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Are e-Cigarettes Safer Than Tobacco? It's Complicated

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This transcript has been edited for clarity.

Joel Beachey, MD: Hello and welcome back to the Mayo Clinic Medscape video series. I am Joel Beachey, a cardiology fellow at Mayo Clinic. Today we will be discussing e-cigarettes and their effectiveness for smoking cessation. I am joined by Dr Jon Ebbert, internist and addiction researcher here at Mayo Clinic. Welcome.

Jon Ebbert, MD: Happy to be here.

What Is an e-Cigarette?

Beachey: Vaping, specifically through the use of e-cigarettes, has become a hot topic. Recently, the Surgeon General, Dr Jerome Adams, [released a statement](#) concerning the health risks associated with use of e-cigarettes, specifically among young people and adults. To start off, what is an e-cigarette?

Ebbert: An electronic cigarette is a device that heats an e-liquid. The e-liquid essentially has four components: propylene glycol, which is a food and cosmetic additive; vegetable glycerin; nicotine; and flavoring agents. The e-liquid is heated by the e-cigarette device, which includes about five different types of metal coils that heat the e-liquid to about 350° C or less, creating an aerosol. That aerosol is inhaled by the user and delivers nicotine to the user's system.

Beachey: What's the difference between a product like an e-cigarette and a product like a Nicotrol inhaler?

Ebbert: An e-cigarette will aerosolize a liquid and create anywhere from large amounts of vapor to very small amounts of vapor; the different products on the market create different amounts of aerosol. A Nicotrol inhaler delivers nicotine predominantly to the oral mucosa where it is absorbed. There is no heating involved in a Nicotrol inhaler.

Another important distinction is the difference between an e-cigarette and burned conventional tobacco. When you burn conventional tobacco, you are heating that tobacco to about 1000° C; that creates tar, which then is deposited in the lungs. That tar also delivers the nicotine that comes from the burned tobacco. There are about 6000 chemicals in burned tobacco. E-cigarettes heat to no more than 350° C, which creates the aerosol, as I mentioned, but there are not as many chemicals in e-cigarettes as in burned conventional tobacco.

Beachey: Why do you think that e-cigarettes have become so prevalent, especially among adolescents and young adults?

Ebbert: I believe it's a confluence of factors. Kids are attracted to technology, and an e-cigarette is essentially an advanced drug-delivery device app. It is also a product that delivers nicotine, which is a reinforcing drug or chemical. Some e-cigarettes are designed specifically to be concealed. You can hide them in your hand and they create very low vapor profiles; that is, they are easy to vape without producing a lot of detectable aerosol. So it allows the user to secretly deliver nicotine.

Advances in the attractiveness of the e-cigarette devices—they can be tailored to the user's comfort level, and their ease and cost—add to their appeal. There is also the fact that kids and adolescents under the age of 25 often like to experiment with chemicals—not all kids, but some—and those kids who are experimenting with chemicals have easy access to nicotine, which is a legal substance. That confluence of circumstances could have predicted the current crisis or epidemic we have with youth using e-cigarettes.

What Are the Risks?

Beachey: E-cigarettes are frequently marketed as a safer alternative to traditional cigarettes, but what are some of the risks of using an e-cigarette?

Ebbert: As I mentioned, conventional cigarettes produce about 6000 or so chemicals when burned; e-cigarettes are relatively less complex in terms of the chemicals produced in the aerosol. If you look at the chemical species in e-cigarette fluid or e-liquid and compared that with the chemicals in the aerosol, at least 16 new chemical species are created through the heating process, even though it heats only up to 350° C, and those chemical species that are created include things like free oxygen radicals, polycyclic aromatic hydrocarbons, and reactive oxygen species and carbonyl species such as formaldehyde. Those are created through the heating process, and although it is low-temperature heating relative to a conventional cigarette, it still creates a lot of potentially dangerous substances that are repeatedly inhaled into the lungs. So the risk is associated with the exposure to these new chemical species that are created.

We also do not know the long-term risks of repeated inhalation of vegetable glycerin and propylene glycol, two of the chemicals in e-cigarettes. We know they are safe as food additives, but once you inhale something, it is a very different risk prospect than something you take orally. We need to consider those risks to the lungs and potentially to the heart.

Beachey: Are e-cigarettes any less addictive than traditional cigarettes?

Ebbert: A great question that requires a more detailed answer. The addictiveness of any chemical is directly related to how quickly it gets into the central nervous system and in what concentration. Inhaled substances that are potentially addictive, such as nicotine or inhaled cocaine, for that matter, are delivered to the brain faster and therefore are potentially more reinforcing and more addictive.

With at least in some of the e-cigarettes on the market today, a lot of nicotine is being delivered, but it is not necessarily being delivered in the same way that nicotine is delivered by a conventional tobacco cigarette. So although there may be more total nicotine in an e-liquid that is vaporized in an e-cigarette, a lot of that nicotine is absorbed in the upper airway, in the mouth and the throat, and it is not delivered at the same speed or in the same concentration as inhaled tobacco smoke with nicotine in it. That has a lot to do with the chemistry of tobacco and the chemistry of e-cigarettes. So lots of nicotine is delivered, but it is difficult to make a clear statement about relative addictive potential because the mechanisms of delivery are so very different.

Can e-Cigarettes Help You Quit Smoking?

Beachey: Can e-cigarettes be an effective tool for smoking cessation?

Ebbert: A study published in the [*New England Journal of Medicine*](#) compared the effectiveness of e-cigarettes with that of nicotine replacements such as the nicotine patch, gum, or lozenge. They randomly assigned smokers who wanted to quit to use the e-cigarette or nicotine replacement therapy, and at 1 year, e-cigarettes nearly doubled the odds of quitting compared with nicotine replacement therapy.

One issue, however, was that many of the people who used the e-cigarette to quit were still on the e-cigarette at the end of the study, whereas most of the patients given the nicotine replacement therapy were not still using nicotine replacement therapy. So, yes, they quit traditional cigarettes, but they were still using the e-cigarette.

The most interesting finding is that very few of them were using an e-cigarette that delivered nicotine in any reasonably high concentration. So they were started on a particular e-cigarette with a concentration of nicotine that was in the normal or medium or moderate range, but most of those patients, even though they were still on e-cigarettes, were using e-liquid that had zero nicotine in it. So they were still using the e-cigarette, but they were tapering off the nicotine. What does that mean from a public health perspective? I think that is still being debated.

Beachey: Should e-cigarettes be recommended to patients for smoking cessation, from your perspective?

Ebbert: We have heard many experts say that e-cigarettes are 95% safer than conventional cigarettes, but that is just looking at the relative concentrations and the types of chemicals in e-cigarettes compared with conventional cigarettes. They are not completely safe. These products deliver those chemical species we talked about.

There are a lot of things that manufacturers can do. We recently completed a systematic review of the literature, looking at all of the design elements that go into e-cigarettes and all the components that go into the manufacturing of e-cigarettes, and we identified some discrete measures that manufacturers and regulatory officials can take to make them safer, and we asked that they make them safer. [*Editor's note: This review is not yet published.*]

At the Nicotine Dependence Center at Mayo Clinic, we do not recommend e-cigarettes for the treatment of tobacco dependence. Patients are using them and we do not tell them to stop, but we say that they need to use the traditional recommended tobacco treatment approaches, such as varenicline, bupropion, and nicotine replacement therapy. We do not recommend e-cigarettes, and we believe these products need to be made safer, but they need to be made safer in a structured way through manufacturing and regulatory practice.

The huge caveat is that I do not think any adolescent under the age of 25 should be using any potentially addictive substance, period. So when we talk about whether to use e-cigarettes for smoking cessation, it is a very different conversation than thinking about the current epidemic among adolescents. As an addiction expert, my belief is that any time you expose a brain younger than age 25 to a potentially addictive substance, you fundamentally change that neurochemistry forever. We need to protect our kids and restrict access to these devices.

Beachey: At this point, it sounds like e-cigarettes are not something we should typically recommend to patients for smoking cessation. What do you say to a patient who tells you that without e-cigarettes, they'd be smoking traditional cigarettes? Who says that e-cigarettes was the thing that helped them quit?

Ebbert: I support them. I talk to them about the risks, which are theoretical at this point. We're hearing about some [lung disease in the news](#) that may be related more to the other, non-nicotine substances in these e-cigarettes. We discuss options for coming off the e-cigarettes, including nicotine weaning, reducing the nicotine concentration, or using nicotine replacement therapy, bupropion, or varenicline to get them to quit the e-cigarette.

Beachey: Dr Ebbert, thank you for joining us here today, and thanks for your important insights. This is an important topic that we will continue to hear more about as we have more research into this area