Electronic cigarettes and the role of the cardiac nurse

Graham Cope, Honorary Senior Research Fellow, University of Birmingham and Freelance Medical Writer, Birmingham. **Email:** graham@copecommunications.com

Cigarette smoking is a major contributor to cardiovascular morbidity and mortality (Ambrose and Barua, 2004), with increasing efforts by health professionals to support cardiovascular patients to quit. Consequently, there is an increasing awareness of the harmful effects of tobacco among patients, who are looking to alternative, 'healthier' forms of nicotine to maintain, or in some cases to stop, their addiction.

Smoking is a well-established risk factor for atherosclerosis, leading to myocardial infarction and stroke, which are the most common causes of death in the UK and worldwide (Nichols et al, 2014). The mechanisms underlying cigarette smoke-induced atherosclerosis and arterial thrombosis are mainly free radicals, reactive nitrogen species, carbon monoxide, nicotine, cadmium and other heavy metals (Csordas and Bernhard, 2013). Smoking also directly affects the heart muscles, leading to systolic and diastolic dysfunction and arrhythmia (Leone et al, 2008). Other effects include constriction of the blood vessels, activation of the platelets, chronic inflammation and hyperlipidaemia (U.S. Department of Health and Human Services, 2014).

The general public is gradually reducing cigarette consumption and turning to alternative forms of nicotine, such as the electronic cigarette (e-cigs). Since their introduction in 2004, there has been rapid growth in sales, with an estimated 2.6 million regular users in the UK (Action on Smoking and Health (ASH), 2015). During this time, e-cigs have been largely unregulated, but have been widely available and have been heavily advertised on television and the internet (Bauld et al, 2014)—particularly since the entry of large tobacco companies into the e-cig market (Pepper et al, 2014).

Electronic cigarettes

Electronic cigarettes typically comprise an atomiser, which is charged by a re-chargeable lithium battery that produces a vapour by heating a solution of nicotine, usually in propylene glycol or glycerine, and sometimes up to 350°C (Britton and Bogdanovica, 2014). The reported concentrations of nicotine vary from zero to 36 mg/ml, but there are many uncertainties about the nicotine delivery and the advertised amounts. There are also wide variations in the solvents used and the flavourings in the e-cig liquids or 'juice', many of which are chosen to be attractive to younger users (Oncken et al, 2015).

Electronic cigarettes are generally considered by smokers to be a safer way of inhaling nicotine (*Box 1*) and more attractive than nicotine replacement therapy (NRT) (West et al, 2015). There has been a consequential fall in NRT sales, which has coincided with a reduction in the number of people attending Stop Smoking Services (Health & Social Care Information Centre (HSCIC), 2015).

Toxicology reports

Electronic cigarettes have been proposed by their manufacturers and supporters as an effective aid to quit (Brown et al, 2014). However, a recent review concluded that the opposite may be true, with users of e-cigs being 28% less likely to quit smoking than non-users (Kalkhoran and Glantz, 2016).

Solvent and flavours

Manufacturers and supporters of e-cigs often advocate that they are healthier than conventional cigarettes and contain only water, nicotine, glycerin, propylene glycol, and flavouring (Zhu et al, 2014). These claims, however, may be misleading as analysis has found varying levels of heavy metals in the vapour, including chromium, cadmium and mercury (*Box 2*) (Pisinger and Døssing, 2014).

Potential carcinogens have also been identified in the vapour, with tobacco-specific nitrosamines being emitted from some devices. DNA-damaging free-radicals have also been detected (Goel, 2015), along with toxic levels of formaldehyde and acetaldehyde (Pisinger and Døssing, 2014). Some e-cig solutions also contain harmful flavourings including diacetyl and acetyl propionyl, which are used to add a buttery taste to the e-cig vapour and are known to cause bronchiolitis obliterans, a debilitating inflammatory lung disease (Farsalinos et al, 2013). It is generally acknowledged that the levels of these and other toxins are much lower and less dangerous than those found in conventional cigarettes; however, they may still pose a risk when inhaled over long periods.

Box 1. Benefits of e-cigs over combustible cigarettes

- Vastly reduced particulate matter in the vapour
- No 'tar' and fewer carcinogens
- No carbon monoxide
- Significantly less second-hand emissions

Box 2. Identified toxicants in e-cigarette vapour

- Nicotine—deleterious to the nervous system and to many non-neurological cell types, including the immune system
- Heavy metals including chromium, nickel, tin, silver, cadmium, mercury, and aluminium
- Tobacco-specific nitrosamines emitted from some devices
- DNA-damaging free-radicals
- Formaldehyde and acetaldehyde, especially when the heating element is operated at high voltage

Nicotine

Although nicotine from NRT and e-cigs are considered relatively safe (McNeill et al, 2015), there is recent evidence that nicotine is deleterious to parts of the nervous system (Cope, 2016). It also has harmful effects on many non-neurological cells, including those in the respiratory tract, immune system and blood vasculature (Cope, 2016). Stimulation of these receptors in the blood vessels increases the formation of atheroma, causes inflammation, modifies the smooth muscle cells, and increases small vessel growth (Santanam et al, 2012).

As well as causing potential harm to users, nicotine is also a powerful poison, with an increasing number of reports of accidental ingestion of nicotine solutions by children, some of which have been fatal (Gupta et al, 2014). There have even been reports of intentional intake of the fluids during suicide attempts (Schipper et al, 2014). Other problems associated with e-cigs arise from substandard and unregulated manufacture leading to injuries caused by explosions (Brown and Cheng, 2014) and loss of property owing to fires started by exploding battery chargers (BBC News, 2014).

Advice to cardiovascular patients

Pharmacotherapy such as nicotine replacement therapy (NRT), bupropion and varenicline are recommended for most smokers trying to quit. NRT includes slow- and rapid-release formulae. These should be used in combination (i.e. slow-release type (patch) used with rapid-release, (e.g. nicotine gum, lozenge, inhaler, nasal spray)) when needed (Stead et al, 2012). NRT can also be used with bupropion or varenicline to increase its efficacy (Cahill et al, 2013).

However, many patients are disillusioned with pharmacotherapy, reflected by high non-adherence rates (Yingst et al, 2015). They are increasingly aware of e-cigs and, because of advertising and anecdotal evidence, will use the devices either as a replacement for combustible cigarettes, or as a smoking-cessation tool.

Considering the effects of nicotine on the vasculature, however, e-cigs potentially pose a significant danger to those cardiovascular patients at risk (Morris et al, 2015). Therefore, information needs to be gathered about their use (*Box 2*). This can be problematic because, as with normal cigarettes, there may be a significant degree of denial or under-reporting (Park et al, 2015). For accurate determination, cotinine (the major breakdown product of nicotine) can be measured. This will assess nicotine intake over the previous 3 days and can be done easily with a point-of-care cotinine test (Cope et al, 2012). This is the only simple approach as carbon monoxide (CO) is not generated by e-cigs. If this is not possible because of non-availability of the technology or because of cost, it is important to integrate questions about the frequency of e-cig use, along with enquiries about tobacco use, into routine consultation (Bhatnagar et al, 2014).

Smoking cessation counselling should rely on tried and tested pharmacotherapy methods combined with the usual '5A' counselling and follow-up (Dino et al, 2011). This involves asking the patient about their smoking status to assess their willingness to make a quit attempt, advising the smoker to stop, assisting them in their stop-smoking efforts, and arranging for follow-up visits to support the patient's efforts (Cope, 2016). If the patient expresses a desire to use e-cigs to quit smoking, nurses and other cardiac health professionals should tell patients about their possible dangers, explain that they should be used for a limited time (not merely as a substitute for conventional cigarettes), and advise that a quit date should be chosen and adhered to.

Conclusion

Assistance with smoking cessation is a fundamental element of the management of the cardiovascular patient. Cardiovascular specialists have a professional obligation to assist with the initiation of cessation treatment and advance tobacco control efforts, and can play an important role in achieving a smoke-free future (Prochaska and Benowitz, 2015). The role of e-cigs as a smoking-cessation tool remains controversial, with some advocating their use as a safer alternative to conventional cigarettes (Gostin, 2015), while others believe the devices should not be normalised and 'should be seen as a part of the armoury of devices intended to wean smokers away from cigarettes, and nothing more' (Watson and Forshaw, 2015).

Proposed regulations which come into effect in the UK on 20th May, when e-cigs will come under the revised EU Tobacco Products Directive, will regulate the amount of nicotine available and improve safety of the liquid containers (McNeill et al, 2015). Certainly, more research is required to determine the benefits of these devices as smoking-cessation aids, as well as potential toxic effects of long-term nicotine and the other chemicals produced. BJCN

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Key Points

- Electronic cigarette use is increasing
- Electronic cigarettes generate a water vapour containing nicotine
- There is no carbon monoxide and other toxins are reduced
- Nicotine may cause detrimental effects
- Safety of e-cigarettes is yet to be established
- Role as a smoking cessation aid needs further investigation