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Predictors Of Dental Opioid Analgesic Prescribing, Opioid Use And Dental Emergency Department Visits In The Mississippi Medicaid Population

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PREDICTORS OF DENTAL OPIOID ANALGESIC PRESCRIBING, OPIOID USE AND DENTAL EMERGENCY DEPARTMENT VISITS IN THE MISSISSIPPI MEDICAID POPULATION

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ABSTRACT

OBJECTIVES: The objectives of this study were: (1) to determine prevalence of opioid analgesics prescribing for non-ED dental related visits in the Mississippi Medicaid population, (2) to assess predictors of receiving opioid analgesics following non-ED dental related events among Mississippi Medicaid beneficiaries, and (3) to determine prevalence of opioid analgesic prescribing for dental related emergency departments (ED) visits in the Mississippi Medicaid population.

METHODS: A retrospective, cross-sectional, observational database analysis using Mississippi Medicaid administrative claims data from January 1, 2015 to December 31, 2016. Beneficiaries with dental related visits were included in this study. Descriptive statistics were utilized to assess the prevalence of opioid prescribing for ED and non-ED dental visit events in the study period. Logistic regression analyses were conducted to assess predictors of receiving an opioid prescription following a non-ED dental related visit. Adjusted odds ratios, 95% confidence intervals and p-values were calculated for the odds of receiving an opioid analgesic and the odds of receiving an opioid analgesic with a morphine equivalent daily dose (MEDD) greater than the median value of 25.

RESULTS: A total of 16,409 dental visit events were identified and 27% of dental visit events were associated with an opioid prescription. Cleaning/preventive procedures had the lowest rate of opioid prescribing (16%) while tooth extraction procedures had the highest rate of opioid prescription (55%). Logistic regression showed that beneficiaries undergoing extraction procedures had six times higher odds to be prescribed an opioid than those undergoing cleaning/preventive procedures [OR=6.27, 95% CI: 4.64-8.46, P <0.0001]. Beneficiaries aged 18 or younger were less likely to receive an opioid in comparison to beneficiaries ages 19 to 45 years [OR=0.30, 95% CI: 0.27-0.33, P <0.0001]. Approximately 12% of opioid prescriptions for dental diseases had dosages of 50 morphine equivalents/day or higher; 53% of these prescriptions were written for more than a 3-day supply and 16% for more than a 7-day supply. Approximately 42% of dental related ED visits events were associated with an opioid prescription, and gum disease/periodontitis had the highest rate of opioid prescriptions for ED visits at 48%.

CONCLUSIONS: The findings of this study indicate that opioids are prescribed for many dental procedures. This study has a broader policy implication for the state of Mississippi regarding opioid abuse and misuse, drug utilization trend monitoring and curtailing opioid abuse by broadening the lens to the field of dentistry.

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CHAPTER I

INTRODUCTION

Introduction

Opioids are a class of drugs used to treat moderate to severe pain. In the United States (U.S.), some opioids are available by prescription, while other opioids, such as heroin, are illegal to use. Some examples of prescription opioid analgesics include as oxycodone, hydrocodone, codeine, and morphine (Compton & Volkow, 2006). Currently, there are 19 pure prescription opioids (not including combinations) that are approved by the Food and Drug Administration (FDA). Many of the current opioids on the market are combination products containing one of the approved opioid medications. A list of all FDA approved opioid analgesic medications can be found in **Appendix A** (FDA Drug Safety Communication, 2016).

The use of opioid medications for the treatment of various types of pain continues to increase (Birnbaum et al., 2011; U.S. Department of Health and Human Services, 2011). The hypnotic effect that opioids elicit have led to abuse and misuse when used for medical and non-medical purposes. In 2010, it was estimated that 12.2 million people reported using pain relievers non-medically for the first time within the past year (Ashrafioun, Edwards, Bohnert, & Ilgen, 2014). With the increased use of opioids, there have also been increases in death due to opioid overdose. The Centers for Disease Control and Prevention (CDC) reported that the number of opioid-related poisoning deaths more than tripled from 1999 to 2003 (U.S. Department of Health and Human Services, 2011). Drug overdose is the leading cause of accidental death in the U.S with 47,055 lethal drug overdoses in 2014. Among these accidental deaths, 18,893 overdose deaths were related to prescription pain relievers (Manchikanti, 2006). Additionally, data from the National Center for Health Statistics reported that opioid analgesic pain relievers were involved in more drug poisoning deaths than other specified drugs, including heroin and cocaine (Rice, Kelman, & Miller, 1991). In the U.S., abuse of prescription

pain medication continues to be a significant and growing problem and opioid use has taken a center stage in this epidemic.

In addition to the mortality and addiction that occurs because of opioids, prescription opioid abuse has a substantial economic cost to society. The estimated societal cost of prescription opioid abuse in 2001 was $8.6 billion (Birnbaum et al., 2006). A few years later, Birnbaum reassessed the societal cost of prescription opioid abuse in 2007 and estimated it to be $55.7 billion (Birnbaum et al., 2011).

Dental Prescribing of Opioid Analgesics

Primary care providers account for approximately half of all prescribed opioid prescriptions that are dispensed (Daubresse et al., 2013). Next to primary care physicians, dentists are the second leading prescribers of immediate-release opioids (Substance Abuse and Mental Health Services Administration, 2012), and have contributed significantly to the prescription opioid volume in the U.S. by prescribing 12% of all immediate release opioid drugs (Denisco et al., 2011). Opioid analgesics are generally used in dentistry for short-term pain management associated with dental surgical procedures, and they are among the most frequently prescribed drugs by dentists (Denisco et al., 2011; Moore & Hersh, 2013; Reece, 2007). Therefore, dentists also potentially play a very important role in opioid abuse and misuse prevention (Moore, Nahouraii, Zovko, & Wisniewski, 2006b; Oakley, O'Donnell, Moore, & Martin, 2011).

In recent times, physician and dental prescription practices have been under the public lens regarding opioid misuse, abuse, and diversion by patients in part due to their prescribing habits. Dental pain, like other forms of pain, is very subjective regarding severity measurement

and most pain scales are unreliable. Hence, in practice, dentists rely on patient complaint and symptoms experienced to determine the necessity to prescribe pain medications. Additionally, dentists are not aware of a patient's history of substance abuse unless voluntarily reported by the patient (McCauley et al., 2016).

Dentists are also usually limited in exposure to drug and opioid addiction training and reporting strategies, such as prescription drug monitoring programs (PDMPs) (Ashrafioun et al., 2014; McCauley et al., 2016). Despite this, a limited number of studies regarding dental opioid prescribing practices and the frequency of multiple concurrent opioid prescriptions among dental patients have been conducted (Deyo et al., 2015; Hersh et al., 2011; Oakley et al., 2011). Similarly, very little is known about the extent to which dental patients report diverting prescription opioids intended for acute dental pain for purposes not intended by the dental prescriber (Ilgen et al., 2012).

Dental clinics that provide affordable dental care, such as university dental training clinics, have been reported to commonly treat patients with alcohol-related problems and/or illicit drug use (Moore et al., 2006b). Another area of consideration when prescribing analgesics by dentists and physicians is determining the patients for whom opioid analgesics are necessary and appropriate, and if so, determining the dose and quantity that should be appropriately prescribed. This is partly due to the prevalence of substance and alcohol abuse that can be encountered within the dental patient population, and also because substance abusers frequently obtain prescription drugs from friends and family for non-medical purposes (Johnson, Hearn, & Barker, 2008).

Regarding emergency department (ED) visits, the number of ED visits for dental pain in the U.S. increased from 1.1 million in 2000 to 2.1 million in 2010 (Wall et al., 2013). Many

more patients with dental pain seek care at the ED and could be prescribed an opioid analgesic without an understanding of their substance abuse history which poses unique problems. (Mendonca et al., 2010; Reece, 2007).

CHAPTER II

LITERATURE REVIEW

Pain and Opioids

Pain is one of the most common diagnoses in primary care facilities (Volkow & McLellan, 2011), and is presented as a complaint by nearly two-thirds of emergency department patients treated in the United States (U.S.) (Cordell et al., 2002). Opioid analgesics have become commonly used for the treatment for moderate to severe pain and have vastly improved the quality of life for many. Nonetheless, its addictive properties have also resulted in potential for abuse and misuse (Bhamb et al., 2006; Gudin, 2012; Victor, Alvarez, & Gould, 2009). Over time, the number of prescribed opioid analgesics, such as fentanyl, oxycodone, hydrocodone, and methadone, has increased. A report by Levy et al. (2015) on opioid prescription indicates that opioid prescription volume increased by 11.4% between 2007 and 2012 (Levy, Paulozzi, Mack, & Jones, 2015) and deaths due to the abuse and misuse of such analgesics has nearly doubled (Johnston, 2010).

Opioid analgesics are typically prescribed for acute and chronic pain by primary care physicians, emergency room physicians, and dentists. In the U.S., the number of opioid prescriptions filled by pharmacies increased by 27% (from 174 million to 238 million) between 2000 and 2011 (Manchikanti et al., 2012). As the use of opioids analgesics for pain management has increased, so has the incidence of opioid abuse and misuse (Manchikanti et al., 2012). As a result of this increase, opioid analgesics have come under public scrutiny from policymakers, patient advocacy groups and clinicians (Okunseri, Okunseri, Xiang, Thorpe, & Szabo, 2014).

Opioid Abuse and Misuse

Pain medications containing hydrocodone and oxycodone have been identified as the most common choice among prescription opioid abusers and misusers. A 2012 National Survey on Drug Use and Health (NSDUH) study estimated that approximately 4.5 million people, who 12 years or older reported nonmedical use of pain relievers in the past month (Substance Abuse and Mental Health Services Administration, 2012).

Opioid abuse and consequently overdose have been increasing steadily in the U.S. for over two decades. Accordingly, rates of prescription opioid poisoning and overdose have risen threefold between 1999 and 2008, and have outpaced popular illicit drugs, such as cocaine and heroin (Paulozzi, Jones, & Mack, 2011). Legitimate prescriptions, and the subsequent misuse (intentional and unintentional as well as diversions) of opioid prescriptions, constitute a major source of the current epidemic of opioid abuse (Inciardi et al., 2009; Shei et al., 2015; Voepel-Lewis, Wagner, & Tait, 2015; Wisniewski, Purdy, & Blondell, 2008). Deaths as a result of opioid overdose have increased fourfold between 1990 and 2010, and it is estimated that about 100 people die each day from an opioid related overdose (CDC, 2013; Coben et al., 2010).

Katz et al. (2007) defines drug misuse as the "use of a medication other than as directed or as indicated, whether willful or unintentional, and whether harm results or not", and drug abuse as "any use of an illegal drug or the intentional self-administration of a medication for a non-medical purpose". Consequences of opioid misuse include opioids poisoning and overdose, and this can occur among individuals who misuse a duly prescribed opioid by taking the medication differently from how it was prescribed. It is important to note that there are other ways in which patients abuse and misuse medications. For example, "doctor shopping" is a phenomenon in which patients visit multiple physicians to obtain opioids in amounts that are

not intended for medical purposes (Cepeda, Fife, Chow, Mastrogiovanni, & Henderson, 2013). Doctor shopping also poses other problems because of the potential for illegitimate drug misuse and possible distribution to others without a prescription (Rigg, Kurtz, & Surratt, 2012). A prior study showed that about 5 to 23% of all prescription opioids dispensed were used for non-medical purposes (Savage, Covington, Gilson, Gourlay, Heit, & Hunt, 2004) with immediate-release (IR) opioids such as hydrocodone and oxycodone being the most commonly abused (Substance Abuse and Mental Health Services Administration, 2012).

The major sources of obtaining prescription drugs that are used for non-medical purposes are family members, friends and in some cases through prescriptions (Substance Abuse and Mental Health Services Administration, 2012). Research by the National Survey on Drug Use and Health (NSDUH) survey reported that in 2008/2009, among people over 12 years of age who had used pain relievers non-medically in the prior year, 70% obtained these drugs from friends or family while 4.8% obtained their pain relievers from drug dealers (Substance Abuse and Mental Health Services Administration, 2012). A 2008 study in the state of Utah reported that 72% of respondents who were prescribed an opioid pain medication had some left over, and 71% of those with leftover medication kept it for future use (CDC, 2010). Additionally, unintentional diversion, in which medication is obtained from family and/or friends, also has been consistently reported as a major source of opioids among adolescent abusers (McCabe, West, & Boyd, 2013a).

Adolescents, particularly, are at risk for opioid overdose. In 2009, the National Institutes of Health's National Institute on Drug Abuse convened, in Rockville, MD, to examine how opioid prescribing pattern in dental settings might contribute to opioid abuse among adolescent patients. This meeting indicated the need for a greater understanding of opioid prescribing

practices in dental offices, including the quantity typically prescribed by dentists as well as the quantity that is needed for adequate post procedural pain management in order to prevent addiction, misuse and abuse (Denisco et al., 2011). To highlight the concern regarding the proliferation of hydrocodone and oxycodone products, the Drug Enforcement Agency (DEA) recently rescheduled hydrocodone products as Schedule II controlled substances (Drug Enforcement Administration, 2014).

Cost Associated with Opioid Abuse and Misuse

Hansen et al. (2011) estimated total costs to be $53.4 billion (2006) for nonmedical use of prescription opioids, of which $42 billion (79%) was attributable to lost productivity, $8.2 billion (15%) to criminal justice costs, $2.2 billion (4%) to drug abuse treatment, and $944 million (2%) to medical complications. Workplace costs related to absenteeism, lost wages and disability accounted for $25.6 billion (46%), health care costs accounted for $25.0 billion (45%), and criminal justice costs accounted for $5.1 billion (9%) (Birnbaum et al., 2011).

McAdam-Marx et al. (2010) evaluated the average yearly cost after an index opioid abuse diagnosis among Medicaid beneficiaries and reported that total costs were significantly higher for the abuse/dependence patients ($14,537) than for patients who were not taking opioids ($8,663) ($P < .001$). When controlling for baseline characteristics, adjusted costs continued to be higher for abuse/dependence patients ($23,556 versus $8,436; $P < .001$) (McAdam-Marx et al., 2010).

Inocencio et al. (2013) reported the average direct cost per poisoning or overdose event was estimated to be $4,006. However, the average direct costs per poisoning were lower for heroin when compared to opioids ($3,198 vs. $4,255). The mean ED treatment cost for all

opioids was estimated to be $1,832. Total estimated direct annual costs to the U.S. were estimated to be $2.2 billion. Prescription opioid poisoning accounted for 80% of all direct medical costs. Specifically, total direct costs were highest for oxycodone ($616 million), hydrocodone ($428 million), methadone ($289 million) and unspecified opioids ($350 million) (Inocencio et al., 2013).

Opioid Overdose Deaths

The United States is currently going through an epidemic due to drug overdose deaths. Since 2000, there has been a 137% increase in the number of deaths from drug overdoses, including a 200% increase in the rate of overdose deaths involving opioids (i.e. opioid pain relievers and heroin) (Rudd et al., 2016). Unintentional poisoning in general currently represents the leading cause of injury related death in the U.S. for adults ages 25–64 years (Murphy et al., 2013; U.S. Department of Health and Human Services, 2011).

The CDC analyzed mortality data to investigate trends of drug overdose deaths, and the types of opioids associated with overdose deaths. In 2014, a total of 47,055 drug overdose deaths occurred in the U.S., representing an increase of 6.5% in one year, from 13.8 per 100,000 persons in 2013 to 14.7 per 100,000 persons in 2014 and increased to 16.3 per 100,000 persons in 2015 (Rudd et al., 2016).

Miller et al. (2015) reported a correlation between the type of opioid and potential for overdose. After adjustment for age, sex, and opioid dose, patients who received long-acting opioids were two times more likely to overdose as compared to patients who received short-acting opioids. (Hazard Ratio, 2.33; 95% CI: 1.26-4.32). The risk of overdose associated with long-acting opioids was particularly significant during the first two weeks after commencement

of treatment (Hazard Ratio, 5.25; 95% CI: 1.88-14.72) (Miller et al., 2015). Additionally, the rate of drug overdose deaths increased significantly for males and females, in people aged 25–44 years and ≥55 years, in non-Hispanic whites and non-Hispanic blacks. Geographically, in the South, Northeast and Midwestern regions of the US, rates of overdose deaths caused by opioids also increased significantly, from 7.9 per 100,000 in 2013 to 9.0 per 100,000 in 2014, a 14% increase in one year (Rudd et al., 2016).

Prevalence of Opioid Prescribing Among Dentists

Data from IMS Health also shows that dentists prescribe about 6.4% of all opioids dispensed in the US; which is equivalent to 18.5 million opioid prescriptions in 2012 (Levy et al., 2015). Denisco et al. (2011) surveyed oral and maxillofacial surgeons and reported that they performed an average of 53 (range 45 to 69) third-molar extractions per month. Extrapolating this information to all 5,542 practicing oral and maxillofacial surgeons in the U.S. at the time, an estimate of 3.5 million third-molar extractions were conducted annually among oral and maxillofacial surgeons, excluding general dentists (Moore, Nahouraii, Zovko, & Wisniewski, 2006a). Hence, up to 3.5 million people may be exposed to the possibility of obtaining opioid analgesics through dental procedures (Denisco et al., 2011).

In a statewide survey conducted in West Virginia in 2010, practicing dentists in the state were asked about their prescribing patterns and experience with drug and substance abuse, misuse and diversion. Among the dentists who did not prescribe opioids, the most commonly prescribed pain relievers were non-steroidal anti-inflammatory drugs (NSAIDs) (64%), followed by acetaminophen (28%). Among those who prescribed opioids, the most commonly prescribed opioid was hydrocodone combined with acetaminophen (73%) (Denisco et al.,

2011). There was considerable variation regarding the amount of opioids prescribed following a third molar extraction procedure. However, the duration of use was typically between two to five days in about 86% of the cases. More importantly in the fight against drug diversion, about 41% of dentists who prescribed an opioid expected patients to have some medication leftover (Denisco et al., 2011).

Prior research has focused on opioid prescribing by dentists after molar extractions, reporting that most (85.0%) dentists prescribed an opioid, most often hydrocodone with acetaminophen, with instructions to take for pain as needed (Haegerich, Paulozzi, Manns, & Jones, 2014). A pilot study by Ilgen, Edwards and Kleinberg (2012) on opioid prescriptions by dentists provided an estimate of the prevalence of nonmedical use of opioids and diversion among dental patients receiving care at an outpatient dental clinic. The study reported that 37.9% of dental patients reported some form of nonmedical use of prescription opioids and 6.5% reported diverting their initial dental medication; which indicates that dental patients may be at a risk of opioid medication abuse and misuse (Ilgen et al., 2012).

Various government public health agencies such as the Office of National Drug Control Policy, the Department of Health and Human Services, and the National Institute on Drug Abuse have identified prescribers as critical intervention points in the fight against the prescription drug abuse epidemic (U.S. Department of Health and Human Services, 2015; Volkow, 2014). A study in a national health care plan with about 2 million beneficiaries reported that providers who were specialists were more likely to prescribe extended release opioids for pain that lasted at least 60 days (Victor et al., 2009). In a large national sample with 121 million patients including prescription data from more than half of the retail pharmacies in the U.S, it was reported that primary care physicians (i.e., general practitioners, family medicine

practitioners and internists) prescribed more opioids (28.8%) to prescribe opioids, compared to dentists (8.0%) and orthopedic surgeons (7.7%) (Volkow, McLellan, Cotto, Karithanom, & Weiss, 2011).

Rigoni reported, in 2003, that dentists prescribe 12% of immediate-release opioids in the U.S, preceded only by family physicians, who prescribe 15% of immediate-release opioids (Rigoni, 2003). Due to information showing that immediate-release opioids constitute the majority of nonmedical use of opioids, dentists have some contribution to this phenomenon (Denisco et al., 2011).

Dentists have reported prescribing opioid medication for the management of pain for procedures such as root canal, implants and tooth extraction. Prior research also consistently shows that most opioid prescriptions prescribed by dentists were for immediate-release formulations, specifically various hydrocodone combinations (Weiland et al., 2015).

A pilot study by Ilgen et al. (2012) on opioid prescriptions by dentists provided an initial estimate of the prevalence of nonmedical use of opioids and diversion among dental patients receiving care at an outpatient dental clinic. The study showed that 37.9% reported some form of nonmedical use of prescription opioids and 6.5% of respondents reported diverting their initial dental medication; which indicates that dental patients may be at an increased risk of opioid medication abuse and misuse (Ilgen et al., 2012).

Dentists prescribe about 1 of every 10 immediate-release opioids dispensed, and opioid prescriptions account for a high proportion of all dental prescriptions (Denisco et al., 2011; Ringwalt et al., 2014). Prior literature suggests that (a) dental patients are potentially vulnerable to personal abuse and misuse of opioid medication (Ashrafioun et al., 2014), (b) dental patients regularly have unused leftover opioid medication that constitutes a significant proportion of

nonmedical use (McCabe, West, & Boyd, 2013b), and (c) access to dental care at a community level is associated with higher rates of opioid abuse because there is an increased availability of prescription opioids (Wright et al., 2014). However, dentists' prescribing patterns may be impacted by increased regulation and prescribing requirements associated with the DEA's decision to reschedule hydrocodone, which could potentially lead to consideration of alternatives for the management of post-procedural pain (Golembiewski, 2015; Curro, 2013)

Dentists regularly encounter patients with addiction which is not just limited to opioid addiction, nevertheless many dentists say they have limited exposure to information regarding addiction treatment which includes but not limited to screening, interventional and referral programs to assist addicts (Ilgen et al., 2012; McNeely et al., 2013). Prescription opioid medications can constitute a risk to those affected by opioid dependency because these prescription while written legitimately for pain control, can be sold on the street, stolen by family members or taken in excess quantities not recommended by the prescriber (CDC, 2013).

Adverse effects of opioid misuse can include the development of more chronic and severe substance use, overdose deaths and other unintentional fatalities (Bohnert et al., 2011; Meyer, Patel, Rattana, Quock, & Mody, 2014; Yokell et al., 2014). Hasegawa et al. (2014) reported that ED visits related to opioid overdose have quadrupled between 1993 to 2010 increasing from 19 to 63 per 100,000 ED visits (+235%; $P_{trend} < 0.001$). Imtiaz et al., (2014) demonstrated that there have been corresponding increases in admission rates, morbidity, and mortality related to opioid use by showing that consumption levels of prescription opioids were very strongly correlated with morbidity and mortality measures per 10,000 people ($r = 0.95$) and opioid overdose deaths per 100,000 people ($r = 0.99$) (Imtiaz, Shield, Fischer, & Rehm, 2014).

Despite increased attention to physician prescribing practices, as well as the role of the dental prescriber in promoting and preventing opioid misuse, abuse, and diversion, limited representative data exists regarding dental opioid prescribing practices and the frequency of multiple concurrent opioid prescriptions among dental patients (Denisco et al., 2011; Haegerich et al., 2014; Nuckols et al., 2014).

Prescription opioid misuse and abuse has increased over the past decade and can been attributed in large part to higher rates of opioid prescribing. Various initiatives across the nation such as prescription drug monitoring programs PDMPs have sought to prevent and reverse opioid abuse and consequently overdose death through education and increasing access to naloxone (Wheeler, Davidson, Jones, & Irwin, 2012). Despite the concern regarding the misuse and abuse of prescription opioids, physicians continue to be able to prescribe them with a balance to the risk and also ensuring that the patients receive the best possible care for their pain (Inocencio et al., 2013).

Also, literature suggests that dentists do not routinely use prescription drug monitoring programs (PDMP) when they prescribe opioid medications (Herman, 2011). PDMPs are databases collected from pharmacies on dispensed controlled substances such as opioids and in some cases benzodiazepines and makes them available to physicians, dentists and pharmacists with the aim of identifying patients who are at risk for, abuse or misuse (Hansen, 2015; Jena, Goldman, Weaver, & Karaca-Mandic, 2014; Paulozzi, 2012).

Prescription Drug Monitoring Programs

Prescription Drug Monitoring Programs (PDMPs) are state run electronic databases that collect data from pharmacies on dispensed controlled substances and make it available to authorized prescribers and pharmacists in order to monitor and identify patients that are at a high risk of opioid abuse (Hansen, 2015). Information from PDMPs are valuable in the identification of patients with concurrent opioid medications which is an indicator of risk for opioid abuse, misuse and overdose (Green et al., 2013; Jena et al., 2014; Paulozzi, 2012).

By October 2012, all 50 states in the U.S. had enacted laws establishing a prescription drug monitoring program, with 42 states having operational programs for monitoring in place (Alliance of States with Prescription Monitoring Programs, 2012). PDMPs allow for active monitoring of prescribing and dispensing records for selected drugs of abuse and are intended to aid providers, including dentists, as well as law enforcement to control prescription drug abuse, misuse and controlled substance use history. PDMP data is used differently depending on the state, nonetheless in most states, information is provided to pharmacy and other health care professionals and, in some cases can be provided to law enforcement (Inocencio et al., 2013). Some states have enacted legislation that mandates the use of PDMPs prior to prescribing opioid substances (Rasubala, Pernapati, Velasquez, Burk, & Ren, 2015). Dentists also reported never using the PDMP because they were not aware it existed or did not know how to access it (Ilgen et al., 2012, McNeely et al., 2013). However, dentists reporting PDMP use found it at least somewhat helpful and PDMP use contributed to prescribing fewer opioid doses (McCauley, Leite, Melvin, Fillingim, & Brady, 2016).

Evidence from research suggests that prescribers may have incorrect perceptions of their patients' risk for drug abuse or misuse (Bartley et al., 2015). Hence, regular use of PDMP data

to inform and improve prescription decisions is highly recommended (Brady et al., 2014; Haegerich et al., 2014; Haffajee, Jena, & Weiner, 2015; Rasubala et al., 2015). Training prescribers like dentists on PDMP use, patient education regarding addiction, is a key national strategy to prevent opioid abuse, misuse and diversion (US Department of Health and Human Services, 2015). Proper training in identification of drug misuse was one major reason why dentists' choose to use PDMP's prior to prescribing, and an overwhelming majority of dentists have an interest in continuing education regarding opioid abuse and misuse as most current dentists have no training in strategies to identify and prevent opioid misuse in their practice (McCauley et al., 2016).Various reasons have been identified as possible barriers to the adoption of PDMPs and these include a general lack of awareness, barriers to accessibility, quality and interpretability of data, uncertainty regarding how to respond in instances of suspected misuse or abuse, litigation fears and privacy concerns (Deyo et al., 2015; Griggs, Weiner, & Feldman, 2015; Islam & McRae, 2014; Rutkow, Turner, Lucas, Hwang, & Alexander, 2015).

Research on potential factors associated with physician opioid prescribing practices has been limited and inconclusive. While some investigations have linked such prescriptions to pain scores (Fanciullo, Hanscom, Seville, Ball, & Rose, 2001), some others have not (Breckenridge & Clark, 2003; Turk & Okifuji, 1997). Some clinicians suggest instead that patients' pain-related behaviors, particularly their distress and disability levels, might be more associated with the prescribing practices of providers than pain scores. The role of practitioner specialty as a factor in the prescribing of opioid medication remains conflicting due to the complex nature of drug abuse (Heins et al., 2006; Heins, Homel, Safdar, & Todd, 2010). The lack of substantiated evidence regarding providers and prescription of opioids this has led researchers to conclude

that opioid prescribing habits are largely idiosyncratic and based largely on providers' beliefs regarding their appropriateness (Tamayo-Sarver, Dawson, Cydulka, Wigton, & Baker, 2004). This necessitates further research into the role of practitioners as a factor in the debate on opioid abuse.

Emergency Department Use for Dental Problems

Emergency departments (EDs) are a very crucial point of entry into the health care system, particularly for people who have difficulty accessing routine preventive health care services. This problem is more pronounced for dental related problems because an estimated 44% of Americans lack dental insurance. Due to this, many experience difficulties in access to dental services (CDC, 1997).

According to the National Hospital Ambulatory Medical Care Survey (NHAMCS), the number of dental ED visits in the U.S. increased from 1.1 million in 2000 to 2.1 million in 2010, representing an increase in the rate and signifies an increasing reliance on emergency services for dental related procedures (Wall et al., 2013). In 2006, there were 120,033,750 hospital-based emergency department visits across the United States and among these, a total of 330,757 visits to hospital ED visits were primarily attributed to dental caries alone. Children accounted for 24,982 visits, whereas adults accounted for 305,775 visits. Fifty-two percent of all visits occurred among females (Nalliah et al, 2010).

According to Okunseri et al. (2015), 50.3% of patients with a non-traumatic dental related visit to the emergency department received an opioid, and the rates for each specific prescribed opioid examined (hydrocodone, oxycodone, and codeine) were 31.6%, 12.3%, 4.1%, respectively (Okunseri et al., 2015). The proportion of Medicaid enrollees with non-traumatic

dental conditions was 29.8% and represented the highest rate compared to other forms of insurance (Okunseri et al., 2015).

Income plays a huge role in predicting ED visits with close to 38% of all visits by both children and adults occurring among individuals residing in lower income areas. This highlights income based disparities in dental healthcare access and emergency room utilization in the United States (Nalliah et al., 2010). A dental ED visit study showed that uninsured individuals account for about approximately 45% of all emergency room dental related visits and close to 20% of all visits by children occurred among children who were uninsured. Medicaid was also the most common payer for all visits by children, accounting as the payer for nearly 53% of all visits (Nalliah et al., 2010).

A dental health study in New York found that 67% of oral health related visits to emergency departments by children who were younger than 6 years of age were attributable to dental caries (Wadhawan et al., 2003). Wilson et al. (1997) reported that 73% of children presenting for dental emergencies in an ED had a primary diagnosis of dental caries. Additionally, Graham et al. (1999) examined the incidence of pediatric emergency room visits for non-traumatic, preventable dental disease, and reported that 48% of cases had a primary diagnosis of caries. Evidently, dental caries is an important personal and public health issue among children. In general, patients who present at an ED with a dental condition would be better served in a dental office setting due to the availability of definitive care and the likelihood of continuity of care as well as the ability to have a one on one encounter with the dental provider (Okunseri et al., 2014).

Emergency departments are an important point of care for dental-related problems, particularly for people who are uninsured. Emergency departments and their providers should be

prepared and equipped to diagnose, provide basic treatment, and, if possible, ensure that follow-up care for dental problems within dental offices should be carried out (Lewis, Lynch, Johnston, 2003). Emergency departments may even face greater numbers of patients with dental complaints if the uninsured population increases and if the current barriers (such as income and insurance coverage) to accessing dental care are not addressed. There is a need for dental training for emergency care providers, as well as for improving dental care during and after ED visits, should be assessed (Lewis, Lynch, Johnston, 2003).

Study Significance

This study examined the patient demographic characteristics as well as disease factors that potentially influence dental patients receiving opioid prescriptions from dentists. Patient level information gives policy makers an understanding of the patient population exposed to opioids through the dentist. Additionally, examining emergency department visits with dental diagnoses can help improve understanding of the burden of emergency department visits for dental purposes, which can inform policy and policy regarding the potential for opioid abuse through opioids administered through the emergency department in the Mississippi Medicaid population.

There is limited literature on the prescribing patterns of dental providers and even less so on predictors of dental opioid prescribing. This study attempts to assess dental opioid prescriptions by understanding the dentist who prescribes and the patient who obtains these prescriptions. Prior research has examined the prevalence of emergency department visits due to dental caries in children. However, this study presents a view of emergency department visits for dental problems and opioid prescriptions associated with them.

CHAPTER II

METHODOLOGY

METHODOLOGY

Study Objectives

The objectives of this study were:

1) To determine prevalence of opioid analgesics prescribing for non-ED dental related visits in the Mississippi Medicaid population.

2) To assess predictors of receiving opioid analgesics following non-ED dental related events among Mississippi Medicaid beneficiaries.

3) To determine prevalence of opioid analgesic prescribing for dental related emergency departments (ED) visits in the Mississippi Medicaid population.

Data Source

The Mississippi Division of Medicaid is a state branch of the United States program that was designed to provide health coverage for indigent families and individuals. Medicaid is a means tested program which is jointly funded by the Federal government and state government, but it is administered by the individual states.

Mississippi Division of Medicaid administrative claims data files were used for this study. The data files include information about enrollment and eligibility; inpatient, outpatient and emergency department services; prescription drug claims; costs; dates of service; and demographics for each beneficiary.

Mississippi Medicaid Administrative Claims Database

The Medicaid administrative claims make up the database. To protect patient privacy, all the beneficiary files were de-identified. These files include: enrollment, inpatient, outpatient, medical, pharmacy, provider information.

The Medicaid beneficiary master file contains enrollment information for all Medicaid beneficiaries. This file contains patient data such as date of birth, gender, race, basis of eligibility, dual eligibility status, insurance type, monthly enrollment status, and county of residence.

The inpatient claims file is a claim level file that contains information of complete hospital stay records for beneficiaries who used inpatient services including diagnoses (e.g., ICD-CM), Current Procedural Terminology (CPT) codes, ED visits, discharge status, length of stay, and payment amount.

The medical claims files are claim level files that contain information related to office-based visits, diagnosis (e.g., ICD-CM), procedure codes (e.g., CPT) date of service, provider type, and amount paid. Claims in medical file are generated from physician's private practice.

The National Provider Identifier (NPI) is a unique 10-digit identification number for health care providers, including both organizations and individuals. This file contains provider information including provider type, description, state of practice, county of practice.

The outpatient claims file is also claim level file that provides information regarding hospital-outpatient visits, diagnosis codes (e.g., ICD-CM), procedure code (e.g., CPT), date of service, and billing information. Claims in the outpatient file are generated in hospital settings.

The prescription claims file is a claim level file that contains information related to filled prescriptions. These claims include: the drug name of the filled medication, dispense date, quantity supplied, number of refills, number of days supplied, amount paid, and National Drug Code (NDC).

Ethical Considerations

Application for human subjects research was submitted and approved by the Institutional Review Board at The University of Mississippi, University, MS.

Study Design

This study is a retrospective, cross-sectional, observational database analysis using Mississippi Medicaid administrative claims data. This study period was from January 1, 2015 to December 31, 2016. The Mississippi Medicaid administrative database contains a beneficiary master file, inpatient claims file, outpatient claims file, medical claims file, and prescription claims file. Each of these files were used for this study.

Study Sample

Inclusion Criteria

Objective 1 and 2:

- Patients with at least one medical claim for a non-ED dental event.
- Patients with a claim for an opioid analgesic prescription medication within 3 days of a dental event were included in the opioid use group.

Objective 3:

- Patients with a claim for ED visit with dental disease diagnoses.
- Patients with a claim for an opioid analgesic prescription medication within 24 hours of the ED visit were included in the opioid use group.

Exclusion Criteria

Patients that were dual eligible (patients with both Medicare and Medicaid coverage), in hospice care or long-term care facilities were excluded from the analysis.

Study Measures and Operationalization

Demographic/ Patient variables

Patient demographic information was obtained from the Medicaid beneficiary Masterfile. The demographic variables included in the study were:

i. Age: 0-18 years, 19-44 years, 45-59 years, and 60+ years

ii. Gender: Male or Female

iii. Race: White/Caucasian, Black/African American, Hispanic, Native American, Other

Opioid Medication/Drug Variables

i. Identification of opioid analgesic variables

To identify opioid prescriptions, national drug codes (NDC) for opioid medications were identified in the Medicaid data using the NDC Masterfile utilizing therapeutic categories that contains all prescription opioids, strength, dosage, form, and formulation for each drug prescribed. The quantity, number of days supplied, and the date the prescription was written and dispensed, were included for each prescription.

ii. Morphine equivalent dose

Morphine Equivalent Daily Dose (MEDD) was used to report the relative daily strength of the opioid analgesics prescribed for dental events. MEDD is calculated by

multiplying the quantity of the prescription for each day of supply by its strength (in milligram equivalents) and a conversion factor, specific to the drug prescribed (Braden et al., 2009). The CDC has a cautionary warning on the prescription of opioids with morphine equivalents greater than 50 MEDD/day (Dowell, D., Haegerich, T. M., & Chou, R., 2016). In this study, we subdivided MEDD into 4 categories: Less than 50 MEDD, 50 to 89 MEDD, 90 to 119 MEDD, and greater than or equal to 120 MEDD.

iii. Number of days supplied

Number of days supplied signifies the number of days the opioid medication was intended for use. Due to the acute nature of dental pain, this variable was measured from the pharmacy claims and categorized into 0-3 days, 4-7 days, 8-15 days, 16-30 days and greater than 30 days.

iv. Emergency department visits

Emergency department(ED) visits were identified using the procedural codes 99281-99285. This represents the visit code by severity of the situation and extensiveness of care evaluation.

v. Provider categories:

General Practice Dentists
Pediatric Dentists
Orthodontists, Oral and Maxillofacial surgeons
MD-Other: Student trainee/Internists, Physicians/Dentists without a specific self-reported identifier

Dental Event Variables

Ten dental visit events were identified using ICD-9-CM and ICD-10-CM codes. The list of ICD-9 and ICD-10 codes for the dental procedures of interest used in this study can be found in **Appendix B**.

International Classification of Diseases (ICD) codes are a set of codes developed by the National Center for Health Statistics (NCHS). ICD codes serve as a useful tool in the classification of morbidity data for health records, medical care review, and ambulatory and other health care programs, as well as for basic health statistics. ICD codes are used to classify diseases and a wide variety of signs, symptoms, abnormal findings, complaints, social circumstances and external causes of injury or disease. Nearly every health condition can be assigned to a unique category and given a code, up to six characters long.

The United States Department of Health & Human Services and the Centers for Medicare and Medicaid Services (CMS) created ICD-9-CM as an extension of the Ninth Revision, International Classification of Diseases (ICD-9), which the World Health Organization (WHO) established to track mortality statistics across the world. ICD-10-CM is the US clinical modification of the World Health Organization's ICD-10. ICD-9 codes will also be used because ICD-10 codes were not implemented until October 2015. Both ICD-9 and ICD-10 codes were used to identify the various dental diagnosis made by the dental providers. A list of the ICD-9 and ICD-10 codes for dental procedures were developed using the Vermont Medicaid Portal dental ICD code database and ICD-10 Code Search (Vermont Medicaid, 2015; ICD-10 Code Search, 2017).

Statistical Analysis

All data were analyzed using the Statistical Analysis System (SAS®) version 9.5 (SAS Institute Inc., Cary, NC). An *a priori* alpha level of 0.05 was used to evaluate significance for all analyses.

Objective 1: Prevalence of opioid analgesics prescribing for dental related visits in the Mississippi Medicaid population

Descriptive statistics

i. *Demographic/Patient level information*: Frequencies and percentages were calculated for all variables (age, gender, race/ethnicity), mean and standard deviation was also computed for age (continuous variable).

ii. *Dental event information:* For each dental event category, the total number and percentage of events in each category, opioid analgesic prescription rate per event category, morphine equivalent daily dose (MEDD) categorized into (less than 50, 50 to 89, 90 to 119, greater than 120) in each category, mean and standard deviation of opioid medication days' supply per category were provided.

iii. *Medication level information*: Frequency and percentages of days supply of medication and type of opioid medication prescribed per dental visit event category.

PROC FREQ, PROC MEANS and PROC TABULATE procedures in SAS® was used to develop frequency tabulations.

Objective 2: Predictors of receiving opioid analgesics following a dental related event among Mississippi Medicaid beneficiaries

A logistic regression model was developed to assess the relationship between predictors (patient/sociodemographic variables) and dental events.

In the first logistic regression model, the predictors were age, race, gender, dental visit event category and prescribing dentist specialty. The dependent variable was the odds of receiving an opioid following a dental related visit.

Another logistic regression model was conducted with the dependent variable being receiving an opioid with a Morphine Equivalent Daily Dose (MEDD) greater than 25 (median value), following a dental visit event. The predictors were age, race, gender, dental visit event category and prescribing dental specialty.

The PROC LOGISTIC procedure in SAS® was used to logistic regression model. Odds ratios, 95% confidence intervals and p-values were obtained for the logistic regression models.

Objective 3: Prevalence of opioid analgesic prescription for dental related emergency department (ED) visits

i. *Demographic/Patient level information*: Frequencies and percentages were calculated for all variables (age, gender, race/ethnicity), mean and standard deviation was also computed for the continuous variable (age).

ii. *Dental event level information**:*** For each dental event category, the total number and percentage of events in each category, opioid analgesic prescription rate per disease category, morphine equivalent daily dose (MEDD) categorized into (less than 50, 50-89, 90-119, greater than 120) in each event category, mean and standard deviation of opioid medication days' supply per category was provided.

iii. *Medication level information*: Frequency and percentages of days supply of medication and type of opioid medication prescribed per dental visit event category were calculated.

PROC FREQ, PROC MEANS and PROC TABULATE procedures in SAS® was used to develop frequency tabulations.

CHAPTER IV

RESULTS

RESULTS

Study Sample

During the period of January 1, 2015 to December 31, 2016 in the Mississippi Medicaid data, a total of 12,388 beneficiaries had at least one dental event during the study period, and 2,673 beneficiaries had a claim for an opioid within 3 days of a dental visit. **Figure 1** shows the sample selection chart for patient level information.

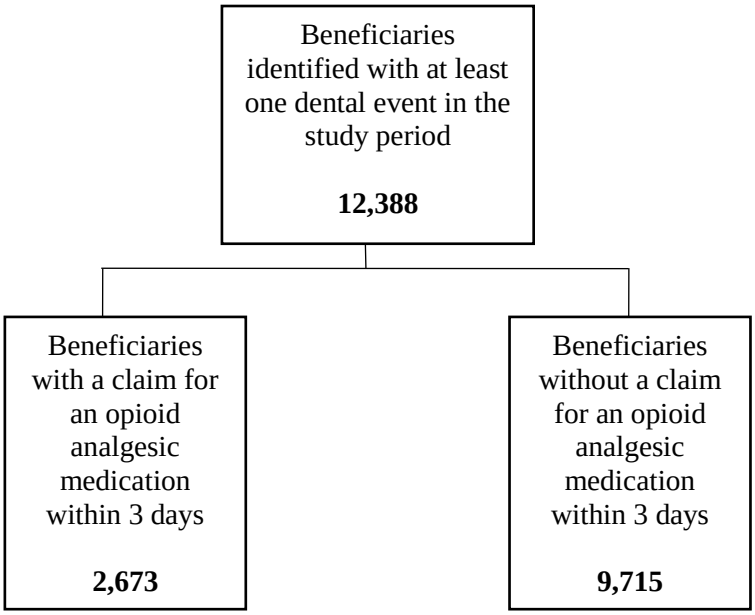

Figure 1: Sample selection chart (Patient level information)

OBJECTIVE 1

Prevalence of opioid analgesics prescribing for non-ED dental related visits in the Mississippi Medicaid population.

i. Patient level information

African Americans accounted for 58.98% of the population, while Caucasians made up 34.40% of the population. The majority of the sample was female (58.04%) and 67.63% of the sample population was below the age of 18, while 27.66% of the population was between the ages of 19 to 44 years. **Table 1** provides frequency tabulations for the sample population demographic characteristics.

Table 1: Sample population demographic characteristics

Demographic Characteristics *N*=12,388	*n*	*%*
Age (*Mean= 16.37, SD=15.27)*		
0-18 years	8,378	67.63
19-44 years	3,426	27.66
45-59 years	495	4.00
60+ years	89	0.72
Race/Ethnicity		
Caucasian	4,261	34.40
African American	7,307	58.98
Hispanic	233	1.88
American Indian	86	0.69
Other	501	4.04
Gender		
Female	7,190	58.04
Male	5,198	41.96

Overall, 21.58% of the beneficiaries who had at least one dental event received an opioid analgesic prescription. Among adults aged between 19 years to 44 years, 45.83% of patients who had at least one dental event received an opioid medication within 3 days. Among adults aged between 45 years to 59 years, 38.79% received an opioid medication within 3 days while only 26.97% adults aged above 60 years received an opioid within 3 days following a dental visit. Children below the age of 18 received the lowest proportion of opioids, among children below 18 years, only 10.59% received an opioid medication within 3 days. **Table 2** provides the proportion of patients receiving an opioid within 3 days following a dental visit.

Table 2: Proportion of patients receiving opioid medication within 3 days following a dental visit

Demographic Characteristics	Total population	Proportion receiving an opioid	
	n	*n*	%
All	12,388	2,673	21.58
Age (*Mean= 16.37, SD=15.27)*			
0-18 years	8,378	887	10.59
19-44 years	3,426	1,570	45.83
45-59 years	495	192	38.79
60+ years	89	24	26.97
Race/Ethnicity			
Caucasian	4,261	920	21.59
African American	7,307	1602	21.92
Hispanic	233	44	18.88
American Indian	86	5	5.81
Other	501	102	20.36
Gender			
Female	7,190	1,875	26.08
Male	5,198	798	15.35

ii. Dental event level information

Of the 12,388 beneficiaries who met the inclusion criteria, a total of 16,409 dental events were identified. Dental events were categorized into ten distinct categories. Overall, 26.70% of the dental events had an associated opioid analgesic prescription within 3 days. Extraction/loss of tooth events accounted for the highest rate of opioid prescriptions (54.71%), while 42.37% of root canal and endodontic treatment procedures were associated with the prescription for an opioid medication.

Cleaning, preventive and cleaning procedures category had the highest opioid average days' supply with a mean of 15.78 days. Dental caries category had an average days supply of

5.61 days while root canal procedures had an opioid average days supply of 10.68 days. Overall, across all dental conditions, the average days' supply of opioid medication was 5.5 days.

Dental caries was the most common dental disease category accounting for 53.70% of the total dental disease events followed by diseases of the pulp with 17.91% of the total dental events. Majority of extraction and loss of tooth events had an associated opioid analgesic prescription (54.71%) and it represented the dental disease category with the highest rate of opioid prescribing following a visit for a dental event. About 42% of dental events involving root canal and endodontic treatment procedures were associated with an opioid medication. Summary statistics for the opioid prescription rates among the disease categories as well as the mean, standard deviation days supply of opioid medication are provided in **Table 3**.

Dental Events	Number of events per category		Proportion associated with an Opioid medication		Days supply of opioid
	n	%	*n*	%	Mean(*SD*)
All	16,409	100.00	4,382	26.70	5.50 (5.57)
Cleaning, Preventative and Fitting procedures	402	2.44	64	15.92	15.78(11.12)
Disorders of Tooth Development	661	4.03	52	7.87	7.15 (5.99)
Embedded and Impacted tooth	1,571	9.57	286	18.20	4.45 (3.52)
Dental Caries	8,811	53.70	2,055	23.32	5.61 (6.13)
Abrasion and Attrition of the teeth	66	0.40	22	33.33	4.68 (5.85)
Diseases of the pulp	2,939	17.91	976	33.21	5.83 (6.86)
Gum disease, Periodontitis and Gingivitis.	513	12.51	160	31.19	6.40 (7.07)
Extraction procedures, Loss of tooth	1,307	7.97	715	54.71	5.74 (6.53)
Root Canal and Endodontic Treatment	118	0.72	50	42.37	10.68 (6.08)
Developmental Cysts	21	0.13	2	9.52	5.50 (2.12)

Table 3: Opioid prescription rate and mean days supply for different dental event categories

Table 4 reports the morphine equivalents doses of opioid prescribed for the ten dental event categories by the four categories. MEDD was categorized into four categories: less than 50, 50 to 89, 90 to 119, greater than 120. Among all dental events, 11.39% of received an opioid with a morphine equivalent daily dose (MEDD) greater than 50. About 238 (16.43%) of opioid prescriptions for embedded and impacted tooth events were prescribed doses with morphine equivalent between 50 and 89. Almost a quarter (13.44%) of opioid prescriptions for abrasions and attrition events had an opioid medication with a morphine equivalent greater than 50, while approximately 11% of dental caries events had an opioid prescribed with a MEDD greater than 50. The number and proportion of disease events in each morphine equivalent category are reported in **Table 4**.

Table 4: Morphine equivalent daily dose of opioid prescriptions for different dental events

Dental events	Morphine Equivalent Daily Dose							
	Less than 50		50 - 89		90 - 119		Greater than 120	
	n	%	*n*	%	*n*	%	*n*	%
All	3,858	88.04	469	10.70	38	0.70	17	0.39
Cleaning, Preventative and Fitting procedures	53	82.81	7	10.94	1	1.56	3	4.69
Disorders of Tooth Development	46	88.46	6	11.54	0	0.00	0	0.00
Embedded and Impacted tooth	238	83.22	47	16.43	1	0.35	0	0.00
Dental Caries	1,822	88.66	206	10.02	19	0.92	8	0.39
Abrasion and Attrition of the teeth	19	86.36	3	13.64	0	0.00	0	0.00
Diseases of the pulp	861	88.22	104	10.66	9	0.82	3	0.31
Gum disease, Periodontitis and Gingivitis.	146	91.25	13	8.13	0	0.00	1	0.63
Extraction procedures, Loss of tooth	622	86.99	83	11.61	8	1.12	2	0.28
Root Canal and Endodontic Treatment	49	98.00	0	0.00	1	2.00	0	0.00
Developmental Cysts	2	100.00	0	0.00	0	0.00	0	0.00

iii. Drug level information

Forty seven percent of all prescriptions were for durations less than 3 days while 83.66% of the prescription had durations less than 7 days and over 93% of the prescriptions were for durations less than or equal to 15 days. **Table 5** shows the days supply categories and frequencies for all prescription opioid medications.

Table 5: Days supply of all prescription opioid medications

Days' supply	***n***	**%**
0-3 days	2,077	47.40
4-7 days	1,589	36.26
8-15 days	412	9.40
16-30 days	290	6.62
> 30 days	14	0.32

Table 6 reports the most frequently prescribed opioids for dental related events. Hydrocodone, codeine and tramadol collectively accounted for 90.74% of opioid medications prescribed for dental related disorders and were the most commonly prescribed medication of opioids for dental related events.

Table 6: Most frequently prescribed opioids for dental related events

Generic Name	***n* (%)**
Acetaminophen-Hydrocodone	2,536 (57.87)
Acetaminophen- Codeine	1,048 (23.92)
Tramadol	392 (8.95)
Acetaminophen- Oxycodone	288 (6.57)
Acetaminophen- Tramadol	35 (0.80)
Oxycodone	30(0.68)
Fentanyl	17 (0.39)
Morphine	15 (0.34)
Meperidine	9 (0.21)
Hydromorphone	3 (0.07)
Hydrocodone- Ibuprofen	4 (0.09)
Buprenorphine	1 (0.02)
Oxymorphone	2 (0.05)

Morphine- Naltrexone	1 (0.02)
Butorphanol	1 (0.02)

OBJECTIVE 2

Predictors of receiving opioid analgesics following dental related events among Mississippi Medicaid beneficiaries

A logistic regression model using PROC LOGISTIC command in SAS to assess the association between the predictor variables (demographic variables, dental visit events and dental provider categories) and odds of receiving an opioid medication following a dental visit. Race/Ethnicity was not a significant predictor of receiving an opioid following a dental visit. Gender was also not a significant predictor of opioid prescriptions. However, age was significant with patients 18 years or younger having a lower odds of receiving an opioid in comparison to patients ages 19 to 45 years (OR= 0.235, 95% CI: 0.213-0.261, P<0.0001).

Regarding dental visit events, cleaning, fitting and preventative procedures (the reference category), beneficiaries who had a disease of the pulp had a higher odds of receiving an opioid analgesic following a dental visit (OR = 2.114, 95% CI: 1.483-3.012, P<0.0001), beneficiaries with gum diseases, periodontitis and gingivitis had a higher odd of receiving an opioid analgesic (OR = 2.852, 95% CI: 1.564-3.587, p< 0.0001), and beneficiaries who had had an extraction procedure and loss of tooth had a higher odd of receiving an opioid analgesic (OR= 2.852, 95% CI: 1.981-4.105, p<0.0001).

Regarding dental providers, general practice dentists had a higher odd of prescribing opioid analgesics following a dental visit in comparison to pediatric dentists (OR=2.336, 95% CI: 2.047-2.666, P<0.0001). **Table 7** presents the adjusted odds ratio and 95% confidence interval for patient variables as well as disease variables associated with an opioid prescription after adjusting for differential prescribing patterns by the providers/provider clustering.

Table 7: Logistic regression examining predictors of being prescribed an opioid

Predictors	Odds Ratio	95% Confidence Interval	P-Value
Race/Ethnicity			
Caucasian	Reference	Reference	Reference
Hispanic/Latino	1.402	0.998-1.970	0.0513
American Indian/Native American	1.522	0.430-5.380	0.5148
African American	0.973	0.892-1.063	0.5464
Other	0.972	0.768-1.232	0.8169
Gender			
Male	Reference	Reference	Reference
Female	0.953	0.866-1.048	0.3178
Age			
0-18	0.235	0.213-0.261	<0.0001
19-45	Reference	Reference	Reference
46-59	1.047	0.881-1.245	0.6029
60+	0.896	0.576-1.394	0.6273
Dental events			
Cleaning, preventative and fitting procedures	Reference	Reference	Reference
Disorders of tooth development	0.952	0.587-1.542	0.8406
Embedded and Impacted tooth	0.722	0.498-1.048	0.0863
Dental Caries	1.267	0.894-1.795	0.1837
Abrasion and attrition of the teeth	1.778	0.845-3.740	0.1297
Diseases of the pulp	2.114	1.483-3.012	<0.0001
Gum diseases, periodontitis and gingivitis	2.852	1.564-3.587	<0.0001
Extraction procedure, Loss of tooth	2.852	1.981-4.105	<0.0001
Root canal and endodontic treatment	1.675	0.987-2.841	0.0559
Developmental cysts of the mouth	0.572	0.119-2.751	0.4861
Dental provider			
General practice dentists	2.336	2.047-2.666	<0.0001
Pediatric dentists	Reference	Reference	Reference
Oral and Maxillofacial surgeons	1.084	0.956-1.228	0.2084
Other dental providers	1.080	0.921-1.265	0.3442

*P <0.05; ** P <0.0001

Table 8 shows results of a logistic regression model using PROC LOGISTIC to show the association between the predictor variables (demographic variables, dental visit events and dental provider categories) with the outcome of the odds of receiving an opioid medication with a morphine equivalent greater than 25 MEDD (median value) following a dental related visit.

African Americans had a slightly lower odd of receiving an opioid medication with a morphine equivalent greater than 25 compared to Caucasians (OR= 0.867, 95% CI: 0.784-0.970, P= 0.0115) while Hispanics/Latinos have a lower odd of receiving an opioid medication with a morphine equivalent greater than 25 compared to Caucasians (OR= 0.360, 95% CI: 0.164-0.790, P= 0.0109). Patients aged 18 years or below had a much lower odd (OR=0.097, 95% CI: 0.083-0.112, P<0.0001) of receiving opioid with a morphine equivalent greater than 25.

Regarding dental events and the odd of receiving an opioid with a morphine equivalent higher than 25, compared to the reference category (cleaning, fitting and preventative procedures), patients with abrasion and attrition of the teeth had a higher odd (OR= 2.585, 95% CI: 1.155-5.787, P=0.0209), patients with diseases of the pulp had a higher odd (OR= 1.877, 95% CI: 1.211-2.908, P=0.0049), gum diseases periodontitis and gingivitis (OR =2.764, 95% CI: 1.672-4.568, P<0.0001), extraction and loss of tooth procedure (OR= 2.100 95% CI: 1.346-3.278, P=0.0011), root canal and extraction procedures (OR=2.757, 95% CI: 1.524-4.987, P=0.0008) have a higher odd of receiving an opioid medication with a morphine equivalent greater than 25.

Regarding dental providers, compared to the reference category of pediatric dentists, general practice dentists had a higher odd of prescribing an opioid with a morphine equivalent greater than 25 (OR=3.734, 95% CI: 3.181-4.382, p<0.0001), oral and maxillofacial surgeons had a

higher odd of prescribing opioids with a morphine equivalent greater than 25 (OR=1.734, 95% CI: 1.486-2.023, P<0.0001).

Table 8: Logistic regression examining association between predictor variables and the odds of being prescribed an opioid with morphine equivalent dose greater than 25

Predictors	Odds Ratio	95% Confidence Interval	P-Value
Race/Ethnicity			
Caucasian	Reference	Reference	Reference
Hispanic/Latino	0.360	0.164-0.790	0.0109*
American Indian/Native American	0.403	0.048-3.409	0.4042
African American	0.872	0.784-0.970	0.0115*
Other	0.845	0.637-1.121	0.2426
Gender			
Male	Reference	Reference	Reference
Female	0.989	0.873-1.119	0.8557
Age			
0-18	0.097	0.083-0.112	<0.0001**
19-45	Reference	Reference	Reference
46-59	0.870	0.717-1.056	0.1601
60+	1.098	0.680-1.771	0.7021
Dental events			
Cleaning, preventative and fitting procedures	Reference	Reference	Reference
Disorders of tooth development	1.011	0.548-1.866	0.9713
Embedded and Impacted tooth	1.241	0.784-1.963	0.3565
Dental Caries	1.219	0.791-1.880	0.3698
Abrasion and attrition of the teeth	2.585	1.155-5.787	0.0209*
Diseases of the pulp	1.877	1.211-2.908	0.0049*
Gum diseases, periodontitis and gingivitis	2.764	1.672-4.568	<0.0001**
Extraction procedure, Loss of tooth	2.100	1.346-3.278	0.0011*
Root canal and endodontic treatment	2.757	1.524-4.987	0.0008*
Developmental cysts of the mouth	1.515	0.289-7.930	0.6229
Dental provider			
General practice dentists	3.734	3.181-4.382	<0.0001**
Pediatric dentists	Reference	Reference	Reference
Oral and maxillofacial surgeons	1.734	1.486-2.023	<0.0001**
Other dental providers	1.298	1.071-1.573	0.0079*

*P <0.05; ** P <0.0001

OBJECTIVE 3

Prevalence of opioid analgesics prescribing for dental related emergency departments (ED) related visits in the Mississippi Medicaid population

Study sample

In the 2015 and 2016 Mississippi division of Medicaid data, a total of 2,574 beneficiaries had a dental related ED visit, and among these, 1,176 had an opioid prescription claim within 24 hours. **Figure 2** shows the sample selection chart for patient level information.

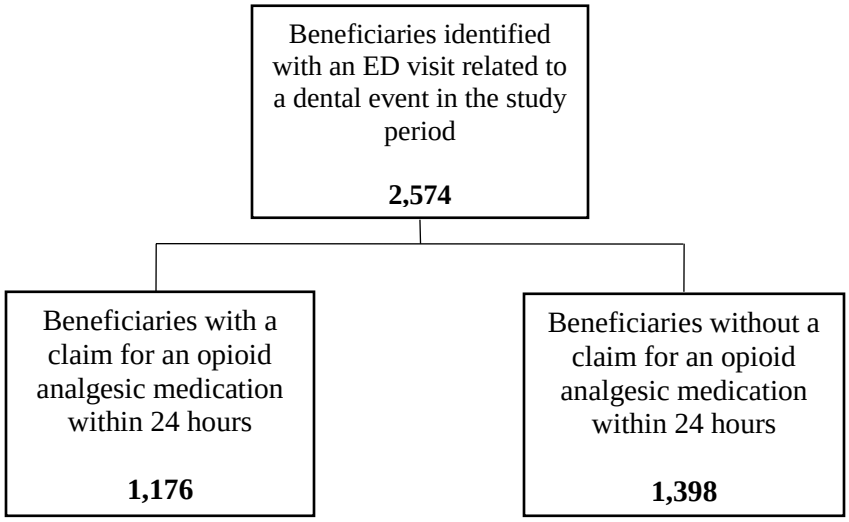

Figure 2: Sample selection chart (Patient level information) for ED related visits

1. Demographic/Patient level information dental related ED visits

African Americans accounted for a little over 60% of the population using the emergency department for dental visits, while Caucasians made up 35.04% of the population. Females accounted for 77.74% of beneficiaries using the ED for dental related events. Only 14.41% of the sample population was 18 years or younger, while 75.87% of the population is between the ages of 19 to 44 years. **Table 9** reports descriptive statistics of the total population using the ED for dental events.

Table 9: Sample characteristics of patients using ED for dental related events.

Demographic Characteristics *n*=2,574	*n*	%
Age (*Mean= 29.71, SD=11.15)*		
0-18 years	371	14.41
19-44 years	1,953	75.87
45-59 years	224	8.70
60+ years	26	1.01
Race/Ethnicity		
Caucasian	902	35.04
African American	1,571	61.03
Hispanic	13	0.51
American Indian	5	0.19
Other	83	3.22
Gender		
Female	2,001	77.74
Male	573	22.26

Approximately 45% of African Americans who used the ED for dental related events were prescribed an opioid analgesic medication within 24 hours, while the rate of prescription among Caucasians was 46.78%. Among patients 18 or younger who used the ED for dental related events, more than half (51.2%) received an opioid analgesic medication while approximately 45% of patients aged 19-44 years who used the ED for a dental related event received an opioid medication. About 48% of males using the ED for dental related events received an opioid analgesic medication while 45% of females received an opioid. **Table 10** provides the proportion of patients receiving an opioid within 24 hours following at least one dental ED visit.

Table 10: Proportion of patients receiving an opioid within 24 hours following a dental ED visit

Demographic Characteristics	Total Population	Proportion receiving an opioid	
n=2,574	*n*	*n*	*%*
All	2,574	1,176	45.70
Age (*Mean= 29.71, SD=11.15)*			
0-18 years	371	190	51.21
19-44 years	1,953	883	45.21
45-59 years	224	95	42.41
60+ years	26	8	30.77
Race/Ethnicity			
Caucasian	902	422	46.78
African American	1,571	708	45.07
Hispanic	13	7	53.85
American Indian	5	2	40.00
Other	83	37	44.58
Gender			
Female	2001	902	45.08
Male	573	274	47.82

2. Event level information for ED related dental visits

A total of 3,417 dental events related to ED visits were identified. Dental events were categorized into ten distinct categories. Summary statistics for the opioid prescription rates among the disease categories encountered in the ED as well as the mean and standard deviation of days supply of opioid medication were calculated.

Overall, 41.59% of all dental related visits to the emergency room had an associated opioid medication prescription. Approximately 42% of ED dental events related to dental caries had an associated opioid prescription, while 48% of ED visits related to gum disease and gingivitis received an opioid medication. Dental caries was the most common event category encountered with 39.04% of the total dental disease events in the ED followed by diseases of the pulp with 33.60% of dental ED visits. **Table 11** reports opioid prescription rate and mean days supply for dental related ED visits.

Table 11: Opioid prescription rate and mean days supply for dental related ED visits

Dental event category	Number of events per category		Proportion associated with an Opioid medication		Days supply of opioid
	n	%	*n*	%	Mean(*SD*)
All	3,417	100.00	1,421	41.59	5.50 (5.57)
Cleaning, Preventative and Fitting procedures	2	0.06	1	50.00	15.00 (-)
Disorders of Tooth Development	7	0.20	4	57.14	3.75 (2.87)
Embedded and Impacted tooth	47	1.38	20	42.55	3.40 (2.13)
Dental Caries	1,334	39.04	563	42.20	4.98 (5.45)
Abrasion and Attrition of the teeth	24	0.70	5	20.83	3.40 (1.67)
Diseases of the pulp	1,148	33.60	469	40.85	4.83 (5.23)
Gum disease, Periodontitis and Gingivitis.	100	2.93	48	48.00	6.48 (7.42)
Extraction procedures, Loss of tooth	743	21.74	307	41.32	5.06 (5.36)
Root Canal and Endodontic Treatment	11	0.32	4	36.36	4.50 (2.08)
Developmental Cysts	1	0.03	0	0.00	- (-)

Table 12 reports the morphine equivalents(MEDD) of opioid prescribed for ED visits related to dental event categories subdivided into four morphine equivalents: less than 50, 50 to 89, 90 to119, greater than 120. The number and proportion of events in each morphine equivalent category is also shown below in **Table 12**.

Table 12: Morphine equivalent daily dose (MEDD) of opioid prescriptions for ED related dental diseases

Dental Disease Category	Morphine Equivalent Daily Dose							
	Less than 50		50 - 89		90 - 119		Greater than 120	
	n	%	*n*	%	*n*	%	*n*	%
All procedures	1,264	88.95	145	10.20	11	0.77	1	0.07
Cleaning, Preventative and Fitting procedures	1	100.00	0	0.00	0	0.00	0	0.00
Disorders of Tooth Development	4	100.00	0	0.00	0	0.00	0	0.00
Embedded and Impacted tooth	15	75.00	5	25.00	0	0.00	0	0.00
Dental Caries	498	88.45	63	11.19	2	0.36	0	0.00
Abrasion and Attrition of the teeth	3	60.00	2	40.00	0	0.00	0	0.00
Diseases of the pulp	419	89.34	47	10.02	3	0.64	0	0.00
Gum disease, Periodontitis and Gingivitis.	45	93.75	3	6.25	0	0.00	0	0.00
Extraction procedures, Loss of tooth	275	89.58	25	8.14	6	1.95	1	0.33
Root Canal and Endodontic Treatment	4	100.00	0	0.00	0	0.00	0	0.00
Developmental Cysts	0	0.00	0	0.00	0	0.00	0	0.00

3. Drug level information on dental related ED visits

Regarding opioid medication variables, approximately 53% of all prescriptions in the ED were for durations less than 3 days while 87.40% of the prescriptions following an ED visit had durations less than 7 days. **Table 13** reports the days' supply of prescribed opioid medications following a dental related E.D visit.

Table 13: Days' supply of prescribed opioid medications for dental related ED visits

Days' supply	*n*	(%)
0-3 days	754	53.06
4-7 days	488	34.34
8-15 days	119	8.37

16-30 days	57	4.01
> 30 days	3	0.21

Hydrocodone accounted for about 62% of opioid prescription in the ED, while codeine was prescribed for about 17% of opioid prescriptions following a dental related ED visit. Hydrocodone, Codeine and Tramadol collectively accounted for 92.58% of opioid medications prescribed for dental related disorders following an ED visit. **Table 14** reports the most frequently prescribed opioids following dental related ED visits.

Table 14: Most frequently prescribed opioids following dental related ED visits

Generic Name	***n* (%)**
Acetaminophen-Hydrocodone	886 (62.35)
Acetaminophen- Codeine	238 (16.75)
Tramadol	192(13.51)
Acetaminophen- Oxycodone	75(5.28)
Acetaminophen- Tramadol	17 (1.20)
Hydrocodone- Ibuprofen	5 (0.35)
Oxycodone	3 (0.21)
Morphine	2 (0.14)
Meperidine	1 (0.07)
Fentanyl	1 (0.03)

CHAPTER V

DISCUSSION

OBJECTIVE 1

Prevalence of opioid analgesics prescribing for non-ED dental related visits in the Mississippi Medicaid population

In this study, we sought to assess various trends in opioid analgesic prescribing for dental related visits using the Mississippi Medicaid database. The results of the study indicate that dental related problems are a prominent source of opioid prescribing. Based on previous research by Levy et al, a study using IMS national prescription audit data on opioid prescription volume by specialty, showed that dentists prescribed 6.4% of all opioids; and this translates to millions of prescriptions (Levy, Paulozzi, Mack, & Jones, 2015).

In our study, we found that dental caries was the most frequently encountered dental disease category. The following dental event categories: (1) tooth extraction procedures and other conditions involving loss of tooth, (2) root canal treatment and endodontic therapies, (3) embedded and impacted tooth, (4) diseases of the pulp and (5) dental caries had a higher odd of receiving an opioid analgesic prescription following a visit, compared to cleaning and preventative procedures. These observations are consistent with other research showing that root canal procedures, periodontics' treatment had a high odd of receiving an opioid prescription per visit to the dentist (Steinmetz et al 2017).

Our study also suggests a lower rate of opioid prescribing among children 18 years and younger. In this study, the rate of opioid prescriptions ages 18 years and younger was about 10.59%. This finding is in line with another study conducted using the National Medicaid analytic extract files to assess the proportion of Medicaid patients dispensed opioids following surgical extraction of teeth. In the 2000-2010 data, they found that 14% of children under 13 and

61% of children under 18 years of age received of opioid prescription for dental extraction procedures. (Baker, J. A., Avorn, J., Levin, R., & Bateman, B. T., 2016). Another study conducted in Canada reported that 50% of children in their study received codeine for less than 3 days (Etminan, M., Nouri, M. R., Sodhi, M., & Carleton, B. C., 2017). The rate of opioid prescribing among children in our study is lower (11%) than other studies showing similar rates of opioid prescriptions among children. However, this could be due to the increased awareness regarding the danger of opioid prescription in the United States.

In our study, morphine equivalent dose of opioids prescribed to patients following dental procedures indicates that the majority of patients in most disease categories received an opioid with a morphine equivalent dose less than 50. However, a small proportion of patients received opioids with morphine equivalent doses greater than 50 for dental events. The Centers for Disease Control and Prevention (CDC) has issued guidelines which encourage clinicians to use caution when prescribing opioids at any dosage. Additionally, they should carefully reassess evidence of individual benefits and risks when considering increasing dosage to 50 morphine milligram equivalents or higher (Dowell, D., Haegerich, T. M., & Chou, R., 2016).

In our study, drug level information indicated that hydrocodone, codeine and tramadol were the most frequently prescribed opioids following a dental related condition. This finding is consistent with previous studies on the most frequently prescribed opioids following dental extraction which showed that hydrocodone, oxycodone, propoxyphene and codeine as the most commonly prescribed opioids following tooth extraction (Baker, J. A., Avorn, J., Levin, R., & Bateman, B. T., 2016). These results indicate the need to provide adequate information to dentists to prevent inappropriate prescribing of opioids to patients who may otherwise be adequately treated for pain with other classes of analgesics.

OBJECTIVE 2

Predictors of receiving opioid analgesics following dental related events among Mississippi Medicaid beneficiaries

A logistic regression model predicting the odds of receiving an opioid medication for dental visits was developed. Our findings indicate that the prescribing of opioid analgesic medication for dental related pain and the odds of receiving an opioid medication is higher among Hispanics, patients with diseases of the pulp, patients that have undergone a tooth extraction procedure or a root canal treatment and patients with gum disease or periodontitis. This observation is in line with previous literature on opioid analgesic prescribing for dental diseases and socioeconomic status showing that minorities had a higher odd of opioid prescriptions for dental diseases (Steinmetz et al, 2017). Our study indicates that regarding providers, compared to the reference category of pediatric dentists, general practice dentists, oral and maxillofacial surgeons had a higher odd of prescribing opioids.

A logistic regression analysis was modeled to predict the odds of receiving an opioid medication with a morphine equivalent dose greater than 25 morphine equivalent daily dose which was the median morphine equivalent in the study population. Our findings indicated that beneficiaries 18 years or younger, had a lower odd of receiving an opioid with a MEDD of 25 or more, while patients with diseases of the pulp, gum diseases or had undergone an extraction procedure have a higher odd of receiving an opioid medication with a dose greater than 25 morphine equivalents. Furthermore, opioid prescribing dosage is important due to CDC guidelines on clinicians being encouraged to understand the benefits and risks when considering increasing opioid dosage to 50 morphine milligram equivalents (MME)/day or greater (Dowell,

D., Haegerich, T. M., & Chou, R., 2016). Our study indicates that regarding providers, compared to the reference category of pediatric dentists, general practice dentists, oral and maxillofacial surgeons had a higher odd of prescribing opioids.

OBJECTIVE 3

Prevalence of opioid analgesics prescribing for emergency departments (ED) related visits in the Mississippi Medicaid population

In this study, we used data from Mississippi Medicaid to assess various trends in opioid use following emergency department (ED) visits for dental conditions. In our study, dental caries accounted for the most frequent dental disease category encountered in ED visits. Gum diseases, loss of tooth and extraction procedures, dental caries, diseases of the pulp all accounted for high proportion of opioid prescriptions following an ED visit. An observational multicenter study on general ED visits showed that among patients whose chief complaint and primary discharge diagnosis was associated with an opioid medication after an ED visit, 5.9% were related to dental pain and 6.2% was related to a dental or oral issue representing 12.1% of total emergency visits due to pain (Hoppe, J. A., Nelson, L. S., Perrone, J., Weiner, S. G., 2015). This indicates a potential reliance on emergency departments for treatment by some patients with dental problems.

Our study also suggests a low rate of opioid prescription following ED use for dental pain among children ages 18 years or younger (14.41%). Approximately 76% of patients receiving opioids following emergency department visit for dental related diseases were between the ages of 19 and 44 years. This trend observed in this study is supported by prior research studies which reported that most patients using ED services associated with dental pain were young adults between the ages of 19 and 33 years (Okunseri, C., Okunseri, E., Xiang, Q., Thorpe, J. M., & Szabo, A., 2014).

Morphine equivalent dose of opioids prescribed to patients following ED dental procedures also shows that a clear majority of patients in most disease categories received an

opioid with a morphine equivalent dose less than 50. However, a small proportion of patients received opioids with morphine equivalent doses greater than 50 after an ED visit. Our study found that hydrocodone was the most commonly prescribed opioid analgesic for ED visits was hydrocodone (62.35%) followed by codeine (16.75%) and finally tramadol (13.51%). A previous study on types of opioid analgesics prescribed in the ED revealed that the most frequently prescribed opioid medications in the ER are oxycodone (52.3%), hydrocodone (40.9%), and codeine (4.8%) and that 90% of prescribed opioids were combination products with analgesics like ibuprofen and acetaminophen (Hoppe, J. A., Nelson, L. S., Perrone, J., Weiner, S. G. 2015).

Limitations

There are several limitations to the study. First, the study was conducted using Medicaid administrative claims data and therefore there is a possibility of misclassification of dental diseases due to coding errors during claims processing. Also, it is possible to have some opioid analgesic prescription claims not related to dental visits included in the study, possibly due to multiple visits in the same time frame by beneficiaries to multiple providers in the same hospital including dentists. Days' supply of opioid used in the calculation could be altered by the pharmacy processing claim to ease payment by insurance thereby potentially confounding the morphine equivalent dosage calculations. Classification of race/ethnicity was determined by hospital staff based on perception of the hospital staff. Additionally, our findings might not be generalizable to the general population or representative of opioid utilization in the general population due to the data being state specific with a population that is generally below the poverty line.

Conclusions

This study is significant because it identifies and characterizes opioid prescription use in dental conditions and gives us an understanding of how specific dental events and demographic factors that contribute to receiving opioid prescriptions following a dental visit in the ED and non-ED setting.

Due to the current CDC warning of provider caution in prescribing opioids with dosage greater than 50 morphine equivalents, this study identifies predictors of high opioid dosage in dental patients and utilizes statistical techniques to assess the relationship between sociodemographic and dental disease variables and high opioid doses for dental related events.

In conclusion, this study has a broader policy implication for the state of Mississippi regarding opioid abuse and misuse, drug utilization trend monitoring and curtailing opioid abuse by broadening the lens to the field of dentistry.

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APPENDICES

APPENDIX A: FDA APPROVED OPIOID ANALGESIC MEDICATIONS

Appendix A: FDA approved opioid analgesic medications

	Generic Name	Brand Names (examples)
1.	Alfentanil	Alfenta
2.	Buprenorphine	Belbuca, Buprenex, Butrans
3.	Butorphanol	No brand name currently marketed
4.	Codeine	Fioricet w/ codeine, Fiorinal w/ codeine, Soma Compound w/ codeine, Tylenol w/ codeine
5.	Dihydrocodeine	Synalgos-DC
6.	Fentanyl	Abstral, Actiq, Duragesic, Fentora,
7.	Hydrocodone	Anexsia, Hysingla ER, Lortab, Norco, Reprexain, Vicodin
8.	Hydromorphone	Dilaudid, Dilaudid-HP, Exalgo
9.	Meperidine	Demerol
10.	Methadone	Dolophine
11.	Morphine	Astramorph PF, Duramorph PF, Embeda, Infumorph, Kadian
12.	Nalbuphine	Nubain
13.	Oxycodone	Oxaydo, Oxycet, Oxycontin, Percocet, Percodan, Roxicet
14.	Oxymorphone	Opana, Opana ER
15.	Pentazocine	Talwin
16.	Remifentanil	Ultiva
17.	Sufentanil	Sufenta
18.	Tapentadol	Nucynta, Nucynta ER
19.	Tramadol	Conzip, Ultracet, Ultram, Ultram ER

APPENDIX B: DENTAL DISEASE CATEGORIES, DENTAL RELATED ICD-9 AND ICD-10 DIAGNOSIS CODES

Appendix B: Dental Disease Categories, Dental Related ICD-9 and ICD-10 Diagnosis Codes

Dental Disease Category	Diagnosis	ICD-9 Code	ICD-10 Code
1	**Cleaning, preventative and fitting procedures**		
	Encounter for dental examination and cleaning without abnormal findings	V722	Z01.20
	Encounter for dental examination and cleaning with abnormal findings	V722	Z01.21
	Encounter for fitting and adjustment of orthodontic device	V53.40,V58.50	Z46.4
2	**Disorders of tooth development**		
	Supernumerary teeth	520.1	K00.1
	Abnormalities of size and form of teeth	520.2	K00.2
	Mottled teeth	520.3	K00.3
	Disturbances in tooth formation	520.4	K00.4
	Hereditary disturbances in tooth structure	520.5	K00.5
	Disturbances in tooth eruption	520.6	K00.6
	Teething syndrome	520.7	K00.7
	Other disorders of tooth development	520.8	K00.8
	Disorder of tooth development, unspecified	520.9	K00.9
3	**Embedded and Impacted tooth**		
	Embedded teeth	520.6	K01.0
	Embedded teeth	520.6	K01.1
4	**Dental Caries**		
	Dental caries on smooth surface limited to enamel	521.01, 521.02	K02.61
	Dental caries on smooth surface penetrating into dentin	521.02, 521.07	K02.62
	Dental caries on the smooth surface penetrating into the pulp	521.03, 521.07	K02.63

5	**Abrasion and attrition of the teeth**		
	Excessive attrition of teeth	521.10, 521.11, 521.12, 521.13, 521.14, 521.15	K03.0
	Abrasion of teeth	521.20, 521.21, 521.22, 521.23, 521.24, 521.25	K03.1
	Erosion of the teeth	521.30, 521.31, 521.32, 521.33, 521.34, 521.35	K03.2
	Pathological resorption of teeth	521.40, 521.41, 521.42, 521.49	K03.3
	Deposits [accretions] on teeth	523.60	K03.6
6	**Disease of the pulp**		
	Necrosis of the pulp	522.10	K04.1
	Pulp degeneration	522.20	K04.2
	Abnormal hard tissue formation in pulp	522.30	K04.3
	Acute apical periodontitis of pulpal origin	522.40	K04.4
	Periapical abscess without sinus	522.50	K04.7
7	**Gum, periodontal and gingival diseases**		
	Periodontosis	523.50	K05.4
	Other periodontal diseases	523.80	K05.5
	Gingival enlargement	523.80	K06.1
	Gingival and edentulous alveolar ridge lesions associated with trauma	523.80	K06.2
8	**Extraction and loss of tooth**		
	Partial loss of teeth due to trauma, unspecified class	525.11	K08.419
	Partial loss of teeth due to periodontal diseases, unspecified class	525.12	K08.429
	Partial loss of teeth due to caries, unspecified class	525.13	K08.439
	Loss of tooth due to fracture	873.63, 873.73	S02.5

9	**Developmental cysts of the oral region**		
	Developmental (nonodontogenic) cysts of oral region	526.10	K09.1
10	**Root canal and endodontic treatment**		
	Perforation of root canal space due to endodontic treatment	526.61	M27.51
	Endodontic overfill	526.62	M27.52

VITA

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