

What do we know about the health effects of electronic cigarettes?

Electronic cigarettes (or e-cigarettes) are battery-operated devices that work by heating a liquid to create a mist (vapour) that is inhaled. An e-cigarette contains a cartridge or tank that is filled with e-liquid. The e-liquids used in an e-cigarette may or may not contain nicotine (see Information Sheet # 1 for further details).

There is a lot of debate about the harms associated with the use of e-cigarettes. Some health professionals, tobacco control and public health experts look at them as a way to reduce the health harms from smoking cigarettes, seeing them as less harmful to health than tobacco-containing products. Others are concerned that they may have unrecognised short-term and/or long-term negative health effects.

There have been only a few studies on the health harms resulting from the use of e-cigarettes whether for the person using the e-cigarette or for those around them (from second-hand vapour). Mostly, studies and reviews agree that:

- The long-term health effects of e-cigarettes are not yet known
- E-cigarettes are likely to be less harmful to health than smoking tobacco products
- Based on what is known about the contents of e-cigarettes and reports from consumers, some short-term health-related harms can be associated with using them, and there is potential for long-term harms as well:
 - Compounds and particles that are harmful to health have been found in e-cigarette vapour, but most of these are at levels much lower than in tobacco smoke
 - Lack of regulation means that the contents of e-liquids may be different to the labelling on the container, and that badly made e-cigarette devices and e-liquid cartridges may increase exposure to health harms.

Long-term health effects of e-cigarettes are not yet known

As e-cigarettes have only been on the market since around 2004, we do not know enough yet about the long-term health effects from using them, as it is too soon for studies to have been done to look at this.¹

The Australian Therapeutic Goods Administration (TGA), the regulatory authority for therapeutic goods in Australia, states that, “no assessment of electronic cigarettes has been undertaken and, therefore, the quality and safety of electronic cigarettes is not known”.² The TGA has not approved e-cigarettes (with or without nicotine) as a therapeutic stop-smoking device in Australia.

E-cigarettes are likely to be less harmful to health than smoking tobacco products

Based on the current evidence, it is reasonable to think that e-cigarettes are safer than tobacco cigarettes. When someone smokes a tobacco cigarette, they inhale over 4000 chemicals, over 60 of which are known to cause cancer in humans.³

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Experts estimate that e-cigarettes have only a fraction of the health risk of cigarettes.^{1,4,5,6} Although there are other chemicals in the e-liquid and vapour of e-cigarettes, and the extent of harm from long-term exposure is not known, experts estimate that using e-cigarettes is around 95% less harmful than smoking tobacco.^{7,8,9}

People who use e-cigarettes and those around them are exposed to fewer toxic chemicals than with tobacco smoking.^{10,11,12} In particular, for example, e-cigarette vapour contains only small amounts of carbon monoxide at levels far below levels in tobacco smoke.¹³ The chemicals contained in tobacco cigarettes are either not found in e-cigarettes at all or are at levels below 5% of what is found in tobacco cigarettes,⁵ and well below the threshold limits for occupational exposure.¹

Health effects are associated with using e-cigarettes

Although the long-term health effects of e-cigarettes are not yet known, some people have reported short term health effects.

Some people who use e-cigarettes, for example, report experiencing minor negative reactions to the vapour (mostly a dry throat).⁸ Some studies have found short-term effects of e-cigarette vapour on the lungs, but how this affects long-term health is not yet clear.¹

While e-cigarettes deliver lower levels of toxins and pollute the air less than tobacco cigarettes, they cannot be considered 'harmless', and the vapour produced from them is *not*, as some people claim, 'just water vapour'.^{14,15} People who use e-cigarettes are exposed to the contents of e-liquid and vapour including:

- Nicotine
- Liquids such as propylene glycol and glycerine, and by-products of heating these liquids
- Flavourings
- Other potentially harmful particles and chemicals

Nicotine

Other than being addictive, nicotine does not appear to contribute to smoking-related diseases¹⁶. Nicotine is listed as a poison by the Therapeutic Goods Administration, but is approved at low levels for use in nicotine replacement therapy products (NRT—such as patches, gum, strips, lozenges, inhalators). These NRT products are currently accepted as an option for use by pregnant women who smoke and who are not able to quit using other methods.¹⁷

The doses of nicotine delivered by electronic cigarettes are not likely to cause significant short or long-term negative health effects for most people.¹⁸ However e-cigarettes, unlike NRT, have not been approved by the TGA as safe or effective for use. In particular, pregnant women who want to use e-cigarettes should discuss their situation with a health professional.

Solutions—propylene glycol and vegetable glycerine

Two chemical compounds that make up most of the e-liquid are propylene glycol and/or vegetable glycerine. These liquids are approved for use in Australia in various foods and pharmaceuticals. They are considered safe to eat or to put on the skin, but they have not been approved as safe for inhaling. The long-term health effects of inhaling these liquids directly into the lungs is not known.¹⁹

A number of studies have found that people using e-cigarettes may be exposed to cancer-causing compounds when propylene glycol or vegetable glycerol are over-heated and vapourised (e.g. formaldehyde, acetaldehyde, acrolein).^{10,20,21,22} However, overheating results in harsh and unpleasant tasting vapours and, under normal circumstances, people using e-cigarettes may self-regulate and avoid inhaling these.²³ Exposure to these cancer-causing compounds may as a result be minimised.⁵

Flavourings

Some studies into e-cigarette flavoured e-liquids have found toxic substances, including at levels that may have negative health effects when inhaled.²⁴ Many of the flavourings are considered safe when taken orally in food or drinks (e.g. diacetyl used in flavouring popcorn), but when heated and inhaled can cause health problems.¹ Although not yet clear in studies, these flavouring chemicals may cause health problems when used for a long time.⁵

Other potentially harmful particles and chemicals

Some studies have found fine particles in e-cigarette vapour that could affect air quality and cause negative health effects for people using e-cigarettes and for by-standers.¹⁹

Other potentially harmful chemicals have been found in some brands of e-cigarettes (e.g. nitrosamines, heavy metals such as cadmium, nickel and lead).¹⁰ One study found particles in the vapour of one brand of e-cigarette that were likely to have come from the metal components and wick of the e-cigarette device. Some substances were found at higher levels than for tobacco-cigarettes.²⁵ Even when levels of these substances are much lower than those in tobacco cigarettes, regular exposure over many years is likely to have some negative effect on health.¹⁸

E-cigarette manufacturing is not regulated so it is difficult to know whether the actual ingredients in e-liquids match what is stated on the packaging. Other chemicals may be added, and the level of nicotine might be higher than stated. Testing of e-cigarettes shows that the nicotine levels often vary from those stated,²⁶ and that some brands may contain toxic compounds (e.g. ethylene glycol).²⁰ Even a cartridge that is labelled as being nicotine-free, may in fact have high levels of nicotine in it.²⁷ Better regulation of e-cigarette and e-liquid manufacturing is likely to reduce exposure to some potentially harmful chemicals.¹

Is e-cigarette vapour harmful to other people?

Like the harms of e-cigarette vapour to the person using the device, the harms of the vapour to by-standers are not known for certain, particularly in the long-term.¹ Unlike

tobacco-containing cigarettes, e-cigarettes do not make 'side-stream' vapour (this means that no vapour comes from them unless the person inhales on the device). So, by-standers are not exposed to any side-stream vapour. Exposure to third-hand nicotine—residues left on surfaces where people have been vaping—is also much lower than for cigarettes.⁵ E-cigarette vapours have been found to contain toxic compounds, including nicotine, although at levels lower than for cigarette smoke.^{6, 8}

Other safety issues

There have been cases reported of children being poisoned when they accidentally drank nicotine-containing e-liquid. Although rare, there have also been several cases of the lithium-ion battery in an e-cigarette 'exploding', or of chargers causing fires.²⁸

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References

- Royal College of Physicians. (2016). *Nicotine without smoke: Tobacco harm reduction*. London:RCP.
- Therapeutic Goods Administration. (2015). 'Electronic cigarettes'. Accessed 23 June 2016. www.tga.gov.au/community-qa/electronic-cigarettes
- Cancer Council Victoria. (2003). 'What's in cigarettes. Fact Sheet'. Accessed 23 June 2016. www.quit.org.au/downloads/resource/facts-evidence/whats-in-cigarettes-fact-sheet.pdf
- Hartmann-Boyce J, McRobbie H, Bullen C, Begh R, Stead LF and Hajek P. (2016). 'Electronic cigarettes for smoking cessation'. *Cochrane Database of Systematic Reviews*, Issue 9. Art. No.: CD010216. DOI: 10.1002/14651858.CD010216.pub3.
- McNeill A, Brose LS, Calder R, Hitchman SC, Hajek P, and McRobbie H. (2015). *E-cigarettes: an evidence update A report commissioned by Public Health England*. Public Health England.
- Hajek P, Etter J, Benowitz N, Eissenberg T, and McRobbie H. (2014). 'Electronic cigarettes: review of use, content, safety, effects on smokers and potential for harm and benefit', *Addiction* 109(11):1801–10. doi: 10.1111/add.12659.
- Nutt DJ, Phillips LD, Balfour D, Curran HV, Dockrell M, Foulds J, Fagerstrom K, Letlape K, Milton A., Polosa R., Ramsey J. and Sweanor D. (2014). 'Estimating the Harms of Nicotine-Containing Products Using the MCDA Approach'. *Eur Addict Res*, 20:218–225.
- West R, Hajek P, McNeill A, Brown J, and Arnott D. (2015). *Electronic cigarettes: what we know so far. A report to UK All Party Parliamentary Groups*. Accessed 23 June 2016. www.smokinginengland.info/reports/
- McNeill A, and Hajek P. (2015). 'Underpinning evidence for the estimate that e-cigarette use is around 95% safer than smoking: authors' note'. *Public Health England publications gateway*: 2015260. Accessed 23 June 2016. www.gov.uk/government/uploads/system/uploads/attachment_data/file/456704/McNeill-Hajek_report_authors_note_on_evidence_for_95_estimate.pdf
- Goniewicz ML, Knysak J, Gawron M, Kosmider L, Sobczak A, Kurek J, Prokopowicz A, Jablonska-Czapla M, Rosik-Dulewska C, Havel C, Jacob P, and Benowitz N. (2013). 'Levels of selected carcinogens and toxicants in vapor from electronic cigarettes'. *Tobacco Control*, Published online 6 March 2013. doi: 10.1136/tobaccocontrol-2012-050859
- Hecht SS, Carmella SG, Kotandeniya D, Pillsbury ME, Chen M, Ransom BW, Isaksson Vogel R, Thompson E, Murphy SE and Hatsukami DK. (2014). 'Evaluation of Toxicant and Carcinogen Metabolites in the Urine of e-Cigarette Users Versus Cigarette Smokers', *Nicotine & Tobacco Research*, 17(6):704–9. doi: 10.1093/ntr/ntu218.
- Harrell PT, Simmons VN, Correa JB, Padhya TA, Brandon TH. (2014). 'Electronic nicotine delivery systems ("e-cigarettes"): review of safety and smoking cessation efficacy', *Otolaryngol Head Neck Surg*, 151(3):381–93. doi: 10.1177/0194599814536847.
- McRobbie H, Phillips A, Goniewicz ML, Myers Smith K, Knight-West O, Przulj D, and Hajek P. (2015). 'Effects of switching to electronic cigarettes with and without concurrent smoking on exposure to nicotine, carbon monoxide, and acrolein'. *Cancer Prev Res*, 8:873–8.
- Pisinger C, and Dossing M. (2014). 'A systematic review of health effects of electronic cigarettes'. *Preventive Medicine*, 69:248–60.
- Grana R, Benowitz N, and Glantz SA. (2013). 'Background Paper on E-cigarettes (Electronic Nicotine Delivery Systems)'. *WHO Tobacco Control Papers*, Winter 2013.
- Farsalinos KE, and Polosa R. (2014). 'Safety evaluation and risk assessment of electronic cigarettes as tobacco cigarette substitutes: a systematic review'. *Therapeutic Advances in Drug Safety*, 5(2):67–86.
- Australian Health Ministers' Advisory Council. (2012). *Clinical Practice Guidelines: Antenatal Care—Module 1*. Canberra: Australian Government Department of Health and Ageing.
- Britton J, and Bogdanovica I. (2014). *Electronic cigarettes. A report commissioned by Public Health England*. London: Public Health England.
- National Health and Medical Research Council. (2015). *NHMRC CEO Statement: Electronic cigarettes (e-cigarettes)*. NHMRC ref # DS13. Accessed 23 June 2016. www.nhmrc.gov.au/_files_nhmrc/publications/attachments/ds13_nhmrc_ceo_statement_ecigarettes.pdf
- Hutzler C, Paschke M, Kruschinski S, Henkler F, Hahn J, and Luch A. (2014). 'Chemical hazards present in liquids and vapors of electronic cigarettes', *Archives of Toxicology*, 88:1295–1308.
- Kosmider L, Sobczak A, Fik M, Knysak J, Zaciera M, Kurek J, and Goniewicz ML. (2014). 'Carbonyl compounds in electronic cigarette vapors - Effects of nicotine solvent and battery output voltage'. *Nicotine & Tobacco Research*, 16, (10):1319–1326.
- Uchiyama S, Ohta K, Inaba Y, and Kunungita, N. (2013). 'Determination of carbonyl compounds generated from the e-cigarette using coupled silica cartridges impregnated with hydroquinone and 2,4-Dinitrophenylhydrazine, followed by high-performance liquid chromatography'. *Analytical Sciences*, 29:1219–1222.
- Farsalinos KE, Voudris V and Poulas K. (2015). 'E-cigarettes generate high levels of aldehydes only in 'dry puff' conditions'. *Addiction*, 110(8):1352–6.
- Tierney PA, Karpinski CD, Brown JE, Luo W, and Pankow JF. (2015). 'Flavour chemicals in electronic cigarette fluids'. *obacco Control*, Published online first: 15 April 2015. doi:10.1136/tobaccocontrol-2014-052175
- Williams M, Villarreal A, Bozhilov K, Lin S, Talbot P. (2013). 'Metal and silicate particles including nanoparticles are present in electronic cigarette cartomizer fluid and aerosol'. *PLoS One*, 8(3):e57987.
- Cheng T. (2014). 'Chemical evaluation of electronic cigarettes'. *Tobacco Control*, 23:ii11–ii17.
- New South Wales Government. 'Are electronic cigarettes and e-liquids safe? Fact sheet'. Accessed 23 June 2016. www.health.nsw.gov.au/tobacco/Factsheets/e-cigs-are-they-safe.pdf
- Australian Association of Smoking Cessation Professionals (AASCP). (2014). 'E-cigarettes: Safety Warning'. *AASCP Newsletter*, Issue #27, August 2014.



Cutting through the haze E-cigarette information sheet series

This information sheet is the second in a series that has been produced to provide information to workers at ACT health and community services and their clients to make informed decisions on the use (or not) of e-cigarettes. The information sheets in this series are:

- #1 What are electronic cigarettes and how do they work?
- #2 What do we know about the health effects of electronic cigarettes?
- #3 Can electronic cigarettes help people to quit smoking?
- #4 Are electronic cigarettes legal in the ACT?

There is debate about the health harms and effectiveness of e-cigarettes. These information sheets do not promote or discourage the use of e-cigarettes, but aim to provide information based on the best available evidence so that members of the ACT community can make their own informed decisions.

All information given in these sheets is of a general nature. Individuals seeking to use e-cigarettes should obtain further medical and/or legal advice for their own situation.

The research evidence surrounding electronic cigarettes is evolving rapidly. Every attempt has been made to ensure the accuracy and currency of this information at the time of writing. ATODA and ACT Health are planning a revision in 2018.