Abstract
The use of nicotine vaporizers (vaping) and e-cigarettes or is one of the newest trends in the adult population. Besides causing harm to the lungs, vaping can have adverse effects on the oral cavity. Despite its negative consequences, the use of these devices is on the rise. Many health care practices are noting an increase in the practice of vaping; however, some professionals may not feel comfortable broaching the subject of its negative effects with their patients. Understanding this issue and having the ability to discuss these issues with patients and their medical care professionals will assist in better health practices.

Educational Objectives
At the conclusion of this educational activity, participants will be able to
1. Discuss the history of e-cigarettes
2. Identify the many contents in e-liquid
3. Understand the health risks associate with vaping
4. Utilize the educational flowchart in a clinical practice setting

Author Profiles
Jennifer S. Sherry, RDH, MSEd, is an associate professor in the dental hygiene program at Southern Illinois University Carbondale. She teaches radiology (lecture and lab), head and neck anatomy, and community oral health/community practicum courses. Her research interests include children’s health issues and school nutrition programs. Norine M. Blackstad is a senior in the dental hygiene program at Southern Illinois University Carbondale. After she graduates, she hopes to begin working full time while pursuing a Master of Public Health degree. Kasey S. Wheatley, RDH, BSDH, is a 2016 graduate of the dental hygiene program at Southern Illinois University Carbondale. Her interest in the vaping topic transpired through her contact with college students during her time as a student.

Author Disclosures
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Abstract
The use of nicotine vaporizers (vaping) and e-cigarettes or is one of the newest trends in the adult population. Besides causing harm to the lungs, vaping can have adverse effects on the oral cavity. Despite its negative consequences, the use of these devices is on the rise. Many health care practices are noting an increase in the practice of vaping; however, some professionals may not feel comfortable broaching the subject of its negative effects with their patients. Understanding this issue and having the ability to discuss these issues with patients and their medical care professionals will assist in better health practices.

Statistics and history of e-cigarettes
The first smokeless nontobacco cigarette device was patented in 1967 by Herbert A. Gilbert. In 2003, Hon Lik, a Chinese pharmacist, was credited with creating the first “modern” e-cigarette. In 2007, e-cigarettes were introduced to the American market advertised as a healthier alternative to traditional smoking. Initially, e-liquids were not regulated by the FDA and consumers and health-care professionals were unaware of chemical compositions, or the ultimate health effects of e-cigarettes. According to manufacturers, the vapor produced by e-liquid is made primarily of propylene glycol, flavoring agent, vegetable glycerin, and nicotine. Dopamine from e-cigarettes contain nine to 450 times fewer toxic substances than that produced by traditional cigarettes. As of today, thousands of brands and flavors are available, giving consumers many choices.

Contents of e-liquid
In 2009, the FDA enacted the Family Smoking Prevention And Tobacco Control Act. Under this act, information provided by the FDA reported on the contents of e-cigarettes. Laboratory analysis of electronic cigarette samples tested positive for “nicotine, as well as varying compositions of flavorings, propylene glycol, glycerin, and other pre/post combustion toxic chemicals.” Table 1 Recent studies have detected the presence of diacetyl in e-liquids. Diacetyl is the main chemical linked to “popcorn lung” (i.e., bronchiolitis obliterans) a condition once ubiquitous in popcorn factory workers. Popcorn lung is an irreversible loss of pulmonary function that becomes so severe a lung transplant is required. Potentially, the diacetyl in e-cigarettes can cause swelling of bronchioles leading to permanent loss of proper pulmonary function.

### Table 1. Toxic Chemicals Used in E-Liquid

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diacetyl</td>
<td>(i.e. genotoxic to human cells--it has been found to damage the DNA found in all cells)</td>
</tr>
<tr>
<td>Nitrosamine (known carcinogen)</td>
<td></td>
</tr>
<tr>
<td>Diethylene glycol (used in antifreeze and toxic to humans)</td>
<td></td>
</tr>
<tr>
<td>Anabasine (insecticide)</td>
<td></td>
</tr>
<tr>
<td>Myosmine (genotoxic to human cells)</td>
<td></td>
</tr>
</tbody>
</table>

Negative effects on the human body
In addition to pulmonary damage, vaping can negatively affect the epithelial-rich oral cavity. Oral epithelial cells are rapidly shed and regenerated to maintain the normal cellular equilibrium. In 2015, an experiment testing the effects of vapor smoke on these cells was conducted. The research found that vapor, with and without nicotine, was cytotoxic to oro-epithelial cell lines inducing breaks in DNA strands. Users who vaped multiple times per day exposed already damaged epithelial cells to these toxic substances, leading to oral ulcerations, potential mutations and oral cancer. In addition, vaping can make it harder for the body to kill harmful microorganisms, leading to immunocompromise and illness. More specifically, a 2011 study found 6% of patients reported mouth irritation, 8% reported sore throat and dry mouth, and 9% reported mouth ulcers after 4 weeks of vaping. After 8 weeks, 8% reported coughing; after 24 weeks, 8% had throat irritation and 7% dry mouth.

Immediate adverse effects of e-cigarettes might be due to the variations of nicotine content of e-cigarette cartridges. Some nicotine content variation exists from 3 mg to 24 mg; however, content can be as high as 100 mg per cartridge. This elevated level can pose an increased risk of nicotine toxicity. There have been reports of severe palatal injuries, oral and nasal damage, as well as respiratory tract burns. Other health consequences that have been documented in past studies include: elevated heart rate and blood pressure, airway inflammation, impaired immunological response, impaired bacterial phagocytosis, ulcerative colitis, lipid pneumonia, and subacute bronchial toxicity.

Adverse health effects of e-cigarettes can also include seizures, disorientation, airway resistance, congestive heart failure, pneumonia, and burns from faulty devices. Another concern is the uncertainty of second and third-hand exposure to the vapor and its effects on nonusers, particularly children. Overall, patients may be more susceptible to other diseases due to decreased immune response. A US sample of 6,607 adult smokers completed an online survey in March 2013. Participants viewed e-cigarette use as less likely to cause lung cancer, oral cancer, or heart disease compared to smoking regular cigarettes. The amount of people who vape has been on the rise, fueled by celebrities who vape such as Katy Perry, Johnny Depp, and Leonardo DiCaprio.
The role of the dental hygienist

The dental hygienist is often the first health-care provider to treat the patient in a dental practice. The ability to educate is solely dependent upon the information that is available to the dental professional. Most dental practices are seeing an increase in the trend of vaping; the following flowchart (Figure 2) can be utilized easily and efficiently in a standard recall or new-patient visit. It can be laminated and used chairside to provide comprehensive information on the negative effects of vaping and strategies to recognize that vaping is not a healthy alternative to smoking cigarettes.

Dental hygienists may want to consider some communication strategies that may assist the patient with understanding the negative effects of vaping. Showing patients the changes within their own hard and soft tissue will be a positive way to reinforce the need to quit vaping. Moreover, the techniques of motivational interviewing and the use of open-ended questions will aid the dental hygienist to listen prior to discussing treatment options to assist in decreasing or quitting use of e-cigarettes.

New FDA Regulations of E-cigarettes*

In May 2016, the FDA finalized a rule extending its authority to all tobacco products, including e-cigarettes, cigars, hookah tobacco and pipe tobacco, among others. This historic rule helped implement the bipartisan Family Smoking Prevention and Tobacco Control Act of 2009, allowing the FDA to improve public health and protect future generations from the ill-effects of tobacco use, including restricting the sale of these products to minors nationwide.26 The new ruling will include the following youth access restrictions:

- Not allowing products to be sold to persons under the age of 18 years (both in person and online);
- Requiring age verification by photo ID;
- Not allowing the selling of covered tobacco products in vending machines (unless in an adult-only facility); and
- Not allowing the distribution of free samples.26

Preventing misleading information and claims by tobacco product manufacturers, being able to evaluate how products are fabricated, and communicate potential risks are all goals of the FDA.26 Another important part of this ruling is to ensure that importers and/or retailers of newly-regulated tobacco products are following the same mandates that other products are utilizing. These are the following updates in the provisions and requirements of the FDA:

- Registering manufacturing establishments and providing product listings to the FDA;
- Reporting ingredients, and harmful and potentially harmful constituents;
- Requiring premarket review and authorization of new tobacco products by the FDA;
- Placing health warnings on product packages and advertisements; and
- Not selling modified risk tobacco products (including those described as “light”, “low”, or “mild”) unless authorized by the FDA.26*This final ruling goes in effect on August 8, 2016.
Conclusion
Since there is limited information that dental professionals can use regarding the ill effects of vaping, more current studies, literature, and regulations are imperative. The FDA should conduct further research about contents of e-liquid and how it can affect not only the oral cavity, but overall health in general. The conversations must be initiated by the dental professionals and more collaboration with medical groups will be beneficial. Bridging the gap between the dental and medical professions will only assist in better health practices by our mutual patients. Unfortunately, health-care professionals still do not know the long-term effects that patients will experience if they make the choice to vape.

References

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Questions

1. According to which association, are e-cigarettes devices that allow users to inhale an aerosol containing nicotine or other substances.
   a. American Dental Hygienists' Association  
   b. Food and Drug Administration  
   c. Centers for Disease Control and Prevention  
   d. National Institutes of Health

2. E-cigarettes are usually operated by a(n):
   a. Electrical outlet  
   b. Match  
   c. Battery-operated device  
   d. None of the above

3. What year was the first smokeless nontobacco cigarette patented?
   a. 1946  
   b. 1967  
   c. 1988  
   d. 1992

4. E-cigarettes were introduced to the American market in what year?
   a. 1967  
   b. 1987  
   c. 2007  
   d. 2010

5. Vapors from e-cigarettes contain nine to ________ times lower toxic substances in the body than smoke inhalation from a regular cigarette.
   a. 200  
   b. 300  
   c. 450  
   d. 1,000

6. Since the new adoption of an FDA ruling regulating e-cigarettes, what age does a person have to be to purchase any product of this type?
   a. 16  
   b. 18  
   c. 21  
   d. 25

7. What is the primary element of the vapor liquid for e-cigarettes?
   a. Propylene glycol  
   b. Flavoring agent  
   c. Vegetable glycerin  
   d. All of the above

8. What tobacco-specific components are in e-liquid?
   a. Anabasine and myosemine  
   b. DNA and genotoxins  
   c. Vegetable oil and acid  
   d. None of the above

9. What substance has been found in e-liquid?
   a. Benadryl  
   b. Caffeine  
   c. Popcorn  
   d. Diacetyl

10. What is the condition caused by vaping that can decrease pulmonary function?
    a. Popcorn lung  
    b. Atherosclerosis  
    c. Arthritis  
    d. Eczema

11. Death to epithelial cells is known as:
    a. Embolism  
    b. Cytotoxicity  
    c. Calculus  
    d. DNA

12. Vaping causes which of the following side effects?
    a. Xerostomia  
    b. Sore throat and ulcers  
    c. Mouth and throat irritation  
    d. All of the above

13. In middle and high school populations, use of e-cigarettes is:
    a. increasing  
    b. decreasing  
    c. waning  
    d. The article did not discuss this data

14. Other side effects of vaping can be:
    a. Hyperactivity  
    b. Caffeine sensitivity  
    c. Rash or burning sensation of the face  
    d. B and C

15. What is a taste ailment that can occur when using the same vaping flavor over a long period of time?
    a. Widow's beak  
    b. Vapor's tongue  
    c. Vapor's skin  
    d. Conjunctivitis

16. What year did the FDA enact the Family Smoking Prevention and Tobacco Control Act?
    a. 1989  
    b. 1999  
    c. 2009  
    d. none of the above

17. What vitamin deficiency (vitamin that is found in meat, fish, and dairy products) can occur when vaping?
    a. Niacin  
    b. B6  
    c. B12  
    d. E

18. Which of the following ia a potential carcinogen found after passing e-liquid through a heated coil?
    a. Nitrosamine  
    b. Nitroglycerine  
    c. Trinitro-toluene  
    d. Nitrium

19. Nicotine content in e-cigarettes can vary from:
    a. 5mg-15mg  
    b. 3mg-24mg  
    c. 3mg-15mg  
    d. 5mg-24mg

20. Preventing misleading information and claims by tobacco product manufacturers are goals of the:
    a. DEA  
    b. EPA  
    c. FBI  
    d. FDA
E Cigarettes, Vaping and Chairside Education

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Course Evaluation
1. Were the individual course objectives met?
   - Objective #1: Yes No
   - Objective #2: Yes No
   - Objective #3: Yes No
   - Objective #4: Yes No

   Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

   2. To what extent were the course objectives accomplished overall? 5 4 3 2 1 0
   3. Please rate your personal mastery of the course objectives. 5 4 3 2 1 0
   4. How would you rate the objectives and educational methods? 5 4 3 2 1 0
   5. How do you rate the author's grasp of the topic? 5 4 3 2 1 0
   6. Please rate the instructor's effectiveness. 5 4 3 2 1 0
   7. Was the overall administration of the course effective? 5 4 3 2 1 0
   8. Please rate the usefulness and clinical applicability of this course. 5 4 3 2 1 0
   9. Please rate the usefulness of the supplemental weblography. 5 4 3 2 1 0
   10. Do you feel that the references were adequate? Yes No
   11. Would you participate in a similar program on a different topic? Yes No
   12. If any of the continuing education questions were unclear or ambiguous, please list them.

   13. Was there any subject matter you found confusing? Please describe.

   14. How long did it take you to complete this course?

   15. What additional continuing dental education topics would you like to see?

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PEACE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

Customer Service 800-633-1681
# Vaping: The Dental Hygienist’s Educational Tool

## Vaping Tools and Contents
- Propylene Glycol
- Vegetable Glycerine
- Artificial flavorings

## Side Effects of Vaping*
- Dry skin
- Dry mouth (xerostomia)
- Rash/burning sensation on face
- Itchiness
- Puffy/Dry Eyes
- Caffeine sensitivity
- Minor bloody nose issues
- Throat irritation/dry cough/hoarseness
- Mouth ulcers on palate, buccal mucosa, gingiva
- Gingival inflammation
- Dizziness and headache

*Some side effects are from decreasing or ceasing tobacco products

## Specific Condition of Vaping
- Vaper’s Tongue (see #1 on back of page)
- Allergies to e-juice or certain medications (see #2 on back of page)
- Vitamin deficiency such as B12 or Zinc (see #3 on back of page)
#1 Vapor's Tongue—Taste ailment that can occur when use same vaping flavor too long; recently switched from smoking; can cause dehydration and/or fatigue, xerostomia, damage to taste buds

#2 Allergies to e-juice or certain medications—Patients who are allergic to Propylene Glycol, Vegetable Glycerine or artificial flavorings; taking the following medications: Thyroid drugs, Captopril (ACE inhibitor), Griseofulvin (Antifungal), Lithium (Manic Depression), Penicillamine (removes excessive copper), Procarbazine (cancer drug), Rifampin (bacteria fighter use in TB cases) or some cancer drugs could have ill effects to vaping products

#3 Vitamin deficiency such as B12 (found in meat, fish, and dairy products) or Zinc (found in Red meat, Poultry, Oysters, Fortified cereals, Whole grains, Beans and Nuts

The best suggestion would be to encourage patients to stop utilizing tobacco products through evidence-based methods (counseling and medications) through the ADHA’s “Ask, Advise, Refer” program or the individual state’s Quitline, if available.