Full length article

The role of marijuana use disorder in predicting emergency department and inpatient encounters: A retrospective cohort study

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ABSTRACT

Background: Marijuana use disorder (MUD) is the most common illegal drug use disorder and its prevalence is increasing. It is associated with psychiatric and medical problems, but little is known about its impact on emergency department (ED) and inpatient utilization rates.

Design: In a retrospective cohort design, we used electronic health record (EHR) data to identify patients with MUD ($n = 2752$) and demographically matched patients without MUD ($n = 2752$) in 2010. Logistic regressions determined risk of ED and inpatient visits each year from 2010 to 2014 for MUD patients versus controls; mixed-effect growth models examined differences in utilization rates over 5-years. Patient characteristics predicting increased risk of utilization were examined among the MUD sample only.

Key results: Rates of ED (OR = 0.87, $p < 0.001$) and inpatient (OR = 0.76, $p < 0.001$) services use significantly declined over 5 years for all patients. Patients with MUD exhibited a significantly greater decline in ED (OR = 0.81, $p < 0.001$) and inpatient (OR = 0.64, $p < 0.001$) use relative to controls. However, MUD patients had significantly greater risk of having ED and inpatient visits at each time point (p's < 0.001). MUD patients with co-occurring other substance use, medical, and/or psychiatric disorders had a greater risk of having ED or inpatient encounters over 5 years (p's < 0.001).

Conclusions: MUD patients remain at high risk for ED and inpatient visits despite decreasing utilization rates over 5 years. Addressing MUD patients' comorbid conditions in outpatient settings may help reduce inappropriate service use.

1. Introduction

Marijuana is the most commonly used "illicit" drug in the U.S. with approximately 12 million people over age 12 reporting past month use (Substance Abuse and Mental Health Services Administration, 2014), and marijuana use disorder (MUD) nearly doubling from 2001-2002 to 2012-2013 (Hasin et al., 2015). The addictiveness of marijuana continues to be debated as the landscape regarding marijuana legalization changes (Volkow et al., 2014), but the evidence largely indicates that excessive use can lead to adverse consequences and diagnoses of MUD (Degenhardt and Hall, 2012; Hall and Degenhardt, 2009; Volkow et al., 2016). In 2014, 4.1 million people 12 years of age or older met the DSM-IV criteria for MUD nationally (Substance Abuse and Mental Health Services Administration, 2014). In addition, most people who develop MUD have comorbid conditions that can worsen prognosis and contribute to poor health outcomes (Degenhardt and Hall, 2012; Hall and Degenhardt, 2009; Substance Abuse and Mental Health Services

Administration, 2014).

Regular and heavy marijuana use is associated with increased risk of anxiety, depression, and psychoses, although causality has not been established (Moore et al., 2007; Volkow et al., 2014). In addition, heavy use, high potency, and exposure at younger ages can all negatively affect the course of mental illness (Volkow et al., 2014). Marijuana use among adolescents also predicts increased risk of MUD in adulthood (Volkow et al., 2014), which in turn predicts high risk of other drug use and escalation to co-occurring substance use disorder (Hall and Degenhardt, 2007). Marijuana frequently is used by persons who drink in excess and use other illicit drugs (Hall and Degenhardt, 2009), which compounds risk to health and safety.

Marijuana is associated with increased risk of several medical conditions. Regular and heavy marijuana use can contribute to respiratory deficits such as airway resistance, large airway inflammation, lung hyperinflation, and can lead to chronic bronchitis (Tashkin, 2013; Tetrault et al., 2007). Marijuana use is also related to a high risk of

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respiratory infections and pneumonia (Owen et al., 2014), vascular conditions that raise the risk of cardio/cerebrovascular events, such as stroke and myocardial infarction (Thomas et al., 2014), and an increased risk of lung and digestive track cancers (Tashkin, 2013). Not surprisingly, these medical conditions are even more prominent among those with MUDs and contribute considerably to the burden of disease (Bahorik et al., 2017). Marijuana has also been associated with increased risk of motor vehicle accidents, and other acute health events (Monte et al., 2015; Rogeberg and Elvik, 2016).

Despite the adverse health effects of MUD, few studies have examined the relationship of MUD to emergency and inpatient service utilization. These are among the most costly health services, and may indicate inappropriate use of health care and/or unmet need. The few studies in this area have focused on any marijuana use rather than on higher severity users with MUD; although MUD patients are likely at the highest risk for utilizing emergency department (ED) and inpatient resources, given the disorder's consistent association with adverse outcomes and poor health. One recent study found marijuana, either used alone or in combination with other drugs, is often reported by those who have ED visits, and this number has increased over the past decade (Volkow et al., 2014; et al., 2016; Zhu and Wu, 2016). Results are mixed regarding the effect of substance use on inpatient use (Burke et al., 2013; Palepu et al., 2005; Walley et al., 2012); and one study found no evidence of an association between frequency of marijuana use and hospital admissions (Fuster et al., 2014). The degree to which such findings are specific to marijuana use or persist over time in persons with MUD, who likely have more complex clinical presentation and service needs than those with subdiagnostic use, is largely unknown.

This study addresses this important question by examining ED and hospitalization utilization trends and trajectories in a large sample of 2752 patients with MUD and 2752 healthy controls in a large integrated health care system. Using electronic health record (EHR) data, we aimed to: (1) Determine the risk of ED and inpatient visits each year from 2010 to 2014 for MUD patients relative to controls; (2) Examine differences in the rates of ED and inpatient utilization between MUD patients and controls over 5-years; and (3) Identify predictors of ED and inpatient utilization over time within the MUD sample.

2. Methods

2.1. Setting

Kaiser Permanente Northern California (KPNC) is a nonprofit, integrated health care delivery system with 4 million members, who account for 45% of the commercially insured population in the region. KPNC operates 21 medical centers and employs more than 7000 physicians. About 78% of members are commercially insured, 14% have Medicare and 8% have Medicaid or other charitable coverage. All participants were selected from the KPNC membership.

2.2. Study participants

This secondary analysis study used EHR data to identify all health system members who: 1) were aged 18 or older, 2) had a visit to a KPNC facility in 2010, and 3) had a recorded ICD-9 diagnosis of marijuana abuse or dependence (i.e., MUD; 305.2-22; 304.3-303.32) in 2010. Any current or existing behavioral health diagnosis (e.g., alcohol use disorder, depression, etc.,) additionally documented for the MUD patients during health care visits from January 1, 2010 to December 31, 2010 were also included (Appendix A in Supplementary material). Within KPNC, MUD and other behavioral health diagnoses can be assigned to patients in any clinic setting (e.g., primary care or specialty care clinic). Diagnoses can be assigned by physicians or any other qualified health care provider who is directly evaluating a patient. All diagnoses are captured through ICD-9 codes.

Control patients were then selected for all unique MUD patients − matching one-to-one on gender, age, and medical home facility, but having no MUD, or any other current behavioral health diagnosis. This accounted for any differences in services, types of behavioral health conditions, or unobservable differences by geographic location. Patients with Medicaid/Medicare were excluded. To control for varying lengths of membership, participants were required to be KPNC members for at least 80% of the study period (at least 4 out of the 5 years examined) as done in prior work (Ray et al., 2005).

The analytical sample consisted of 5504 individuals: 2752 patients with a MUD and 2752 patients without a MUD. Institutional review board approval for the study was obtained from the Kaiser Foundation Research Institute.

2.3. Key measures

2.3.1. Patient characteristics

Age, gender, race/ethnicity, neighborhood income, and diagnoses were extracted from the EHR. Race/ethnicity was collapsed into five categories: White, Black, Hispanic, Asian, and other. Neighborhood income was measured using 2010 census data, based on member zip code. Comorbid medical conditions were measured by the Charlson Comorbidity Index (Charlson et al., 2008); higher scores indicate greater medical disease burden. Patients in the overall sample were determined to have a tobacco use disorder (ICD-9: 305.1) if documented during a patient visit in 2010. Patients with MUD were determined to have other co-occurring or substance use and/or psychiatric disorders (Appendix A in Supplementary material), based any current or existing ICD-9 diagnoses documented during patient visits in 2010.

2.3.2. Health service utilization

KPNC health service utilization data between 2010 and 2014 were extracted from the EHR. For each year, we defined separate dichotomous measures of ED and inpatient hospitalization, (1 = present, 0 = else). ED and inpatient utilization external to KPNC was captured through claims data.

2.4. Analyses

Frequencies and means were used to characterize the sample. We then employed χ^2 tests (categorical variables) and independent t tests (continuous variables) to identify differences between MUD patients and controls. To compare the odds of ED and inpatient visits, we first conducted cross-sectional analyses with a series of multivariate logistic regression analyses for each year (2010, 2011, 2013, and 2014) comparing MUD patients to controls. All models adjusted for gender (1 = men; 0 = else), race/ethnicity (white = reference; Hispanic, Asian, black, unknown/other), age (18–29 = reference; 30–39; 40–49; 50 +), neighborhood income (1 = median annual income per household $\geq$ 50 K, 0 = else), medical comorbidity (Charlson Comorbidity Index score) and tobacco use disorder (1 = tobacco use disorder; 0 = else).

Longitudinal analyses were conducted within a generalized mixed-effects growth model framework, using penalized-quasi likelihood estimation for computing parameter estimates of binary outcomes. This approach to longitudinal data analysis is a form of hierarchical linear modeling for repeated measures data, where multiple measurement occasions are nested within persons (Raudenbush and Bryk, 2009). These analyses began with unconditional growth models predicting ED or inpatient use over time (coded: 0 = 2010; 1 = 2011; 2 = 2012; 3 = 2013; 4 = 2014) to examine the service use trajectory of patients in the overall sample (combined samples of MUD patients and controls). We then constructed conditional growth models predicting ED or inpatient use over time including a time × MUD (reference group = control) interaction, to examine differences among MUD patients and