

E-cigarette exposure impairs immune responses in mouse model, new research finds

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A photo of 117mm e-cigarette. Image: Wikipedia.

In a study with mice, Johns Hopkins Bloomberg School of Public Health researchers have found that e-cigarettes compromise the immune system in the lungs and generate some of the same potentially dangerous chemicals found in traditional nicotine cigarettes.

E-[cigarettes](#) are an emerging public health health concern, as they gain popularity among current and former smokers as well as those who have never smoked, including teenagers. The perception that [e-cigarettes](#) pose little health risk is so entrenched that some smokers, including those with chronic obstructive pulmonary disease (COPD), are switching from cigarettes to e-cigarettes. (Many COPD patients continue to smoke after their diagnosis.) Both cigarettes and e-cigarettes are sources of nicotine.

E-cigarettes contain less nicotine than cigarettes, but actual nicotine intake by e-cigarette users can approximate that of cigarette smokers.

The findings will be published on Feb. 4 in the journal *PLOS ONE*.

"Our findings suggest that e-cigarettes are not neutral in terms of the effects on the lungs," notes senior author Shyam Biswal, PhD, a professor in the Department of Environmental Health Sciences at the Bloomberg School. "We have observed that they increase the susceptibility to respiratory infections in the mouse models. This warrants further study in susceptible individuals, such as COPD patients who have switched from cigarettes to e-cigarettes or to new users of e-cigarettes who may have never used cigarettes."

For their study, researchers divided the mice into two groups: one was exposed to e-cigarette vapor in an inhalation chamber in amounts that approximated actual human e-cigarette inhalation for two weeks, while the other group was just exposed to air. The researchers then divided each group into three subgroups. One received nasal drops containing *Streptococcus pneumoniae*, a bacteria responsible for pneumonia and sinusitis, among other illnesses, in humans. A second received nasal drops of the virus Influenza A, and the third subgroup did not receive either virus or bacteria.

The mice exposed to e-cigarette vapor were significantly more likely to develop compromised immune responses to both the virus and the bacteria, which in some cases killed the mice, the researchers found.

"E-cigarette vapor alone produced mild effects on the lungs, including inflammation and protein damage," says Thomas Sussan, PhD, lead author and an assistant scientist in the Department of Environmental Health Sciences at the Bloomberg School. "However, when this exposure was followed by a bacterial or viral infection, the harmful effects of e-

cigarette exposure became even more pronounced. The e-cigarette exposure inhibited the ability of mice to clear the bacteria from their lungs, and the viral infection led to increased weight loss and death indicative of an impaired immune response."

The researchers believe this study, thought to be the first to examine animal response to e-cigarette inhalation, will serve as a model for future studies on the effects of e-cigarettes.

Since their introduction to the U.S. market in 2007, e-cigarettes have prompted debate as to their risk in general and relative to cigarettes. E-cigarettes, which at their simplest consist of a battery, an atomizer and a cartridge, produce a vapor that is inhaled and then exhaled by the user. Previous analyses of e-cigarette vapor have identified chemicals that could be toxic or carcinogenic, including particulates, formaldehyde and volatile organic compounds, but at lower levels than [cigarette smoke](#). Another thing working in the favor of e-cigarettes in the risk continuum is that they don't combust the way cigarettes do, limiting some of the chemicals released in cigarette smoke.

As part of their study, the researchers also determined that e-cigarette vapor contains "[free radicals](#)," known toxins found in cigarette smoke and air pollution. Free radicals are highly reactive agents that can damage DNA or other molecules within cells, resulting in cell death. Cigarette smoke contains 1014 free radicals per puff. Though e-cigarette vapor contains far fewer free radicals than cigarette smoke - one percent as much - their presence in e-cigarettes still suggests potential health risks that merit further study, the researchers say.

"We were surprised by how high that number was, considering that e-cigarettes do not produce combustion products," Sussan says. "Granted, it's 100 times lower than cigarette smoke, but it's still a high number of free radicals that can potentially damage cells."

The U.S. Food and Drug Administration last spring announced that it was going to begin regulating e-cigarettes. E-cigarette sales are projected to overtake cigarette sales in the next decade. Teen use of e-cigarettes outpaces cigarette use, according to a recent survey released by the National Institute on Drug Abuse. And, according to the U.S. Centers for Disease Control and Prevention, more than one-quarter million teenagers who reported never having smoked a cigarette reported using e-cigarettes in 2013.

More information: "Exposure to electronic cigarettes impairs pulmonary anti-bacterial and anti-viral defenses in a mouse model" *PLOS ONE*.

Provided by Johns Hopkins University Bloomberg School of Public Health

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