Cannabis Use in Hospitalized Patients with Chronic Pain

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ABSTRACT

Introduction: To date, no study has reported the prevalence of cannabis use in chronic pain patients. The aim of this study is to investigate the trends in cannabis use among chronic pain in-patients from 2011 to 2015 in the USA.
Methods: Patients were identified from the National Inpatient Sample (NIS) database using the International Classification of Diseases, Ninth and Tenth Revision, diagnosis codes for chronic pain and cannabis use. Annual estimates and trends were determined for cannabis use, patient characteristics, cannabis use among subgroups of chronic pain conditions, cost, length of stay, and associated discharge diagnosis.
Results: Between 2011 to 2015, a total of 247,949 chronic pain patients were cannabis users, increasing from 33,189 to 72,115 ($P < 0.001$). There were upward trends of cannabis use in females (38.7–40.7%; $P = 0.03$), Medicare insured patients (32.7–40.4%; $P < 0.01$), patients with lowest annual household income (36.1–40.9%; $P = 0.02$), patients aged 45–64 years (45.9–49.2%; $P < 0.001$), and patients with tobacco use disorder (63.8–72.4%; $P < 0.0001$). Concurrently, cannabis use decreased among patients with opioid use

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disorder (23.8–19.9%; $P < 0.001$). Cannabis use increased from 2011 to 2015 in patients with chronic regional pain syndrome, trauma, spondylosis, and failed back surgery syndrome. Adjusted total hospitalization cost increased from \$31,271 (\$1333) in 2011 to \$38,684 (\$946) in 2015 ($P < 0.001$).

Conclusions: Cannabis use increased substantially from 2011 to 2015, while the rates of cannabis use in opioid users down-trended simultaneously. Disparities in cannabis use among subgroups should be explored further.

Key Summary Points

Why carry out this study?

Cannabis is a commonly used psychoactive substance, and its use has been suggested to have a high prevalence among patients with chronic pain

With the recent legalization of marijuana across several states in the US, there is a dire need to establish a baseline use among hospitalized patients

The aim of this study is to investigate the trends in cannabis use among chronic pain in-patients from 2011 to 2015 in the US

What was learned from the study?

We found that cannabis use is increasing among chronic pain patients and a subpopulation of chronic pain patients (tobacco users, men, low household income, Medicaid insurance coverage, and certain chronic pain syndromes). However, we observed that the rates of cannabis use in opioid users were down-trending simultaneously

In the era of recent legalization of cannabis use in certain regions of the US, our study reveals a rising trend among certain groups of hospitalized patients with chronic pain

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INTRODUCTION

Chronic pain is a major public health issue with an estimated 12-month prevalence of 37% in developed countries and as high as 41% in developing countries [1]. Cannabis is a commonly used psychoactive substance, and its use has been suggested to have a high prevalence among patients with chronic pain [2]. Prior to the recent ongoing legalizations driven by public demand, illegal access to the substance was exceptionally high [3]. Now cannabis is the most frequently consumed illicit drug, driven by increased availability and new medicinal perspective [4].

Though cannabis use was a taboo just a decade ago, increased widespread availability of medical and recreational cannabis coupled with social acceptability and its potential medicinal value has led to a normalization of its use in everyday life. Despite the lower potential addiction potential of those who consume cannabis, one in ten will progress to develop cannabis use disorder [5, 6]. Cannabis use may be a precipitating factor in further developing additional substance abuse and has been

implicated in a causal model for abuse/dependence on a diversity of other drugs [7].

This is evidenced by a report of the health effects of cannabis, which supports the use of cannabis for chronic pain and associated conditions such as fibromyalgia, multiple sclerosis, and sleep apnea [8]. As cannabis gains a role in the treatment of chronic pain conditions, the development of cannabis use disorder and ultimately subsequent illicit substance abuse disorder in patients becomes a concern [9]. In this study we assess the prevalence of cannabis use among inpatients with chronic pain using a national inpatient database.

METHODS

Database Characteristics

NIS data from 2011 to 2015 were reviewed and included in our analysis. The NIS (National Inpatient Sample) is one of the Healthcare Cost and Utilization Projects databases sponsored by the Agency for Healthcare Research and Quality [10]. This database is considered the largest all-payer inpatient care database in the US and has been used in multiple instances to analyze national trends in outcomes, quality, charges, access, and health care utilization based on data extracted from 7 to 8 million hospital stays.

These hospital stays represent approximately 20% of the US community hospitals, defined as all academic medical centers, general specialty hospitals, and non-federal and short-term medical centers. The NIS is publicly available and contains no personal identifying information. Hence, this study was exempt from institutional review board approval. In our analysis, we included chemical dependency treatment facilities, long-term acute care hospitals, short-term rehabilitation facilities, and psychiatric hospitals. Hospitals within a given stratum have similar statistical probability of sample selection regardless of appearance in a prior sample. Further information on the design and statistical information of the NIS is available at http://www.hcup-us.ahrq.gov.

Inclusion and Exclusion Criteria

Our study evaluated patient information data acquired from NIS from 2011 to 2015 to determine the trends of comorbid cannabis use in patients with chronic pain. Cannabis users were identified based on International Classification of Diseases (ICD) codes for cannabis dependence (ICD-9 codes: 304.30-3, ICD-10 codes: F12.10, F12.11, F12.19, F12.20, F12.21, F12.29, F12.288, F12.988, and F12.188) and non-dependence (ICD-9 codes: 305.20-3, ICD-10 codes: F12.90, F12.99). This definition is consistent with prior reported studies in the cardiovascular literature [11, 12]. Due to the lack of specific ICD-9-CM codes for medical cannabis use, we assumed that patients with a clinical diagnosis of cannabis abuse, dependence, or non-dependence represent patients with recreational cannabis use. Studies have shown that medical cannabis users also use cannabis recreationally [13, 14] with 86% of people who report ever using cannabis for medicinal purposes also using it recreationally [15]. Hence, ICD-9-CM codes for cannabis abuse, dependence, or disorder were used to represent recreational cannabis use. Patients without a diagnosis of chronic pain were excluded from our analysis.

Outcomes

Our primary outcomes were trends in cannabis use, patient characteristics, and cannabis use among subgroups of chronic pain conditions. Hospital charges, length of hospital stay, number of inpatient procedures, discharge destinations, and associated discharge diagnosis were considered our secondary outcomes. The appropriate weights from the NIS database were applied to obtain trends and annual national estimates.

Statistical Analysis

In our statistical analysis, we calculated the frequencies of these outcomes for each year and determined whether there were any trends in outcomes from 2011 to 2015. We used guidance from the Agency for Healthcare Research and

Quality for survey analysis. Survey-specific commands were used to obtain descriptive statistics and perform trend analyses (e.g., svymean, svytab, svyregress). The provided trend weights were used to obtain national estimates. For tests of trend, we used survey-specific linear regression. We adjusted for trends in patient characteristics over time by using a logistic regression model for survey data (svy:regress) and included the year (centered around the mean) as a continuous variable. We conducted our analysis using STATA 14 [16].

Compliance with Ethics Guidelines

This study uses anonymous patient data from another source and so is exempt from needing ethics approval.

RESULTS

Trends of Cannabis Use in Chronic Pain Patients

Between 2011 to 2015, approximately 10.3 million patients with chronic pain were identified. Of this cohort 247,949 were cannabis users. The estimated number of patients using cannabis increased from 33,189 in 2011 to 72,114 in 2015 ($P < 0.001$) (Table 1). The yearly prevalence of cannabis use among patients with chronic pain increased from 2.4% in 2011 to 3.9% in 2015 ($P < 0.001$) (Fig. 1).

Trends of Cannabis Use and Patient Characteristics

The trends in patient characteristics are displayed in Table 1. The mean (SE) age of cannabis users increased from 42.80 (0.25) to 45.40 (0.14) years ($P < 0.0001$) with the highest proportion of patients observed among patients aged 45–64 years. The lowest proportion was observed in elderly patients > 84 years old. Between 2011 to 2015, there was an upward trend in cannabis use among patients within the 45–64- and 65–84-year age groups. Cannabis use was lower among females, and the proportion increased from 38.7 in 2011 to 40.2 in 2015 ($P = 0.03$). The proportions of cannabis users were highest among whites at 70.1% (0.39) with the lowest proportion observed in Asian/Pacific Islanders at 0.51% (0.05). From 2011 to 2015, the proportion of cannabis use increased from 17.8% (1.20) to 21.0% (0.66) among blacks but decreased from 71.4% (1.50) to 69.7% (0.74) among whites.

Patients at the lowest income quartile had the highest proportion of cannabis use, 39.4% (0.47), and those at the highest quartile had the lowest proportion of cannabis use, 11.9% (0.28). From 2011 to 2015, the proportion of cannabis users increased from 36.1% (1.90) to 40.9% (0.74) among the lowest income quartile but decreased from 13.1% (1.10) to 12.0% (0.52) among the highest income quartile. Patients with cannabis use were mostly covered by Medicaid and least often covered by private insurance (36.8% vs. 11.9%; $P = 0.02$). From 2011 to 2015, the proportion of cannabis users increased from 32.7% (1.10) to 40.4% (0.63) among Medicaid patients but remained stable among Medicare and private insurance patients. Most patients who used cannabis were admitted at hospitals with large bed sizes compared to smaller sizes (59.9% vs. 14.08%; $P < 0.0001$). From 2011 to 2015, the proportion of cannabis users increased from 8.4% (1.20) to 15.9% (0.90) among small bed size facilities but decreased from 68.2% (2.56) to 56.7% (1.50) among larger bed size facilities.

Trends of Cannabis Use Among Subgroups of Chronic Pain Diagnosis

Trauma patients had the highest proportion of cannabis users but patients with failed back surgery syndrome (FBSS) had the lowest proportion (6.89% vs. 0.70%) (Table 2). From 2011 to 2015, the proportion of cannabis users trended up among patients with chronic regional pain syndrome (CRPS) [1.25 (0.17) to 1.96 (0.24); $P = 0.02$], trauma [5.23 (0.56) to 8.98 (0.71); $P < 0.001$], spondylosis [0.57 (0.04) to 1.2 (0.05); $P < 0.001$], FBSS [0.47 (0.12) to 0.97 (0.15); $P < 0.001$], and other chronic pain diagnoses [2.4 (0.11) to 3.49 (0.07); $P < 0.01$].

Table 1 Patient-level characteristics for cannabis use by calendar year

Characteristics	Overall	2011	2012	2013	2014	2015	Trend P value
Total patients with cannabis use, weighted no. (SE)	247,949 (3473)	33,189 (1960)	39,700 (1328)	45,935 (1565)	57,010 (1856)	72,115 (2263)	0.00
Prevalence of cannabis use disorder (%)	2.4	1.9	2.1	2.3	2.6	3.0	
Patient characteristics							
Age							
Mean (SE), years	44.3 (0.08)	42.8 (0.25)	43.3 (0.17)	44.1 (0.17)	44.8 (0.15)	45.4 (0.14)	0.00
< 45%	47.5 (0.28)	51.5 (0.88)	49.9 (0.66)	47.7 (0.65)	46.4 (0.53)	45.2 (0.5)	
45–64	48.3 (0.26)	45.9 (0.83)	47 (0.63)	48.6 (0.62)	49.1 (0.51)	49.2 (0.47)	
65–84	4.2 (0.1)	2.6 (0.2)	3.0 (0.2)	3.7 (0.21)	4.4 (0.22)	5.6 (0.22)	
> 84	0.04 (0.00)	0.01 (0.01)	0.04 (0.02)	0.02 (0.02)	0.05 (0.02)	0.04 (0.02)	
Female sex, % (SE)	39.7 (0.23)	38.7 (0.71)	39.6 (0.59)	39.4 (0.54)	39.4 (0.48)	40.7 (0.42)	0.03
Race, % (SE)							0.24[a]
White	70.1 (0.39)	71.4 (1.5)	70.5 (0.89)	70.1 (0.85)	69.7 (0.78)	69.7 (0.74)	
Black	20.1 (0.34)	17.8 (1.2)	18.8 (0.78)	20.4 (0.76)	20.8 (0.71)	21 (0.66)	
Hispanic	6.4 (0.2)	6.6 (0.82)	7.2 (0.5)	6.4 (0.45)	6.0 (0.36)	6.2 (0.32)	
Asian/Pacific Islander	0.51 (0.05)	0.36 (0.08)	0.44 (0.09)	0.44 (0.1)	0.59 (0.13)	0.59 (0.12)	
Native Americans	1.2 (0.13)	1.8 (0.88)	1 (0.18)	1.1 (0.19)	0.99 (0.15)	1.1 (0.17)	
Others	1.8 (0.1)	2.1 (0.4)	2.1 (0.28)	1.6 (0.18)	2.0 (0.2)	1.5 (0.14)	
Income quartiles, % (SE)[b]							0.02[c]
0–25	39.4 (0.47)	36.1 (1.9)	39 (1.00)	39.7 (1.0)	39.2 (0.93)	40.9 (0.84)	
26–50	28.0 (0.34)	28.5 (1.3)	27.3 (0.75)	28.8 (0.77)	30.0 (0.67)	26.2 (0.60)	
51–75	20.7 (0.3)	22.3 (1.2)	21.0 (0.66)	20.4 (0.66)	19.4 (0.58)	21.0 (0.53)	

Table 1 continued

Characteristics	Overall	2011	2012	2013	2014	2015	Trend P value
76–100	11.9 (0.28)	13.1 (1.1)	12.7 (0.63)	11.1 (0.58)	11.5 (0.52)	12.0 (0.52)	
Administrative/financial details							
Payment source, % (SE)							0.02[d]
Medicare	30.8 (0.25)	29.0 (0.79)	30.1 (0.6)	31.9 (0.58)	30.6 (0.5)	31.4 (0.50)	
Medicaid	36.8 (0.33)	32.7 (1.1)	33.2 (0.68)	32.3 (0.63)	40.7 (0.71)	40.4 (0.63)	
Private insurance	16.7 (0.25)	17.6 (0.91)	16.4 (0.52)	16.1 (0.53)	16.2 (0.5)	17.4 (0.48)	
Elective admissions	12.1 (0.29)	12.6 (1.2)	12.3 (0.66)	11.5 (0.57)	11.6 (0.53)	12.5 (0.49)	
Bed size, % (SE)[e]							0.00[f]
Small	14.0 (0.43)	8.4 (1.2)	12.0 (0.94)	12.4 (0.96)	17.3 (1.08)	15.9 (0.97)	
Medium	26.1 (0.57)	23.5 (2.32)	26.7 (1.41)	25.1 (1.35)	26.6 (1.33)	27.4 (1.27)	
Large	59.9 (0.66)	68.2 (2.56)	61.3 (1.57)	62.5 (1.56)	56.1 (1.57)	56.7 (1.50)	
Teaching hospital, % (SE)	56.7 (0.7)	42.9 (3.0)	50.1 (1.67)	51.5 (1.69)	63.5 (1.48)	64.5 (1.39)	0.00
Hospitals in urban locations	89.4 (0.42)	86.1 (2.22)	88.9 (0.95)	88.4 (0.91)	90.5 (0.8)	90.0 (0.66)	0.01

SE standard error, *CUD* cannabis use disorder

[a] For trends between whites vs. others

[b] Median household income quartiles based on patient zip code

[c] Trend for lowest quartile (0–25th percentile) vs. others

[d] For Medicare vs. others

[e] Bed size categorization using Agency for Healthcare Research and Quality methods based on number of hospital beds, hospital's location, and teaching status

[f] Large vs. others, negative trend

However, the trend of cannabis use was stable among post-surgical patients ($P = 0.72$).

Trends of Cannabis Use and Healthcare Utilization

After adjusting for inflation, the total hospital cost of patients with cannabis use increased from $31,271 ($1333) in 2011 to $38,684 ($946) in
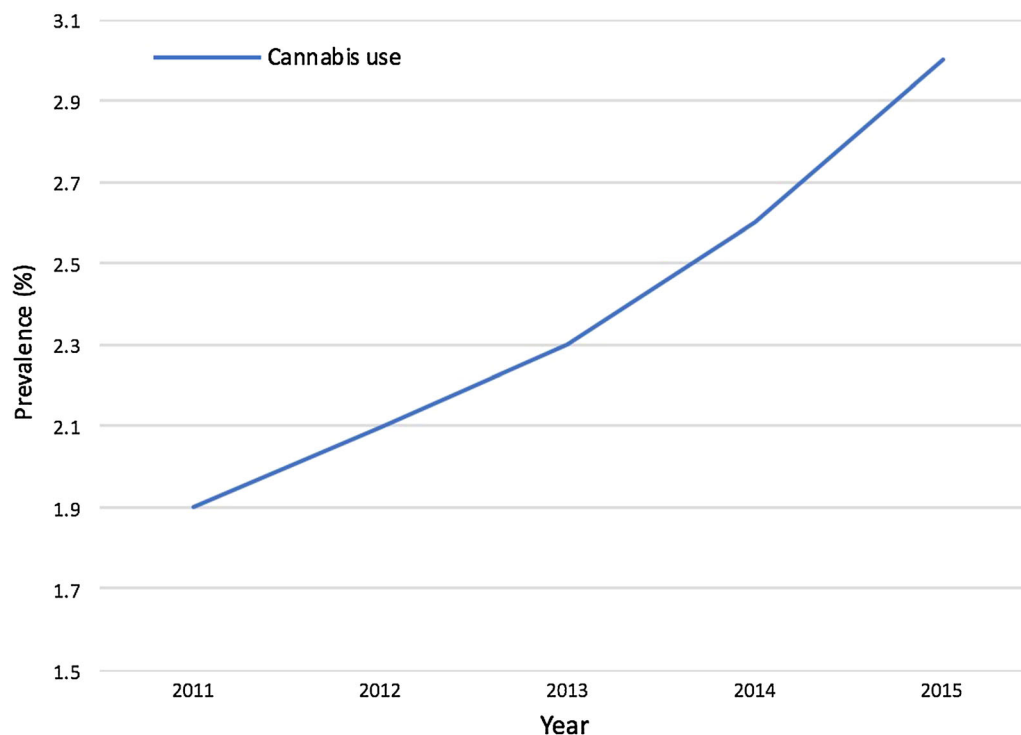
Fig. 1 Trend of prevalence of cannabis use among patients with chronic pain, 2011–2015

2015 ($P < 0.001$) (Table 3). The mean length of hospital stay trended up marginally from 2012 to 2015 ($P = 0.03$). The majority of patients were discharged home or to self-care (77.9%).

Trends of Cannabis Use and Discharge Diagnosis

The proportion of cannabis use among chronic pain patients who had a diagnosis of tobacco use disorder (TUD), depression, and opioid use disorder (OUD) were 68.8%, 20.0%, and 21.9%, respectively. From 2011 to 2015, there was an increase in cannabis use among patients with TUD (63.8% vs. 72.4%; $P < 0.001$). However, we noticed a decline in cannabis use among patients with OUD patients (23.8% vs. 19.9%; $P < 0.01$).

DISCUSSION

Our study found that, within our sample, the proportion of patients with chronic pain using

cannabis was 2.4%. Moreover, over the course of our study, from 2011 to 2015, we identified a significant and progressive increase in the number of patients using cannabis. In patients with chronic pain, cannabis use more than doubled during this period, from 33,189 to 72,114 people. We observed an increasing trend in patients with chronic regional pain syndrome (1.25–1.96%), trauma (5.23–8.98%), spondylosis 0.57–1.2%), FBSS (0.47–0.97%), and other chronic pain diagnoses (2.4–3.49%) (Table 2). This overall increase is not surprising given that several studies have shown cannabis to be effective in mitigating inflammation and demonstrated benefit to chronic pain symptoms with the use of cannabis, including improved pain, functional outcomes, and quality of life in patients with chronic pain syndromes [17–23]. With chronic pain projected to increase over the next 2 decades to a rate of one in three people from the current rate of one in five people, our findings foretell that cannabis use can be projected to increase even more rapidly [24–26]. As evidence of benefits of cannabis use grows, even countries slow to

Table 2 Trends of cannabis use among different subgroups of chronic pain diagnosis

Chronic pain diagnosis subgroups	Overall	2011	2012	2013	2014	2015	Trend P value
CRPS, % (SE)	1.45 (0.09)	1.25 (0.17)	1.23 (0.18)	1.60 (0.2)	1.28 (0.18)	1.96 (0.24)	0.02
Trauma, % (SE)	6.89 (0.29)	5.23 (0.56)	6.62 (0.63)	6.73 (0.67)	6.95 (0.62)	8.98 (0.71)	0.00
Post-surgical, % (SE)	2.42 (0.2)	2.39 (0.42)	2.3 (0.46)	2.18 (0.41)	2.96 (0.51)	2.34 (0.45)	0.72
Spondylosis, % (SE)	0.84 (0.02)	0.57 (0.04)	0.67 (0.03)	0.85 (0.04)	0.95 (0.04)	1.2 (0.05)	0.00
FBSS, % (SE)	0.7 (0.06)	0.47 (0.12)	0.5 (0.11)	0.69 (0.13)	0.9 (0.14)	0.97 (0.15)	0.00
Other chronic pain, % (SE)	2.93 (0.03)	2.4 (0.11)	2.61 (0.06)	2.78 (0.07)	3.06 (0.07)	3.49 (0.07)	0.00

CRPS complex regional pain syndrome, *FBSS* failed back surgery syndrome

embrace medical cannabis legislation have seen increases in patient awareness of and interest in the therapy [27].

While our study identified a rising prevalence in the use of cannabis among patients with chronic pain, patients with chronic pain frequently have comorbid conditions that may additionally benefit from cannabis use. Various studies have reported that the increased enactment of medicinal cannabis will lead to improved access to cannabis as an alternative pharmaceutical therapy for the treatment of several chronic pain conditions [28, 29]. Across all states that had legalized cannabis for medical use, Baron et al. found pain syndromes, such as migraines, headaches, and arthritis, reported as the most common indication for cannabis use. In addition they found opioids to account for the majority of prescription medications substituted with cannabis, followed by anti-depressants, anti-anxiety medications, and nonsteroidal anti-inflammatory drugs (NSAIDs) [28].

Despite the rising trend of cannabinoid use, which implies improved access to patients who have a need for cannabinoid management of chronic pain, concerns remain regarding cannabis serving as a common illicit gateway drug [29]. This is evidenced by studies that demonstrate a rise in cannabis use among teens, supported by a corresponding decline in the

perception of associated risk [30, 31]. In the whole population, approximately 12% of people aged $\geq$ 12 years had used cannabis at least once in the past year [30]. This observed increase in use suggests a perceived risk of use as well as increase of use among the general population is significant and may contribute to our finding of an increased trend of cannabis use in chronic pain patients. As a whole, these observations may shed light on the overall transformation of knowledge, attitudes, and beliefs in the US population toward the social acceptability of cannabis use; however, further research is needed to investigate outcomes of widespread increases in cannabis use.

Our study showed that the average age of chronic pain patients who use cannabis increased from 42.8 to 45.4 years during the years 2011 to 2015. Moreover, the highest proportion of cannabis use was observed in patients aged 45–84 years and the lowest in those > 85. These results are in line with the findings of Baron et al. who found a mean age of 40 years among all cannabis users but conflict with the results of Vin-Ravin et al., who found 65% of cannabis users to be < 40 years old [28, 32].

The majority of chronic pain patients using cannabis belonged to a lower socioeconomic class (SEC) compared to non-cannabis users. This was similarly shown by Hill et al. and Vin-Raviv et al. [29, 32]. The lowest proportion of

Table 3 Healthcare utilization of cannabis users by calendar year

Characteristics	Overall	2011	2012	2013	2014	2015	Trend P-value
Hospitalization cost, % (SE), 2015 US$	35,026 (428)	31,271 (1333)	30,999 (808)	34,009 (944)	26,174 (830)	38,684 (946)	0.00
Length of stay, mean (SE), days	5.2 (0.04)	5.11 (0.15)	4.98 (0.08)	5.22 (0.08)	5.29 (0.08)	5.27 (0.07)	0.03
Number of procedures, mean (SE), n	1.06 (0.01)	0.99 (0.04)	1.00 (0.03)	1.10 (0.03)	1.1 (0.03)	1.07 (0.03)	0.01
Hospitalization outcome, % (SE)							
Home or self-care	77.9 (0.22)	79.25 (0.68)	79.3 (0.51)	77.95 (0.49)	77.43 (0.46)	76.98 (0.43)	
Short-term hospital	1.97 (0.07)	2.3 (0.25)	2.17 (0.18)	2.04 (0.16)	1.93 (0.14)	1.71 (0.11)	
Skilled care facility	8.66 (0.14)	8.26 (0.42)	7.98 (0.33)	8.71 (0.32)	8.68 (0.29)	9.17 (0.26)	
Home health care	6.43 (0.13)	5.21 (0.38)	5.19 (0.28)	6.05 (0.28)	7.13 (0.29)	7.35 (0.27)	
Discharge diagnosis, % (SE)							
Tobacco use disorder	68.8 (0.31)	63.8 (1.20)	65.9 (0.68)	67.5 (0.62)	70.0 (0.55)	72.4 (0.50)	0.00
Depression	20.0 (0.24)	19.7 (0.84)	19.4 (0.51)	19.5 (0.51)	20.1 (0.45)	20.8 (0.46)	0.09
Opioid use disorder	21.9 (0.27)	23.8 (1.10)	23.0 (0.64)	23.0 (0.59)	21.6 (0.53)	19.9 (0.45)	0.00

SE standard error

cannabis use, 11.9%, was found in the highest income quartile while the highest proportion of cannabis use, 39.4%, was in the lowest income quartile. In our analysis of the payer base, we found that patients with cannabis use were mostly covered by Medicaid. Furthermore, we observed an increased proportion of cannabis users on Medicaid, from 32.7 to 40.4%. Cannabis users were least covered by private insurance, 11.9%, compared to non-cannabis users, 36.8%.

In contrast, Baron et al. reported cannabis use to be associated with a higher SEC [28]. Moreover, Baron et al. found that patients who use cannabis for chronic pain syndromes were more likely to be employed (62.8%) and have education beyond high school (73.6%). Only 5.5% of the patients using medicinal cannabis for chronic pain were retired, which is in line with a decrease in observed use with increasing age. Their study was conducted via electronic questionnaire, which may be a source of

selection bias leading to a preponderance of the upper class accounting for the discrepancy between our results. Despite this limitation and potential for bias, a trend of increased cannabis use among patients of higher SEC may be correlated with increased awareness, knowledge, and access to the benefits of cannabis use. Our analysis however does not support this trend; over the course of our study period, the lowest income quartile saw an increase in the proportion of cannabis users, 36.1–40.9%, whereas the highest income quartile saw a decrease in the proportion of cannabis users, 13.1–12.0%. A history of chronic pain may contribute to this observed discrepancy although further studies are needed for elucidation.

Healthcare cost and utilization have been shown to be highest in patients with increasing numbers of comorbidities [33, 34]. In our study we note that the total hospital cost of patients with cannabis use increased from $31,271 (SD $1333) in 2011 to $38,684 (SD $946) in 2015 (Table 3), with the mean length of hospital stay also increasing from 2012 to 2015. Interestingly, in an analysis of cannabis use and inpatient outcomes among hospitalized patients, Vin-Ravin et al. reported cannabis users as having fewer comorbid conditions on admission (78% vs. 71%) compared to non-users [32]. This led Vin-Ravin et al. to report a significantly reduced odds of in-hospital mortality and morbidity in cannabis users compared with non-cannabis users (odds ratios of 0.41 and 0.44, respectively). This indicates that cannabis use may have some degree of all cause morbidity and mortality benefit among hospitalized patients. The increase in healthcare spending among chronic pain patients using cannabis is difficult to explain based on these previous studies together. We would expect increases in cannabis use to lead to decreases in overall spending; however, our findings show the opposite trend. The disparity in our findings may partly be due to the fact that the majority of cannabis users in the study by Vin-Ravin et al. were < 40 years old, who are less likely to have comorbidities and ultimately have lower health care costs compared with the predominant cannabis users in our study who were between 45 and 64 years old. Moreover, the increased spending among chronic pain patients using cannabis, which we note in our study, may largely be due to an overall trend of increased hospital spending. Our findings are supported by the concept of "super-additive costs" per Cortaredona et al. and may be explained by an increasing trend of older patients having more comorbidities and as a result higher health care utilization and resultant costs [34].

Our study has several limitations. First, the NIS database does not contain variables that can evaluate disease severity. The degree of cannabis use and its relationship to worsening chronic pain was not available for analysis. In addition, the definite relationship between chronic pain and cannabis may not be well established with this administrative data set. We included only chronic pain patients with a history of cannabis use. However, it is very difficult to elucidate the indication for cannabis prescription or consumption among our chronic pain cohort. Cannabis use may be secondary to other medical comorbidity outside of chronic pain. Second, the NIS database does not include detailed comorbid cannabis use disorder-related cost information, but rather total hospital charges. This unfortunately makes specific cost analysis, such as intensive care unit (ICU) admission cost, cost of administered anesthesia, procedure room charges, and postoperative charges, impossible. Third, healthcare utilization outcomes available for analysis in this study may not be directly related to comorbid cannabis use. They could be influenced by multiple factors such as payer status and social factors. Fourth, the NIS database is highly dependent on the selection and accuracy of the appropriate diagnostic ICD codes reported [35]. The rise in concomitant cannabis use may reflect a coding artifact or the implementation of new ICD-9 codes. This makes it is very difficult to determine the actual incidence of cannabis use in hospitalized patients with chronic pain. Furthermore, the criteria used for diagnosis of conditions such as CRPS were not reported in our database. The lack of standardization may affect the quality of our result.

CONCLUSION

The consequences of a fast-approaching landscape of widespread cannabis legalization may greatly impact the management of chronic pain patients; cannabis may offer a viable therapeutic approach to decreasing opioid dependence. As a whole, our results show that cannabis use is on the rise in patients with chronic pain and can be expected to continue to trend upwards in the face of increasing societal awareness and availability of legal cannabis.

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