.6% male, 85.6% White, and 72.9% non-Hispanic/Latinx. Our CTree model correctly predicts 911 calling 83% of the time, using 4 variables: whether something was tried and worked to reverse the overdose, how many overdoses the respondent had seen, whether someone other than the respondent called 911, and whether there was a hospital nearby (Figure A, Part a, available as a supplement to the online version of this article at <http://www.ajph.org>). OOB accuracy was 82%.

When no response technique was attempted or worked, nobody else called 911, and there was not a hospital nearby, 911 was called 13 out of 16 times (81%). When there was a hospital nearby and none of the response techniques worked or was attempted, and nobody else called 911, 911 was called 3 out of 10 times (30%). When 1 of the response techniques was attempted and worked and the respondent had previously witnessed 13 or fewer overdoses in the past year, 911 was called 15% of the time. When 1 of the response techniques worked and the respondent had witnessed greater than 13 overdoses in the past year, 911 was called 5 out of 7 times (71%). When no response technique was attempted or worked but someone else called 911, the respondent called 911 in 5 out of 32 cases (16%).

The first subanalysis included additional subgroups based on a larger P value (Figure A, Part b, available as a supplement to the online version of this article at <http://www.ajph.org>). The in-sample predictive accuracy of this model remained 83%; OOB accuracy increased to 84%. This subanalysis revealed that when 1 of the response techniques was tried and worked and the respondent had witnessed 13 or fewer overdoses in the past year, respondents who did not believe it was their responsibility to call 911 did not do so (0/24), while respondents who believed it was their responsibility called 911 in 17 of 88 cases (19%). Feeling “responsible” often had to do with whether one was “in charge” of the location or scene where the overdose occurred.

The second subanalysis shows differences among those who believed it was their responsibility to call 911, determined by (1) whether someone else called 911, (2) whether there was a large amount of drugs at the scene, (3) if the respondent had a warrant, and (4) if the respondent had access to a phone (Figure A, Part c, available as a supplement to the online version of this article at <http://www.ajph.org>). Nearly 30% of those who had warrants but did not have a large amount of drugs at the scene called 911. The in-sample and OOB accuracy were equivalent (83% and 84%, respectively) to the previous models.

DISCUSSION

Three aspects of the social and policy environment predicted whether PWUDs call 911 for an overdose: the effectiveness of response strategies employed, the behavior of other bystanders, and whether the responder believed calling is their responsibility (and contextual issues

related to this (e.g., presence of drugs or warrants). These findings suggest that PWUDs engage in collective action to respond to overdoses. Recommendations include expanded naloxone distribution to ensure PWUD networks are sufficiently naloxone-saturated and that PWUDs have the skills to reverse overdoses. Advance safety planning, in which networks of PWUDs are encouraged to determine preferences and responsibilities for calling 911 in advance, might expedite decisions and improve network safety in the event that an overdose does occur. This work also highlights the need for stronger legal protections that ensure that PWUDs feel safe calling 911, bolsters support for efforts to separate law enforcement from medical responses for overdoses, and demonstrates the need to include PWUDs in intervention development.^{10,11} Limitations include an inability to generalize beyond the area where data were collected; these models should be tested in other samples to increase confidence in our conclusions. **AJPH**

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CONTRIBUTORS

K. D. Wagner conceptualized the analysis and wrote the original draft. K. D. Wagner, B. Koch, and R. Harding performed formal analysis. J. M. Bowles, S. R. Verdugo, R. Harding, and P. J. Davidson participated in conceptualization. K. D. Wagner and R. Harding contributed to project administration. K. D. Wagner, S. R. Verdugo, P. J. Davidson developed the study methodology. K. D. Wagner and P. J. Davidson acquired funding. J. M. Bowles and S. R. Verdugo collected the data. B. Koch, J. M. Bowles, S. R. Verdugo, R. Harding, and P. J. Davidson contributed to validation of analyses. R. Harding curated the data. All authors participated in writing, reviewing, and editing.

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CONFLICTS OF INTEREST

S. R. Verdugo is currently the medical director for FirstWatch Solutions Inc. FirstWatch is a company that creates technological solutions to manage and use real-time 911 data to inform emergency medical response. Before working at FirstWatch, S. R. Verdugo was a project coordinator on the NIH/NIDA-funded study related to this report. S. R. Verdugo conducted data collection and analysis related the larger study while she was employed as project coordinator for the NIH/NIDA-funded study. Her contributions toward the preparation of the current article occurred while she was employed by FirstWatch Inc. FirstWatch was compensated as a vendor to query 911 data for the larger NIH-funded studies related to this report, but has not contributed in any way to the development of the current article other than with salary support paid to S. R. Verdugo. K. D. Wagner and P. J. Davidson. These authors also have testified as unpaid invited experts (Davidson) and public comment (Wagner) on the topic of opioid overdose and naloxone availability for the US Food and Drug Administration, NIH, and other state and local governmental bodies.

HUMAN PARTICIPANT PROTECTION

The University of California, San Diego, Institutional Review Board approved all study activities. Respondents provided verbal informed consent using a script that described the study and the risks and benefits of participation. Because a signature would have been the only identifying information provided by participants, the study was granted a waiver of documentation of consent by the institutional review board.

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