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A latent class analysis of drug and substance use patterns among patients treated in emergency departments for suspected drug overdose

Stephen Liu*, Alana Vivolo-Kantor

Division of Overdose Prevention, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, USA

HIGHLIGHTS

- National syndromic surveillance found 120,706 suspected overdoses, 2017–2018.
- Five classes of patients were determined from the emergency department visits.
- 3 of the classes were heroin overdose; non-heroin opioid overdose/use; polysubstance.
- 2 of the classes were young females, non-opioid drugs; older female, benzodiazepine.
- Classes can target initiation of treatment for patient with drug use disorder.

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ABSTRACT

Introduction: Polysubstance use and misuse can increase risks for nonfatal and fatal drug overdose. To categorize drugs used in combination in nonfatal overdoses, we analyzed data from emergency department (ED) overdose-related visits in 18 states funded by CDC's Enhanced State Opioid Overdose Surveillance (ESOOS) program.
Methods: From 2017 to 2018, 120,706 ED visits included at least one hospital discharge code indicating acute drug poisoning for opioids, stimulants, hallucinogens, cannabis, anti-depressants, sedatives, alcohol, benzodiazepines, or other psychotropic drugs. Latent class analyses were conducted to determine the groupings of drug combinations in overdose visits.
Results: Latent class analyses indicated a model of 5 classes – mostly heroin overdose (42.5% of visits); mostly non-heroin opioid overdose/use (27.3%); opioid, polysubstance (11.0%); female, younger (< 25 years), other non-opioid drugs (10.5%); female, older (> 55 years), benzodiazepine (8.0%). Findings indicated that heroin continues to be a large burden to EDs, yet EDs are also seeing overdose survivors with polydrug toxicity.
Conclusions: Medication-assisted treatment could be initiated in the emergency department following overdose for patients with opioid use disorder, and post-overdose protocols, such as naloxone provision and linkage to treatment and harm reduction services, have the potential to prevent future overdose for those at risk.

1. Introduction

Drug overdoses have substantial burden on morbidity and mortality in the United States (Hedegaard, Bastian, & Trinidad, 2018; Scholl, Seth, & Kariisa, 2018; Seth, Rudd, & Noonan, 2018), and the current drug overdose epidemic is projected to continue to worsen (Jalal, Buchanich, & Roberts, 1979). Opioid overdose mortality rates increased by 12.0% from 2016 to 2017, with 47,600 deaths involving opioids in the United States in 2017 (Centers for Disease Control and Prevention, 2017; Scholl et al., 2018). Sharp increases over time are often attributed to certain types of opioids. The first wave was marked by deaths from prescription opioids beginning in the 1990s; the second wave beginning

Abbreviations: AIC, Akaike's Information Criterion; BIC, Bayesian Information Criterion; CDC, Centers for Disease Control and Prevention; CI, confidence interval; ED, Emergency department; HER, electronic health records; ESOOS, Enhanced State Opioid Overdose Surveillance; ESSENCE, Electronic Surveillance System for the Early Notification of Community-Based Epidemics; HIE, health information exchanges; HIV, Human Immunodeficiency Virus; ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification; IMF, illicitly-manufactured fentanyl; LCA, latent class analysis; LL, log-likelihood; LR, likelihood ratio; NSDUH, National Survey on Drug Use and Health; NSSP, National Syndromic Surveillance Program; OR, odds ratio; PDMP, prescription drug monitoring programs; SAS, Statistical Analysis Software

* Corresponding author at: Division of Overdose Prevention, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, 4770 Buford Highway NE MS:F62, Atlanta, GA 30341, USA.
E-mail address: SLiu@cdc.gov (S. Liu).

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in 2010 involved increases in heroin-involved deaths. Finally starting in 2013, increases in deaths involving synthetic opioids, likely from illicitly-manufactured fentanyl (IMF), were observed (Centers for Disease Control and Prevention, 2017; Gladden, Martinez, & Seth, 2016; Hedegaard, Warner, & Miniño, 2017; Kolodny, Courtwright, & Hwang, 2015; Rudd et al., 2014, 2016; Scholl et al., 2018).

There are also concurrent increases in other drug overdoses and polydrug use contributing to mortality. The most common in these overdose deaths included opioids, benzodiazepines, and stimulants (Warner, Trindad, & Bastian, 2016). In 2016, opioid-involved deaths had large percentages of concomitant drug involvement, for example 69.2% and 70.5% for fentanyl-related and heroin-related deaths, respectively (Hedegaard et al., 2018; Warner et al., 2016). The substantial increase in opioid-related deaths from 2002 to 2015 is attributed in part to co-occurring use of benzodiazepines and heroin (Kandel, Hu, & Griesler, 2017). An analysis from 2010 to 2016 identified increasing trends in deaths involving synthetic opioids other than methadone in addition to deaths related to the following drugs: other opioids (prescription and illicit), cocaine, psychostimulants, benzodiazepines, and other drug types (e.g., antidepressants, barbiturates) (Jones, Einstein, & Compton, 2018; Kariisa, Scholl, & Wilson, 2019).

Though it is essential to understand which drugs used in combination cause an overdose death, it is equally important to determine polysubstance use contributing to nonfatal overdose. The study of nonfatal opioid overdoses treated in emergency departments (EDs) are of paramount importance for overdose surveillance and intervention. Changes in trends of overdose-related ED visits can signal changing, perhaps worsening, patterns of substance use and misuse before overdose mortality data are available; therefore, nonfatal overdose data can provide an earlier indication of the need for public health action. Because patients who experience a nonfatal overdose are at much higher risk for subsequent nonfatal overdose and/or a fatal overdose (Olfson, Wall, & Wang, 2018), identifying the etiology of these opioid-related ED visits could potentially provide opportunities to intervene and save lives. Nonfatal opioid overdoses are also often associated with complications of pulmonary, cardiovascular, muscular, and renal systems (Darke & Hall, 2003).

Medicaid data show that among those who had a nonfatal opioid overdose, males, persons aged 34 years and older, those recently prescribed benzodiazepines, and those whose previous overdoses involving heroin were more likely to have a subsequent nonfatal or fatal drug overdose within one year (Olfson et al., 2018). Another study of ED visits involving opioid overdoses showed that while non-heroin opioid overdose discharges decreased during 2010–2014, heroin-involved discharges have increased (Guy, Pasalic, & Zhang, 2018).

Although several studies have analyzed ED visit discharge or billing data, there has been a substantial time lag from the date of visit to when data are available for analysis. The strength of ED syndromic surveillance data is rooted in the ability to identify changing disease patterns early, before diagnoses are confirmed, and to help mobilize a rapid response (Henning, 2004). Consequently, ED syndromic data can be analyzed to alert communities of meaningful changes in overdose-related ED visits, in concert with prevention and harm reduction strategies, because of the rapid availability of this information (Ising, Proescholdbell, & Harmon, 2016; Vivolo-Kantor, Seth, & Gladden, 2018). With the inclusion of discharge diagnosis codes, which provide standardized information on clinical care and diagnoses, we can draw from the perspective of medical professionals. Results on self-reported drug use may be biased, and our analysis of discharge codes will complement findings from studies drawing upon surveys (Meacham, Roesch, & Strathdee, 2018), specifically from the National Survey on Drug Use and Health (NSDUH) (Castaldelli-Maia, Andrade, & Keyes, 2016; Ghandour, Martins, & Chilcoat, 2008; Jones, Baldwin, & Compton, 2017; Kandel et al., 2017). Several of these studies have largely focused on defining subgroups within the larger population with opioid use disorder or with self-reported drug use behaviors. There is a lack of information on these persons identified in latent classes when they access emergency care, including emergency department visits and hospitalizations.

Recognizing that drug overdoses are heterogeneous events, the objective of this study is to describe typologies of *emergency department visits* involving suspected nonfatal drug overdoses. To our knowledge, this is the first latent class analysis to determine overlapping substance-related discharge diagnosis codes among patients treated in the emergency department for drug overdose. Previous research studies using latent class analyses have used participant self-report of drug use with no observation of actual behavior and have focused on persons who use drugs, but do not have necessarily have outcomes that require seeking healthcare (i.e., overdose) (Fong, Matusow, & Cleland, 2015; Kendler, Ohlsson, & Sundquist, 2013; Meacham et al., 2015, 2018; Monga, Rehm, & Fischer, 2007; Scherer, Romano, & Voas, 2018). Our analysis with available data from several states conducting drug overdose surveillance with emergency department data will be able to characterize the classes of patients affected by nonfatal drug overdoses including the combination of drugs used at the time of overdose.

2. Methods

2.1. Dataset

Analyses are based on data from states participating in the Centers for Disease Control and Prevention's (CDC) Enhanced State Opioid Overdose Surveillance (ESOOS) program (https://www.cdc.gov/drugoverdose/foa/state-opioid-mm.html) and the National Syndromic Surveillance Program (NSSP) (Gould, Walker, & Yoon, 2017). The ESOOS program was implemented to track and analyze ED data with the aim of establishing an early warning system to detect sharp increases (i.e., potential outbreaks) or decreases (e.g., to rapidly identify successful intervention efforts) in nonfatal overdoses including suspected drug overdoses, opioid overdoses, and heroin overdoses. NSSP partners with medical facilities, state and local health departments, vendors for electronic health records (EHR), or health information exchanges (HIE) to transmit data from internal medical record systems to the BioSense Platform so that they can be analyzed in the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE, https://www.cdc.gov/nssp/biosense/onboarding.html). The data sent to NSSP by these partners provide near timely information primarily on visits to hospital EDs, but the system also includes data from outpatient clinics and ambulatory care centers (CDC NSSP, 2018). NSSP requires specific data elements, including information on the date and time of visit, the chief complaint, and discharge diagnosis codes to be shared using HL7 version 2.5.1 (CDC NSSP, 2016). Please see https://www.cdc.gov/nssp/biosense/publications.html for additional information on how NSSP processes data from HL7 messages.

2.2. Sample

Our current analysis includes 18 states from all four US Census regions, who allow the CDC ESOOS team access to their NSSP data for analysis in ESSENCE. A total of 5755 EDs, outpatient clinics, and ambulatory care centers from these states submitted data to NSSP for a