Evidence summary: The health effects of nicotine

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Purpose of this briefing

This briefing summarises the current evidence on the health effects of nicotine and outlines the key implications for policymaking. It has been produced by ASH with input from **Prof Ann McNeill**, King's College London; **Prof Jamie Brown** and **Prof Lion Shahab**, University College London; **Prof Nick Hopkinson** and **Prof Alan Boobis**, Imperial College London; **Prof Sanjay Agrawal**, Chair, Royal College of Physicians Tobacco Advisory Group; **Prof Jacob George**, University of Dundee; **Dr Jasmine Khouja**, University of Bath; and **Dr Andy McEwen**, Chief Executive, National Centre for Smoking Cessation and Training.

In summary: **Nicotine is addictive but carries few direct risks to health on its own. It can be used in non-tobacco products such as NRT and vapes and is an effective aid to quitting smoking. However, it should not be used by people who do not already smoke.**

What is nicotine and how does it work?

Nicotine is the primary addictive pharmacological constituent of tobacco smoke. It acts on nicotinic acetylcholine receptors in the brain (and elsewhere) to trigger the release of dopamine and other neurotransmitters and reinforce repeated use.[1]

Most adults who use nicotine in the UK first became addicted through tobacco products.[2] The need to relieve nicotine withdrawal symptoms (cravings) is the main process that sustains smoking behaviour, and it is these symptoms that make it hard for people to give up smoking. However, it is not nicotine that makes smoking so lethal; instead it is the thousands of carcinogenic and toxic chemicals in tobacco smoke.

A recent review by the Royal College of Physicians (RCP) states that *"nicotine itself confers little risk to health"* relative to smoked tobacco, though *"acute exposure… can result in addiction, short-term elevated heart rate and systolic blood pressure"*.[3]

How does nicotine play a role in smoking cessation?

Nicotine-containing products can help people quit smoking and manage cravings without exposing them to most of the harm from tobacco. In the UK, nicotine replacement therapy (NRT) products like patches, gum, and inhalators are front-line medications widely used to help people quit smoking. NRT is licensed for use in pregnancy, for people with cardiovascular disease, and in children aged 12+.

Nicotine vapes are recommended as a stop smoking aid by NICE[4] and the NHS.[5] Both trial[6] and real-world[7] evidence supports their effectiveness. A Cochrane systematic review (the gold standard of evidence review) found that people using nicotine vapes are almost twice as likely to successfully quit smoking than those using NRT. While vaping is not risk-free, it is *significantly* less harmful than smoking.[8] [9] Any health risks that emerge from vaping are more likely to come from inhaling chemicals *other than nicotine* in these products.

What are the main health impacts of nicotine?

Most nicotine use occurs through smoking tobacco and there is limited evidence on the effects of nicotine separate from smoking. The key potential impacts are summarised below:

- **Addiction/dependence**: The main risk from nicotine use is addiction. Depending on how quickly nicotine is delivered, the dose and the accompanying chemicals, nicotine use can rapidly cause dependence. Nicotine dependency can make people feel stressed, restless, irritable and unable to concentrate.
- **Cardiovascular effects (short term)**: Nicotine use can lead to acute increases in heart rate and systolic blood pressure. However, these effects are short lived and long-term evidence of cardiovascular harm is lacking. A large population based observational study of people using NRT failed to find any increased risk of heart attack or stroke in this group.[10] The current evidence suggests that smokers who switch to nicotine vapes/e-cigarettes away from smoking have a significant and early improvement in their vascular health.[11] In patients with coronary artery disease who smoked, switching completely to vaping after having a stent fitted reduced long-term cardiac risk by 18% compared with those who smoked.[12]
- **Brain development/neuro-cognitive effects**: Nicotine does not appear to significantly impact brain development. Most people who smoke start before age 20, so any cognitive impact from nicotine use should be present in long-term smokers. One study following a cohort of children born in 1932, who had their IQ tested at age 11, found no difference in cognitive function at age 70 between never and ex-smokers.[13] Animal studies suggest that nicotine may influence some aspects of brain development, but it is unclear whether these effects occur in humans, and separating the impact of nicotine from that of smoking is difficult.[14] Pre-existing brain differences may also make some children more susceptible to using substances, including nicotine.[15] [16]
- **Potential impact on mental health:** Smoking is linked to the development of mental health conditions like schizophrenia and depression,[17] though nicotine itself does not appear to be the main driver.[18] The evidence suggests that other chemicals in tobacco smoke, and the harms of smoking more generally, may play a larger role. Vaping is also associated with poorer mental health; however evidence of a causal link is less clear.
- **Acute reactions to toxic level of nicotine**: At very high levels nicotine can be toxic and produce unpleasant side-effects such as dizziness, nausea and vomiting. Users can quickly learn to avoid these acute effects by consuming less nicotine.
- **Cancer**: The research consensus is that nicotine does not cause cancer, nor is it linked in isolation to most of the diseases that smoking causes.

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