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Media Release

POTENTIALLY TOXIC COMPOUNDS FOUND IN VAPING LIQUIDS

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LIQUIDS for use in electronic cigarettes include potentially toxic chemicals – including benzaldehyde, menthol and trans-cinnamaldehyde – for many of which no information on inhalation health effects are available, according to new research published by the Medical Journal of Australia.

The study, led by Associate Professor Alexander Larcombe, from the Telethon Kids Institute and the Wal-Yan Respiratory Research Centre, and Professor Ben Mullins and Dr Sebastien Allard from Curtin University, was an expansion of earlier research. This time the researchers looked at a wider range of 65 "e-liquids", before and after an accelerated ageing process that simulated the effects of vaping. All of the tested e-liquids were purchased from Australian suppliers and labelled as "nicotine-free".

"Nicotine was found in trace amounts in six fresh e-liquids (maximum, 3.25 mg/L) but not in aged e-liquids," Larcombe and colleagues reported.

"In our earlier study, six of 10 e-liquids contained nicotine (maximum, 2900 mg/L). The results for our more recent samples may indicate cleaner manufacturing processes, or that nicotine was present as nicotine salts rather than as freebase nicotine," they wrote.

"Propylene glycol and glycerol were the main ingredients by proportion in each e-liquid. The propylene glycol/glycerol ratio was not specified for three e-liquids. Most e-liquids were labelled as including 30% propylene glycol/70% glycerol, but the actual value was within 10 percentage points of the labelled amount for only 11 (propylene glycol) or 21 (glycerol) of these e-liquids.

"Benzyl alcohol, a solvent/flavour enhancer, was found in 42 of 65 e-liquids and 32 of 65 aged e-liquids, at levels of up to 1687 mg/L. Benzyl alcohol … is a dermal sensitising agent and skin allergen that elicits severe reactions in some people.

"Benzaldehyde, added to e-liquids for its almond-like flavour, was detected in 60 fresh and 61 aged e-liquids at concentrations ranging from 11.4 µg/L to 17.3 mg/L. Benzaldehyde inhibits microsomal cytochrome P450 2A6 (CYP2A6)20 — increasing systemic nicotine exposure and blood nicotine concentrations in smokers — reduces phagocytosis (a mechanism used to remove pathogens and cell debris), and is an inhalation irritant. Benzaldehyde can also react with propylene glycol in e-liquids, producing aldehyde propylene glycol acetals that activate airway irritant receptors.

Other flavouring chemicals found frequently were **menthol** ("enhances the addictive properties of nicotine and inhibits nicotine metabolism"), **ethyl maltol** ("effects of heating and inhaling it are largely unknown, but it increases free radical formation in e-cigarette aerosols; free radicals induce oxidative stress, which affect cell survival and proliferation, and inflammation; reacts with iron and copper (potentially present in e-liquids as coil residue) to produce toxic hydroxypyranone complexes"), ***trans*-cinnamaldehyde** ("impairs innate immune cell function in the lung, supresses bronchial airway epithelial cell ciliary motility and mitochondrial function, inhibits microsomal CYP2A6, impairs neutrophil, macrophage and natural killer cell function, and reduces oxidative burst when heated and inhaled"), and **ethyl vanillin** ("reduces oxidative burst and inhibits in vitro free radical formation").

"We found that a range of harmful chemicals are present, and that the heating/cooling/ageing process can affect e-liquid chemical composition," Larcombe and colleagues concluded.

"We acknowledge that the chemical composition of e-liquids is not entirely representative of the aerosol inhaled by e-cigarette users. Nevertheless, our finding that every e-liquid tested contained one or more chemicals potentially harmful to health provides a clear motivation for further investigations."

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About the Wal-yan Respiratory Research Centre

The Wal-yan Respiratory Research Centre is a global epicentre for paediatric respiratory research informing clinical practice and driving a new research agenda for childhood lung health. A powerhouse partnership between the Telethon Kids Institute, Perth Children's Hospital Foundation and Perth Children's Hospital, the Centre aims to prevent and cure respiratory illness in children and ensure that all children have healthy lungs for life. The Centre has a 30-year history of globally competitive research from diverse groups of internationally acclaimed researchers in Western Australia, working in paediatric research. For more information, visit: walyanrespiratory.org.au