



Published in final edited form as:

Am J Med. 2019 April ; 132(4): 478–488.e4. doi:10.1016/j.amjmed.2018.11.038.

National Rate of Tobacco and Substance Use Disorders Among Hospitalized Heart Failure Patients

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Abstract

BACKGROUND: Several cardiotoxic substances impact heart failure incidence. The burden of comorbid tobacco or substance use disorders among heart failure patients is under-characterized. We describe the burden of tobacco and substance use disorders among hospitalized heart failure patients in the United States.

METHODS: We calculated the proportion of primary heart failure hospitalizations in the 2014 National Inpatient Sample with tobacco or substance use disorders accounting for demographic factors.

RESULTS: Of 989,080 heart failure hospitalizations, 15.5% (n = 152,965) had documented tobacco (n = 119,285, 12.1%) or substance (n = 61,510, 6.2%) use disorder. Female sex was associated with lower rates of tobacco (odds ratio [OR] 0.72; 95% confidence interval [CI], 0.70–0.74) and substance (OR 0.37; 95% CI, 0.36–0.39) use disorder. Tobacco and substance use disorder rates were highest for hospitalizations <55 years of age. Native American race was associated with increased risk of alcohol use disorder (OR 1.67; 95% CI, 1.27–2.20) and black race with alcohol (OR 1.09; 95% CI, 1.02–1.16) or drug (OR 1.63; 95% CI, 1.53–1.74) use

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Authorship: All authors had access to the data and a role in writing the manuscript.

Conflict of Interest: GCF: Research: National Institutes of Health, American Heart Association; Consulting: Abbott (modest), Amgen, Janssen, Medtronic, Novartis; all other authors have no conflicts of interest to report.

SUPPLEMENTARY MATERIAL

Supplementary data associated with this article can be found in the online version, at <https://doi.org/10.1016/j.amjmed.2018.11.038>.

disorder. Medicaid insurance or income in the lowest quartile were associated with increased risk of tobacco and substance use disorders.

CONCLUSIONS: Tobacco and substance use disorders affect vulnerable heart failure populations, including those of male sex, younger age, lower socioeconomic status, and racial/ethnic minorities. Enhanced screening for tobacco and substance use disorders in hospitalized heart failure patients may reveal opportunities for treatment and secondary prevention.

Keywords

Alcohol; Drug use; Health care disparities; Heart failure; Hospitalization; Substance use; Tobacco

INTRODUCTION

Heart failure is the fourth overall principal diagnosis, and first among cardiovascular conditions as the reason for hospitalization in the United States.¹ Heart failure is a prevalent condition with several preventable etiologies, including uncontrolled hypertension or ischemic heart disease.² Behavioral risk factors such as tobacco, alcohol, and drug use are known to contribute to heart failure incidence.^{3–5} Alcohol,^{6,7} cocaine,^{8,9} and amphetamines^{10–12} have cardiotoxic effects. Drug overdose death rates in the US are rising, especially in younger persons.¹³ The burden of active tobacco and substance use disorders among hospitalized heart failure patients in the US has not been well described.

Nationally representative administrative data facilitate understanding the burden of tobacco and substance use disorders among heart failure patients and its potential influence on health outcomes. Vulnerable populations, including patients from racial/ethnic minorities or lower socioeconomic status, may be at increased risk of developing tobacco or substance use disorders for multiple reasons including social stressors, lack of economic opportunity, and community factors.^{14–16} Identifying heart failure patients with tobacco or substance use disorders is critical to developing treatment strategies to address observed cardiovascular health disparities.

We describe the national burden of heart failure and comorbid tobacco or substance use disorder among hospitalized patients in the United States. We used data from the 2014 National Inpatient Sample (NIS) to describe diagnosis rates of tobacco and substance use disorders among hospitalized heart failure patients and examined demographic groups that may be at higher risk for these disorders.

METHODS

Data Source

The NIS dataset provides hospital administrative data through the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project. It contains approximately 7 million weighted hospital discharges representing 35 million inpatient hospitalizations.¹⁷ The NIS unit of analysis is a discharge; therefore, readmissions are not identified. The sample is drawn from 44 states and the District of Columbia, covering more than 96% of the US population. A 20% stratified sample is obtained from 4411 US community hospitals. All

insurance payer sources are included. Survey weights are provided to obtain national estimates for relevant statistics.

Study Cohort

Heart failure was defined by any International Classification of Diseases, Ninth Revision-Clinical Modification (ICD-9-CM) code that mentioned a heart failure syndrome (Supplementary Table 1, available online). A primary heart failure hospitalization was defined as any heart failure ICD-9-CM code used as the first listed discharge code, consistent with prior publications.^{18,19} Patients younger than 18 years were excluded. Race/ethnicity was classified as white, black, Hispanic, Asian/Pacific Islander (PI), or Native American, as captured by administrative hospital data. Additional demographic factors included age, sex, payer source, geographic census division, and median household income based on ZIP Code.

Substance use disorder was defined as any alcohol or drug use disorder, excluding tobacco, which was a separate outcome. Tobacco, alcohol, and drug use disorders were defined using Clinical Classifications Software and ICD-9-CM codes (Supplementary Table 2, available online).²⁰ Drug use disorder was sub-divided into cocaine, cannabis, opioid, amphetamine, psychotherapeutic (pain relievers, tranquilizers, stimulants, and sedatives), hallucinogen, and other use disorder categories (Supplementary Table 3, available online).²¹

Statistical Analysis

Overall and for each tobacco and substance use disorder category, we estimated the national proportion of hospitalized heart failure patients and provided descriptive statistics for patient characteristics, select comorbidities, hospital length of stay, and inpatient mortality. We next stratified heart failure hospitalizations by sex and other demographic factors (age, race/ethnicity, geographic census division, payer source, and median household income of patient's ZIP Code). For each stratum, we reported the percentage of patients in each tobacco or substance use disorder category.

Tobacco and substance use disorder rates were age-standardized (by single year of life for ages between 18 and 90 years or greater) using the 2000 US Standard Population, per Center for Disease Control and Prevention recommendations.²² To evaluate demographic factors (sex, race/ethnicity, region, health insurance, and median household income) associated with each comorbid tobacco or substance use disorder category, we used logistic regression models accounting for clustering (region and hospital level) and nonlinear age-adjustment using multivariable fractional polynomials.²³ Selection of best-fit multivariable fractional polynomial models used a closed-test algorithm.²⁴ This curvilinear adjustment was used to reduce residual confounding that may arise secondary to model misspecification using age as a single linear term.²⁵

All estimation procedures were performed with appropriate NIS survey weights to account for sampling design, and all results are presented as the weighted national 2014 hospitalized population. Analyses were performed in STATA 15.1 (StataCorp, College Station, Tex). The institutional review board provided an exemption for this research.

RESULTS

There were 989,080 heart failure hospitalizations in the US in 2014 (Table 1), of which 15.5% (n = 152,965) had documented tobacco or substance use disorder. Tobacco use disorder was found in 12.1% (n = 119,285), substance use disorder in 6.2% (n = 61,510), alcohol use disorder in 3.5% (n = 34,285) and drug use disorder in 3.5% (n = 34,600). Both tobacco and substance use disorder were documented on 2.8% (n = 27,830) of heart failure hospitalizations, while both alcohol and drug use disorder were found in 0.7% (n = 7375).

In the overall heart failure cohort, mean patient age was 72.0 years (SD 14.2), and females comprised almost half (48.5%) of the hospitalizations. The majority of heart failure hospitalizations were for patients age 65 years or older (71.2%), of white race/ethnicity (64.3%), and with payer source of Medicare (74.2%). The most common comorbidities were hypertension (81.8%) and coronary artery disease (55.3%). Demographic patterns of the cohort with no tobacco or substance use disorder mirrored that of the overall heart failure cohort.

Tobacco Use Disorder and Heart Failure Hospitalizations

Tobacco use disorder patients were younger (mean age 61.2 years, SD 12.7) than the overall heart failure cohort and 36.0% female (Table 1). Tobacco use disorder was more common among males than females across demographic subcategories (Table 2). Rates were highest for both sexes between ages 45 and 55 years (30.8% males, 26.6% females). Native American males had highest age-adjusted rates (31.4%), while white and Native American females had highest age-adjusted rates (21.8% and 21.1%, respectively). Tobacco use disorder rates were highest in the East South Central region (17.5% males, 11.3% females) and for payer status of no charge (34.8% males, 19.5% females), self-pay (33.5% males, 24.5% females), or Medicaid (32.8% males, 23.1% females). Rates of tobacco use disorder increased as median household income decreased.

Substance Use Disorder and Heart Failure Hospitalizations

Heart failure hospitalizations with documented substance use disorder represented younger patients (mean age 57.6 years, SD 13.0) than the overall or tobacco use disorder cohorts and were 22.9% female (Table 1). Substance use disorder diagnosis rates were highest for males 45 to 55 years of age (25.1%) and females <45 years of age (13.9%) (Table 2). Native Americans had the highest rates of substance use disorder when age adjusted (31.2% males, 13.1% females). Substance use disorder was highest for heart failure hospitalizations in the Pacific region, payer status of Medicaid, self-pay or no-charge, and for lower income quartiles.

Alcohol Use Disorder and Heart Failure Hospitalizations

Alcohol use disorder was less common among female heart failure hospitalizations relative to tobacco and drug use disorder (Table 1). Heart failure hospitalizations for those age 45 to 55 years had highest rates of alcohol use disorder (13.2% males, 3.7% females) (Table 2). Alcohol use disorder rates were highest among Native Americans (23.8% males, 8.3% females, age-adjusted), the Pacific region (8.1% males, 1.6% females), payer status of no

charge (16.6% males, 4.1% females), Medicaid (14.0% males, 3.4% females) or self-pay (13.6% males, 3.1% females), and the lowest income quartile.

Drug Use Disorder and Heart Failure Hospitalizations

Heart failure hospitalizations with drug use disorder were the youngest cohort (mean age 53.9 years, SD 12.3) and 29.1% female (Table 1). Racial/ethnic minorities had higher representation among drug use disorder hospitalizations, as 44.9% of drug use disorder hospitalizations were for black race/ethnicity. Medicaid insurance (43.3%) and lowest quartile income (47.3%) was more prevalent among heart failure hospitalizations with drug use disorder compared with no use, tobacco, or alcohol use disorder (Table 1).

Cocaine was the most frequent substance-specific drug use (11,700 hospitalizations), followed by other unspecified drugs (n = 8855), cannabis (n = 8060), opioids (n = 5840), and amphetamines (n = 5280) (Table 3). Drug use disorder was generally most common for both sexes age <45 years. For males, highest rates of drug use disorder were for Asian/PI hospitalizations (age-adjusted 26.5%), while for females, highest rates were for black hospitalizations (age-adjusted 9.4%) (Table 2). Asian/PI males and females had highest rates of amphetamine use (age-adjusted 12.8% and 4.0% respectively) (Table 3). Black males and females had highest rates of cannabis (age-adjusted 5.8% and 3.8%, respectively) and cocaine use (age-adjusted 5.8% and 4.5%, respectively) (Table 3).

The Pacific region had the highest rates of drug use disorder (11.9% males, 4.7% females) (Table 2). Medicaid hospitalizations had the highest rates of drug use disorder overall and for cocaine, opioid, and amphetamine use disorders for both sexes. Those in the lowest income quartile had the highest rates of drug use disorder overall and for most subcategories.

Associated Demographic Factors

Black race ethnicity was associated with substance (odds ratio [OR] 1.30; 95% confidence interval [CI], 1.24–1.36), alcohol (OR 1.09; 95% CI, 1.02–1.16), and drug (OR 1.63; 95% CI, 1.53–1.74) use disorder (Table 4). Native American race/ethnicity was associated with alcohol use disorder (OR 1.67; 95% CI, 1.27–2.20). All census divisions, when compared with New England, were associated with tobacco use disorder. The Pacific region was also associated with substance (OR 1.81; 95% CI, 1.63–2.02), alcohol (OR 1.15; 95% CI, 1.01–1.32), and drug (OR 2.85; 95% CI, 2.43–3.33) use disorder, while the Mountain region was associated with drug use disorder (OR 1.44; 95% CI, 1.20–1.73). Payer status of Medicaid was associated with tobacco (OR 1.50; 95% CI, 1.44–1.57), substance (OR 1.98; 95% CI, 1.88–2.09), alcohol (OR 1.75; 95% CI, 1.63–1.88), and drug (OR 2.15; 95% CI, 2.01–2.30) use disorder. Payer status of selfpay, no charge, or other was also associated with each use disorder. The lowest income quartile was associated with substance use disorder (OR 1.25; 95% CI, 1.17–1.33), while all income quartiles were associated with tobacco or drug use disorder when compared with the highest income quartile. Curvilinear relationships are noted between age and risk of tobacco, alcohol, and drug use disorder (Supplementary Figures 1–3, available online).

Female sex was associated with lower odds of tobacco (OR 0.72; 95% CI, 0.70–0.74), substance (OR 0.37; 95% CI, 0.36–0.39), alcohol (OR 0.23; 95% CI, 0.22–0.25), and drug

(OR 0.58; 95% CI, 0.55–0.62) use disorder (Table 4). All racial/ethnic groups had decreased risk of tobacco use disorder when compared with whites, except for Native Americans. Hispanic race/ethnicity was associated with less substance (OR 0.80; 95% CI 0.74–0.86) or drug (OR 0.76; 95% CI, 0.69–0.83) use disorder, and Asian/PI race/ethnicity was associated with less substance (OR 0.65; 95% CI, 0.57–0.75), alcohol (OR 0.53; 95% CI, 0.43–0.65), and drug (OR ; 95% CI, 0.70–0.97) use disorder. Private insurance was associated with less tobacco (OR 0.80; 95% CI, 0.76–0.83), substance (OR 0.81; 95% CI, 0.76–0.86), and drug (OR 0.59; 95% CI, 0.54–0.65) use disorder.

DISCUSSION

Among national heart failure hospitalizations, 15.5% had comorbid tobacco or substance use disorders. Tobacco use disorder was most common at 12.1% overall, a rate similar to prior studies (15.9% of heart failure patients in OPTIMIZE-HF²⁶ smoked cigarettes in the past year, while 17% of males and 10% of females in ADHERE²⁷ were current smokers). For certain male heart failure subgroups, including those age 45–55 years, Native American race/ethnicity, and payer status of Medicaid, self-pay, or no charge, our results show that approximately one-third of hospitalizations had tobacco use disorder. Tobacco use in OPTIMIZE-HF patients contributed to earlier age (>10 years difference) of decompensation requiring hospital admission.²⁶ Quitting smoking may be as effective a treatment as prescribing angiotensin-converting enzyme inhibitors, beta-blockers, and aldosterone inhibitors in improving survival.^{28,29}

Drug use disorder was uncommon among older heart failure patients. The etiology of heart failure in advanced age is well established,³⁰ largely due to coronary artery disease and poorly controlled hypertension. However, the pathogenesis of heart failure in patients under 40 years is less clear, with many patients diagnosed with idiopathic cardiomyopathy.^{31–33} Untreated drug use disorder may be responsible for heart failure in these young patients where the etiology remains unclassified, as we found high rates of drug use disorder in this population. Because high rates of cocaine and methamphetamine use have been noted among younger heart failure patients^{4,11,34} and heart failure due to stimulant use may have a reversible component,^{12,35} targeted preventive and treatment efforts for young patients with drug use disorder may reduce the burden of heart failure.

There is a paucity of literature investigating tobacco and substance use disorders in heart failure patients, especially among racial/ethnic subgroups. While Native American race was associated with increased risk of alcohol use disorder, these patients also had high rates of tobacco and drug use disorders. Recent data from the National Survey on Drug Use and Health show that American Indians or Alaska Natives have higher prevalence of tobacco use and cigarette smoking than all other racial/ethnic groups.³⁶ Black race was associated with substance, alcohol, and drug use disorder. Cocaine use disorder was highest among black heart failure hospitalizations, while amphetamine use disorder was highest for Asian/PI heart failure hospitalizations. A prior study of 11,258 heart failure patients from the ADHERE-EM database found that self-reported illicit drug use with cocaine or methamphetamines was associated with black race, compared with white.³⁴ Black men and women present with heart failure at a younger age and have the highest age-standardized hospitalization rates

compared with other race/ethnicities in the US.³⁷ Addressing underlying substance use disorders in black patients may reduce the burden of heart failure attributed to substances and reduce hospitalizations. Conversely, Asian/PI males and females have the lowest hospitalization rates for heart failure compared with other races in the US.³⁷ However, the Asian/PI population in the US is rapidly growing,³⁸ with high rates of amphetamine use,^{39,40} which may contribute to future heart failure hospitalizations.

Geographically, the Pacific region stands out for high rates of substance use disorder, especially drug use disorder. Data from the National Survey on Drug Use and Health report high prevalence of past-month illicit drug use by individuals 18 years or older within Pacific states.⁴¹ Patterns of use in heart failure patients may mirror those of the general population. Providers should be aware of types of substance use prevalent in their region.

Rates of tobacco and substance use disorders were higher for patients of lower socioeconomic status as represented by payer status (Medicaid, self-pay, or no charge) and median household income quartiles. Socioeconomic factors mediate differences in tobacco and substance use disorders based on race/ethnicity. While we cannot adjust for complex community stressors predisposing to tobacco or substance use disorders, evaluating community risk factors for tobacco and substance use disorders, such as density of tobacco stores,¹⁴ and identifying vulnerable groups may help develop preventive and treatment strategies, reducing observed disparities.

Tobacco and substance use disorders in heart failure patients have implications for the broader health system. Substance use leads to increased costs from decreased productivity, health care costs, and crime.⁴² Tobacco,^{43,44} alcohol,⁴³ and cocaine⁴⁵ use are associated with increased readmission risk in heart failure patients. Screening for tobacco and substance use disorders has historically been deficient in primary care, emergency department, and hospital settings;⁴⁶ despite efforts to improve screening, rates are likely under-appreciated. Heart failure patients who actively smoke but are attempting to quit may be coded with a different ICD-9-CM code than tobacco use disorder, further underestimating numbers.⁴⁷ Tobacco and substance use disorders may have even larger negative effects on the health care system than currently reported.

Limitations

The NIS does not use unique patient identifiers; a hospitalization may represent a new patient or a patient already captured in the sample being readmitted, which may increase rates. We are unable to account for geographic or provider coding variation in ICD-9-CM coding. Some conditions, notably tobacco use disorder, may be under-coded. Due to constraints within ICD-9-CM codes, we could not quantify amount or duration of tobacco or substance use disorders. Heavier or prolonged tobacco or substance use may have more detrimental cardiotoxic effects, but even substance use that does not qualify for a diagnosis may contribute to heart failure. Many hospitalized heart failure patients with drug use disorder used “other drugs,” illustrating the complexity of coding for specific drug use. Finally, unmeasured confounding, related to other lifestyle or cardiovascular risk factors not measured, may influence some of these associations, especially as related to socioeconomic status or race/ethnicity.

Conclusions

Comorbid tobacco or substance use disorder among hospitalized heart failure patients in the US particularly affects males, younger individuals, and those of lower socioeconomic status. A heart failure hospitalization is an opportunity to screen for and treat tobacco or substance use disorders. To effectively manage heart failure, better recognition of comorbidities portending worse outcomes should be included in full assessments of patients. Further research on interventions that reduce rates of tobacco or substance use disorders among discharged heart failure patients are needed.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding: BZ is supported by the American College of Cardiology Presidential Career Developmental Award and American Heart Association Scientist Development Grant 17SDG33630113.

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CLINICAL SIGNIFICANCE

- In the United States, 15.5% of patients hospitalized for heart failure had documented tobacco or substance use disorder.
- Tobacco or substance use disorders were more common among males, younger age groups, select racial/ethnic minorities, lower socioeconomic status, and patients with Medicaid insurance.
- Efforts to screen for and support the treatment of tobacco and substance use disorders are needed for patients hospitalized for heart failure.

Table 1

Baseline Characteristics of Hospitalized Heart Failure Patients in the US in 2014*

	Overall	No Use Disorder	TUD	SUD	AUD	DUD
HF hospitalizations, n (%)	989,080	836,115 (84.5%)	119,285 [†] (12.1%)	61,510 [‡] (6.2%)	34,285 (3.5%)	34,600 (3.5%)
Female	48.5%	51.4%	36.0%	22.9%	15.1%	29.1%
Age, mean (SD)	72.0 (14.2)	74.1 (13.5)	61.2 (12.7)	57.6 (13.0)	60.4 (12.5)	53.9 (12.3)
Age range, y						
<45	4.3%	3.2%	9.1%	14.1%	9.2%	19.5%
45–<55	8.6%	6.2%	20.9%	28.5%	24.2%	35.0%
55–<65	15.9%	13.3%	30.7%	29.5%	30.2%	29.7%
65–75	24.0%	23.9%	25.6%	18.7%	25.0%	10.6%
>75	47.2%	53.3%	13.7%	9.2%	11.4%	5.2%
Race/ethnicity						
White	64.3%	66.0%	56.7%	45.8%	51.9%	37.0%
Black	19.8%	17.8%	30.1%	36.8%	31.0%	44.9%
Hispanic	7.2%	7.3%	5.5%	9.0%	8.9%	9.4%
Asian/PI	1.9%	2.0%	1.3%	2.0%	1.4%	2.7%
Native American	0.4%	0.4%	0.6%	0.7%	0.9%	0.5%
Other	2.2%	2.2%	2.0%	2.3%	2.2%	2.4%
Missing	4.2%	4.3%	3.8%	3.4%	3.7%	3.0%
Region						
New England	5.0%	5.4%	3.0%	3.9%	4.7%	2.9%
Middle Atlantic	14.8%	15.3%	11.3%	11.9%	13.1%	10.9%
East North Central	17.0%	16.9%	17.9%	15.7%	17.2%	14.0%
West North Central	6.3%	6.4%	6.2%	4.5%	4.9%	4.1%
South Atlantic	22.2%	22.0%	23.7%	21.6%	23.0%	20.3%
East South Central	7.4%	7.3%	8.9%	5.4%	5.7%	4.7%
West South Central	11.5%	11.5%	11.9%	9.4%	9.4%	9.1%
Mountain	4.2%	4.1%	4.6%	5.2%	4.8%	5.5%
Pacific	11.7%	11.1%	12.6%	22.3%	17.2%	28.6%
Primary payer						

	Overall	No Use Disorder	TUD	SUD	AUD	DUD
Medicare	74.2%	78.2%		53.3%	42.0%	46.6%
Medicaid	9.4%	6.8%		22.2%	32.6%	25.3%
Private insurance	11.6%	11.2%		13.9%	13.0%	16.0%
Self-pay	2.9%	2.1%		7.2%	8.8%	8.4%
No charge	0.3%	0.2%		0.7%	0.9%	1.0%
Other	1.6%	1.5%		2.4%	2.5%	2.5%
Income quartile						
0 to 25	32.6%	31.0%		42.0%	42.5%	39.0%
26 to 50	27.5%	27.7%		26.9%	24.7%	25.4%
51 to 75	21.1%	21.6%		18.2%	17.7%	16.4%
76 to 100	16.8%	17.8%		10.7%	12.0%	13.9%
Comorbidities						
Hypertension	81.8%	82.1%		81.0%	77.6%	75.9%
CAD	55.3%	51.5%		54.0%	42.2%	40.8%
Atrial fibrillation	41.5%	44.2%		24.8%	25.9%	31.7%
Obese	22.2%	22.0%		23.5%	21.5%	20.0%
Valve disease	29.9%	30.9%		23.9%	24.8%	26.7%
VT	5.3%	5.0%		6.6%	7.4%	8.0%
AMI	3.6%	3.6%		4.0%	2.9%	3.0%
PVD	13.1%	12.9%		15.2%	9.1%	10.4%
Diabetes mellitus	47.9%	48.8%		44.5%	35.1%	36.7%
COPD	31.1%	28.4%		51.4%	34.6%	32.1%
Anemia	33.5%	34.7%		26.7%	27.1%	26.2%
Fluid/electrolyte	33.6%	33.6%		33.1%	36.3%	39.8%
Procedures						
Cardiac catheterization	9.0%	8.3%		12.8%	13.2%	10.6%
Pulmonary artery catheter	1.1%	1.0%		0.9%	1.4%	1.5%
Cardiac device	2.3%	2.3%		2.0%	2.4%	2.7%
Dialysis	5.9%	6.0%		5.9%	5.1%	6.4%
Mechanical ventilation	9.4%	9.3%		10.1%	9.6%	9.2%
Blood transfusions	5.7%	6.0%		3.9%	3.9%	4.5%

	Overall	No Use Disorder	TUD	SUD	AUD	DUD
Inpatient mortality Crude	2.9%	3.2%		1.3%	1.7%	2.0%
Age-adjusted	1.8%	2.0%		1.0%	1.3%	1.2%
Length of stay						
Median, d		4		4	4	4
95th percentile, d		14		12	14	15
Discharge status						
Routine	49.9%	47.3%		64.9%	66.0%	63.8%
Against medical advice	1.2%	0.7%		3.7%	4.4%	3.2%
Died	2.9%	3.2%		1.3%	1.7%	2.0%
DUD						1.2%

Abbreviations: AMI = acute myocardial infarction; AUD = alcohol use disorder; CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease; DUD = drug use disorder; Fluid/electrolyte = fluid and electrolyte disorders; HF = heart failure; Income quartile = median household income quartile by zip code; PI = Pacific Islander; PVD = peripheral vascular disease; SUD = substance used disorder (alcohol or drug use disorders); TUD = tobacco use disorder; VT = ventricular tachycardia.

* National estimates of counts and diagnosis rates estimated accounting for National Inpatient Sample survey design and weights. Age adjustment weighted to 2000 US standard population.

[†] 27,830 hospitalizations had both TUD and SUD documented.

[‡] 7375 hospitalizations had both AUD and DUD documented.

Table 2
Heart Failure Patient Characteristics by Tobacco or Substance Use Disorder Status Stratified by Sex*

Males	TUD (n = 76,375)		SUD (n = 47,425)		AUD † (n = 29,085)		DUD (n = 24,535)	
Age range, y	Crude	Adj.	Crude	Adj.	Crude	Adj.	Crude	Adj.
<45	27.6%	24.2%	24.2%	10.0%	17.9%	16.4%	17.9%	16.4%
45–<55	30.8%	25.1%	25.1%	13.2%	16.4%	16.4%	16.4%	16.4%
55–<65	26.2%	15.4%	15.4%	9.5%	8.1%	8.1%	8.1%	8.1%
65–75	14.5%	7.1%	7.1%	5.6%	1.9%	1.9%	1.9%	1.9%
>75	4.3%	1.8%	1.8%	1.4%	0.4%	0.4%	0.4%	0.4%
Race	Crude	Adj.	Crude	Adj.	Crude	Adj.	Crude	Adj.
White	13.1%	25.8%	6.6%	18.8%	4.6%	9.1%	2.6%	12.9%
Black	22.8%	24.3%	17.1%	19.2%	8.8%	7.8%	11.1%	14.0%
Hispanic	12.4%	16.9%	12.3%	23.9%	7.3%	10.3%	6.8%	17.6%
Asian/PI	12.5%	23.9%	11.4%	30.9%	4.5%	13.2%	8.3%	26.5%
Native American	21.5%	31.4%	14.7%	31.2%	11.3%	23.8%	6.8%	18.2%
Other	13.5%	16.9%	9.9%	17.6%	6.2%	9.5%	5.2%	11.6%
Region								
New England	9.1%	7.4%	7.4%	5.3%	2.8%	3.6%	2.8%	3.6%
Middle Atlantic	11.6%	7.7%	7.7%	5.2%	4.0%	3.0%	4.0%	3.0%
East North Central	15.4%	8.8%	6.6%	5.9%	4.4%	4.2%	4.2%	4.2%
West North Central	15.1%	9.0%	9.0%	5.9%	2.7%	3.9%	2.7%	3.9%
South Atlantic	16.0%	17.5%	6.6%	4.6%	4.9%	6.0%	6.0%	6.0%
East South Central	17.5%	15.8%	7.9%	4.9%	8.1%	11.9%	8.1%	11.9%
West South Central	15.8%	15.7%	10.6%	5.9%	3.8%	2.2%	2.2%	2.2%
Mountain	15.7%	16.7%	17.1%	8.1%	14.0%	20.5%	14.0%	20.5%
Pacific	16.7%	10.9%	5.5%	3.8%	6.8%	3.5%	6.8%	3.5%
Payer								
Medicare	10.9%	28.7%	28.7%	14.0%	3.5%	14.0%	3.5%	14.0%
Medicaid	32.8%	16.3%	9.5%	6.8%	13.6%	14.0%	13.6%	14.0%
Private insurance	16.3%	33.5%	23.6%	13.6%	14.0%	14.0%	14.0%	14.0%
Self-pay	33.5%	33.5%	23.6%	13.6%	14.0%	14.0%	14.0%	14.0%

Males	TUD (n = 76,375)	SUD (n = 47,425)	AUD [†] (n = 29,085)	DUD (n = 24,535)
No charge	34.8%	26.8%	16.6%	15.2%
Other	20.4%	12.1%	6.7%	6.6%
Income quartile				
0 to 25	19.2%	12.1%	6.9%	7.0%
26 to 50	14.7%	8.4%	5.3%	4.1%
51 to 75	13.1%	7.8%	5.1%	3.8%
76 to 100	9.6%	6.8%	4.6%	2.8%
Females	TUD (n = 42,895)	SUD (n = 14,075)	AUD (n = 5190)	DUD (n = 10,065)
Age range, y				
<45	21.9%	13.9%	3.0%	12.4%
45-<55	26.6%	12.7%	3.7%	10.3%
55-<65	19.1%	5.9%	2.2%	4.3%
65-75	10.9%	2.2%	1.2%	1.1%
>75	2.9%	0.8%	0.4%	0.4%
Race/ethnicity	Crude	Adj.	Crude	Adj.
White	8.0%	21.8%	2.1%	10.5%
Black	13.8%	18.8%	5.9%	10.8%
Hispanic	5.5%	10.9%	2.6%	8.7%
Asian/PI	3.4%	11.5%	1.8%	9.4%
Native American	12.5%	21.1%	3.5%	13.1%
Other	8.4%	13.1%	2.5%	5.4%
Region				
New England	5.0%	2.3%	1.1%	1.2%
Middle Atlantic	6.8%	2.1%	0.8%	1.5%
East North Central	10.0%	2.7%	1.1%	1.8%
West North Central	8.8%	2.3%	1.0%	1.5%
South Atlantic	9.5%	3.0%	1.2%	2.1%
East South Central	11.3%	2.3%	0.8%	1.7%
West South Central	9.0%	2.2%	0.7%	1.6%
Mountain	9.9%	4.1%	1.5%	2.8%
Pacific	8.7%	5.8%	1.6%	4.7%

Males	TUD (n = 76,375)	SUD (n = 47,425)	AUD [†] (n = 29,085)	DUD (n = 24,535)
Payer				
Medicare	6.6%	1.7%	0.7%	1.1%
Medicaid	23.1%	12.5%	3.4%	10.6%
Private insurance	11.8%	3.3%	1.7%	1.9%
Self-pay	24.5%	9.9%	3.1%	8.1%
No charge	19.5%	7.7%	4.1%	4.6%
Other	13.1%	4.1%	2.2%	2.2%
Income quartile				
0 to 25	11.7%	4.0%	1.3%	3.1%
26 to 50	8.8%	2.6%	1.0%	1.8%
51 to 75	7.5%	2.4%	1.0%	1.6%
76 to 100	5.5%	1.9%	1.0%	1.1%

Abbreviations: Adj. = age-adjusted rate; AUD = alcohol use disorder; DUD = drug use disorder; Income quartile = median household income by zip code; n = weighted national hospitalizations; PI = Pacific Islander; SUD = substance use disorder (alcohol or drug use disorders); TUD = tobacco use disorder.

* Age adjustment weighted to 2000 US standard population.

[†] Alcohol and drug categories are not mutually exclusive.

Table 3
Heart Failure Patient Characteristics by Drug Use Disorder Status Stratified by Sex*

Males	Cocaine (n = 8740)	Cannabis (n = 6115)	Opioids (n = 3625)	Amphetamine (n = 4150)	Psych (n = 125)	Other (n = 5765)
Age range, y						
<45	4.9%	6.2%	1.7%	4.4%	0.1%	3.8%
45-<55	6.4%	4.1%	2.0%	3.2%	0.1%	3.7%
55-<65	3.3%	1.8%	1.4%	1.1%	<0.05%	1.7%
65- 75	0.6%	0.4%	0.5%	0.2%	<0.05%	0.5%
>75	<0.05%	<0.05%	0.1%	None	<0.05%	0.2%
Race	Crude	Crude	Crude	Crude	Crude	Crude
White	0.4%	2.3%	4.0%	0.5%	2.6%	0.7%
Black	6.3%	5.8%	3.1%	5.8%	1.1%	0.5%
Hispanic	1.8%	3.9%	1.3%	4.9%	3.0%	2.0%
Asian/PI	1.0%	4.3%	1.7%	4.6%	0.7%	4.2%
Native American	1.1%	1.5%	3.9%	0.7%	0.4%	2.0%
Other	1.8%	3.9%	2.1%	1.3%	2.8%	0.7%
Region						
New England	1.1%	0.5%	0.7%	<0.05%	None	1.0%
Middle Atlantic	1.7%	0.8%	1.0%	<0.05%	<0.05%	0.8%
East North Central	1.7%	1.3%	0.8%	<0.05%	<0.05%	0.9%
West North Central	1.1%	1.0%	0.3%	0.4%	<0.05%	0.8%
South Atlantic	2.0%	1.2%	0.6%	0.1%	<0.05%	1.1%
East South Central	1.0%	0.8%	0.4%	0.1%	0.1%	0.9%
West South Central	1.7%	0.9%	0.3%	0.5%	<0.05%	1.1%
Mountain	1.1%	1.4%	0.6%	2.1%	<0.05%	1.8%
Pacific	2.4%	2.3%	1.4%	4.8%	<0.05%	2.2%
Payer						
Medicare	0.7%	0.5%	0.4%	0.2%	<0.05%	0.6%
Medicaid	7.8%	4.8%	2.8%	4.6%	<0.05%	4.0%
Private insurance	1.1%	1.0%	0.5%	0.5%	<0.05%	0.9%
Self-pay	5.2%	4.2%	1.1%	2.8%	0.1%	3.1%

Males	Cocaine (n = 8740)	Cannabis (n = 6115)	Opioids (n = 3625)	Amphetamine (n = 4150)	Psych (n = 125)	Other (n = 5765)
No charge	7.5%	4.1%	1.9%	0.3%	None	4.1%
Other	2.8%	1.6%	0.4%	1.2%	None	1.5%
Income quartile						
0 to 25	2.9%	1.9%	1.1%	0.8%	<0.05%	1.6%
26 to 50	1.2%	1.0%	0.5%	0.8%	<0.05%	1.0%
51 to 75	1.1%	1.0%	0.5%	0.9%	<0.05%	0.9%
76 to 100	0.7%	0.5%	0.5%	0.8%	<0.05%	0.7%
Females	Cocaine (n = 2960) Cannabis (n = 1945) Opioids (n = 2214) Amphetamine (n = 1130) Psych (n = 220) Other (n = 3090)					
Age range, y						
<45	3.4%	3.5%	1.7%	2.4%	0.1%	3.1%
>=45 to <55	4.6%	2.2%	1.7%	1.6%	0.1%	2.0%
>=55 to <65	1.4%	0.9%	1.1%	0.3%	<0.05%	1.3%
>=65 to <=75	0.1%	0.1%	0.3%	<0.05%	<0.05%	0.6%
>75	<0.05%	None	0.2%	<0.05%	<0.05%	0.2%
Race	Crude	Crude	Crude	Crude	Crude	Crude
White	0.1%	0.2%	0.4%	0.2%	0.1%	0.5%
Black	2.4%	1.3%	0.7%	0.2%	<0.05%	1.0%
Hispanic	0.3%	0.2%	0.6%	0.4%	<0.05%	0.7%
Asian/PI	0.1%	0.3%	0.2%	0.7%	<0.05%	0.2%
Native American	None	0.2%	0.5%	0.5%	<0.05%	0.7%
Other	0.8%	0.5%	0.5%	0.1%	<0.05%	0.6%
Region						
New England	0.2%	0.1%	0.5%	None	<0.05%	0.5%
Middle Atlantic	0.7%	0.3%	0.4%	None	<0.05%	0.4%
East North Central	0.6%	0.5%	0.4%	<0.05%	<0.05%	0.6%
West North Central	0.4%	0.3%	0.4%	0.1%	<0.05%	0.5%
South Atlantic	0.8%	0.4%	0.4%	<0.05%	0.1%	0.7%
East South Central	0.4%	0.3%	0.3%	<0.05%	0.2%	0.7%
West South Central	0.5%	0.4%	0.1%	0.2%	<0.05%	0.5%
Mountain	0.4%	0.5%	0.8%	0.8%	<0.05%	0.8%
Pacific	0.9%	0.6%	1.1%	1.5%	0.1%	1.0%

Males	Cocaine (n = 8740)	Cannabis (n = 6115)	Opioids (n = 3625)	Amphetamine (n = 4150)	Psych (n = 125)	Other (n = 5765)
Payer						
Medicare	0.2%	0.1%	0.3%	0.1%	<0.05%	<0.05%
Medicaid	4.2%	2.4%	1.9%	1.8%	<0.05%	0.2%
Private insurance	0.5%	0.3%	0.4%	0.1%	<0.05%	0.1%
Self-pay	3.3%	2.6%	0.8%	1.6%	0.1%	0.3%
No charge	3.1%	1.0%	0.5%	None	None	0.7%
Other	0.7%	0.3%	0.6%	0.3%	None	0.3%
Income quartile						
0 to 25	1.2%	0.7%	0.5%	0.2%	0.1%	0.9%
26 to 50	0.4%	0.3%	0.4%	0.2%	<0.05%	0.6%
51 to 75	0.3%	0.2%	0.4%	0.3%	<0.05%	0.5%
76 to 100	0.2%	0.1%	0.4%	0.1%	<0.05%	0.4%

Abbreviations: Adj. = age-adjusted rate; Income quartile = median household income by zip code; n = weighted national hospitalizations; None = no observations; PI = Pacific Islander; Psych = psychotherapeutic.

* Age-adjustment weighted to 2000 US standard population. Drug subcategories are not mutually exclusive. Hallucinogen data not included above due to small numbers (n = 20).

Demographic Factors Associated with Tobacco or Substance Use Disorder Among Hospitalized Heart Failure Patients^{*,†}

Table 4

	TUD	SUD	AUD	DUD
Characteristic Sex (ref: Male)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Female	0.72 (0.70–0.74) [#]	0.37 (0.36–0.39) [#]	0.23 (0.22–0.25) [#]	0.58 (0.55–0.62) [#]
Race/ethnicity (ref: White)				
Black	0.88 (0.85–0.91) [#]	1.30 (1.24–1.36) [#]	1.09 (1.02–1.16) //	1.63 (1.53–1.74) [#]
Hispanic	0.48 (0.45–0.51) [#]	0.80 (0.74–0.86) [#]	0.91 (0.83–1.00) ^{\$}	0.76 (0.69–0.83) [#]
Asian/PI	0.51 (0.45–0.58) [#]	0.65 (0.57–0.75) [#]	0.53 (0.43–0.65) [#]	0.83 (0.70–0.97) ^{\$}
Native American	0.97 (0.80–1.17)	1.15 (0.91–1.46)	1.67 (1.27–2.20) [#]	0.90 (0.64–1.26)
Other	0.74 (0.66–0.81) [#]	0.92 (0.81–1.05)	0.85 (0.72–1.01)	1.10 (0.93–1.30)
Region (ref: New England)				
Middle Atlantic	1.17 (1.07–1.28) //	0.78 (0.70–0.87) [#]	0.79 (0.69–0.90) //	0.86 (0.73–1.01)
East North Central West	1.46 (1.34–1.59) [#]	0.83 (0.75–0.93) //	0.88 (0.77–1.00)	0.84 (0.72–0.99) ^{\$}
North Central	1.58 (1.43–1.75) [#]	0.74 (0.65–0.85) [#]	0.73 (0.62–0.86) [#]	0.87 (0.71–1.05)
South Atlantic	1.33 (1.22–1.45) [#]	0.74 (0.67–0.83) [#]	0.79 (0.69–0.89) [#]	0.77 (0.66–0.90) //
East South Central	1.41 (1.28–1.54) [#]	0.56 (0.49–0.63) [#]	0.59 (0.50–0.69) [#]	0.57 (0.47–0.68) [#]
West South Central	1.26 (1.15–1.38) [#]	0.61 (0.54–0.68) [#]	0.58 (0.51–0.67) [#]	0.68 (0.58–0.81) [#]
Mountain	1.48 (1.33–1.64) [#]	1.07 (0.94–1.22)	0.86 (0.73–1.02)	1.44 (1.20–1.73) [#]
Pacific	1.53 (1.40–1.68) [#]	1.81 (1.63–2.02) [#]	1.15 (1.01–1.32) ^{\$}	2.85 (2.44–3.33) [#]
Payer (ref: Medicare)				
Medicaid	1.50 (1.44–1.57) [#]	1.98 (1.88–2.09) [#]	1.75 (1.63–1.88) [#]	2.15 (2.01–2.30) [#]
Private insurance	0.80 (0.76–0.83) [#]	0.81 (0.76–0.86) [#]	1.06 (0.98–1.14)	0.59 (0.54–0.65) [#]
Self-pay	1.64 (1.54–1.75) [#]	1.88 (1.73–2.03) [#]	1.97 (1.78–2.18) [#]	1.84 (1.67–2.04) [#]
No charge	1.55 (1.29–1.87) [#]	2.00 (1.61–2.48) [#]	2.38 (1.83–3.10) [#]	1.76 (1.34–2.31) [#]
Other	1.18 (1.07–1.30) [#]	1.23 (1.09–1.39) //	1.20 (1.02–1.40) ^{\$}	1.26 (1.07–1.48) [#]
Income Quartile (ref: 76–100)				
0 to 25	1.42 (1.35 to 1.50) [#]	1.25 (1.17 to 1.33) [#]	1.05 (0.97 to 1.14)	1.57 (1.43 to 1.73) [#]

	TUD	SUD	AUD	DUD
26 to 50	1.25 (1.19 to 1.32) [#]	1.06 (0.99 to 1.14)	0.97 (0.89 to 1.05)	1.21 (1.10 to 1.33) [#]
51 to 75	1.18 (1.12 to 1.25) [#]	1.02 (0.95 to 1.10)	0.96 (0.88 to 1.05)	1.15 (1.03 to 1.27) ^{//}

Abbreviations: AUD = alcohol use disorder; CI = confidence interval; DUD = drug use disorder; Income quartile = median household income by zip code; OR = odds ratio; PI = Pacific Islander; SUD = substance used disorder (alcohol or drug use disorders); TUD = tobacco use disorder.

* Cluster-adjusted logistic regressions on the odds of comorbid tobacco or substance use disorder stratified by substances. Multivariable fractional polynomial adjustment for age across all models.

[†] *P*-values:

[§] *P* < .05

^{//} *P* < .01

[#] *P* < .001.