HHS Public Access

Author manuscript

Int J Drug Policy. Author manuscript; available in PMC 2019 April 01.

Published in final edited form as:

Int J Drug Policy. 2018 April ; 54: 35–42. doi:10.1016/j.drugpo.2017.12.017.

Using Medical Examiner Case Narratives to Improve Opioid Overdose Surveillance

Emily Hurstak, MD, MPH, MAS[a], **Christopher Rowe, MPH**[b], **Caitlin Turner, MPH**[b], **Emily Behar, MA**[b], **Rachel Cabugao**[b], **Nikolas P. Lemos, MS, PhD**[c], and **Phillip Coffin, MD, M.I.A**[b]

[a]Division of General Internal Medicine, University of California, San Francisco, Zuckerberg San Francisco General Hospital and Trauma Center, San Francisco, CA, USA

[b]Substance Use Research Unit, San Francisco Department of Public Health, San Francisco, CA, USA

[c]Department of Laboratory Medicine, University of California, San Francisco, Zuckerberg San Francisco General Hospital and Trauma Center, San Francisco, CA, USA

Abstract

Background—Current opioid overdose mortality surveillance methods do not capture the complexity of the overdose epidemic. Most rely on death certificates, which may underestimate both opioid analgesic and heroin deaths. Categorizing deaths using other characteristics from the death record including route of drug administration may provide useful information to design and evaluate overdose prevention interventions.

Methods—We reviewed California Electronic Death Reporting System records and San Francisco Office of the Chief Medical Examiner (OCME) toxicology reports and investigative case narratives for all unintentional opioid overdose deaths in San Francisco County from 2006–2012. We chose this time period because it encompassed a period of evolution in local opioid use patterns and expansion of overdose prevention efforts. We created a classification system for heroin-related and injection-related opioid overdose deaths and compared demographic, death scene, and toxicology characteristics among these groups.

Results—We identified 816 unintentional opioid overdose deaths. One hundred fifty-two (19%) were standard heroin deaths, as designated by the OCME or by the presence of 6–monoacetylmorphine. An “expanded” classification for heroin deaths incorporating information from toxicology reports and case narratives added 20 additional heroin deaths (13% increase), accounting for 21% of all opioid deaths. Two hundred five deaths (25%) were injection-related,

Corresponding Author: Emily E. Hurstak, MD, MPH, MAS, UCSF/ZSFG Box 1364, San Francisco, CA 94143, Emily.hurstak@ucsf.edu, Emilyhurstak@gmail.com, Phone: (646) 509-5189, Fax: (415) 206-5586. Author for Back-up Correspondence: Phillip Coffin, MD, M.I.A., F.A.C.P., Community Health Equity and Promotion Branch, Population Health Division, San Francisco Department of Public Health, 25 Van Ness Avenue, Suite 500, San Francisco, CA 94102, Phillip.coffin@sfdph.org, (415) 437-6200.

Conflicts of Interest:

To the best of our knowledge, no conflict of interest, financial or other, exists.

60% of which were attributed to heroin. A combined classification of expanded heroin and injection-related deaths accounted for 31% of opioid overdose deaths during this period.

Conclusions—Using additional sources of information to classify opioid overdose cases resulted in a modest increase in the count of heroin overdose deaths but identified a substantial number of non-heroin injection-related opioid analgesic deaths. Including the route of administration in the characterization of opioid overdose deaths can identify meaningful subgroups of opioid users to enhance surveillance efforts and inform targeted public health programming including overdose prevention programs.

Keywords

Opioid Overdose; Injection Drug Use; Heroin; Prescription opioids; Death certificates

Introduction

Opioid overdose is a leading cause of death in the United States (Calcaterra, Glanz, & Binswanger, 2013; M. Warner, Chen, & Makuc, 2009; M. Warner, Chen, Makuc, Anderson, & Minino, 2011). In recent years, national opioid overdose surveillance data demonstrate that the types of opioids causing overdose are evolving (Rudd, Seth, David, & Scholl, 2016). While opioid analgesics were responsible for the rapid increase in overdose mortality during the 2000s, deaths due to heroin and synthetic opioids have been responsible for more recent increases (Calcaterra, et al., 2013; Peterson, et al., 2016; Rudd, et al., 2016). Existing opioid overdose surveillance strategies may not completely capture changing trends in opioid overdose. For example, fentanyl mixed with or sold as heroin or other prescription opioids increases the risk of overdose death, but is often difficult to identify using post-mortem toxicology and is inconsistently specified as a cause of death on death certificates (Gladden, Martinez, & Seth, 2016; Lung & Lemos, 2014; Rudd, et al., 2016; Somerville, et al., 2017).

When data are available, public health authorities track opioid overdose mortality by the type of opioid involved. Opioid types are extracted from International Classification of Disease (ICD) codes on death certificates (CDC, 2015), which may result in under-estimation or misclassification of specific opioid types (Jauncey, Taylor, & Degenhardt, 2005; Mertz, Janssen, & Williams, 2014; Ruhm, 2016). In addition, up to one quarter of death certificates with drug overdose listed as the cause of death do not include the specific drugs implicated (M Warner, Paulozzi, Nolte, Davis, & LS, 2013). In response to these limitations, epidemiologists and researchers have proposed more comprehensive overdose surveillance efforts relying on multiple data sources including cause of death registries, toxicology reports, autopsies, medical examiner reports, and prescription drug monitoring systems (Cone, et al., 2003; Hargrove, et al., 2017; Hirsch, Proescholdbell, Bronson, & Dasgupta, 2014; Landen, et al., 2003).

Death certificates are imperfect data sources for identifying specific causative drugs in overdose. In addition, they do not typically include information about the route of drug administration. Route of administration is notable because injection of opioids is associated with a higher risk of addiction and unintentional overdose (Black, Trudeau, Cassidy, Budman, & Butler, 2013; Darke & Hall, 2003; Liebling, Green, Hadland, & Marshall,

2017), and because people who inject drugs (PWID) may be qualitatively distinct from people who ingest opioids by means other than injection (Brugal, et al., 2002; Novak & Kral, 2011). Furthermore, interventions designed to reduce opioid overdose mortality tend to target populations that are not defined exclusively by the type of opioids that they use. For instance, in regions of the United States where laws permit syringe access and lay naloxone distribution, naloxone has historically been delivered through syringe access programs targeting PWID (Wheeler, et al., 2015). As a result, we would expect early lay naloxone provision in such regions to reduce opioid overdose mortality for PWID, regardless of the type of opioid ingested.

Currently, it is unclear how much of the opioid analgesic epidemic is occurring among PWID who transitioned from illicit opioids to opioid analgesics, as opposed to occurring among a new population of individuals who were not previously using illicit opioids. Obtaining accurate estimates of the number of people who inject drugs is challenging due to multiple methodologic limitations (Lansky, et al., 2014), yet recent data suggest increases in the rates of injection of opioid analgesics (Jones, Christensen, & Gladden, 2017). Using additional data sources to track the route of drug administration may help to clarify the evolving relationships between injection drug use (IDU), specific opioid types, and overdose mortality.

In order to improve our understanding of opioid overdose mortality in San Francisco, we undertook a detailed review of San Francisco County opioid overdose medical examiner case narratives and toxicology reports from 2006–2012. In line with methods used by others (Davidson, et al., 2003; Mertz, et al., 2014; Visconti, Santos, Lemos, Burke, & Coffin, 2015), we reviewed medical examiner case narratives, toxicology reports, and cause of death designations. We created a classification system for heroin-related and injection-related overdose deaths. We then compared demographic, death scene, and toxicology characteristics among these subgroups. We chose to review overdose cases from 2006–2012 because they occurred during a time of evolving opioid use patterns and expansion in overdose prevention programming in San Francisco (Enteen, et al., 2010).

Methods

Study Setting and Data Sources

We identified all opioid overdose deaths occurring in San Francisco County from 2006–2012 in the California Electronic Death Reporting System (CA-EDRS), a statewide electronic repository of vital records. San Francisco is located in Northern California with a population of approximately 860,000. We reviewed a list of all potential overdose deaths and manually selected cases that included an opioid or unspecified substance in the cause of death. We excluded cases that occurred outside of San Francisco County or deaths designated as a suicide or homicide by the medical examiner. For cases that identified an unspecified substance in the cause of death, we manually reviewed toxicology reports and included cases that were found to involve opioids.

After generating a complete list of opioid overdose deaths from review of CA-EDRS records, we reviewed investigative case narratives from the San Francisco Office of the Chief

Medical Examiner (OCME) for all identified cases. The OCME is required to investigate all deaths that may be related to drug or alcohol use. When a case comes under the jurisdiction of the OCME, an investigator arrives at the death scene typically within an hour of death being declared by first responders. Investigators prepare a report that describes the events preceding death, the discovery of the body by witnesses, the medical history of the decedent, and characteristics of the death scene that may have contributed to the death such as drug paraphernalia, body positioning, and environmental exposures. OCME medical personnel collect postmortem toxicology specimens from all decedents unless other circumstances prevent testing (e.g., decomposition, delay in reporting death). A physician with certification in internal medicine and addiction medicine [E.H.] completed review of OCME toxicology reports and investigative case narratives for all overdose cases during this period, recording qualitative variable abstraction in a database. A second physician [P.C.] reviewed all cases; discrepancies in variable assignment were resolved through team case review. The Institutional Review Board of the University of California San Francisco approved as exempt this analysis of death records (IRB# 15-17539).

Measures and Definitions

a) Decedent and Death Scene Characteristics—We obtained demographic characteristics, including age, gender, and race/ethnicity of decedents from CA-EDRS. We abstracted additional measures related to the decedent and death scene from OCME case narratives. These measures included history of heroin use and history of IDU as obtained by the OCME investigators through interviews with healthcare providers, witnesses, friends, and family members. We also abstracted the location in which the decedent was found as well as who found the decedent. For location, we identified single room occupancy (SRO) hotels, privately owned institutions known to have lower cost monthly rents and typically located in low-income areas of the city, by referencing the name and address of death to a list of SROs generated by the San Francisco Department of Public Health. For who found the decedent, we defined a cohabitant as an individual staying with the decedent at the time of the overdose event, which included permanent and temporary arrangements. We abstracted whether prescription opioids or injection drug paraphernalia (e.g. syringes, cookers, or tourniquets) were found at the death scene. Lastly, we defined a decedent as being found “deceased on scene without resuscitation attempt” if the case narrative described the individual as being found “beyond resuscitative efforts” by first responders or medical personnel.

b) Toxicology and Causal Substance Designation—When available, causal substances were identified as the substances listed in the cause of death designation by the OCME. For cases where no specific drug was included in the cause of death (cases classified as polysubstance overdose or mixed drug overdose), individual case review was completed by a committee comprised of two physicians trained in addiction medicine [E.H., P.C.] and expert consultation with the San Francisco OCME’s Chief Forensic Toxicologist [N.P.L]. The content of each case review included OCME toxicology reports of blood and other specimens (including urine, cerebrospinal fluid, or tissue) as well as OCME case narratives. We modeled our classification system on the case review process used by the OCME.

c) Classification of Heroin Overdoses—We developed a classification system for heroin-related deaths similar to methods used by others (Davidson, et al., 2003; Hearn & Walls, 1998; Mertz, et al., 2014). Correctly identifying heroin overdose deaths is challenging due to heroin's rapid metabolism into morphine (Bogusz, Maier, & Driessen, 1997; Goldberger, et al., 1994; Gottas, et al., 2013). Heroin is typically metabolized to an initial metabolite 6–monoacetylmorphine (6MAM) within three minutes of ingestion (Bogusz, et al., 1997; Goldberger, et al., 1994); the presence of 6MAM on toxicology samples suggests a shorter survival time before death (Darke & Duflou, 2016).

The San Francisco OCME consistently tested for the presence of 6MAM in decedents during our period of review. However, given that relying on the presence of 6MAM on toxicology reports alone may lead to undercounting of heroin overdoses, we developed a more inclusive definition of heroin overdose cases. To reflect the subset of heroin deaths that are captured as part of typical overdose surveillance, we designated "standard" heroin deaths as deaths explicitly determined to involve heroin by the OCME or deaths involving detection of heroin's metabolite 6–monoacetylmorphine (6MAM) in toxicology reports. We also developed an "expanded" definition of heroin deaths, which included all "standard" heroin deaths as well as deaths that fell under the following non- "standard" criteria:

1. cases in which the toxicology report demonstrated a suggestive ratio of morphine to codeine (a ratio greater than one) that has been shown to correlate with heroin metabolism (Ellis, McGwin, Davis, & Dye, 2016; Konstantinova, et al., 2012), or;
2. cases in which the toxicology report demonstrated a presence of morphine and either a) the death scene had characteristics suggestive of heroin (e.g. heroin found on the scene, witness reports of heroin use prior to death); or b) the death scene had evidence of IDU (e.g. injection drug paraphernalia including syringes, cookers, tourniquets); or c) the decedent had a known history of heroin use.

Of note, we did not designate heroin overdose cases as involving a specific type of heroin (black tar etc.), because details that would allow this level of categorization were not included consistently in case narratives.

d) Classification of Injection-Related Overdoses—Our definition of injection-related opioid overdose deaths included any case that had death scene evidence of recent IDU, as indicated by the presence of injection drug paraphernalia. Injection-related overdose cases included cases that could be attributed to heroin or to other opioids.

e) Combined Classification of Heroin or Injection-Related Overdoses—We created a combined classification that included both "expanded" heroin deaths and the more general category of "injection-related" opioid overdose deaths. This subgroup of opioid overdose decedents comprised of PWID and heroin-users allowed identification of individuals targeted by overdose prevention efforts in San Francisco during our period of review (Enteen, et al., 2010).

Statistical Analysis

We used Wilcoxon rank-sum and Fisher's exact tests to compare decedent demographics, decedent drug use history, death scene details, and other substances implicated in death between 1) "Standard" heroin deaths and all other opioid overdose deaths; 2) "Expanded" heroin deaths and all other opioid overdose deaths; 3) Injection-related opioid overdose deaths and all other opioid overdose deaths; and 4) The combined classification of "expanded" heroin deaths and injection-related opioid overdose deaths and all other opioid overdose deaths. We performed analyses using Stata version 13 (StataCorp, College Station, TX, USA).

Results

All Opioid Overdose Deaths 2006–2012 (Table 1)

From January 1, 2006 to December 31, 2012 we identified 816 unintentional opioid overdose deaths in San Francisco County (Table 1). Decedents had a mean age of 47.5 years (SD=11.8), 525 (64%) were non-Hispanic white, 170 (21%) non-Hispanic Black/African American, 76 (9%) Hispanic/Latino, and 45 (6%) were identified as another race or ethnicity. Five hundred seventy-one (70%) decedents were male. Although case reports did not consistently characterize decedents as transgender, six (0.7%) decedents were trans women based on case narratives.

One hundred seventy-two (21%) decedents had a known history of heroin use, while 186 (23%) had a history of IDU. First responders found the majority of individuals in a private residence (n=419, 51%,) or a single room occupancy hotel (n=239, 29%), while 83 (10%) were found in public spaces. A cohabitant (n=335, 41%) or a staff member from the decedent's residence (n=263, 32%) found the majority of individuals after the overdose event. The majority of individuals (n=616, 76%) were found in a state considered "beyond resuscitative measures" by first-responders.

Standard and Expanded Heroin Overdose Deaths (Table 1)

Of all opioid deaths, 152 (19%) were classified as "standard" heroin deaths (Table 1). The "expanded" classification of heroin deaths added an additional 20 deaths (13% increase), resulting in a total of 172 (21% of all opioid deaths). Of these 20 additional deaths, ten were identified on the basis of a suggestive ratio of morphine to codeine on post-mortem toxicology, while the remaining ten were identified through a combination of morphine on toxicology and other suggestive death scene characteristics such as evidence of IDU or a known history of heroin use.

Compared to opioid analgesic deaths, both "standard" and "expanded" heroin decedents were more likely to be older ("standard": p=0.005; "expanded": p=0.006), male (p=0.01; p=0.014), and to have a history of heroin (p<0.001; p<0.001) or IDU (p<0.001; p<0.001). Both "standard" and "expanded" heroin cases were less likely to be found in a private residence and more likely to be found in a public space (p<0.001; p=0.002), and less likely to have prescription opioids present at the death scene (p<0.001; p<0.001). Both classifications of heroin cases were also less likely to have benzodiazepines (p<0.001;

p<0.001) or methadone (p<0.001; p<0.001) involved in the death. Heroin deaths were more likely to involve cocaine (p<0.001; p<0.001) or methamphetamine (p=0.034; p=0.03).

Injection-Related Opioid Overdose Deaths (Table 2)

Among all opioid deaths, 205 (25%) were injection-related, 55% (n=112) of which were "standard" heroin deaths and 60% (n=123) of which were "expanded" heroin deaths. Thirteen percent (n=82) of opioid analgesic deaths, defined in relation to "expanded" heroin deaths, involved IDU.

Compared to those with non-injection related overdose, decedents with injection-related overdose deaths were more likely to be younger, male, and have a history heroin and IDU (all p≤0.001). Injection-related overdose deaths were also less likely to be found in a private residence and more likely to be found in an SRO or public space (p<0.001). They were less likely to be found by a cohabitant and more likely to be found by a residence staff member or social worker (p<0.001). They were less likely to have prescription opioids present at the death scene (p<0.001). Injection-related deaths were less likely to involve benzodiazepines (p<0.001) or methadone (p=0.04) and more likely to involve cocaine (p<0.001) or methamphetamine (p=0.001).

Combined Classification of "Expanded" Heroin Deaths and Injection-Related Deaths (Table 3)

Combining "expanded" heroin and injection-related opioid deaths accounted for 254 (31%) of all opioid overdose deaths from 2006–2012. Compared to the remaining opioid analgesic deaths, deaths in this combined category were more likely to be younger (p<0.001), male (p=0.004), and to have a history of heroin use (p<0.001), or IDU (p<0.001). Deaths in the combined category were also less likely to be found in a private residence, more likely to be found in an SRO or public space (p<0.001), less likely to be found by a cohabitant, and more likely to be found by a residence staff or social worker (p=0.015). They were less likely to have prescription opioids present at the death scene (p<0.001). Overdose deaths in this combined category were less likely to involve benzodiazepines (p<0.001) or methadone (p=0.002), and more likely to involve cocaine (p<0.001) or methamphetamine (p=0.001).

Discussion

To our knowledge, this is the first local census of opioid overdose deaths to incorporate data from investigative case narratives to specifically identify PWID among opioid overdose decedents. While we identified only a modest number of additional heroin deaths using a comprehensive review of medical examiner records, we found a substantial number of injection-related opioid overdoses that did not involve heroin. The combined classification of heroin and injection-related deaths accounted for a larger proportion of opioid overdose deaths, and identified a subgroup of high-risk opioid users who have been targeted by public health interventions in San Francisco.

While others have found (Mertz, et al., 2014) or suspected (Sternfeld, Perras, & Culross, 2010) under-estimation of heroin overdose deaths from surveillance that relies solely on death certificates, our "expanded" classification of heroin deaths only marginally increased

the count of heroin-related deaths. This may be due to local variation in the classification of heroin-related deaths by medical examiners. In an effort to reconcile inconsistent identification of causal drugs, multiple groups, including the National Association of Medical Examiners, American College of Medical Toxicology, and Substance Abuse and Mental Health Services Administration, have proposed that all substances thought to contribute to death be included on overdose death certificates (Davis, 2014) and that agencies create uniform standards and definitions to classify opioid overdose deaths (Goldberger, Maxwell, Campbell, & Wilford, 2013). Until such standardized processes become the norm, our findings underscore the importance of local evaluation of overdose surveillance methods (Slavova, et al., 2015).

Through our review of investigative case narratives, we identified high-risk sub-groups of PWID that included both people who had used heroin and those who had used other opioids. In the case of HIV prevention, surveillance efforts demonstrate success in utilizing transmission category (e.g. IDU, male-to-male sexual contact, heterosexual contact) to both track HIV-related trends (CDC, 2016; Peters, et al., 2016) and to evaluate the impact of interventions targeting these specific populations (Bhattacharjee, et al., 2015; Hurley, Jolley, & Kaldor, 1997; Monteiro, et al., 2015). Opioid overdose surveillance may benefit from similar tools and measures to classify overdose deaths and evaluate prevention efforts.

For example, several low-threshold interventions target PWID, including syringe access services (Des Jarlais, Feelemyer, Modi, Abdul-Quader, & Hagan, 2013; Enteen, et al., 2010), supervised injection facilities (Kerr, Mitra, Kennedy, & McNeil, 2017; Potier, Laprevote, Dubois-Arber, Cottencin, & Rolland, 2014), infectious disease screening programs (Doyle, et al., 2015; Fernandez-Lopez, Folch, Majo, Gasulla, & Casabona, 2016; Hahne, et al., 2013), and behavioral interventions (Dutta, Wirtz, Baral, Beyrer, & Cleghorn, 2012; Sacks-Davis, Horyniak, Grebely, & Hellard, 2012). PWID can be readily targeted for overdose prevention including naloxone distribution and overdose prevention education in the context of other programs, such as syringe access. However, a growing number of PWID live in rural areas, where these services are limited (Wejnert, et al., 2016). Using additional data sources to quantify the proportion of opioid overdose deaths that involve injection could improve local surveillance efforts and inform prevention strategies, particularly with regard to where and how to focus prevention efforts.

We add to a substantial body of literature calling for improvements in opioid surveillance methods by using multiple available death record sources to classify overdose deaths. Our results emphasize the public health value of standardizing death record documentation and encouraging inclusion of details regarding the specific drugs involved (Slavova, et al., 2015) and the route of drug administration. Future research can evaluate the sensitivity of our methods to identify injection-related overdose deaths and assess automated methods to improve classification systems for opioid overdose surveillance. However, because local jurisdictions (often at the state level in the United States) are responsible for the quality and processing of death-related data, there is considerable heterogeneity in the information recorded on death records (Breiding & Wiersema, 2006; Slavova, et al., 2015). Death certificates, used by that National Center for Health Statistics to classify overdose deaths in the United States, often do not include details such as the specific drugs involved (Landen, et

al., 2003; Slavova, et al., 2015; Wysowski & Nourjah, 2004), the sources of those drugs, or the route of drug administration. Review of medical examiner records and other vital records can provide more complete public health surveillance data (Landen, et al., 2003), but current methods to extract this information from reports are cumbersome. There are efforts to use natural language processing to extract literal text from death certificates to improve identification of specific drugs in mortality surveillance (Trinidad, Warner, Bastian, Minino, & Hedegaard, 2016). It is possible that similar methods could be employed to extract data on route of drug administration from investigative overdose reports.

This study has several limitations. First, our classification of “expanded” heroin deaths and of injection-related deaths relied on OCME reports. Although standard protocols exist for the investigation and reporting of deaths, it is possible that investigative efforts and subsequent reporting varied by OCME investigator or changed over time. Second, our findings are specific to San Francisco County from 2006–2012. Given the regional and temporal variability in the opioid epidemic, our findings may not be generalizable to other regions or time periods. Third, there is no gold standard for defining an injection-related drug overdose event; thus, we cannot assess the sensitivity of the definitions used in this analysis. Related to this limitation, the records reviewed here did not provide definitive evidence of how the opioid implicated in overdose was ingested. The definition we use characterizes cases as occurring among individuals with IDU based on historical data and death scene details. Finally, the records we reviewed did not consistently include certain decedent characteristics such as gender identity and participation in a methadone maintenance program. Although overdose deaths among transgender individuals may have been underestimated as a result of inconsistent reporting, it is important to track gender identity as part of opioid overdose surveillance efforts given the unique vulnerability of gender minorities.

Conclusions

Characterizing opioid overdose deaths solely by the type of opioid involved in the overdose may be insufficient to adequately track a complex opioid epidemic with dynamic licit and illicit markets and drug use patterns. Expanding surveillance techniques to incorporate data from investigative case narratives can identify important characteristics of opioid overdose deaths, distinguish meaningful subgroups at risk, including vulnerable populations, and inform local public health priorities.

Acknowledgments

Funding:

This study was supported by National Institute of Drug Abuse (NIDA grant K24DA042720).

Role of Funding Source:

This study was funded by a grant from the National Institute of Drug Abuse K24DA042720 [Coffin]. Dr. Hurstak received fellowship support from National Institute of Health T32HP19025.

The authors gratefully acknowledge their colleagues at the San Francisco Office of the Chief Medical Examiner for their assistance with this project. In particular, Dr. Nikolas Lemos, former Director of the San Francisco Forensic Toxicology Laboratory, provided invaluable support in the acquistion and interpretation of toxicology records.

References

Bhattacharjee P, McClarty LM, Musyoki H, Anthony J, Kioko J, Kaosa S, Ogwang BE, Githuka G, Sirengo M, Birir S, Blanchard JF, Muraguri N, Isac S, Moses S. Monitoring HIV Prevention Programme Outcomes among Key Populations in Kenya: Findings from a National Survey. PloS One. 2015; 10:e0137007. [PubMed: 26313642]

Black RA, Trudeau KJ, Cassidy TA, Budman SH, Butler SF. Associations between public health indicators and injecting prescription opioids by prescription opioid abusers in substance abuse treatment. J Opioid Manag. 2013; 9:5–17. [PubMed: 23709299]

Bogusz MJ, Maier RD, Driessen S. Morphine, morphine-3-glucuronide, morphine-6-glucuronide, and 6-monoacetylmorphine determined by means of atmospheric pressure chemical ionization-mass spectrometry-liquid chromatography in body fluids of heroin victims. Journal of Analytical Toxicology. 1997; 21:346–355. [PubMed: 9288586]

Breiding MJ, Wiersema B. Variability of undetermined manner of death classification in the US. Injury Prevention. 2006; 12(Suppl 2):ii49–ii54. [PubMed: 17170172]

Brugal MT, Barrio G, De LF, Regidor E, Royuela L, Suelves JM. Factors associated with non-fatal heroin overdose: assessing the effect of frequency and route of heroin administration. Addiction. 2002; 97:319–327. [PubMed: 11964108]

Calcaterra S, Glanz J, Binswanger IA. National trends in pharmaceutical opioid related overdose deaths compared to other substance related overdose deaths: 1999–2009. Drug Alcohol Depend. 2013; 131:263–270. [PubMed: 23294765]

CDC. Wide-ranging Online Data for Epidemiologic Research (WONDER), Multiple-Cause-of-Death file, 2000–2014. Centers for Disease Control and Prevention (CDC); 2015. http://wonder.cdc.gov.ucsf.idm.oclc.org/

CDC. HIV Surveillance Report, 2015. Diagnoses of HIV Infection in the United States and Dependent Areas, 2015. 2016; 27:26–50. https://www.cdc.gov/hiv/pdf/library/reports/surveillance/cdc-hiv-surveillance-report-2015-vol-27.pdf.

Cone EJ, Fant RV, Rohay JM, Caplan YH, Ballina M, Reder RF, Spyker D, Haddox JD. Oxycodone involvement in drug abuse deaths: a DAWN-based classification scheme applied to an oxycodone postmortem database containing over 1000 cases. Journal of Analytical Toxicology. 2003; 27:57–67. discussion 67. [PubMed: 12669998]

Darke S, Duflou J. The toxicology of heroin-related death: estimating survival times. Addiction. 2016; 111:1607–1613. [PubMed: 27082514]

Darke S, Hall W. Heroin overdose: research and evidence-based intervention. Journal of Urban Health. 2003; 80:189–200. [PubMed: 12791795]

Davidson PJ, McLean RL, Kral AH, Gleghorn AA, Edlin BR, Moss AR. Fatal heroin-related overdose in San Francisco, 1997–2000: a case for targeted intervention. J Urban Health. 2003; 80:261–273. [PubMed: 12791802]

Davis GG. Complete republication: National Association of Medical Examiners position paper: Recommendations for the investigation, diagnosis, and certification of deaths related to opioid drugs. Journal of Medical Toxicology. 2014; 10:100–106. [PubMed: 24132519]

Des Jarlais DC, Feelemyer JP, Modi SN, Abdul-Quader A, Hagan H. High coverage needle/syringe programs for people who inject drugs in low and middle income countries: a systematic review. BMC Public Health. 2013; 13:53. [PubMed: 23332005]

Doyle JS, Aspinall EJ, Hutchinson SJ, Quinn B, Gore C, Wiktor SZ, Hellard ME. Global policy and access to new hepatitis C therapies for people who inject drugs. International Journal on Drug Policy. 2015; 26:1064–1071. [PubMed: 26118794]

Dutta A, Wirtz AL, Baral S, Beyrer C, Cleghorn FR. Key harm reduction interventions and their impact on the reduction of risky behavior and HIV incidence among people who inject drugs in low-income and middle-income countries. Current Opinion in HIV and AIDS. 2012; 7:362–368. [PubMed: 22647588]

Ellis AD, McGwin G, Davis GG, Dye DW. Identifying cases of heroin toxicity where 6-acetylmorphine (6-AM) is not detected by toxicological analyses. Forensic Science, Medicine, and Pathology. 2016; 12:243–247.

Enteen L, Bauer J, McLean R, Wheeler E, Huriaux E, Kral AH, Bamberger JD. Overdose prevention and naloxone prescription for opioid users in San Francisco. J Urban Health. 2010; 87:931–941. [PubMed: 20967505]

Fernandez-Lopez L, Folch C, Majo X, Gasulla L, Casabona J. Implementation of rapid HIV and HCV testing within harm reduction programmes for people who inject drugs: a pilot study. AIDS Care. 2016; 28:712–716. [PubMed: 27007000]

Gladden RM, Martinez P, Seth P. Fentanyl Law Enforcement Submissions and Increases in Synthetic Opioid-Involved Overdose Deaths - 27 States, 2013–2014. MMWR: Morbidity and Mortality Weekly Report. 2016; 65:837–843. [PubMed: 27560775]

Goldberger BA, Cone EJ, Grant TM, Caplan YH, Levine BS, Smialek JE. Disposition of heroin and its metabolites in heroin-related deaths. Journal of Analytical Toxicology. 1994; 18:22–28. [PubMed: 8127080]

Goldberger BA, Maxwell JC, Campbell A, Wilford BB. Uniform standards and case definitions for classifying opioid-related deaths: recommendations by a SAMHSA consensus panel. Journal of Addictive Diseases. 2013; 32:231–243. [PubMed: 24074189]

Gottas A, Oiestad EL, Boix F, Vindenes V, Ripel A, Thaulow CH, Morland J. Levels of heroin and its metabolites in blood and brain extracellular fluid after i.v. heroin administration to freely moving rats. British Journal of Pharmacology. 2013; 170:546–556. [PubMed: 23865556]

Hahne SJ, Veldhuijzen IK, Wiessing L, Lim TA, Salminen M, Laar M. Infection with hepatitis B and C virus in Europe: a systematic review of prevalence and cost-effectiveness of screening. BMC Infectious Diseases. 2013; 13:181. [PubMed: 23597411]

Hargrove SL, Bunn TL, Slavova S, Quesinberry D, Corey T, Ralston W, Singleton MD, Ingram V. Establishment of a comprehensive drug overdose fatality surveillance system in Kentucky to inform drug overdose prevention policies, interventions and best practices. Injury Prevention. 2017

Hearn, W., Walls, H. Common methods in postmortem toxicology. In: Karch, S., editor. Drug Abuse Handbook. Boca Raton, FL: CRC Press; 1998. p. 890-926.

Hirsch A, Proescholdbell SK, Bronson W, Dasgupta N. Prescription histories and dose strengths associated with overdose deaths. Pain Medicine. 2014; 15:1187–1195. [PubMed: 25202775]

Hurley SF, Jolley DJ, Kaldor JM. Effectiveness of needle-exchange programmes for prevention of HIV infection. Lancet. 1997; 349:1797–1800. [PubMed: 9269214]

Jauncey ME, Taylor LK, Degenhardt LJ. The definition of opioid-related deaths in Australia: implications for surveillance and policy. Drug Alcohol Rev. 2005; 24:401–409. [PubMed: 16298834]

Jones CM, Christensen A, Gladden RM. Increases in prescription opioid injection abuse among treatment admissions in the United States, 2004–2013. Drug and Alcohol Dependence. 2017; 176:89–95. [PubMed: 28531769]

Kerr T, Mitra S, Kennedy MC, McNeil R. Supervised injection facilities in Canada: past, present, and future. Harm Reduct J. 2017; 14:28. [PubMed: 28521829]

Konstantinova SV, Normann PT, Arnestad M, Karinen R, Christophersen AS, Morland J. Morphine to codeine concentration ratio in blood and urine as a marker of illicit heroin use in forensic autopsy samples. Forensic Sci Int. 2012; 217:216–221. [PubMed: 22137531]

Landen MG, Castle S, Nolte KB, Gonzales M, Escobedo LG, Chatterjee BF, Johnson K, Sewell CM. Methodological issues in the surveillance of poisoning, illicit drug overdose, and heroin overdose deaths in new Mexico. American Journal of Epidemiology. 2003; 157:273–278. [PubMed: 12543628]

Lansky A, Finlayson T, Johnson C, Holtzman D, Wejnert C, Mitsch A, Gust D, Chen R, Mizuno Y, Crepaz N. Estimating the number of persons who inject drugs in the united states by meta-analysis to calculate national rates of HIV and hepatitis C virus infections. PloS One. 2014; 9:e97596. [PubMed: 24840662]

Liebling EJ, Green TC, Hadland SE, Marshall BDL. Injection drug use and overdose among young adults who use prescription opioids non-medically. Addictive Behaviors. 2017; 76:20–26. [PubMed: 28735037]

Lung DD, Lemos NP. Fentanyl: cause of death or incidental finding? Postmortem peripheral blood concentrations with and without documented transdermal patch use. Forensic Toxicology. 2014; 32:118–125.

Mackelprang JL, Graves JM, Rivara FP. Homeless in America: injuries treated in US emergency departments, 2007–2011. Int J Inj Contr Saf Promot. 2013

Mertz KJ, Janssen JK, Williams KE. Underrepresentation of heroin involvement in unintentional drug overdose deaths in Allegheny County, PA. J Forensic Sci. 2014; 59:1583–1585. [PubMed: 25041514]

Monteiro JF, Galea S, Flanigan T, de Monteiro ML, Friedman SR, Marshall BD. Evaluating HIV prevention strategies for populations in key affected groups: the example of Cabo Verde. Int J Public Health. 2015; 60:457–466. [PubMed: 25838121]

Novak SP, Kral AH. Comparing injection and non-injection routes of administration for heroin, methamphetamine, and cocaine users in the United States. Journal of Addictive Diseases. 2011; 30:248–257. [PubMed: 21745047]

Peters PJ, Pontones P, Hoover KW, Patel MR, Galang RR, Shields J, Blosser SJ, Spiller MW, Combs B, Switzer WM, Conrad C, Gentry J, Khudyakov Y, Waterhouse D, Owen SM, Chapman E, Roseberry JC, McCants V, Weidle PJ, Broz D, Samandari T, Mermin J, Walthall J, Brooks JT, Duwve JM. HIV Infection Linked to Injection Use of Oxymorphone in Indiana, 2014–2015. New England Journal of Medicine. 2016; 375:229–239. [PubMed: 27468059]

Peterson AB, Gladden RM, Delcher C, Spies E, Garcia-Williams A, Wang Y, Halpin J, Zibbell J, McCarty CL, DeFiore-Hyrmer J, DiOrio M, Goldberger BA. Increases in Fentanyl-Related Overdose Deaths - Florida and Ohio, 2013–2015. MMWR: Morbidity and Mortality Weekly Report. 2016; 65:844–849. [PubMed: 27560948]

Potier C, Laprevote V, Dubois-Arber F, Cottencin O, Rolland B. Supervised injection services: what has been demonstrated? A systematic literature review. Drug and Alcohol Dependence. 2014; 145:48–68. [PubMed: 25456324]

Rowe C, Santos GM, Vittinghoff E, Wheeler E, Davidson P, Coffin PO. Predictors of participant engagement and naloxone utilization in a community-based naloxone distribution program. Addiction. 2015; 110:1301–1310. [PubMed: 25917125]

Rudd RA, Seth P, David F, Scholl L. Increases in Drug and Opioid-Involved Overdose Deaths - United States, 2010–2015. MMWR: Morbidity and Mortality Weekly Report. 2016; 65:1445–1452. [PubMed: 28033313]

Ruhm CJ. Drug poisoning deaths in the United States, 1999–2012: a statistical adjustment analysis. Popul Health Metr. 2016; 14:2. [PubMed: 26778921]

Sacks-Davis R, Horyniak D, Grebely J, Hellard M. Behavioural interventions for preventing hepatitis C infection in people who inject drugs: a global systematic review. International Journal on Drug Policy. 2012; 23:176–184. [PubMed: 22000602]

Slavova S, O'Brien DB, Creppage K, Dao D, Fondario A, Haile E, Hume B, Largo TW, Nguyen C, Sabel JC, Wright D. Drug Overdose Deaths: Let's Get Specific. Public Health Reports. 2015; 130:339–342. [PubMed: 26345488]

Somerville NJ, O'Donnell J, Gladden RM, Zibbell JE, Green TC, Younkin M, Ruiz S, Babakhanlou-Chase H, Chan M, Callis BP, Kuramoto-Crawford J, Nields HM, Walley AY. Characteristics of Fentanyl Overdose - Massachusetts, 2014–2016. MMWR: Morbidity and Mortality Weekly Report. 2017; 66:382–386. [PubMed: 28406883]

Sternfeld I, Perras N, Culross PL. Development of a coroner-based surveillance system for drug-related deaths in Los Angeles county. Journal of Urban Health. 2010; 87:656–669. [PubMed: 20440654]

Trinidad JP, Warner M, Bastian BA, Minino AM, Hedegaard H. Using Literal Text From the Death Certificate to Enhance Mortality Statistics: Characterizing Drug Involvement in Deaths. National Vital Statistics Reports. 2016; 65:1–15.

Visconti AJ, Santos GM, Lemos NP, Burke C, Coffin PO. Opioid Overdose Deaths in the City and County of San Francisco: Prevalence, Distribution, and Disparities. Journal of Urban Health. 2015

Volkow, ND. Naloxone—A Potential Lifesaver | Nora's Blog. NIDA; Retrieved 1/20 2016

Warner M, Chen LH, Makuc DM. Increase in fatal poisonings involving opioid analgesics in the United States, 1999–2006. NCHS Data Brief. 2009:1–8.

Warner M, Chen LH, Makuc DM, Anderson RN, Minino AM. Drug poisoning deaths in the United States, 1980–2008. NCHS Data Brief. 2011:1–8.

Warner M, Paulozzi L, Nolte K, Davis G, LSN. State variation in certifying manner of death and drugs involved in drug intoxication deaths. Acad Foren Path. 2013; 3:231–237.

Wejnert C, Hess KL, Hall HI, Van Handel M, Hayes D, Fulton P Jr, An Q, Koenig LJ, Prejean J, Valleroy LA. Vital Signs: Trends in HIV Diagnoses, Risk Behaviors, and Prevention Among Persons Who Inject Drugs - United States. MMWR: Morbidity and Mortality Weekly Report. 2016; 65:1336–1342. [PubMed: 27906906]

Wheeler E, Jones TS, Gilbert MK, Davidson PJ. Centers for Disease C and Prevention. Opioid Overdose Prevention Programs Providing Naloxone to Laypersons - United States, 2014. MMWR: Morbidity and Mortality Weekly Report. 2015; 64:631–635. [PubMed: 26086633]

Wysowski DK, Nourjah P. Analyzing prescription drugs as causes of death on death certificates. Public Health Reports. 2004; 119:520. [PubMed: 15504443]

Table 1

Characteristics and bivariate comparisons of “Standard” and “Expanded” heroin deaths in San Francisco County 2006–2012 (n=816).

	All Opioid Overdose Deaths	“Standard” Heroin Deaths†	Opioid Analgesic Deaths		“Expanded” Heroin Deaths‡	Opioid Analgesic Deaths	
	N (%)✤	N (%)✤	N (%)✤	*p*-value	N (%)✤	N (%)✤	*p*-value
n	816 (100.0)	152 (18.6)	664 (81.4)		172 (21.1)	644 (78.9)	
EVIDENCE OF INJECTION DRUG USE							
Evidence of Injection Drug Use *	205 (25.1)	112 (73.7)	93 (14.0)	<0.001	123 (71.5)	82 (12.7)	<0.001
DECEDENT DEMOGRAPHICS							
Age (mean, SD)	47.5 (11.8)	44.8 (12.5)	48.2 (11.6)	0.005	45.1 (12.2)	48.2 (11.7)	0.006
Race							
White	525 (64.3)	96 (63.2)	429 (64.6)	0.534	109 (63.4)	416 (64.6)	0.695
Black/African American	170 (20.8)	34 (22.4)	136 (20.5)		39 (22.7)	131 (20.3)	
Hispanic/Latino	76 (9.3)	11 (7.2)	65 (9.8)		13 (7.6)	63 (9.8)	
Other/Mixed	45 (5.5)	11 (7.2)	34 (5.1)		11 (6.4)	34 (5.3)	
Gender							
Cis-Female	239 (29.3)	31 (20.4)	208 (31.3)	0.01	37 (21.5)	202 (31.4)	0.014
Cis-Male	571 (70.0)	121 (79.6)	450 (67.8)		135 (78.5)	436 (67.7)	
Transfemale	6 (0.7)	00.0	6 (0.9)		00.0	6 (0.9)	
DECEDENT HISTORY							
History of Heroin Use *	172 (21.1)	77 (50.7)	95 (14.3)	<0.001	87 (50.6)	85 (13.2)	<0.001
History of Injection Drug Use	186 (22.8)	78 (51.3)	108 (16.3)	<0.001	86 (50.0)	100 (15.5)	<0.001
DEATH SCENE DETAILS							
Location Found							
Private Residence	419 (51.3)	63 (41.4)	356 (53.6)	0.001	74 (43.0)	345 (53.6)	0.002
SRO	239 (29.3)	49 (32.2)	190 (28.6)		55 (32.0)	184 (28.6)	
Public Space	83 (10.2)	29 (19.1)	54 (8.1)		30 (17.4)	53 (8.2)	
Other	75 (9.2)	11 (7.2)	64 (9.6)		13 (7.6)	62 (9.6)	
Who Found Victim							
Cohabitant	335 (41.1)	53 (34.9)	282 (42.5)	0.095	63 (36.6)	272 (42.2)	0.081

	All Opioid Overdose Deaths	"Standard" Heroin Deaths†	Opioid Analgesic Deaths		"Expanded" Heroin Deaths‡	Opioid Analgesic Deaths	
	N (%)⁘	N (%)⁘	N (%)⁘	*p*-value	N (%)⁘	N (%)⁘	*p*-value
Non-cohabitant layperson	117 (14.3)	20 (13.2)	97 (14.6)		21 (12.2)	96 (14.9)	
Paramedic or Police Officer	47 (5.8)	11 (7.2)	36 (5.4)		12 (7.0)	35 (5.4)	
Passerby	47 (5.8)	15 (9.9)	32 (4.8)		17 (9.9)	30 (4.7)	
Residence Staff/Social Worker	263 (32.2)	50 (32.9)	213 (32.1)		55 (32.0)	208 (32.3)	
Prescription Opioids Found At Scene	324 (39.7)	25 (16.4)	299 (45.0)	<0.001	28 (16.3)	296 (46.0)	<0.001
Found Beyond Resuscitative Efforts	616 (75.5)	107 (70.4)	509 (76.7)	0.277	121 (70.3)	495 (76.9)	0.179
OTHER CAUSAL SUBSTANCES							
Benzodiazepines Involved	156 (19.1)	9 (5.9)	147 (22.1)	<0.001	10 (5.8)	146 (22.7)	<0.001
Cocaine Involved	355 (43.5)	97 (63.8)	258 (38.9)	<0.001	110 (64.0)	245 (38.0)	<0.001
Methamphetamine Involved	93 (11.4)	25 (16.4)	68 (10.2)	0.034	28 (16.3)	65 (10.1)	0.03
Prescription Opioids							
Codeine Involved	39 (4.8)	00.0	39 (5.9)	<0.001	6 (3.5)	33 (5.1)	0.428
Oxycodone Involved	146 (17.9)	3 (2.0)	143 (21.5)	<0.001	6 (3.5)	140 (21.7)	<0.001
Hydrocodone Involved	96 (11.8)	5 (3.3)	91 (13.7)	<0.001	5 (2.9)	91 (14.1)	<0.001
Morphine Involved	222 (27.2)	00.0	222 (33.4)	<0.001	18 (10.5)	204 (31.7)	<0.001
Methadone Involved **	334 (40.9)	27 (17.8)	307 (46.2)	<0.001	33 (19.2)	301 (46.7)	<0.001

†"Standard" heroin deaths include deaths designated as heroin deaths by the San Francisco Medical Examiner and deaths in which 6 – monoacetylmorphine was detected in the urine or serum toxicology.

‡"Expanded" heroin deaths include all "standard" heroin cases as well as those in which the toxicology report demonstrated a presence and suggestive ratio of morphine to codeine that has been shown to correlate with heroin metabolism, or in which the toxicology report demonstrated a presence of morphine and either 1) the death scene had characteristics suggestive of heroin (e.g. heroin found on the scene, witness reports of heroin use prior to death); 2) the death scene had evidence of injection drug use; or 3) the decedent had a noted history of heroin use.

⁘Percentages calculated for *n* are out of the total number of opioid overdose deaths (i.e., row percentages), whereas percentages for all other characteristics are calculated out of the total number of each subcategory of opioid overdose death (i.e., column percentages).

*As described in the text, these characteristics were included in our definition of "expanded" heroin deaths; associated percentages and p-values should be interpreted accordingly.

**We cannot distinguish methadone prescribed for pain from methadone opioid replacement therapy.

Table 2

Characteristics and comparisons of injection-related and non-injection related opioid overdose deaths in San Francisco County 2006–2012 (n=816).

	Injection-Related Opioid Overdose Death	Other Opioid Deaths	
	N (%)	N (%)	*p*-value
n[✜]	205 (25.1)	611 (74.9)	
HEROIN CLASSIFICATION			
"Standard" Heroin Death[†]	112 (54.6)	40 (6.5)	p<0.001
Opioid Analgesic Death	93 (45.4)	571 (93.5)	
"Expanded" Heroin Death[‡]	123 (60.0)	49 (8.0)	p<0.001
Opioid Analgesic Death	82 (40.0)	562 (92.0)	
DECEDENT DEMOGRAPHICS			
Age (mean, SD)	44.7 (11.9)	48.5 (11.7)	p<0.001
Race			
White	135 (65.9)	390 (63.8)	0.949
Black/African American	42 (20.5)	128 (20.9)	
Hispanic/Latino	17 (8.3)	59 (9.7)	
Other/Mixed	11 (5.4)	34 (5.6)	
Gender			
Cis-Female	41 (20.0)	198 (32.4)	0.001
Cis-Male	161 (78.5)	410 (67.1)	
Transfemale	3 (1.5)	3 (0.5)	
DECEDENT HISTORY			
History of Heroin Use	85 (41.5)	87 (14.2)	p<0.001
History of Injection Drug Use	112 (54.6)	74 (12.1)	p<0.001
DEATH SCENE DETAILS			
Location Found			
Private Residence	69 (33.7)	350 (57.3)	p<0.001
SRO	92 (44.9)	147 (24.1)	
Public Space	29 (14.1)	54 (8.8)	
Other	15 (7.3)	60 (9.8)	
Who Found Victim			
Cohabitant	66 (32.2)	269 (44.0)	p<0.001
Non-cohabitant layperson	23 (11.2)	94 (15.4)	
Paramedic or Police Officer	10 (4.9)	37 (6.1)	
Passerby	18 (8.8)	29 (4.7)	
Residence Staff/Social Worker	87 (42.4)	176 (28.8)	
Prescription Opioids Found At Scene	53 (25.9)	271 (44.4)	p<0.001
Dead on the Scene	159 (77.6)	457 (74.8)	0.334
OTHER CAUSAL SUBSTANCES			
Benzodiazepines Involved	16 (7.8)	140 (22.9)	p<0.001

	Injection-Related Opioid Overdose Death	Other Opioid Deaths	
	N (%)	N (%)	*p*-value
Cocaine Involved	133 (64.9)	222 (36.3)	p<0.001
Methamphetamine Involved	37 (18.0)	56 (9.2)	0.001
Methadone Involved *	71 (34.6)	263 (43.0)	0.040

❖Percentages for *n* are calculate out of 816, the total number of opioid overdose deaths in San Francisco County 2006–2012

†"Standard" heroin deaths include deaths designated as heroin deaths by the San Francisco Medical Examiner and deaths in which 6 – monoacetylmorphine was detected in the urine or serum toxicology.

‡"Expanded" heroin deaths include all "standard" heroin cases as well as those in which the toxicology report demonstrated a presence and suggestive ratio of morphine to codeine that has been shown to correlate with heroin metabolism, or in which the toxicology report demonstrated a presence of morphine and either 1) the death scene had characteristics suggestive of heroin (e.g. heroin found on the scene, witness reports of heroin use prior to death); 2) the death scene had evidence of injection drug use; or 3) the decedent had a noted history of heroin use. Because evidence of injection-drug paraphernelia was included in our definition of 'expanded' heroin deaths; associated percentages and p-values should be interpreted accordingly for injection-related overdoses.

*We cannot distinguish methadone prescribed for pain from methadone opioid replacement therapy.

Table 3

Characteristics and comparisons of opioid overdose deaths in San Francisco County 2006–2012 by classification as “expanded” heroin death or injection-related (n=816)

	“Expanded” Heroin OR Injection-Related Opioid Overdose Death†	Other Opioid Deaths	
	N (%)	N (%)	*p*-value
n✣	254 (31.1)	562 (68.9)	
DECEDENT DEMOGRAPHICS			
Age (mean, SD)	45.2 (11.9)	48.6 (11.7)	p<0.001
Race			
White	162 (63.8)	363 (64.6)	0.933
Black/African American	56 (22.0)	114 (20.3)	
Hispanic/Latino	22 (8.7)	54 (9.6)	
Other/Mixed	14 (5.5)	31 (5.5)	
Gender			
Cis-Female	56 (22.0)	183 (32.6)	0.004
Cis-Male	195 (76.8)	376 (66.9)	
Transfemale	3 (1.2)	3 (0.5)	
DECEDENT HISTORY			
History of Heroin Use *	112 (44.1)	60 (10.7)	p<0.001
History of Injection Drug Use	127 (50.0)	59 (10.5)	p<0.001
DEATH SCENE DETAILS			
Location Found			
Private Residence	102 (40.2)	317 (56.4)	p<0.001
SRO	97 (38.2)	142 (25.3)	
Public Space	37 (14.6)	46 (8.2)	
Other	18 (7.1)	57 (10.1)	
Who Found Victim			
Cohabitant	90 (35.4)	245 (43.6)	0.015
Non-cohabitant layperson	30 (11.8)	87 (15.5)	
Paramedic or Police Officer	14 (5.5)	33 (5.9)	
Passerby	22 (8.7)	25 (4.4)	
Residence Staff/Social Worker	94 (37.0)	169 (30.1)	
Prescription Opioids Found At Scene	61 (24.0)	263 (46.8)	p<0.001
Dead on the Scene	187 (73.6)	429 (76.3)	0.526
OTHER CAUSAL SUBSTANCES			
Benzodiazepines Involved	21 (8.3)	135 (24.0)	p<0.001
Cocaine Involved	162 (63.8)	193 (34.3)	p<0.001
Methamphetamine Involved	44 (17.3)	49 (8.7)	0.001
Methadone Involved **	84 (33.1)	250 (44.5)	0.002

✣Percentages for *n* are calculate out of 816, the total number of opioid overdose deaths in San Francisco County 2006–2012

† "Expanded" heroin deaths include all "standard" heroin cases as well as those in which the toxicology report demonstrated a presence and suggestive ratio of morphine to codeine that has been shown to correlate with heroin metabolism, or in which the toxicology report demonstrated a presence of morphine and either 1) the death scene had characteristics suggestive of heroin (e.g. heroin found on the scene, witness reports of heroin use prior to death); 2) the death scene had evidence of injection drug use; or 3) the decedent had a noted history of heroin use.

* As described in the text, these characteristics were included in our definition of "expanded" heroin deaths; associated percentages and p-values should be interpreted accordingly.

** We cannot distinguish methadone prescribed for pain from methadone opioid replacement therapy.