Retrospective Study

Characteristics of Hospitalized Adults with Opioid Use Disorder in the United States: Nationwide Inpatient Sample

Brook T. Alemu, PhD[1], Olaniyi Olayinka, MD[2], and Brian C. Martin, PhD[3]

From: [1]School of Health Sciences, Western Carolina University, Cullowhee, North Carolina, United States; [2]Department of Psychiatry and Behavioral Sciences, Interfaith Medical Center, Brooklyn, New York, United States; [3]Master of Public Health Program, Eastern Virginia Medical School, Norfolk, VA, United States

Address Correspondence:
Brook Alemu, PhD, MPH
School of Health Sciences,
Western Carolina University
3971 Little Savannah Rd.
Cullowhee, NC 28723
E-mail: balemu@wcu.edu

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Background: Although the clinical significance and treatment management of opioid use disorder (OUD) is sufficiently discussed, utilization of healthcare services associated with OUD has not been adequately studied in the United States.

Objective: To provide a descriptive assessment of the utilization of health care services for adults with OUD in the United States.

Study Design: A retrospective cross-sectional study design based on the National Inpatient Sample (NIS) developed by the Healthcare Cost and Utilization Project.

Setting: All OUD cases included in the 2016 NIS database. Adults aged 18 years or older were included in the study.

Methods: We analyzed a stratified probability sampling of 7.1 million hospital discharges weighted to 35.7 million national discharges. We used ICD-10-CM codes to identify OUD cases. Groups were compared using the Student's t-test for continuous variables and the χ^2 test for categorical variables. Total cost per hospital discharge was determined by converting the total per case hospital charge to a hospital cost estimate (estimate = total charges X hospital cost-to-charge ratio).

Results: In 2016, an estimated 741,275 Americans were associated with OUD. Among patients with OUD, 73% were White, 12% were African-American, 8% were Hispanic, 0.6% Asian-American/Pacific Islander, 0.9% were Native Americans, and 2% were other race; 49% of patients with OUD were women. A large proportion (43%) of the OUD hospitalizations were billed to Medicaid. The average hospital length of stay for all OUD patients was 5.6 days, and the average cost per discharge was $11,233. A higher average LOS was observed for patients who died during hospitalization (8.4 days), Asian-American/Pacific Islander patients (6.8 days), patients covered by self-pay (6.8 days), patients with median household income of 71,000 or more (5.8 days), patients discharged from hospitals in the Northeast ($10,540) and patients discharged from hospitals in large hospitals ($12,570). The most frequently observed diagnosis associated with patients with OUD were alcohol/drug abuse or dependence, psychosis, and septicemia.

Limitations: These data sources are comprised of hospital discharge records, originally collected for billing purposes, and may be subject to provider biases and variations in coding practices.

Conclusions: In the United States, very few health issues have garnered the attention of such diverse sectors as the opioid crisis. Our analysis of 2016 NIS data found that patients with OUD accounted for approximately 740,000 discharges that year. This represents about a 55% increase over 2015. We also demonstrate that inpatient settings provide a unique opportunity for targeting evidence-based, comprehensive interventions at patients with OUD.

Keywords: Opioid use disorder, discharge diagnosis, hospital resource utilization, cost-to-charge ratio, HCUP, NIS, AHRQ

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The United States is experiencing an epidemic of prescription opioid misuse (1), with prescription opioid overdose deaths more than quadrupling between 1999 and 2015 (2-4). There were approximately 11.8 million "past-year" opioid misusers in 2016, representing 4.4% of the total United States (US) population aged 12 or older (5). Among painkillers, opioids lead the list with oxycodone as the number one prescription drug misused (6-8).

Although the clinical significance and treatment management of opioid use disorder (OUD) is sufficiently discussed (9-11), utilization of health care services associated with opioid use disorder has not been adequately studied. With the current increase in overall health care costs in the US, there is a strong interest to enhance efficacy through reform and system improvement (12,13). A better understanding of common characteristics of hospitalized patients and patterns of discharge diagnoses associated with opioid use disorder may help hospitals improve efficiency of care, decreasing costs while maintaining high standards of care.

Using the 2016 National Inpatient Sample (NIS), we sought to provide a descriptive assessment of inpatient hospital resource utilization associated with OUD in the US. Specifically, we sought to identify the demographic and socioeconomic characteristics of hospitalized patients, healthcare costs, as well as other factors associated with OUD among US adults.

METHODS

This section describes the inpatient sample and our data analysis plan.

Nationwide Inpatient Database

The current analysis used the 2016 NIS developed by the Health Care Cost and Utilization Project (HCUP). NIS is the largest publicly available all-payer inpatient care database in the United States, containing data on more than 7 million hospital stays per year. Its large sample size is ideal for developing national and regional estimates and enables analyses of rare conditions, uncommon treatments, and special populations (14). The 2016 NIS includes a full calendar year of data with diagnosis and procedure codes reported using the ICD-10-CM/PCS (15). The NIS approximates a 20% stratified sample of all discharges from US community hospitals, excluding rehabilitation and long-term acute care hospitals. The database contains information on all patients, regardless of payer, including individuals covered by Medicare, Medicaid, or private insurance, as well as those who are uninsured.

Types of Hospitals included in the NIS

The NIS is a sample of discharges from US community hospitals, defined as all nonfederal, short-term, general, and other specialty hospitals, excluding hospital units of institutions. Included among community hospitals are specialty hospitals such as obstetrics-gynecology, ear-nose-throat, orthopedic, and pediatric institutions. Also included are public hospitals and academic medical centers.

Study Variables and Analysis Plan

We analyzed 35.7 million hospital discharges included in the 2016 NIS. Adults 18 years or older were included in the study. Variables including age group, gender, race, emergency department services use indicator, primary expected payer, inpatient mortality indicator, median household income, admission day, patient location, total number of procedures, total number of diagnoses, discharge quarter, indicator of primary expected payer, hospital region, total hospital charge, total hospital cost, and hospital length of stay were assessed.

International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) (15) was used to identify OUD cases (F11, F11.1x, F11.2, F11.2x, F11.9, F11.9x). The code suffix "x" represents all possible codes that follow the stated code prefix. Total cost per hospital discharge was determined by converting the total per case hospital charge to a hospital cost estimate (estimate = total charges X hospital cost-to-charge ratio). The groups were compared using Student's t-test for continuous variables and the χ^2 test for categorical variables. Continuous variable data were presented as median and mean and categorical variables were presented as numbers (n) and percentages (%). Statistical analysis was performed using SAS®, version 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

Table 1 compares the demographic, socioeconomic, and hospital characteristics of adults diagnosed with OUD. Of the total hospital discharges that occurred in 2016, we estimate that 741,275 were associated with OUD. Discharged patients spent a total of 4,173,658 inpatient days at a cost of $8.2 billion. Compared to patients without OUD, patients with OUD had a longer mean hospital stay (5.6 days versus 4.7 days, *P* < .0001)

and a higher percentage use of emergency department services (67% versus 58%, *P* < .0001). Overall, adults with OUD accounted for 2.5% of all hospital discharges, 2.2% of all hospital charges, and 2.9% of all hospital days among patients hospitalized in 2016.

The median age of patients with OUD was 17 years younger than patients without OUD (44 years versus 61 years). Among patients with OUD, 73% were White, 12% were African-American, 8% were Hispanic, 0.6% Asian-American/Pacific Islander, 0.9% were Native Americans, and 2% were other race; 49% of patients with OUD were women. More than a third of OUD-related discharges (36%) occurred in areas denoted in our study using zip code designations with mean household annual income ≤ $42,999 compared with 31% in non-OUD discharges. Among non-OUD related discharges, 20% occurred in households with a mean annual income of $71,000 or more compared to 16% for OUD-related discharges. All differences were statistically significant (*P* < .0001).

Various health insurance coverage plans were billed for the services provided to the OUD-related discharges. A large proportion (43%) of the OUD hospitalizations were billed to Medicaid, a federal government health insurance plan that provides coverage mostly for low-income individuals. On the other hand, 29% of the bill was covered by Medicare. In the population without OUD, 47% of hospital discharges were billed to Medicare, with 27% billed to private insurance companies. More patients with OUD were self-pay compared to patients discharged with other conditions (7% versus 4%).

In 2016, more than 93% of patients with OUD had ≥ 5 diagnoses compared to patients without OUD (92%). Discharges among adults with OUD appear to take place in hospitals located in urban areas (95%), a pattern also found among adults without OUD (93%). In line with this finding, more adults with OUD (67%) utilized emergency department services compared to adults without OUD (58%).

The average hospital length of stay (LOS) for all patients with OUD was 5.6 days and the average cost per discharge was $11,233 (Table 2). Patients aged 56 years or older had the highest average LOS (6.0) and total cost per discharge ($14,194). Compared to Asian-American/Pacific Islanders ($15,692), Native Americans ($13,924), Hispanics ($12,267), African-Americans ($11,287), and Whites ($10,961) had lower charge per discharge (Table 2). Higher average LOS was observed for Asian-American/Pacific Islander patients (6.8 days), patients covered by

Table 1. *Characteristic of hospitals and patient discharges involving adults with opioid use disorder.*

Characteristics	Adults with OUD	Adults without OUD	*P*
Unweighted sample n	148,255	5,889,472	
Weighted population n	741,275	29,447,337	
Age Group (in years), %			
Young adults (18-35)	34.77	20.42	< .0001
Middle-aged adults (36-55)	36.41	20.26	
Older adults (≥ 56)	28.82	59.31	
Median age	44	61	
Women, %	48.98	58.38	< .0001
Race/Ethnicity			
White	73.39	67.66	< .0001
Black	14.37	15.15	
Hispanic	8.37	10.89	
Asian-American/Pacific Islander	0.57	2.75	
Native American	0.87	0.61	
Other	2.43	2.94	
Charge, $	44,325	50,726	< .0001
Cost, $	11,233	12,528	< .0001
Mean Length of Stay, days	5.63	4.71	< .0001
ED$ Services Used	67.07	57.72	< .0001
Primary Expected Payer			
Medicare	28.70	47.21	< .0001
Medicaid	42.99	17.93	
Private insurance	17.55	27.79	
Self-Pay	6.69	3.79	
No charge	0.82	0.35	
Other	3.24	2.93	
Died During Hospitalization, %	1.27	2.21	< .0001
Median Income (by zip code)			
≤ $1 - 42,999	36.02	30.73	< .0001
43,000 - 53,999	25.32	25.62	
54,000 - 70,999	22.23	23.86	
≥ 71,000	16.43	19.78	
Admission Day is a Weekend	23.17	20.25	< .0001
Patient Location (PL)&			
Urban	94.89	92.83	< .0001
Rural	5.11	7.17	
NPR# ≥ 2	28.73	39.80	< .0001
NDX* ≥ 5	93.34	87.11	< .0001

Table 1 con.'t. *Characteristic of hospitals and patient discharges involving adults with opioid use disorder.*

Characteristics	Adults with OUD	Adults without OUD	P
Discharge Quarter			
First quarter	24.31	25.24	< .0001
Second quarter	25.00	24.93	
Third quarter	25.98	24.91	
Fourth quarter	24.71	24.92	
Region of Hospital			
Northeast	25.30	18.70	< .0001
Midwest	20.94	22.42	
South	32.54	38.62	
West	21.21	19.29	
Bed-size category			
Small (1-99)	20.71	18.92	< .0001
Medium (100-399)	28.17	29.02	
Large (≥ 400)	51.12	52.06	

$ED= Emergency Department; &PL=based on urban-rural classification scheme for U.S. counties developed by the National Center for Health Statistics (NCHS); #NPR= Total number of procedure during hospitalization; *NDX=total number of diagnoses

Table 2. *Hospital length of stay and total hospital charge by patient and hospital characteristics for patient discharges with opioid use disorder.*

Characteristics	Length of stay ($\bar{x}, \sigma^2$) Ω	Total charges ($\bar{x}, \sigma^2$)	Total cost ($\bar{x}, \sigma^2$)
All patients	5.6 (16.5)	$44,325 ($201,301)	$11,233 ($46,472)
Age Group, years			
Young adults (18-35)	5.2 (15.8)	$33,899 ($177,568)	$8,793 ($43,539)
Middle-aged adults (36-55)	5.7 (17.3)	$43,647 ($215,524)	$11,145 ($50,330)
Older adults (≥ 56)	6.0 (16.3)	$57,362 ($207,734)	$14,194 ($44,380)
Gender			
Men	5.7 (17.2)	$45,252 ($221,217)	$11,478 ($51,850)
Women	5.5 (15.9)	$43,349 ($178,149)	$10,973 ($40,087)
Race/ethnicity			
White	5.6 (16.4)	$43,660 ($186,072)	$10,961 ($40,325)
Black	5.6 (16.8)	$43,053 ($24,9365)	$11,287 ($63,038)
Hispanic	5.7 (16.5)	$51,676 ($236,240)	$12,267 ($58,141)

Table 2 con't. *Hospital length of stay and total hospital charge by patient and hospital characteristics for patient discharges with opioid use disorder.*

Characteristics	Length of stay ($\bar{x}, \sigma^2$) Ω	Total charges ($\bar{x}, \sigma^2$)	Total cost ($\bar{x}, \sigma^2$)
Asian-American/ Pacific Islander	6.8 (23.7)	$61,418 ($288,681)	$15,692 ($77,794)
Native American	6.2 (20.0)	$44,443 ($184,310)	$13,924 ($56,004)
Other	6.0 (17.9)	$51,827 ($24,0023)	$12,503 ($54,660)
ED$ Services Use Indictor			
ED Used	5.5 (15.9)	$46,429 ($18,7620)	$11,518 ($41,443)
ED Not Used	5.9 (17.7)	$39,970 ($22,6717)	$10,640 ($55,431)
Died during hospitalization			
Deceased	8.4 (31.3)	$132,083 ($535,243)	$32,782 ($131,796)
Not Deceased	5.6 (16.3)	$43,256 ($192,280)	$10,964 ($44,044)
Median Income (by zip code)			
≤ $1 - 42,999	5.6 (16.6)	$42,142 ($200,368)	$10,502 ($4,8634)
43,000 - 53,999	5.5 (15.7)	$42,415 ($167,718)	$10,839 ($39,109)
54,000 - 70,999	5.6 (16.5)	$45,642 ($206,143)	$11,676 ($45,867)
≥ 71,000	5.8 (17.3)	$49,910 ($242,752)	$12,660 ($52,158)
Admission day is a weekend			
Weekend	5.4 (15.7)	$44,502 ($189,856)	$11,258 ($47,900)
Weekdays	5.7 (16.8)	$44,272 ($204,623)	$11,149 ($41,377)
Patient Location (PL)*			
Urban	5.6 (16.4)	$44,668 ($185,053)	$11,216 ($46,070)
Rural	5.5 (16.4)	$37,245 ($202,453)	$11,266 ($53,424)
Total number of procedures (NPR)			
NPR < 2	4.4 (11.5)	$26,967 ($96,840)	$7,022 ($25,666)
NPR ≥ 2	8.6 (23.8)	$87,555 ($324,018)	$21,718 ($71,601)
Total number of diagnoses (NDX)			
NDX < 5	3.7 (9.3)	$14,991 ($48,653)	$4,025 ($10,296)
NDX ≥ 5	5.8 (16.9)	$46,440 ($207,221)	$11,752 ($47,829)

Table 2 con't. *Hospital length of stay and total hospital charge by patient and hospital characteristics for patient discharges with opioid use disorder.*

Characteristics	Length of stay ($\bar{x}$, σ^2) Ω	Total charges ($\bar{x}$, σ^2)	Total cost ($\bar{x}$, σ^2)
Discharge quarter			
First quarter	5.7 (17.0)	$43,764 ($189,337)	$11,102 ($42,386)
Second quarter	5.5 (16.1)	$43,074 ($182,179)	$11,012 ($42,860)
Third quarter	5.6 (16.1)	$44,009 ($215,139)	$11,133 ($54,778)
Fourth quarter	5.7 (17.0)	$46,557 ($217,145)	$11,660 ($44,608)
Region of Hospital			
Northeast	6.0 (16.4)	$40,225 ($192,364)	$10,540 ($38,772)
Midwest	5.0 (12.8)	$31,588 ($120,663)	$9,306 ($33,102)
South	5.7 (17.2)	$41,168 ($203,775)	$9,991 ($49,074)
West	6.0 (18.6)	$66,960 ($255,763)	$15,953 ($59,004)
Bed-size category			
Small (1-99)	5.1 (13.7)	$33,022 ($127,696)	$9,168 ($30,825)
Medium (100-399)	5.3 (14.9)	$40,786 ($187,181)	$10,297 ($38,548
Large (≥ 400)	6.0 (18.3)	$50,784 ($229,606)	$12,570 ($54,696)

ΩData are presented in mean ($\bar{x}$) & standard deviation (σ^2); $^\$$ED= Emergency Department; *PL=based on urban-rural classification scheme for U.S. counties developed by the National Center for Health Statistics. The total charge and total cost for patients with opioid use disorder in 2016 was $32,463,668,171(≈$32.5 billion) and $8,226,630,164(≈$8.2 billion) respectively. Total cost was identified by converting the total hospital charge to hospital cost estimates (Hospital Costs = Cost-to-Charge Ratios*Total Charges).
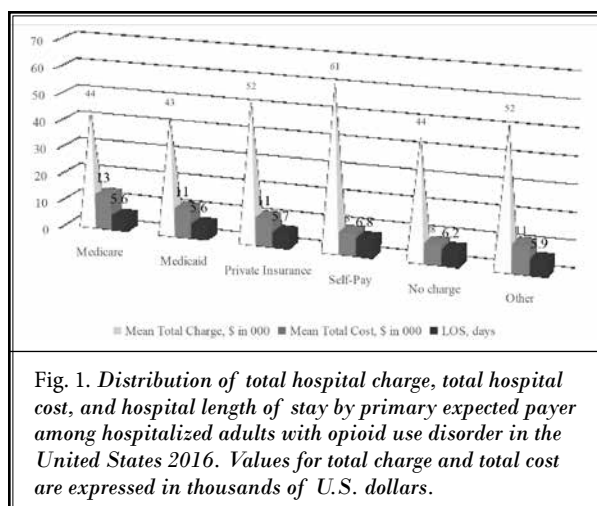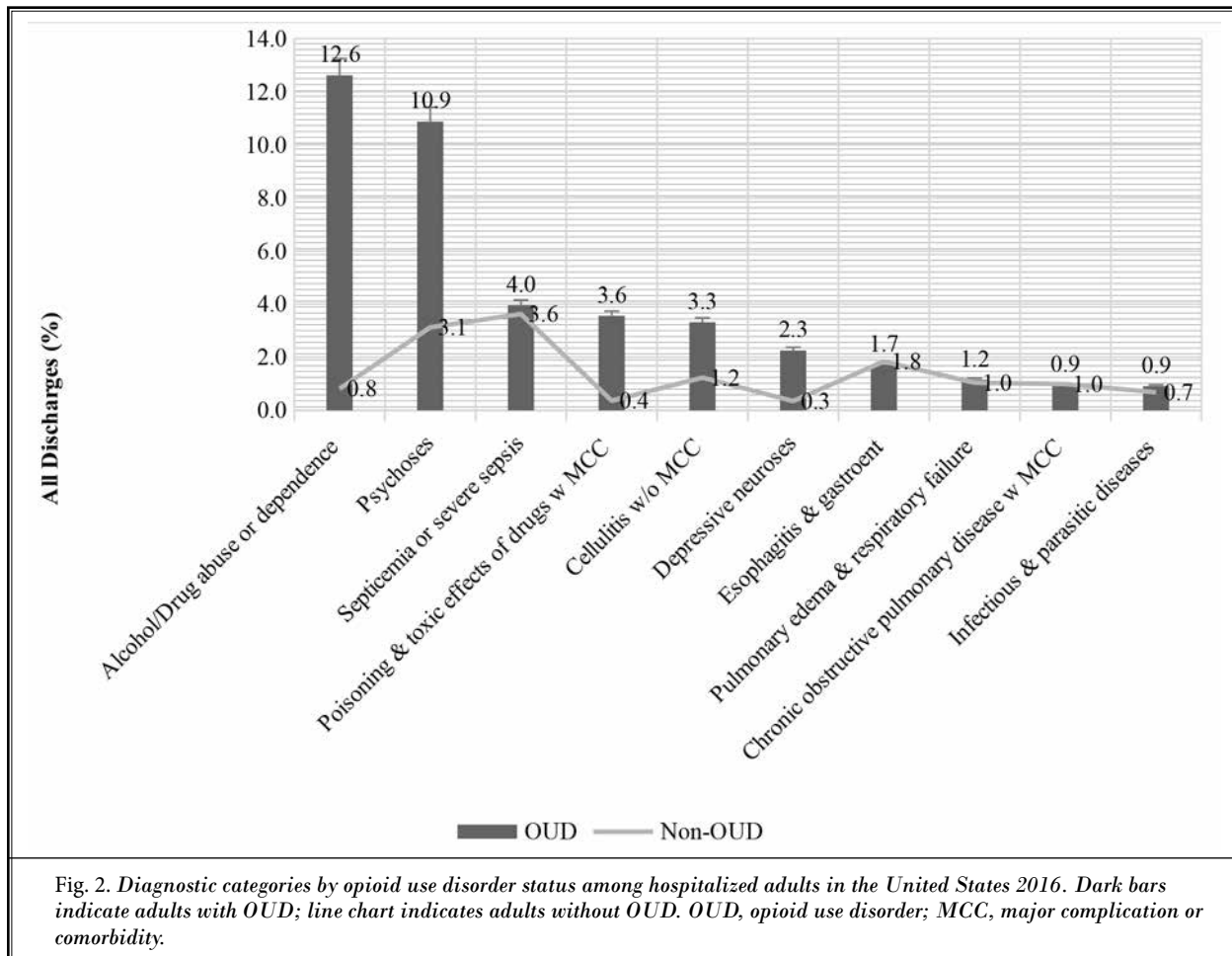

Fig. 1. *Distribution of total hospital charge, total hospital cost, and hospital length of stay by primary expected payer among hospitalized adults with opioid use disorder in the United States 2016. Values for total charge and total cost are expressed in thousands of U.S. dollars.*

septicemia or severe sepsis. Major joint replacement or reattachment of a lower extremity, septicemia or severe sepsis, and esophagitis, gastroenteritis and miscellaneous digestive disorders without major complication or comorbidity were more common among non-OUD discharges.

DISCUSSION

Opioid use continues to affect individuals, families, communities, and the nation at large, requiring holistic and multi-level approaches to prevent opioid overdose deaths. Our analysis of 2016 NIS data found that patients with OUD accounted for approximately 740,000 discharges that year representing about a 55% increase over the 2015 data that was reported by the Centers for Disease Control and Prevention (CDC) (16). Although the reason for this increase is unclear, it may reflect a true increase or a difference in how opioid-related events are captured in the database that was used for this study (NIS data) versus the National Vital Statistics System, the database that was used for the CDC study. The former, however, appears to be in keeping with most studies showing a worsening of the public health effect of opioids over the past 2 decades (2,7,11,16-18). While the number of patients with co-occurring OUD at discharge is increasing, they are only a fraction of the estimated 2 million Americans with OUD (17). Regardless, this study shows that inpatient settings provide a unique opportunity for targeting evidence-based, comprehensive interventions for patients with OUD. These include providing psychoeducation on the dangers of opioid use to all patients, simultaneously treating co-occurring OUD during inpatient stay, and expanding physician training and access to available treatments for OUD, including buprenorphine (3).

self-pay (6.8 days, Fig. 1), patients who died during hospitalization (8.4 days), patients with median household income of $71,000 or more (5.8 days), patients discharged from hospitals in the Northeast (6 days), and patients discharged from large hospitals (6 days). Patients with OUD who had 2 or more procedures performed during hospitalization had a higher average LOS (8.6 days) and proportionately significant cost per discharge ($131,362).

Figure 2 demonstrates common diagnoses of hospital discharges among patients with OUD compared with patients without OUD. The most frequently observed diagnosis associated with patients with OUD are alcohol/drug abuse or dependence, psychosis, and

Fig. 2. *Diagnostic categories by opioid use disorder status among hospitalized adults in the United States 2016. Dark bars indicate adults with OUD; line chart indicates adults without OUD. OUD, opioid use disorder; MCC, major complication or comorbidity.*

Knowledge of the changing sociodemographic characteristics of patients with OUD is important, as this may guide public health policies including those related to resource-allocation and development of drug-prevention strategies. The findings in this study are largely in keeping with emerging evidence that a higher proportion of patients with OUD are younger adults, white, and likely to have a lower annual income compared with individuals without OUD (18,19). Of note, discharge data related to OUD may be skewed given that uninsured patients and those from minority groups (e.g., African-Americans and Asian-Americans) are less likely to seek care for substance use disorder (20).

Average LOS is often used in health services practice and research as a proxy for the efficiency of health care delivery (21,22). Additionally, a shorter hospital stay has been reported to correlate with an overall reduction in health care costs and inversely with the

risk for hospital-acquired infections (22). In this study, a higher cost per discharge and, understandably, a higher average LOS was found among patients with OUD (5.6 days) compared with non-OUD cases (4.7 days), Asian-American/Pacific Islanders, those hospitalized in the Northeast, and patients who died during hospitalization. While it is unclear whether being diagnosed with OUD and the type and the severity of comorbid medical conditions played a role in this finding, one could hypothesize that patients with OUD with severe/complex/terminal medical conditions had longer hospital stays than those admitted for less severe medical problems. Despite the aforementioned, it is worth noting that longer hospital stays do not always correlate with disease status and severity because of multiple confounding factors (23).

Regarding the type of health insurance, patients with private insurance had longer hospital stays compared with those on Medicaid, reflecting national hos-

pital stay trends observed in the 2016 HCUP data (24). Ironically, Medicaid beneficiaries suffer a high burden of substance use disorder but face significant barriers to comprehensive drug treatment. Hence, policies that improve access and support the development of innovative drug intervention programs for this vulnerable group should be encouraged.

An explanation of the cost-to-charge ratios (CCRs) might help clarify the difference between analyzing hospital charge versus hospital cost data. The HCUP NIS contains data on total charges for each hospital in the databases. This charge information represents the amount that hospitals billed for services, but does not reflect how much hospital services actually cost (25). Information on CCRs was obtained from the hospital accounting reports collected by the Centers for Medicare and Medicaid Services. Statistical imputation for missing values and internal validation studies were carried out by HCUP to enhance the accuracy of the CCRs (26,27). Most hospital-based studies use total charge as a proxy measurement for actual cost which may lead to drawing unwarranted conclusions about economic efficiency and hospital resource utilizations (25). To maximize the accuracy of the cost estimation, our study used a more accurate cost by converting the total hospital charge to hospital cost estimates using CCRs.

Limitations

We recognize that there are several important limitations associated with this study, common to studies using data obtained from hospital discharge abstracts. First, OUD cases in this study are limited to ICD-10-CM codes defined as "Disorders related or resulting from abuse or misuse of opioids" and did not include the "T40" codes reported in ICD-10-CM as conditions related to "Poisoning by, adverse effect of and underdosing of narcotics and psychodysleptics [hallucinogens]." Additionally, OUD cases were not classified based on the type/source of the opioids that were used (e.g., prescribed versus nonprescribed [street] opioids, or natural versus synthetic versus semisynthetic opioids). Second, because of the retrospective nature of this study and the dependence on secondary data analysis, we are unable to ascertain the order of diagnosis of OUD and the other clinical conditions. Additionally, since the subsequent care, LOS, and cost may be related to care for sepsis, psychosis, pulmonary edema, or any of the other possible primary diagnoses, the associations reported in the study should be interpreted with caution. Third, the data were extracted from the NIS

comprised of hospital discharge records, originally collected for administrative purposes and may be subject to provider biases and variations in coding practices (28). Fourth, the use of these ICD-code–dependent data also limits the ability to differentiate the source of opioid use disorder. Fifth, the NIS database includes data from community, nonrehabilitation hospitals, and does not include data from noncommunity hospitals, such as Veterans Affairs, Department of Defense, and Indian Health Service hospitals, long-term hospitals, psychiatric hospitals, and alcohol/chemical dependency treatment facilities (29), further underestimating the prevalence of opioid use during pregnancy. However, as nationally validated databases, we do not anticipate any systemic biases that may have affected the analysis or results. Despite these limitations, the data sources provide a unique insight into community hospital resource utilization characteristics among patients with OUD, as well as relevant demographic and descriptive information on the patients with OUD population. The analysis provides insight into potential risk factors for adverse health care and treatment outcomes, and potentially vulnerable subgroups within the broader population.

CONCLUSION

The cost of OUD to individuals, families, and society is significant, with American taxpayers also bearing the brunt of the burden. As we continue to mitigate the opioid epidemic, these national-level estimates of resource utilization may guide efforts to target effective interventions to specific populations and reduce the health care cost of the opioid crisis in the United States.

Author Contributions

BA had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. He also developed the design of the study and wrote the first draft of the manuscript. OO and BCM designed the study protocol, managed the literature searches, and helped interpret the study.

of interest to report. The study was conducted in accordance with the 1964 Declaration of Helsinki and we received institutional review board (IRB) approval from the Western Carolina University IRB.

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