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US Trends of Opioid-use Disorders and Associated Factors Among Hospitalized Patients With Spinal Conditions and Treatment From 2005 to 2014

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Study Design. Serial cross-sectional study utilizing the National Inpatient Sample (NIS) 2005 to 2014.

Objective. The aim of this study was to examine the trends of opioid-use disorders among hospitalized patients with spinal conditions and treatment and to identify its contributing factors.

Summary of Background Data. The opioid is widely used in chronic spinal conditions, and misuse of prescriptions is the main culprit of the opioid crisis. Cannabis, the most commonly utilized illicit drug, has recently been substituted for opioid despite increasing cannabis-use emergency room visits. There is limited information on opioid-use disorders, the association with cannabis, and other contributing factors.

Methods. We analyzed the 2005 to 2014 NIS data that identified opioid-use disorders among hospitalized patients with

cervical and lumbar spinal conditions and treatment using the *International Classification of Disease, Ninth Revision-Clinical Modification codes* for opioid abuse, dependence, poisoning, and cervical and lumbar spinal diseases and procedures. The compound annual growth rate (CAGR) was used to quantify trends of opioid-use disorders among hospitalized patients. Multilevel and multivariable regression analyses were performed to determine their contributing factors.

Results. The number of hospitalizations with spinal conditions and treatment increased from 2005 to 2011, then decreased between 2011 and 2014 with an overall decrease in length of stay, resulting in the CAGR of -1.60% ($P < .001$). Almost 3% (2.93%, $n = 557,423$) of hospitalized patients with spinal conditions and treatment were diagnosed as opioid-use disorders and its CAGR was 6.47% ($P < .0001$). Opioid-use disorders were associated with cannabis-use disorders (odds ratio 1.714), substance use, mental health condition, younger age, white race, male sex, higher household income, and public insurance or uninsured.

Conclusion. This study suggests that opioid-use disorders are increasing among hospitalized patients with spinal conditions and treatment and associated with several demographic, and socioeconomic factors, including cannabis-use disorders.

Key words: cannabis, hospitalization, lower back pain, marijuana abuse, mental health, opioid, opioid-use disorders, spinal diseases, substance-use disorders, trends.

Level of Evidence: 3

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Chronic low back pain (CLBP) is the most common reason for opioid prescription in outpatient clinics in the United States.¹ The United States has the highest surgical rate for spinal disorders in the world, and the rate is increasing, despite the similar incidence and prevalence of spinal disorders worldwide.^{2–4} Considering that CLBP is the most common reason for prescribed opioids, it is common for CLBP patients to be on opioids before spinal surgery. Chronic opioid use is more common among patients who undergo orthopedic surgeries than

among those who undergo other types of surgeries.⁵ Retrospective studies have revealed that preoperative opioid use in patients with spinal diseases is associated with increased risks of postoperative opioid use and worse surgical outcomes including a higher rate of repeated surgeries.^{6,7}

In 2016, >11.5 million people reported misuse of prescription pain medicine⁸ and 115 Americans to die every day from an opioid overdose.⁹ On October 27, 2017, the president declared the opioid crisis a national public health emergency under section 319 of the Public Health Service Act. This declaration was renewed on October 18, 2018, because of the continued consequences of the opioid epidemic. In effect, the opioid-use disorder has been increasing among the general population with some variance in the rate of opioid-related hospitalization depending on age, ethnicity, geographic location,¹⁰ and household income.¹¹ However, the study on opioid-use disorders among more vulnerable population such as patients with painful spinal conditions and treatment was limited.

Substances abuse and mental health conditions were previously reported to be a contributor to the development of chronic opioid use that begins during the postoperative period.^{5,12,13} Cannabis remains the most commonly used illicit drug in the United States with an estimated 22.2 million people using it currently, and an additional 2.4 million people reporting first-time use annually.¹⁴ There were increasing emergency department visits related to cannabis use from 2006 to 2014¹⁵ with marijuana legalization in 33 states and the District of Columbia during the last two decades. Although there is an ongoing debate on whether cannabis is a gateway drug¹⁶ or a substitute for opioid use,¹⁷ little attention about the effects of marijuana legalization on opioid-use disorders among patients with spinal conditions and treatment is rising. Therefore, it is necessary to examine the association of cannabis, mental health conditions, and other substances abuse among patients with painful spinal conditions and treatment.

The purpose of our study is two-fold: to examine the temporal trends of opioid-use disorders among hospitalized patients with spinal conditions and treatment in the United States from 2005 to 2014, and to identify contributing factors to the increasing opioid-use diseases within the same period (Summary slide-2, <http://links.lww.com/BRS/B450>, Suppl Tables, <http://links.lww.com/BRS/B451>).

METHODS

Data Source and Study Population

This study was based on the National Inpatient Sample (NIS). NIS is the largest publicly available, all-payer US hospital inpatient dataset. It contains a 20% stratified sample of hospital inpatient stays from across the United States. The dataset captures discharge information from hospital inpatient stays and belongs to the family of the Healthcare Cost and Utilization Project sponsored by the Agency for Healthcare Research and Quality (AHRQ).¹⁸ The NIS can be weighted to generate national estimates. We

used a 10-year data from 2005 to 2014. The use of the NIS dataset is entirely anonymous with no risk of a confidentiality breach. An institutional review board approval was waived. We completed a data user agreement with the AHRQ before using the NIS database.

Measures

We identified opioid-use disorders in hospitalized patients with cervical and lumbar spinal conditions and treatment using the International Classification of Disease, Ninth Revision, Clinical Modification (*ICD-9-CM*) diagnostic and procedure codes to identify opioid abuse, dependence or poisoning. (Search terms included “continuous”, “episodic”, “unspecified”; See Table 1 for details.). The term “in remission” was excluded.

Events of interest measured included the annual rate of opioid, cannabis, other substance-use disorders and spinal conditions, and treatment-related hospital discharges. We also measured the annual number of hospitalizations and length of stay. We examined patient characteristics including age, sex, race, primary payer, number of comorbidities, the severity of illness, cannabis use, other substance use, and hospital region (Table 2), as there has been a variation of opioid-related hospitalization based on these factors.^{10,11} All-patient refined diagnosis-related group was used to classify the severity of illness (0 [lowest]–4 [highest]).¹⁹ A dummy variable was created for the year subset of 2010–2014) for two reasons. First, the CDC designated 2010 as the start of the second wave epidemic era when heroin overdose deaths began to increase sharply.²⁰ Furthermore, on October 19, 2009, the Department of Justice issued a memo stating that it would not prosecute marijuana users and sellers who complied with state laws for marijuana use.²¹

Statistical Analysis

First, the compound annual growth rate (CAGR) was used to quantify temporal trends of the annual number of opioids, cannabis, and other substance use-use hospitalizations in patients with spinal diseases. Its statistical significance was tested by Rao-Scott correction for χ^2 tests for categorical variables. The CAGR supposes that year A is x and year B is y , and $CAGR = (y/x)^{1/(B-A)} - 1$ has been widely used for health care valuation.^{22,23} Multilevel and multivariable regression analysis was performed to determine the relationship between opioid-use disorders and patient demographics, hospital factors, and socioeconomic status. To evaluate the effect of missing data on spine-related hospitalizations, we compared baseline characteristics between the missing and analyzed samples' characteristics. There were no statistical differences between the baseline characteristics of the selected and missing data. The model was determined to be stable, and the assumption of randomly missing data was found to be reasonable using the observed data. All analyses were performed using SAS statistical software version 9.4 (SAS Institute Inc., Cary, NC). All reported P values were 2-tailed and P value <0.05 was considered statistically significant.

TABLE 1. ICD-9-CM Codes Used for Spinal Conditions and Treatment, Opioid, Cannabis, and Substance-use Disorders and Mental Health Conditions

Diagnostic Categories	ICD-9-CM Codes
Lumbar spine	
Disc and spine diseases	7213, 72142, 72210, 72251, 72273, 72293, 72402, 72403, 7242, 7243, 7244, 7245, 7246, 72470, 72471, 72479, 7248, 7249, 7265
Status post-surgery	72280, 72283, V454
Procedure codes	301, 302, 309, 31, 8050, 8051, 8052, 8053, 8054, 8059, 8104, 8105, 8106, 8107, 8108, 8130, 8134, 8135, 8136, 8137, 8138, 8139, 8162, 8163, 8164, 8165, 8166, 8451, 8459, 8460, 8464, 8465, 8468, 8469, 8480, 8481, 8482, 8483, 8484, 8485
Cervical spine	
Disc and spine diseases	7210, 7211, 7220, 7224, 72271
Status post-surgery	72281, 72291, 7230, 7231, 7232, 7233, 7236, 7237, 7238, 7239
Procedure codes	8101, 8102, 8103, 8131, 8132, 8133, 8461, 8462, 8466
Drugs	
Opioid	30400, 30401, 30402, 30403, 30470, 30471, 30472, 30473, 30550, 30551, 30552, 30553, 96500, 96501, 96502, 96509, E8500, E8501, E8502, E9350, E9351, E9352
Marijuana	3043, 30430, 30431, 30432, 30433, 30520, 30521, 30522, 30523
Alcohol	30300, 30301, 30302, 30303, 30390, 30391, 30392, 30393, 30500, 30501, 30502, 30503, 9800, 9801, 9802, 9803, 9808, 9809
Sedative	30410, 30411, 30413, 30540, 30541, 30542, 30543, 9670, 9671, 9672, 9673, 9674, 9675, 9676, 9678, 9679, 9680, 9691, 9692, 9693, 9694, 9695, E851, E8521, E8522, E8523, E8524, E8525, E8528, E8529, E8530, E8531, E8532, E8538, E8539, E9370, E9371, E9372, E9379, E9380, E9801, E9802, E9803
Cocaine	30420, 30422, 30423, 30560, 30561, 30562, 30563, 97081, 97089
Stimulant	30440, 30441, 30442, 30443, 30570, 30571, 30572, 30573, 9696, 96970, 96971, 96972, 96973, 96979, 9700, 9701, 9709, E8541, E8542, E8543, E8548, E9404, E9409, E9412
Hallucinogen	30450, 30451, 30452, 30453, 30530, 30531, 30532, 30533, E8541, E8555, E8556, E8558, E8559
Other	30460, 30461, 30462, 30463, 30470, 30471, 30472, 30480, 30481, 30483, 30490, 30491, 30492, 30580, 30581, 30582, 30583, 30590, 30591, 30592, 9690, 96901, 96902, 96903, 96904, 96905, 96909, E8541, E9390, E9391, E9392, E9393, E9394, E9395, E9396, E9897, E9398, E9399
Mental health condition	
Mood disorders	29600, 29601, 29602, 29603, 29604, 29605, 29606, 29610, 29611, 29612, 29613, 29614, 29615, 29616, 29620, 29621, 29622, 29623, 29624, 29625, 29625, 29626, 29630, 29631, 29632, 29633, 29634, 29635, 29640, 29641, 29642, 29643, 29644, 29645, 29646, 29650, 29651, 29652, 29653, 29654, 29655, 29656, 29660, 29661, 29662, 29663, 29664, 29665, 29666, 2967, 29680, 29681, 29682, 29689, 29690, 29699
Psychosis	2970, 2971, 2972, 2973, 2978, 2979, 2980, 2981, 2982, 2983, 2984, 2988
Anxiety disorders	30000, 30001, 30002, 30009, 30010, 30011, 30012, 30013, 30014, 30015, 30016, 30019, 30020, 30021, 30022, 30023, 30029, 3003, 3004, 3005, 3006, 3007, 30081, 30082, 30089
Personality and other disorders	3009, 3030, 30110, 30111, 30112, 30113, 30120, 30121, 30122, 3013, 3014, 30150, 30151, 30159, 3016, 3017, 30181, 30183, 30184, 30189, 3019

ICD-9-CM indicates International Classification of Diseases, 9th Revision, Clinical Modification.

TABLE 2. Temporal Trends of Hospitalized Patients With Spinal Conditions and Treatment

Variables	2005		2008		2011		2014	
	N	%	N	%	N	%	N	%
Total weighted N	1,370,599		1,875,053		2,339,687		1,997,471	
Age group, y								
<30	92,266	6.7%	110,617	5.9%	128,983	5.5%	114,620	5.7%
30–39	121,507	8.9%	147,748	7.9%	177,903	7.6%	142,350	7.1%
40–49	231,918	16.9%	287,322	15.3%	331,696	14.2%	248,020	12.4%
50–59	253,208	18.5%	371,294	19.8%	495,390	21.2%	429,655	21.5%
60–69	225,864	16.5%	352,183	18.8%	474,238	20.3%	434,730	21.8%
70–79	239,558	17.5%	317,560	16.9%	391,295	16.7%	353,165	17.7%
≥80	206,279	15.1%	288,330	15.4%	340,181	14.5%	274,930	13.8%
Sex								
Male	598,783	43.7%	822,914	43.9%	1,044,519	44.6%	909,371	45.5%
Female	771,816	56.3%	1,052,140	56.1%	1,295,167	55.4%	1,088,101	54.5%
Race								
Black	119,303	8.7%	177,837	9.5%	263,788	11.3%	232,145	11.6%
Hispanic	84,594	6.2%	113,351	6.0%	163,519	7.0%	142,815	7.1%
Asian or Pacific Islander	16,460	1.2%	28,379	1.5%	29,520	1.3%	30,360	1.5%
Native American/other	37,053	2.7%	56,449	3.0%	61,294	2.6%	60,405	3.0%
White	1,113,188	81.2%	1,499,038	79.9%	1,821,566	77.9%	1,531,746	76.7%
Median household income								
0–25 th percentile	339,412	24.8%	497,422	26.5%	649,608	27.8%	573,805	28.7%
26 th –50 th percentile	336,443	24.5%	516,330	27.5%	574,208	24.5%	557,855	27.9%
51 st –75 th percentile	360,701	26.3%	439,744	23.5%	593,675	25.4%	464,025	23.2%
76 th –100 th percentile	334,043	24.4%	421,557	22.5%	522,196	22.3%	401,785	20.1%
Primary payer								
Medicare	651,392	47.5%	895,040	47.7%	1,161,729	49.7%	1,024,576	51.3%
Medicaid	127,519	9.3%	178,378	9.5%	258,436	11.0%	277,840	13.9%
Uninsured	48,341	3.5%	72,103	3.8%	102,673	4.4%	68,160	3.4%
Other	75,705	5.5%	98,995	5.3%	115,567	4.9%	82,920	4.2%
Private insurance	467,642	34.1%	630,537	33.6%	701,281	30.0%	543,976	27.2%
Number of comorbidities*	1.80	1.53	2.20	1.72	2.48	1.83		
Severity of illness subclass								
APR-DRG 0,1, lowest	508,773	37.1%	587,229	31.3%	636,322	27.2%	714,735	35.8%
APR-DRG 2	543,601	39.7%	756,688	40.4%	955,673	40.8%	748,565	37.5%
APR-DRG 3	232,031	16.9%	396,032	21.1%	567,157	24.2%	424,950	21.3%
APR-DRG 4, highest	86,194	6.3%	135,105	7.2%	180,534	7.7%	109,220	5.5%
Opioid-use disorders								
Yes	5632	0.4%	46,738	2.5%	77,396	3.3%	70,090	3.5%
No	27,351	2.0%	1,828,316	97.5%	2,262,291	96.7%	1,927,381	96.5%
Cannabis-use disorders								
Yes	9956	0.7%	17,159	0.9%	29,723	1.3%	35,190	1.8%
No	1,360,643	99.3%	1,857,894	99.1%	2,309,964	98.7%	1,962,281	98.2%
Substance-use disorders								
Yes	80,855	5.9%	124,059	6.6%	180,308	7.7%	166,040	8.3%
No	1,289,744	94.1%	1,750,994	93.4%	2,159,378	92.3%	1,831,431	91.7%
Mental health conditions								
Yes	275,212	20.1%	469,148	25.0%	665,156	28.4%	615,555	30.8%
No	1,095,387	79.9%	1,405,906	75.0%	1,674,531	71.6%	1,381,916	69.2%
Hospital region								
Northeast	320,150	23.4%	407,343	21.7%	450,217	19.2%	371,145	18.6%
Midwest	248,622	18.1%	301,844	16.1%	451,588	19.3%	440,115	22.0%
South	507,396	37.0%	742,567	39.6%	940,856	40.2%	785,252	39.3%
West	294,432	21.5%	423,299	22.6%	497,026	21.2%	400,960	20.1%

*Mean/SD.

RESULTS

Descriptive Characteristics of Hospitalized Patients With Spinal Conditions and Treatment and Opioid-use Disorders

The 2005 to 2014 NIS database contained 382,516,561 hospital inpatient stays. Among the 23,663,307 hospitalizations with cervical and lumbar spinal conditions and treatment, 4,657,522 cases were removed because of missing value in an observation (Figure 1). Among 19,005,785 hospitalizations with spinal conditions and treatment, opioid-use disorders were 2.93% (557,423). Table 2 presents a descriptive analysis of patient and hospital characteristics.

Trends of Hospitalizations With Spinal Conditions and Treatment and Length of Hospital Stay

Figure 2 presents the temporal trends of hospitalizations with spinal conditions and treatment and the annual average length of hospital stay. The CAGR of these hospitalizations was 4.27% ($P < .001$; 1,370,599 hospitalizations in 2005 and 1,997,471 hospitalizations in 2014). There were two trends in the annual number of hospitalizations with spinal conditions and treatment: monotonic increase during the period between 2005 and 2011 and decrease during the period between 2011 and 2014. Most patient sociodemographics and hospitalization characteristics were relatively stable during the period observed, as shown in Table 2. We observed overall decreasing trends in the length of hospital stay, with the sharpest decrease from 2010 to 2011. The CAGR of hospital length of stay was -1.60% ($P < 0.001$).

Trends of Opioid, Cannabis, and Other Substance-use Disorders Among Hospitalized Patients With Spinal Conditions and Treatment

Figure 3 presents the trends of annual rates of opioid, cannabis, and other substance-use disorders among hospitalized patients. We observed an increasing trend in annual rates of all opioid, cannabis, and other substance-use disorders except the rate of other substance-use disorder in 2008. The CAGRs of them were 6.47%, 10.34%, and 3.88%, respectively (all $P < 0.001$).

Multivariable Analyses of Opioid-use Disorders and Its Associated Factors Among Hospitalized Patients With Spinal Conditions and Treatment

Table 3 shows the relationship between opioid-use disorder and its associated factors based on multivariable analyses. On average, the likelihood of opioid-use disorders increased about 5.2% annually from 2005 to 2014 (odds ratio [OR] 1.052, 95% confidence interval [CI] 1.049–1.054). Opioid-use disorders happened over 25% more often among hospitalized patients with spinal conditions and treatment during the period from 2010 to 2014 compared from 2005 to 2009 (OR 1.268, 95% CI 1.252–1.284).

Regarding age, opioid-use disorder among hospitalized patients was more common in the younger age group, and monotonically declined as the age increased. Compared to privately insured patients, all other patients were >1.5 times more likely to be diagnosed as opioid abuse, dependence, or poisoning (OR 1.668, 95% CI 1.637–1.699 for Medicare patients; OR 1.780, 95% CI 1.746–1.814 for Medicaid

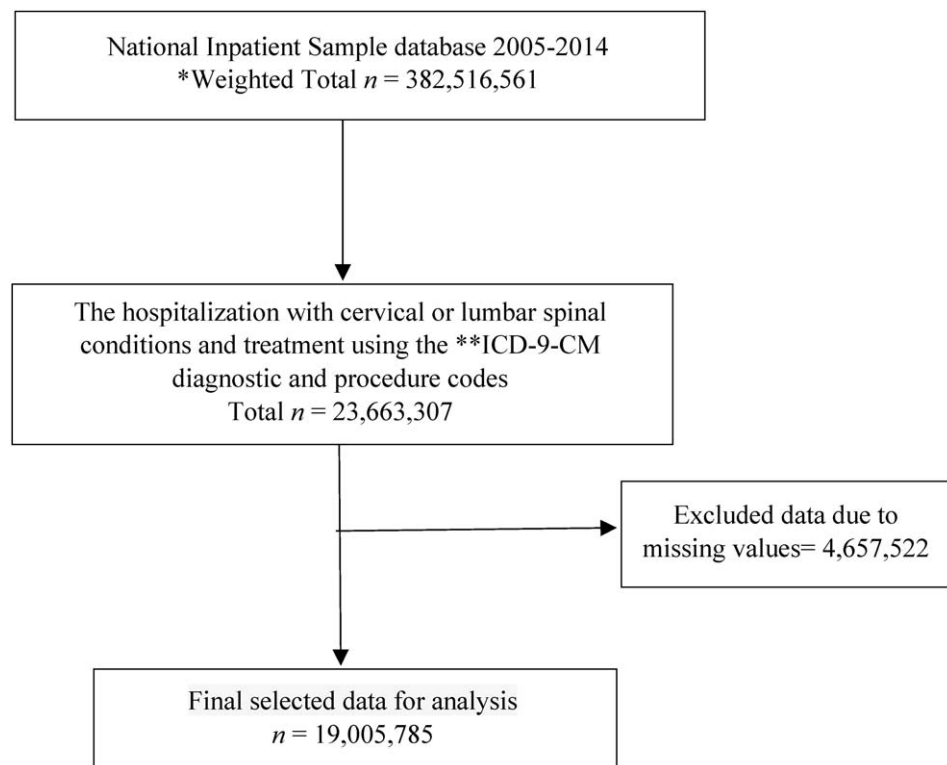


Figure 1. Patient selection process. Note: *Weighted indicates survey adjustments to estimate national population estimates./ CD-9-CM indicates International Classification of Diagnosis, Ninth Revision, Clinical Modification.

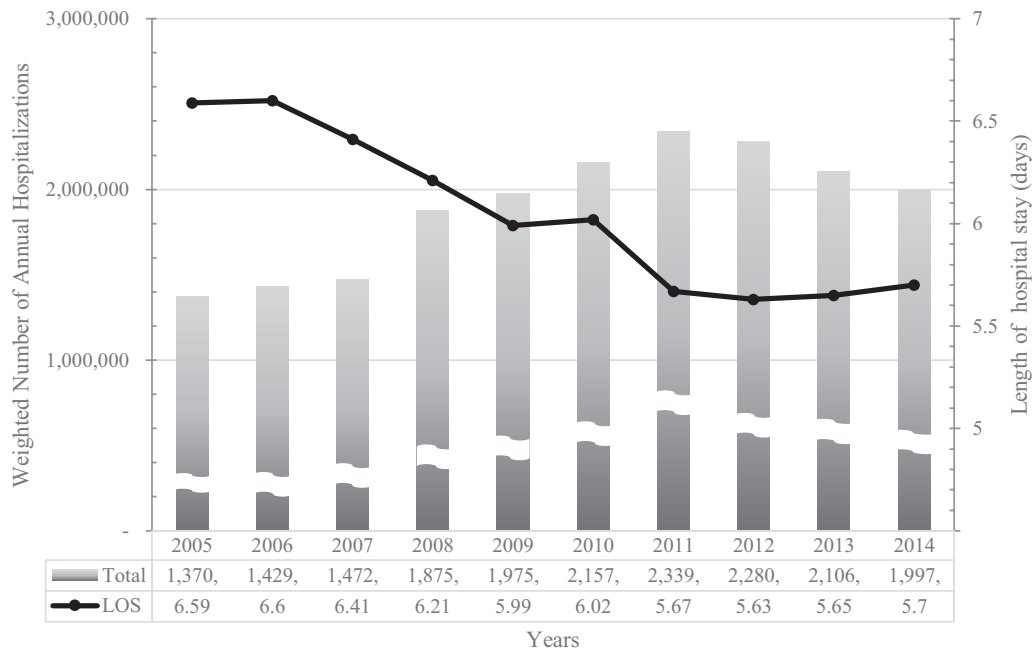


Figure 2. Annual total numbers of hospitalized patients with cervical and lumbar spinal conditions and treatment (total) and length of hospital stay (LOS).

patients; OR 1.965, 95% CI 1.918–2.014 for the uninsured).

Regarding cannabis and substance, patients with cannabis and substance-use disorders were more vulnerable to opioid (OR 1.714, 95% CI 1.666–1.765 for cannabis; OR 5.382, 95% CI 5.299–5.466 for other substances)

It is not surprising that patients with mental health conditions were more vulnerable to opioid than patients without mental health conditions (OR 2.203, 95% CI 2.172–2.234).

Opioids abuse, dependence, or poisoning was more common in the Western and Northeastern region than the

Midwestern and Southern region among hospitalized patients with spinal conditions and treatment.

DISCUSSION

The present study examined the nationwide temporal trends of opioid-use disorders among hospitalized patients with spinal conditions and treatment. The critical finding is the monotonically increasing pattern of opioid-use disorders (annually 6.47%) as observed in national reports from the CDC and self-report studies of increasing opioid abuse, dependence, or poisoning and treatment utilization patterns in the United States.⁸ A growing trend of opioid-use disorder

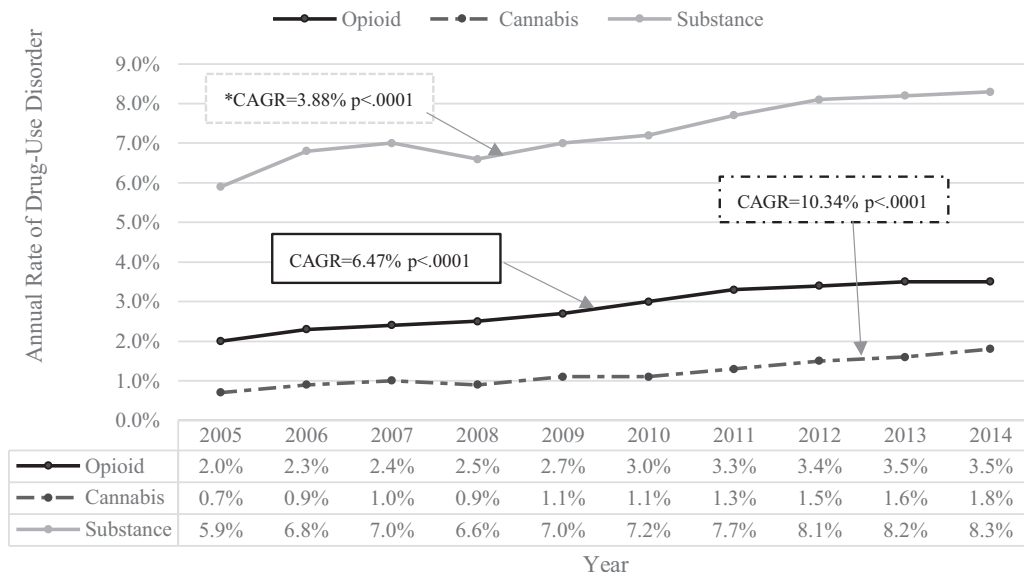


Figure 3. Annual trends of opioid, cannabis, and other substance-related disorders among hospitalized patients with spinal conditions and treatment from 2005 to 2014. CAGR indicates compound annual growth rate.

TABLE 3. Relationship Between Opioid-use Disorders and Contributing Factors Among Hospitalized Patients With Spinal Conditions and Treatment (Multivariate regression analysis)

	Odds ratios	95% CIs		Odds ratios	95% CIs	
Year increment (continuous variable)				1.052	1.049	1.054
Year dummy (categorical variable)						
2010–2014	1.268	1.252	1.284			
2005–2009	Reference					
Age group, y						
<30	Reference			Reference		
30–39	0.996	0.972	1.021	0.997	0.973	1.022
40–49	0.702	0.686	0.719	0.704	0.687	0.721
50–59	0.567	0.554	0.580	0.565	0.552	0.579
60–69	0.291	0.283	0.300	0.290	0.282	0.298
70–79	0.130	0.125	0.135	0.130	0.125	0.135
≥80	0.063	0.060	0.066	0.063	0.060	0.066
Male sex	1.083	1.069	1.098	1.083	1.068	1.097
Race						
White	Reference			Reference		
Black	0.601	0.587	0.615	0.600	0.587	0.614
Hispanic	0.696	0.677	0.714	0.695	0.677	0.714
Asian or Pacific Islander	0.407	0.373	0.445	0.405	0.371	0.443
Native American/other	0.765	0.735	0.796	0.765	0.735	0.796
Median household income						
0–25 th percentile	Reference			Reference		
26 th –50 th percentile	1.004	0.987	1.021	1.001	0.984	1.019
51 st –75 th percentile	1.046	1.028	1.065	1.046	1.028	1.065
76 th –100 th percentile	1.090	1.069	1.111	1.089	1.068	1.111
Primary payer						
Private insurance	Reference			Reference		
Medicare	1.668	1.637	1.699	1.667	1.636	1.698
Medicaid	1.780	1.746	1.814	1.771	1.737	1.805
Uninsured	1.965	1.918	2.014	1.963	1.916	2.011
Other	1.114	1.081	1.148	1.114	1.081	1.148
Number of comorbidities	1.059	1.055	1.063	1.060	1.055	1.064
Severity of illness subclass						
APR-DRG 0,1, lowest	Reference			Reference		
APR-DRG 2	1.446	1.422	1.470	1.446	1.423	1.470
APR-DRG 3	1.473	1.443	1.504	1.463	1.433	1.494
APR-DRG 4, highest	1.313	1.273	1.354	1.308	1.268	1.349
Cannabis-use disorders						
Yes	1.714	1.666	1.765	1.707	1.659	1.757
No	Reference			Reference		
Substance-use disorders						
Yes	5.382	5.299	5.466	5.389	5.306	5.473
No	Reference			Reference		
Mental health conditions						
Yes	2.203	2.172	2.234	2.194	2.163	2.225
No	Reference			Reference		
Hospital region						
West	Reference			Reference		
Northeast	0.983	0.965	1.002	0.987	0.968	1.006
Midwest	0.644	0.631	0.658	0.643	0.629	0.656
South	0.756	0.742	0.769	0.755	0.742	0.768

APR-DRG indicates all-patient refined diagnosis-related group; CI, confidence interval.

in this study is consistent with the same epidemiologic database of increasing opioid-use hospitalizations among patients with lumbar spinal fusion procedures.¹²

Trends of Hospitalizations With Spinal Conditions and Treatment and Length of Hospital Stay

Regarding trends of hospitalizations with spinal conditions and treatment, our findings are consistent with those from other studies on decreasing trends of elective lumbar spinal surgeries since 2011.²⁴ Spinal surgeries are among the most costly procedures in the US health care system.²⁵ Length of hospital stay decreased during the study period. The Center for Medicare and Medicaid Services implemented a series of Medicare reform policies linking quality of performance to payment under the umbrella of Affordable Care Act including Hospital Acquired Conditions in 2008, Hospital Readmission Reduction Program in 2012, and spine bundle program in 2013. These policies led to cost containment by reducing hospital length of stay as well as readmission after spinal procedures and surgeries. Besides, the rapid proliferation of ambulatory surgery centers in the 2000s may have contributed to the reduction in the hospital-based elective spinal surgery.^{26,27} The effect of this shift of this practice pattern on the increasing trend of increasing opioid-related hospitalizations despite the decreasing hospital stay warrants further investigation beyond the health policy effects.²⁸

Age, Demographic and Socioeconomic Characteristics and Assumption of Purpose of Opioid Abuse, Dependence, or Poisoning

We observed a distinct pattern in the relationship between age and opioid-use disorders. Compared to middle-aged and older adults, young adults (<30 years' old) are the most vulnerable to opioid, and the risk of opioid-use disorders declines monotonically with progressing age. This finding supports the previous results that young adults are more likely than older adults to use opioids because young adults tend to perceive opioids as low risk, both for prescription and recreational uses.²⁹ Our findings may suggest illicit use as a potential contributing factor for opioid-use disorders among young adults, although the reason for opioid use was not available in our analysis. It is interesting to see the discordance of the median household income and primary payer in opioid-use disorders. Population with private insurance has the lowest rate, whereas the group with the highest median household income has the highest percentage. It may be secondary to the shift of the insurance carrier regardless of the household income after chronic disabling painful spinal conditions with opioid abuse, dependence, or poisoning. This fact warrants further investigation as this report lacked the longitudinal socioeconomic information of the individuals.

Cannabis, Other Substances, and Mental Health Conditions as Associated Factors of Opioid-use Disorders

Cannabis legalization during the last 18 years has led to a broader spectrum of medicinal as well as recreational use.

Sound production is more efficient than black market production, and falling cannabis prices have increased the accessibility of use among young adults.³⁰ Although there is an ongoing debate about whether cannabis is a gateway drug, our findings imply that cannabis use and opioid use can mutually increase each other, based on the reports from survey³¹ and claim data.¹⁵ Continuous use of cannabis, either medicinally or recreationally, may lead to increased dependence and higher tolerance levels. Therefore, it is possible that medical and recreational use of marijuana might lead to more detrimental health outcomes such as cannabis abuse or dependence. Because of the nature of our cross-sectional study design using the NIS dataset, we were unable to examine whether cannabis use begins before the opioid use. Also, socioeconomic status, depression, and anxiety were reported to be associated with an increased risk of persistent opioid use at 1 year following the intervention in this group.^{13,32} A recent study revealed about 50% of patients undergoing spinal surgery might be consuming opioids at the time of the surgical procedures, and 20% of this population may be opioid-dependent.²⁹

Limitations and Strengths

As this study was a retrospective review of hospital discharge-based data, there are several significant limitations. First, this study only included discharge data and no actual medical assessments. Besides, the hospital discharge-based database does not provide information on actual consumption, dosage, or use patterns of the opioids, cannabis, or other substances. Second, we relied on ICD-9-CM codes that, to a certain extent, may have limited accuracy in capturing the actual person who used opioid, cannabis, and other substances with or without mental health conditions because of incorrect coding or missing data from coding practices and awareness of clinician's differences.¹⁵ Furthermore, the identification of persons who used illicit drugs with mental health conditions was significantly underestimated, considering low sensitivity and high specificity in weighted estimates from discharge dataset.³³ This study cannot address the potential for unrecognized coding errors or unreported events that could influence the results. Third, our analysis could not fully specify the severity and onset of spinal diseases as well as time since spinal surgeries or procedures. Also, the temporal relationship, that is, the opioid-use disorders occurred before admission and was the cause of hospitalization, or occurred during the hospitalization, as an unintended overdose from the hospital-prescribed medication, was not investigated. Future studies need to consider this information using other datasets. Lastly, we did not fully interpret factors associated with opioid-use disorders among hospitalized patients with spinal conditions and treatment and variables (sex, income) because of insufficient precedent studies explaining clinical and policy implications of these findings. Given the extensive and recent data from the nationally representative dataset, we believe that temporal trends and associated factors of opioid-use disorders among hospitalized patients

with spinal conditions and treatment are likely generalizable to most patients with spinal diseases.

In summary, this study shows that opioid-use disorders among hospitalized patients with spinal conditions and treatment steadily increased from 2005 to 2014 in US hospitals. This trend was associated with cannabis and other substance-use disorders, mental health conditions, younger age, white race, higher household income, and public insurance or uninsured.

➤ Key Points

- ❑ Previous studies reported that chronic opioid use or preoperative opioid prescription for patients with spinal conditions and treatment increased the risk of opioid-related hospitalization or postoperative readmission.
- ❑ This study shows that opioid-use disorders increased by 6.47% annually among patients with spinal diseases from 2005 to 2014 in US hospitals.
- ❑ This increasing rate of opioid-use disorder was associated with the cannabis-use disorder, younger age, white race, male sex, higher income, and public insurance, and uninsured.

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