



Appeal of electronic cigarettes in smokers with serious mental illness☆☆☆☆



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HIGHLIGHTS

- Electronic cigarettes may be appealing to chronic smokers with serious mental illness.
- Participants reduced use of combustible cigarettes when given e-cigarettes.
- Carbon monoxide levels decreased when people were given e-cigarettes for 4 weeks.

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ABSTRACT

Introduction: Up to 75% of people with serious mental illness (SMI) smoke, and most are highly dependent on nicotine, consuming more cigarettes per day than smokers without mental illness. Even with evidence-based treatment, relapses are common, resulting in high morbidity and early mortality from tobacco-related diseases. Electronic cigarettes (e-cigarettes) are theoretically safer because they deliver no tar or carbon monoxide; however, their appeal is largely untested in people with SMI.

Methods: We enrolled 21 chronic smokers with SMI who had failed a quit attempt and were not engaged in cessation treatment. Research staff provided e-cigarettes and instructions on how to use them, and assessed participants weekly for 4 weeks.

Results: Of the enrolled participants, 19 completed weekly assessments. From baseline to the final study visit, mean self-reported use of combustible tobacco declined from 192 to 67 cigarettes/week ($t = 3.62$, $df = 17$, $p = 0.005$), confirmed by reduction in breath carbon monoxide from 27 ppm to 15 ppm ($t = 3.246$, $df = 18$, $p = 0.004$). Use of e-cigarettes did not escalate over the 4 weeks. Temporary and mild side effects, including dry/sore throat, nausea, dizziness, and cough, were reported by 58% of participants. End of trial ratings of enjoyment, satisfaction compared to regular cigarettes, and willingness to buy e-cigarettes were high (ranging from 3.82–4.51 on a 5-point scale).

Conclusions: Results of this study suggest that people with SMI may find e-cigarettes an appealing substitute for combustible cigarettes. We found no evidence of increasing nicotine dependence. Further randomized studies are needed to better assess e-cigarette appeal and toxicity.

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1. Introduction

Despite the health risks of smoking, people with serious mental illness (SMI), including schizophrenia and bipolar disorder, are more likely to start and are less able to permanently quit (Glasheen, Hedden,

Forman-Hoffman, & Colpe, 2014; Lasser et al., 2000; McClave, McKnight-Eily, Davis, & Dube, 2010). Although the smoking rate in the general population has steadily declined over the past several decades, rates of smoking have remained high for people with SMI (de Leon & Diaz, 2005; Kalman, Morissette, & George, 2005). Lifetime smoking rates among people with SMI are estimated to be 50–85%, similar to rates in the general population in 1965 (Escobedo & Peddicord, 1996). High rates of smoking are associated with poor health outcomes (Birkenaes, Opjordsmoen, Brunborg, et al., 2007; DH, Correll, Bobes, et al., 2011; Sokal, Messias, Dickerson, et al., 2004) and dramatic early mortality – people with SMI die up to 30 years earlier than the general population (Colton & Manderscheid, 2006).

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The main addictive component in tobacco, nicotine, has limited toxicity in the amount delivered by cigarettes (Benowitz, 2008) and is now available in a novel group of products, electronic cigarettes (e-cigarettes). E-cigarettes use an electronic filament to aerosolize nicotine (dissolved in propylene glycol or other liquid) and deliver it to the oral and pulmonary mucosa, where it is absorbed into the bloodstream. The e-cigarette may be an appealing noncombustible product for health-conscious smokers because it not only delivers nicotine but also mimics the hand-to-mouth behavioral component of smoking.

Since the product's introduction by a Chinese pharmacist in 2003, electronic cigarettes (e-cigarettes) have seen a meteoric rise unparalleled by any other non-combustible nicotine delivery system (Ayers, Ribisl, & Brownstein, 2011; Foulds, Veldheer, & Berg, 2011). E-cigarette use surged from 2.7% of Americans in 2010 (Regan, Promoff, Dube, & Arrazola, 2013) to 8.1% in 2012 (Zhu et al., 2013). A higher number, 32.2%, of current smokers report having tried e-cigarettes. A separate analysis of the same 2012 survey data revealed that people who reported ever having experienced mental health symptoms, compared with those who had not experienced mental health symptoms, were more likely to have ever-used an e-cigarettes (14.8% v. 6.6%) (Cummins, Zhu, Tedeschi, Gamst, & Myers, 2014). Among regular smokers who responded to this survey, 40.3% of those with mental health symptoms had tried e-cigarettes versus 28.7% of smokers without mental health symptoms. A recent study of smokers with SMI who were enrolled in a cessation treatment study reported increasing e-cigarette use over five years; with 25% of those who enrolled in 2013 reporting ever having ever tried e-cigarettes (Prochaska & Grana, 2014). Because this study did not include a direct question about use of e-cigarettes (use was reported in an open-ended item on "all forms of tobacco use"), this may under-estimate actual use.

Although only a minority of e-cigarette devices has undergone testing, the weight of the existing evidence from chemical, toxicological and clinical studies designed to evaluate the safety of e-cigarettes suggests that using e-cigarettes may result in significant reduction in harm compared to continued use of tobacco cigarettes (Farsalinos & Polosa, 2014). Several laboratory studies of e-cigarettes have shown that levels of toxins in vapor were non-detectable or very low (Farsalinos & Polosa, 2014; Cahn & Siegel, 2011; Goniewicz, Knysak, Gawron, et al., 2014; Rabinowitz, 2014; Westenberger, 2009). The FDA evaluated e-cigarette vapor for harmful compounds, including carcinogenic tobacco specific nitrosamines (TSNA) (Westenberger, 2009), finding that the maximum level of TSNA in e-cigarette vapor was 8.2 ng/g, similar to the level in a nicotine patch (8.0 ng/g) and vastly less than the level in Marlboro cigarette smoke (6260 ng/g). The FDA also found no detectable levels of diethylene glycol, a toxin used in tobacco processing. In some recently tested brands, e-cigarette vapor contained low levels of carcinogens similar to or less than those found in commonly used nicotine replacement inhalers (Goniewicz et al., 2014). Other studies have demonstrated that e-cigarette vapor did not have any inflammatory effect on complete blood count indices (Flouris, Poulaniti, Chorti, et al., 2012), had no negative effects on myocardial function (Farsalinos, Tsiapras, Kyrzopoulos, Savvopoulou, & Voudris, 2014a), and did not cause significant reduction in lung function (3% reduction FEV1/FVC) compared to cigarette smoke (7% reduction FEV1/FVC) (Flouris, Chorti, Poulaniti, et al., 2013). Finally, the amount of nicotine absorbed by second generation e-cigarette users is lower than or similar to levels absorbed by smokers or nicotine replacement therapy users, and addiction testing suggested low liability (Vansickel, Weaver, & Eissenberg, 2012). However, e-cigarettes using high voltage batteries may be less safe (Jensen, Luo, Pankow, Strongin, & Peyton, 2015), there are some case reports of toxic effects on the lungs (Hureaux, Drouet, & Urban, 2014; McCauley, Markin, & Hosmer, 2012), and third generation e-cigarettes may have higher addiction liability (Farsalinos et al., 2014b) and other safety problems. Further, vaporized flavors added to 'e-juice' may be harmful (Barrington-Trimis, Samet, & McConnell, 2014). In sum, the initial laboratory research that has focused on first and second

generation e-cigarettes suggests that substituting e-cigarettes for combustible tobacco in smokers who have been unable to quit may reduce harm because of a reduction in overall toxin exposure.

Whether e-cigarettes are appealing to smokers, particularly those who are unable to or unwilling to quit smoking, is not yet clear, and whether e-cigarettes will lead to worsened addiction in these smokers is also unknown. In a single published study of e-cigarettes in smokers with SMI, two of 14 smokers with schizophrenia stopped smoking completely and half reduced smoking by 50% (Caponnetto, Auditore, Russo, Cappello, & Polosa, 2013). Although this very small study suggested that smokers with schizophrenia may find e-cigarettes appealing, more data is needed to determine the appeal of e-cigarettes and whether they can lead to a net reduction in harm among highly addicted smokers, such as those with SMI. We conducted a pilot study of behavioral appeal and addiction liability of e-cigarettes in this group. We hypothesized that smokers with SMI would find e-cigarettes appealing as measured behaviorally by replacing their usual combustible tobacco with electronic cigarettes, without escalation in use.

2. Methods

We assessed the appeal of e-cigarettes over 4 weeks among smokers with a schizophrenia spectrum disorder or bipolar disorder. Between October 2013 and June 2014, we enrolled 21 consenting participants who were psychiatrically stable in mental health treatment at a New England community mental health center. Participants were recruited through self-referral and clinician referrals, and were paid \$10 each for baseline and weekly study visits. Informed consent and all study procedures were approved by the Dartmouth College and New Hampshire Department of Health and Human Services Committees for the Protection of Human Subjects.

2.1. Participants

Eligible individuals met the following inclusion criteria: age ≥ 18 ; primary DSM-IV axis I diagnosis, based on chart review and confirmation by the community mental health center team psychiatrist, of schizophrenia, schizoaffective disorder, or bipolar disorder; SMI defined by at least moderate impairment in multiple domains of life functioning due to mental illness, smoking at least 10 cigarettes per day, history of failed treatment-facilitated quit attempts, and voluntary informed consent for participation. Exclusion criteria were: current use of e-cigarettes, medical instability; and primary diagnosis of dementia or significant cognitive impairment defined as a Mini Mental Status Examination (Folstein, Folstein, & McHugh, 1975) (MMSE) score < 24 .

2.2. Procedures

After obtaining informed consent from participants, trained research interviewers administered a baseline assessment, including all study measures. They instructed participants on the proper use of e-cigarettes, and provided a supply of 2nd generation e-cigarettes (N-JOY brand) based on each participant's level of use of combustible tobacco. Each e-cigarette cartridge was approximately equivalent to two packs of combustible cigarettes. Participants returned for 4 weekly study visits to evaluate smoking behavior, breath carbon monoxide (CO) level, and possible side effects, and to return used cartridges and receive a new supply of e-cigarettes.

2.3. Measures

At each visit we used a one-week Timeline Follow-Back Questionnaire (Brown et al., 1998; Sobell & Sobell, 1992) to document use of tobacco products each day in the prior week. We administered the Fagerström Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) to assess dependence on cigarettes. We

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