



## Important Considerations for Providers Regarding the Use of Electronic Cigarettes

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### Introduction

The use of electronic nicotine delivery systems such as electronic cigarettes has increased considerably in recent years among youth and adults [1,2]. While the majority of adult electronic cigarette users are current conventional cigarette smokers, an increasing number of adolescents who have not previously smoked are using use electronic cigarettes [3]. Despite these trends, many health care providers report feeling uninformed about the health risks associated with the use of these products. For example, in a study of 615 Minnesota physicians and nurse practitioners caring for adolescent patients, Pepper and colleagues found that most respondents reported having low levels of knowledge and comfort discussing electronic cigarettes with patients, and nearly all expressed the wish to learn more [4]. In a survey of obstetrical providers, 14% responded that electronic cigarette use poses no health risks to pregnant women, and only 5% reported that they felt sufficiently informed about the health risks of emerging tobacco products including electronic cigarettes [5]. Finally, in a survey of North Carolina physicians, 48% of respondents reported that patients frequently or sometimes ask about electronic cigarettes and 13% incorrectly believed that electronic cigarettes are already approved by the U.S. Food and Drug Administration (FDA) for smoking cessation [6].

Pepper and colleagues also found that the top three most frequently reported sources of information on electronic cigarettes did not include professional sources, but rather included patients, news stories, and advertisements [4]. Electronic cigarette advertisements and other media frequently include direct or implied claims that electronic cigarettes have negligible or reduced health risks [7]. Confusion among medical providers may reflect exposure to these messages, combined with a lack of quality data from the scientific community on electronic cigarette emissions and exposures on which to base counseling decisions.

### The Nature of Electronic Cigarette Liquid

The health risk to an individual from electronic cigarette use may not be fully known until sufficient time has passed for studies of long term, chronic mainstream inhalation exposure to the insufficiently characterized constituents of electronic cigarette aerosol [7,8]. For this reason, the Forum of International Respiratory Societies published a

position statement in 2014 that concluded: "The potential benefits of electronic cigarettes to an individual smoker should be weighed against potential harm to the population of increased social acceptability of smoking and use of nicotine, the latter of which has addictive power and untoward effects" [9]. The American Lung Association statement on electronic cigarettes is similarly cautious: "The American Lung Association is concerned about the potential health consequences of electronic cigarettes (e-cigarettes), as well as the unproven claims that they can be used to help smokers quit" [10]. In April 2014, the FDA issued a proposal to regulate products meeting the legal definition of a tobacco product, including electronic cigarettes, but the proposed rule is not yet final [11]. Absent federal regulation, it is difficult for the public health and medical communities and consumers to know what chemicals are contained in electronic cigarettes, or what the short- and long-term health implications might be.

The electronic cigarette liquid itself ranges in appearance from lightly tinted to very dark brown (depending on the extent of the dilution of a tobacco extract to possibly produce different concentrations of nicotine). Nicotine used in electronic cigarette liquids is typically derived from tobacco extracts and not synthetically produced. This extract is combined with propylene glycol and/or glycerol solvents, producing a highly complex suspension of substances to which flavorants are added [7,8,12]. Current research has found that emissions from electronic cigarettes generally contain toxic and carcinogenic chemicals like carbonyls or aldehydes. Carbonyls and aldehydes are usually not additives of electronic cigarette liquid, but rather they are formed by the decomposition of propylene glycol and/or glycerol when the solvents are heated by the coil of the electronic cigarette device [13] (Figure 1). Research also shows that electronic cigarettes currently in use deliver lower concentrations of some harmful constituents than conventional cigarette smoke, such as tobacco specific nitrosamines (TSNAs) and polycyclic aromatic hydrocarbons (PAHs) [14]. However, there is no level of exposure to these carcinogens that represents an acceptable exposure level. As electronic cigarette products continue to evolve, new risks may emerge due to changes in e-liquid formulations or product design, which may be of importance to health care professionals. In addition, the use of these products to deliver substances other than electronic cigarette liquids (such as marijuana) can present additional challenges to the clinician [15].



**Figure 1:** Electronic cigarette mouthpiece with particles of insoluble apparently thermally decomposed tobacco extract from the aerosol (left); and evidence of thermally decomposed material on the wick in proximity to the heating element (right).

In addition to toxicants known to be found in electronic cigarette aerosol (also known as “vapor”), [Figure 1](#) shows insoluble particulate in the mouthpiece of a disposable electronic cigarette (left) that appear to be products of thermal decomposition of the e-liquid by the heating element (right) prior to delivery through the mouthpiece. Therefore, the aerosol which electronic cigarette users inhale is not a pure, single component solution. Although the actual quantification of health risk from inhalation of aerosols from the device is not possible at this time due to the limited amount of good quality data available on emissions from these rapidly evolving products, the inhalation of partially thermally decomposed tobacco extract in propylene glycol and glycerol from electronic cigarettes raises questions about the potential for health risks. The healthcare professional should be aware of the chemically complex and uncharacterized nature of mainstream electronic cigarette emissions when counseling patients regarding electronic cigarette use.

### “Less Harmful Cigarette Alternative,” Cessation, and Gateway to Dual Use

Even after taking into account active exposure to minimally characterized aerosol constituents, many healthcare professionals might still have favorable attitudes toward electronic cigarettes if they believed it that it could be used effectively for smoking cessation or can reduce health risks with long term active exposure compared to combustible tobacco product use. In the survey by Kandra et al., two-thirds of physicians indicated electronic cigarettes are a helpful cessation aid and 35% recommended them to their patients [6]. However, randomized trials on the efficacy of electronic cigarettes for cessation from conventional cigarettes are inconclusive [15], and electronic cigarettes are not approved by the FDA for cessation. Accordingly, the U.S. Preventive Services Task Force recently concluded that the current evidence is insufficient to recommend electronic cigarettes for tobacco cessation in adults, including pregnant women, and recommended that clinicians direct patients who smoke tobacco to other cessation interventions with established effectiveness and safety [16]. In addition, many conventional cigarette smokers who begin using electronic cigarettes don’t completely quit tobacco use and become dual users of both products. Approximately two-thirds of current electronic cigarette smokers also use conventional cigarettes [17]. Conventional cigarette smokers who reduce their cigarette use without quitting still have substantially increased risk for tobacco-related adverse health outcomes [18]. Adult smokers who switch to electronic cigarettes need to do so completely to maximize health benefits, and not just cut back on conventional cigarettes or substitute electronic cigarettes situationally or periodically [19].

Health care providers treating adolescents and young adults may have particular concerns about the use of these products, especially among their non-smoking patients. Indeed, Pepper et al. reported that health care providers expressed concern that electronic cigarettes

could lead to subsequent initiation of combustible tobacco use among adolescents who did not previously use tobacco [4]. This concern is supported by emerging data. In a study of Los Angeles high school students, ever electronic cigarette users were more likely than never users to progress to combustible tobacco use (Odds Ratio: 2.73 [95% CI, 2.00 - 3.73]), after adjusting for sociodemographic, environmental, and intrapersonal risk factors for smoking [19]. Similarly, a study using a national sample of youth and young adults also found an increased odds of progression to traditional cigarette smoking among electronic cigarette users compared with nonusers [20,21]. Thus, concern among healthcare professionals about the risk of progression to use of combusted products, as reported by Pepper and colleagues [4], may be well-founded. In addition, healthcare professionals should be aware that most electronic cigarettes deliver nicotine, a toxic and highly addictive substance that has been shown in animal studies to adversely affect adolescent brain development, which is consistent with studies of adolescent cigarette smokers documenting deficits in memory and attention [22-25]. Additionally, in pregnant women, use of electronic cigarettes poses a host of potential risks associated with exposure to nicotine, including adverse pregnancy outcomes and impaired fetal brain and lung development [19].

### Conclusion

In summary, healthcare providers should be aware that the health risks from using electronic cigarette use continue to emerge, but presently include multiple risks associated with nicotine exposure, including addiction, potentially altered brain development in adolescents, and adverse pregnancy outcomes. Therefore, adolescents and pregnant women should be advised to avoid electronic cigarettes because of their adverse health effects. Emissions from electronic cigarettes can contain low levels of potentially harmful constituents including PAHs, TSNAs, carbonyls, and aldehydes and so pose health risks. Further, poorly characterized, heat-induced partial decomposition products of a highly complex tobacco extract in propylene glycol and glycerol present potential, but yet unknown, health risks.

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