Clearing the Air on Electronic Cigarettes

Robin L. Corelli, PharmD
UCSF School of Pharmacy
Karen S. Hudmon, DrPH, MS, RPh
Purdue University College of Pharmacy

Supporter

- Supported by the Pharmacy Technician Certification Board.

Disclosures

- Drs. Corelli and Hudmon declare no conflicts of interest, real or apparent, and no financial interests in any company, product, or service mentioned in this program, including grants, employment, gifts, stock holdings, and honoraria.

Program Learning Objectives

- Target Audience: Pharmacists and Pharmacy Technicians
- ACPE#: 0202-0000-16-017-L04-P
  0202-0000-16-017-L04-T
- Activity Type: Knowledge-based

- Describe the differences between conventional and electronic cigarettes (e-cigarettes) as nicotine delivery devices.
- Describe population-based trends of e-cigarette use in the United States.
- Discuss potential benefits of e-cigarettes as a harm-reduction strategy for current smokers.
- Explain the risks associated with e-cigarettes.
- Discuss controlled trials evaluating the efficacy of e-cigarettes for smoking cessation.
Self-Assessment Question 1
Which of the following statements is TRUE?
Electronic nicotine delivery systems (ENDS)...
A. Are subject to strict quality control standards by the FDA  
B. Heat (but do not burn) liquid, thereby creating vapor  
C. Generate an aerosol that contains only water vapor and trace amounts of nicotine  
D. Deliver lower concentrations of nicotine to the lungs than conventional cigarettes

Self-Assessment Question 2
Which of the following statements is true?
A. The prevalence of e-cigarette usage has nearly doubled among middle and high school students over the past 5 years  
B. Adolescents who have used e-cigarettes have lower intentions to smoke cigarettes than do adolescents who have not used e-cigarettes  
C. Women exhibit a higher prevalence of e-cigarette use than do men.  
D. The proportion of young adults (18-24 years) who are current e-cigarette users exceeds that of older adults (>25 years)

Self-Assessment Question 3
Which of the following adverse effects has been reported with electronic nicotine delivery system use:
A. Peripheral neuropathy  
B. Blurred vision  
C. Facial burns/trauma  
D. Syncope

Self-Assessment Question 4
Which of the following statements is a benefit of ENDS use among current smokers?
A. A reduction in the number of cigarettes smoked per day  
B. No exposure to carcinogens or toxins  
C. Unlike second-hand tobacco smoke, aerosols generated pose no risk to others  
D. More effective cessation treatment for patients who have failed conventional nicotine replacement therapy

Self-Assessment Question 5
Controlled clinical trials with electronic cigarettes for cessation have found:
A. Approximately 50% of subjects using e-cigarettes successfully are able to quit smoking for at least 6 months  
B. For quitting smoking, e-cigarettes are significantly more effective than is the nicotine patch  
C. When used short term, e-cigarettes are well-tolerated  
D. E-cigarettes have efficacy rates for cessation that are comparable to varenicline at 6 months follow-up

The content for this session derives from the Rx for Change: Clinician-Assisted Tobacco Cessation program.
Audience Poll #1 [clicker]

How would you rate your current knowledge of e-cigarettes?
A. Poor
B. Fair
C. Good
D. Very Good
E. Excellent

Audience Poll #2 [clicker]

How often do your patients inquire about e-cigarettes?
A. Never
B. Very rarely (once a month or less)
C. Rarely (2 to 3 times a month)
D. Occasionally (2 to 3 times a week)
E. Frequently (at least once a day)
F. Not applicable; I do not work with patients

Audience Poll #3 [clicker]

Have you ever recommended e-cigarettes for cessation?
A. No
B. Yes
C. I do not work with patients
D. Tobacco cessation is not within my scope of practice

Electronic Nicotine Delivery Systems: Background

- Devices similar in appearance to cigarettes, cigars, pipes, or pens
- Battery-operated devices that create a vapor for inhalation
  - Simulates smoking but does not involve combustion of tobacco
- Also known as
  - E-cigarette
  - E-hookah, Hookah pen
  - Vapes, Vape pen, Vape pipe
  - Electronic nicotine delivery system (ENDS)

ENDS: Design

- Power source
  - Rechargeable or disposable battery
- Reservoir or Cartridge containing e-liquid solution
- Microprocessor
- Airflow sensor or Activating button
- Atomizer (vaporization chamber + heating element)
  - Metal heating element vaporizes liquid at 65-120°C

ENDS: Product variety

<table>
<thead>
<tr>
<th>Product</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposable</td>
<td>Cigarette-shaped; battery + cartridge with atomizer; not rechargeable</td>
</tr>
<tr>
<td>Rechargeable</td>
<td>Cigarette-shaped; rechargeable battery connects to atomizer; often contains element to regulate length/frequency of puffs</td>
</tr>
<tr>
<td>Pen-style</td>
<td>Larger device, often with higher capacity battery; refillable cartridge; manual switch to regulate length/frequency of puffs</td>
</tr>
<tr>
<td>Tank-style</td>
<td>Much larger; higher capacity battery; large refillable cartridge; easily modified</td>
</tr>
</tbody>
</table>

Images from Grana et al., https://escholarship.org/uc/item/13p2b72n
E-Liquid Constituents

- Solutions generally contain:
  - Propylene glycol (PG)
  - Vegetable glycerin (VG)
  - Flavorings (tobacco, fruit, chocolate, mint, candy, etc.)
  - Nicotine (0-36 mg/mL)

ENDS Variable Product Characteristics

- Lack of product regulation or standardization can lead to variability in:
  - Aerosol production
  - Nicotine concentrations
  - Nicotine delivery
  - Nicotine yield can vary as much as 50-fold due to puff topography and device design features

Variable Nicotine Yield from ENDS: Effect of Power Source Voltage

Nicotine Variability in ENDS Refill Solutions

- Analysis of nicotine concentrations in widely used e-liquid preparations were compared to the manufacturers’ labeled concentration
  - Brands tested: Johnson Creek, Red Oak, V2 Cigs, and Freedom Smoke USA
  - 35/54 (65%) of nicotine-containing fluids deviated ±10% from labeled concentration (92% in excess of labeled concentrations; range, 10.4% to 76.1%)
  - Of 5 products unlabeled for nicotine concentration:
    - No nicotine in 3 products
    - Nicotine >100 mg/mL in 2 products
- Quality control standards and monitoring are necessary for e-liquid formulations

Epidemiology of the E-cigarette Epidemic

- Trends over time, by population subgroup
- Data sources:
  - Independent research studies
  - National Health Interview Survey: CDC National Center for Health Statistics
    - First asked in 2014
    - N=36,697 non-institutionalized civilian adults (18+ yrs)
    - Collected continuously throughout the year for CDC by interviewers from the US Census Bureau


*Respondents who reported every day or some day e-cigarette use

© 2016 by the American Pharmacists Association. All rights reserved.
**Adults Who Had Ever Tried E-cigarettes and Current Use of E-cigarettes (2014)**

"Ever use" defined as having ever tried electronic cigarettes, even once. "Current use" defined as using e-cigarettes every day or some days.

- Total: 55.4%
- Current cigarette smoker: 22.0%
- Recent former cigarette smoker (< 1 year): 3.7%
- Long-term former cigarette smoker (1+ years): 3.2%
- Never cigarette smoker: 12.6%

Source: CDC/NCHS, National Health Interview Survey, 2014.

---

**Never Smokers: Ever tried an e-cigarette (2014)**

- Total: 3.2%
- 18-24: 9.7%
- 25-44: 3.5%
- 45-64: 1.2%
- 65+: 0.2%

Source: CDC/NCHS, National Health Interview Survey, 2014.

---

**Current E-cigarette Use, by Sex, Age, and Race/Hispanic or Latino Origin (2014)**

- All adults: 9.7%
- Men: 11.9%
- Women: 7.5%
- 18-24: 13.4%
- 25-44: 11.9%
- 45-64: 7.5%
- 65+: 5.5%
- Hispanic: 11.9%
- Non-Hispanic white: 11.9%
- Non-Hispanic black: 11.9%
- Non-Hispanic AIAN: 11.9%
- Non-Hispanic Asian: 11.9%


---

**Past-Month E-Cigarette Use Among U.S. Middle and High School Students (2011 vs 2014)**

- Middle school students: 2011 = 1.1%, 2014 = 11.9%
- High school students: 2011 = 3.9%, 2014 = 15.0%

From 2013 to 2014, current use of e-cigarettes tripled and surpassed current use of cigarettes.


---

**Conversion from E-Cigarette Use to Tobacco Smoking in Early Adolescence**

- Between 2011 and 2013, never smoking youth who used e-cigarettes increased from 79,000 to 263,000
- E-cigarette use is associated with increased intention to smoke cigarettes (44% among ever users vs 21.5% among never users; p<0.001)
- In a longitudinal study (n=2530), students who reported using e-cigarettes at baseline were more likely than non-users to initiate tobacco smoking in the following 12 months


---

**Electronic Nicotine Delivery Systems Fad or Disruptive Innovation?**

- **Tobacco Industry Involvement**
  - Altria (Philip Morris)
    - Cigarette brands: Marlboro, Merit, Virginia Slims
    - E-cigarette brands: Mark Ten, Green Smoke, Accord*
  - Reynolds American
    - Cigarette brands: Camel, Newport, Pall Mall
    - E-cigarette brands: VUSE, Eclipse*
  - Imperial Tobacco
    - Cigarette brands: Kool, Salem, Winston
    - E-cigarette brand: Blu

*No longer available
Smokers’ Perceptions—Use of ENDS or Smokeless Tobacco for Harm Reduction

- Current smokers were more interested in using ENDS than smokeless tobacco to:
  - Reduce health risk
  - Decrease number of cigarettes smoked
  - Quit smoking
- Among current smokers, 38.5% believe that ENDS are approved by the FDA for smoking cessation
- Current smokers who had talked with their physician or nurse about ENDS for quitting (27.2%):
  - 66% of clinicians endorsed
  - 19% of clinicians did not recommend
  - 15% of clinicians had no opinion/were unaware

Perceptions of Cigarettes, E-cigarettes and Nicotine Replacement Therapy Among ENDS Users

**E-cigarette vs Cigarette**

<table>
<thead>
<tr>
<th>(+) Less hazardous</th>
<th>(+) Less irritating</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) Less addictive</td>
<td>(+) Less expensive</td>
</tr>
<tr>
<td>(+) Better taste</td>
<td>(+) Reduced cravings for nicotine</td>
</tr>
<tr>
<td>(+) Less negative social image</td>
<td>(+) Better for reducing anxiety/worry</td>
</tr>
<tr>
<td>(+) Less expensive</td>
<td>(+) More effective for stress</td>
</tr>
<tr>
<td>(-) Less helpful for anxiety/worry</td>
<td>(+) Better taste</td>
</tr>
<tr>
<td>(-) Less effective for stress</td>
<td>(+) More satisfying</td>
</tr>
</tbody>
</table>

**E-cigarette vs NRT**

<table>
<thead>
<tr>
<th>(+) Less hazardous</th>
<th>(+) Less irritating</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) Less addictive</td>
<td>(+) Less expensive</td>
</tr>
<tr>
<td>(+) Better taste</td>
<td>(+) Reduced cravings for nicotine</td>
</tr>
<tr>
<td>(+) Less negative social image</td>
<td>(+) Better for reducing anxiety/worry</td>
</tr>
<tr>
<td>(+) More effective for stress</td>
<td>(+) More satisfying</td>
</tr>
</tbody>
</table>

ENDS: Potential Health Risks

**Propylene Glycol (PG)**

- Common ingredient in e-cigarettes for producing vapor and “throat hit” sensation
- The FDA has classified propylene glycol as “generally recognized as safe” for oral intake
- Limited studies suggest adverse effects on airways
  - Short-term exposures (e.g., aviation emergency training, entertainment industry) have been associated with ocular and upper airway irritation
  - Long-term indoor air exposure might exacerbate and/or induce asthma and rhinitis in children
- The long-term effects associated with inhalation are unknown

**Vegetable Glycerin (VG)**

- Common ingredient in e-cigarettes for aerosol production
- The FDA has classified glycerin as “generally recognized as safe” for oral intake
- Long-term effects associated with pulmonary inhalation are unknown

**Nicotine**

- Nicotine is highly addictive
- Nicotine may cause adverse cardiovascular effects (increased HR, BP) and may impair endothelial function
  - Likely less harmful than nicotine delivered via combustion
- Accidental poisoning, especially in children
  - E-cigarette liquid typically contains 6-36 mg nicotine per mL
  - Lethal adult oral dose (40-80 mg); in children, 8 mg may be life-threatening
  - Calls to U.S. Poison Control Centers for e-cigarette liquid exposures increased 733% from 2012 to 2014


Source: American Association of Poison Control Centers

© 2016 by the American Pharmacists Association. All rights reserved.
ENDS: Potential Health Risks

Flavoring Agents

- In 2014, there were 466 distinct brands of ENDS and more than 7,764 unique flavors1.
- Flavors deemed by the Flavor & Extract Manufacturers Association (FEMA) “generally recognized as safe” for oral use cannot be deemed safe for inhalation2.
- Diacetyl or acetyl propionyl (imparts buttery/fruity/cocoa flavor) found in ~75% of sweet-flavored e-cigarette liquids—many samples exceeded NIOSH safety limits3,4.
- Diacetyl, while deemed safe for ingestion by FEMA and FDA, has been shown to cause bronchiolitis obliterans (“pop-corn lung”) when inhaled.

1 Zhu et al., Tob Control 2014;23(Suppl 3):iii3-iii9.
2 Tierney et al., Tob Control 2015; April 15. [Epub ahead of print]
4 Allen et al., Environ Health Perspect 2015; Dec 8. [Epub ahead of print]

ENDS: Potential Health Risks

Carcinogens1-3

- E-cigarette liquids contain small amounts of nitrosamines.
- E-cigarette aerosols contain the following carcinogens:
  - Formaldehyde
  - Chromium
  - Acetaldehyde
  - Nickel
  - Acrolein
- Levels of most substances lower than found in tobacco smoke.
- No safe level of exposure has been determined.
- With intense heating (tank models with increased voltage), higher amounts of formaldehyde and acetaldehyde are generated—similar to concentrations in tobacco smoke3.

1 Bhatnagar et al., Circulation 2014;130:1418–1436.
2 Goniewicz et al., Tob Control 2014;23:133–139.

ENDS: Potential Health Risks

Secondhand Aerosol Exposure1,2

- During vaping sessions, compounds and particles emitted into the indoor air include:
  - Propylene glycol
  - Nicotine
  - Glycerin
  - Flavoring agents
  - Heavy metals
  - Polycyclic aromatic hydrocarbons.
- Levels of most substances lower than found in conventional cigarette smoke.
- Long-term safety of second-hand exposure to ENDS aerosols is unknown.

1 Bhatnagar et al., Circulation 2014;130:1418–1436.

ENDS: Potential Health Risks

Conclusions

- Propylene glycol might cause respiratory irritation and increase the risk for asthma.
- Nicotine is highly addictive.
- Refill cartridges with high concentrations of nicotine are a poisoning risk, especially in children.
- Carcinogenic substances are found in some aerosols.
- Use of ENDS leads to emission of propylene glycol, particles, nicotine, and carcinogens into indoor air.

ENDS have not been proven to be safe.

Compounds in Tobacco Smoke

An estimated 4,800 compounds in tobacco smoke, including 11 proven human carcinogens.

<table>
<thead>
<tr>
<th>Gases</th>
<th>Particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon monoxide</td>
<td>Nicotine</td>
</tr>
<tr>
<td>Hydrogen cyanide</td>
<td>Nitrosamines</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Lead</td>
</tr>
<tr>
<td>Benzene</td>
<td>Cadmium</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>Polonium-210</td>
</tr>
</tbody>
</table>

Nicotine is the addictive component of tobacco products, but it does NOT cause the ill health effects of tobacco use.
### Comparison of Toxin Levels
Conventional Cigarettes and ENDS

<table>
<thead>
<tr>
<th>Toxin</th>
<th>Cigarette (mcg/mainstream smoke)</th>
<th>E-cigarette (mcg/15 puffs)</th>
<th>Ratio (cig: ENDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>1.6 – 52</td>
<td>0.2 – 5.6</td>
<td>9</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>52 – 140</td>
<td>0.11 – 1.36</td>
<td>450</td>
</tr>
<tr>
<td>Acrolein</td>
<td>2.4 – 62</td>
<td>0.07 – 4.19</td>
<td>15</td>
</tr>
<tr>
<td>Toluene</td>
<td>8.3 – 70</td>
<td>0.02 – 0.63</td>
<td>120</td>
</tr>
<tr>
<td>NNN</td>
<td>0.005 – 0.19</td>
<td>0.00006 – 0.00043</td>
<td>380</td>
</tr>
<tr>
<td>NNK</td>
<td>0.012 – 0.11</td>
<td>0.00011 – 0.00283</td>
<td>40</td>
</tr>
</tbody>
</table>

NNN = nitrosonornicotine

NNK = NNN + 4-methylnitrosoamino-1-(3-pyridyl)-1-butanone

1Goniewicz et al., Tob Control 2014;23:133–139.

### Tobacco Industry Safety Innovation:
“Light” Cigarettes

The difference between Marlboro and Marlboro Lights...

**ENDS: Potential Benefits**

- Reduced exposure to carcinogens and toxins found in combusted tobacco smoke \(\rightarrow\) Harm Reduction
- Alternative nicotine delivery device for patients who fail or do not tolerate proven therapies (NRT, bupropion SR, varenicline)
  - Might address the behavioral or sensory aspects of smoking
- No tobacco smoke odor, ash
- Reduced risk of fires
- Reduced litter (cigarette butts)

### ENDS: Research Publications (2000-present)

US National Library of Medicine PubMed citations identified using search term “electronic cigarette”

### E-cigarettes for Cigarette Substitution
Caponnetto et al., PLoS ONE 2013;8(6):e66317

<table>
<thead>
<tr>
<th>Population</th>
<th>Adults (18-70 years; n=300) in Catania, Italy ≥10 cpd x minimum of 5 years unmotivated to quit</th>
</tr>
</thead>
</table>
| Intervention | Randomly assigned to:  
Group A (n=100): 7.2 mg E-cig x 12 wks  
Group B (n=100): 7.2 mg E-cig x 6 wks → 5.4 mg x 6 wks  
Group C (n=100): 0 mg E-cig x 12 wks  
No behavioral counseling or cessation support provided |
| Timeline   | 12 months                                                                                   |

### Results: Smoking Abstinence
Self-reported and CO verified

<table>
<thead>
<tr>
<th>Follow-up</th>
<th>Quit rates (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-month</td>
<td>11.0 17.0 4.0</td>
<td>0.04</td>
</tr>
<tr>
<td>6-month</td>
<td>12.0 10.0 5.0</td>
<td>0.39</td>
</tr>
<tr>
<td>12-month</td>
<td>13.0 9.0 4.0</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Caponnetto et al., PLoS ONE 2013;8(6):e66317
Results: Changes in Cigarette Smoking from Baseline

Caponnetto et al., PLoS ONE 2013;8(6):e66317

- E-cigarettes, with or without nicotine, reduced the mean daily cigarette consumption from 21.4 at baseline to 13.9 cigarettes/day at 52 weeks
- E-cigarettes, with or without nicotine, were tolerated with few adverse effects

E-cigarettes for Smoking Cessation

<table>
<thead>
<tr>
<th>Population</th>
<th>Adults (&gt;18 years; n=657) in New Zealand ≥10 cpd for past year Motivated to quit smoking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>Randomly assigned to: Nicotine e-cigarette (n=289); 16 mg e-cig x 13 wks Nicotine patch (n=295); 21mg/24hr patch x 13 wks Placebo e-cigarette (n=73); 0 mg e-cig x 13 wks Behavioral counseling provided by telephone quitline</td>
</tr>
<tr>
<td>Timeline</td>
<td>6 months</td>
</tr>
</tbody>
</table>

Results: Continuous Abstinence
Nicotine e-cigarette vs Nicotine patch


<table>
<thead>
<tr>
<th></th>
<th>Nicotine e-cigarette (n=289)</th>
<th>Nicotine patch (n=295)</th>
<th>Placebo e-cig (n=73)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>38 (13.1%)</td>
<td>27 (9.2%)</td>
<td>5 (6.8%)</td>
</tr>
<tr>
<td>6 months</td>
<td>21 (7.3%)</td>
<td>17 (5.8%)</td>
<td>3 (4.1%)</td>
</tr>
</tbody>
</table>

No significant differences

Results: Decreases in Cigarettes Smoked Daily*
Nicotine e-cigarette vs Nicotine patch


<table>
<thead>
<tr>
<th></th>
<th>Nicotine e-cigarette group</th>
<th>Nicotine patch group</th>
<th>Difference (e-cig – patch)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>10.8</td>
<td>9.1</td>
<td>1.7</td>
<td>0.006</td>
</tr>
<tr>
<td>6 months</td>
<td>9.7</td>
<td>7.7</td>
<td>1.9</td>
<td>0.002</td>
</tr>
</tbody>
</table>

*For those reporting smoking at least 1 cigarette in the past 7 days.

"A third of the participants allocated to the e-cigarettes groups reported continued use at 6 months, suggesting that they might become long-term e-cigarette users.”

E-cigarettes for Smoking Cessation

- Study Conclusions
  - Insufficient statistical power to conclude superiority of nicotine e-cigarettes versus nicotine patches or placebo e-cigarettes
  - E-cigarettes, with or without nicotine, were modestly effective in helping smokers to quit; long-term (6-month) abstinence rates were similar to nicotine patch therapy
  - All treatments were tolerated; adverse events were not linked to products
  - Uncertainty exists about the place of e-cigarettes in tobacco control; further studies are needed
Electronic Cigarettes: FDA Position

• E-cigarettes have not been fully studied, therefore consumers currently do not know:
  – the potential risks of e-cigarettes when used as intended
  – how much nicotine or other potentially harmful chemicals are being inhaled during use
  – if there are any benefits associated with using these products
• It is unknown whether e-cigarettes lead young people to try other tobacco products, including conventional cigarettes, which are known to cause disease and lead to premature death

http://www.fda.gov/newsevents/publichealthfocus/ucm172906.htm

Electronic Cigarettes: FDA Position

• FDA Regulation of e-cigarettes
  – Only e-cigarettes that are marketed for therapeutic purposes are currently regulated by the FDA Center for Drug Evaluation and Research. The FDA Center for Tobacco Products currently regulates:
    • cigarettes
    • cigarette tobacco
    • roll-your-own tobacco
    • smokeless tobacco
  – FDA has issued a proposed rule that would extend the agency’s authority to cover additional products that meet the legal definition of a tobacco product, such as e-cigarettes.

http://www.fda.gov/newsevents/publichealthfocus/ucm172906.htm

Use and Sale of Electronic Cigarettes

APhA Policy (adopted 3/2014)

• APhA opposes the sale of e-cigarettes and other vaporized nicotine products in pharmacies until such time that scientific data support the health and environmental safety of these products.
• APhA opposes the use of e-cigarettes and other vaporized nicotine products in areas subject to current clean air regulations for combustible tobacco products until such time that scientific data support the health and environmental safety of these products.
• APhA urges pharmacists to become more knowledgeable about e-cigarettes and other vaporized nicotine products.
• APhA urges the FDA to require the full disclosure of all ingredients in e-cigarettes and other vaporized nicotine products in both the pre-use and vapor states.


U.S. Preventative Services Task Force

Draft Recommendations for Adults who Smoke Tobacco

“The current evidence is insufficient to recommend electronic nicotine delivery systems (ENDS) for tobacco cessation.”

“Clinicians should direct patients who smoke tobacco to other cessation interventions with established effectiveness and safety.”


Electronic Nicotine Delivery Systems

Summary of Current Evidence

• Predominantly used by smokers and smokers considering cessation
• Used as an alternative to cigarette smoking and as cessation aids
  – Perceived as less harmful than conventional cigarettes
• Use by adolescents and young adults is increasing

Electronic Nicotine Delivery Systems

Summary of Current Evidence

• ENDS have not been proven to be safe
  – Quality control for many products is lacking; consumers do not have reliable product information
  – Nicotine delivery is highly variable
  – Ingredients that can irritate airways; might be harmful when inhaled repeatedly over prolonged periods of time
  – Adverse health effects associated with second-hand vapor exposure cannot be excluded, because ENDS emit ultrafine inhalable particles and carcinogens into indoor air
  – Nicotine solutions used in ENDS increase the risk of accidental nicotine poisoning
**Electronic Nicotine Delivery Systems**  
**Summary of Current Evidence**
- ENDS can reduce the desire to smoke and reduce nicotine withdrawal symptoms.
- Some smokers reduce the number of cigarettes smoked or quit smoking as a result of using ENDS.
- The efficacy of ENDS as an aid for sustained smoking cessation has not been established.

**ENDS: Possible Pros and Cons**

**PROS**
- Large % of current smokers switch and vaping is less harmful.
- Current smokers completely switch to vaping, then quit vaping.

**CONS**
- Dual use (smoking + vaping).
- Reduced quitting.
- Smoking is “normalized.”
- Gateway to smoking.

**ENDS: Future Research Questions**
- How do nicotine pharmacokinetics differ between ENDS and conventional cigarettes?
- How do aerosol constituents vary by device and user variables? What toxicants are created? What is the potential for drug-interactions with ENDS aerosols?
- What standardized methods should be used to evaluate ENDS?
- What are the health effects of dual and poly-tobacco use compared to ENDS alone or conventional cigarettes?
- Do ENDS delay or facilitate cessation?

**Key Points**  
**Recommendations for Clinicians**
- ENDS use should be included in tobacco screening questions.
- ENDS use by adolescents and adults who are current non-smokers should be discouraged.
- Until more is known about the potential risks, ENDS should not be promoted as a safe alternative to smoking.
- Until long-term safety and efficacy data are available, recommend evidence-based, FDA-approved treatments (NRT, bupropion SR, varenicline, combination therapy) for cessation.
- For smokers unable to quit using proven effective therapies, ENDS might be appropriate after patient-specific discussion of risks and benefits.
  - Inform patients that although ENDS aerosol is likely to be less toxic,
    - Products are unregulated.
    - Might contain low levels of toxic chemicals.
    - Have not been proven effective as cessation aids.
  - Advise patients to quit smoking entirely—even low level smoking imposes health risks.

Key Points
Policy Recommendations for Clinicians

Clinicians should support regulations that:
• Prohibit the use of ENDS anywhere that the use of conventional cigarettes is prohibited
• Subject ENDS marketing to the same restrictions that apply to conventional cigarettes (including no radio or television advertising)
• Prohibit the use of characterizing flavors in ENDS, particularly candy and alcohol flavors
• Prohibit advertising that claims or suggests that ENDS are effective smoking cessation devices

Self-Assessment Question 1
Which of the following statements is TRUE?
Electronic nicotine delivery systems (ENDS)...
A. Are subject to strict quality control standards by the FDA
B. Heat (but do not burn) liquid, thereby creating vapor
C. Generate an aerosol that contains only water vapor and trace amounts of nicotine
D. Deliver lower concentrations of nicotine to the lungs than conventional cigarettes

Self-Assessment Question 2
Which of the following statements is true?
A. The prevalence of e-cigarette usage has nearly doubled among middle and high school students over the past 5 years
B. Adolescents who have used e-cigarettes have lower intentions to smoke cigarettes than do adolescents who have not used e-cigarettes
C. Women exhibit a higher prevalence of e-cigarette use than do men.
D. The proportion of young adults (18-24 years) who are current e-cigarette users exceeds that of older adults (>25 years)

Self-Assessment Question 3
Which of the following adverse effects has been reported with electronic nicotine delivery system use:
A. Peripheral neuropathy
B. Blurred vision
C. Facial burns/trauma
D. Syncope

Self-Assessment Question 4
Which of the following statements is a benefit of ENDS use among current smokers?
A. A reduction in the number of cigarettes smoked per day
B. No exposure to carcinogens or toxins
C. Unlike second-hand tobacco smoke, aerosols generated pose no risk to others
D. More effective cessation treatment for patients who have failed conventional nicotine replacement therapy

Thank You!
Speaker Contact Information:
Robin Corelli, PharmD
UCSF School of Pharmacy
robin.corelli@ucsf.edu
Karen Hudmon, DrPH, MS, RPh
Purdue University College of Pharmacy
khudmon@purdue.edu
Self-Assessment Question 5

Controlled clinical trials with electronic cigarettes for cessation have found:

A. Approximately 50% of subjects using e-cigarettes successfully are able to quit smoking for at least 6 months
B. For quitting smoking, e-cigarettes are significantly more effective than is the nicotine patch
C. When used short term, e-cigarettes are well-tolerated
D. E-cigarettes have efficacy rates for cessation that are comparable to varenicline at 6 months follow-up