Electronic-cigarette use by individuals in treatment for substance abuse: A survey of 24 treatment centers in the United States

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HIGHLIGHTS

- E-cigarette use was examined among 1113 patients enrolled in substance abuse treatment
- 55.5% reported lifetime use of e-cigarettes, 30.5% were current users (past 30 days)
- A majority (87.1%) of current e-cigarette users also currently smoked cigarettes
- E-cigarettes used for smoking cessation and times/places when smoking was prohibited
- Dual users may be heavier smokers trying to quit or reduce their cigarette smoking

ARTICLE INFO

ABSTRACT

Prevalence and reasons for using electronic cigarettes (e-cigarettes) was examined among patients enrolled in 24 substance abuse treatment centers in the United States (N = 1113). Prevalence of e-cigarette use was assessed for the full sample. Bivariate analyses and multivariate logistic regression were used to identify characteristics associated with e-cigarette use among current cigarette smokers (the majority of e-cigarette users). Overall 55.5% of the sample reported lifetime use of e-cigarettes, and 30.5% reported using e-cigarettes in the past 30 days (current users). The main reasons for using e-cigarettes were (a) at times/places when smoking was prohibited (53.5%), and (b) as a way to quit/reduce cigarette smoking (50.3%). Daily vs non-daily e-cigarette users were more likely to use e-cigarettes both as a way to reduce health risks, and as a way to quit/reduce cigarette smoking. A majority of e-cigarette users (87.1%) reported dual use of e-cigarettes and tobacco cigarettes during the past month. Among current cigarette smokers, those that also used e-cigarettes smoked more cigarettes per day, were more likely to have made a past year cigarette quit attempt, and to have tried nicotine replacement therapy compared to cigarette only smokers. There was a high rate of dual e-cigarette and cigarette use by persons enrolled in addiction treatment. E-cigarette users may be heavier cigarette smokers trying to quit or reduce their cigarette smoking. However, e-cigarettes were also used at times when individuals could not smoke cigarettes. Substance abuse treatment centers developing tobacco policies need to consider these potentially conflicting reasons for using e-cigarettes.

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1. Introduction

A high percentage of individuals with drug and alcohol dependence smoke cigarettes (Kozlowski et al., 1986; Lai et al., 2000; Marks et al., 1997; McKee & Weinberger, 2013). Individuals with psychiatric disorders, including drug and alcohol dependence, are estimated to smoke approximately 44% of all cigarettes smoked in US (Lasser et al., 2000). Compared to the general population, smokers with substance use co-morbidities tend to be heavier smokers, score higher on measures of nicotine dependence, and have poorer smoking cessation outcomes (Burling et al., 1997; Dawson, 2000; Hughes & Kalman, 2006; John et al., 2003). Among cigarette smokers with drug or alcohol dependence, the highest smoking rates have been reported for individuals who seek treatment for substance abuse; with low estimates at 65% and higher estimates up to 90%, significantly higher than the general population (Guydish et al., 2011, 2015; Richter & Arnsten, 2006). Individuals receiving treatment for substance use disorders also have high rates of mortality from tobacco related diseases (Bandiera et al., 2015; Hurt et al., 1996). In 2013 there were 21.6 million individuals with drug and alcohol dependence in the US, with 4.1 million receiving treatment for substance abuse in the past year (SAMHSA, 2013). Further, smoking cessation has been found to have either no effect or improve treatment

outcomes for substance abuse, with little evidence that it worsens outcomes (Baca & Yahne, 2009; Kalman et al., 2010; Prochaska et al., 2004; Thurgood et al., 2016). The very high rates of smoking among those in addiction treatment, together with the declining rates in the general population, makes this population important in continued efforts to reduce tobacco use in the US.

Electronic cigarettes (e-cigarettes) remain largely unregulated in the US, though the e-cigarette market is currently estimated to be a multi-billion dollar industry and their use continues to grow (Herzog & Gerberi, 2013). There is an ongoing debate concerning the potential benefits and risks of e-cigarette use. E-cigarettes may have potential for harm reduction among tobacco smokers, but remain unproven as a smoking cessation device (Bhatnagar et al., 2014; Kalkhoran & Glantz, 2016; McRobbie et al., 2014). In this context it is important to assess both the prevalence of and reasons for e-cigarette use in among individuals in treatment for substance abuse, a population that has been identified as vulnerable for tobacco use. This research may help to inform future product regulation regarding use of e-cigarettes by vulnerable populations and provide a better understanding of how and why e-cigarettes are being used.

This study was designed to: (1) assess the prevalence of e-cigarette use in a national sample of persons enrolled in substance abuse treatment; (2) assess reasons for e-cigarette use; and (3) to compare demographic and smoking characteristic of cigarette only smokers vs dual users (cigarette smokers who also use e-cigarettes).

2. Methods

2.1. Participants and recruitment procedure

The sample consisted of 1113 participants recruited from 24 substance abuse treatment centers (10 residential, 7 methadone maintenance, and 7 outpatient clinics) affiliated with the NIDA Clinical Trials Network (CTN). All sites had at least 60 active patients and the number of participants recruited per clinic ranged from 28 to 53, with a median of 50. Directors from each clinic were asked about the size of active number of patients. Our survey sampled 1113 individuals from a total estimated population of 6801 total participants. A detailed description of the criterion and selection of clinic sites is reported in Guydish et al. (in press). Because each drug and alcohol treatment center has unique characteristics, and there are a number of obstacles to surveying this population, the goal of this study was to survey a large sample of individuals in the United States currently in treatment for substance abuse from a range of clinic types and geographic locations. The clinics sampled were selected to be representative of drug treatment centers in the NIDA CTN within the United States, however, data was collected as a convenience sample within each clinic site, and for this reason the sample may not necessarily be a nationally representative. All clients at each center (regardless of smoking status) were eligible to participate in the survey as long as they were physically present the day of the site visit and had been in treatment at that center for at least 10 days. All participants provided informed consent and completed the survey. The number recruited per clinic ranged from 28 to 53, and each participant received a $20.00 gift card. Each treatment program received a $2000 program incentive following the site visit. All procedures were approved by the Institutional Review Board of the University of California, San Francisco.

2.2. Procedure & measures

Surveys were prepared using Qualtrics software and self-administered during an onsite visit (between May 2014 and February 2015) at each clinic using iPads linked to a secure university server where data were stored.

Survey items used in the current analysis included questions assessing demographic information (age, gender, race/ethnicity, and education), and primary drug for which the client sought treatment.

Based on the distribution among participants, the racial groups used in the current analyses were African American/Black, White, or other race. Being Hispanic or Latino was assessed with a separate question. Individuals were characterized as current, former, or never cigarette smokers. Current smoking status was defined as persons who reported smoking at least 100 cigarettes during their lifetime and reported currently smoking cigarettes. Current smokers reported the number of cigarettes smoked per day (CPD), time to first cigarette after waking (TTFC), number of past year serious quit attempts (lasting at least 24 h), and use of smoking cessation products. Having a past year serious quit attempt, and ever use of nicotine replacement therapy (NRT) were analyzed as dichotomous variables (yes/no). Readiness to quit smoking cigarettes was assessed by categorizing participants into one of three pre-action stages of change based on Prochaska & DiClemente (1983): (a) Precontemplation – no intention to quit smoking within the next 6 months, (b) Contemplation – intention to quit smoking within the next sixth months, and (c) Preparation – intention to quit within the next 30 days.

All participants were asked to report lifetime use of e-cigarettes. Those reporting lifetime e-cigarette use were then asked whether they had used e-cigarettes in the past 30 days (characterized as current users). Those reporting past 30-day e-cigarette use were then asked about frequency of use (daily, weekly, or < weekly). Participants also reported reasons for using e-cigarettes with the following response options: (1) at times you cannot smoke, (2) as a way to reduce health risks, (3) as a tool to reduce or quit smoking, or (4) for a "different" reason; individuals were instructed to select all that apply.

2.3. Data analysis

Overall cigarette and e-cigarette prevalence data were analyzed for the full sample. Bivariate analyses were used to compare dual users (current cigarette smokers who used e-cigarettes in the past 30 days) versus cigarette only smokers for demographic variables and tobacco use characteristics. Significant differences between daily and non-daily e-cigarette users have been reported (Hitchman et al., 2015), and reasons for using e-cigarettes were also compared between these two groups. T-tests were used for continuous variables, and Pearson's chi-square tests for categorical variables. Next, we conducted an exploratory analysis, such that variables associated with the outcome (dual users vs. cigarette only users) at p < 0.10 were then included in a multivariate logistic regression, to estimate the association of each predictor controlling for key demographic variables (Bursac et al., 2008). The p < 0.10 level for the multivariate logistic regression model was used to avoid missing variables that might be associated with the outcome by being too strict, as recommended by Hosmer and Lemeshow (2000). The predictors identified thought the bivariate analyses and included in the regression model were primary drug, smoking days/week, average cigarettes per day, past year cigarette quit attempts, and ever use of nicotine replacement therapy. Two additional variables (stage of change, and weeks in current treatment program) were included in the model to control for readiness to quit smoking and treatment duration. The demographic variables included in the regression model were age, sex, and ethnicity. Because primary drug for which patients were in treatment was related to type of treatment clinic (i.e. methadone, outpatient, residential), primary drug but not clinic type was used in the analyses. Associations were considered significant at an alpha level of 0.05 or less. Means are presented ± standard deviation (SD). All statistical analyses were performed using SPSS 22 (IBM Corporation, Armonk, NY, USA).

3. Results

3.1. Demographics characteristics

A detailed breakdown of the demographic and descriptive statistics of the full sample are reported in Guydish et al. (in press). The sample

was 50.2% male with an average age of 38.3 ± 11.7 years. Participants were primarily White (62.8%) or African American (20.5%), and a majority were non-Hispanic (88.1%). Education level was mixed with 24.3% with less than a high school education, 63.9% with a high school degree or GED equivalent, and 11.8% with a college degree. Individuals reported that the primary drug or which they sought treatment was 46% for opiates/analgesics, 21% for stimulants, 20% for alcohol, 7% for marijuana, and 7% for other drugs.

3.2. Prevalence of cigarette and e-cigarette use

Most participants (77.8%) were current cigarette smokers, 14.3% were former cigarette smokers, and 7.8% were never cigarette smokers.

Over half (55.5%) of all participants had used an e-cigarette in their lifetime, with 30.5% reporting current e-cigarette use (within the past month). Among current e-cigarette users (n = 340), 87.1% were current cigarette smokers, 12.4% were former cigarette smokers, and 0.6% were never cigarette smokers. Also among current e-cigarette users, 27.9% used e-cigarettes daily, 30.0% used e-cigarettes weekly, and 42.1% used e-cigarettes less than once a week in the past month.

3.3. E-cigarette use among current cigarette smokers

Univariate comparisons between cigarette only smokers and dual users (cigarettes and e-cigarettes) are presented in Table 1 (a subset the full sample, N = 867). Dual users were more likely to be younger, women, and White, smoked more cigarettes per day than cigarette only smokers, were more likely to have made a cigarette quit attempt in the past year lasting at least 24 h, and report any lifetime use of NRT. E-cigarette users were also more likely than cigarette only smokers to report opiates as the primary drug for which they sought treatment. No significant difference between the groups were found for being Hispanic/Latino, education level, smoking days/week, time to first cigarette (a measure of dependence), or readiness to quit cigarette smoking.

A logistic regression model (Table 2), including variables from Table 1 with a p-value < 0.10 found similar results for factors associated with e-cig use among cigarette smokers. The model found that being of younger age (AOR = 0.95, p < 0.001), White (AOR = 1.78, p = 0.02), smoking more CPD (AOR = 1.03, p = 0.01), having made a serious tobacco quit attempt in the past year (AOR = 1.68, p = 0.002), and lifetime use of NRT (AOR = 1.53, p = 0.007) were all predictive of dual use of cigarettes and e-cigarettes in the past month. However there were two differences from the bivariate analyses. Controlling for all other variables, primary drug of choice and gender were no longer significantly associated with dual use.

3.4. Reasons for using e-cigarettes and comparison of daily and non-daily e-cigarette users

In the survey, participants reported reasons for using e-cigarettes, allowing for the selection of multiple response options. Among all current e-cigarette users, the two most frequent reasons for using e-cigarettes were (1) at times when the respondent could not smoke cigarettes (53.5%), and (2) as a way to reduce or quit cigarette smoking (50.3%). A lower percent reported using e-cigarettes as a way to reduce health concerns about tobacco smoking (33.5%), or "for a different reason" (27.9%).

Reasons for using e-cigarettes were also compared between daily (N = 95) and non-daily (N = 244) e-cigarette users. Daily e-cigarette users were more likely to report using e-cigarettes as a way to reduce the health risks of tobacco smoking (53.7% vs 25.8%, χ^2 = 23.79, p < 0.001), and as a way to quit or reduce cigarette smoking (66.3% vs 44.3%, χ^2 = 13.30, p < 0.01) compared to non-daily e-cigarette users. There were no significant differences between daily and non-daily e-cigarette users for using e-cigarettes "at times when you can't smoke cigarettes", or in choice of the response option "for a different reason".

4. Discussion

One of the goals of this study was to determine the prevalence of e-cigarette use in a national sample of persons enrolled in substance abuse treatment. Over half (55.5%) of the participants had tried e-cigarettes, and 30.5% had used e-cigarettes within the month. In 2014, 12.6% of U.S. adults had ever tried an e-cigarette with 3.2% reporting current use; with higher rate among current cigarettes smokers (47.6% reporting ever use, 22.0% reporting current use; Schoenborn & Gindi, 2015). A high prevalence of e-cigarette use among individuals in substance abuse treatment is consistent with two studies in similar but localized populations: opiate dependent smokers in Fall River, Massachusetts (73% lifetime, 34% current use; Stein et al., 2015); and individuals in outpatient substance abuse treatment in Baltimore, Maryland (58% lifetime, 17% current; Peters et al., 2015). Together, these results indicate that individuals in treatment for substance abuse, a population with a high prevalence of cigarette smoking, may be more likely to try e-cigarettes compared to the general population. However, all studies indicate a large number of people who report lifetime use of e-cigarettes are not current users, highlighting the need for longitudinal data on use of e-cigarettes.

For current e-cigarette users the most common reasons for use were (a) as a way to quit or reduce cigarette smoking, and (b) at times and places when tobacco cigarette smoking is prohibited. This was significantly higher than the percentage that reported using e-cigarettes as a way to reduce health risks. A large proportion also reported e-cigarette use "for another reason" suggesting that our response options did not capture all the reasons why individuals were using e-cigarettes. Curiosity, not assessed in the present study, may be a large reason for e-cigarette experimentation and use (Kong et al., 2015; Stein et al., 2015). Future research on e-cigarettes should include additional response options to more fully characterize the reasons for using e-cigarette among in this population.

Among individuals in substance abuse treatment, daily (versus non-daily) e-cigarette users were more likely to report using e-cigarettes as a way to reduce health risks and to quit or reduce tobacco cigarette use. There was no difference between daily and non-daily e-cigarette users for the use of e-cigarettes at times when the respondent could not smoke cigarettes or in using e-cigarettes for "other reasons". Daily and non-daily users may use e-cigarettes for different reasons. It has previously been reported that there may be differences between daily and non-daily e-cigarette users in regard to smoking cessation (Hitchman et al., 2015; Brose et al., 2015), and this warrants further evaluation among individuals in treatment for substance abuse. While the current study did not directly examine the effects of smoking cessation on substance abuse treatment outcomes, three recent reviews have concluded that cessation while in addiction treatment has either no effect or can improve substance abuse treatment outcomes (see Baca & Yahne, 2009; Kalman et al., 2010; Prochaska et al., 2004; Thurgood et al., 2016)".

A majority (87.1%) of e-cigarette users in substance abuse treatment were found to be current cigarette smokers. There were significant differences between cigarette only smokers and dual users (cigarettes and e-cigarettes). Contrary to our expectation, dual users were found to smoke more cigarettes per day. One potential explanation is that e-cigarette users (who also smoke cigarettes) may be heavier smokers who are trying to quit or reduce their use of tobacco. Supporting this explanation, dual e-cigarette and cigarette users in substance abuse treatment smoked more cigarettes per day, were more likely to have tried nicotine replacement therapy in the past, and to have made a serious cigarette quit attempt in the past year compared to cigarette only smokers. This is consistent with data from non-substance abuse treatment populations that found e-cigarette use was associated with daily cigarette smoking, higher nicotine dependence, and past year tobacco quit attempts (McMillen et al., 2014; Pulvers et al., 2015; Rutten et al., 2015).

Table 1
Sample characteristics of cigarette only smokers versus dual users (cigarettes plus e-cigarettes).

Variable	Cigarettes only (N = 571)	Duals users (N = 296)	Total (N = 867)	χ^2/t	p
Age, M ± SD	39.7 ± 11.7	34.2 ± 10.1	37.9 ± 11.5	6.86	<**0.001**
Sex, % female	45.6%	56.8%	49.6%	9.28	**0.002**
Hispanic or Latino (% yes)	11.8%	9.8%	11.1%	0.76	0.43
Ethnicity, %				29.11	<**0.001**
White	58.4%	76.7%	64.7%		
African American/Black	23.7%	11.8%	19.6%		
Other	17.9%	11.5%	15.7%		
Education, %				0.42	0.81
< High school (HS)	26.3%	24.3%	25.6%		
HS or GED equivalent	63.9%	65.2%	64.4%		
College degree	9.8%	10.5%	10.0%		
Primary drug, %				10.54	**0.03**
Alcohol	18.2%	13.2%	16.5%		
Stimulants	21.2%	22.0%	21.5%		
Opiates	46.8%	55.9%	49.9%		
Cannabis	6.7%	4.7%	6.0%		
Other	7.2%	4.1%	6.1%		
Weeks in current program, M ± SD	63.9 ± 139.2	50.3 ± 101.5	59.3 ± 127.7	1.49	0.14
Cigarettes per day (CPD), M ± SD	12.6 ± 7.6	14.0 ± 8.6	13.1 ± 8.0	−2.53	**0.01**
Smoking days/week, M ± SD	6.6 ± 1.2	6.8 ± 1.0	6.7 ± 1.1	−1.84	0.07
Time to first cigarette, %				3.11	0.37
Within 5 min of waking	35.0%	39.9%	36.7%		
6–30 min of waking	43.4%	37.8%	41.5%		
31–60 min of waking	11.7%	11.1%	11.5%		
After 60 min of waking	9.8%	11.1%	10.3%		
Readiness to quit smoking cigarettes				3.41	0.18
Preparation	26.5%	30.4%	27.8%		
Contemplation	37.0%	39.2%	37.8%		
Precontemplation	36.5%	30.4%	34.4%		
Past year cigarette quit attempt, % yes	42.9%	51.4%	45.8%	5.60	**0.02**
Ever use of NRT, % yes	45.4%	56.4%	49.1%	9.54	**0.002**

Dual users were current cigarette smokers who used E-cigarettes in the past 30 days. M = mean; SD = standard deviation.

Results from the logistic regression model suggests that among cigarette smokers in addiction treatment, e-cigarette use may be associated with being of younger age and being White. This is consistent with what has been previously published reported for among adults in the US (McMillen et al., 2014). Being of younger age was previously found to be associated with e-cigarette use among individuals in outpatient substance abuse treatment in Baltimore, Maryland (Peters et al., 2015). Our study confirms this using a national sample and suggests that younger individuals enrolled in substance abuse treatment may be more likely to try e-cigarettes. Peters et al. (2015) found that being White was not associated with e-cigarette use, although, the coding of race in the regression models could have contributed to differences between our studies. The Peters et al., 2015 also had a higher overall sampling of African Americans compared to our study (26.0% vs 19.6%). However, while there was not a significant differences found in prevalence of E-cigarette use in the Peters et al., 2015 study for race, ever use of e-cigarettes was higher in Whites vs. African Americans, which is consistent with our results.

In the bivariate analyses gender and primary drug were significantly different between dual users and cigarette only smokers, however, these factors were not found to be significant in the logistic regression model. On average white women in our sample were younger than

white men (39.7 vs. 35.1 years old) and those in treatment for opiates were younger than individuals in treatment for alcohol (36.7 vs. 42.0 years old). For this reason in the regression model, age was a significant predictor of e-cigarette use among current cigarette smokers but gender and primary drug was not.

One limitation of the current study is it remains unclear whether e-cigarette users who were former cigarette smokers (12.2% of all e-cigarette users) had quit cigarettes using e-cigarettes or re-initiated nicotine use with e-cigarettes. These have different implications and future studies regarding e-cigarettes should seek to clarify this relationship. Another limitation of the current study is that e-cigarettes are a rapidly evolving product with multiple different device types. Different e-cigarette device types have been found to be more or less effective at delivering nicotine (Lopez & Eissenberg, 2015; Pagano et al., 2015) and going forward it will be important to determine which e-cigarette device types are being used. A third limitation is the cross-sectional design, in which changes in cigarette or e-cigarette use could not be assessed. There remains a need for data that addresses the efficacy of e-cigarette for smoking cessation among individuals in treatment for substance abuse as this was found to be a large reason for their use. The high rate of dual use highlights the need to evaluate the health consequences of smoking cigarettes and using e-cigarettes together. Lastly, the clinics

Table 2
Logistic regression analyses of characteristics associated with E-cigarette use among current cigarettes smokers.

Variable	AOR	95% CI	p value
Age	0.95	0.94, 0.97	<**0.001**[*]
Sex			
Male (ref)	–	–	–
Female	1.27	0.93, 1.75	0.14
Ethnicity			
African American/Black (ref)	–	–	–
White	1.78	1.10, 2.86	**0.02**[*]
Other	0.97	0.54, 1.72	0.91
Primary drug,			
Alcohol (ref)	–	–	–
Stimulants	1.52	0.57, 2.78	0.11
Opiates	1.22	0.91, 4.10	0.39
Cannabis	0.85	0.76, 3.25	0.69
Other	0.79	0.42, 2.68	0.55
Weeks in current program	1.00	1.00, 1.00	0.53
Cigarettes per day (CPD)	1.03	1.01, 1.05	**0.01**[*]
Smoking days/week	1.05	0.90, 1.23	1.23
Readiness to quit smoking cigarettes			
Preparation (ref)	–	–	–
Precontemplation	0.85	0.58, 1.24	0.40
Contemplation	0.69	0.46, 1.05	0.08
Past year cigarette quit attempt			
No (ref)	–	–	–
Yes	1.68	1.20, 2.34	**0.002**[*]
Ever use of NRT			
No (ref)	–	–	–
Yes	1.53	1.12, 2.08	**0.007**[*]

Logistic regression model. Ref = reference category, AOR = adjusted odds ratio, CI = confidence interval.

[*] $p < 0.05$.

were selected to be representative of drug treatment centers in the NIDA CTN but within each clinic site, data was collected as a convenience sample. Methadone clinics were one of the three treatment programs surveyed in our study. For this reason, there was a higher prevalence of individuals reporting opiates and reduced prevalence of alcohol as the primary drug for which treatment was received compared to other surveys among individuals in treatment for drug and alcohol dependence (CBHSQ, 2015). Distribution of race and ethnicity was similar to what was reported in the Substance Abuse and Mental Health Services Administration (SAMHSA), Treatment Episode Data Set (TEDS), though our study had a higher prevalence of women (49.6% vs. 35.9%; CBHSQ, 2015). Methadone programs were over-represented in our sample, as 7 of the 24 programs were methadone programs. For this reason, there was a higher prevalence of individuals reporting opiates and reduced prevalence of alcohol as the primary drug for which treatment was received compared to other surveys among individuals in treatment for drug and alcohol dependence (CBHSQ, 2015). For this reason, the sample may not necessarily be a nationally representative. Despite this limitation, there are a number of challenges to sampling individuals within active drug treatment and the current survey design allowed for data collection for a large of individuals currently in substance abuse treatment.

Most participants were current cigarette smokers (77.8% of all participants sampled). These results are consistent with previously published reports of a high prevalence of cigarette smoking among individuals in treatment for drug and alcohol dependence (Guydish et al., 2011, 2015). This population represents an important target for

future smoking cessation interventions due to the high rates of smoking and poor smoking cessation outcomes. E-cigarettes were used both as a way to quit or reduce cigarette smoking and at times when individuals could not smoke cigarettes. This suggests that while e-cigarettes were being used for smoking cessation, they were also being used in combination with tobacco cigarettes and possibly to get around smoking restrictions, which could potentially undermine smoking cessation efforts in this population. As more substance abuse treatment centers in the US adopt smoke free policies to promote smoking cessation, it will be important that treatment centers develop policies regarding e-cigarette use that address these potentially conflicting reasons for use. This highlights the complexity of the e-cigarette debate and the need for more research regarding the efficacy of e-cigarettes for smoking cessation. There is also a need for the dissemination of accurate information to both staff and clients at substance abuse treatment programs regarding what is known and remains unknown about e-cigarettes.

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