News Release

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Mechanical and Chemical Characteristics of Electronic Cigarettes Contribute to Potentially Hazardous Effects

ATS 2015, DENVER ─ Unlike standard cigarettes, the components of electronic cigarettes are not regulated and standardized, thus they vary widely between products. The characteristics of these e-cigarette elements, including their delivery systems, combustion apparatuses, and the composition of the nicotine solutions they contain may affect the levels of potentially hazardous substances in the vapor they produce, according to a new study presented at the 2015 American Thoracic Society International Conference.

"While the chemical compositions and negative health effects of tobacco smoke have been well studied, e-cigarettes have yet to undergo the same level of scrutiny," said lead author Daniel Sullivan, MD, of the University of Alabama School of Medicine. "In our study, we found that differences in the mechanical and chemical makeup of e-cigarettes affected their generation of combustion products known to have adverse effects on human health."

The power generated by the tested units was found to correlate with the production of acrolein, an irritant associated with an increased risk for lung cancer, acetaldehyde, which is also associated with an increased cancer risk and may increase the risk of addiction, and formaldehyde, another known carcinogen. Under some test conditions, formaldehyde levels were comparable to those seen in traditional tobacco cigarettes.

The formation of these chemicals was found to be positively correlated with the glycerol:propylene glycol ratio in the solutions tested. Glycerol and propylene glycol are commonly used as nicotine solvents in e-cigarettes.

In addition, the researchers found that e-cigarette condensate inhibited the enzymatic activity ofLTA_4H, an enzyme involved in the resolution of pulmonary inflammation, in a dose dependent manner similar to that observed with tobacco smoke.

“Our results reveal the essential properties of e-cigarettes that affect their production of substances known to be toxic to human health,” said Dr. Sullivan. “This data speaks to the importance of more careful scrutiny and standardization of the components of these widely used devices.”

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** Please note that numbers in this release may differ slightly from those in the abstract. Many of these investigations are ongoing; the release represents the most up-to-date data available at press time.*

Abstract 67997
Mechanical and Chemical Components of Electronic Cigarettes Affect Combustion Product Formation and Biological Pathways of Inflammation
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Abstract Body

Introduction/Rationale

A recent surge in usage of electronic cigarettes (e-cigarettes) has led to many questions about the health effects of such devices. A major hurdle in assessing the risks of their use is the lack of standardization of these products. Relevant variables include: delivery system, combustion apparatus, and nicotine solution composition. We hypothesized that these factors have biological relevance; and herein, we dissect the essential elements that contribute to e-cigarettes' health risk profile.

Methods

Components and nicotine formulations (including Johnson Creek original tobacco flavor) typical of e-cigarette users were obtained. The common vaporization mediums of glycerol and propylene glycol were also evaluated. Vaporization was performed with 1.8-2.5ohm coils with 3.3-4.8V 1650mAh batteries. Coil temperatures were determined using an infrared thermometer. E-cigarette condensate (ECC) was prepared by bubbling e-cigarette

vapor through a phosphate buffered saline solution. Combustion products were derivatized with measurements done via liquid chromatography tandem mass spectrometry. Leukotriene A_4 hydrolase (LTA_4H) peptidase activity was assessed via colorimetric synthetic peptide degradation. LTA_4H epoxide hydrolase activity was measured in human neutrophils exposed to combustion products via a leukotriene B_4 ELISA.

Results

Coil temperature was found to be a function of coil resistance and battery voltage. Inter-coil consistency was shown for identical coils with coil failure occurring above a temperature plateau. Generation of acrolein, acetaldehyde, and formaldehyde for a given system was found to correlate with the power generated by the unit. Under certain conditions, chemical levels were similar to those seen in traditional cigarettes. Combustion product formation was also demonstrated to be positively correlated with the glycerol:propylene glycol ratio in the solution being vaporized. Finally, ECC was found to inhibit both enzymatic roles of LTA_4H (an enzyme affected by cigarette smoke and critical in the resolution of pulmonary inflammation) in a dose dependent manner similar to that seen in cigarette smoke studies.

Conclusions

For the first time, we show that it is necessary to account for both the mechanical components of e-cigarettes as well as the chemical makeup of their nicotine solutions in understanding not only the generation of combustion products by these devices, but also the potential health effects of their use. Our findings also suggest that standardization of e-cigarettes, including the power and configuration of the vapor solution under study will be necessary to gain meaningful insight into potential health effects of e-cigarettes.