

REVIEW ARTICLE

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Electronic cigarettes: Should health professionals oppose use by their patients?

Emma S Lydall, Brian Eadon, Hugo C van Woerden

ABSTRACT

Aims: Electronic cigarettes are rapidly becoming the most popular type of tobacco-free nicotine product sold in the UK. The aim of this review was to summarize existing literature on the potential risks and benefits posed by e-cigarettes. **Methods:** A thorough search of relevant databases was undertaken using the search terms: electronic cigarette/s, e-cigarette/s, e-cig/s, electronic nicotine delivery system/s. **Results:** Electronic cigarettes contain small amounts of toxic chemicals including tobacco-specific nitrosamines, which are known to be human carcinogens; impurities such as myosamine, anabasine, and beta-nicotyrine, which are considered to be harmful to humans; and diethylene glycol, which can be toxic in high doses. Mouth and throat irritation are the most commonly reported side effects in follow-up studies. However, substitution of electronic cigarettes in the homes of parents who currently smoke improves indoor air quality and should be associated with a fall in the risk of sudden infant death syndrome, respiratory

illness and ear disease. **Conclusion:** Electronic cigarettes need standards that reduce product variation and licensing as a medicinal product to provide validated external quality assurance of ingredients and potential contaminants. However, based on their risks and benefits to others, and leaving aside the issues of their use as an aid to smoking cessation, there may be a case for their short-term use where patients have failed to give up smoking using other smoking cessation techniques to reduce exposure of others to second hand smoke.

Keywords: Electronic cigarettes, E-cigarettes, Smoking, Tobacco, Public health

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INTRODUCTION

Often the development of new technologies is associated with new ethical dilemmas for health professionals. The recent development of electronic cigarettes (e-cigarettes) as an alternative to smoking provides such a dilemma, where health professionals have to weigh up the relative risks and benefits of encouraging a behavior that may have a small but unquantified risk against a large and well-established risk.

The risks associated with new technologies are often poorly described. This review examines the available literature on e-cigarettes as opposed to smoking tobacco and examines the ethics of promoting their use by health professionals.

Since their invention by Chinese pharmacist, Hon Lik, in 2003, e-cigarettes have become the most popular type of tobacco-free nicotine product sold in the UK, bringing about a decline in the use of licensed nicotine replacement therapy [1]. They have opened up a new market place, with new manufacturers, marketing and distribution networks, particularly related to the online commercial sector.

WHAT ARE E-CIGARETTES?

There is much variability in the design of e-cigarette brands but, in general they consist of a battery and a fluid-filled cartridge. Inhalation activates an atomizer that turns the liquid into a fine mist/vapor. Besides nicotine, the cartridges often contain flavorings such as tobacco, chocolate, mint and fruit. Many e-cigarettes have a light-emitting diode at the tip of the cigarette that lights up during inhalation. Such features enable the product to mimic the act of smoking, thereby mirroring many of the behavioral components of smoking addiction as well as triggering a response from the same brain receptors that form the pharmacological basis of cigarette addiction.

Despite the rising popularity of e-cigarettes, the key question is: do e-cigarettes pose significant health risks? There is currently much debate in the literature surrounding this question, with strong opinions formed based on scarce evidence.

LITERATURE SEARCH

To inform these questions, a thorough search of the following databases was undertaken: Medline, Embase, PsychInfo, Cinahl, BNI, and Social Care Online. The search terms used were: E-cigarette/s, E-cig/s, Electronic cigarette/s, Electronic Nicotine Delivery System/s. One journal (Tobacco-control) was hand searched and a number of websites were explored for relevant literature including: ASH, UK Centre for Tobacco Control Studies and the Tobacco Dependence Research Unit.

The search identified over 130 articles including the search terms above. However, screening of these references revealed that almost all of them reported very poor quality evidence (e.g. individual case studies), or they reported only the short term effect of e-cigarettes. The purpose of this review is to outline currently available literature on this topic in order to present a balanced viewpoint that will enable health professionals and potential users of e-cigarettes to make an informed judgment about the products.

Do e-cigarettes pose significant health risks?

A number of studies have been undertaken to characterize the ingredients in e-cigarettes [2–9]. These have identified the main components of e-cigarette cartridges as nicotine and propylene glycol (the latter is commonly used as a vehicle in inhaled medications and is considered safe for use in foods.) In 2009, the US Food and Drug Administration published the results of a chemical analysis of two leading brands of e-cigarettes [2]. This demonstrated inconsistencies between the categories used to label e-cigarettes such as ‘zero’, ‘medium’ and ‘high’ nicotine content and the actual nicotine concentrations in the e-cigarette cartridges. Cartridges of the same brand, with the same label could emit a different amount of nicotine with each puff, suggesting that there was little quality control underpinning the manufacturing process. These brands also contained toxic chemicals including tobacco-specific nitrosamines, which are known to be human carcinogens; impurities such as myosamine, anabasine, and beta-nicotyrine, which are considered to be harmful to humans; and diethylene glycol, which can be toxic in high doses.

Tobacco specific nitrosamines were also found in a study by Laugesen [10]. Whilst the presence of these chemicals is of concern, papers that make recommendations against the use of e-cigarettes based on this evidence often do not consider that the levels of carcinogens found in the brands tested ranged from 0.07–0.2% of those present in regular cigarettes. Indeed, the highest level of tobacco-specific nitrosamines found in a cartridge was 8.2 ng/g, a similar amount to that found in a nicotine patch [11]. Diethylene glycol was found at 1% in one of the eighteen samples tested by the FDA and has not been identified in any other studies.

Hadwiger et al. also identified a brand of e-cigarettes that had been manufactured to contain amino-tadalafil and rimonabant. Amino-tadalafil is an analogue of ‘Cialis’, used to treat erectile dysfunction and rimonabant was historically authorized as a weight loss drug in Europe but its license was retracted because of safety concerns over suicidality, depression and other related side-effects. Hadwiger et al. also reported evidence of poor quality control, as indicated by the presence of nicotine in products labeled as nicotine free [12].

The current lack of restrictions surrounding the constituents of e-cigarettes is problematic. However, it is promising that studies have been able to form a comprehensive characterization of e-cigarette ingredients. When it is considered that only around 5300 of the estimated 10,000–100,000 chemicals in cigarette smoke have been identified [13], this would suggest that, with greater quality control and restrictions, e-cigarettes may be regarded as much less toxic than regular cigarettes.

Alongside the need for restrictions on the constituents of e-cigarettes, there is also a requirement for e-cigarettes to be adequately labeled with ingredients and clear instructions for use. Trtchounian and Talbot

[14] examined six brands of e-cigarettes and found that most cartridges leaked upon replacement. The effects of absorbing cartridge fluid via the skin are unknown. Although e-cigarettes are likely to be less toxic than regular cigarettes, limited descriptions of their ingredients (including contaminants released in vapor and impurities in the ingredients) are likely to mean that the public are unaware of the presence of potentially toxic chemicals, leading to the perception that they are entirely safe. Receiving correct information about the chemicals in e-cigarettes may mean that more people choose to use them as an aid to complete cessation, rather than a long-term replacement for cigarettes. E-cigarettes are manufactured in many different parts of the world and internal quality assurance, although necessary, cannot be the basis on which products that contain nicotine are regarded as safe. Given the global nature of trade external quality assurance is necessary.

A number of claims from e-cigarette manufacturers are not based on published scientific findings [14]. For example, one brand stated 'within two weeks your lung capacity will increase by 30%, your energy levels will increase, your throat and lungs will feel markedly better, wrinkles in your skin will become less noticeable and color will return to your skin' (Brand: Liberty Stix). Such claims may lead a potential user to believe that the product promotes better health the longer it is used, thereby undermining the ideal of complete cessation.

Cross sectional studies

Much of the evidence available concerning the potential adverse effects of e-cigarettes has come from cross-sectional survey data in which users report only minor side-effects including mouth and throat irritation, headache, vertigo and nausea [15]. However, such studies introduce bias by recruiting via e-cigarette websites. They also suffer the limitation that, due to the relatively recent rise in e-cigarette popularity, there is no way of capturing any long-term health effects of using these products at present.

Controlled studies

There have been very few controlled studies examining the potential of e-cigarettes to produce adverse health effects. Those that have been published have examined the acute physiological effects of e-cigarettes in a laboratory setting, with mixed findings. When tested under acute conditions, there were no apparent adverse effects of e-cigarettes on cardiac function and blood count parameters [16, 17]. However, Vardavas et al. [18] identified some acute adverse respiratory effects of e-cigarette use, including increased airway resistance. Adverse events were also observed in a six-month observational study by Polosa et al. [19]. Again, mouth and throat irritation were the most commonly reported side effects and no serious adverse events were reported.

However, a serious limitation of this study is that 32.5% of participants were lost to follow-up, and whether or not any of these participants left the study due to an experience of adverse effects is unknown. In a later study by the same authors the most frequently reported adverse events were mouth irritation (20.6%), throat irritation (32.4%), and dry cough (32.4%) [20]. A RCT that used e-cigarettes that either had nicotine or no nicotine in smokers showed marked improvement in symptoms, particularly breathlessness, suggesting that the side effect profile of e-cigarettes is lower than that for smoking [21].

Potential benefits

Although there is currently insufficient evidence to conclude that e-cigarettes are as safe as licensed forms of nicotine replacement therapy for the user, an experiment by McAuley et al. [22] has suggested that in terms of indoor air quality during use, e-cigarettes are much less toxic than regular cigarettes. Wagener et al. [23] noted that there are potential advantages of e-cigarettes. Second hand smoke remains a serious public health concern, substantially raising the risk of sudden infant death syndrome, respiratory illness and ear disease [24]. In 2010, Dove and colleagues conducted a study examining serum cotinine levels [25]. They found no evidence that children living with smokers had experienced a reduction in their exposure to second hand smoke, despite the introduction of smoking bans in public places. As a large number of caregivers do not maintain smoke-free homes [26], the use of e-cigarettes by caregivers who smoke and are unwilling or unable to quit, may have significant health benefits for children currently exposed to second hand smoke.

DISCUSSION

The evidence currently available surrounding the safety of e-cigarettes suggests that they are less toxic than regular cigarettes, and are more likely to be comparable in toxicity to licensed forms of nicotine replacement therapy. However, without standardization, the results from any one study cannot be generalized, due to uncontrolled variability between and within e-cigarette brands. For this reason, people who wish to quit smoking should be directed strongly towards evidence-based treatments (behavioral support and approved pharmacotherapy). People who have decided to use e-cigarettes of their own accord should be advised that there is not enough evidence available for us to recommend them. However, if a person believes that e-cigarettes are helping them to stay off regular cigarettes, and their fear is a return to smoking in favor of using a licensed product, the emphasis should be on remaining smoke-free rather than e-cigarette free. Although there are obvious public health concerns with respect to undermining efforts to

de-normalize smoking, particularly for the young, the primary goal of tobacco control is to ‘reduce mortality and morbidity associated with tobacco use’. This goal should be the main consideration with respect to any advice given regarding the use of e-cigarettes. The e-cigarette industry also has an obligation to ensure that any role for e-cigarettes as part of smoking cessation is clarified by appropriate research [27–29].

CONCLUSION

It can be argued that at least some of the e-cigarettes available are probably no more harmful than nicotine patches. However, e-cigarettes are not a homogenous class of products based on current studies of their chemical composition. The current lack of standardization or regulation of the content of e-cigarettes cannot exclude that some brands may have significant levels of human toxins. This is changing as the UK and other governments are starting to move towards regulation of brands. Based on their risks and benefits to others, and leaving aside the issues of their use as an aid to smoking cessation, there may be a case for their short term use where patients have failed to give up smoking using other smoking cessation techniques. There is also a need for the public sector to fund and undertake research on the use of e-cigarettes and to further assess whether licensing procedures need to be put into place as is happening in some countries. Such research would provide smokers with information on which to base an informed decision as to whether or not to use e-cigarettes.

Author Contributions

Emma S Lydall – Conception and design, Drafting the article, Final approval of the version to be published

Brian Eadon – Analysis and interpretation of data, Critical revision of the article, Final approval of the version to be published

Hugo C van Woerden – Conception and design, Critical revision of the article, Final approval of the version to be published

Guarantor

The corresponding author is the guarantor of submission.

Conflict of Interest

Authors declare no conflict of interest.

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