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An Introduction to the Electronic Waterpipe

Andrea M. Stroup^{a,b} and Steven A. Branstetter^{a,c}

^aPennsylvania State University, Department of Biobehavioral Health, 219 Biobehavioral Health Building, Penn State University, University Park, PA 16802, USA

^bAndrea M. Stroup, ams5818@psu.edu

^cSteven A. Branstetter, Corresponding Author, sab57@psu.edu

Abstract

Despite the associated negative health outcomes, waterpipe smoking remains a popular method of tobacco consumption, specifically in young adults. While there have been expanding efforts to decrease waterpipe use, there is a new, non-combustible waterpipe device on the market, the electronic waterpipe (e-waterpipe), that could serve as an alternative to traditional, combustible waterpipe smoking. There is currently no known literature evaluating the ewaterpipe including prevalence of use or its health risks. This mini review defines the ewaterpipe, explains how an e-head is used to construct an e-waterpipe, and describes the various e-head models available for use. The review also discusses implications of e-head use and provides recommendations for future research and regulation.

Keywords

e-head; e-bowl; waterpipe; e-waterpipe; electronic nicotine delivery system; hookah

1. Introduction

Waterpipe smoking remains a national research priority as the prevalence of use continues to increase in the US (U. S. Department of Health and Human Services [DHHS], 2017). National estimates suggest that more than one in ten adults have used a traditional, combustible waterpipe (Weaver et al., 2016). Nearly 10 million adults in the US currently smoke traditional waterpipe (TWP) and 1.4 million use every day or some days (Hu et al., 2016). Emerging adults aged 18–24 report the highest rates of TWP smoking (Hu et al., 2016). In the U.S., approximately 12.2% of young adults and 10% of college students report

Contributors

Andrea Stroup conducted literature searches, provided summaries of previous research studies and wrote the first draft of the manuscript. Steven Branstetter made edits throughout the draft. All authors contributed to and have approved the final manuscript.

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Conflict of Interest

Andrea Stroup reports no conflicts of interest.

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past-year TWP use (Schulenberg et al., 2018). Despite the high rates of TWP use, there are health risks that can negatively impact overall health.

TWP smoking has been associated with cancer (American Lung Association [ALA], 2011), oral infections (ALA, 2011), and respiratory diseases (Akl et al., 2010). Previous literature has shown that during a one-hour TWP smoking session, an individual may inhale as much smoke as consuming 100 cigarettes (ALA, 2007). In addition, users are exposed to toxic substances that are shown to increase the risk of developing clogged arteries and heart disease later in life (ALA, 2007; Cobb, Sahmarani, Eissenberg, & Shihadeh, 2012; Eissenberg, Ward, Smith-Simone, & Maziak, 2008). Salivary cotinine levels, reflecting nicotine exposure, are strongly and positively correlated with TWP use, suggesting a risk of addiction associated with TWP smoking (Nosratzahi, Arbabi-Kalati, Alijani, & Tajdari, 2015). Also, scores reported on the Lebanese Waterpipe Dependence Scale (LWDS-11; Salameh, Waked, & Aoun, 2008), a validated waterpipe-specific nicotine dependence measure, have been associated with frequency of use and exposure to carbon monoxide (CO) and nicotine (Aboaziza & Eissenberg, 2015; Alzoubi et al., 2013; Kassim, Al-Bakri, Al'Absi, & Croucher, 2014). Although there are known health risks associated with smoking TWP, the prevalence of use continues to increase in the U.S. (Hu et al., 2016).

Because of the known addiction and health risks associated with TWP use, there have been increased efforts to prevent TWP use among young smokers, as well as public health messaging aimed at reducing or eliminating use among current users. Additionally, a new product has emerged in the marketplace within the last 5–7 years that provides users with a non-combustible option; the electronic waterpipe (e-waterpipe; EWP) is a battery-powered, electronic vaporizer, with internal mechanisms similar to an e-cigarette that allows smokers to use e-liquid in a waterpipe device.

It is important to differentiate between an EWP and other electronic devices that typically are grouped together including e-cigarettes and e-hookahs. Previously, literature has used the terms e-cigarette and e-hookah to describe handheld, pen-shaped products that electronically with internal mechanisms heats and vaporizes e-liquid (Dube, Pathak, Nyman, & Eriksen, 2015). The term e-waterpipe was constructed by our team because the device is part of a new category of electronic smoking devices and the chosen term reflects the unique aspects of the device that combines an electronic head that heats and vaporizes e-liquid, with a traditional waterpipe base that includes a water bowl and individual hoses that allow multiple smokers to use the device simultaneously. Thus, the EWP is not necessarily a single device, rather is a combination of commercially available products that create a larger smoking system.

Specifically, the EWP consists of two separate elements: the body of the TWP (i.e., a water-filled bowl, stem, and hose) and the “e-head”, an electronic component which uses a heating mechanism similar to an e-cigarette. The e-head heats a flavored liquid solution of nicotine and other additives (e-liquid), which is then vaporized into an aerosol and inhaled by the user through the TWP stem and hoses. Because there is no combustion of tobacco using an e-head, it has been suggested that the EWP, like e-cigarettes, may result in lower overall health risks as compared to TWP (Farsalinos & Polosa, 2014). However, there is currently

no literature on benefits of transitioning from burning tobacco in a TWP to electrically heating e-liquid in an e-head. Likewise, there are no known studies evaluating health consequences associated with e-head use.

It is known that tobacco use and experimentation may be influenced by social and environmental factors (DHHS, 2012). Given that EWP use, like TWP use, may typically be done in social settings, and that the EWP may be seen as a “safe” alternative to TWP, EWP may gain popularity and become increasingly socially acceptable similar to e-cigarettes. In order to understand what role EWP may play in the tobacco marketplace, it will be necessary to identify the perceptions of EWP among those most likely to transition from TWP or those at highest risk to experiment with such new products. Given that EWP is a recent development, and that there is little, if any, descriptions or empirical examinations of the EWP, the purpose of this paper was to examine the EWP device, its typical usage, variations in the product, its similarities to TWP, and to provide a general introduction for researchers and clinicians to a new nicotine delivery device and potential alternative to TWP.

2. Methods

An initial literature search was completed prior to this review in an effort to identify all interchangeable terms associated with TWP, ENDS, and the EWP to ensure a comprehensive comparison to existing products and provide an overview of the EWP. Previous research on existing TWP, ENDS and other tobacco products were analyzed to explain the functionality, uses, and potential harm of the EWP. Literature referenced consisted of English language, peer-reviewed articles accessed via PubMed, Google Scholar and other relevant databases. Next, a search of online tobacco retailers was conducted to identify models of EWP and accessories that are commercially available and compare models (i.e., battery size, power, cartomizer specifications, and price). The terms e-hookah, e-bowl, and e-head were used by consumer websites and e-head manufacturers to develop product names and were ultimately used in the present search. In order to characterize the e-heads, research staff scanned website content, product packaging and pictures of products. If the manufacturer or retailer websites provided incomplete information about the e-head, then those characteristics were coded as not available in Table 1 (N/A).

3. E-head and E-Waterpipe Description

3.1 E-Waterpipe Function

Traditional waterpipes (TWP) use a ceramic or glass head to hold tobacco which is heated by coals. When the head is placed on top of a waterpipe, air is drawn through the coal and tobacco smoke is drawn through the stem, bowl, and hose to the user. The EWP is a large smoking system that utilizes an electronic head (e-head), a metal stem, water-filled bowl, and hose, similar to that in a TWP. The component that varies between a TWP and EWP is the type of head used (ceramic/glass vs. electronic). Rather than burning shisha, the e-head electrically heats e-liquid. When a smoker inhales through the hose, it activates a pressure sensor (i.e., similar to the activation of an e-cigarette) that turns on the heating coils, which atomizes the e-liquid. The aerosol is drawn down the stem, into the water found in the bowl, where it travels via bubbles through the water and converts back into vapor in the air pocket

above the water. The vapor is then inhaled by the smoker through a hose. To date, there is no information on what temperature the vapor reaches throughout this process or what amount of aerosol, if any, gets filtered when passing through the water. On the bottom of e-heads, there is a triangle-shaped area where a universally-sized grommet, which provides an air-tight seal connecting the e-head to the body, is located. Another option for e-head users is to insert the hose directly into the e-head's grommet to smoke. In this situation, the smoker would no longer be pulling the vapor through water found in the bowl of the TWP body which would be categorized as vaping using an e-head, not an EWP.

3.2. E-head Internal Mechanisms

The e-heads come equipped with either a clearomizer or cartomizer which is used to store e-liquid and to house a heating coil. The clearomizer/cartomizer can be accessed in most e-heads by unscrewing the device into two pieces. Typically, one piece will contain the battery and the control panel (if applicable) and the other will contain the cartomizer/clearomizer. Cartomizers have differing characteristics such as being pre-filled with e-liquid or being refillable (Table 1). The pre-filled cartomizers are disposable and replaceable, whereas the refillable option can be cleaned and reused. Cartomizers contains a polyfill material that carries e-liquid from the chamber to the heating coil (Lerner et al., 2015; Salter, 2014). Polyfill may decrease the abundance of flavor from the e-liquid and may retain flavor from previous smoking sessions (Salter, 2014). A clearomizer is a see-through, glass or plastic storage chamber that holds e-liquid. In the middle of the chamber, there is an atomizer which contains the heating coil to electrically heat the e-liquid and wicks to carry the e-liquid from the chamber to the coil (Salter, 2014). A few benefits of using a clearomizer instead of a cartomizer include the smoker can easily see the level of e-liquid in their device and wicks can often provide a stronger flavor. If there is a preference of a clearomizer or cartomizer, the smoker would need to research the components of each e-head since there is variation among the models.

Cartomizers/clearomizers can hold varying amounts of e-liquid (Table 1), with no standardized size across models of e-heads. This review has identified e-heads that have tanks with maximum volumes of 2mL, 8mL, 10mL, 16mL, and 50mL. In some instances, tank size is not labelled or advertised. For example, the Fantasia E-Bowl (Hookahjunkie.com, 2018) uses a prefilled, disposable cartomizer that does not disclose the e-liquid capacity. Another e-head gives the option to purchase a refillable cartomizer to replace the disposable cartomizer (i.e., Smoke Free Electronic Hookah Pyramid; Smoke Free, Inc., 2018). When using an e-head, nicotinic or non-nicotinic e-liquid can be used. For e-heads using pre-filled, disposable cartomizers, replacements will vary in nicotine content and flavor, but typically not brand. In contrast, e-heads that come with a clearomizer can be refilled with any e-liquid, including brand, flavor and nicotine variations.

E-liquid is heated by a battery located inside of the e-head and is typically accessible to the smokers. As shown in Table 1, there are varying battery sizes in e-heads. Battery power in e-heads are measured in milli-ampere hour (mAh) and range from 900 mAh – 4,440 mAh. In several models, the battery power for the device is not labelled or advertised. All e-heads can be recharged using a wall or USB charger and can be charged while vaping, although the

safety of this is undetermined. On most e-heads, there is no on/off switch; it is automatically activated by inhalation and goes to “sleep” after inactivity.

3.3. E-head Control Panel

A few e-head models have a control panel on the outside of the device that shows the battery life of the e-head. In one technologically-advanced model, the Square E-Head (Square Smoke, 2018), the control panel displays a puff counter and puff duration timer. Although these displayed measurements could be beneficial to research, there is no literature detailing their validity or reliability. This review did not find any other e-heads with these advanced features. Another feature of a control panel is that it provides the ability to adjust the battery-powered heat (i.e., voltage or wattage) within a range. The voltage being used will vary based on the smoker’s preference since it may affect flavor intensity and vapor production. In models with this option, the temperature remains the same until it is changed by the smoker. Not all e-heads have a control panel or the option to alter the voltage/wattage being used to heat the e-liquid (Table 1). In over half of the identified models, the power is non-variable, meaning the temperature of heat is pre-determined by the manufacturer and cannot be changed by the smoker. Also shown in Table 1, the pre-set power levels are not always provided by the manufacturer (i.e., Kelvin H1 E-Bowl and Fantasia E-bowl; Hookahjunkie.com, 2018; TheHookah.com, 2018).

4. Conclusion

Based on high rates of TWP and e-cigarette use in young adults, there is reason to believe that the EWP has the ability to become a popular method of nicotine consumption, particularly among youth and young adult users among whom experimentation with new products may be more common. It is possible that perceptions of the EWP will be similar to the positive perceptions of e-cigarettes including perceptions of reduced addiction potential and reduced health risk (Harrell et al., 2015; Pearson, Richardson, Niaura, Vallone, & Abrams, 2012), and those perceptions may influence non-users of TWP to experiment with EWP or current TWP smokers to transition to EWP.

There is a need for studies to determine perceptions of the EWP, experiences of EWP users, levels of exposure to nicotine and other constituents of EWP vapor, and the likelihood of TWP smokers, e-cigarette smokers, traditional cigarette smokers and non-smokers using EWP, and if the EWP is viewed as a viable alternative to TWP. Additionally, future research should determine if passing the aerosol through water affects nicotine and toxin exposure. Moreover, there is a need to understand smoking behaviors that may be unique to EWP. For example, when using an e-cigarette, shorter and lighter puffs are recommended; however, TWP smokers tend to take longer and deeper puffs. It is not known if TWP users who transition to EWP will alter their puffing behavior or continue to smoke in a manner similar to TWP. Research shows that approximately one hour of TWP smoking consists of approximately 200 puffs (90,000 ml smoke inhaled; Cobb, Ward, Maziak, Shihadeh, & Eissenberg, 2010). If a smoker completes a smoking session (approximately 30–60 minutes) using the EWP, there remains a question regarding the amount of toxicant and nicotine

exposure. Finally, it will be important to know if there are potential health effects of inhaling e-liquid aerosol in EWP.

Despite these concerns, there may be a reduction of harm associated with EWP use compared to a TWP smoking. First, EWP use should not expose the smoker to carbon monoxide (CO) based on the heating mechanism in the device which is similar to e-cigarette use (McRobbie et al., 2015). This would be a reduction from TWP CO exposure since one puff of a TWP can have up to ten times the volume of CO than in a conventional cigarette (Ashurst, Urquhart, & Cook, 2012), which can be detrimental to health. There are additional risks associated with TWP use including cancer (ALA, 2011), respiratory problems (Akl et al., 2010) and heart-related issues including clogged arteries, heart disease, and increased heart rate and blood pressure (Akl et al., 2010; ALA 2007; Blank et al., 2011). Since no studies have investigated the health effects of EWP use, it is too early to determine if it will have similar health risks.

Findings suggest that e-cigarettes produce chemical emissions of carbonyl compounds, metals, NNK (a carcinogen associated with smoking-related cancers), and propylene glycol (Goniewicz et al., 2014; Offermann, 2015). Exposure to those associated toxins have resulted in increased reports of mouth and throat irritation and dry cough (Polosa et al., 2014). Additionally, e-cigarette use is associated with elevated diastolic blood pressure (Farsalinos, Tsiapras, Kyrzopoulos, Savvopoulou, & Voudris, 2014) and increased respiratory resistance (Vardavas et al., 2012). Many e-liquid flavoring chemicals have also been categorized as unsafe and detrimental to health (Allen et al., 2016; Farsalinos et al., 2014). It was found that of 51 e-cigarette flavors tested, 39 contained diacetyl, 23 contained 2,3-pentanedione, and 46 contained acetoin (Allen et al., 2016). These three flavorings have been associated with bronchiolitis obliterans, also known as “popcorn lung” (Allen et al., 2016). Given that EWP uses similar mechanisms for heating and vaporizing e-liquids, it is possible that the EWP has similar health risks.

Although e-heads are regulated under the FDA’s 2016 deeming rule, there may be a benefit to examining the regulation of the e-head with more scrutiny. For example, the varying levels of power used to regulate the temperature of vapor can be harmful if used incorrectly. Some e-heads come pre-set to one permanent power which may be too strong for a smoker and may burn their throat. If the FDA were to standardize the power, such as limiting the maximum temperature or requiring adjustable levels of powers, this situation could be avoided. However, prior to enacting any comprehensive regulatory action on the EWP, a more thorough understanding of its use patterns, potential risk, exposure, and addiction is needed.

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Abbreviations:

e-head	electronic waterpipe head
e-waterpipe or EWP	electronic waterpipe
TWP	traditional waterpipe

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Highlights

- This is the first known review introducing and describing the e-waterpipe.
- An e-waterpipe is a non-combustible replacement to combustible waterpipe smoking.
- There is no known literature evaluating prevalence or safety of e-waterpipe use.
- When using an e-waterpipe, e-liquid is vaporized via an e-head.

Table 1. *Description of Electronic Waterpipe Heads (E-heads)**

Name/Brand	Battery	Power	Cartomizer Specifications	Price	Similar E-heads
Aspire Proteus E-Hookah Head	5000 mAh	Non-Variable: 70W	Refillable 10 mL	\$49.99-\$59.99	n/a
Fantasia E-Bowl	4400 mAh	Non-Variable: n/a	Prefilled, Replaceable, size n/a	\$49.99-\$79.99	n/a
Flux E-Bowl by Luxury Lites	5000 mAh	Non-Variable: 100W	Refillable 50 mL	\$79.99-\$99.99	Kangerm Electronic Hookah Bowl, ePuffer E-Hookah
Kelvin H1 E-Bowl	900 mAh	Non-Variable: n/a	Refillable 2 mL	\$29.99-\$129.99	Rook Electronic Bowl, El-Badia E-Bowl, Ehuqa Electronic Hookah Bowl, Shisha Evolve Electronic Shisha Hookah Device
Smoke Free Electronic Hookah Pyramid	n/a	Non-Variable: n/a	Prefilled, Replaceable; optional refillable cartomizer (16 mL)	\$99.99	n/a
Square E-Head	2400 mAh	Range: 3.2–6.0V	Refillable 8 mL	\$99.99-\$119.99	n/a
Starbuzz Wireless E-Head	n/a	Range: 10–40W	Refillable 8 mL	\$84.99-\$159.99	n/a
Volt E-Vapor Hookah Bowl	2400 mAh	Range: 3.2–6.0V	Refillable 10 mL	\$99.99-\$149.99	Amanoo E-Head

* There are several styles of e-heads that are identical or similar, but are sold under different brand names (see *Table 1, Similar E-heads*). The e-head models provided in column 1 were randomly selected to represent the category of similar models.

All columns displaying “not available” (n/a) are those that did not have publically available information (i.e., product label and/or distributor did not provide the information).