Methamphetamine Use and Dental Disease: Results of a Pilot Study

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ABSTRACT

Purpose: The purpose of this study was to evaluate the feasibility of using a standard dental examination to detect methamphetamine use.
Methods: Data were collected from 31 patients in a hospital-based inpatient chemical dependency treatment unit using cross-sectional study design. Patients who reported current methamphetamine use were compared with patients who denied methamphetamine use on data from dental examinations and an in-depth substance use assessment.
Results: Evidence of a relationship between methamphetamine use and dental disease was not detected in this sample. Both groups had a high degree of behaviors and risk factors other than substance abuse that contributed to dental disease.
Conclusion: Based on these data, clients who used methamphetamine could not be distinguished from those who used other substances. Both groups presented significant dental disease, however, and it may be that most, if not all, patients in this hospital-based unit had significant chronic health problems including dental disease. Although adolescent use of methamphetamine is primarily restricted to older adolescents, consequences of use are severe and early identification of drug use may forestall some of the more severe consequences. (J Dent Child 2007;74:85-92)

KEYWORDS: METHAMPHETAMINE, DENTAL DISEASE, METHAMPHETAMINE ABUSE, ADOLESCENT METHAMPHETAMINE USE, CHEMICAL DEPENDENCY TREATMENT

Many substance abuse treatment providers anecdotally report that clients who abuse methamphetamine have substantial dental disease. Recently, clinicians in dental care settings have identified what they believe to be the same phenomenon. This possibility of an identifiable link between drug use and dental disease provides dental health professionals in a primary care setting with an opportunity for early intervention and referral for substance abuse related problems. However, the details of this linkage have not been developed, and additional research is needed to verify associations and suggested interventions.

Methamphetamine is a powerfully addictive central nervous system stimulant. It is classified by the Drug Enforcement Administration as a Schedule II stimulant, indicating that is has a high potential for abuse with limited medical use. Methamphetamine use causes increased activity, decreased appetite, hypothermia and a general sense of well-being. Effects last for six to eight hours. Long term use can cause dependence and addiction psychosis, paranoia, hallucinations, mood disturbances, stroke, and weight loss, Typically, methamphetamine is a white powder that easily dissolves in water. It can be snorted, smoked, injected or taken orally. Methamphetamine (meth) abuse has increased in fact and in notoriety in the past decade, mainly due to the relationship of meth use with violence and criminal activity and due to problems providing adequate treatment for abusers.

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ADOLESCENT USE OF METHAMPHETAMINE

According to the 2003 National Survey on Drug Use and Health (NSDUH), 12.3 million Americans (5% of the population) age 12 and older had tried methamphetamine at least once in their lifetime, with the majority of users between the ages of 18 and 24.[1] Analyses of adolescent drug users comparing methamphetamine users to other drug users have identified that adolescent females and older youths

Figure 1. An example of dental caries associated with methamphetamine use.

were most likely to use methamphetamine. From 1995 to 2003, methamphetamine-related emergency room visits involving patients 6 to 17 years old increased 88% (2,338 to 4, 392). Fifty-six percent of methamphetamine-related emergency room visits in 2002 were among 18- to 34-year-olds.[2] Adolescent methamphetamine users report greater psychosocial dysfunction and higher rates of return to substance use following treatment than nonmethamphetamine users.[3] Shieh[4] identified suicidal ideation in 16% of young Taiwanese methamphetamine users, along with adjustment disorder, depressive disorder, and emotional instability. Although the rates of use among adolescents have not changed significantly between 2002 and 2004, the number who met criteria for abuse or dependence increased from 28% in 2002 to 59% in 2004.[1]

METHAMPHETAMINE AND DENTAL DISEASE

Published information on the association of methamphetamine use and dental disease is primarily descriptive, including recommendations for identification of potential substance abusers. Some research describes the difficulty of isolating the causes of dental disease among substance abusers because of the numerous unhealthy behaviors that accompany chronic substance abuse. Clinical findings identify a pattern of caries involving the buccal and interproximal surfaces of the anterior teeth (see Figure 1).[5] These patients may appear thin and malnourished and report symptoms of TMJ and myofacial pain, as well as night bruxism with severe occlusal wear. Many report a high consumption of sugared soda pop (6 or more cans per day) and minimal food intake. These patients respond poorly to preventive dental efforts and instead seek more aggressive measures such as extraction and/or pain medication. They frequently fail to show for appointments.[6]

Anecdotal information from substance abuse clinicians and patients themselves indicated a severe increase in dental disease among methamphetamine users, with patients even referring to themselves as having *crank mouth*. The paucity of scientific information investigating this phenomenon is remarkable, given the enormous economic, social, and legal impact substance abuse has on society. If dental providers can identify methamphetamine abuse through dental exams, the opportunity for early intervention with the combined possibility of better treatment outcomes for abusers clearly justifies the need for further exploration of this subject.

Methamphetamine is identified as being linked to xerostomia.[5] Since saliva is an anticariogenic solution and appears to have a protective effect against caries, any reduction in production of saliva is a concern for dental health. The amphetamine-type appetite suppressant drugs have been shown to decrease or inhibit salivary flow and, thus, contribute to the development of caries, periodontal disease, and oral candidiasis.[7,8] Therefore, this study's theoretical model becomes a deductive logic model:

1. Xerostomia is caused by the reduction in the flow rate of saliva and can lead to increased caries.
2. Methamphetamine use is linked to xerostomia.
3. Methamphetamine abusers will have more dental disease than expected for the general population and for other drug abusers.

Because many other factors, especially among substance abusing populations, are known to contribute to dental disease, these other intervening variables were included in the research model (see Figure 2).

The purpose of this research was to determine if methamphetamine users have worse dental disease than other drug users. Because no screening tool exists, one aspect of the study was the development and feasibility testing of a screening protocol for identification of methamphetamine

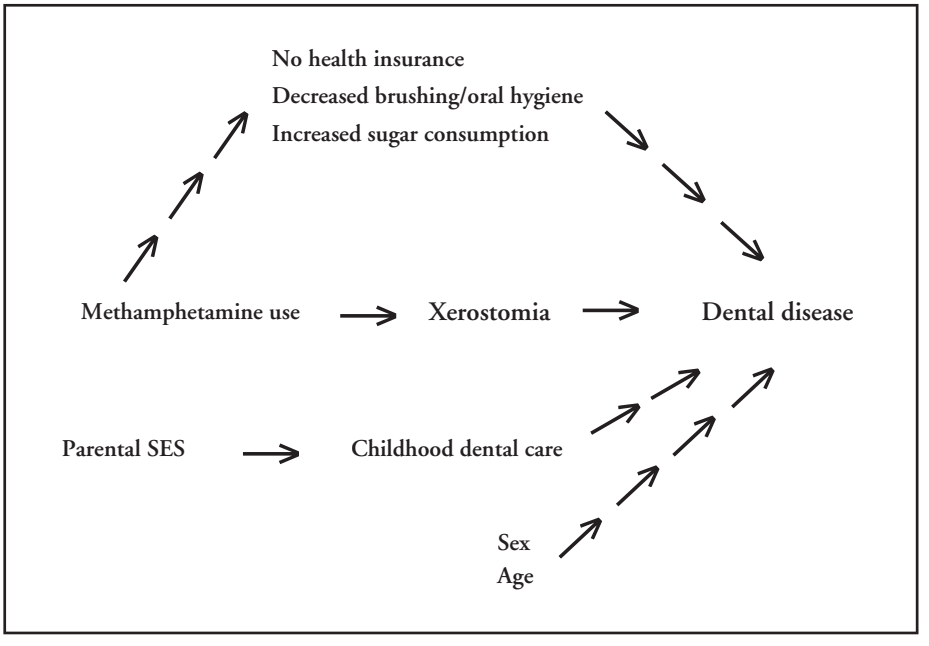

Figure 2. Research model

A. **Substance abuse:** A destructive pattern of substance use, leading to significant social, occupational, or medical impairment.

B. Must have 3 (or more) of the following, occurring when the substance use was at its worst:

1. **Substance tolerance:** Either need for markedly increased amounts of substance to achieve intoxication, or markedly diminished effect with continued use of the same amount of substance.

2. **Substance withdrawal symptoms:** Either (a) or (b).

   (a) the substance's characteristic withdrawal syndrome; or

   (b) substance (or one closely related) is taken to relieve or avoid withdrawal symptoms.

3. Substance was often taken in larger amounts or over a longer period than was intended,

4. Persistent desire or unsuccessful efforts to cut down or control substance use.

5. Great deal of time spent in using substance or recovering from effects.

6. Important social, occupational, or recreational activities given up or reduced because of substance use.

7. Substance use continues, despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been worsened by substance use (eg, continued use despite knowing that an ulcer was made worse by drinking alcohol).

Figure 3. DSM IV criteria for substance dependence.[17]

abusers in a primary health care dental clinic. This study addressed the following questions:

1. Can methamphetamine abuse be identified through a dental exam? That is, do methamphetamine abusers have quantifiably more dental disease or a specific profile of dental disease as compared to other substance abusers?
2. Do methamphetamine abusers experience more dry mouth (xerostomia) than other substance users?
3. Do differences in other factors contributing to dental disease exist between methamphetamine abusers and other substance abusers?

METHODS

PARTICIPANTS

Prior to initiation of the study, all procedures were approved by the Institutional Review Board of the University of Iowa, Iowa City, Iowa. Research participants were recruited from February 2001 through October 2002 from the Chemical Dependency Unit at the University of Iowa Hospitals and Clinics (UIHC-CDU). The UIHC-CDU was a 20-bed inpatient hospital-based treatment program that had been in existence since 1966. Approximately 25 new patients were admitted to the program monthly. Five to 10 of the monthly admissions were reported to be methamphetamine abusers. The population included adults from 18 to 79 years, and the male to female admission ratio was 3:1. Length of stay for patients ranged from 1 to 6 weeks, with an average inpatient length of stay of 2 weeks. The exclusion criterion for this study was whether patients had an active serious mental illness other than substance abuse. A total of 17 methamphetamine abusers and 18 other substance users were recruited for this study.

The original research plan was to compare these subjects with normative data from the state of Iowa. No comprehensive figures on dental health, however, have been published in the state since 1980[9], and it was felt that these would not be appropriate comparisons for subjects who were most likely exposed to fluoridated water.

A research assistant (RA) met with potential participants to explain the purpose and procedures for the study and attempt recruitment. The RA used the IRB-approved Information Summary and Consent Form to explain this study's purpose. Patients who chose to participate fell into 1 of 2 groups, based on DSM IV[10] criteria (Figure 3): (1) methamphetamine users; or (2) other substance users.

Demographic characteristics of the 2 groups are presented in Table 1. Participants were predominately male, Caucasian, and 30 to 35 years of age, although age was significantly different between the 2 groups studied. The majority in both groups had at least some access to dental care as children. Although Medicaid covered about half of each group, almost half of those in the methamphetamine group had no insurance coverage (compared with 22% of the other substance use group). Both groups had high numbers of decayed or filled teeth, were primarily tobacco

Table 1. Participant Demographic Characteristics

	Other substance users (n=18)	Meth. user (n=17)
Male: % (n)	94 (17)	82 (14)
Age: Mean±(SD)	41 (10.1)	32 (10.4)
Race: % (n)		
Caucasian	83 (15)	94 (16)
African American	17 (3)	6 (1)
Native American	0	
Insurance: % (n)		
Medicaid	50 (9)	47 (8)
Private	28 (5)	6 (1)
None	22 (4)	47 (8)
Childhood access to dental care: n (%)		
Annual	17 (13)	67 (11)
Emergency only	22 (4)	24 (4)
None	6 (1)	12 (3)
Total no. of teeth: Mean±(SD)	27 (4.1)	23 (8.4)
Total no. of filled or decayed surfaces: Mean±(SD)	17 (16.6)	17 (17.0)
Dry mouth when using: % (n)	39 (7)	77 (13)
Tobacco user: % (n)	72 (13)	82 (14)
Drinks sugared sodas when using: % (n)	17 (3)	36 (6)
Eats sweets when using: % (n)	22 (4)	29 (5)
Neglects oral hygiene when using: % (n)	33 (6)	65 (11)
Weight loss (lbs.): Mean±(SD)	23 (15.9)	27 (15.5)

users, and had experienced significant weight loss while using chemicals.

RESEARCH DESIGN

Data were collected using a cross-sectional design divided into 2 groups:

1. methamphetamine abusers,9 defined as those subjects with a positive diagnosis of methamphetamine dependence, as indicated by 3 or more positive responses to the DSM IV criteria for methamphetamine dependence screening tool (Figure 4); and
2. other drug users,9 defined as those who did not have a positive diagnosis of methamphetamine dependence as indicated by less than 3 positive responses to the screening tool. Data from the standardized drug use history interview and dental behaviors permitted exploration of other distinguishing characteristics and differences between the groups.

ASSESSMENT PROCEDURES

Patients were assessed for drug use history and other pertinent demographic and historical information, as detailed in the information summary using the Addiction Severity Index (5th ed)[11], a widely used interview schedule that has been shown to be reliable and valid among substance abusers applying for treatment.

Upon completion of this initial assessment, these subjects were provided a routine dental examination using a mirror, explorer, periodontal probe, and digital palpitation in an examination room at the UIHC-CDU. Results of the dental examination were recorded using standard documented procedures. The examiner was blinded to the medical diagnoses of patients. Participants identified as needing follow up dental care were referred to the appropriate resource. Participants also completed a 7-question survey concerning perceived dietary and dental health (Figure 5).

DATA ANALYSIS

Data were analyzed using logistic regression to evaluate whether group membership could be predicted based on number of dental caries lesions by number of teeth (Figures 6 and 7). Bivariate differences between groups were evaluated only with: (1) the Fisher exact test; (2) the Wilcoxon-Mann-Whitney test; and (3) t tests. Multivariate analyses were conducted using logistic regression. All tests were 2-tailed. SAS (version 9.1.2, 2004) was used for all statistical analyses. While the sample size was not large, this study was adequately powered for large effect sizes. This was deemed reasonable since a method to screen or detect methamphetamine abuse should exhibit a large correlation or association with the criterion. With 17 methamphetamine users and 18 users of other substances, the authors had 80% power to detect a standardized difference (Cohen's d) of 0.976 using alpha set to 0.05, 2-tailed based on a simple t test. The nonparametric tests were not appreciably less powerful and, given the distributions, may have been substantially more powerful. For the logistic regression, the authors had 80% power to detect an odds ratio of 2.61 or larger—assuming a continuous independent variable with a 1 standard deviation shift.

RESULTS

The 2 groups were compared on total number of natural teeth present and total caries lesion numbers.. For the total number of teeth, there were no significant differences between the methamphetamine users and the other substance users (Wilcoxon-Mann-Whitney test[12,13], S=301; Fisher exact test, *P*=.88). Also, there was no significant difference in the total

Please answer the following related to your methamphetamine use in a 12-month period.

1. Have you needed to use more methamphetamine over time to get high or achieve the desired effect? **Yes**___ **No**___
2. Have you noticed less of an effect with the same amounts of methamphetamine? **Yes**___ **No**___
3. Have you continued using methamphetamine to avoid the negative effects of coming down? **Yes**___ **No**___
4. Have you ever used more methamphetamine or used for a longer period of time than you originally intended? **Yes**___ **No**___
5. Have you ever thought about cutting back on your methamphetamine use or tried to cut back or control your methamphetamine use? **Yes**___ **No**___
6. Do you spend a lot time obtaining methamphetamine for your personal use? **Yes**___ **No**___
7. Have you given up important social, occupational, or recreational activities because of your methamphetamine use? (This includes important family or work activities) **Yes**___ **No**___
8. Have you ever been incarcerated or hospitalized related to your use of methamphetamine? **Yes**___ **No**____

(Staff answer only)

Number of "yes" answers _____ Meets DSM IV criteria? Yes____ No____

Figure 4. Survey instrument to identify methamphetamine dependence.

decayed and filled surfaces between groups (Wilcoxon-Mann-Whitney test[12,13], S=278.5; Fisher exact test, *P*=.37).

An overall logistic regression model was evaluated, including both number of teeth and total filled and decayed surfaces by group. This comparison yielded no significant differences between the 2 groups (overall 2 log likelihood Fisher exact test, *P*=.17). For total decayed and filled surfaces, the odds ratio was 1.02 with a 95% confidence interval (CI) of .97 to 1.06. For total number of teeth, the odds ratio was 1.12 with a 95% confidence interval of 0.98 to 1.3. This small CI range indicates that, even if there were an effect—not seen due to power—it would likely be small. Based on this sample, evidence of any relationship between group membership and caries lesion numbers could not be supported.

The researchers predicted that methamphetamine users would have significantly more xerostomia than the other drug use group and, thus, would contribute to greater dental disease. Although a greater percent of methamphetamine users experienced dry mouth when using substances than other substance users (65% vs 35%), this difference was not significant (Fisher exact test, *P*=.08).

Second, an independent sample t test revealed that age of other substance users (M=40.67±10.11 SD) differed significantly from methamphetamine users (M=32.41±10.38; t (33)=2.38, *P*=.023). Methamphetamine users were, on average, significantly younger than the comparison group. Even though the ultimate effects of methamphetamine use are not significantly different from the long-term effects of using other substances, methamphetamine users may experience accelerated consequences related to dental disease and, thus, can be detected at an earlier age.

Access to dental care as a child is crucial to adult oral health. Methamphetamine users could not be distinguished from other drug users based on the availability of dental care during childhood (Fisher exact test, *P*=.79). Since childhood access to health care is more a reflection of parental socioeconomic status (SES) than current participant SES, for this population, parental SES is a better predictor of adult dental health than is current participant SES. See Table 2 for results of univariate tests.

There is some evidence to suggest that adolescents who begin early substance use share personality characteristics—such as rebelliousness, aggression, and other disruptive behaviors—which may predispose them to this early use.[14,15] It is not certain, however, if these characteristics predate use or coincide with the onset of use. Some studies have suggested that children of alcoholics have subtle brain differences—which are markers for later development of substance use disorders—and these differences are more evident in children with behavioral traits such as sensation seeking and poor impulse control.[16,17] Certainly, some of these personality traits can contribute to a lack of self-care that would increase dental disease in later life.

A distinct weakness to this design is that the consequences of methamphetamine use can result in some of the covariates included in the regression model. For example, long-term methamphetamine use often results in job loss and, hence, loss of health insurance. Thus, the multivariate test may have been overly conservative and, instead, univariate logistic regressions would shed some light on the simple relationships. Therefore, the relationships between group membership, current health insurance, and drug use and current employment status were examined. There was no significant relationship between drug use and current insurance status (Fisher exact test, *P*=.133) or between drug use and current employment status (Fisher exact test, *P*=.46)

CONCLUSIONS

The purpose of this study was to evaluate the feasibility of using results from a standard dental examination to detect methamphetamine use. In this sample, although significant dental problems were identified, no statistically significant differences in dental disease among methamphetamine users and other drug users were detected. Thus, it is concluded that, at this time, methamphetamine users cannot be identified per

1) When using drugs, which best describes your oral hygiene (dental care) habits?

a. I brushed at least twice a day and after eating when I could.
b. I may not have brushed as regularly as I had in the past, but never fully neglected my teeth, brushing at least once a day.
c. I brushed when I thought of it, which was sometimes only once a week.
d. I discontinued regular oral hygiene.

2) When using drugs, my eating habits can best be described by which of the following?

a. Though my appetite was suppressed, I ate at least 2 healthy meals daily and much of the same food I ate before becoming a regular drug user.
b. My appetite was suppressed, and I seldom ate when using drugs.
c. Though my appetite for solid foods was suppressed, I had a great thirst.
d. I binge ate. I ate large quantities of food when hungry and nearly nothing at other times.

3) When using drugs, I drink a lot of which of the following? (Circle any that apply.)

a. Regular soft drinks or colas
b. Diet soft drinks or colas
c. Water
d. Coffee or tea with sugar
e. Coffee or tea without sugar
f. Juices
g. Milk
h. Beer
i. Wine
j. Other alcoholic drinks

4) When using drugs, I eat a lot of which of the following? (Circle any that apply.)

a. Meat, chicken, and/or fish
b. Vegetables and/or fruits
c. Sweets or sugared foods
d. Carbohydrates such as cereals, breads, and pastas
e. None of these

5) Since using drugs, what best describes your weight?

a. Remained about the same
b. Lost weight (amount _____ lbs.)
c. Gained weight (amount _____lbs.)

6) When using drugs, which best describes your saliva (spit)?

a. I have more saliva when I use drugs
b. I haven't noticed a change
c. My mouth seems dry when I use drugs

7) How would you describe your oral health? (Circle all that apply.)

a. Good
b. I have a lot of pain
c. My teeth look gross
d. My gums bleed a lot
e. My gums hurt

Figure 5. Dental-related behaviors survey instrument.

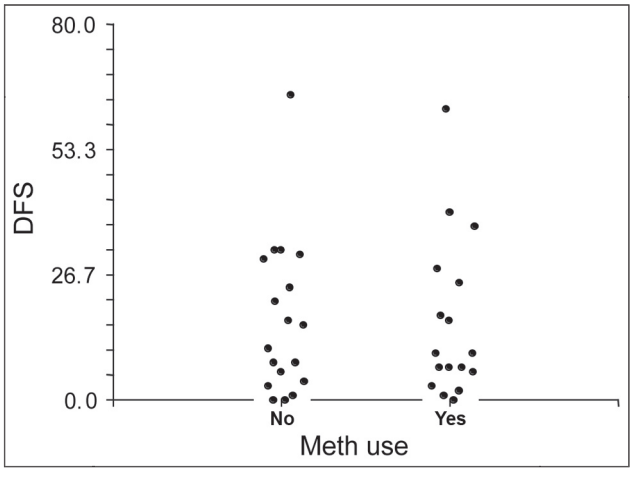

Figure 6. Methamphetamine use by total number of decayed/filled surfaces (DFS).

se through dental examinations. So what can be concluded? In theory and from clinical lore, methamphetamine abuse produces more dental disease than abuse of other substances, but these data did not support that hypothesis. This research did find, however, that substance abusers who are receiving treatment in an inpatient program have bad teeth and are disenfranchised by being uninsured and underemployed. This problem needs intervention and treatment within the health care system, because health care providers are not reaching these individuals.

The possibility of Neyman bias,[18,19] that is diminished numbers related to severe effects of chronic heavy drug use—may have an effect on these groups. Those with more severe drug use histories may be incarcerated or deceased. These consequences, however, could equally apply to both groups. Also, the time lag from risk behavior to outcome may be an issue—dentists might see an increase of caries in 10 years time.

Drug use alone is not responsible for the increased dental disease. Other factors influencing the disease process would include:

1. social and environmental conditions preceding drug use;
2. behaviors coinciding with drug use; and
3. drug side effects.

Social and environmental conditions would include:

1. socioeconomic status;
2. childhood access to dental care; and

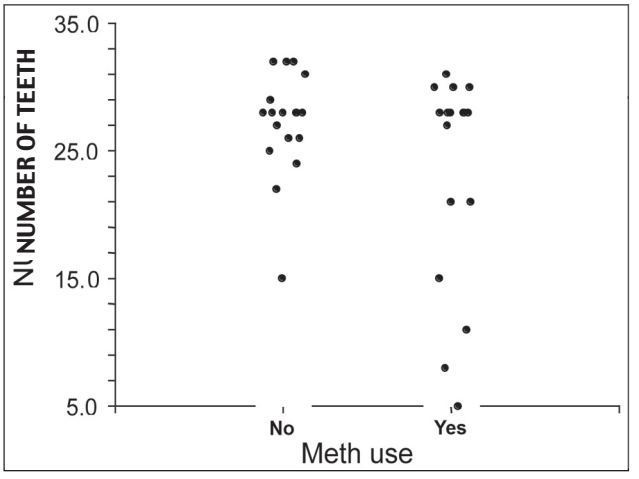

Figure 7. Methamphetamine use by total number of teeth.

3. availability of fluoridated water during childhood (was it available and was it used?).

Behaviors coinciding with drug use include: (1) increased sugar consumption; (2) decreased dental hygiene practices; (3) poor nutrition, (4) effects of smoking; and (5) lack of health insurance.

Drug side effects include:

1. xerostomia;
2. appetite suppression (contributing to poor nutritional intake);
3. teeth grinding; and
4. dehydration related to elevated metabolism and increased physical activity while under the influence.

These influencing factors were all included in the predictive research model (Figure 7) and, through this research, do appear to have an impact on overall dental health.

Previous articles related to methamphetamine use and dental disease[5,6] were descriptive in nature and did not involve data collection and analysis. Although this study identified similar characteristics between both groups, additional comparisons cannot be made due to the small sample sizes. In contrast to the clinical impressions of some research and practitioners, these data do not support the notion of an identifiable pattern of dental disease specific to methamphetamine use, as no differences in disease were noted between methamphetamine users and other substance users.

This study was limited by the selection bias, which exists in all substance abuse research when participation is on a recruitment/voluntary basis. These subjects may have:

1. been motivated by concern about excessive dental disease;
2. agreed to volunteer; and
3. represented the more seriously affected.

Also, the limited diversity (ie, few female participants and a predominately Caucasian subject group) make generalizing to larger populations questionable. These limitations need to be addressed in future research. Sample size may also be an issue. For dental disease to clearly differentiate methamphetamine abuse vs other drugs, or from poverty in general, however, implies a fairly large effect size to be considered "prognostic." This study's sample size was sufficiently powered for large effect sizes. Furthermore, the confidence intervals presented indicated that what differences might be found in larger samples will tend to be clinically insignificant.

Implications for practice derived from this research include the need for training of dental students to recognize symptoms that may be related to drug use and, thus, indicate the need for possible substance abuse intervention. Adolescent patients presenting with high levels of dental disease need to be queried for possible drug use. Health care providers in general need to:

1. ask patients about their substance use routinely;
2. collaborate with substance abuse providers for onsite evaluations; and
3. refer patients to treatment as needed.

The dental/dietary-related behaviors survey used in this research is brief and would be simple to administer as part of the initial exam. Also, pain medications should not be over-prescribed. Primary care institutions such as dental clinics are good opportunities for substance abuse intervention sites and can lead to improved use of health care providers to identify substance abuse needs and contribute to the cost effectiveness of early intervention.

Methamphetamine abuse can be addressed in 3 major ways:

Table 2. Results of Univariate Tests

Characteristic	Other substance (n=18)		Meth user (n=17)		Test statistic	df	*P*
	n	%	n	%			
Age (ys)*	40.7±10.1 SD		32.4±10.4 SD		t=2.38	33	.023
Insurance:							
Medicaid	9	50	8	47	†		.133
Private	5	28	1	6			
None	4	22	8	47			
Employment:							
Full time	7	40	4	24	†		.460
Part time	2	11	1	6			
Unemployed/ disabled	9	50	12	8			
Childhood access to dental care:							
Annual	13	17	11	65	†		.790
Emergency only	4	22	4	24			
None	1	6	2	23			
Xerostomia:							
More saliva	6	33	2	12	†		.08
Less saliva	7	39	13	77			
No change	5	38	2	12			
Tobacco user	13	72	14	82	†		.467
Sugared sodas	3	17	6	35	†		.208
Oral hygiene:							
Daily brushing	12	67	6	24	†		.177
Weekly brushing	4	11	7	41			
Discontinue all	2	50	4	24			

**** Age is only statistically significant difference in characteristic in both groups.***

† Fisher exact test.

1. For the most severe situations, treatment for methamphetamine abuse is generally preceded by action from the court or health care system after a prolonged period of use and incurrence of serious consequences, either legal or health related.
2. Early intervention strategies could include identification of drug users by primary health care providers, including dentists.
3. Various organizations (eg, schools or social services agencies) could provide universal prevention interventions for a more general audience such as public service announcements through the media.

Although treatment is needed for methamphetamine abusers, earlier intervention with users who indicate a concern for their physical health by accessing primary care providers might provide the opportunity for recruitment into treatment or initiation of an innovative program among a less seriously affected population and may produce better outcomes.

This pilot study was an initial attempt to identify the effects of methamphetamine use on dental disease. Research with a larger sample size as well as comparison group data is recommended. Research with younger populations to assess the effects of methamphetamine and other drugs on adolescent or younger users before they develop the severity of dental disease this older population experienced is also recommended. Follow-up studies on patients with a history of more diverse use would be useful as well. A brief substance abuse assessment can be included in the initial screening process of dental exams. It appears that long-term abuse of any substance may result in xerostomia that may have a negative impact on dental health. Clearly, dental care providers are in an excellent position to initiate early intervention where needed.

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