Mods & Pods

“What Makes a Juul a Juul?”
“Vaping” – Technically Aerosolization
ENDS Evolution

1st generation
'cig-a-like'
Cartridge, atomiser and battery

2nd generation
“Vape pens”
Tank and battery
Refillable

3rd generation
Mechanical 'mods'
Variable power options
Pod System
Juul
Mod Systems
Pod Systems
Vaping “Archetypes”

Sub-Ohm Vaping with Mod Systems

Pod Vaping with Pod Systems
Coil Mechanics Drive Aerosol Production
Aerosolization With Heat: “It’s All About The Coil”

1. Kanthal (chromium-iron-aluminum)
2. Nichrome (nickel-chrome)
3. Stainless steel
4. Nickel
5. Titanium

Mod Systems

Pod Systems
Mod System Coils
Pod System Coil
The Aerosol: Its not just water vapor

• E-cigarette Aerosol contains:
  • **Carbonyl Compounds**: formaldehyde, acetaldehyde, and acrolein
  • **Metals**: tin, silver, iron, nickel aluminum, sodium, chromium, copper, magnesium, manganese, lead, potassium and silicate nanoparticles
  • **Tobacco specific nitrosamines (TSNAs)**: carcinogenic compounds found in tobacco and tobacco smoke.

(Schripp et al, 2012; Westenberger 2009; Goniewicz et al, 2013; Williams et al, 2013)
Carbonyl Compounds Created By Oxidation of E-Juice From Contact with the Heated Nichrome Wire (>350ºC)

**Aerosolization - Up to 18 additional compounds**

Carbonyl Compounds in E cig Vapor by Voltage & Heat

Formaldehyde

- VG
- VG:PG
- PG

Acetaldehyde

Battery output voltage

<table>
<thead>
<tr>
<th>Voltage (volts)</th>
<th>Formaldehyde (nominal ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td>0</td>
</tr>
<tr>
<td>4.0</td>
<td>1</td>
</tr>
<tr>
<td>4.8</td>
<td>3</td>
</tr>
</tbody>
</table>

Heater temperature

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Formaldehyde (nominal ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>0</td>
</tr>
<tr>
<td>300</td>
<td>0</td>
</tr>
<tr>
<td>350</td>
<td>0</td>
</tr>
<tr>
<td>400</td>
<td>0</td>
</tr>
<tr>
<td>450</td>
<td>0</td>
</tr>
<tr>
<td>500</td>
<td>0</td>
</tr>
</tbody>
</table>

* Empirical fit


Flavors R us! (all 15,000+ of them)

- Flavoring
- Nicotine
- Vegetable glycerin
- Propylene glycol
### E-liquid Flavorings

<table>
<thead>
<tr>
<th>Chemical Group</th>
<th>Flavoring Chemical</th>
<th>CAS Number</th>
<th>Flavor Type</th>
<th>Flavor Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldehydes</td>
<td>Geranial</td>
<td>141-27-5</td>
<td>Citrus</td>
<td>Citrus, lemon</td>
</tr>
<tr>
<td></td>
<td>Benzaldehyde</td>
<td>100-52-7</td>
<td>Fruity</td>
<td>Almond, fruity, powdery, nutty, and benzaldehyde-like</td>
</tr>
<tr>
<td></td>
<td>Cinnamaldehyde</td>
<td>104-55-2</td>
<td>Spicy</td>
<td>Sweet, spice, cinnamon red, hot, warm</td>
</tr>
<tr>
<td></td>
<td>Vanillin</td>
<td>121-33-5</td>
<td>Vanilla</td>
<td>Sweet, vanilla, creamy, chocolate</td>
</tr>
<tr>
<td>Ketones</td>
<td>Diacetyl</td>
<td>431-03-8</td>
<td>Buttery</td>
<td>Sweet, creamy, buttery, pungent, with a pungent caramellic nuance</td>
</tr>
<tr>
<td></td>
<td>Acetyl propionyl</td>
<td>600-14-6</td>
<td>Buttery</td>
<td>Buttery, nutty, toasted, caramellic, diacetyl and acetoin notes</td>
</tr>
<tr>
<td></td>
<td>Raspberry ketone</td>
<td>5471-51-2</td>
<td>Fruity</td>
<td>Sweet, berry jam, raspberry, ripe, floral</td>
</tr>
<tr>
<td>Oxygen containing</td>
<td>Furfural</td>
<td>98-01-1</td>
<td>Bready</td>
<td>Brown, sweet, woody, bready, nutty, caramellic with a burnt astringent nuance</td>
</tr>
<tr>
<td></td>
<td>5-Methylfurfural</td>
<td>620-02-0</td>
<td>Caramellic</td>
<td>Sweet, caramellic, bready, brown, coffee-like</td>
</tr>
<tr>
<td></td>
<td>Maltol</td>
<td>118-71-8</td>
<td>Caramellic</td>
<td>Sweet, caramel, cotton candy, jam, fruity, baked bread</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>2-Acetypyrazine</td>
<td>22047-25-2</td>
<td>Popcorn</td>
<td>Musty, roasted, corn chip, popcorn, nutty, potato-like</td>
</tr>
</tbody>
</table>

Solvent Carrier: Vegetable Glycerin ("VG")

- Glycerol from vegetables
- Sweetener - 60% as sweet as sucrose
- Food preservative
- Gel capsule component
- Personal care products to make them “smooth”
Solvent Carrier: Propylene glycol ("PG")

- Pharmaceutical solvent
- Food additive
- Additive in moisturizer, cosmetics, toothpaste, hand sanitizer
- Non-toxic antifreeze (toxic = ethylene glycol)
- Asthma inhaler & nebulizer component
Nicotine Delivery By Device Type

New generation Ecigs deliver more nicotine than first generation Ecigs

What is a “Nicotine Salt”?

Salt:
- Smoother taste
- Higher concentration delivered

Free Base:
- Harsher taste
- Limits concentration delivered

Add:
- Benzoic acid
- Salicylic acid
- Malic acid

Lower pH

Make:
- Nicotine benzoate
- Nicotine salicylate
- Nicotine malate

Lower pH

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Lower pH
What is a “Nicotine Salt”?  

• “Nic salt,” “salt nic,” or “salt nicotine”  
  • Forms naturally in leaf tobacco and is generally considered to be a more stable form vs. traditional “freebase nicotine” salt found in most E-liquids  

• “Freebase nicotine” has a higher pH level  
  • Taste is “harsher” at higher pH  

• Benzoic Acid added  
  • Helps to make nicotine salts smooth and palatable in higher concentrations at a lower pH  

• Requires a higher temperature to properly vaporize (Pod system)  

• Relative nicotine content  
  • Juul  
    • 5% nicotine by weight (59 mg/mL)  
    • 3% nicotine by weight (35 mg/mL)  
  • E-liquids (non salts)  
    • 0, 3, 6, 12, and 18 mg/mL
Health Effects of ENDS
EVALI

• As of December 27, 2019, a total of 2,561 hospitalized EVALI cases have been reported to CDC from all 50 states, the District of Columbia, and two U.S. territories (Puerto Rico and U.S. Virgin Islands)

• 55 deaths have been confirmed in 27 states and the District of Columbia (as of December 27, 2019)
Many Vaping Illnesses Linked To Black Market 'Dank Vapes' Or Other THC Products
Lithium Battery Explosions
“Thermal Runaway”

Injury types:
- Flame
- Chemical
- Blast


CDC: What we know

• Analyses of fluid samples of patients with e-cigarette, or vaping, product use associated lung injury (EVALI) identified vitamin E acetate, an additive in some THC-containing e-cigarette, or vaping, products
  • THC was identified in 82% of the samples and nicotine was identified in 62% of the samples

• These findings provide direct evidence of vitamin E acetate at the primary site of injury within the lungs
E-cigarettes and MI Risk – recent updates

Table 1
Summary of recent cross-sectional population studies which have investigated the relationship between e-cigarette use and the risk of developing myocardial infarction (MI)

<table>
<thead>
<tr>
<th>Authors</th>
<th>Population</th>
<th>Risk of MI in e-cigarette users</th>
</tr>
</thead>
</table>
| Alzahrani et al, 2018    | n = 69,725 | Occasional users: OR, 1.16 (95% CI, 0.93–1.42)  
                            Daily users: OR, 1.79 (95% CI, 1.20–2.66) |
| Alzahrani and Glantz, 2019[a] | n = 97,625 | Occasional users: OR, 1.49 (95% CI, 1.06–2.09)  
                            Daily users: OR, 2.14 (95% CI, 1.41–3.25) |
| Vindhyal et al, 2019[a]  | n = 96,467 | Current users: OR, 1.56 (95% CI, 1.45–1.68)  |
| Bhatta and Glantz, 2019  | n = 32,320 | Occasional users: OR, 1.99 (95% CI, 1.11–3.59)  
                            Daily users: OR, 2.25 (95% CI, 1.23–4.11) |
| Osei et al, 2019         | n = 449,092| Current daily users: OR, 1.35 (95% CI, 0.74–2.46)  
                            Dual daily users: OR, 1.59 (95% CI, 1.20–2.08) |
| Ndunya and Muatu, 2019   | n = 410,651| Current users: OR, 1.59 (95% CI, 1.53–1.66)  |

Abbreviations: 95% CI, 95% confidence interval; MI, myocardial infarction; OR, odds ratio.

[a] This data originates from the same U.S. National Health Interview Survey (NHIS).
IPAL (Inhaled Particle Aerosol Lab)

https://www.youtube.com/watch?v=9TobzEmhx_Y
Treatment
Online tools – TRUTH initiative

WANT 2 QUIT VAPING?

TEXT "DITCH JUUL" TO 88709
BecomeAnEX

- Online community offering tools, resources, and support
  - Mayo supported blog
Pharmacotherapy
Menu of Options – Long-acting Options

Nicotine patch
- 7 mg
- 14 mg
- 21 mg

Bupropion (Zyban®, Wellbutrin)
- Available doses:
  - 150 mg
  - 300 mg

Varenicline (Chantix™)
- Available doses:
  - 0.5 mg
  - 1 mg
Pharmacotherapy
Menu of Options – Short-acting Options

Nicotine inhaler
Nicotine nasal spray
Nicotine gum
Nicotine lozenge Mini lozenge

Available doses:
2 mg
4 mg

Available doses:
2 mg
4 mg
Expert Recommendations
## Draft: Recommendation Summary

<table>
<thead>
<tr>
<th>Population</th>
<th>Recommendation</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>All adults</td>
<td>The USPSTF recommends that clinicians ask all adults about tobacco use and provide U.S. Food and Drug Administration (FDA)--approved pharmacotherapy or behavioral interventions (alone or in combination) for cessation in adults who use tobacco.</td>
<td>A</td>
</tr>
<tr>
<td>Pregnant women</td>
<td>The USPSTF recommends that clinicians ask all pregnant women about tobacco use and provide behavioral interventions for cessation in pregnant women who use tobacco.</td>
<td>A</td>
</tr>
<tr>
<td>Pregnant women</td>
<td>The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of pharmacotherapy interventions for tobacco cessation in pregnant women.</td>
<td>I</td>
</tr>
<tr>
<td>All adults who smoke tobacco</td>
<td>The USPSTF concludes that the current evidence is insufficient to recommend electronic nicotine delivery systems (ENDS) for tobacco cessation. The USPSTF recommends that clinicians direct patients who smoke tobacco to other cessation interventions with established effectiveness and safety (see above).</td>
<td>I</td>
</tr>
</tbody>
</table>
Expert Panel Conclusions & Recommendations

American Cancer Society- E-cigarettes should not be used to quit smoking, all tobacco products including e-cigarettes pose a risk to the health of the user.

American Heart Association - position statement from 2014

American Medical Association – calls for total ban on all vaping products not approved by FDA

American Lung Association

“The Food and Drug Administration has not found any e-cigarette to be safe and effective in helping smokers quit. If smokers are ready to quit smoking for good, they should call 1-800-QUITNOW or talk with their doctor about finding the best way to quit using proven methods and FDA-approved treatments and counseling”
• England continues to take small progressive steps towards ensuring vaping remains an accessible and appealing alternative to smoking.
Regulation around the World

- **UAE** - Banned - illegal
- **EU** - Similar position as USA
- **Singapore** - Banned
- **Australia** – Banned
- **United States** – age increase to 21 in all states by Sept 2020
  - Flavor Bans- partial bans
  - More to come…
Heated Tobacco Products - IQOS

- “Heat-not-burn tobacco” products
- In 2019, the FDA allowed the first type of tobacco heating system to be marketed and sold in the U.S. IQOS, produced by Philip Morris International, is now being sold in select test markets by Altria around the country.
Document in EHR

- E-cigarette use should be included in tobacco screening questions that are part of every health examination.
From the Mayo Clinic NDC:
Dr. Taylor Hays : Medical Director

https://www.youtube.com/watch?v=KZaY6LAICEY
Thank you!
Shumaker.therese@mayo.edu