E-cigarettes disrupt lung function and raise risk of infection

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A study led by researchers at Baylor College of Medicine raises health concerns about the use of electronic cigarettes. Published in the *Journal of Clinical Investigation*, the work shows that chronic exposure to e-

cigarette vapors disrupts normal lung function in mice and also reduces the ability of immune cells residing in the lungs to respond to viral infection. These alterations were observed with vapors without nicotine, warranting deeper investigations on the effects the allegedly safe-to-use solvents in e-cigarettes have on people.

"E-cigarettes currently are the most commonly consumed tobacco substitute in the adolescent population. More than 3 million high school age adolescents as well as about 10 million adults in the U.S. are active users," said corresponding author Dr. Farrah Kheradmand, a pulmonologist and professor of medicine at Baylor College of Medicine.

Some e-cigarette-related studies have reported negative effects of vaping on health, while other reports stand for the safety of the products when compared to tobacco cigarettes.

"These opposing views on the safety of e-cigarettes prompted one of my graduate students, Matthew Madison, to investigate the effects of chronic exposure to e-cigarette vapors and to conventional tobacco smoke on murine lung function," said Kheradmand, who also holds the Nancy Chang, Ph.D. Endowed Professorship for the Biology of Inflammation Center at Baylor. "We also looked at the effect of vapors or smoke on the function of immune cells called macrophages residing within the lung. These cells represent a first line of defense against viral infections such as those caused by influenza virus."

The experimental design consisted of four groups of mice. One group was exposed to e-cigarette vapors containing nicotine in the common vaping solvents propylene glycol and vegetable glycerin, in the proportions (60/40) found in e-cigarettes. A second group received vapors with only solvents but no nicotine. These groups were compared with mice exposed to tobacco smoke or to clean air.

The mice were exposed to tobacco smoke or e-cigarette vapors for four months following a regimen equivalent to that of a person starting smoking at about teenage years until their fifth decade of life. This smoking regimen markedly increases the risk of people developing emphysema, a condition in which the lungs' air sacs are damaged causing shortness of breath.

The researchers found that, as expected, mice that were chronically exposed to cigarette smoke or to e-cigarette vapors with nicotine and solvents had severely damaged lungs and excessive inflammation resembling those in human smokers with emphysema.

Unexpectedly, Kheradmand, Madison and their colleagues found that the treatment with e-cigarette vapors made of propylene glycol and vegetable glycerin solvents only (no nicotine), which are currently considered to be safe solvents, also damaged the lungs. In this case, the researchers did not observe inflammation and emphysema; instead, they found evidence of abnormal buildup of lipids (fats) in the lungs that disrupted both normal lung structure and function.

They also found that the accumulated fat was not from the solvent, rather it was from an abnormal turnover of the protective fluid layer in the lungs. In addition, they observed abnormal accumulation of lipids within resident macrophages. When the mice were exposed to influenza virus, the macrophages with abnormal lipid accumulation responded poorly to the infection.

"In summary, our experimental findings reveal that, independent of nicotine, chronic inhalation e-cigarette vapors disrupts normal murine lung function and reduces the ability of resident immune cells to respond to infection, increasing the susceptibility to diseases such as influenza," Kheradmand said. "Our experimental findings share similarities with previous multiple case reports describing the presence of lipid-laden

macrophages in pulmonary fluid from people with e-cigarette-associated pneumonia. Our results support further investigations into the solvents used in vaping."

More information: Matthew C. Madison et al, Electronic cigarettes disrupt lung lipid homeostasis and innate immunity independent of nicotine, *Journal of Clinical Investigation* (2019). DOI: 10.1172/JCI128531

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