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Alcohol-involved overdose deaths in US Veterans

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Abstract

Background: Alcohol-involved overdose deaths are increasing and often occur with other substances but have been minimally studied compared to other causes of overdose.

Methods: We used national Veterans Health Administration (VHA) records linked to National Death Index data from 2012–2018 to examine trends in alcohol-related overdose mortality. Patient characteristics and treatment receipt were compared across categories of alcohol overdose deaths (alcohol-only, alcohol+opioids which may include additional substances, and alcohol+other substances without opioids).

Results: From 2012–2018, 2,421 Veterans died from an alcohol-involved overdose (alcohol-only: 868, alcohol+opioids: 1,269, alcohol+other substances: 284). The alcohol-involved overdose rate increased 57% during this period. Compared to those who died of an alcohol-only overdose, Veterans who died from alcohol+opioids and alcohol+other substances were more likely Black or Hispanic, and to have an opioid use disorder, but less likely to live in rural areas or to be diagnosed with alcohol use disorder (AUD). Only 32.5% of those who died from alcohol-involved overdose received treatment in a substance use disorder clinic in the year preceding death, compared to 65.1% seen in mental health and 85.7% in primary care. Only 9.5% of Veterans who died from alcohol overdose received medication treatment for AUD and 24.8% received psychotherapy for AUD in the year preceding death.

Conclusions: Alcohol overdose is increasing primarily related to overdoses involving opioids and other substances. Most patients did not receive any effective medication or psychotherapy

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treatments for AUD, suggesting further need to identify those at risk and to target treatment for this vulnerable group in healthcare settings.

Keywords

alcohol overdose; poisoning; alcohol use disorder treatment; alcohol screening

1. Introduction

Alcohol is the third leading preventable cause of mortality in the US, after tobacco use and poor diet and exercise (Mokdad et al., 2004). More than 95,000 people die annually due to alcohol-related causes and alcohol use disorder (AUD) is the most prevalent substance use disorder, outnumbering all other substance use disorders combined other than tobacco use disorder (Esser, 2020; Grant et al., 2016, 2015). The mortality risks of chronic alcohol use have been well-researched and include liver disease, cardiovascular disease, and certain cancers (World Health Organization, 2018). Less is known about the contributors to mortality related to acute alcohol use, which primarily results from alcohol-involved overdose either alone or in combination with other substances (White et al., 2020). Unlike the substantial body of research on overdose due to opioids or benzodiazepines (Baird et al., 2017; Charlson et al., 2009; Community Management of Opioid Overdose, 2014; Danovitch et al., 2020; Grella et al., 2021), that have informed major prevention efforts, there have been no prior studies comprehensively examining characteristics of patients who died from alcohol overdose, which are critical for informing life-saving treatment and prevention strategies.

Prior work has examined trends and contributors broadly to alcohol mortality (D'Souza et al., 2020; Spillane et al., 2020; White et al., 2020), and found that similar to other overdose patterns in the US, alcohol-involved overdose, either alone or in combination with other substances, is rising; in 2017, alcohol contributed to 12,954 overdose deaths in the US (White et al., 2020). As the overdose epidemic, which initially focused on the role of opioids, continues to escalate, the epidemiology has shifted to increasingly one of polysubstance overdose, including combinations of opioids, stimulants, sedatives, and alcohol (Coughlin et al., 2021; Gladden, 2019; Hedegaard, 2020; Spillane et al., 2020; White et al., 2020). Alcohol's role in overdose has clear mechanistic and dose-response underpinnings. Alcohol is a known respiratory depressant and has synergistic effects with opioids and the risk of a fatal overdose is increased when these substances are used concurrently (Fernandez et al., 2019). Excessive alcohol consumption in a short amount of time (i.e., binge drinking) exceeds the body's ability to metabolize alcohol, resulting in increased blood alcohol content (BAC). Alcohol overdose occurs when BAC levels become so high that it impairs basic life supporting functions, causing respiratory depression, reduced control of the gag reflex, and decreased heart rate ("Alcohol Overdose: The Dangers of Drinking Too Much," n.d.). With recent data indicating substantial increases in alcohol consumption since the start of COVID-19 given easy access and use to address increased psychosocial stressors (Pollard et al., 2020; Rodriguez et al., 2020), greater understanding of alcohol-involved overdose is even more critical, given that alcohol consumption is a modifiable risk factor. Despite concerns about increases in hazardous alcohol use, little is

known about people who die from alcohol overdose, including changes in trends and points of healthcare contact to prioritize overdose prevention and substance use disorder treatment efforts.

This study links the most recently available data from the largest integrated healthcare provider nationally, the Veterans Health Administration (VHA), with National Death Index (NDI) data. The aims of the current study were to: 1) describe trends in patients who died from overdoses related to alcohol-only, alcohol co-involved with opioids, and alcohol co-involved with other substances from 2012 to 2018, and 2) compare patient and service utilization characteristics across alcohol overdose typologies (i.e., alcohol-only, alcohol+opioids, alcohol+other substances) to inform where future prevention and treatment efforts should be prioritized to reach these vulnerable populations.

2. Methods

2.1 Data sources and study design

This retrospective cohort study links VHA patient data with Veteran National Death Index (NDI) data from the National Vital Statistics System mortality files. The Veteran NDI data was obtained from the VA Suicide Data Repository, which provides cause of death data for Veterans (Defense Suicide Prevention Office, 2021). Types of overdose deaths were classified using the International Classification of Diseases, Tenth Revision (ICD-10). Individuals were included in the study cohort if they had at least one inpatient or outpatient VHA encounter in the year prior to overdose death and were aged 18 years or older (see Appendix Table 1 for detailed cohort flow). This study was approved by the VA Ann Arbor Healthcare System Institutional Review Board.

2.2 Measures

2.2.1 Cause of Death—The NDI includes national data on causes of death and date of death for all US residents, using death certificate information from state vital statistics offices. We comprehensively examined alcohol involvement across all types of overdoses. Individuals were included if they died during fiscal years (FYs) 2012–2018 from underlying cause of death classified as unintentional (as indicated by ICD codes X40–X44), undetermined (Y10–Y14), intentional (X60–X69), or assault/homicide (X85–X90; see Appendix Table 2 for prevalence across categories). The sample was further restricted to alcohol involved overdose if alcohol was listed as an underlying or as a multiple cause of death (Appendix Table 1). Other substances may also have been involved, but alcohol was involved in all of the overdose deaths included. From there, patients were categorized in the following mutually exclusive categories: alcohol-only overdose, alcohol+opioids, and alcohol+other substances. Those categorized in alcohol+opioids could have other substances involved but must include an opioid, whereas those in alcohol+other substances could include any other substance besides opioids.

2.2.2 Patient Characteristics—Demographic and patient clinical characteristics were obtained from the VHA Corporate Data Warehouse (CDW), the national database of VHA medical records. We included the following demographic characteristics: age, sex, race/

ethnicity, homelessness status, and rural/urban residence. Rural/urban status was defined by Rural-Urban Commuting Areas (RUCAs) geographic taxonomy using patient zip codes ("USDA ERS - Rural-Urban Commuting Area Codes," n.d.), and homelessness by utilization of homeless Veteran services in the 12-month period preceding death (Appendix Table 3). In addition, clinical conditions (i.e., mental health, substance use disorders) documented in medical records were included in the 12-month period preceding overdose. Specific clinical diagnoses included AUD, opioid use disorder, other substance use disorders, depressive disorders, and post-traumatic stress disorder (PTSD) (Appendix Table 4). In addition, we also examined screening results for hazardous drinking using the Alcohol Use Disorders Identification Test-Consumption (AUDIT-C) in the year prior to death among this cohort (Bradley et al., 2016a, 2007). The number of Elixhauser Comorbid conditions was included to indicate overall medical complexity (van Walraven et al., 2009). Finally, we included treatment utilization prior to overdose, including treatment in primary care, primary care mental health integration (the VHA's collaborative care for improving treatment of mental health conditions in primary care (Post et al., 2010)), mental health, substance use disorder, and PTSD clinic (Appendix Table 5). We specifically examined use of evidence-based treatments for alcohol use disorder (AUD) by examining receipt of psychotherapy for AUD and medications for AUD (Appendix Table 6).

2.3 Statistical Analyses

First, we examined trends in alcohol overdose rates across the three categories of patients. To obtain alcohol overdose rates, annual cohorts of VHA Veterans were created each year between FY2012–2018 and overdose mortality rates were calculated per 100,000 person-years of risk time across the VHA Veteran population in each fiscal year (Lin et al., 2019; McCarthy et al., 2009). Poisson regressions with log person-years as an offset were used to compare changes in rates including those adjusted for demographic changes (age, gender, race/ethnicity) from 2012 to 2018 in the overall VHA patient populations (Lin et al., 2019). Then using the entire cohort of patients who died from alcohol-involved overdose, patient demographic and clinical characteristics, including treatment utilization, were compared across the three groups: alcohol-only overdose, alcohol+opioids, and alcohol+other substances. Adjusted logistic regression models were used to compare characteristics of alcohol+opioids patients with alcohol-only and alcohol+other substances with alcohol-only.

3. Results

3.1 Description of cohort and trends

From FY2012 to 2018, 2,421 patients died from any alcohol-involved overdose including 868 (35.9%) patients who died from alcohol-only, 1,269 (52.4%) alcohol+opioids, and 284 (11.7%) alcohol+other substances. From 2012 to 2018, the rate of alcohol-involved overdose increased from 4.11 to 6.44 per 100,000 person-years (Figure 1; Rate Ratio = 1.57, 95% CI 1.33–1.84). Rates of alcohol-only overdose remained generally stable over the study period (from 1.98 in 2012 to 2.01 in 2018, Rate ratio = 1.02, 95% CI 0.78–1.30). However, rates of alcohol+opioid overdose increased from 1.72 in 2012 to 3.66 in 2018 (Rate ratio = 2.13, 95% CI 1.68–2.69), and rates of alcohol+other substances increased

from 0.40 in 2012 to 0.78 in 2018 (Rate ratio = 1.94, 95% CI 1.53–2.46). Appendix Table 7 depicts adjusted changes in rates over the study period. Across alcohol-involved overdoses, stimulants (20.9%, n=505) were the most commonly involved other substance, followed closely by the specific opioids, heroin (20.8%, n=503) and prescription opioids (19.8%, n=480; Appendix Table 8). Descriptive information and clinical characteristics of this cohort of patients who died from alcohol-involved overdose is shown in Table 1. Briefly, the cohort comprised of mostly middle-age (45–64 years olds; 62.4%), men (95.0%) who were White non-Hispanic (67.05; 19.3% were Black non-Hispanic). About one-quarter had been recently homeless (27.8%) and most were non-rural dwelling (87.8%). Among these Veterans who died from alcohol overdose, 75% had completed AUDIT-C screening in the year prior to death and 49% of male and 44% of female Veterans met criteria for hazardous alcohol use (Bradley et al., 2007, 2016b).

3.2 Patient characteristics across alcohol overdose groups

Table 1 depicts patient characteristics comparing individuals across the three overdose groups Patients who died from alcohol-only overdose were significantly more likely to be White non-Hispanic and live in rural areas and less likely to be homeless, and less likely to be diagnosed with opioid use disorder. Prevalence of comorbid mental health conditions including depression and PTSD were similar across the groups. Prevalence of diagnosed AUD was higher among those who died from alcohol-only overdose, though on average only 57.3% of patients who died from alcohol overdose had an AUD diagnosis in the year prior to death. Figure 2a and 2b depict specific substances involved in overdose across the alcohol overdose groups.

In adjusted analyses (Table 2), compared to patients who died from alcohol-only overdose, those who died from alcohol+opioids had significantly lower likelihood of being ≥ age 65 (AOR 0.33, 95% CI 0.19–0.55), rural (AOR 0.54, 95% CI 0.39–0.74), diagnosed with AUD (AOR 0.46, 95% CI 0.36–0.58) and significantly higher likelihood of being male (AOR 2.03, 95% CI 1.33–3.10), Black non-Hispanic (AOR 2.08, 95% CI 1.59–2.73), Hispanic (AOR 1.98, 95% CI 1.23–3.18), and diagnosed with opioid use disorder (AOR 6.37, 95% CI 4.69–8.66). Compared to patients who died from alcohol-only, those who died from alcohol+other substances had significantly lower likelihood of being diagnosed with AUD (AOR 0.43, 95% CI 0.29–0.62) and significantly higher likelihood of being Black (AOR 3.71, 95% CI 2.61–5.28), Hispanic (AOR 2.27, 95% CI 1.14–4.52), and diagnosed with opioid use disorder (AOR 2.19, 95% CI 1.34–3.58).

3.3 Healthcare and AUD treatment utilization prior to overdose

Utilization of outpatient care varied widely across treatment settings ranging from 85.7% of patients seen in primary care and 65.1% seen in mental health clinics compared to 32.5% seen in SUD clinic within one year prior to death (Table 3). Only a small proportion of patients across all groups received medications for alcohol treatment in the year prior to overdose death (9.5%), and only 24.8% received any psychotherapy for AUD.

4. Discussion

In this study of the population of Veterans in the Veterans Health Administration, we found alcohol-involved overdose increased 57% from FY2012 to 2018, due primarily to an increase in rate of overdose involving alcohol, opioids, and other substances. Alcohol+opioid overdoses (which may have also included other substances) comprised the majority of alcohol-involved overdoses, followed by alcohol-only overdoses. There were important differences in patient characteristics across the three categories. However, the most concerning finding is that across all patients who died from an alcohol-involved overdose, although the large majority received alcohol screening and many screened positive for hazardous alcohol use, only a small fraction received medication or psychotherapy for AUD, demonstrating a large care gap.

These results showing increasing alcohol overdose rates are consistent with the few other studies that have reported trends in alcohol-related mortality (Spillane et al., 2020; White et al., 2020), but we focus on acute alcohol-related deaths due to overdose with more recent data and show increases are related to rises in overdoses involving alcohol in combination with opioids and other substances. These results indicate increasing rates of mortality related to alcohol overdose, which has been under-recognized compared other causes of substance overdose, indicating further efforts are needed to prevent alcohol overdose, which is a critical and addressable contributor to alcohol-related mortality. Little prior work has explicitly addressed overdose risk and treatment needs for patients using alcohol combined with opioids or other substances, although there are efficacious approaches to reducing opioid overdose risk through behavioral interventions and increasing availability of naloxone (Chen et al., 2020; Smart et al., 2021). Concerning overdoses involving alcohol and opioids, naloxone, an opioid antagonist, could reverse the effects of the opioid, but it is unclear how effective naloxone is when another respiratory depressant like alcohol is present. Nevertheless, given naloxone's role as a primary means of opioid overdose prevention, it may be particularly vital to ensure access to naloxone for people who use opioids with other substances, including alcohol. Given the synergistic effects of alcohol and opioids on respiratory depression, where even a moderate amount of alcohol in combination with a moderate dose of opioids can substantially decrease respiration (van der Schrier et al., 2017), a smaller amount of either opioids or alcohol, when used in combination, could precipitate an overdose compared to the use of either alone. It is also important to engage patients with AUD or risky alcohol use in conversations about the risk of overdose, but further studies are needed, like those in other types of overdose (Bohnert, 2011; Park et al., 2015), to understand the relationship between quantity and frequency of alcohol use and risk of overdose to guide prevention strategies.

Several important differences in patient characteristics were identified across alcohol-related overdose groups. Alcohol-only overdoses were more likely among Veterans residing in rural areas than alcohol overdose deaths that also involved opioids and/or other substances. This is consistent with recent national trends showing higher rates of alcohol-induced deaths in rural compared to urban parts of the US (Spencer et al., 2020). Veterans who died from alcohol-involved overdoses that also included other substances compared to alcohol-alone were more likely to identify as Hispanic or as Black than as non-Hispanic White. This finding fits

within the context of prior work documenting disproportionate rates of alcohol-attributable deaths broadly among racial and ethnic minorities relative to alcohol use prevalence (Keyes et al., 2012), and greater increases in overdoses involving alcohol and prescription opioids from 2002–03 to 2014–15 among minorities compared to those who identified as White (Kandel et al., 2017). In addition, people who died from polysubstance-related alcohol overdose deaths (i.e., alcohol+opioid or alcohol+other substance) were less likely to have received a diagnosis of AUD in the year prior to death. This may be due to other diagnoses, such as opioid use disorder, being disproportionately identified and highlighting the need for thorough assessments of substance use disorders among people who use multiple substances to improve diagnostic accuracy and identify particularly vulnerable patients.

Finally, despite the high rate of AUD in this sample, people who died from alcohol-related overdose deaths had low rates of use of the frontline treatments for AUD, including both AUD medication and psychotherapy, even though most had been screened via the AUDIT-C and many had screened positive for hazardous alcohol use in the year prior to death. AUD is a major risk factor for overdose, and there are effective treatments for AUD, but these treatments primarily are available in specialty SUD clinics. Some patients may have been referred and did not seek care due to barriers including treatment stigma, limited transportation, and ambivalence about treatment (Chartier et al., 2016; Coulson et al., 2009). Overall, treatment rates are quite low among patients with AUD; approximately 90% of people in the US who could (Olfson et al., 2019) benefit from AUD treatment do not seek or engage in such care. Similarly, we find that treatment utilization among those who died from alcohol overdose is quite low in the year before death, despite the high risk behaviors and comorbidities. Although use of medication treatment was higher than the 5% found among the broader Veteran population with AUD (Williams et al., 2017), the rates of treatment found here remain extremely low, given both signs of active hazardous drinking from the AUDIT-C scores and the clear impacts of alcohol use in this cohort. These results emphasize the need to increase treatment reach for complex patients with high levels of alcohol use and treatment need. Individuals who died of overdose with alcohol+opioids and alcohol+other substances were more often seen in SUD clinics, but still only a quarter of all patients were seen in SUD clinics within one year prior to death. The majority were seen in mental health and primary care settings, where screening for high risk alcohol and substance use should take place, with appropriate follow-up and referrals or initiation of treatment in those settings.

Despite the novelty of these analyses in a large population, there are important limitations to consider when interpreting the findings herein. First, the sample is of US Veterans and predominantly male, which may not generalize to the US population and women. However, the VHA provides care to a population at elevated risk for overdose and is the largest single provider of substance use disorder care in the US (Wyse et al., 2018), which provides a unique data source of a vulnerable population to examine national cause of death data and treatment utilization. Only care received through VHA is included in these findings. Some Veterans obtain medications, such medications for AUD, outside of the VHA (Moyo et al., 2019), and Veterans not receiving VHA care are not included in these data. There is also evidence suggesting that alcohol is often omitted from death certificates (Castle et al., 2014; Hanzlick, 1988). Alcohol's role in other causes of mortality is often under-counted and

under-documented in death certificate data, indicating these results are likely a conservative estimate of alcohol involvement in overdose deaths.

In sum, we found that alcohol-involved overdose rates have increased in Veterans, primarily related to increases in overdoses involving alcohol, opioids and other substances. The vast majority of patients who died from an alcohol-involved overdose, who likely represent a population with severe consequences from alcohol use and AUD, do not receive any medications or psychotherapy for AUD. Even compared to the treatment gap for other overdose populations, the treatment gap is enormous for those who die from alcohol overdose. To date, there have been minimal studies examining the population who die from alcohol-involved overdose and interventions to prevent these deaths. Future studies should examine which patients are at the highest risk for alcohol overdose and target overdose prevention and AUD treatment in these patients in non-specialty settings and better engage these patients in AUD care. To do this successfully, it will be critical to determine how to identify those in need and engage these patients who are often non-treatment-seeking and decrease barriers to care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Declaration of interests:

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Conflicts of interest:

Dr. Lin serves as a consultant for National Committee on Quality Assurance on alcohol use disorder treatment via a grant from Alkermes.

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Highlights

- Alcohol overdose mortality rate increased 57% in Veterans from 2012–2018
- Alcohol overdose is increasing primarily due to overdoses involving opioids and other substances
- < 10% who died from alcohol overdose received AUD medication and < 25% received psychotherapy
- Most Veterans who died from alcohol overdose were seen in primary care or mental health but not in SUD settings

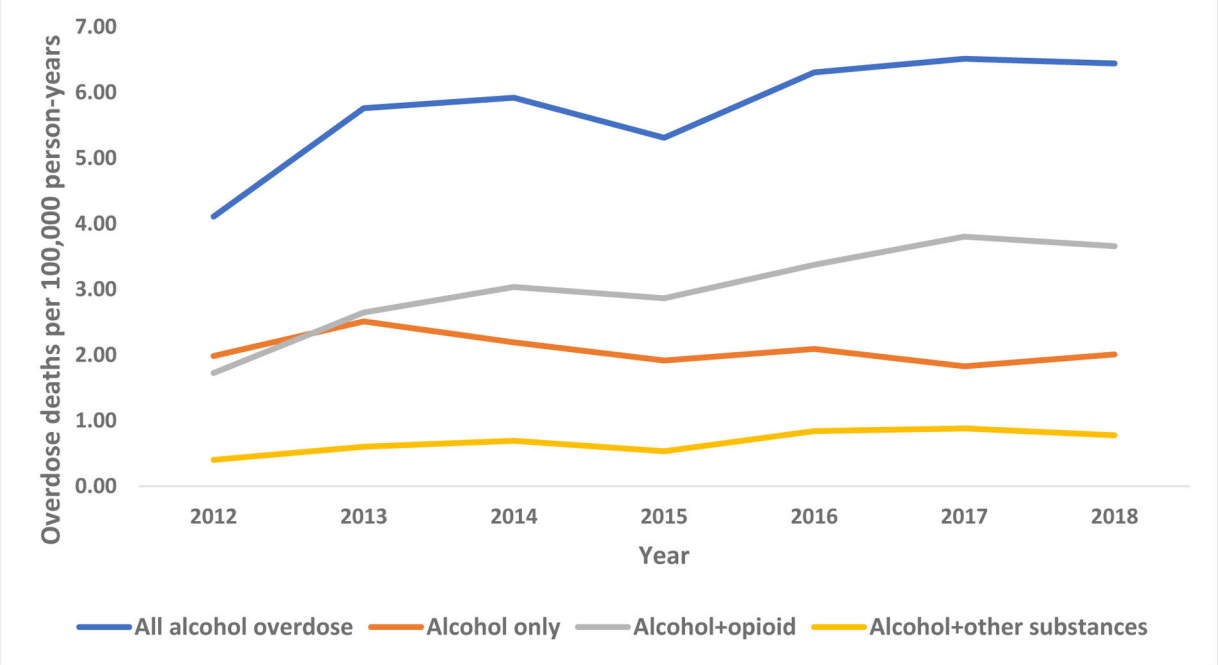

Figure 1.
Alcohol-involved overdose rates in US Veterans (2012–2018)

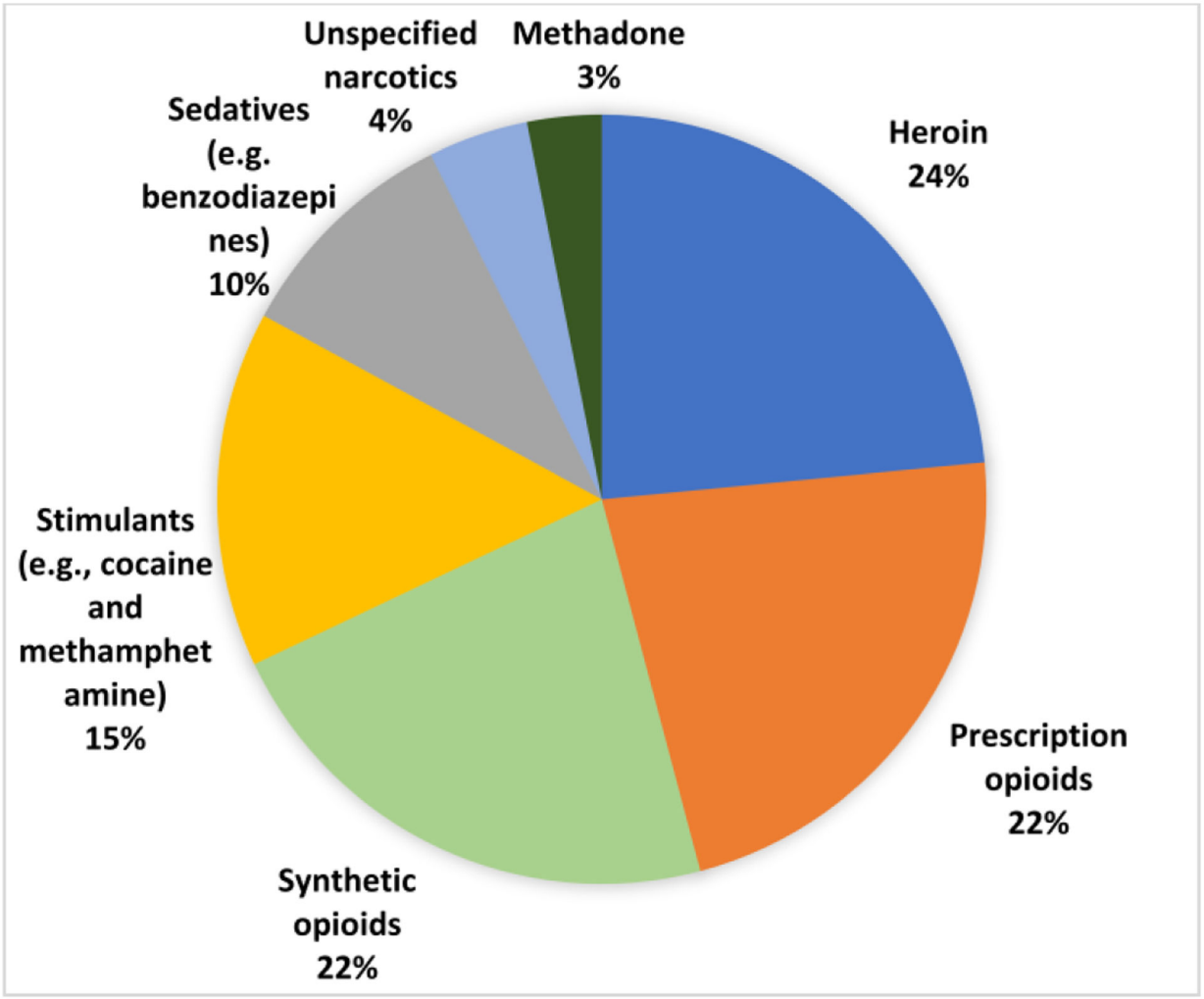

Figure 2a.
Substances involved in alcohol + opioid overdose (n=1,269)

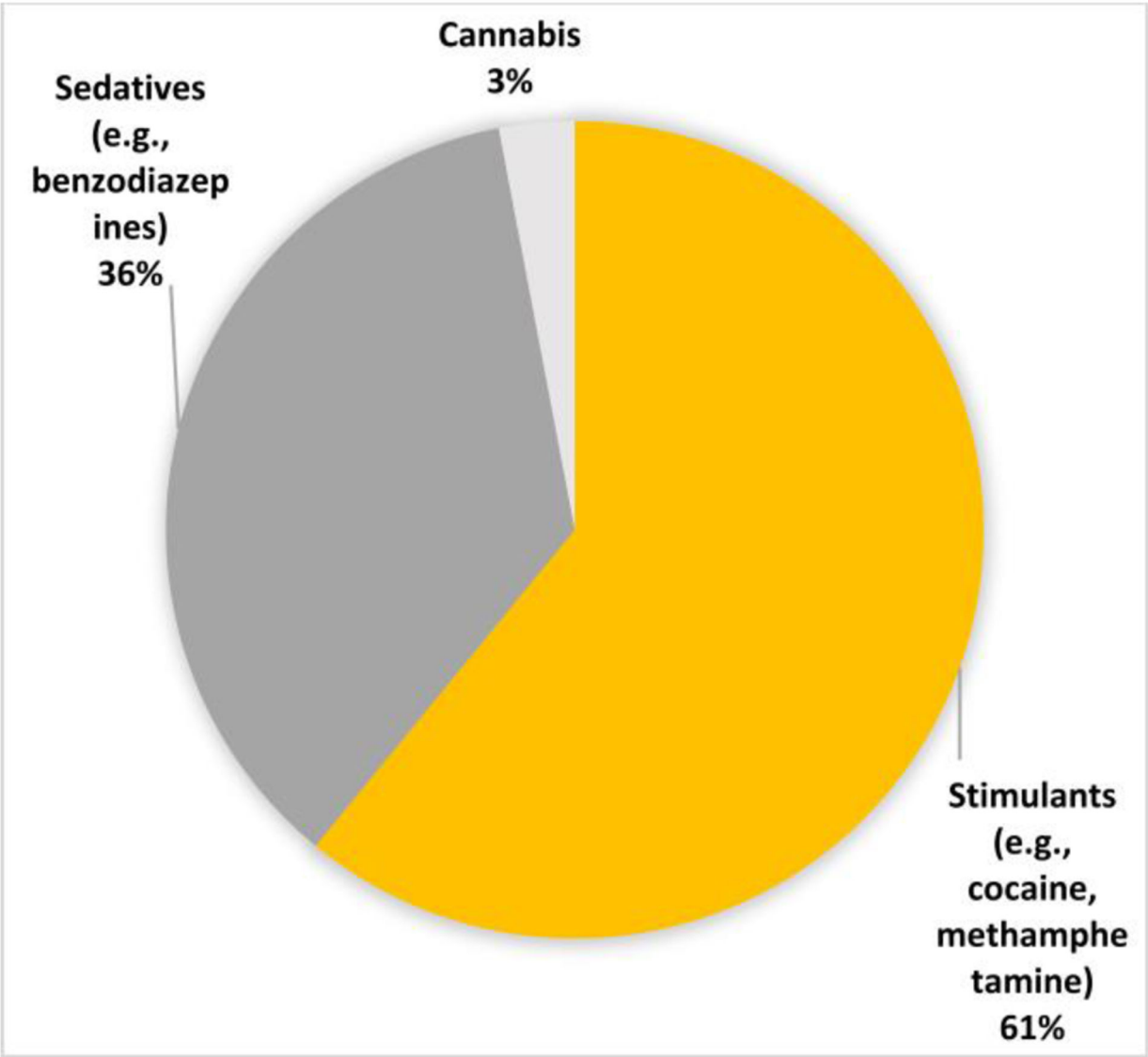

Figure 2b.
Substances involved in alcohol + other substance overdose (n=284)

Table 1.

Comparing characteristics of patients across alcohol overdose groups

	Alcohol-only (n= 868, 35.9%)	Alcohol + opioids (n=1269, 52.4%)	Alcohol + other substances (n=284, 11.7%)	*p*-value	All alcohol-involved overdose (n=2421)
Age Group (years)					
18 – 29	33 (3.8%)	66 (5.2%)	13 (4.6%)		112 (4.6%)
30 – 44	142 (16.4%)	260 (20.5%)	43 (15.1%)	<0.01	445 (18.4%)
45 – 64	510 (58.8%)	821 (64.7%)	180 (63.4%)		1511 (62.4%)
65 and older	183 (21.1%)	122 (9.6%)	48 (16.9%)		353 (14.6%)
Male	810 (93.3%)	1221 (96.2%)	269 (94.7%)	0.01	2300 (95.0%)
Race/Ethnicity					
White, non-Hispanic	642 (74.0%)	826 (65.1%)	155 (54.6%)	<0.01	1623 (67.0%)
Black, non-Hispanic	100 (11.5%)	275 (21.7%)	92 (32.4%)		467 (19.3%)
Hispanic	29 (3.3%)	69 (5.4%)	14 (4.9%)		112 (4.6%)
Other/Unknown	97 (11.2%)	99 (7.8%)	23 (8.1%)		219 (9.1%)
Homeless	197 (22.7%)	385 (30.3%)	91 (32.0%)	<0.01	673 (27.8%)
Rurality					
Non-rural	724 (83.4%)	1145 (90.2%)	257 (90.5%)	<0.01	2126 (87.8%)
Rural	117 (13.5%)	85 (6.7%)	20 (7.0%)		222 (9.1%)
Other/unknown	27 (3.1%)	39 (3.1%)	7 (2.5%)		73 (3.0%)
Key mental health and substance use disorder screening and diagnoses					
Alcohol use disorder	540 (62.2%)	697 (54.9%)	150 (52.8%)	<0.01	1387 (57.3%)
Opioid use disorder	62 (7.1%)	374 (29.5%)	36 (12.7%)	<0.01	472 (19.5%)
Other substance use disorder	288 (33.2%)	447 (35.2%)	101 (35.6%)	0.58	836 (34.5%)
Depressive disorder	461 (53.1%)	666 (52.5%)	165 (58.1%)	0.23	1292 (53.4%)
PTSD	248 (28.6%)	405 (31.9%)	79 (27.8%)	0.16	732 (30.2%)
Received AUDIT-C screening	650 (74.9%)	951 (74.9%)	217 (76.4%)	0.86	1818 (75.1%)
Hazardous alcohol use in men[1]	348 (57.3%)	401 (43.9%)	92 (45.1%)	< 0.01	841 (48.8%)
Hazardous alcohol use in women[2]	23 (53.49%)	13 (34.21%)	5 (38.46%)	0.15	41 (43.62%)
# of medical conditions					
0	101 (11.6%)	162 (12.8%)	33 (11.6%)	0.87	296 (12.2%)
1	111 (12.8%)	158 (12.5%)	30 (10.6%)		299 (12.4%)
2	121 (13.9%)	187 (14.7%)	39 (13.7%)		347 (14.3%)
≥3	535 (61.6%)	762 (60.1%)	182 (64.1%)		1479 (61.1%)

[1] AUDIT-C≥4

[2] AUDIT-C≥3

Table 2.

Logistic regression models comparing patients across alcohol overdose groups

	Alcohol + opioids vs. alcohol-only (reference)	Alcohol + others vs. alcohol-only (reference)
Age group		
18–29 (ref)	ref	ref
30–44	0.95 (0.58,1.58)	0.66 (0.31,1.41)
45–64	0.79 (0.49,1.28)	0.63 (0.31,1.28)
65 and older	0.33 (0.19,0.55) *	0.58 (0.27,1.25)
Sex (ref=female)	2.03 (1.33,3.10) *	1.45 (0.78,2.71)
Race/Ethnicity		
White, non-Hispanic (ref)	ref	ref
Black, non-Hispanic	2.08 (1.59,2.73) *	3.71 (2.61,5.28) *
Hispanic	1.98 (1.23,3.18) *	2.27 (1.14,4.52) *
Other/unknown	0.94 (0.68,1.30)	1.14 (0.68,1.88)
Homeless (ref = no)	1.13 (0.90,1.42)	1.53 (1.09,2.15) *
Rurality		
Non-rural (ref)	ref	ref
Rural	0.54 (0.39,0.74) *	0.59 (0.35,0.99) *
Other/unknown	1.00 (0.59,1.72)	0.61 (0.25,1.49)
Key clinical diagnoses		
Alcohol Use Disorder	0.46 (0.36,0.58) *	0.43 (0.29,0.62) *
Opioid Use Disorder	6.37 (4.69,8.66) *	2.19 (1.34,3.58) *
Other Substance Use Disorder	1.14 (0.93,1.39)	1.11 (0.82,1.51)
Depressive Disorder	0.88 (0.70,1.11)	1.38 (0.96,1.98)
PTSD	1.09 (0.87,1.37)	0.99 (0.70,1.40)
# of comorbidities		
0 (ref)	ref	ref
1	1.11 (0.76,1.61)	0.95 (0.52,1.76)
2	1.29 (0.87,1.91)	1.27 (0.69,2.34)
≥3	1.11 (0.76,1.62)	1.24 (0.68,2.26)

* $p < 0.05$

Table 3.

Treatment utilization prior to alcohol-involved overdose deaths[1]

Total No. (%)	Alcohol alone (n= 868, 35.9%)	Alcohol + opioids (n=1269, 52.4%)	Alcohol + others (n=284, 11.7%)	*p*-value	All alcohol-involved overdose (n=2421)
Points of healthcare contact					
PTSD clinic					
12 months	82 (9.5%)	134 (10.6%)	32 (11.3%)	0.59	248 (10.2%)
6 months	57 (6.6%)	90 (7.1%)	18 (6.3%)	0.84	165 (6.8%)
3 months	39 (4.5%)	54 (4.3%)	13 (4.6%)	0.95	106 (4.4%)
7 days	6 (0.7%)	17 (1.3%)	3 (1.1%)	0.36	26 (1.1%)
SUD clinic					
12 months	251 (28.9%)	440 (34.7%)	95 (33.5%)	0.02	786 (32.5%)
6 months	189 (21.8%)	324 (25.5%)	71 (25.0%)	0.13	584 (24.1%)
3 months	139 (16.0%)	238 (18.8%)	52 (18.3%)	0.26	429 (17.7%)
7 days	34 (3.9%)	78 (6.2%)	13 (4.6%)	0.07	125 (5.2%)
General mental health clinics					
12 months	553 (63.7%)	830 (65.4%)	192 (67.6%)	0.46	1575 (65.1%)
6 months	467 (53.8%)	695 (54.8%)	160 (56.3%)	0.75	1322 (54.6%)
3 months	362 (41.7%)	551 (43.4%)	131 (46.1%)	0.41	1044 (43.1%)
7 days	89 (10.3%)	130 (10.2%)	36 (12.7%)	0.46	255 (10.5%)
Primary care					
12 months	742 (85.5%)	1087 (85.7%)	245 (86.3%)	0.95	2074 (85.7%)
6 months	588 (67.7%)	892 (70.3%)	212 (74.7%)	0.08	1692 (70.0%)
3 months	406 (46.8%)	633 (49.9%)	150 (52.8%)	0.15	1189 (49.1%)
7 days	62 (7.1%)	85 (6.7%)	17 (6.0%)	0.79	164 (6.8%)
Primary care mental health integration					
12 months	108 (12.4%)	131 (10.3%)	46 (16.2%)	0.02	285 (11.8%)
6 months	62 (7.1%)	82 (6.5%)	25 (8.8%)	0.37	169 (7.0%)
3 months	37 (4.3%)	60 (4.7%)	17 (6.0%)	0.49	114 (4.7%)
7 days	6 (0.7%)	11 (0.9%)	4 (1.4%)	0.53	21 (0.9%)
Receipt of alcohol-related treatment					
AUD medication treatment					
12 months	90 (10.4%)	113 (8.9%)	27 (9.5%)	0.53	230 (9.5%)
6 months	68 (7.8%)	82 (6.5%)	19 (6.7%)	0.46	169 (7.0%)
3 months	48 (5.5%)	64 (5.0%)	12 (4.2%)	0.68	124 (5.1%)
7 days	11 (1.3%)	27 (2.1%)	2 (0.7%)	0.13	40 (1.7%)
AUD psychotherapy					
12 months	224 (25.8%)	310 (24.4%)	67 (23.6%)	0.67	601 (24.8%)
6 months	160 (18.4%)	199 (15.7%)	51 (18.0%)	0.22	410 (16.9%)
3 months	116 (13.4%)	134 (10.6%)	37 (13.0%)	0.12	287 (11.9%)
7 days	13 (1.5%)	26 (2.1%)	5 (1.8%)	0.64	44 (1.8%)

[1]Treatment utilization categories are not mutually exclusive. For example, a patient who received a SUD clinic visit 9 months before overdose death would also be counted within the 7 day, 3 months and 6 months' categories.