



**Sylvia R. Karasu M.D.**

The Gravity of Weight

# Behind the Smoke-Screen of Vaping: E-Cigarettes

Condensing information from the nuance of vapor

Like 11

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Vincent Van Gogh, "Skull with a Burning Cigarette," Van Gogh Museum, Amsterdam, circa 1885.

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They come in “Cherry Crush,” “Snappin’ Apple,” “Chocolate Treat,” coffee, mint, crème caramel, black cherry marshmallow, buttered popcorn, cotton candy, Fruit Loops, and over 7,700 other “unique flavors.” (England et al, *American Journal of Preventive Medicine*, 2015; Hildick-Smith et al, *Journal of Adolescent Health*, 2015; Zhu et al, *Tobacco Control*, 2014.) Sound like gourmet specialty candy or ice cream? Hardly. They are among the flavor varieties available for electronic cigarettes.

Electronic cigarettes (e-cigarettes) are essentially electronic nicotine delivery systems, also referred to as ENDS. Nicotine, of course, is the major toxic chemical in traditional tobacco cigarettes, though traditional cigarettes contain 7,000 compounds and at least 70 “recognized carcinogens.” (Hildick-Smith et al, 2015) Vapor from e-cigarettes contains lower levels of potentially toxic chemicals than traditional cigarettes, but users should not fall into the trap of thinking of them the way cigarette smokers had once thought of “lite” or “filtered” products that ultimately have proven no safer

than traditional tobacco products. (Drummond and Upson, *Annals of the American Thoracic Society*, 2014)



E-cigarettes come in a variety of sizes and shapes and flavors though they are primarily a nicotine delivery system. Credit: kitira65.

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It was in 1964 that the U.S. Surgeon General first issued a report linking smoking to lung cancer and chronic bronchitis. In attempts over the years to wean people from traditional cigarettes, manufacturers have created nicotine replacement therapies, such as nicotine transdermal patches, nasal spray, gum, and lozenges, all of which are FDA-approved. (Hildick-Smith et al, 2015). Nevertheless, traditional cigarette smoking continues “to cause a massive burden of avoidable disease and premature mortality” throughout the world. (Drummond and Upson, 2014) A January 2017 editorial in *The Lancet* notes that 6 million people die from tobacco each year, and there are

projections that the number is expected to rise to 8 million by 2030; global health costs and loss of productivity are estimated at \$1 trillion.

There have been two philosophies that have dominated efforts at controlling the use of tobacco—abstinence and harm reduction, and there has been “tension” between the two different camps. E-cigarettes have increased the tension because it is not clear whether they are able to “render combustion of tobacco obsolete,” i.e., whether they “deliver promise or peril.” (Abrams, *JAMA*, 2014)

The U.S. tobacco company Philip Morris had first begun working on electronic cigarette technology in the 1990s, ostensibly to develop a safer cigarette, but the company became concerned about possible FDA regulations on tobacco and tabled its product until around 2001. (Dutra et al, *Tobacco Control*, 2016). A Chinese pharmacist is credited with inventing e-cigarettes around 2003; the first device arrived in the U.S. market in 2007. (Orellana-Barrios et al, *American Journal of Medicine*, 2015) By 2014, there were over 450 brands on the market. (Zhu et al, 2014)

E-cigarettes are available in several different types: disposable cigarette-shaped; rechargeable cigarette-shaped; pen-shaped medium-sized rechargeable; and rechargeable vaporizers that



Edvard Munch, "Self-Portrait with Burning Cigarette," National Gallery, Norway, 1895.

Source: WikimediaCommons.org/Public Domain



E-cigarettes produce a vapor-like cloud; those who use are called "vapers" and the process is called "vaping." Credit: mauro\_grigollo.

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are larger devices that apparently can deliver almost as much nicotine as traditional cigarettes. (Glasser et al, *American Journal of Preventive Medicine*, 2017; Grana et al, *Circulation*, 2014) There are also e-hookahs, e-cigars, and even e-pipes. (Zhu et al, 2014) These products have become big business and are expected to reach \$10 billion globally in 2017 as many of the major tobacco companies have begun to purchase or develop this technology. (Tremblay et al, *BiomedCentral Medicine*, 2015; Zhu et al, 2014)

E-cigarettes have been called a "disruptive technology." (Glasser et al, 2017; Abrams, 2014; Etter, *Biomed Central Medicine*, 2015) First used to describe the Internet, a "disruptive technology" is one that can "radically alter market forces, profit expectations, and business models," as opposed to a "sustaining technology" that "reinforces the same markets and economic assumptions that existed previously." (Anderson, *Journal of the American Medical Informatics Association*, 2000.)

E-cigarettes have four component parts: a battery (usually lithium); a heating element that enables temperatures to rise high enough to produce an aerosol; a vaporizing chamber; and a solution cartridge that contains nicotine, flavoring, and either propylene glycol or glycerin. Batteries can be automatic or manual. In some models, batteries can be charged by using a USB port on a computer. Significantly, there have been reports of severe thermal burns, lacerations, and even explosions from overheated batteries. (Orellana-Barrios et al, 2015; Glasser et al, 2017)

Some e-cigarettes enable the user to adjust the amount of nicotine inhaled. Researchers note that the aerosol that is produced is technically not a



Some of the batteries of e-cigarettes can be charged using a USB port on a computer; high school students even charge them surreptitiously at their desks. Batteries have been known to explode and cause severe thermal burns and lacerations.

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vapor since it has a “particulate phase” and not just a gas phase typical of a vapor. Nevertheless, those who use e-cigarettes are called “vapers” and the process is called “vaping.” (Orellana-Barrios et al, 2015) These are indeed “very strange vapours” (Ben Jonson, *Bartholomew Fair*, 1614) and “confounding vapors.” (G.K. Chesterton, *William Blake*, 1910)

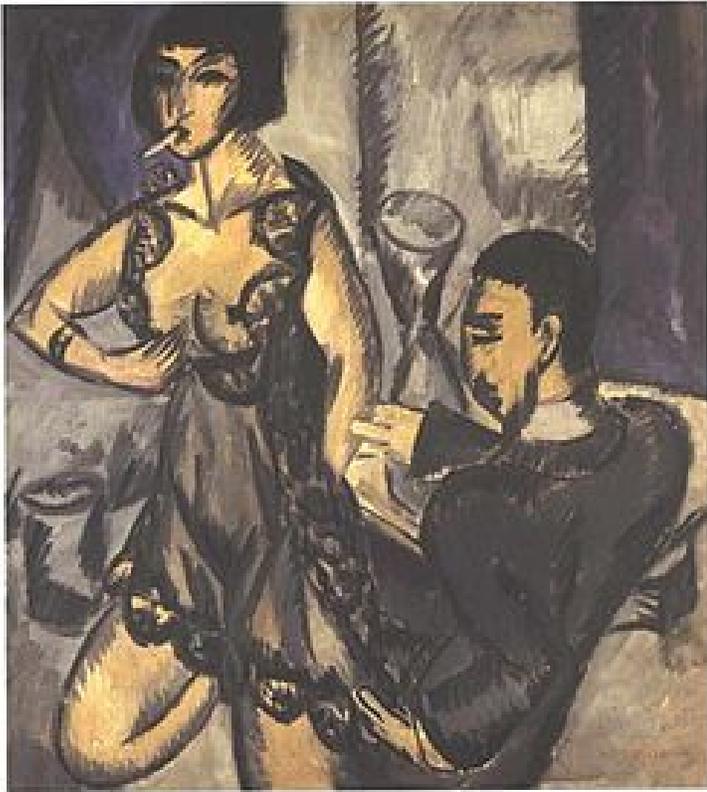
Essentially, e-cigarettes deliver nicotine to the lungs, but it is not clear where most of it is absorbed (Palazzolo, *Frontiers in Public Health*, 2013). An e-cigarette cartridge can deliver from 150 to 300 puffs; a traditional cigarette yields 10 to 15 puffs. Adverse reactions include mouth and

throat irritation, vertigo, headaches, and nausea. Nicotine itself is not only toxic, but potentially lethal, especially for children.

Toxicity, i.e., the “toxicant fingerprint” (Orr, *Tobacco Control*, 2014) for e-cigarettes depends on the product’s design and the amount of nicotine exposure. Because nicotine is delivered to the lungs and absorbed in the mouth, its absorption, metabolism, distribution, and excretion can be similar to traditional cigarettes. Both involve a respiratory route: e-cigarettes involve aerosol exposure while traditional cigarettes involve inhalation of smoke by the burning of tobacco. Apparently, it is difficult to extrapolate toxicity findings among the different brands that are commercially available, and there is no scientific consensus on “testing paradigms” to use to compare traditional cigarettes with e-cigarettes.

Many substances have been found in the solutions of e-cigarettes, including tobacco alkaloids, aldehydes, heavy metals (e.g., nickel, lead, cadmium, chromium), arsenic, and volatile organic compounds. (Orellana-Barrios et al, 2015) The vaping liquid products of glycerin and propylene glycol are of particular concern and potentially carcinogenic as they are oxidized to formaldehyde and other toxic chemicals. (Callahan-Lyon, *Tobacco Control*, 2014) Other factors that may affect the inhalation of toxic chemicals include climate conditions, air flow, room size, number of other vapers, type and age of the system used, battery voltage, puff length and amount of suction on the device, interval between puffs (Callahan-Lyon, 2014; Evans and Hoffman, *Tobacco Control*, 2014), and experience of the user.

Further, there has been inaccurate product labeling such that products that supposedly do not contain nicotine have actually been found to contain it. (Palazzolo, 2013) There may also be inconsistent nicotine delivery because of a lack of industry standards in assessing the ingredients and methods used in manufacturing. (Callahan-Lyon, 2014)



Ernst Ludwig Kirchner (1880-1938), "Couple in a Room," date unknown.

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Originally, there were no U.S. regulations on the manufacture, marketing, or sale of e-cigarettes, and many sales have been and continue to be transacted over the Internet. Significantly, Switzerland is the only country where the sale of nicotine-containing e-cigarettes is completely banned. (Greenhill et al, *Journal of Adolescent Health*, 2016) By mid-2014, 44 U.S. states had planned or already enacted legislative regulations on e-cigarettes, (Tremblay et al, 2015); it was only last May 2016 that the FDA finally decided to step in and legislate their sale as it does for other tobacco substances: once the legislation fully takes effect over the next few years, the sale of e-cigarettes will be banned to anyone under age 18, and a photo I.D. will be required. (FDA *Consumer Health Information*, June 2016)

The major focus and cause for concern now are on the growing use of e-cigarettes by adolescents.

(Tremblay et al, 2015) There is considerable fear that vaping will encourage both teens and young adults to begin to use or continue using traditional cigarettes, i.e., that e-cigarettes may become a “gateway” to traditional cigarettes, especially in those who have never smoked previously. (England et al, 2015; Palazzolo, 2013) As tobacco smoking has fallen in these populations over recent years, from a high of 35% in the mid '90s to 9.2% in 2014 (Barrington-Trimis et al, *Pediatrics*, 2016), vaping has increased considerably: from 2014, in 21 cross-sectional studies involving adolescents, those reporting “ever use” rose from 6.4% to 31%. (Greenhill et al, 2016) In other words, the current use of e-cigarettes has, for the first time, surpassed cigarette smoking, and there is concern that the use “renormalizes” smoking. (Barrington-Trimis et al, 2016) Unfortunately, adolescents believe e-cigarettes are safer than traditional cigarettes, have a propensity for risky, thrill-seeking behaviors, and are particularly influenced by their peers. (Greenhill et al, 2016; Carroll Chapman and Wu, *Journal of Psychiatric Research*, 2014)

Studies have shown that nicotine exposure during “periods of developmental vulnerability” such as during adolescence, can impair neuronal development, brain circuitry that leads to changes in “brain architecture,” and neurobehavioral functioning. (Greenhill et al, 2016; England et al,



Enrique Simonet (1866-1927), "Smoking Shisha at the Teashop," 1892.

Source: WikimediaCommons.org/Public Domain

2015) Further, adolescents exposed to nicotine are more likely to become dependent on it. Nicotine exposure may have long-term effects on cognitive behavior, including reduced attention span and increased impulsivity in adulthood. (Yuan et al, *Journal of Physiology*, 2015) England et al (2015) acknowledge that ethical issues involving human experimentation "make it unlikely that there will ever be definitive human studies that fully quantify the effects of nicotine on the developing brain." They emphasize, though, that use of e-cigarettes "warrants extreme caution," including exposing the fetus to its effects during pregnancy.

Researchers also emphasize that since traditional cigarettes have not been advertised on television since the 1970s, heavy advertising of e-cigarettes is reaching a new generation not used to such marketing. (Grana et al, 2014) Even though as many as 85% of e-cigarette users report using the product to quit smoking, in some studies, e-users were found to be no more likely to quit one year later than non-users. (Grana et al, 2014) Further, since e-cigarettes are not approved for quitting, there are no "therapeutic instructions" for how to use them as replacements for traditional cigarettes.

**Bottom line:** Even though e-cigarettes technically don't send out smoke, we can think metaphorically that e-cigarettes may generate their own "smoke-screen." We don't know their long-term effects; further, they may not necessarily lead to decreased smoking, and they may even encourage "dual use" and the "renormalization" of smoking traditional cigarettes. There are now, though, enough data to warrant caution for everyone, but especially for vulnerable populations like adolescents and pregnant women.

Note: My subtitle was inspired by Neal Stephenson's 1992 disquieting, science fiction novel *Snow Crash* in which facial expressions convey information about what's going on in the mind of another: "Condense fact from the vapor of nuance." (p. 60)

For those who want the most complete bibliography on e-cigarettes (with 811 references), see the recent review by Glasser et al in *The American Journal of Preventive Medicine*, 2017)



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## About the Author



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**In Print:** *The Gravity of Weight: A Clinical Guide to Weight Loss and Maintenance*

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