Second-hand vaping

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This briefing covers only potential effects of e-cigarette “second-hand vaping” – non-users inhaling emissions exhaled into the air by users. For general information, please consult our e-cigarette briefing.

Key points:

- in general, e-cigarette vapour contains fewer harmful substances at lower concentrations than second-hand tobacco smoke (SHS)
- the available evidence does not suggest that these emissions present a significant risk to the health of the general population, but it is not possible to quantify the total health risk it may pose, in contrast to the clear evidence of harm caused by SHS
- components of these emissions, such as particulate matter, may pose health risks, especially to vulnerable populations such as children and those with respiratory or cardiovascular conditions
- ASH Scotland considers that a blanket ban on e-cigarette use in indoor public places would not be justified without significant new developments in the evidence base
- however, individual premises – particularly those whose clientele are at higher risk of respiratory or cardiovascular conditions or where customers have indicated that they prefer restrictions may wish to introduce their own rules on indoor use.

Introduction

Electronic cigarettes, or e-cigarettes (also referred to as nicotine vapour products and electronic nicotine delivery systems) are a new category of products which aim to replace or supplement tobacco cigarettes. They are thought to be less harmful for users than lit tobacco when used as a substitute, but questions have arisen over the risks they could pose to bystanders.
E-cigarettes produce a vapour consisting of a suspension of flavourings and (usually) nicotine which is inhaled by the user (or vaper). This vapour is intended to deliver nicotine deep into the lungs in the same manner as tobacco smoke. After being exhaled, this vapour persists in the air, particularly in indoor environments, and could conceivably pose health risks to bystanders.

Individual components of e-cigarette emissions are certainly hazardous. But it is not clear that these components present a significant risk to health in air following vaping. Even very hazardous chemicals may not present a serious risk at low concentrations, or if exposure is limited to short periods of time. The risk profile of passive vaping is therefore different from the risk of active vaping.

E-cigarettes are a diverse and developing product category comprising a wide variety of device types, liquids and flavours. Current research may not reflect the newest developments in the market, and some elements of risk may differ between products. We have attempted to take an evidence-based view of the potential health risks these devices could pose, while recognising their rapid development and change.

In this briefing, we have not looked in detail at suggestions that e-cigarettes can cause children to view smoking behaviour more positively, that they could make smoke-free laws more difficult to enforce or that seeing e-cigarettes being used could trigger former smokers to return to tobacco use.

What's in e-cigarette vapour?

The primary components of e-cigarette liquid are water, propylene glycol and/or glycerine, flavourings and, generally, nicotine. While all e-liquids appear to contain these basic components, different brands and products appear to yield different airborne concentrations of pollutants.

Particulate matter (PM)

PM is the sum of all particles suspended in the air, whatever their chemical composition. Consequently, the hazard or toxicity of these particles varies not just by concentration but by source, composition and particle size.

E-cigarette aerosol has been shown to have a particle size distribution broadly comparable to cigarette smoke with many particles in the ultrafine range able to deposit in the alveolar area of the lungs. For this reason, high concentrations of
PM$_{2.5}$ (particles smaller than 2.5µm in diameter) and ultrafine particles (or UFPs, smaller than 100nm in diameter) are often used to gauge the potential health risks of inhalation exposures.

Research has shown variable concentrations of PM$_{2.5}$ in indoor spaces where vaping is permitted. This is likely to vary by interior volume, ventilation and the source of the PM – different devices and liquids may result in different concentrations. Nonetheless, numerous studies have shown that indoor vaping can lead to PM$_{2.5}$ concentrations in excess of the World Health Organisation’s recommended 24 hour average limit.$^{6-8}$ Liquids without nicotine may have a greater impact.$^{9}$

Research on the impact of UFPs is less common, due to the comparative difficulty of measuring this class of particle. One study suggested significant UFP production in vapour, with the size distribution of particles in the air changing as larger inhaled particles are absorbed into the lung.$^{5}$ However, UFP production by an e-cigarette was described in another paper as two orders of magnitude lower than that produced by a tobacco cigarette.$^{10}$

**Metals**

Metals can be seen as a component of particulate matter, but have their own harm profiles. A wide range of toxic metals have been reported in e-cigarette emissions. Cadmium, nickel, lead and chromium have all been shown to be present in variable concentrations in e-cigarette aerosol.$^{11}$ One study showed that nickel, zinc, and silver were released in similar concentrations following both tobacco cigarette and e-cigarette use,$^{12}$ while another showed a variety of metals, including nickel, zinc, copper and aluminium at higher concentrations in e-cigarette aerosol than in tobacco cigarette smoke.$^{13}$ These metals have been used to manufacture cartridges for e-liquid, suggesting that faulty manufacturing$^{13}$ or corrosive components of the liquid$^{14}$ may result in the release of particles into e-liquid.

**Volatile organic compounds (VOCs)**

VOCs are compounds of carbon which participate in atmospheric photochemical reactions.$^{15}$ They are of concern as an indoor air pollutant which can be harmful to health, though the level of risk different VOCs may pose can vary. VOCs are produced in significant concentrations by tobacco smoking.
Propylene glycol has been observed at elevated levels in air following e-cigarette use.\textsuperscript{5,9} This chemical is present at higher levels following tobacco smoking.\textsuperscript{5}

During heating, both glycerine and propylene glycol can decompose to produce formaldehyde,\textsuperscript{16} a carcinogenic VOC also present in tobacco smoke. It has been reported that e-cigarette vapour can contain very high levels of formaldehyde, considerably in excess of that created by cigarette use.\textsuperscript{17} This has been challenged as resulting from a coil which has been overheated under circumstances which would not reflect real use.\textsuperscript{18} Another study which measured formaldehyde in indoor air following e-cigarette use found that levels did not rise above background in most cases (with the exception of one of the six liquids tested),\textsuperscript{9} while yet another found only a small rise in formaldehyde which may be attributable to levels naturally present in human breath.\textsuperscript{5} This suggests that formaldehyde production may vary between liquids and the characteristics of the devices used.\textsuperscript{9}

In general, several VOCs appear to be produced during e-cigarette use but at significantly lower levels than during tobacco use.\textsuperscript{12}

\textit{Flavourings}

It is well-established that some flavourings which have been used in e-liquid are harmful when inhaled, such as diacetyl and acetyl propionyl.\textsuperscript{19} However, it is unknown whether these chemicals would necessarily be harmful at the concentrations they are present in vapour, rather than when being inhaled directly by an e-cigarette user.

\textit{Polycyclic aromatic hydrocarbons (PAHs)}

PAHs are hydrocarbons which contain multiple ring-like structures. These chemicals are often produced during incomplete burning,\textsuperscript{20} and are released in significant quantities during tobacco smoking. They are known to be toxic and carcinogenic.\textsuperscript{20}

One study which measured PAHs showed that concentrations during vaping were 30-90\% higher than background levels, with carcinogenic PAHs 20\% higher than background.\textsuperscript{9} However, another study found that no PAHs were detectable following e-cigarette use indoors.\textsuperscript{12} E-cigarette use may cause the release of PAHs, but likely at considerably lower levels than tobacco cigarettes.
**Tobacco-specific nitrosamines (TSNAs)**

TSNAs are carcinogenic chemicals present in tobacco and tobacco smoke.\(^{21}\) They are formed from nicotine and related chemicals within tobacco.

Some e-cigarette liquids appear to contain TSNAs, while others do not.\(^{22}\) The presence of TSNAs in vapour appears to be related directly to their presence in liquid, indicating that they are not produced during the vaping process but are aerosolised. TSNAs concentrations in e-liquid may be orders of magnitude lower than in cigarettes,\(^{23}\) suggesting that second-hand vapour would have much lower concentrations of TSNAs than second-hand smoke.

**Air nicotine**

Several studies have demonstrated that nicotine is released into the air during use of electronic cigarettes\(^{24,25}\). However, less nicotine is seen in the air than following the use of a tobacco cigarette, and airborne nicotine is generally not considered to pose a health risk in and of itself.

**Comparison with second-hand smoke**

In general, ambient vapour contains fewer harmful substances than second-hand tobacco smoke – for instance, carbon monoxide, while commonly found in cigarette smoke, does not appear to be present in e-cigarette vapour.\(^{24}\) Those harmful substances which are present in vapour occur in considerably lower concentrations than in SHS. On the balance of existing evidence it appears that exposure to e-cigarette vapour in most realistic bystander scenarios is likely to be considerably less harmful than exposure to SHS.

That is not to say that e-cigarette vapour is completely harmless. The presence of fine and ultrafine particles in high concentrations under certain conditions suggests that there is a risk to health inherent in being in the presence of vapour, particularly for those with underlying cardiovascular\(^{26}\) or respiratory\(^{27}\) conditions who may be especially vulnerable to the effects of particulate matter and other air pollution. It should be noted that, while PM emissions are integral to the way e-cigarettes work, other pollutants could be reduced or removed through technical changes to the devices – the presence of heavy metals, for instance, could be mitigated through changes to the way that cartridges are made. Careful but
proportionate regulation will be required to ensure e-cigarettes are as safe as they can be.

Conclusions

There is not currently evidence to suggest that occasional exposure to e-cigarette vapour presents a significant health risk to the general population, in contrast to the clear evidence of harm from second-hand smoke. Therefore, legal measures to restrict vaping in all indoor public places would require significant new developments in the current evidence base.

Policymakers may wish to consider whether premises which frequently host more susceptible people, such as children or those with health conditions, should restrict the use of e-cigarettes indoors.

References

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