Electronic cigarettes for smoking cessation

Jamie Hartmann-Boyce senior researcher, Rachna Begh NIHR postdoctoral research fellow, Paul Aveyard professor of behavioural medicine

What you need to know

- Electronic cigarettes (e-cigarettes) were originally designed as a smoking cessation aid, and the limited evidence available suggests e-cigarettes containing nicotine may help people stop smoking
- Evidence suggests e-cigarettes are considerably safer than traditional cigarettes
- The technology used in e-cigarettes has evolved considerably over time, and newer devices are typically better at delivering nicotine, which might enhance effectiveness

A 42 year old electrician has tried to stop smoking several times, including with the aid of pharmacotherapy and behavioural support. He asks you about using electronic cigarettes (e-cigarettes). His work partner stopped smoking a year ago and is still using e-cigarettes now. He has heard that e-cigarettes are as damaging as the real things and worries that if he ends up addicted to e-cigarettes he’ll not have gained anything.

About 60% of current adult smokers in Great Britain have tried electronic cigarettes (e-cigarettes), and 18% are current e-cigarette users.1 In England, over 40% of people who try to stop smoking do so with the aid of e-cigarettes.2 About 52% of current e-cigarette users are former smokers.3 Some people who stop smoking with an e-cigarette are still using e-cigarettes a year later.4 In this article we look at whether e-cigarettes help people who smoke to cut down and stop smoking, what are the health risks from e-cigarette use, and how these compare with smoking.

Cigarette and nicotine addiction

Most people who smoke cigarettes are addicted, and the main vehicle of that addiction is nicotine. When stopping smoking, people experience cravings for cigarettes, which drives return to smoking. These cravings for smoking are less intense when nicotine is substituted; thus replacing nicotine from sources other than cigarettes can facilitate achieving abstinence.

Transferring from cigarettes to other nicotine delivery devices, such as nicotine replacement therapy (NRT) or e-cigarettes, can transfer cigarette addiction to nicotine addiction. Around half of lifetime regular smokers will eventually die from smoking related causes,5 whereas evidence on harms of addiction to NRT or e-cigarettes show it is much less hazardous. Moreover, while cigarette smoking is tenacious, only a minority of people who transfer to NRT (and do not return to smoking) are persistent users.6 While there is less evidence on persistent use of e-cigarettes after quitting smoking, one French cohort study found that over half of people who quit smoking with the aid of e-cigarettes were no longer using e-cigarettes six months later.7 Persistent users of NRT and e-cigarettes report doing so primarily to avoid a return to smoking.6 7

All nicotine delivery devices—cigarettes, NRT, and e-cigarettes—provide nicotine dose information. It is not possible to use this to compare the nicotine dose delivered across the types of devices, however, as the dose the user receives depends much more on how the device is used than the stated package dose.8 Adding additional nicotine delivery devices, such as by using NRT or e-cigarettes while smoking, does not usually increase nicotine dose and tends to reduce tobacco dependence.9-11
What are electronic cigarettes?

E-cigarettes heat a liquid into an aerosol for inhalation, which usually comprises propylene glycol and glycerol, with or without flavours (3). Different models of e-cigarettes are available, typically referred to as first, second, third, or fourth generation devices (4). The “e-liquid” or “juice” is stored in disposable or refillable cartridges or a reservoir, depending on the type of device. E-liquid varies in its nicotine content, from liquid which contains no nicotine to liquid that contains doses >20 mg/mL. E-cigarette users are sometimes described as “vapers” and e-cigarette use as “vaping.”

E-cigarettes were originally designed as a smoking cessation aid. In those that contain nicotine, urges and withdrawal symptoms may be reduced by substituting the nicotine from tobacco smoke—as with more traditional forms of nicotine replacement therapy (such as nicotine patches or gum). E-cigarettes may also facilitate smoking cessation by addressing the sensory and behavioural aspects of addiction to smoking cigarettes.

How well do they work for cutting down?

There is no definitive evidence that reducing cigarette consumption without quitting improves health. For that reason, the 2016 Cochrane review of electronic cigarettes for smoking cessation did not address reduction. However, people who want to reduce usually want to quit eventually, and there is evidence from a separate Cochrane review that, in people unmotivated to quit, providing NRT to help people initially reduce their cigarette consumption can lead to increased quit rates in the longer term. It therefore follows that nicotine-containing e-cigarettes may also be helpful in promoting reduction and abstinence, but the 2016 Cochrane review of tobacco harm reduction interventions included only one small study of e-cigarettes, meaning there was insufficient direct evidence to conclude this.

What are the harms?

Studies conducted in people using e-cigarettes to quit smoking have not detected serious adverse effects, and the devices seem well tolerated by people who smoke. However, as e-cigarettes have been used for only a few years, there is scant epidemiological data on the safety of e-cigarettes when used as a long term or permanent replacement for smoking. Most studies which have reported on safety of e-cigarettes were small, uncontrolled, and followed participants for six months or less, and therefore the Cochrane review of e-cigarettes judged the quality of evidence on adverse events from e-cigarettes as low. As almost all regular use of e-cigarettes occurs in former or current smokers, interpreting future epidemiological data will be difficult, though longer term studies are under way (see “Ongoing studies” in Cochrane review). Based on comparisons of the composition of carcinogens and toxicants in tobacco smoke and e-vapour, a Royal College of Physicians report estimated that the harm arising from long term vapour inhalation from e-cigarettes is unlikely to exceed 5% of the harm from smoking tobacco. Although many have criticised this figure, there is consensus among public health experts that smoking is more dangerous than vaping.

Many studies—mostly small and uncontrolled—have investigated aspects related to the safety of e-cigarettes. Findings on individual outcome groups and key biomarkers are summarised in Boxed Text on page 3 of 1 and 3, drawing on the 2016 Cochrane review of e-cigarettes but updated to include relevant studies published since.
nor quit rates were significantly different between those assigned to e-cigarettes with nicotine and those assigned to patch, though confidence intervals do not rule out an important difference for six-month cessation (risk ratio 1.26 (95% CI 0.68 to 2.34), 584 participants). 18

Multiple trials are ongoing comparing e-cigarettes with traditional forms of nicotine replacement therapy (NRT). 17 At present there are only two completed randomised controlled trials of e-cigarettes for smoking cessation with follow-up at six months or longer, whereas there are over 100 definitively establishing the efficacy and safety of nicotine replacement therapy for smoking cessation. 15, 17 The Royal College of Physicians has stated that, as e-cigarettes are not currently made to medications standards, they are “probably more hazardous than NRT.” 12

How cost effective are they?
Though other forms of NRT are often paid for by healthcare systems, e-cigarettes are not as they are not medically licensed. There are no evaluations of cost effectiveness.

Safety in people with pre-existing conditions
Results from individual studies in people with chronic obstructive pulmonary disease, asthma, and hypertension have generally shown improvements in symptoms and have not detected serious adverse effects. We found no studies providing evidence regarding the safety of e-cigarette use during pregnancy. Findings in these populations from retrospective chart reviews are summarised in I.

What happens in people who cut down tobacco smoking but don’t stop?
Most studies of e-cigarettes compare people using them exclusively with people exclusively using combustible forms of tobacco. However, dual use is common in the general population. 1 There are no long term data on the safety of dual use, but data from one short term study detected reductions in toxicants in people who switched from using only combustible tobacco to using combustible tobacco and e-cigarettes. 16 None of the included studies in the Cochrane review found an increase in adverse events or undesirable changes in biomarkers in people who began using e-cigarettes in addition to combustible tobacco. 17 However, there is no definitive evidence that reducing cigarette consumption without quitting improves health.

How do they compare with other nicotine replacement therapies?
Only one randomised controlled trial with long term follow-up is available comparing e-cigarettes with nicotine replacement therapy. In the ASPIRE trial, participants were randomised to e-cigarettes with nicotine, e-cigarettes without nicotine (placebo), or nicotine patch for 13 weeks. Neither adverse events
How patients were involved in the creation of this article
We held discussions with three members of the UK Centre for Tobacco and Alcohol Studies smokers' panel before drafting the current article; these discussions informed what was included in the sections on safety and tips for patients. Panel members also commented on the full article, resulting in revisions to the tips for patients.

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Contributors JHB, RB and PA all contributed to the conception and design of the work; the acquisition, analysis, and interpretation of the data; the drafting and revision of the manuscript critically for important intellectual content; and final approval of the version to be published. JHB is guarantor.


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### Tables

**Table 1** Summary of changes in tobacco toxicant biomarkers reported in longitudinal studies of smokers who switched partially or fully to e-cigarettes for at least a week

<table>
<thead>
<tr>
<th>Comparison†</th>
<th>Summary of results</th>
<th>Study duration</th>
<th>Sample size</th>
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<tbody>
<tr>
<td><strong>Exhaled carbon monoxide (CO)</strong></td>
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<tr>
<td>e-cigarettes v continuing smoking</td>
<td>Statistically significant declines in e-cigarette users; no significant changes in continuing smokers who did not use e-cigarettes 17,24</td>
<td>4 weeks to 8 months</td>
<td>3 studies (2 RCTs, 1 observational), n=480</td>
</tr>
<tr>
<td>Nicotine e-cigarettes v non-nicotine e-cigarettes</td>
<td>No differences between groups 17,24</td>
<td>1 to 3 weeks</td>
<td>2 RCTs, n=123</td>
</tr>
<tr>
<td>Before-after provision of and instruction to use e-cigarettes</td>
<td>Statistically significant declines from baseline to follow-up in both exclusive e-cigarette users and dual users 17,25-27</td>
<td>1 week to 2 years</td>
<td>8 studies (3 RCTs, 5 observational), n=344</td>
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| **Known tobacco-related carcinogens** |                                                                                   |                      |               |
| e-cigarettes v continuing smoking | Declines in three carcinogens in both groups, but changes were statistically significant in e-cigarette users only; statistically significant group differences observed 24 | 12 weeks             | 1 RCT, n=408  |
| Before-after study of provision of and instruction to use e-cigarettes | Statistically significant reductions in at least some of the measured toxicants in both exclusive e-cigarette users and dual users. No studies found increases in any of the toxicants measured 17-28 | 10 days to 4 weeks   | 3 studies (1 RCT, 2 observational), n=97 |

| **Blood pressure** |                                                                                   |                      |               |
| e-cigarettes v continuing smoking | General population: no clinically or statistically significant group differences 24 | 12 weeks to 2 years  | 2 studies (1 RCT, 1 observational), n=497 |
| Nicotine e-cigarettes v non-nicotine e-cigarettes | No significant (clinical or statistical) changes among or between groups 24 | 1 year               | 1 RCT, n=300  |

| **Heart rate** |                                                                                   |                      |               |
| e-cigarettes v continuing smoking | No clinically significant changes in people who switched from smoking alone to partial or exclusive use of e-cigarettes 24,30 | 12 weeks to 1 year   | 2 RCTs, n=708 |
| Nicotine e-cigarettes v non-nicotine e-cigarettes | No significant (clinical or statistical) changes among or between groups 24,30 | 1 year               | 1 RCT, n=300  |

| **Lung function (including FEV1, FVC)** |                                                                                   |                      |               |
| e-cigarettes v continuing smokers | No clinically significant changes (one study in healthy volunteers, one in people with COPD) 24,31 | 12 weeks to 2 years  | 2 studies (1 RCT, 1 observational), n=456 |
| Before-after study of provision of and instruction to use e-cigarettes | Statistically significant improvements over a 2 year period (study in people with asthma) 24,30 | 2 years             | 1 observational, n=18 |

* BMJ 2018;360:j5543 doi: 10.1136/bmj.j5543 (Published 17 January 2018)
Table 2  Summary of findings from studies of e-cigarette use in people with pre-existing conditions

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<tr>
<th>Condition</th>
<th>Study details</th>
<th>Findings</th>
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| Asthma                                         | Uncontrolled study of people who smoked and switched to e-cigarettes using 2 years of data from medical records (n=18)²⁸   | No evidence of harm
Statistically significant improvements in asthma control questionnaire (ACQ) scores and lung function parameters over study period |
| Hypertension                                   | Two year study of blood pressure readings from medical records comparing people with hypertension who continued smoking with those who switched (n=89)²⁸ | E-cigarette use well tolerated
No severe adverse reactions or acute decompensation in blood pressure in e-cigarette users
Statistically significantly lower systolic and diastolic blood pressure in e-cigarette users than in matched tobacco smokers at 12 months (P<0.001) |
| Chronic obstructive pulmonary disease (COPD)   | Two year study of data from medical records comparing people with COPD who continued smoking with those who switched (n=48)²⁴ | Statistically significant reduction in COPD exacerbations in e-cigarette users, from 2.3 (SD 1.0) at baseline to 1.8 (SD 1.0, P=0.002) at 1 year and 1.4 (SD 0.9, P<0.001) at 2 years. No changes in matched controls |
Figures

Components of an electronic cigarette

- Mouthpiece
- Heating element (atomiser) heats the "juice" to make vapour
- Cartridge (tank) holds the liquid "juice"
- Microprocessor
- Battery
- Many devices have a switch to activate the heating element
- Some devices have a light-emitting diode on the end to stimulate the glow of a burning cigarette

Components of an electronic cigarette
Different generations of electronic cigarettes

1st Generation

‘cig-a-like’
Cartridge, atomiser and battery

2nd Generation

‘vape pens’
Tank and battery
Refillable

3rd Generation

Mechanical ‘mods’
Variable power options