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Epidemiologic trends and geographic patterns of fatal opioid intoxications in Connecticut, USA: 1997–2007

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ABSTRACT

Background: The leading cause of injury death among adults in Connecticut (CT), USA is drug poisonings. We analyzed the epidemiology and geographic distribution of opioid-involved accidental drug-involved intoxication deaths ("overdoses") in CT over an 11-year period.

Methods: We reviewed data from 1997 to 2007 on all adult accidental/undetermined drug intoxication deaths in CT that were referred to the Office of the Chief Medical Examiner (OCME). Regression analyses were conducted to uncover risk factors for fatal opioid-involved intoxications and to compare heroin- to prescription opioid- and methadone-involved deaths. Death locations were mapped to visualize differences in the geographic patterns of overdose by opioid type.

Results: Of the 2900 qualifying deaths, 2231 (77%) involved opioids. Trends over time revealed increases in total opioid-related deaths although heroin-related deaths remained constant. Methadone, oxycodone and fentanyl, the most frequently cited prescription opioids, exhibited significant increases in opioid deaths. Prescription opioid-only deaths were more likely to involve other medications (e.g., benzodiazepines) and to have occurred among residents of a suburban or small town location, compared to heroin-involved or methadone-involved deaths. Heroin-only deaths tended to occur among non-Whites, were more likely to involve alcohol or cocaine and to occur in public locations and large cities.

Conclusions: The epidemiology of fatal opioid overdose in CT exhibits distinct longitudinal, risk factor, and geographic differences by opioid type. Each of these trends has implications for public health and prevention efforts.

1. Introduction

Opioid drugs are vitally important for the treatment of pain, opioid dependence, and terminal illness but also have the potential to produce physical dependence, abuse, addiction, and overdose. An illegal opioid, heroin, is one of the most common drugs of abuse worldwide, nationally, and in New England (Substance Abuse and Mental Health Services Administration, 2009; UNODC, 2009). As with other states in New England, Connecticut (CT) witnessed a substantial increase in heroin abuse beginning in the early 1970s with the most recent peak of heroin abuse coinciding with peak purity in 1999 (Ciccarone, 2009; Ciccarone et al., 2009). More recently, and consistent with national trends, heroin abuse has been compounded by increasing levels of abuse of prescription opioids, including methadone (Paulozzi, 2006; Paulozzi et al., 2006a, 2006b, 2009; Paulozzi and Ryan, 2006; Spiller et al., 2009).

Vital statistic calculations indicate that as of 2006, mortality due to drug poisoning is the leading cause of injury death among adults in CT (Warner et al., 2009), with unintentional drug poisonings—"overdoses"—claiming the lives of about one resident per day. Despite these alarming statistics, little is known about the epidemiology of fatal overdose in CT. One reason may be due to the data sources.

Publicly available surveillance sources inadequately track overdoses, and none collects data on events occurring in CT. The Centers for Disease Control and Prevention (CDC) National Violent Death Reporting System does not include drug overdose death as part of its event surveillance. The nearest metropolitan areas that have contributed longitudinal data to SAMHSA's Drug Abuse Warning Network (DAWN) are Boston and New York City; Providence, Rhode Island, joined DAWN in 2009. Vital statistics available from the CDC rely upon state-reported death certificate data. However, death certificates may lack drug-specific information in the "cause of death" field (e.g., "combined opiate toxicity" cause without information on which opiates were involved) and have limited and sometimes inaccurate reporting of the locations of injury/death and residence. For instance, location of injury may have been recorded as the loca-

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tion where the decedent was pronounced dead (e.g., the hospital), which may differ from the location of injury (e.g., home). Geographic analyses, therefore, would incorrectly attribute deaths to cities, where hospitals are located. In contrast, data available from the CT Office of the Chief Medical Examiner (OCME), like many other state medical examiner databases, provide information on cause and manner of death, other significant medical conditions, extensive toxicological findings of all substances detected in available specimens, and key details on the circumstances of the death, including addresses specifying location of injury and residence. A local and detailed examination of CT overdose deaths using medical examiner data is therefore in order.

Connecticut is similar to other states in the New England region with respect to the geography of drug abuse. The state is a network of suburbs and small town areas, with only 5 cities with populations over 100,000. The cities and even several pockets of small towns have long legacies of heroin use, as "hubs" of distribution along the major interstate highways and the New York–Providence–Boston drug trafficking route (Fox and Leukhardt, 2002; Grund et al., 1995). Anecdotal evidence suggests increases in suburban drug use and, in particular, prescription opioid abuse over the past decade, creating a new demographic of opioid users (Merritt, 2008). Scientific evidence to substantiate these local anecdotes is lacking. Local and regional media have reported on prescription opioid abuse, rising overdose deaths in the suburbs (Calefati, 2008; Fox and Leukhardt, 2002), and transitions to heroin use from OxyContin®, a purported "gateway" drug (Inciardi et al., 2009; Levy, 2007), despite evidence to the contrary (Grau et al., 2007).

This study aimed to analyze the epidemiology of opioid-involved accidental intoxication deaths in CT over 11 years (1997–2007) by examining longitudinal trends and geographic differences within this New England state.

2. Methods

2.1. Sample

Data were abstracted from the records of the CT Office of the Chief Medical Examiner (OCME) and included autopsy reports, toxicological analyses, hospital and ambulance case notes and records including information regarding history of substance abuse, medication records, death investigation and death scene reports including photos and detailed documentation of medications or drug paraphernalia found at the death scene, police reports including witness statements and information regarding previous criminal histories, and death certificates which included demographic information. The OCME reviews all accidental deaths that occur among CT residents.

All drug-involved deaths from 1997 to 2007 in CT due to intoxication and determined to be of accidental or undetermined manner by the OCME were eligible for this analysis. Initially, an electronic query of the case files was performed, applying the search terms of 'toxicity' or 'intoxication' to the cause of death and other significant conditions' data fields. Eligible cases were then reviewed individually, with 2005 cases reviewed by hand (microfiche, hard copy, electronic files, as available) at the OCME to clarify discrepancies in the toxicological and address fields. We examined deaths occurring within the age range of 17–70. Excluded cases had died out of state ($n = 20$); had a cause of death due to motor vehicle, bicycle or motorcycle accident, drowning, asphyxia, smoke inhalation, or capital punishment; or involved fatal intoxication by carbon monoxide ($n = 50$), caffeine ($n = 1$), cyanide ($n = 1$), water ($n = 1$), or ethylene glycol (an antifreeze, $n = 1$). Alcohol-only intoxication deaths were included in the analysis.

Socio-demographics available in the OCME files included gender and age. We were unable to consider ethnic categories as a covariate in our analyses due to differences in administrative coding of ethnicity over time. Race categories were used instead, dichotomized as White versus non-White for the multivariable regressions due to low frequencies in the non-White categories. Locations of injury and residence (street address, city, ZIP code) were available for all decedents. When the town/city of injury was the same as the residence, decedents were considered having died in their hometown. When location of injury was noted in the case file or discovered upon investigation as occurring in a public place (e.g., park, restaurant, public bathroom, hotel, street), the injury location was coded as such. The decedent's residence was coded according to whether or not they lived in one of the 5 cities (Bridgeport, Hartford, New Haven, Stamford, and Waterbury) with a population ≥100,000. Homelessness at the time of death was assigned to decedents for whom a home address was not given and where the case review indicated they were homeless. Homeless decedents were assigned the city of residence corresponding to the location of their last shelter stay or to the location of the event.

Post-mortem toxicology data were available for all but 5 decedents and included drugs and drug metabolites. The OCME routinely autopsies all potential victims of drug overdose and screens them for licit and illicit drugs. Quantitative analyses of drugs and drug metabolites in postmortem blood, body fluids, and liver were performed by a number of validated analytical methods employing gas chromatography–mass spectrometry that permitted detection of heroin or morphine, prescription opioids (as a class and by drug name), cocaine, alcohol, antidepressants (coded as tricyclics, selective serotonin reuptake inhibitors, other antidepressants), and benzodiazepines (as a class and by drug name). Deaths were classified according to whether they were opioid-related and which specific patterns of opioids were involved.

2.2. Geospatial data

All locations were assigned geographic identifiers (i.e., geocoded) first within ArcGIS (ESRI, Redlands, CA) with a match criterion of ≥80%. Unmatched addresses were then reviewed by hand and iteratively re-geocoded until every case had latitude and longitudinal coordinates. Locations that were described but that did not have a street address (e.g., in the woods of a state park, street intersection) were geocoded by hand using GPS Visualizer (www.gpsvisualizer.com/geocoder/) or Google maps. Thereafter, the few remaining addresses were assigned the centroid of the city/town. This analysis aggregated locations to the city/town level. Maps of the location of residence were prepared displaying at the city/town level the rate per 100,000 population of deaths due to any opioid, heroin-only, prescription opioid-only, and methadone-only.

2.3. Statistical analyses

Descriptive statistics summarized trends over time and for each year. Counts of deaths were those related to any opioid and by the specific opioid type involved in each death and included: heroin as the only opioid, methadone as the only opioid, only prescription opioids other than methadone, or polyopioid. We used Poisson regression methods (Agresti, 2007) to examine longitudinal changes in the number of overdose deaths.

Bivariate statistics (Pearson and Likelihood ratio χ^2 tests and nonparametric Mann–Whitney U or Kruskal–Wallace tests) compared (1) opioid to non-opioid related drug intoxication deaths and (2) patterns among opioid-involved deaths involving a single opioid. Thus, analyses reflected how opioid-related deaths differed from other drug-related accidental intoxication deaths and differences in risk factors among opioid users, respectively. Regression covariates were selected based on detected bivariate associations of $p < 0.10$; all analyses controlled for age, gender, and race. Logistic regression assessed factors independently associated with heroin-only deaths and nominal logistic regression compared differences in correlates of fatal opioid overdoses due to heroin-only to those due to patterns of other opioids. Regression analyses controlled for year of death with 2007 as the reference year. We used SAS version 9.2 (Cary, NC) for analyses. Statistical tests of the regression parameters were two-sided, conducted at the alpha = 0.05 level. The Yale Human Investigations Committee determined this study to not be human subjects research (defined as research on *living* humans). In accordance with CT state statute, the research project was reviewed and approved by the Commission on Medicolegal Investigations (http://www.cga.ct.gov/2005/pub/Chap368q.htm#Sec19a-411.htm).

3. Results

There were 9784 accidental/undetermined deaths in CT during the study period. Applying the case eligibility criteria, there were 2900 drug-involved accidental/undetermined intoxication deaths in Connecticut from 1997 to 2007, inclusive; 2231 (76.9%) of those were opioid-involved. Table 1 differentiates the characteristics of opioid-involved from non-opioid involved drug intoxication deaths. Opioid-related accidental/undetermined intoxication deaths tended to occur among men, to affect those under 44 years of age, to also involve alcohol and benzodiazepines, and were less likely to involve cocaine and antidepressants compared to non-opioid intoxication deaths.

Toxicological data were available for 2644 decedents (91.2% of all cases) and for 1975 of the opioid-involved deaths (88.5% of 2231), indicating involvement of specific opioid(s). Opioid cases that lacked complete toxicological data were more likely to be male compared to all other opioid-involved deaths (84% versus 75%, $p = 0.002$) but were not distinguishable from the deaths involving heroin on any demographic or geographic variables. Of the 1975