

How safe is vaping?

August 8 2018, by Simon Cotton



Credit: AI-generated image ([disclaimer](#))

A [survey of adolescents](#) carried out by researchers at Coventry University has shown that less than half of e-cigarette users knew that vape products contain nicotine or that they are addictive, raising the possibility that they could be a gateway to smoking normal cigarettes. Nicotine addiction is a real problem but the health issues posed by e-cigarettes are potentially [greater than](#) just addiction.

The first Europeans to arrive in America at the end of the 15th century soon encountered the local custom of smoking tobacco – and they in turn introduced the practice to Europe. Successive English monarchs were opposed to it – King James I famously wrote a book entitled [A Counterblaste to Tobacco](#) – but, in the end, governments settled on taxing it.

The compound responsible for the pleasurable aspects of smoking tobacco (and for its addictive properties) is [nicotine](#), a "secondary metabolite" produced by the tobacco plant *Nicotiana tabacum* as a [defence against herbivores](#).

Smoking tobacco destroys most of the molecules present in it, including nicotine, but the small amount of nicotine that survives (around 10%) is carried from the lungs, via the blood, to the brain within less than ten seconds. Once in the brain, it stimulates the release of neurotransmitters, [including the "pleasure molecule" dopamine](#). The link between taking a "drag" on the cigarette and the brain's "pleasure" response explains why smoking can be so addictive, as it associates pleasure with the act of smoking.

A dangerous game

Most of the dangers of smoking do not come directly from nicotine. Cigarette smoke contains around [4,000 different compounds](#) and the most dangerous molecules are carcinogens such as benzo[a]pyrene and nitrosamines such as N'-nitrosonornicotine (NNN), which is derived from nicotine. Tobacco "tar", which is carried in the smoke to the mouth and lungs, is rich in these toxic substances.

If you smoke tobacco, the smoke damages the DNA in organs exposed to it as well as others indirectly exposed, speeding up genetic mutations and increasing the risk of cancer – not just of the lung, but also of the

mouth, larynx, liver, cervix, oesophagus, pancreas, bladder and kidney. Not all these mutations lead to cancer, but the more of them there are, the more likely it is that cancer-causing [mutations will occur](#).

According to the [World Health Organisation](#) (WHO), smoking-related disease causes around six million deaths a year (about 600,000 of these from "passive smoking"). Around 100,000 of these deaths occur in the UK and half a million in the US. Nicotine does not cause these deaths directly, but addiction to nicotine does.

Within the past decade or so, e-cigarettes have been marketed as a way to enjoy smoking with fewer of the health risks of traditional cigarettes – for one thing, as e-cigarettes don't burn tobacco, they should eliminate the risks associated with tar. They contain a battery, a metal heating element and a reservoir of liquid, which is converted to a vapour by the heating element and is inhaled by the smoker. The liquid is made up of a solvent, either glycerol or [propylene glycol](#), nicotine, and often food-grade flavourings.

So what's the problem with e-cigarettes, if they do not produce carcinogenic tar? Well, nicotine or other molecules found in e-cigarettes [can still affect lung health](#). A significant number of the flavour chemicals used in many liquids are aldehydes, and these are often irritants of the mucosal tissue in the [respiratory tract when inhaled](#).

Typical examples are cinnamaldehyde (cinnamon), vanillin (vanilla) and diacetyl (buttery). [Tests on endothelial cells](#), the cells which line the [blood vessels](#) and the inside of the heart, show that some e-cigarette flavourings and their constituents (such as vanillin, cinnamaldehyde, diacetyl, isoamyl acetate and menthol) may harm blood vessels. They caused higher levels of an inflammatory marker (interleukin-6) and lower levels of nitric oxide, a molecule with several roles, such as inhibiting inflammation and clotting, and dilating blood vessels. In the

body, these two changes are considered to be an early predictor of heart disease. Although the food flavourings are in themselves safe when used in food (as are the solvents) that does not mean they necessarily are entirely safe for a different use, [such as in e-cigarettes](#).

[Studies have shown](#) that some of these molecules, notably the solvents, can be decomposed when heated to above 300°C by the [heating element](#) in the e-cigarette. [Three substances](#), all aldehydes, formed on the breakdown of glycerol and propylene glycol have come in for [particular attention](#) – acrolein, methanal and ethanal.

You've probably met [acrolein](#) (propenal) – it's the chemical formed when cooking oil is heated until it begins to smoke. It is toxic and can severely irritate eyes and nasal passages. [Ethanal](#) (acetaldehyde) and methanal (formaldehyde) are also toxic – [methanal](#), in particular, is a well-known carcinogen.

These substances may also be formed by decomposition of the flavouring molecules.

The verdict

So are these molecules produced at dangerous concentrations in e-cigarettes? While use of e-cigarettes has been [shown to lead](#) to significantly lower levels of certain carcinogenic metabolites in the urine of their smokers, compared to the levels found in smokers of traditional cigarettes, they [have been linked](#) with [higher levels](#) of some particulates, including the metals cadmium, nickel, chromium, lead and zinc. These may have originated in the heating coil.

There is particular concern that the rapid growth in the use of e-cigarettes has not been accompanied by proper assessment of the risks accompanying their use, especially over the long term. While [some](#)

[reports](#) have said that e-cigarettes are much safer than conventional cigarettes, [one study](#) has concluded that regular use of e-cigarettes by young people leads to them becoming heavier smokers of conventional cigarettes; [another American study](#) concluded that use of e-cigarettes by teenagers doubles the risk of coughs and bronchitis compared with non-smokers.

E-cigarettes are freely available in the UK, and US, but are banned or restricted in some countries, including Norway, Brazil, Singapore and Australia. A letter [published in the *British Medical Journal*](#) also warned: "Further basic science and epidemiological research is needed to increase our evidence base on the benefits and harms of [e-cigarette](#) vapour. Until then patients should not be misled into thinking that the likelihood of future harm is negligible when there is insufficient evidence to advocate this."

At present, then, the bottom line is that no one knows whether there are long-term risks associated with e-cigarettes. Caution is required.

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