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Between the Tank and the Coil: Assessing How Metals End Up in E-Cigarette Liquid and Vapor

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New market reports predict the global e-cigarette market will grow by 16.6% annually in coming years, reaching a value of USD27 billion by 2022.[1] The surging popularity of e-cigarettes has made it hard for safety research to keep up, and it may be many years before we understand any health risks that may be associated with the use of the devices. In the meantime, investigators are studying potential exposures in people who vape. The authors of a study in *Environmental Health Perspectives* now report finding chromium, nickel, lead, and other metals in the vapor produced by e-cigarettes.[2]

E-cigarettes work by heating a nicotine-containing liquid (commonly called e-liquid) to produce vapor. Not all e-cigarettes are alike; different brands and styles of e-cigarettes heat the vapor to varying degrees, and the heating coils can contain different metals. The most commonly used coils are made of alloys of iron, chromium, and aluminum or nickel and chromium.[3] The goal of the new study was to assess whether the metal coil in the e-cigarette gives off metals when heated, thereby contaminating the e-liquid and/or vapor.

The relative benefits and risks of e-cigarettes are being widely debated. For many tobacco researchers, vaping represents a dramatic safety improvement over smoking. A 2017 study compared saliva levels of nicotine, carcinogens, and other toxicants in e-cigarette users versus smokers.[4] Vapers had significantly lower levels of *N*-nitrosamines and volatile organic compounds, both of which have been linked to cancer. Given the high rates of smoking-related disease and death, in 2016 the U.K. Royal College of Physicians stated that "in the interests of public health it is important to promote the use of e-cigarettes, [nicotine replacement therapy] and other nontobacco nicotine products as widely as possible as a substitute for smoking."[5]

Saying that e-cigarettes are safer than cigarettes does not mean they are risk free, however. Although e-cigarettes do not burn tobacco, the vapor they produce can contain particulate matter as well as chemicals such as carbonyls, volatile organic compounds, and metals.[6,7] In addition, one animal study found evidence that nicotine delivered via e-liquid may be metabolized into potentially carcinogenic nitrosamines in the body.[8]

Scientists have also identified flavorings in the refill liquid that may be harmful when inhaled.[9] Prue Talbot, an environmental health researcher at the University of California, Riverside, and one of the first scientists to investigate e-cigarettes, says that diacetyl—a compound linked to bronchiolitis obliterans, also known as "popcorn

Different styles of e-cigarettes all have some form of atomizer (heating unit) and tank (or cartridge) that contains the e-liquid. The liquid is wicked from the tank into the atomizer. There it is heated by a metal coil to produce vapor. Image: © O. Bellini/Shutterstock.

lung"—is one of the most concerning. "When we think about diseases associated with smoking or vaping, we're often thinking about cancer, but other diseases, such as popcorn lung, could develop in long-term studies," she says. Talbot was not involved in the new research.

For the current study, 56 participants brought in their own e-cigarettes and e-liquid refill dispensers. First author Pablo Olmedo, a postdoctoral researcher at the Johns Hopkins Bloomberg School of Public Health at the time of the study, and colleagues measured the amount of 15 metals in the e-liquid from each participant's refill dispenser (i.e., before the liquid meets the heating element) as well as in the vapor produced by the e-cigarette and the e-liquid remaining in the tank after vaping (i.e., after the liquid meets the heating element).

In general, the metal concentrations measured in the tank and vapor were higher than those in the refill dispenser, suggesting that the heating coil is a potential source of the metals. Some concentrations were far higher; for instance, levels of nickel jumped from a median 2.03 μg/kg in the refill dispenser to a median 68.4 μg/kg and 233 μg/kg in the vapor and tank, respectively. The investigators also estimated exposures that might result from daily use of each e-liquid sample and concluded that health-based limits recommended by the Agency for Toxic Substances Disease Registry and the U.S. Environmental Protection Agency could be exceeded in many cases for nickel, chromium, manganese, and lead.

The presence of the metals in the liquid and vapor does not prove that e-cigarettes are harmful. "The concentration of metals that we found is remarkable, but we need to look in other countries [and in] different and new devices, and get biological samples from more people to evaluate a person's actual exposure and the actual health risk," Olmedo notes.

Olmedo suggests the results could help manufacturers design better heating elements for e-cigarettes in order to reduce the potential for metal contamination. Reliable information about the safety—or risk—of e-cigarettes, however, is likely to take at least another decade, Talbot says. "E-cigarettes have been on the market for about a decade," she points out, "and it may take around twenty years to fully understand the effects of e-cigarettes on health."

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