



**Puff and Anarchy:
Vape Technology and Its Consequences**

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Disclosures

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- Nothing to disclose



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Objectives

- Examine the underlying science behind vaping related to e-cigarette technology and its derivatives
- Discuss smoking cessation and e-cigs:
What was promised? What has been delivered?
- Review the "full spectrum CBD liquid" and the "Entourage Effect" of CBD and vaping



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Elements in common for e-cig system...

- Power supply – single use battery or rechargeable (~3.7 volts)
- Microprocessor control – detects demand; voltage of battery (and alert the user when the battery reaches a specified value)
- Storage compartment – either a simple wick or actual liquid reservoir
- Atomizer/vaporizer unit
- Drip tube and user mouth piece



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Typical e-cigarette



https://en.wikipedia.org/wiki/Construction_of_electronic_cigarettes



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Propylene Glycol and Vegetable Glycerin

- The Food and Drug Administration (FDA) has **classified propylene glycol** as an additive that is "generally recognized as **safe**" for use in food. ... It may exist in air in the vapor form, although **propylene glycol** must be heated or briskly shaken to produce a vapor. **Propylene glycol** is practically odorless and tasteless
- **Vegetable glycerin**
 - By-product of soap manufacturing
 - Common use in cosmetics
 - Generally considered safe in low concentrations – concerns emerging re pulmonary effects
- **But when heated, toxicity changes dramatically***

*Jensen R. Paul et al. Hidden Formaldehyde in E-Cigarette Aerosols. N Engl J Med. 372:4 Jan 22, 2015



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So... where did the e-cigarette come from?

- Herbert A Gilbert, a 2 ppd smoker patented a smokeless nontobacco cigarette in 1965... but it never caught on
 - But in 2003, Hon Lik in China developed and patented the "e-cigarette" to address the massive smoking problem in China*
 - Now, it's a \$10 billion/yr worldwide industry
- Originally, the nicotine containing liquid was in free-base form**
 - "Big tobacco" has known for years this is not the most efficient way to deliver nicotine to the brain but through existing tobacco chemistry, the development of nicotine salts has become the norm
 - "better bang for the buck"
 - Higher nicotine concentrations delivered to the brain
 - Cheaper replacement "e-juice" for vapor systems

*<https://patents.google.com/patent/EP1618803A1/en?inventor=Lik+Hon&sort=old>
 **Barrington-Trimis, Jessica et al Adolescents' Use of "Pod Mod" E-Cigarettes – Urgent Concerns. N Engl J Med 379: 12 2018



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PG + VG (heat) = VAPOR

- Relative ratio of PG/VG determines quality of the 'vapor'
 - Higher PG = thinner liquid, greater 'smoke hit' in throat
 - Higher VG = more viscous, greater volume of smoke
 - Other variables include temperature of the atomizer and quantity of liquid
 - ie, capillary action of original e-cig = limited vapor
 - "drip" delivery of PG/VG to heater element = huge volumes of smoke*
- What ever substances are present in the vape liquid will play a role in what is in the vapor (including PG/VG)
 - Diacetyl is a flavoring chemical: it and oxidation products appear in the vapor, ie, acetic acid
 - Pesticides (in far greater concentrations after concentrating)
 - Thermal decomposition of propylene glycol and flavoring agents create toxic aldehydes**

*Suchitra Krishnan-Sarin et al E-Cigarettes and "Dripping" among High-School Youth, Pediatrics 2017: 139(3)
 ** Andrey Khlystov and Vera Samburova Flavoring Compounds Dominate Toxic Aldehyde Production during E-Cigarette Vaping. Environ. Sc. Technol. 2016. 50. 13080-13085



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In a perfect world....

- Vaping would involve taking pure compounds of vehicle (PG/VG) and active ingredient (nicotine/THC/CBD, etc) in precise concentrations, applied to a heating element held to exacting standards to deliver ONLY the desired elements of the mixture
- BUT...
- In reality.... The starting materials are not pure and typically contain >1 flavoring agents, the proportions may/may not be clearly defined and, as a result of a number of variables, the compound(s) delivered may contain trace heavy metals, undesired oxidation products of both known and unknown toxicity, and device modifications that are impossible to control



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Smoking Cessation

- In Canada, e-cigarette use is increasing, specially among youth*
 - Use in Canadians age 16-17 increased from 29.3% in 2017 to 37% in 2018
 - Moreover, prevalence and frequency of vaping increased among never and experimental smokers in parallel with market rise of higher nicotine concentration delivery systems
 - E-cigarette use is strongly associated with initiation & ongoing use of cigarette smoking
 - 14-30 year old nonsmokers who use e-cigarettes have a >3 fold increased risk (23.2% vs 7.2%) of initiation of cigarette smoking (1 in 6)
 - E-cigarettes are an additional smoking cessation tool
 - Randomized clinical trial (Hajek P, et al. Randomized trial of e-cigarettes vs nicotine-replacement)
 - E-cigarettes are unregulated products with potentially dangerous health effects
 - Clinicians should ask every patient about e-cigarette use

*Aloosh Mehdi et al E-Cigarettes CMAJ 2019 Oct 15;191:E1136



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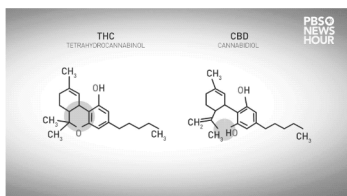
Cannabinoid Delivery Systems

- The recent state legalization of medical marijuana and, in some cases, recreational marijuana has resulted in the search for "safer" and more efficient drug delivery systems
 - Many thought of vaping as a "less harmful" way to use cannabis
 - Evidence on medical effectiveness is unclear
 - Even use of CBD in pediatric epilepsy is coming into question
 - Mounting evidence of significant risk intrinsic to the vaping process



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The Active Ingredients – but there are many more



<https://www.analyticalcannabis.com/articles/cbd-vs-thc-what-are-the-main-differences-297486>



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Counterfeit e-Liquids and Pods

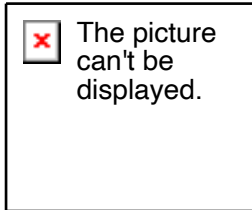
- CBD and THC oils are viscous: "the thicker the liquid, the higher the concentration"
 - UNLESS it has been adulterated or "diluted" with a cheaper material with similar viscosity to cannabis oils, ie, "vitamin E oil"
 - Why do it? MONEY!
- The replacement pods are all available from the manufacturers in China – regardless of brand name

*Boudi F, Patel S, Boudi A, et al. (December 11, 2019) Vitamin E Acetate as a Plausible Cause of Acute Vaping-related Illness. Cureus 11(12): e6350. DOI 10.7759/cureus.6350



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Is It Pure or Adulterated: CBD and THC?



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Regulatory Framework – A Real Mess

- Cannabis and ALL compounds derived therefrom are ILLEGAL
 - Schedule 1 at the federal level
- Hemp is 'cannabis' containing less than 0.3% THC by dry weight (legal)
 - CBD from 'hemp' is legal (Hemp Farm Bill 2018*)
- Cannabis containing more than 0.3% THC is marijuana (illegal)
 - CBD from marijuana – still illegal
- Cannabis or any of its products cannot cross international borders

*<https://www.fda.gov/news-events/congressional-testimony/hemp-production-and-2018-farm-bill-07252019>



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So, what is the message to your patients?

- If you don't smoke: DON'T START (including e-cigs)
 - If you are a smoker, get professional, knowledgeable help to quit
- If you chose vaping as a delivery system – for nicotine, CBD, or THC – make sure you are aware of the risks
 - Stay away from the net – the Wild West is not the place to trust your health to
 - Find a local vendor you can trust and get to know them
 - Cheapest isn't always the way to go, especially if you factor in a double lung transplant into the equation
- Avoid flavored "juices." The flavoring agents may be more dangerous than the active ingredients



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