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Trends in licit and illicit drug-related deaths in Florida from 2001 to 2012

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ABSTRACT

Background: Florida, the epicenter of the recent prescription drug epidemic in the United States, maintains a statewide drug mortality surveillance system. We evaluated yearly profiles, demographic characteristics, and correlation between drug trends to understand the factors influencing drug-induced mortality.
Methods: All drug-related deaths reported to the Florida Medical Examiners Commission during 2001–2012 were included ($n = 92{,}596$). A death was considered "drug-related" if at least one drug was identified in the decedent. Depending on its contribution to death, a drug could be listed as a causative agent or merely present, but not both.
Results: Rate of drug-caused deaths was 8.0 per 100,000 population in 2001, increasing to 17.0 in 2010 and then decreasing to 13.9 in 2012. Benzodiazepines had the highest mortality rate in 2010, although <10% were solely due these drugs. Opioid-caused mortality rate also peaked in 2010 and started to decline (−28%) in 2010–2012. The heroin-caused mortality rates were negatively correlated with opioids and benzodiazepines (ρ's ≥ -0.670; $P \leq 0.034$). Ethanol- and cocaine-mortality rates stabilized to 3.0–3.1 and 2.8–3.0 per 100,000 over 2009–2012, respectively. Amphetamines, zolpidem, and inhalants-caused deaths were on the rise with rates of ≤0.6 per 100,000.
Conclusions: Overall declines in benzodiazepine- and opioid-caused deaths in 2011–2012 may have been related to Florida's attempts to regulate prescription drug abuse. This period, however, was also marked by a rise in heroin-caused mortality, which may reflect growing use of heroin as an alternative. Increases in amphetamines, zolpidem, and inhalants-induced mortality are an additional public health concern.

1. Introduction

Drug misuse imposes significant burdens on societies worldwide, taking a considerable toll on the human lives from overdoses and diseases associated with drug use such as AIDS, hepatitis, and various hepatic, respiratory, and cardiovascular conditions [1]. High prevalence of suicides, accidents, and violent behaviors associated with drug use also contributes to the drug-related fatalities [1–3]. Globally, the drug-related mortality rate is estimated at 40 (range, 20.8–49.3) deaths per million among the population aged 15–64 years [4]. From 1990 to 2010 in Europe, 6500–8500 overdose deaths have been reported each year [5]. In the United States, over 40,000 individuals died from drug-induced causes in 2010, representing 22% of injury-related deaths, with an estimated 105 drug overdose deaths occurring every day [6,7]; drug-induced mortality steadily increased from 7.6 to 13.1 per 100,000 U.S. population from 2001 to 2010 [6].

Florida, the fourth most populous among 50 states in the U.S. (19.6 million in 2013), has been the epicenter of the illegal distribution of prescription drugs [8,9]. The death rate per 100,000 population in Florida for prescription drugs increased from 7.3 in 2003 to 11.9 in 2008 (U.S. rate, 6.5 in 2008), and further increased to 13.4 in 2009 [8]. Since then, a number of state-level changes occurred that may potentially alter the drug-related mortality

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trends [10]. These changes include (a) implementation of legislation to regulate the dispensing of prescription drugs that comprised establishing a prescription drug monitoring program; (b) law enforcement task force teams targeting illegal distribution of prescription controlled substances [11]; and (c) tightening licensure requirements and practice standards for pain management practitioners and clinics as well as pharmacies and drug wholesale distributors [12].

Timely monitoring of drug-related mortality patterns is an important public health function that can help understand the impact of such changes and also detect emerging threats. For example, evidence revealed a spike in heroin overdose deaths throughout the U.S. including Florida [13]. Florida has a centralized medical examiner system, which provides a robust drug-related surveillance system for monitoring deaths from specific drugs. The data provide valuable information for understanding relationship among drug-related deaths, drug intake trends, and regulations, which may aid in establishing preventive measures for future drug overdoses.

In the present study, we investigated drug-related fatalities that were reported to the state of Florida Medical Examiners Commission (MEC) from 2001 to 2012. District medical examiners establish the cause of death based on autopsy findings, toxicology results, the decedent's drug use history, physical evidence, and other factors, and subsequently report the drug-related deaths to the MEC. The mortality rates for prescription and illicit drugs as well as ethanol were examined during the 12-year period.

The primary aim of this study was to assess yearly patterns, demographic characteristics, and correlation among the drugs, in order to identify potential risk factors and emerging threats associated with these avoidable deaths. The secondary aim was to evaluate the ratios between drug-caused deaths and drug-present deaths for specific substances to study relative lethality of the commonly abused drugs and thereby improve our understanding of difference in harm related to individual drugs. This study expands our previous trend report from 2003 to 2009 on drug overdose deaths in Florida [9], connecting the findings with more recent years when notable changes in drug control policy and drug use patterns occurred nationally as well as statewide.

2. Methods

2.1. Case inclusion criteria

All drug-related deaths reported by the Florida district (regional) medical examiners to the MEC through toxicology reports from 2001 to 2012 were included in this study. There are 24 Medical Examiner Districts in Florida and the Florida Department of Law Enforcement MEC maintains a central database of case reports pertaining to drug-related deaths. A death was considered "drug-related" if at least one drug of interest to the MEC was identified in the decedent, whether the drug was the cause of death or was simply present. When a drug is detected in the decedent, a medical examiner determines its role in the cause of death after evaluating entirety of the evidence including case history, autopsy findings, and toxicology results indicating if the drug was detected at a lethal concentration. Alternatively, while a drug is identified in the decedent, the drug may not have played a causal role in the death and/or toxicology testing detected the drug at a non-lethal concentration. In this case, the drug is recorded as "present" and not the cause of death [14]. Multiple drugs can be listed as a cause of death and/or present. A single drug is reported as either a causative factor or a presenting factor, but not both.

The number of drugs for which the MEC collected mortality information increased from 14 in 2001 to 50 in 2012, reflecting increasing number of drugs implicated in the cause of death over time. The list of drugs included in the MEC database in 2001–2012 is presented in Fig. 1. Overall, deaths related to the following drugs or drug groups were reported: Amphetamines, benzodiazepines, cannabis, carisoprodol/meprobamate, cocaine, ethanol, γ-hydroxybutyric acid (GHB), heroin, inhalants, opioids, phencyclidine (PCP), and zolpidem. Heroin is not included in the opioids group; heroin-caused deaths were distinguished from morphine-caused deaths by the presence of 6-acetylmorphine and/or evidence of heroin use obtained during the death investigation. Drugs composed of individual drug groups may differ by year. For instance, the benzodiazepines group comprised "benzodiazepines" and "flunitrazepam" in the 2001–2002 data whereas it was reported as "alprazolam," "diazepam," "flunitrazepam," and

Drug Group	2001-2002	2003-2007	2008	2009	2010-2012
Ethanol	x	x	x	x	x
Amphetamine		x	x	x	x
Methamphetamine		x	x	x	x
MDMA		x	x	x	x
MDA		x	x	x	x
MDEA		x	x	x	x
Phentermine					x
Methylated amphetamines	x				
Other amphetamines		x	x	x	
Alprazolam		x	x	x	x
Diazepam		x	x	x	x
Flunitrazepam	x	x	x	x	x
α-Hydroxyalprazolam					x
α-Hydroxytriazolam					x
7-Aminoclonazepam					x
Clonazepam					x
Chlordiazepoxide					x
Desalkylflurazepam					x
Estazolam					x
Flurazepam					x
Lorazepam					x
Midazolam					x
Nordiazepam					x
Oxazepam					x
Temazepam					x
Triazolam					x
Other benzodiazepines	x	x	x	x	x
Cannabis	x	x	x	x	x
Carisoprodol		x	x	x	x
Cocaine	x	x	x	x	x
GHB	x	x	x	x	x
Nitrous oxide	x	x	x	x	x
Freon		x	x	x	x
Difluoroethane			x	x	x
Chlorodifluoromethane					x
Helium					x
Toluene					x
Other inhalants		x	x	x	x
Ketamine	x	x	x	x	x
PCP	x	x	x	x	x
Zolpidem				x	x
Heroin	x	x	x	x	x
Hydrocodone	x	x	x	x	x
Methadone	x	x	x	x	x
Oxycodone	x	x	x	x	x
Fentanyl		x	x	x	x
Hydromorphone		x	x	x	x
Meperidine		x	x	x	x
Morphine		x	x	x	x
Propoxyphene		x	x	x	x
Tramadol		x	x	x	x
Oxymorphone				x	x
Buprenorphine				x	x
Codeine					x
Other opioids		x	x	x	
Total	14	31	32	35	50

Fig. 1. List of drugs involved in deaths that were reported to the Florida Medical Examiners Commission from 2001 to 2012. MDA – 3,4-methylenedioxyamphetamine; MDEA – 3,4-methylenedioxy-N-ethylamphetamine; MDMA – 3,4-methylenedioxy-N-methylamphetamine; GHB – gamma-hydroxybutyrate; PCP – phencyclidine.