



Public Health  
England

Protecting and improving the nation's health

# E-cigarettes: an evidence update

## A report commissioned by Public Health England

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## Foreword

The role and impact of electronic cigarettes has been one of the great debates in public health in recent years and we commissioned this independent review of the latest evidence to ensure that practitioners, policy makers and, most importantly of all, the public have the best evidence available.

Many people think the risks of e-cigarettes are the same as smoking tobacco and this report clarifies the truth of this.

In a nutshell, best estimates show e-cigarettes are 95% less harmful to your health than normal cigarettes, and when supported by a smoking cessation service, help most smokers to quit tobacco altogether.

We believe this review will prove a valuable resource, explaining the relative risks and benefits of e-cigarettes, in terms of harm reduction when compared with cigarettes and as an aid to quitting.

We will continue to monitor the position and will add to the evidence base and guidance going forward.

A handwritten signature in black ink, appearing to read 'Duncan Selbie' in a cursive, flowing style.

Duncan Selbie, Chief Executive, PHE

## Key messages

1. Smokers who have tried other methods of quitting without success could be encouraged to try e-cigarettes (EC) to stop smoking and stop smoking services should support smokers using EC to quit by offering them behavioural support.
2. Encouraging smokers who cannot or do not want to stop smoking to switch to EC could help reduce smoking related disease, death and health inequalities.
3. There is no evidence that EC are undermining the long-term decline in cigarette smoking among adults and youth, and may in fact be contributing to it. Despite some experimentation with EC among never smokers, EC are attracting very few people who have never smoked into regular EC use.
4. Recent studies support the Cochrane Review findings that EC can help people to quit smoking and reduce their cigarette consumption. There is also evidence that EC can encourage quitting or cigarette consumption reduction even among those not intending to quit or rejecting other support. More research is needed in this area.
5. When used as intended, EC pose no risk of nicotine poisoning to users, but e-liquids should be in 'childproof' packaging. The accuracy of nicotine content labelling currently raises no major concerns.
6. There has been an overall shift towards the inaccurate perception of EC being as harmful as cigarettes over the last year in contrast to the current expert estimate that using EC is around 95% safer than smoking.
7. Whilst protecting non-smoking children and ensuring the products on the market are as safe and effective as possible are clearly important goals, new regulations currently planned should also maximise the public health opportunities of EC.
8. Continued vigilance and research in this area are needed.

## Executive summary

Following two previous reports produced for Public Health England (PHE) on e-cigarettes (EC) in 2014, this report updates and expands on the evidence of the implications of EC for public health. It covers the EC policy framework, the prevalence of EC use, knowledge and attitudes towards EC, impact of EC use on smoking behaviour, as well as examining recent safety issues and nicotine content, emissions and delivery. Two literature reviews were carried out to update the evidence base since the 2014 reports and recent survey data from England were assessed.

EC use battery power to heat an element to disperse a solution of propylene glycol or glycerine, water, flavouring and usually nicotine, resulting in an aerosol that can be inhaled by the user (commonly termed vapour). EC do not contain tobacco, do not create smoke and do not rely on combustion. There is substantial heterogeneity between different types of EC on the market (such as cigalikes and tank models). Acknowledging that the evidence base on overall and relative risks of EC in comparison with smoking was still developing, experts recently identified them as having around 4% of the relative harm of cigarettes overall (including social harm) and 5% of the harm to users.

In England, EC first appeared on the market within the last 10 years and around 5% of the population report currently using them, the vast majority of these smokers or recent ex-smokers. Whilst there is some experimentation among never smokers, regular use among never smokers is rare. *Cigarette* smoking among youth and adults has continued to decline and there is no current evidence in England that EC are renormalising smoking or increasing smoking uptake. Instead, the evidence reviewed in this report point in the direction of an association between greater uptake of EC and reduced smoking, with emerging evidence that EC can be effective cessation and reduction aids.

Regulations have changed little in England since the previous PHE reports with EC being currently governed by general product safety regulations which do not require products to be tested before being put on the market. However, advertising of EC is now governed by a voluntary agreement and measures are being introduced to protect children from accessing EC from retailers. Manufacturers can apply for a medicinal licence through the Medicines and Healthcare products Regulatory Agency (MHRA) and from 2016, any EC not licensed by the MHRA will be governed by the revised European Union Tobacco Products Directive (TPD).

A summary of the main findings and policy implications from the data chapters now follows.

## Summary of Chapter 3: UK policy framework

The revised TPD will introduce new regulations for EC or refill containers which are not licensed by the MHRA. The cap on nicotine concentrations introduced by the TPD will take high nicotine EC and refill liquids off the market, potentially affecting heavier smokers seeking higher nicotine delivery products.

The fact that no licensed EC are yet on the market suggests that the licensing route to market is not commercially attractive. The absence of non-tobacco industry products going through the MHRA licensing process suggests that the process is inadvertently favouring larger manufacturers including the tobacco industry, which is likely to inhibit innovation in the prescription market.

## Policy implications

- From May 2016, following the introduction of the revised TPD, ECs will be more strictly regulated. As detailed elsewhere in the report, the information we present does not indicate widespread problems as a result of EC. Hence, the current regulatory structure appears broadly to have worked well although protecting non-smoking children and ensuring the products on the market are as safe and effective as possible are clearly important goals. New regulations currently planned should be implemented to maximise the benefits of EC whilst minimising these risks.
- An assessment of the impact of the TPD regulations on the UK EC market will be integral to its implementation. This should include the degree to which the availability of safe and effective products might be restricted.
- Much of England's strategy of tobacco harm reduction is predicated on the availability of medicinally licensed products that smokers want to use. Licensed ECs are yet to appear. A review of the MHRA EC licensing process therefore seems appropriate, including manufacturers' costs, and potential impact. This could include a requirement for MHRA to adapt the processes and their costs to enable smaller manufacturers to apply, and to speed up the licensing process. The review could also assess potential demand for the EC prescription market and what types of products would be most appropriate to meet that demand.

## Summary of Chapter 4: Prevalence of e-cigarette use in England/Great Britain

*Adults:* Around one in 20 adults in England (and Great Britain) use EC. Current EC users are almost exclusively smokers (~60%) or ex-smokers (~40%), that is smokers who now use EC and have stopped smoking altogether. EC use among long-term ex-smokers is considerably lower than among recent ex-smokers. Current EC use among



never smokers is very low, estimated to be 0.2%. The prevalence of EC use plateaued between 2013-14, but appeared to be increasing again in 2015.

*Youth:* Regular EC use among youth is rare with around 2% using at least monthly and 0.5% weekly. EC use among young people remains lower than among adults: a minority of British youth report having tried EC (~13%). Whilst there was some experimentation with EC among never smoking youth, prevalence of use (at least monthly) among never smokers is 0.3% or less.

Overall, the adult and youth data suggest that, despite some experimentation with EC among never smokers, EC are attracting few people who have never smoked into regular use.

*Trends in EC use and smoking:* Since EC were introduced to the market, cigarette smoking among adults and youth has declined. In adults, overall nicotine use has also declined (not assessed for youth). These findings, to date, suggest that the advent of EC is not undermining, and may even be contributing to, the long-term decline in cigarette smoking.

### Policy implications

- Trends in EC use among youth and adults should continue to be monitored using standardised definitions of use.
- Given that around two-thirds of EC users also smoke, data are needed on the natural trajectory of 'dual use', ie whether dual use is more likely to lead to smoking cessation later or to sustain smoking (see also Chapter 6).
- As per existing NICE guidance, all smokers should be supported to stop smoking completely, including 'dual users' who smoke and use EC.

### Summary of Chapter 5: Smoking, e-cigarettes and inequalities

Smoking is increasingly concentrated in disadvantaged groups who tend to be more dependent. EC potentially offer a wide reach, low-cost intervention to reduce smoking and improve health in disadvantaged groups.

Some health trusts and prisons have banned the use of EC which may disproportionately affect more disadvantaged smokers.

## Policy implications

- Consideration could be given to a proactive strategy to encourage disadvantaged smokers to quit smoking as quickly as possible including the use of EC, where appropriate, to help reduce health inequalities caused by smoking.
- EC should not routinely be treated in the same way as smoking. It is not appropriate to prohibit EC use in health trusts and prisons as part of smokefree policies unless there is a strong rationale to do so.

## Summary of Chapter 6: E-cigarettes and smoking behaviour

Recent studies support the Cochrane Review findings that EC can help people to quit smoking and reduce their cigarette consumption. There is also evidence that EC can encourage quitting or cigarette consumption reduction even among those not intending to quit or rejecting other support. It is not known whether current EC products are more or less effective than licensed stop smoking medications, but they are much more popular, thereby providing an opportunity to expand the number of smokers stopping successfully. Some English stop smoking services and practitioners support the use of EC in quit attempts and provide behavioural support for EC users trying to quit smoking; *self-reported* quit rates are at least comparable to other treatments. The evidence on EC used *alongside smoking* on subsequent quitting of smoking is mixed.

## Policy implications

- Smokers who have tried other methods of quitting without success could be encouraged to try EC to stop smoking and stop smoking services should support smokers using EC to quit by offering them behavioural support.
- Research should be commissioned in this area including:
  - longitudinal research on the use of EC, including smokers who have not used EC at the beginning of the study
  - the effects of using EC while smoking (temporary abstinence, cutting down) on quitting, and the effects of EC use among ex-smokers on relapse
  - research to clarify the factors that i) help smokers using EC to quit smoking and ii) deter smokers using EC from quitting smoking, including different EC products/types and frequency of use and the addition of behavioural support, and how EC compare with other methods of quitting which have a strong evidence base
- It would be helpful if emerging evidence on EC (including different types of EC) and how to use EC safely and effectively could be communicated to users and health professionals to maximise chances of successfully quitting smoking.

## Summary of Chapter 7: Reasons for use and discontinuation

A number of surveys in different populations provide evidence that reducing the harm from smoking (such as through cutting down on their cigarette consumption or helping with withdrawal during temporary abstinence) and the desire to quit smoking cigarettes are the most important reasons for using EC. Curiosity appears to play a major role in experimentation. Most trial of EC does not lead to regular use and while there is less evidence on why trial does not become regular use, it appears that trial due to curiosity is less likely to lead to regular use than trial for reasons such as stopping smoking or reducing harm. Dissatisfaction with products and safety concerns may deter continued EC use.

### Policy implications

- Smokers frequently state that they are using EC to give up smoking. They should therefore be provided with advice and support to encourage them to quit smoking completely.
- Other reasons for use include reducing the harm from smoking and such efforts should be supported but with a long-term goal of stopping smoking completely.

## Summary of Chapter 8: Harm perceptions

Although the majority of adults and youth still correctly perceive EC to be less harmful than tobacco cigarettes, there has been an overall shift towards the inaccurate perception of EC being at least as harmful as cigarettes over the last year, for both groups. Intriguingly, there is also some evidence that people believe EC to be less harmful than medicinal nicotine replacement therapy (NRT).

### Policy implications

- Clear and accurate information on relative harm of nicotine, EC and tobacco cigarettes is needed urgently (see also Chapter 10).
- Research is needed to explore how health perceptions of EC are developed, in relation to tobacco cigarettes and NRT, and how they can be influenced.

## Summary of Chapter 9: E-cigarettes, nicotine content and delivery

The accuracy of labelling of nicotine content currently raises no major concerns. Poorly labelled e-liquid and e-cartridges mostly contained less nicotine than declared. EC used

as intended pose no risk of nicotine poisoning to users. However, e-liquids should be in 'childproof' packaging.

Duration and frequency of puffs and mechanical characteristics of EC play a major role in determining nicotine content in vapour. Across the middle range of nicotine levels, in machine tests using a standard puffing schedule, nicotine content of e-liquid is related to nicotine content in vapour only weakly. EC use releases negligible levels of nicotine into ambient air with no identified health risks to bystanders. Use of a cigalike EC can increase blood nicotine levels by around 5 ng/ml within five minutes of use. This is comparable to delivery from oral NRT. Experienced EC users using the tank EC can achieve much higher blood nicotine levels over a longer duration, similar to those associated with smoking. The speed of nicotine absorption is generally slower than from cigarettes but faster than from NRT.

### Policy implications

- General labelling of the strength of e-liquids, along the lines used for example indicating coffee strength, provides sufficient guidance to consumers.
- Regulatory interventions should ensure optimal product safety but make sure EC are not regulated more strictly than cigarettes and can continue to evolve and improve their competitiveness against cigarettes.

### Summary of Chapter 10: Safety of e-cigarettes in light of new evidence

Two recent worldwide media headlines asserted that EC use is dangerous. These were based on misinterpreted research findings. A high level of formaldehyde was found when e-liquid was over-heated to levels unpalatable to EC users, but there is no indication that EC users are exposed to dangerous levels of aldehydes; stressed mice poisoned with very high levels of nicotine twice daily for two weeks were more likely to lose weight and die when exposed to bacteria and viruses, but this has no relevance for human EC users. The ongoing negative media campaigns are a plausible explanation for the change in the perception of EC safety (see Chapter 8).

None of the studies reviewed above alter the conclusion of Professor Britton's 2014 review for PHE. While vaping may not be 100% safe, most of the chemicals causing smoking-related disease are absent and the chemicals which are present pose limited danger. It has been previously estimated that EC are around 95% safer than smoking. This appears to remain a reasonable estimate.

### Policy implications

- There is a need to publicise the current best estimate that using EC is around 95% safer than smoking.
- Encouraging smokers who cannot or do not want to stop smoking to switch to EC could be adopted as one of the key strategies to reduce smoking related disease and death.

### Summary of Chapter 11: Other health and safety concerns

There is a risk of fire from the electrical elements of EC and a risk of poisoning from ingestion of e-liquids. These risks appear to be comparable to similar electrical goods and potentially poisonous household substances.

### Policy implications

- The risks from fire or poisoning could be controlled through standard regulations for similar types of products, such as childproof containers (contained within the TPD but which are now emerging as an industry standard) and instructions about the importance of using the correct charger.
- Current products should comply with current British Standard operating standards.
- Records of EC incidents could be systematically recorded by fire services.

### Summary of Chapter 12: International perspectives

Although EC use may be lower in countries with more restrictions, these restrictions have not prevented EC use. Overall, use is highest among current smokers, with low numbers of non-smokers reporting ever use. Current use of EC in other countries is associated with being a smoker or ex-smoker, similar to the findings in the UK. EC use is frequently misreported with experimentation presented as regular use. Increases in youth EC trial and use are associated with decreases in smoking prevalence in all countries, with the exception of one study from Poland.

### Policy implications

- Future research should continue to monitor and evaluate whether different EC policies across countries are related to EC use and to smoking cessation and smoking prevalence.
- Consistent and agreed measures of trial, occasional and regular EC use among youth and adults are urgently needed to aid comparability.