

Teen vaping

Time to clear the air



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Vaping has escalated at alarming rates among adolescents and young adults. It's time to educate teens about the hidden health risks of these innocuous nicotine delivery systems.

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The vaping culture of using non-cigarette tobacco and electronic nicotine delivery systems (ENDS) is the latest risky trend among adolescents and young adults. Vaping is the use of high-tech, advanced electronic devices such as electronic cigarettes (e-cigarettes), refillable atomizers, and other tobacco products as an alternative or in addition to regular cigarettes.¹ A concerning 10-fold to 11-fold rapid rise noted in middle and high school students poses dangers of nicotine exposure to the pediatric population.²

This article will explore the risk-taking behavior of adolescents engaging in vaping; the effects of vaping and the indiscriminate use of nicotine products on the young; and strategies that healthcare providers can use to collaborate with patients and families to reduce their risk of harm from this emerging public health epidemic.

Background

The first e-cigarette was conceptualized and patented in 1965 by Herbert Gilbert as

a safe and harmless modality to smoking cigarettes.^{3,4} In 2003, an electronic atomizer version was patented by Ruyan Technology in China, marketed to the United States in 2007, and touted as a healthier alternative to smoking conventional cigarettes.³ Since the emergence of Ruyan's first-generation e-cigarette, novel models have emerged in design, engineering, and nicotine delivery methods resulting in second-, third-, and fourth-generation ENDS delivery devices.⁴

Modern generation devices have included mid-sized e-cigarettes known as personal vaporizers (PVs), which are similar to a pen or laser pointer.⁴ The advanced personal vaporizers (APVs) contain a mechanical firing device called a "mod" (short for "modification") that may be used in conjunction with different atomizers (tank systems), and they vary in size, shape, and delivery methods. The most innovative and advanced devices, however, are regulated "vape mods," which contain an internal circuitry. Lingo used among the diversity of delivery devices includes vapes, vape pens, e-cigs, e-hookahs, mods, and tank systems.^{3,4}

Regardless of the novel delivery devices, use of nicotine-containing products in any

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form presents dangers and is unsafe.⁴

Escalation of misuse

Vaping is a significant public health concern and has escalated at alarming rates among adolescents and young adults. During 2011-2012, data from the National Youth Tobacco Survey revealed a modest increase in e-cigarette use (used 1 or more times within the past 30 days) among students in grades 6 to 12, from 1.1% to 2.1%.⁴ From 2011 to 2014, the use of e-cigarettes grew rapidly to 13.4% of high school students and 3.9% of middle school students. By 2014, e-cigarettes had become the most frequently used tobacco product among young persons, exceeding conventional cigarette use. In 2015, over 3 million middle school and high school students reported e-cigarette use, equating to 1 in every 6 school students, and over 25% reported trying e-cigarettes.

In young adults aged 18 to 24 years, e-cigarette use (used 1 or more times

FROM 2013 TO 2014

E-cigarette use among middle and high school students tripled, rising from approximately 660,000 to 2 million students¹⁹

within the past 30 days) more than doubled from 2013 to 2014 to 13.6%, and as of 2014, more than one-third had tried e-cigarettes.⁴ E-cigarette use data among teenagers and young adults represent the various product types of ENDS.^{3,4}

What the vaping culture entails

Vaping refers to the vaporization of substances (nicotine, flavorings, cannabis, or other substances in popularity) wherein oil, liquid, or plant material is heated to a temperature resulting in the release of aerosolized water vapor and active ingredients (nicotine, cannabis) delivered via inhaled aerosol.³⁻⁵ Tremendous controversy has arisen surrounding potential harm reduction or risks as-

sociated with e-cigarettes/vaping in young persons.³

Nicotine, a highly addictive substance in any form, is commonly vaped.^{3,4} Health effects of nicotine include hemodynamic effects secondary to catecholamines (eg, increase in heart rate and blood pressure; vasoconstriction of arteries and vessels; endothelial dysfunction; atherosclerosis acceleration).³ During adolescence while the brain is developing, nicotine can result in addiction and harmful consequences such as behavioral and cognitive impairments, memory issues, inattention, and executive function impairments.^{4,6}

Harmful effects have been found from e-cigarette aerosol and additives.⁴ Brief exposure to propylene glycol aerosol has been reported to

PEDIATRIC-FOCUSED LINKS ON E-CIGARETTES AND VAPING

AMERICAN ACADEMY OF PEDIATRICS:
E-Cigarettes and Electronic Nicotine Delivery Systems bit.ly/AAP-ENDS

CALIFORNIA STATE UNIVERSITY FULLERTON:
Electronic Cigarettes: Information for Parents bit.ly/CSUF-ecig-parent-info

CAMPAIGN FOR TOBACCO-FREE KIDS:
Electronic Cigarettes: An Overview of Key Issues bit.ly/tobaccofreekids-ecig-overview

CENTERS FOR DISEASE CONTROL AND PREVENTION:
E-Cigarettes and Young People: A Public Health Concern bit.ly/CDC-ecigs

MYHEALTH.ORG:
The Truth: Is Your Teen Vaping? bit.ly/myhealthoc-teen-vaping

NATIONAL INSTITUTE ON DRUG ABUSE:
Teens and E-Cigarettes bit.ly/NIDA-teens-and-ecigs

TV Spotlight on Electronic Cigarettes:
YouTube bit.ly/NIDA-youtube-ecigs

NEMOURS FOUNDATION, DUPONT PEDIATRICS:
KidsHealth: About E-Cigarettes bit.ly/KidsHealth-ecigs

TeensHealth: E-Cigarettes
bit.ly/TeensHealth-ecigs

US DEPARTMENT OF HEALTH AND HUMAN SERVICES:
E-Cigarette Use Among Youth and Young Adults: A Report of the Surgeon General bit.ly/HHS-ecigs-SurgeonGeneral-report

Know the Risks: E-Cigarettes and Young People bit.ly/HHS-ecigs-know-the-risks

Know the Risks: E-Cigarettes and Young People. Talk with your Teens About E-Cigarettes: A Tip Sheet for Parents bit.ly/HHS-ecigs-parent-tip-sheet

US FOOD AND DRUG ADMINISTRATION:
Vaporizers, E-Cigarettes, and Other Electronic Nicotine Delivery Systems bit.ly/FDA-tobacco-products



be a respiratory and eye irritant in patients without asthma.⁶ Contemporary generations of high-powered e-cigarettes comprising tank systems have the capacity to heat nicotine liquids to high temperatures that produce cancer-causing carcinogens such as formaldehyde and acetaldehyde in the vapor.^{4,6} Metals detected in some e-cigarette aerosol, including lead, silver, tin, nickel, iron, cop-

school students in Connecticut was consistent with high rates of using e-cigarettes to vape cannabis (lifetime cannabis user, 18%; lifetime dual users, 26.5%).⁷ Besides the potential for nicotine addiction, addiction risk exists for cannabis and other illicit drug use.⁴ Little is known about the long-term health effects of vaping and even less has been established about the potential harm of vaping other

young adults along with perceived low harm as compared with conventional tobacco products and curiosity.³

Emerging evidence of use patterns has revealed that e-cigarettes are being utilized by young persons for various alternative behaviors such as smoke tricks, vape competitions, and vaping other substances including cannabis and cocaine.⁸

"Dripping" is one of the newest trends wherein e-liquid at high temperatures is manually applied directly on the atomizer coil and the vapor produced is inhaled.⁸ In the first study to evaluate prevalence rates for dripping conducted by Yale University on high school students (n=7045) from 8 different Connecticut schools, anonymous surveys evaluated tobacco use behaviors and perceptions. Results of the anonymous surveys revealed that 26.1% of e-cigarette ever users (n=1080) reported using the device for dripping, equating to 1 in 4 adolescents. Reasons for dripping included: thicker vapor clouds (63%); better-tasting flavors (38.7%); and a stronger hit produced in the throat (27.7%) by dripping. Safety studies are not available on the practice of dripping, although some research suggests e-liquid exposure may have a considerable increase in toxic vapors (eg, acetaldehyde, formaldehyde, acetone) and may increase exposure to high levels of nicotine.

Promoting public awareness

Adolescents encompass over 20% of the population in the United States.⁹ Harm reduction prevention and early interventions of risky behavioral patterns established during the developmental periods of youth are not only significant for influencing adolescents' current health status, but also their future health status

In 2014, the products most commonly used by high school students were:¹⁹

e-cigarettes 13.4% || hookah 9.4% || cigarettes 9.2%
cigars 8.2% || smokeless tobacco 5.5% || snus 1.9% || pipes 1.5%

per, and cadmium, may be products of the heating element (coil).⁴

Secondhand e-cigarette aerosol exposure to nicotine, particles, and potentially toxic chemicals have been found in emissions studies.³ The effects of potentially harmful doses of heated and aerosolized ingredients of e-cigarette liquids including solvents, flavorings, and toxicants are not fully understood.⁴

Dual use of vaping nicotine and smoking cigarettes presents added health concerns.^{3,4} An association has been identified in young persons between e-cigarette use and the propensity to use other tobacco products, in particular the use of combustible products (ie, cigarettes).⁴ To illustrate, 58.8% of high school students in 2015 reported using e-cigarettes and additionally combustible tobacco products.

The evolving landscape of recreational and medicinal marijuana (cannabis) use has given rise to an increase in vaping cannabis.^{5,7} In 2017, a study conducted among 3847 high

school students in Connecticut was consistent with high rates of using e-cigarettes to vape cannabis (lifetime cannabis user, 18%; lifetime dual users, 26.5%).⁷

Targeted advertising

Robust marketing and colorful advertising campaigns directed toward the youth population through social media outlets, television, and on the Internet proliferated between 2011 and 2013.^{3,6} One study found television advertisements soared 256%, reaching over 24 million young persons.³ Appealing, child-friendly flavorings are a marketing endeavor to attract adolescents, disguise harsh tobacco, and facilitate nicotine addiction.^{4,6}

In 2014, 466 brands and 7764 distinctive flavors of e-cigarette products were available.^{3,4} Emerging evidence suggests that flavorings when vaporized at high temperatures result in chemical reactions of toxic levels of carbonyl compounds such as formaldehyde, although the health effects are not completely appreciated.^{4,8} Flavorings/taste were among the 3 most commonly reported reasons for e-cigarette use among teenagers and

into adulthood. In 1 study in which teenagers were asked why they used e-cigarettes, more than half the students stated the main reason was simple curiosity.¹⁰ Of concern was that when asked what they were inhaling when vaping, more than 60% reported that they were vaporizing “just flavoring,” not realizing e-cigarettes contain nicotine. Only 10% of the adolescent research participants stated they were using e-cigarettes in an attempt to quit smoking regular cigarettes.

Another alarming problem is the increase (161% to 333%) in calls to poison control centers that involve children aged younger than 5 years suffering potentially fatal poisonings through the ingestion, inhalation, or absorption through the skin or eyes attributed to access to the liquid nicotine cartridges, which are not required to be childproof.³ Concentrations of e-liquid nicotine for refilling e-cigarettes are ample enough to result in a fatal overdose sometimes as high as 1000 mg/10 mL and are commonly sold in colorful bottles or cartridges attractive to children.^{3,4}

The use of ENDS has achieved notoriety to the adolescent population in particular via the Internet through social networking and by the promotion of tobacco products using viral strategies from tobacco companies that have been directly and indirectly marketing via social media.¹¹ The traditional dissemination of research findings, health information, and regulatory actions using journal publications and government reports to stakeholders involved in this public health problem may need to be reconsidered.¹² Technologic advancements with communication and advertising outlets may have implications for public health advocates who will need to explore alternative strategies

ICD-10 CODES VAPING

The following are suggested ICD-10 codes for the diagnosis and treatment of tobacco/nicotine use or abuse in children. Check with your contracted plan and individual state Medicaid program for coverage policy.

F17.290 Nicotine dependence, other tobacco product, uncomplicated

F17.298 Nicotine dependence, other tobacco product, with other nicotine-induced disorders

F12.90 Cannabis use, unspecified, uncomplicated

F12.10 Cannabis abuse, uncomplicated

F12.21 Cannabis dependence, in remission

T65.291A Toxic effect of other tobacco and nicotine, accidental (unintentional), initial encounter (*For children who accidentally ingest a liquid nicotine refill*)

Z71.6 Tobacco abuse counseling

Z72.0 Tobacco use

Z87.891 Personal history of nicotine dependence

to engage and inform the community at large on emerging health concerns, promotion, and prevention.

Parental support and guidance

A national endeavor issued by the

office of the US Surgeon General, *E-Cigarette Use Among Youth and Young Adults*, outlines 6 goals and strategies to reduce e-cigarette use among adolescents and young adults.⁴ Strategies to accomplish these goals encompass areas where stakeholders (eg, individuals, parents/caregivers, families, teachers, coaches, youth influencers) can become involved. One way parents can engage is to become educated on the risk of e-cigarette use, enabling the parent/caregiver to educate their own children about the harmful effects of e-cigarettes, other nicotine products, and vaping of illicit substances. Being tobacco-free role models, opening discussions about the harms of tobacco and nicotine products, and protecting young persons from indirect exposure, such as tobacco smoke or aerosol from e-cigarettes, are illustrations.

Role of healthcare providers

Lack of knowledge can be a result of healthcare providers' receiving little or no formal training in either their academic or practice settings on screening, treating, or providing referrals to young patients and their families in regard to vaping. Healthcare providers may not even be screening for the use these products. If asked about tobacco use, adolescents and young adults who are using these products may not consider them tobacco, and respond that they are not using them. A recommendation would be to add vaping to the electronic medical record's tobacco screening tool when screening for tobacco use in the pediatric population.

Healthcare providers can play a key role both in clinical practice and as faculty in higher education. The provision of skills necessary to ad-

dress the health and safety implications of pediatric nicotine use and exposure needs to be incorporated into clinical practicum course objectives. Education initiatives in medical and nursing practice can enhance the ability to assess and synthesize data, make clinical judgments, and initiate diagnostics decisions. The development of appropriate plans of care and anticipatory guidance may be a sustainable, long-term solution related to this evolving public health epidemic.

Recommendations for policy and practice

Regulatory policy lagged behind the rapid revolution of e-cigarettes and vaping resulting in risk to children, adolescents, and young adults.¹³ In 2014, the US Food and Drug Administration (FDA) expanded regulatory authority under the Family Smoking Prevention and Tobacco Control Act of 2009 to include all tobacco products including e-cigarettes and hookahs.^{4,11} Concerns by public health advocates exist because the proposed regulations do

not include regulations of marketing practices or flavored nicotine products targeting young persons.¹³ E-cigarettes presented a paradigm shift in the tobacco landscape. Vaping has gained huge popularity among the younger population and is an area wherein expanded tobacco control policies and enhanced surveillance of current and emerging patterns of use are needed.⁴

Although recent regulations are now restricting the sale of these products to minors nationwide, the marketing of these products in colored refill packages and in a variety of candy flavors is aimed at attracting the younger generation with the misperception of being a harmless habit.⁹ Added hazards include a rise in vaping other substances such as the concoction of chemicals, cannabis, or synthetic drugs. Legalization of medical marijuana and recreational marijuana use in some states are reasons rooted in escalating use of vaporized cannabis use among youth. Emerging patterns of alternative use, such as dripping in 1 in 4 high school

students, support the need for regulations and restrictions on e-cigarette devices to avoid easy manipulation for novel experimentation.⁸

Globally, taxation has been used as an effective means to reduce cigarette consumption. with approximately a 10% increase in price resulting in a 1% decrease in smoking prevalence.¹² There is wide variability in the taxation of non-cigarette tobacco products in some markets where ENDS have not been subject to tobacco taxes. Consumers, particularly adolescents, may seek more cost-effective products, thus switching to other tobacco products or substituting related ENDS. The FDA could evaluate risk/exposure claims providing opportunities for tax advantages to products as a way to draw users away from more hazardous products. Such regulations could also bring about changes in non-cigarette tobacco products that could impact public health by reducing attractiveness and/or toxicity.

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NEW JERSEY DEBATES LEGISLATIVE BAN ON SALE OF FLAVORED ELECTRONIC SMOKING DEVICES

The New Jersey State Assembly and Senate are reviewing a legislative bill (S298/A3704)^{14,15} to ban all flavored electronic cigarette products.¹⁶ If the bill passes in both legislative houses and is approved by Governor Chris Christie, the opponents of the new law are concerned that vape stores statewide would be out of business.¹⁷

This bill would expand on the 2008 New Jersey law that already restricts the sale or distribution of flavored electronic smoking devices, cartridges, and liquid refills to adults, except for 3 flavors: clove, menthol, or tobacco.¹⁶ The

current law also prohibits the sale or distribution of electronic smoking devices to individuals aged younger than 19 years, the same as cigarettes.¹⁷

Although many understand the marketing concerns and potential health risks of vaping as related to minors, the opponents of the bill resent the limited sale of flavors to adults and the potential impact on positive anecdotal experiences of quitting traditional tobacco products by vaping instead.¹⁷ Proponents of the bill and public health advocates are concerned these products are marketed toward young persons and may increase the incidence of tobacco use among children.

Despite the protests, the controversial bill appears to be enduring the debate paralleling antivaping legislation that is prevailing worldwide.



ment is believed to be influenced by age, frequency of respiratory track infections, and social factors such as daycare exposure. The American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) currently recommends tympanostomy tube placement for children with bilateral OME if they are aged 3 months and older and have hearing difficulty, the study notes. Tube placement also may be indicated in children with unilateral or bilateral OME if there are other symptoms present, such as ear discomfort, vestibular problems, and reduced quality of life or school performance. Likewise, the American Academy of Pediatrics supports tympanostomy tubes for children who have experienced recurrent AOM, with 3 episodes over 6 months or 4 episodes in a year.

In children with OME, researchers found that mean hearing thresholds increased by 9.1 decibels after tympanostomy placement, and that tympanostomy tubes, tympanostomy tubes with adenoidectomy, and myringotomy with adenoidectomy were the most effective interventions when it came to hearing improvements. There were no differences, however, in hearing thresholds between children treated with tympanostomy versus watchful waiting after 1 to 2 years.

For long-term hearing improvements, the research team found that tympanostomy tube insertion with adenoidectomy and myringotomy with adenoidectomy were the 2 most effective interventions, while tympanostomy tubes alone, antibiotic prophylaxis, and watchful waiting were the least effective strategies.

For AOM, researchers compared tympanostomy placement to a placebo group and found that 3 of 20 children in the placebo group had no further episodes of AOM, while 12 in 22 who received tympanostomy tubes were without additional episodes after the intervention. Another study analyzed by the research team found that 40% of children in a placebo group had no further episodes of AOM compared with 35% in the tympanostomy tube group. Researchers noted, however, that children in that study who were treated with tympanostomy tubes had a shorter duration of AOM episodes than the placebo group.

Although evidence does support short-term positive results, researchers note that the lack of long-term hearing benefits between watchful waiting and tube placement supports the hypothesis of the preferred natural, spontaneous resolution of middle-ear effusion that most children experience.

Despite some limited evidence of improved quality of life after tube placement, neither of the 2 studies that evaluated parental stress or health-related quality of life found a significant difference between tympanostomy tube placement and watchful waiting, according to the researchers. Also, adverse events were difficult to track as they were not often reported, and many cohorts did not follow up post-tympanostomy tube placement until the extrusion of the tube.

Researchers note that they were not able to predict which children would be most likely to benefit from tympanostomy tube insertion for chronic middle-ear effusion, although there was evidence that tubes might be particularly effective in young children attending daycare or in older children with persistent hearing impairments lasting more than 3 months.

Steele says his report does not offer recommendations on when or if tubes should be placed, but says the findings are in line with recommendations already established by the AAO-HNS. He says he hopes the report will encourage shared decision making between parents and pediatricians. ■



For reference, go to
[ContemporaryPediatrics.com/
tympanostomy-tubes](http://ContemporaryPediatrics.com/tympanostomy-tubes)

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Summary

There is the potential risk that public misperceptions and regulatory practices do not often coincide with the actual risk for tobacco products.¹² The pervasive tobacco control movement based on strong science has been instrumental in driving numerous pol-

icy changes. Some of these positive strategies include indoor smoking restrictions, advertising bans aimed at children, taxation (providing an economic disincentive for smokers to continue), and education. These effective methods can influence strategies regarding the use of non-

cigarette tobacco products that may result in beneficial outcomes in public health for the future. ■



For references, go to
[ContemporaryPediatrics.com/
teen-vaping](http://ContemporaryPediatrics.com/teen-vaping)