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Abstract

Drug abuse, currently a national epidemic affecting millions of Americans, causes numerous health issues including increased dental disease. There are several factors which can contribute to an increase in caries and missing teeth. One of the most discussed mechanisms is xerostomia. Drug abusers tend to have large sugar intakes which exacerbates the problems caused by xerostomia. Drug abusers are also at risk for oral infections associated with dental decay due to their altered saliva composition. Unfortunately, once the symptoms are present there is little that can be done to correct them and the goal of the treating dentist should be increased dental hygiene and ongoing prevention.

Introduction

Substance abuse and misuse is a national public health crisis. In 2015, more than 27 million people in the United States reported current illicit drug use or misuse of prescription drugs. In addition, The National Survey on Drug Use and Health reported that over 66 million people misuse alcohol in a month. Alcohol and drug misuse and related disorders are taking an enormous toll on individuals, families, and society as a whole as a result of the increased costs of healthcare associated with these conditions.

Methods

The articles mentioned in this paper were collected and compiled using research available to the public through Google Scholar, PubMed, and EBSCO host. Some of the articles may be under restricted access to academic circles and was made available to the author through the TouroLib system. Sources were evaluated for usefulness based on publication date and original publication source.

Commonly abused drugs

In addition to the many psychological and medical challenges presented by drug abuse, there are also extensive oral health problems which drug abuse causes. To further understand the nature of the oral health issues, it is first necessary to understand what is considered a drug and the major classes of drugs which people tend to abuse. Drugs can be defined as an exogenous chemical not necessary for normal cellular functioning that significantly alters the function of certain cells in the body, even when taken in relatively low doses. Endogenous neurotransmitters are not drugs, synthetic chemicals which mimic the effects of these endogenous chemicals, however, are considered a drug. Another stated qualification for a drug is that it is effective even in small quantities, this is an important part of the definition, as large quantities of any substance will alter the normal function of cells (Carlson, 2013).

People abuse drugs for the euphoric feelings and their ability to cause "mental detachment". The reason why people do not abuse antibiotics is because they do not induce these feelings. The drugs which people abuse can be separated into two distinct categories, central depressants and stimulants, defined by their effects on neurotransmitters. In the world of illicit drugs, these substances are often referred to by a "street name". It is important for a clinician to be familiar with not only the pharmaceutical name of a drug but with the street name as well, since many patients may not know the pharmaceutical name and may resort to using street names (Rome, 2001).

Stimulants, or "Uppers", is a class of drugs that mimic the effects of the sympathetic nervous system. The endogenous agonists of the sympathetic nervous system are the catecholamines; epinephrine, norepinephrine, and dopamine. The catecholamines function as both hormones and neurotransmitters. The pharmacokinetics of these drugs can affect a multitude of mechanisms, direct activation of postsynaptic receptors, the breakdown and reuptake of neurotransmitters, and stimulating production of catecholamines. Stimulants include, caffeine, ephedrine, nicotine, and cocaine.

One of the most commonly abused stimulants is methamphetamine. Methamphetamine, also known as, meth, speed, crank, tweek, chalk, amongst other names, is a white crystalline powder. Methamphetamine can be snorted, smoked, or injected. The popularity of methamphetamine is in large part because of its ease to obtain. Methamphetamine can be synthesized at home from commonly available ingredients (Lineberry and Bostwick, 2006). The FDA approves methamphetamine hydrochloride, sold under the name Desoxyn, to treat attention deficit disorder with hyperactivity as well as exogenous obesity, however the FDA advises that the inherent risk of methamphetamine must be strongly considered when prescribing it. The physical effects of methamphetamine are systemic. They include, loss of appetite, hyperactivity, tachycardia, bradycardia, rapid breathing, dry mouth, excessive sweating, and bruxism. Methamphetamine is taken recreationally to produce euphoria as well as an aphrodisiac. This article will discuss the effects of methamphetamine on oral health. Methamphetamine causes periodontal disease as well as rampant caries (cavities), the effect of methamphetamine on oral health is so unique that it has been referred to as Meth Mouth (Rommel, et. al, 2015).

The second class of drugs is depressants, or, "downers". Depressants, are the opposite of stimulants, they lower neurotransmission levels and depress arousal and stimulation in the brain. The pharmacokinetics of depressants are slightly more complicated. Neurons communicate through excitatory synapses, one neuron excites another which excites another neuron, and so on. If this excitatory process would happen uncontrollably, the neurons in the brain would be firing constantly, resulting in a seizure. To prevent this from happening, there is a class of neurons which have inhibitory effects. These neurons

secrete GABA (gamma-aminobutyric acid) which has a postsynaptic inhibitory effect. Depressants activate the various GABA receptors which results in an overall inhibitory effect. The most commonly prescribed class of depressants are benzodiazepines. Benzodiazepines are drugs which are used to reduce anxiety, promote sleep, and reduce seizures. Valium (diazepam) and Librium (chlordiazepoxide) are two common benzodiazepines. Other common depressants include barbiturates, cannabis, and alcohol (Carlson, 2013).

Opioids, the current medical terminology which refers to both endogenous and exogenous opioid, are drug which have the properties of both a depressant and a stimulant. Opioids create a state of euphoria, much like a stimulant, but its physical expression is similar to that of a depressant, i.e. slowed breathing, sedation, and hypothermia (NAABT.org). What is particularly scary about opioids is their tendency to cause respiratory depression. Even a small dose can be lethal, when taken together with Xanax (alprazolam), or other commonly prescribed drugs, which also causes respiratory depression.

With the exception of alcohol, drug abuse was limited to a small population who tended to be socially disadvantaged. Today, drug abuse is evenly distributed across all social strata (Friedlander and Mills, 1985). The stereotypical drug abuser is one of low socioeconomic status, and frequently neglects both general and oral hygiene. With the increase of abusers who do not fit this image, the issue of drug abuse, and its effect on oral health, has now come to the forefront.

Drug Abuse and Dental Decay

The correlation between drug abuse and severe dental decay has long been known. A study conducted in Iran was composed of 5,900 people; 2,662 were men (45.1%), between the ages of 15 and 75. One thousand and eleven (17.1%) of those people used opioids. The participants in the study underwent a face to face interview with a trained practitioner, during which information pertaining to the frequency of their drug use was obtained. In accordance with the Diagnostic and Statistical Manual of Mental Disorders (DMS-IV2), individuals who reported taking opioids at least three times a week were considered addicted. After the interview a dentist performed a thorough oral exam. Dental decay was recorded according to the DMFT index (decayed, missing, and filled teeth) established by the World Health Organization. Dental plaque and gum disease were also noted using the plaque index and the community periodontal index (CPI).

For people addicted to opioids, participants had a mean number of 9.07 teeth missing, compared to a mean of 6.42 for non-addicted users. There was a mean of 9.50 decayed teeth for addicted opioid users compared to 8.95 decayed teeth for participants not addicted to opioid use. Similar results for the number of filled teeth as well; 6.36 fillings for addicted participants compared to a mean of 3.89 for non-addicted participants. Overall the DMFT index for addicted users had a score of 17.10 compared to 13.10 for non-addicted users (Mohammadi, et al. 2017).

The authors say that the data proves a clear increase in the number of missing, decayed, and filled teeth, in opioid users. There are however some shortcomings with the study. Although other studies consider self-reporting of drug use a reliable indicator of actual drug use, there are of course people who are not totally honest with their drug use habits. More challenging, however, is the difference in age among the participants in the trial. The mean age of the addicted individuals was 56.01 while the mean age of non-addicted individuals was 48.19. This difference is statistically significant ($p=0.00$) considering the large sample size. Some of the discrepancy in the DMFT index between the addicted and non-addicted individuals can be associated with the age difference as aging is an influence in tooth loss. The study would have been more reliable had the mean age of the two groups been the same or at least statistically insignificant.

A study of 571 methamphetamine users in Los Angeles County, California was conducted and also shows a correlation between methamphetamine use and dental decay. This study focused exclusively on methamphetamine users and compared their results to a study done by National Health and Nutrition Examination Survey (NHANES). NHANES does a survey every two years, with participants selected to be nationally representative without being selected based on risk factors or pre-existing conditions. This study was conducted to answer two questions, do methamphetamine users have a higher rate of dental disease compared to non-users, and are different teeth affected between methamphetamine users and non-users.

Participants in the study were selected based on stratified sampling protocol of heavy, mild, and moderate, methamphetamine users. Intraoral exams were conducted by dentists who were trained by the national examiner in the NHANES study. All protocols of the study adhered to NHANES regulations so that the two studies can have maximum comparability. Although many variables were tested, the main one focused on was the DMFT index. As opposed to the Iran study which relied on self-reporting of drug use alone, this study utilized urine testing to confirm drug use. Data was also collected on sociodemographic and behavioral variables; gender, age, ethnicity, education, history of smoking, frequency of basic oral hygiene, and soda consumption.

Whereas the Iran study compared opioid users and non-users with little regard for sociodemographic information and the differences it may make, this study divided the participants into five propensity score groups, with each group having comparable sociodemographic backgrounds as the participants in the NHANES study. Multiple statistical analysis tests; t tests, chi-square tests, and Fisher tests, were used to confirm the accuracy in comparing the data from the Los Angeles County study to that of the NHANES study.

Of the 571 participants in the study, 19 of them were

completely edentulous (missing teeth). A shocking number considering that mean age of the participants was only 44. Compared to the NHANES study, methamphetamine users were forty percent less likely to have all their teeth. Methamphetamine users were also found to have approximately four times more caries and were twice as likely for the caries to be untreated. Close to twenty percent more methamphetamine users had decayed, missing, or filled teeth compared to the NHANES participants. Methamphetamine users were also more likely to have missing teeth when compared to the demographically similar NHANES participants (Shetty, et.al. 2016).

Similar studies from other locales also point to an increase in both the number of missing teeth and the number of carries in patients addicted to drugs. A study in Queensland, Australia studied several drugs and their role in dental decay (Reece, 2007). Another study, based in Munich, Germany also determined that there is a correlation between methamphetamine and rampant caries (Rommel, 2015).

Xerostomia

The most common complaint methamphetamine users express is that of "dry mouth" (Shafer, 2005). One study has 72% of substance abusers reporting suffering from an excessively dry mouth (Rommel, et. al., 2016). Dry mouth or xerostomia, is a fairly common complaint with estimates ranging between 0.9% and 64.8% of the population suffering from a form of dry mouth. There is a lack of data on the prevalence of xerostomia leading to such a wide range (Navazesh and Kumar, 2009). Xerostomia is usually associated with salivary gland hypofunction.

Although saliva is ninety-eight percent water, the other two percent contains many important substances. Included in those substances are the electrolytes, sodium, potassium, calcium, chloride, bicarbonate, and phosphate. Saliva also contains important enzymes needed for digestion, amylase, lingual lipase, and kallikrein. Another important component of saliva is its antimicrobial enzymes; lysozyme, lactoperoxidase, lactoferrin, and immunoglobulin A.

The importance of the electrolytes in saliva is their ability to regulate and maintain the pH of the mouth. Ideally, the pH of the mouth should be between 6.2 and 7.4. Anymore acidic and the acid can dissolve the hard minerals which make up the teeth. The ions present in saliva act as a buffer, keeping the pH within that important range.

Although there have been some studies which did not find a correlation between decreased saliva production and drug abuse (Busfield, 1961), more recently there are others that have reported a correlation (Heng, et al. 2008). The mean saliva production of a person is 1-2 ml/min. A stimulated salivation of less than 0.7 ml/min is considered low. In one study, the average methamphetamine user had an average saliva flow rate of only 0.36 ml/min (Rommel, et. al., 2016).

Saliva production is regulated by both the sympathetic and parasympathetic nervous systems. When norepinephrine binds to the alpha-adrenergic receptor it causes an increase in calcium levels which results in increased saliva production. Methamphetamine seems to activate the alpha-2-receptor which is a salivary inhibitor in the brain (Saini, 2005).

Xerostomia is considered to be an adverse drug event of properly prescribed opioid medication (Chapman, et. al., 2010). Although a concrete mechanism between opioid use and xerostomia has not been found, there are several working theories as to what may cause these symptoms. One theory is based upon the proven correlation between opioid use and decreased pancreas function. Perhaps there is a similar effect on the salivary glands which also are exocrine glands. Another theory is that after opioid use, there is a clear change in color, from red to very pale, of the oral mucosa. This change in color suggests local vasoconstriction of the capillaries and small arterioles in the mouth. This decreased blood flow can also inhibit saliva production (Odeh, et al. 1992).

Additionally, drug abusers also tend to go long periods with inadequate food and drink. This leads to a generalized dehydration, resulting in decreased saliva production especially when coupled with the hypermetabolic effects of illicit drugs (Goodchild, et al. 2007) Another theory points to the concomitant use of antidepressants and other drugs which can also cause xerostomia (Darke and Ross, 2000).

Sugar Intake

Regardless of any proven cause of drug abuse induced xerostomia, the mere fact that drug abusers consider their mouth to be dry, leads to another problem. Drug abusers tend to crave sugar and drink large amounts of non-diet soda. Mountain Dew is a commonly reported favorite drink of methamphetamine users and contains 31 grams of sugar, the equivalent of eight sugar cubes, in a single eight ounce serving. When considering that that is a single serving, and one can have many cups over the course of one day, that is an abnormally high level of sugar consumption (Goodchild, et al. 2007). One case report mentions a light user of methamphetamine, who would drink 1.5 liters of soda a day, that is a staggering one hundred and ninety six grams of sugar consumed from drinks alone (Wang, et al. 2012). As part of the Los Angeles County survey of 541 methamphetamine users, researchers obtained the number of non-diet soda drinks they had per day. The results of the study when compared to national averages, show a direct correlation between non-diet soda consumption and methamphetamine use. Although for years there was anecdotal evidence to this, this was the first survey to confirm it from a scientific and statistical standpoint (Murphy, 2016).

Opioid users have an additional factor which increases their sugar levels. There are three main opioid receptors in the brain;

mu, kappa, and delta (Titsas and Ferguson 2002). Preclinical animal studies suggest that action of mu and kappa agonists at the nucleus accumbens shell, hypothalamus, and paraventricular nucleus is associated with a development of a preference for sweetened food. Furthermore, eating sugar results in a down regulation of enkephalin MRNA production which then results in an increase in mu receptor agonism (Mysels and Sullivan, 2010). This increase in sugar consumption, especially when coupled with hyposalivation, leads to rampant caries and subsequent tooth loss.

Methamphetamine abuse leads to hyperactivity and excessive neuromuscular activity which causes bruxism (Rommel, et. al., 2016). Bruxism is excessive jaw clenching and teeth grinding. Opioid users also suffer from bruxism as there is an increase in neurosis which results in jaw clenching and teeth grinding (Titsas and Ferguson, 2002). Although bruxism is relatively common in non-drug dependent adults as well, the degree of grinding and clenching seems to be much greater in the addicted population. Bruxism shows to be particularly damaging to drug abusers due to the already weakened enamel from sugar consumption, poor oral hygiene, and hyposalivation.

Oral Infections

Another problem which drug abusers face is oral candidiasis. Opioids have been found to have an inhibitory effect on the phagocytosis of Candida by macrophages (Titsas and Ferguson, 2002). Saliva also plays a role in preventing oral candidiasis as it unifies the innate immune defense against Candida Albicans and prevents its proliferation. Saliva also contains the immunoglobulin IgA which aggregates the Candida Albicans cells and then destroys them by swallowing the aggregate (Salvatori, et al. 2016). Candida Albicans has also been found to cause pulpal inflammation, resulting in tooth loss, when the microorganism reaches the pulp through dental caries (Baumgartner et. al. 2000).

It has been known for a long time that Streptococcus mutans is a pathogenic organism which causes enamel loss and caries (Loesche, 1986). Recent clinical studies have shown large numbers of Candida albicans along with Streptococcus mutans in plaque obtained from carious lesions. Scientists were surprised to find this as no other co-colonization between this bacteria and yeast were previously known (Carvalho et al. 2006). Recent research shows that co-culture of Candida albicans and Streptococcus mutans with sucrose resulted in production of the S. mutans exoenzyme (GtfB) that bound to mannans and β-1,3 glucans found on the fungal outer cell wall, allowing them to survive the innate immune factors present in the mouth. In the same study, it was shown that coinfection in rats with both C. albicans and S. mutans increased the severity and number of smooth-surface caries lesions by 2-fold in the presence of sucrose (Falsetta et al. 2014). It is no surprise then that drug abusers who have an increased presence of both Candida albicans and Streptococcus mutans as well as a large sugar intake are at risk for severe caries.

One theory for the increase of dental disease in drug abusers was the caustic nature of inhaled and smoked drugs (McGrath and Chan, 2005). The Los Angeles County study, however, found that the dental consequences of methamphetamine abuse were more pronounced in users who injected the drug (Shetty, 2016). With injection of the drug there should be little or no decay if the issue was the caustic nature of the smoke. Heavy drug abusers tend to inject the drug as it provides for a quicker and stronger "high." The poor health of heavy drug abusers and the increase of the associated side effects are probably responsible for the findings of the Los Angeles County study.

Treatment Concerns

Drug abusers will usually only visit the dentist after they stop abusing the drug and they are suffering from severe pain. It is therefore important that dentists be aware of previous drug abuse to avoid prescribing a medication which may cause relapse. Most users will not admit that they are or were users for fear of being judged. Therefore dentists must be trained to recognize the main signs and symptoms of drug abuse (De-Carolis, et al., 2015). Dentists should also take notice of skin lesions which can indicate intravenous drug use. The practitioner may decide to take the patient's blood pressure as a way of disguising their search for needle tracks (Saini, et al. 2013). Dentists should not make use of pre-written prescription forms as it can potentially be used to obtain drugs which were not prescribed (Smit and Naidoo, 2015).

When treating patients who have a history of drug abuse, providing adequate pain relief can be challenging. Most abusers have a tolerance to several pain medications as a result of drug abuse, and other medications may cause relapse (Saini, 2013). Local anesthetic containing epinephrine (commonly used as a vasoconstrictor in dental surgery) must be avoided as there are known drug interactions between epinephrine and commonly abused drugs. The importance of this must be stressed to the patient as it may result in cardiac dysrhythmias, cerebrovascular injury, and even myocardial infarctions (Smit and Naidoo, 2015). Dentists may recommend non-steroidal analgesics, for example, ibuprofen and naproxen. Acetaminophen can be used as well (Saini, et al. 2013).

Conclusion

Drug abuse is considered an epidemic and there is a large effort underway to inform the public of the dangers involved. Drug abuse has serious detrimental effects on the body. Oral health is one of the most noticeable side effects, as drug abusers are commonly missing multiple teeth. Dentists must know how to recognize the signs of drug abuse and can be on the forefront of fighting this epidemic.

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