E-CIGARETTES: A SOLUTION TO TOBACCO OR JUST TOBACCO IN SOLUTION?

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Dr. Crotty Alexander earned her medical degree from Duke University School of Medicine and completed her Internship and Residency at Massachusetts General Hospital, with Chief Residency at Newton Wellesley Hospital. She completed the Harvard Pulmonary and Critical Care Fellowship Program, followed by a post-doctoral fellowship in Infectious Disease and Innate Immunity at UCSD.

She has been active in the American Thoracic Society (ATS) and designed a very well received Pulmonary Critical Care Bootcamp for incoming fellows in May 2014. On a personal note, she is the proud mother of two sons, ages 4 and 2 who usurp most of her time. She also loves to travel and has gone to Australia, Fiji and Italy in the last few years.

OBJECTIVES:
Participants should be better able to:

1. Obtain a detailed understanding of the components and inner-workings of electronic cigarettes (e-cigarettes).

2. Understand known and potential toxicities of e-cigarettes.

3. Understand why these devices are now being regulated and the pros and cons of aggressive regulation.
E cigarettes: a solution to tobacco or just tobacco in solution?

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Disclosures

• I have nothing to disclose.

• Advertisements are contained in this presentation, but companies were chosen at random for educational purposes.
Question 1

What are e-cigarettes?

a) tobacco cigarettes with electronic component to initiate combustion
b) drug delivery device operated by a rechargeable battery
c) inhaler with a microprocessor to accurately deliver nicotine doses
d) portable electronic water pipe used to inhale nicotine in vapor form
e) faux-cigarettes bought on-line to use by your SIM
• Cigarettes
  • History

• Electronic (E)-cigarettes
  • History
  • Smoking Cessation
  • Data in Humans
  • Basic Research Studies

• Should I recommend e-cigarettes to my patients?

The real reason dinosaurs became extinct
Tobacco Cigarette Smoking

• 19% of all adults (44 million) in the U.S. smoke cigarettes
• Leading preventable cause of death in the U.S. (>480,000/yr; 1 of every 5). 289 billion in healthcare costs per year
• Is the cause of 90% (M) and 80% (F) of lung cancers
• 90% of COPD-related deaths
• Increases risk of coronary artery disease (CAD) and stroke by 2-4x


Historical Perspective

• Invented in 7-9th century by Mayans in Central America
• 1500s - Brought back to Spain
• 1600s - the Pope banned smoking in holy places
• 1830s - First U.S. anti-tobacco movement
• 1852 - Matches were introduced
• 1865 - Commercially made by Washington Duke
• 1881 - Machine made = increased production to 120,000 daily
• 1900 - Lung cancer was so rare that only 140 cases were in the published medical record (1% of cancer cases in 1878)
War + Military

- Cigarettes were given to U.S. soldiers in WWI and WWII and included in C-ration meals in Vietnam.
- Cigarettes are still sold at a significant discount to service men and women (20-73% off) who have higher rates of use (32-45%)

Tobacco Cigarette Smoking Cessation

- Success rates
  - Cold turkey
  - Nicotine replacement therapy (NRT) only
  - Oral medication
  - Counseling, support
  - Medication + NRT
  - Medication + NRT + Counseling
Electronic Cigarettes

E-cigarettes were invented by pharmacist Hon Lik in 2003 in China, and entered the international market in 2007.

• Drug delivery device which does not require combustion
• How they work: a battery is activated to heat a metal coil (atomizer) that creates a fine suspension of particles of liquid or solid or both, in a gas
• E-juice is the liquid inside the cartridge, and is heated to a maximum temperature of 55°C for aerosolization
• Can be activated either manually or pneumatically
Question 2

E-cigarette use is:

a) tripling in the adult U.S. population annually
b) doubling in middle-school and high-schoolers annually
c) primarily limited to conventional cigarette smokers in adults
d) all of the above
No Smell – Smoke Anywhere

TASTES & SMOKES BETTER THAN A REAL CIGARETTE!

No Toxic Chemicals!
No Tar or Yellow Teeth
No Smelly Clothes
Smoke Anywhere!

ELECTRONIC CIGARETTE

STEAMZ is not a Cigarette
But looks and Tastes like a Cigarette

No Tar  No Ash
No Tears  No Fire
No Stains  No Cancer
No Tobacco  No Bad breath
No Carbon monoxide  No Passive smoking
E-cigarettes

Use in minors is more than doubling annually (p<0.05), with 10% of high-schoolers using. 20% use e-cigarettes alone (no conventional tobacco).

Adult e-cigarette use on the rise, gains popularity especially among teens.


E-cigarette use more than doubles among middle and high school students from 2011-2012. CDC. Sept 2013.

Teens Who Try E-Cigarettes Are More Likely To Try Tobacco, Too.

E-juice

• Components: humectant(s) + nicotine + flavor(s)
  • Propylene glycol
  • Vegetable glycerin
  • Nicotine – anywhere from 6 to 26 mg/mL
  • >200 brands

• Vapers tend to vape 2-20x as much as they would smoke

E-juice cartridge

Flavors of E-juice

• Thousands of flavors to appeal to all populations
• To appeal to children: Chocolate, Tootsee Roll, Cinnamon Toast Crunch, Fruit Loops, Cotton Candy and Thin Mint.
Statement from the CDC, 2014

“The increase is not surprising. The e-cigarettes are marketed heavily, particularly by television, which is ironic since tobacco advertising on TV has been banned for decades. And the flavors that are offered are very appealing to young people.”
• Oxford Dictionaries word of the year: vape
  • Use doubled in 2014
  • Selfie was the word of the year in 2013
  • Originated in 1983 in a UK magazine, to describe a hypothetical device at that time
    – Vape pen
    – Vape shop
    – Vaporium
    – Tobacco cigarette (retronym)
Manufacturing

- Highly variable quality control
- Lack of uniform manufacturing standards
- Huge differences between brands in all studies to date, including ours (Goniewicz 2013, Czogala 2014)
- Labels do not include full chemical composition, and when they include nicotine concentration information, the measured levels do not match up (Goniewicz 2013)

Labeling vs. Reality?

<table>
<thead>
<tr>
<th>Literature</th>
<th>Matrix</th>
<th>Units</th>
<th>Nicotine level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goniewicz et al²³</td>
<td>Refill solution</td>
<td>mg</td>
<td>0±0.0 to 25±1.1</td>
</tr>
<tr>
<td></td>
<td>Cartridge</td>
<td>mg</td>
<td>0±0.0 to 19±0.3</td>
</tr>
<tr>
<td></td>
<td>Aerosol</td>
<td>mg/150 puffs</td>
<td>0.3±0.2 to 8.7±1.0</td>
</tr>
<tr>
<td>Etter et al³⁶⁶⁶⁶⁶⁶⁶</td>
<td>Refill solution</td>
<td>mg/mL</td>
<td>N.D. to 29.0</td>
</tr>
<tr>
<td>Kirschner et al⁶⁶⁶⁶</td>
<td>Refill solution</td>
<td>mg/mL</td>
<td>14.8±0.2 to 87.2±2.7</td>
</tr>
<tr>
<td>Cameron et al⁶⁶⁶⁶</td>
<td>Refill solution</td>
<td>mg/mL</td>
<td>8.5±0.16 to 22.2±0.62</td>
</tr>
<tr>
<td>Pellegrino et al⁶⁶⁶⁶</td>
<td>Cartridge</td>
<td>% WoW</td>
<td>&lt;0.001 to 0.25</td>
</tr>
<tr>
<td></td>
<td>Aerosol</td>
<td>mg/ml³</td>
<td>&lt;0.01 to 6.21</td>
</tr>
<tr>
<td>McAuley et al¹¹</td>
<td>Indoor air</td>
<td>ng/l</td>
<td>538 to 8770</td>
</tr>
<tr>
<td>Chash et al¹⁷</td>
<td>Cartridge</td>
<td>mg/cigarette</td>
<td>0.00 to 15.3</td>
</tr>
<tr>
<td></td>
<td>Cartridge</td>
<td>mg/cigarette</td>
<td>0 to 25.6</td>
</tr>
<tr>
<td></td>
<td>Aerosol</td>
<td>μg/100 mL puff</td>
<td>0 to 21.8</td>
</tr>
<tr>
<td></td>
<td>Aerosol</td>
<td>μg/35 mL puff</td>
<td>0 to 43.2</td>
</tr>
<tr>
<td>Golb et al⁶⁶⁶⁶⁶⁶⁶⁶</td>
<td>Cartridge</td>
<td>mg/cigarette</td>
<td>3.23±0.5 to 4.07±0.54</td>
</tr>
<tr>
<td></td>
<td>Aerosol</td>
<td>μg/100 mL puff</td>
<td>0.3 for puffs 11 to 50 to 1.0 for puffs 1 to 10</td>
</tr>
<tr>
<td>Westenberger⁶⁶⁶⁶⁶⁶⁶⁶</td>
<td>Cartridge</td>
<td>mg/cigarette</td>
<td>0.00 to 6.76</td>
</tr>
<tr>
<td></td>
<td>Aerosol</td>
<td>μg/100 mL puff</td>
<td>0.25 to 43.2</td>
</tr>
<tr>
<td>Westenberger⁶⁶⁶⁶⁶⁶⁶⁶</td>
<td>Refill solution</td>
<td>μg/mL</td>
<td>N.D. to 25.6</td>
</tr>
</tbody>
</table>

*Deviation from label=(measured value – labelled value) / labelled value.
1Calculation performed by this analysis based on reported data in each study.
N.A., not available; N.D., not detected.

### Table 2  Aldehydes reported in refill solutions and aerosols of e-cigarettes

<table>
<thead>
<tr>
<th>Literature</th>
<th>Matrix</th>
<th>Units</th>
<th>Formaldehyde</th>
<th>Acetaldehyde</th>
<th>Acrolein</th>
<th>o-Methyl benzaldehyde</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goniewicz et al.</td>
<td>Aerosol</td>
<td>µg/150 puffs</td>
<td>3.2±0.8</td>
<td>2.0±0.1</td>
<td>N.D.</td>
<td>1.3±0.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>56±1±1.4</td>
<td>13.6±2.1</td>
<td>N.D.</td>
<td>7.4±0.4</td>
</tr>
<tr>
<td>Lim and Shin</td>
<td>Refill</td>
<td>solution mg/L</td>
<td>0.02 to 10.09</td>
<td>0.10 to 15.63</td>
<td>N.D.</td>
<td>N.T.</td>
</tr>
<tr>
<td>Ohta et al.</td>
<td>Aerosol</td>
<td>mg/m³</td>
<td>260</td>
<td>&lt;LOQ</td>
<td>&lt;LOQ</td>
<td>N.T.</td>
</tr>
<tr>
<td>Urushiyama et al.</td>
<td>Aerosol</td>
<td>mg/m³</td>
<td>8.3</td>
<td>11</td>
<td>9.3</td>
<td>N.T.</td>
</tr>
<tr>
<td>Laugesen</td>
<td>Aerosol</td>
<td>ppm/38 ml puff</td>
<td>0.25</td>
<td>0.34</td>
<td>N.D.</td>
<td>0.33</td>
</tr>
</tbody>
</table>

<LOQ, below the limit of quantitation but above the limit of detection; N.D., not detected; N.T., not tested by the study.

### Table 3  Tobacco-specific nitrosamines reported in aerosols, refill solutions and cartridges of e-cigarettes

<table>
<thead>
<tr>
<th>Literature</th>
<th>Matrix</th>
<th>Units</th>
<th>NNN</th>
<th>NNK</th>
<th>NAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goniewicz et al.</td>
<td>Aerosol</td>
<td>µg/150 puffs</td>
<td>N.D. to 4.3±2.4</td>
<td>N.D. to 28.3±13.2</td>
<td>N.T.</td>
</tr>
<tr>
<td>Kim and Shin</td>
<td>Refill</td>
<td>solution µg/L</td>
<td>0.34 to 60.08</td>
<td>0.22 to 9.84</td>
<td>0.09 to 62.19</td>
</tr>
<tr>
<td>Westenberger et al.</td>
<td>Cartridge</td>
<td>mg/cartridge</td>
<td>N.D. to &lt;LOQ</td>
<td>N.D. to &lt;LOQ</td>
<td>N.D. to &lt;LOQ</td>
</tr>
<tr>
<td>Laugesen</td>
<td>Cartridge</td>
<td>ng/cartridge</td>
<td>BDL to 3.87</td>
<td>0.26 to 1.46</td>
<td>BDL to 2.16</td>
</tr>
</tbody>
</table>

<LOQ, below the limit of quantitation but above the limit of detection; BDL, below detection limit; N.D., not detected; N.Q., not quantifiable; N.T., not tested; N.N., N-nitrosornicotine; NNK, 4-(N-nitrosomethylamino)-1-(3-pyridyl)-1-butanone; NAT, N-nitrosonorabine; NAB, N-nitrosomabazine.


### Table 4  Metals reported in aerosols and cartridges of e-cigarettes

<table>
<thead>
<tr>
<th>Literature</th>
<th>Units</th>
<th>Cadmium</th>
<th>Nickel</th>
<th>Lead</th>
<th>Chromium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goniewicz et al.</td>
<td>µg/150 puffs</td>
<td>N.D. to 0.22±0.16</td>
<td>0.11±0.05 to 0.29±0.08</td>
<td>0.03±0.03 to 0.57±0.28</td>
<td>N.T.</td>
</tr>
<tr>
<td>Williams et al.</td>
<td>µg/10 puffs</td>
<td>N.T.</td>
<td>0.005</td>
<td>0.017</td>
<td>0.007</td>
</tr>
<tr>
<td>Laugesen</td>
<td>µg/cartridge</td>
<td>N.D.</td>
<td>N.D.</td>
<td>N.D.</td>
<td>N.D.</td>
</tr>
</tbody>
</table>

N.D., not detected; N.T., not tested by the study.


### Table 6  Polycyclic aromatic hydrocarbons and cresol reported in aerosols from one e-cigarette cartridge

<table>
<thead>
<tr>
<th>Literature</th>
<th>Cresol</th>
<th>PAHs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Anthracene</td>
</tr>
<tr>
<td>Laugesen</td>
<td>0.16 ppm/38 ml puff</td>
<td>7 ng/cartridge</td>
</tr>
</tbody>
</table>

N.D., not detected.
Confluent layer of human keratinocytes (HaCaTs) on transwells with air interface exposed to EV for 15 min, followed by 2 hr recovery.

Legend
PG= Propylene Glycol
GSL= Green Smart Living
VG= Vegetable Glycerin
N= Nicotine
Toxins in E-cigarette Vapor

- Present, but lower than in smoke
  - Ethylbenzene
  - Benzene
  - Toluene
  - Acetone
  - Formaldehyde
  - Acetaldehyde
  - TSNA – tobacco specific nitrosamines
  - Nicotine
  - DEG – diethylene glycol

- Same level as in smoke: Benzo(a)pyrene

- Higher in vapor than in smoke: Glycols

Hidden Formaldehyde in E-Cigarette Aerosols

Toxicities

• Direct – on the user
• Indirect – secondhand vapor
• Accidental poisoning – ingestion of e-juice, primarily by children. 427 e-cigarette related poisoning exposures in 2012 (childproof caps needed)
Regulation

- Availability
- Purchase
- Use
- Advertising: TV, Billboards, Magazines, Computer Ads

E-cigarette vapor exposure of mice
E-cigarette vapor exposure of mice
60min exposures for 2 weeks

![Graph showing F4/80+ as % of CD45.2+](image)

Electronic Cigarette Liquid Increases Inflammation and Virus Infection in Primary Human Airway Epithelial Cells

Qun Wu\(^*\), Di Jiang, Maisha Minor, Hong Wei Chu
Department of Medicine, National Jewish Health, Denver, Colorado, United States of America

**Background/Objective:** The use of electronic cigarettes (e-cigarettes) is rapidly increasing in the United States, especially among young people since e-cigarettes have been perceived as a safer alternative to conventional tobacco cigarettes. However, the scientific evidence regarding the human health effects of e-cigarettes on the lung is extremely limited. The major goal of our current study is to determine if e-cigarette use alters human young subject airway epithelial functions such as inflammatory response and innate immune defense against respiratory viral (i.e., human rhinovirus, HRV) infection.

**Methodology/Main Results:** We examined the effects of e-cigarette liquid (e-liquid) on pro-inflammatory cytokine (e.g., IL-6) production, HRV infection and host defense molecules (e.g., short palate, lung, and nasal epithelium clone 1, SPLUNC1) in primary human airway epithelial cells from young healthy non-smokers. Additionally, we examined the role of SPLUNC1 in lung defense against HRV infection using a SPLUNC1 knockout mouse model. We found that nicotine-free e-liquid promoted IL-6 production and HRV infection. Addition of nicotine into e-liquid further amplified the effects of nicotine-free e-liquid. Moreover, SPLUNC1 deficiency in mice significantly increased lung HRV loads. E-liquid inhibited SPLUNC1 expression in primary human airway epithelial cells. These findings strongly suggest the deleterious health effects of e-cigarettes in the airways of young people. Our data will guide future studies to evaluate the impact of e-cigarettes on lung health in human populations, and help inform the public about potential health risks of e-cigarettes.
Why are people using e-cigarettes?

• Health concerns of smokers
• Increased cost of tobacco cigarettes
• Indoor and outdoor smoking restrictions (Etter 2011)
• Relieve smoking withdrawal symptoms due to workplace smoking restrictions
Question 3

Based on data thus far, e-cigarettes used for smoking cessation are as efficacious as...

a) Chantix 1mg PO bid

b) Nicotine patches 21mg qd

c) Nicotine gum 4mg PO q1-2h

d) Zyban 150mg PO bid + nicotine gum 2mg PO q1-2h
Smoking Cessation Tool

• Act of “smoking” that mimics conventional smoking
  • physical hand-to-mouth motion is more similar than gum, lozenges or patches
• E-cigarettes reduce cravings for smokers
• E-cigarette use reduces relapses in quitters


Electronic cigarettes for smoking cessation: a randomised controlled trial

Christopher Bullen, Colin Howe, Murray Laugesen, Hayden McRobbie, Varsha Paran, Jonathan Williman, Natalie Walker

Findings 657 people were randomised (289 to nicotine e-cigarettes, 295 to patches, and 73 to placebo e-cigarettes) and were included in the intention-to-treat analysis. At 6 months, verified abstinence was 7.3% (21 of 289) with nicotine e-cigarettes, 5.8% (17 of 295) with patches, and 4.1% (three of 73) with placebo e-cigarettes (risk difference for nicotine e-cigarette vs patches: 1.51 [95% CI −2.49 to 5.51]; for nicotine e-cigarettes vs placebo e-cigarettes 3.16 [95% CI −2.29 to 8.61]). Achievement of abstinence was substantially lower than we anticipated for the power calculation, thus we had insufficient statistical power to conclude superiority of nicotine e-cigarettes to patches or to placebo e-cigarettes. We identified no significant differences in adverse events, with 137 events in the nicotine e-cigarettes group, 119 events in the patches group, and 36 events in the placebo e-cigarettes group. We noted no evidence of an association between adverse events and study product.

Interpretation E-cigarettes, with or without nicotine, were modestly effective at helping smokers to quit, with similar achievement of abstinence as with nicotine patches, and few adverse events. Uncertainty exists about the place of e-cigarettes in tobacco control, and more research is urgently needed to clearly establish their overall benefits and harms at both individual and population levels.

Lancet 2013; 382: 1629–37
### Table 2

<table>
<thead>
<tr>
<th>Behavior after one month and one year in e-cigarette users.</th>
</tr>
</thead>
<tbody>
<tr>
<td>After one month</td>
</tr>
<tr>
<td>N participants</td>
</tr>
<tr>
<td>Interval between baseline and follow-up, days (median (25th, 75th centiles))</td>
</tr>
<tr>
<td>Among daily vapers at baseline, percent (N) still vaping daily at follow-up</td>
</tr>
<tr>
<td>Among daily smokers who were vamping daily at baseline, percent (N) still vamping daily at follow-up</td>
</tr>
<tr>
<td>Among non-vapers at baseline, percent (N) vamping daily or occasionally at follow-up</td>
</tr>
<tr>
<td>Among smokers</td>
</tr>
<tr>
<td>Among daily vapers at baseline, percent (N) baseline ex-smokers who relapsed to smoking daily or occasionally at follow-up</td>
</tr>
<tr>
<td>Dual users</td>
</tr>
</tbody>
</table>

**Continuous abstinence**

<table>
<thead>
<tr>
<th>Nicotine e-cigarettes (n=289)</th>
<th>Patches (n=295)</th>
<th>Difference χ² p value</th>
<th>Relative risk (95% CI)</th>
<th>Risk difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 month</td>
<td>67 (23.2%)</td>
<td>47 (15.9%)</td>
<td>0.03</td>
<td>1.46 (1.04 to 2.04)</td>
</tr>
<tr>
<td>3 months</td>
<td>38 (13.1%)</td>
<td>27 (9.2%)</td>
<td>0.12</td>
<td>1.44 (1.00 to 2.03)</td>
</tr>
<tr>
<td>6 months (primary outcome)</td>
<td>21 (7.3%)</td>
<td>17 (5.8%)</td>
<td>0.46</td>
<td>1.26 (0.88 to 1.84)</td>
</tr>
</tbody>
</table>

**Sensitivity analyses for 6 months continuous abstinence data**

- Complete case analysis: 21/241 (8.7%) vs. 17/215 (7.9%)
- Per-protocol analysis 1: 21/231 (9.1%) vs. 15/207 (7.2%)
- Per-protocol analysis 2: 20/211 (9.5%) vs. 13/151 (8.6%)
- Per-protocol analysis 3: 12/147 (8.2%) vs. 12/138 (8.7%)
- Including not biochemically verified: 30 (10.4%) vs. 21 (7.1%)

**7 day point prevalence abstinence**

| 1 month                      | 69 (23.9%)     | 53 (17.3%)            | 0.05                   | 1.38 (1.03 to 1.87)      | 5.59 (0.05 to 12.13)    |
| 3 months                     | 62 (21.5%)     | 50 (17.0%)            | 0.17                   | 1.17 (0.91 to 1.52)      | 4.50 (-1.88 to 10.88)   |
| 6 months                     | 61 (21.1%)     | 45 (15.6%)            | 0.09                   | 1.35 (0.96 to 1.91)      | 5.52 (-0.75 to 11.79)   |

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**Lancet 2013; 382: 1629–37**

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**Short Communication**

A longitudinal study of electronic cigarette users

Jean-François Etter a, b, Chris Bullen b
• May have failed 2/2 poor nicotine delivery. Newer generation devices could be different, or having people use higher nicotine concentration e-juices.

• May have failed without intensive counseling support — but most subjects picking up e-cigs to help them quit do not also seek intensive counseling support.

• E-cigarettes are an alternative to nicotine patches — cheaper, don’t require a prescription, less burden on the healthcare system

Lancet 2013; 382: 1629–37

Question 4

E-cigarettes could be made safer by:

a) substituting water for glycols and glycerin

b) using e-juice without nicotine

c) consistently using a high voltage battery with the device

d) taking long, slow puffs of ~4 seconds duration
Question 4

E-cigarettes could be made safer by:

1. using e-juice without nicotine
2. taking long, slow puffs of ~4 seconds duration
3. substituting water for glycols and glycerin
4. consistently using a high voltage battery with the device

Could they be made safer?

- Change propylene glycol to water
- Consistent heating temp, as low as possible (consistent batteries and microprocessors)
- Use clean materials in the manufacturing process
Known effects of E-cigarettes on humans
Data are Sparse

• No change in peripheral white blood count after 1 hour \( (WBC; \text{Flouris 2012}) \)
• Acute vaping did not change cardiac function – LV function is impaired in tobacco smokers \( (\text{Farsalinos 2012}) \)
• Vaping causes upper airway irritation \( (\text{Vardavas 2011}) \)
• Second-hand vapor leads to the same nicotine levels as conventional cigarettes in secondhand recipients \( (\text{Flouris 2013}) \)
• Nicotine has adverse effects on brain development \( (\text{U.S. Surgeon General 2014}) \)

Many small papers, most funded by e-cigarette companies in some way, and authors involved with e-cigarette companies as well.

Conventional Tobacco Cigarettes

• Deliver nicotine and > 4,000 chemicals via combustion and inhalation of smoke
• 100 chemicals are known carcinogens
• 900 chemicals have cancer-causing potential \( (\text{WHO}) \)
• Some examples: arsenic, polonium, carbon monoxide
• Second-hand smoke is composed of \textit{sidestream} smoke from the burning cigarette plus exhaled smoke. Is responsible for >600,000 deaths per year worldwide and 40% of children are exposed
• 23% of high-school students currently use a tobacco product

E-cigarettes, The good

- May theoretically assist smokers trying to quit by delivering nicotine into the bloodstream as effectively as other nicotine replacements.
- Simulates behavioral and sensory dimensions of smoking

E-cigarettes, The bad

- Dual use may reinforce nicotine addiction
- Observing vaping makes current and ex-smokers desire a real cigarette
- They have been proven to contain toxins
Recommendations

1. As clinicians we need to be aware of the epidemic of e-cigarette use.
2. Cigarette smoke has well defined toxicities, and e-cigarettes could theoretically facilitate smoking cessation.
3. Well designed longitudinal clinical trials are needed!
4. Basic science may help inform clinical research and could be clinically directive until definitive human studies can be completed.