E-cigarettes: informing the conversation with patients

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Since their invention shortly after the start of the new millennium, electronic cigarettes (e-cigarettes) have grown in popularity. They may be referred to by a range of other names, including the colloquial term ‘vape’, or the more scientific electronic nicotine delivery system (ENDS). Some organisations advocate their use in smoking cessation alongside conventional products such as nicotine replacement therapy (NRT). In contrast, other organisations warn against their use, citing potential adverse consequences from an emerging evidence base.

Nonetheless, e-cigarette use is common and increasing in the UK. Healthcare professionals should therefore be comfortable enquiring about e-cigarette use, taking a history as they would for traditional cigarettes, and making a record of this in the notes. Understanding and recognising potential adverse consequences is also important to be able to counsel patients who choose to continue e-cigarette use.

However, existing data suggest that the majority of healthcare professionals are not comfortable in their own knowledge of e-cigarettes, or how to discuss them with patients. This article will highlight key information about e-cigarettes, how they work, their advantages and disadvantages with reference to the evidence base, and how to approach a consultation with a patient who uses e-cigarettes, or who wishes to use them as a smoking cessation aid.

History
The first e-cigarette was invented in China by pharmacist Hon Lik in 2003. An active smoker, he was determined to find a method to help him quit for good, strengthened in his motivations by his father’s recent diagnosis of lung cancer, which would unfortunately prove fatal. E-cigarettes function as smokeless, electronic systems to deliver nicotine-containing products commonly referred to as vapour or e-liquid.

Following their invention, e-cigarettes rapidly spread around
the world, with patents registered in the USA, the UK and the EU in 2003. The USA granted the first patent for e-cigarettes in 2006, with UK retailers marketing them the following year.

In the UK, uptake of e-cigarettes has risen steadily over the past 10 years, with 1.6% of adults reporting e-cigarette use in 2012, rising to 5.4–6.2% for adults and 1.7% for 11–18-year-olds by 2018, with a higher prevalence still in current or ex-smokers. By 2014, ENDS were the fastest growing category of products sold in UK supermarkets. Though data suggest that the majority of e-cigarette brands are independently owned, several e-cigarette brands are owned by tobacco-trading parent companies despite being designed to draw consumers away from traditional cigarette products.

In the UK, e-cigarettes are subject to the Tobacco and Related Products Regulations 2016, which enforces Directive 2014/40/EU of the European Parliament (see Table 1), with the same protection remaining in place post-Brexit.

### E-cigarette anatomy

Devices come in a variety of forms, and can be disposable but are more commonly rechargeable. Frequently encountered classes/generations of e-cigarette are illustrated in Table 2.

Devices typically comprise the mouthpiece, an atomiser, an e-liquid/vapour-containing cartridge (second and third generations), and a battery. E-liquid cartridges can contain nicotine, or cannabinoid derivatives such as tetrahydrocannabinol (THC) and cannabidiol (CBD). Greater restriction of e-liquid contents was introduced by European and UK Parliament legislation, though many different brands and flavours remain routinely available in supermarkets as well as in specialist shops, in person or online. However, some devices allow the user to modify and create their own e-liquid cartridges, and e-liquid may be sourced from informal vendors, which can circumvent this legislation and increase risks of adverse events.

### Demographics

ENDS use in the UK is rising and totalled 5.4–6.2% of all adults in 2018. They are used most commonly by current or former smokers. In 2018, only a third of current smokers had never tried e-cigarettes and 14.9–18.5% were current users, compared with 10.3–11.3% of ex-smokers.

In the USA, where e-cigarettes are more commonly used tobacco product in young people. In 2020, 4.7% of middle school and 19.6% of high school students had used an e-cigarette in the past 30 days, and 40% of e-cigarette users aged 18–40 years had never tried cigarettes. Though the proportion of adult e-cigarette users in the USA is lower than in the UK at 3.2% in 2018, they are more likely to be never-smokers than in the UK (1.3% vs 0.4–0.8%).

Although not yet mirrored in the UK data, these trends seen in the USA are obviously very concerning. Rates of never-smokers taking up vaping, particularly young adults, this is actually very uncommon in the UK. In 2018, only 0.2% of young people aged 11–18 years and 0.4–0.8% of adults identifying as never-smokers reported e-cigarette use.

### Benefits: smoking cessation

E-cigarettes as aids to smoking cessation are advocated by several organisations including Public Health England. This is based on the principle of risk-reduction – simply, e-cigarettes provide nicotine in a much safer form than traditional cigarettes. Although neither are entirely risk-free, e-cigarettes are generally accepted to confer less risk to both the user and passive smokers than traditional cigarettes. Similarly, the risk to the fetus in pregnant women is also considered lower than with traditional cigarettes. This is because e-cigarettes do not contain the combustion products responsible for smoking-related cardiovascular and respiratory disease, and cancer.

The rates of successful quit attempts using e-cigarettes remains small. At six months, 4.1% of all attempts with non-nicotine e-cigarettes, 7.8% with nicotine-containing e-cigarettes, and 5.8% with nicotine patches will prove successful, showing minimal difference between attempts made using e-cigarettes versus traditional NRT. These findings were largely confirmed in a recent Cochrane systematic review of 56 randomised and non-randomised trials investigating the role of nicotine and non-nicotine e-cigarettes in smoking cessation.

The included studies provided moderate-certainty evidence that nicotine containing e-cigarettes increased successful quit attempts when compared to non-nicotine e-cigarettes or tradi-

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**Table 1. Regulations for electronic cigarettes introduced by European Parliament Directive 2014/40/EU, and reinforced in the UK by the Tobacco and Related Products Regulations 2016.**

| Component                  | Regulation                                                                 |
|----------------------------|-----------------------------------------------------------------------------|
| Advertising and provision of information | • Restrictions on advertising, promotions, and sponsorship  
• Information must be provided from manufacturer six months prior to marketing  
• Mandatory health warnings comprise ≥30% of packaging, stating it contains nicotine, which is highly addictive  
• Information leaflet on how to use, contraindications and side-effects |
| Safety                     | • Child and tamper-proof  
• Protection against breakage and leakage  
• Suspected adverse event reporting system by manufacturer |
| Content                    | • Strength of nicotine limited to 20mg/ml (2%)  
• Cartridges limited to 10ml  
• Tanks limited to 2ml  
• Additive ingredients banned (vitamins, minerals, caffeine, taurine) |
| Demographics               | • Annual provision of sales data from manufacturers |
tional NRT, although absolute increases were small at 4%. The authors caution that further prospective investigation to confirm these findings is required as the majority of included studies in this systematic review were non-randomised trials and often investigated older classes of e-cigarettes.14

Patients using e-cigarettes also often report greater satisfaction and greater reduction in smoking than those using nicotine patches, and e-cigarettes are regarded as the most popular form of smoking cessation aid with smokers wishing to quit.13 Current position statements and the existing evidence base advocate their combination with stop smoking counseling, the most effective smoking cessation tool.17,14

Concerns

There are growing concerns about potential harms of e-cigarettes. The World Health Organization’s (WHO’s) stance on e-cigarettes contrasts with Public Health England. Their particular concerns include the risk to users and passive non-users of toxic substance inhalation, the addictive nature of nicotine and its impact on brain development in children and adolescents, cardiorespiratory disorders, risks of fetal damage in pregnant e-cigarette users, and physical trauma resulting from device malfunction.15 The potential impacts of e-cigarettes on adolescent brain development is particularly alarming considering these are used by almost one in five American high school students, a large proportion of whom have never tried traditional cigarettes.11 They represent a growing young population who may become addicted to nicotine exclusively through these novel nicotine delivery systems, risking both neurodevelopmental and cardiorespiratory consequences over a prolonged period of time.

WHO states that the role of e-cigarettes in smoking cessation is unclear, due to heterogeneity of devices and a lack of evidence supporting their efficacy, and that existing evidence-based methods of smoking cessation support are recommended instead.15

Putting this into context, the regulation of e-cigarettes in the UK and EU is not universal across the world, and the WHO advice must reflect health data pertaining to countries where regulation of e-liquid content is less stringent. However, some warnings, including those concerning nicotine and physical damage, are applicable to all devices regardless of regulation.

Device malfunction

Dangers of e-cigarette malfunction, including devices exploding or catching fire, have been reported. Although these incidents seem to be fairly uncommon, the potential harm to the user and people utilising the surrounding area is significant. Burns and other injuries have been reported, as well as damage to property. However, the risk of accidental fires caused by e-cigarettes is over a hundred-fold less than with traditional cigarettes (see Figure 1).16

Safety checks, such as periodically inspecting the device for defects; using the correct, branded, non-generic, charger; and not leaving devices charging unsupervised for long periods, can help mitigate these risks.

| Generation               | Description and characteristics                                      |
|--------------------------|---------------------------------------------------------------------|
| First-generation, AKA ‘cigalike’ | • Disposable<br>• Appearance mimics traditional cigarettes<br>• Closed systems |
| Second-generation, AKA ‘pens’  | • Rechargeable<br>• Similar in appearance to a fountain pen<br>• Larger than first-generation devices<br>• Refillable cartridges |
| Third-generation, AKA ‘mods’   | • Larger<br>• Longer charge time<br>• Refillable separate cartridges<br>• Increased ability for modification |

Table 2. Characteristics and examples of different generations of e-cigarettes. As product development has advanced, devices are now commonly rechargeable and provide more capacity for customisation by the user. Figures adapted from Bauld et al. Electronic cigarette marketing: current research and policy. Cancer Research UK. October 201616

Figure 1. Fires per week caused by smoking March 2013–2016

Figure 1. Fires per week caused by different smoking-related materials in the UK, with information from the National Fire Chiefs Council.16 Fire experts recommend swapping traditional cigarettes or pipes to e-cigarettes to reduce the risk of fire and subsequent harm. Although not the most common cause of accidental fires, mortality from smoking-related fires remains high

E-cigarette or vaping product use-associated lung injury

Shortly after the widespread uptake of e-cigarettes in the USA, healthcare professionals began to encounter a clinical syndrome of acute respiratory distress and lung injury not caused by any infective agent, commonly occurring in young males with recent e-cigarettes use. As the condition became increasingly prevalent, it was termed e-cigarette or vaping product use-assoc-
Confmed
All of:
• Use of an e-cigarette 90 days prior to symptom onset
• Absence of pulmonary infection*
• No evidence of alternative plausible diagnoses (e.g., cardiac, rheumatological, neoplastic pathology)

Probable
All of:
• Use of an e-cigarette 90 days prior to symptom onset
• Pulmonary infiltrates such as opacification on plain chest X-ray, OR ground-glass opacity on CT chest
• Infection identified, OR minimum testing to exclude infection not done/not possible, BUT clinical team do not think infection is the sole cause of lung injury
• No evidence of alternative plausible diagnoses

*Minimum recommended work-up: a negative respiratory viral panel, a negative influenza PCR or rapid test if influenza testing is supported locally, and all other clinically indicated respiratory infections, such as urine antigen for Streptococcus pneumoniae and Legionella, sputum culture in productive cough, bronchoalveolar lavage analysis if performed, and HIV-associated opportunistic infections if indicated

Table 3. Diagnostic criteria for confirmed and probable e-cigarette or vaping product use-associated lung injury (EVALI) developed by the US Centers for Disease Control and Prevention

Chronic cardiovascular and respiratory effects

Vascular dysfunction
The negative impact of traditional cigarettes on vascular function is well established. Endothelial dysfunction resulting from oxidative stress is responsible for instigating atherosclerosis, the hallmark disease progress in a range of cardiovascular disorders.

Both e-cigarettes and traditional cigarettes transiently increase blood pressure following use. Additionally, both are associated with oxidative stress and vascular dysfunction. Concerningly, chronic e-cigarette use is associated with increased low-density lipoprotein, which predisposes to atherosclerosis. Though the adverse impact on the vasculature for e-cigarettes is comparatively less than for traditional cigarettes, it is elevated compared with non-smokers. It is likely this is a result of the vascular impact of nicotine, but further studies are needed.

Chronic lung disease
There is also concern that longer term, e-cigarettes might cause pulmonary fibrosis and chronic obstructive pulmonary disease. Similar to vascular dysfunction, e-cigarette aerosol also negatively impacts on various processes integral to pulmonary health, including reduced airway cilial function, impaired immune cell action, and increased microbial presence and virulence in distal airways.

Specific e-liquid components also confer negative effects on the lung. Propylene glycol upregulates proinflammatory receptors in the airways in a manner similar to asthmatic hyperreactivity, and also affects phagocytosis. Nicotine also affects macrophages and inhibits apoptosis. Various e-liquid flavours such as aldehydes can cause airway irritation, cytotoxicity and cilial dysfunction.

Though no long-term prospective human data are available, in mice, chronic e-cigarette exposure (six months) causes airway remodelling, inflammation, neutrophilia and emphysema. It
seems unlikely that e-cigarettes will be without pathological consequences within the human lung and elsewhere, though when we will be able to prove or disprove this is less clear. The multitude of long-term adverse impacts on health conferred by traditional cigarettes were not known until many decades after their initial widespread use. At present, we can only reflect on potential consequences of 10–15 years of widespread e-cigarette use. Regular monitoring of suspected adverse events arising from e-cigarettes via UK and EU-mandated registries will aid recognition of new complications in future, though it is unlikely we will appreciate the full picture of any long-term harms until well into this century.

| Objective       | Possible phrasing or action                        | Rationale                                                                 |
|-----------------|----------------------------------------------------|---------------------------------------------------------------------------|
| Initial enquiry | “Do you smoke cigarettes or electronic cigarettes?” | E-cigarette use may be less readily volunteered by patients               |
| Quantification  | “Do you also smoke cigarettes?”                    | Clarify if not volunteered. E-cigarettes riskier in never-smokers         |
|                 | “How long have you used e-cigarettes and why did you start?” | Same questions you would use to determine ‘pack years’ in traditional cigarettes |
|                 | “How many times a day do you use them?”            |                                                                           |
|                 | “Do you use nicotine-containing e-liquid?”          | Risks of nicotine in young people                                         |
|                 | If so: “Do you know the concentration of nicotine (in mg/ml)?” | Allows quantification of nicotine use per day. For reference, a traditional cigarette has 10–15mg, with a systemic dose of 1–2mg. 20-a-day smokers starting vaping will typically use 20ml of 18mg/ml nicotine-containing e-liquid per week. Blood nicotine concentration can be comparable between traditional and e-cigarettes in established users (around 13–14ng/ml). |
|                 | “What size are the cartridges?”                     |                                                                           |
|                 | “How long would a cartridge typically last you or how many do you use each week?” |                                                                           |
| Source          | “Where did you get your device?”                    | THC-containing e-liquid confers a higher risk of EVALI                    |
|                 | “Where do you get your e-liquid?”                   |                                                                           |
| Safety          | “Do you ever make your own e-liquid, or source this from friends or acquaintances?” | Homemade or informally sourced e-liquid may circumvent strict regulations on content |
|                 | “Do you use the correct branded charger that came with your device?” | Increased risk of fires or device explosion with generic chargers         |
| Contextualise   | Consider whether symptoms or signs of e-cigarette complications are present | Does this patient have new or worsening respiratory symptoms suggestive of EVALI? Burns or other trauma from device malfunction? |
| Cessation       | “Have you ever tried to stop using e-cigarettes?”   | Personalise this to the patient as you would for traditional cigarettes   |
|                 | Assess motivation to stop                           | Never-smokers should be strongly encouraged to stop                       |
|                 | Offer NRT and other appropriate support             |                                                                           |
|                 | Explain risks – particularly for never-smokers      | E-cigarettes may be recommended as a short-term cessation aid for traditional cigarettes, but not continued indefinitely |

Table 4. An overview of best practice points on e-cigarettes to consider incorporating into a social history. Many aspects can be borrowed from established practice for traditional cigarettes, with discussions around specific risks and role in smoking cessation tailored to the patient and e-cigarettes. Establishing motivations for starting and willingness to stop are both important. The risk-benefit ratio is different for never vs current and ex-smokers.
Putting this into practice: taking a vaping history
Many healthcare professionals will be less familiar with discussing e-cigarettes with patients. We have suggested some best practice points in Table 4. Many techniques can be borrowed from discussions on traditional cigarettes and smoking cessation, which healthcare professionals will be more familiar with. The encounter should be tailored to the individual patient, with informed discussions of risk and encouragement to stop being central focuses.

Taking an accurate history of e-cigarette use confers benefits at both population and individual level. At a population level, this will construct an accurate picture of e-cigarette use, which may be important for associating future health consequences with e-cigarettes. Mandatory registries of suspected e-cigarette-related adverse events will also assist with this. At an individual level, it allows healthcare professionals to track use over time, and where desired, offer support for those wishing to discontinue using e-cigarettes.

Resources
NICE has published guidance on counselling patients who wish to stop using traditional cigarettes with e-cigarettes as an adjunct.38

The National Centre for Smoking Cessation and Training has also produced an online training package on how to support patients to quit smoking using e-cigarettes, available at https://elearning.ncsct.co.uk, as well as comprehensive briefing on the current evidence base for ENDS as smoking cessation aids and beyond.12

Summary
E-cigarette use in the UK is common and increasing. The stance of different public bodies on the relative harms of e-cigarettes and their role in smoking cessation is variable. Some recommend e-cigarettes as a smoking cessation adjunct, with others reluctant to do so due to lack of evidence.

Numbers of both adult and adolescent never-smokers taking up e-cigarettes remain low in the UK. However, in the USA, e-cigarettes are the most common nicotine delivery system in young people, a large proportion of whom have never tried traditional cigarettes.

Potential harms of e-cigarettes include device malfunction, fire risk, developmental problems in pregnancy and young people, and cardiorespiratory dysfunction and disease. Healthcare professionals should become familiar with discussing e-cigarettes with patients. This article and the suggested resources propose best practice points in taking a vaping history, discussing risks posed by e-cigarettes and supporting patients in e-cigarette cessation.

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Declaration of interests
None to declare.

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