POLICY STATEMENT Organizational Principles to Guide and Define the Child Health Care System and/or Improve the Health of all Children

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Electronic Nicotine Delivery Systems

SECTION ON TOBACCO CONTROL

abstract

Electronic nicotine delivery systems (ENDS) are rapidly growing in popularity among youth. ENDS are handheld devices that produce an aerosolized mixture from a solution typically containing concentrated nicotine, flavoring chemicals, and propylene glycol to be inhaled by the user. ENDS are marketed under a variety of names, most commonly electronic cigarettes and e-cigarettes. In 2014, more youth reported using ENDS than any other tobacco product. ENDS pose health risks to both users and nonusers. Nicotine, the major psychoactive ingredient in ENDS solutions, is both highly addictive and toxic. In addition to nicotine, other toxicants, carcinogens, and metal particles have been detected in solutions and aerosols of ENDS. Nonusers are involuntarily exposed to the emissions of these devices with secondhand and thirdhand aerosol. The concentrated and often flavored nicotine in ENDS solutions poses a poisoning risk for young children. Reports of acute nicotine toxicity from US poison control centers have been increasing, with at least 1 child death reported from unintentional exposure to a nicotine-containing ENDS solution. With flavors, design, and marketing that appeal to youth, ENDS threaten to renormalize and glamorize nicotine and tobacco product use. There is a critical need for ENDS regulation, legislative action, and counter promotion to protect youth. ENDS have the potential to addict a new generation of youth to nicotine and reverse more than 50 years of progress in tobacco control.

FREE

This document is copyrighted and is property of the American Academy of Pediatrics and its Board of Directors. All authors have filed conflict of interest statements with the American Academy of Pediatrics. Any conflicts have been resolved through a process approved by the Board of Directors. The American Academy of Pediatrics has neither solicited nor accepted any commercial involvement in the development of the content of this publication.

The guidance in this statement does not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

American Academy of Pediatrics Federal advocacy efforts should be coordinated with the AAP Department of Federal Affairs in Washington, DC, and with AAP chapters on state advocacy efforts to protect children from the harmful effects of tobacco use and secondhand smoke exposure.

All policy statements from the American Academy of Pediatrics automatically expire 5 years after publication unless reaffirmed, revised, or retired at or before that time.

www.pediatrics.org/cgi/doi/10.1542/peds.2015-3222

DOI: 10.1542/peds.2015-3222

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2015 by the American Academy of Pediatrics

DEFINITIONS

- Secondhand aerosol: emissions from electronic nicotine delivery systems (ENDS) that are discharged into the surrounding environment with ENDS use, both directly from the ENDS and exhaled from the lungs of the user.
- Thirdhand aerosol: ENDS emissions that remain on surfaces and in dust after ENDS use, which can be reemitted into the gas phase or react with oxidants in the environment to yield secondary pollutants.
- ENDS alternate names: electronic cigarettes, e-cigarettes, e-cigs, electronic cigars, e-cigars, electronic hookah, e-hookah, hookah sticks, personal vaporizers, mechanical mods, vape pens, and vaping devices.

BACKGROUND

ENDS, including electronic cigarettes (e-cigarettes), are handheld devices that produce an aerosol from a solution typically containing nicotine,

Downloaded from http://publications.aap.org/pediatrics/article-pdf/136/5/1018/1093898/peds_2015-3222.pdf by guest on 28 December 2021

flavoring chemicals, and carrier solvents such as propylene glycol and vegetable glycerin (glycerol) for inhalation by the user. Wide variability exists in ENDS terminology, product design, and engineering. For the purposes of the current policy statement, the term ENDS encompasses devices that are typically battery operated and produce emissions for inhalation. Alternate names for these products include electronic cigarettes, e-cigarettes, e-cigs, electronic cigars, electronic hookah, e-hookah, hookah sticks, personal vaporizers, mechanical mods, vape pens, and vaping devices.

Although commonly referred to as a vapor, the emission from ENDS is most accurately referred to as an aerosol, which is a suspension of fine particles in a gas.[1] Despite variations in terminology, ENDS products generally have several common components that include a flow sensor, aerosol generator, battery, and solution storage area.[2] When a user draws a breath (or "vapes") from the device, a flow sensor detects the change in pressure and activates the aerosol generator. The generator draws the solution from the storage area and heats and/or mechanically disperses the solution, creating an aerosol. This aerosol is inhaled by the user, who then exhales it. Nonusers can be exposed to the emissions both from the aerosol that is exhaled as well as from the aerosol that is generated from the device. Some ENDS products have a light-emitting diode that simulates the lit end of a conventional cigarette.

There are more than 460 different brands of ENDS, which vary considerably in price, quality, and design.[3,4] ENDS can be purchased in various retail outlets, including vendors that sell tobacco, "vape" shops, mall kiosks, gas stations, convenience stores, grocery stores, and pharmacies, as well as through Internet vendors. ENDS can be disposable or reusable; the reusable ENDS products have a rechargeable battery.[4] The ENDS solution storage containers also vary widely, ranging from prefilled cartridges to tank-style, large refillable cartridges.[4,5] Although many of the early "first-generation" ENDS were designed to resemble conventional cigarettes, newer ENDS models largely do not and may resemble other common objects such as a pen or flashlight.

EPIDEMIOLOGY OF YOUTH ENDS USE

ENDS use has increased dramatically among youth. The National Youth Tobacco Survey (NYTS) began surveying ENDS use in 2011, asking questions only about e-cigarettes. Ever use (defined by the NYTS as having ever tried an e-cigarette) among middle school students increased from 1.4% in 2011 to 3% in 2013.[6,7] Current use (defined by the NYTS as use of an e-cigarette at least 1 day in the past 30 days) among middle school students was 0.6% in 2011 and increased to 3.9% in 2014, a 650% increase.[7,8] Among high school students, ever use increased from 4.7% in 2011 to 11.9% in 2013, and current use increased from 1.5% in 2011 to 13.4% in 2014, an 890% increase.[6–9] Other surveys of high school students have found higher current use at 17% to 18%, with ever use as high as 29%.[10,11] The 2014 NYTS and Monitoring the Future survey both documented for the first time that more teenagers used e-cigarettes in the past 30 days than any other tobacco products, including conventional cigarettes.[8,11] ENDS use has been documented as highest among male subjects, non-Hispanic white youth, and Hispanic youth.[8,12]

A 2013 survey of high school students found that e-cigarette-only users had fewer social and behavioral risk factors than conventional cigarette users, raising concern that ENDS are attracting youth who may not otherwise have used tobacco products.[10] In addition, high levels of dual use of ENDS and conventional cigarettes have been noted in both adults[13,14] and youth.[6,9,10,12,15] Among youth, self-reported e-cigarette use was also associated with higher odds of ever or current conventional cigarette smoking.[15] Compared with nonusers, youth who used e-cigarettes perceived them as healthier than cigarettes[10]; however, youth using e-cigarettes were less likely to achieve abstinence from conventional cigarettes.[15]

Youth exposure to ENDS secondhand and thirdhand aerosol has also potentially increased with the increase in adult ENDS use. The percentage of e-cigarette ever use in adults rose from 3.3% in 2010 to 8.5% in 2013, and current use increased from 1% in 2010 to 2.6% in 2013.[13] Adult conventional cigarette smokers exhibited the largest growth in ever use of ENDS, increasing from 9.8% in 2010 to 36.5% in 2013.

ENDS MARKETING AND SALES

The increasing awareness, sales, and use of ENDS is being fueled by the marketing and promotion of ENDS in the media, including television, movies, video games, social media, the Internet, radio and print media, billboards, and point-of-sale advertising, as well as by celebrity role models. Advertisements and promotional efforts in broadcast media have been shown to promote youth initiation and progression of tobacco use.[16] ENDS companies have marketed their products with claims of being "healthier" and "safer" than conventional cigarettes; these claims have not been scientifically validated.[3,17] There are also unsubstantiated claims that ENDS can be used to "smoke anywhere" and both explicit and implicit claims that ENDS are smoking cessation aids (currently unapproved by the US Food and Drug Administration [FDA]).

Among all media outlets, ENDS advertising expenditures increased from $6.4 million in 2011 to $18.3

Downloaded from http://publications.aap.org/pediatrics/article-pdf/136/5/1018/1093898/peds_2015-3222.pdf by guest on 28 December 2021

million in 2012, with the majority spent on magazine and television advertisements.[18] Although tobacco advertisements on television have been legally banned since 1971 because of the Public Health Cigarette Smoking Act, there are no current regulations in place limiting ENDS advertisements.[19] Although the current generation of children and adolescents had not previously been exposed to tobacco advertisements on television, youth exposure to television advertisements for ENDS increased by 256% from 2011 to 2013.[20] In 2013, 80% of US youth aged 12 to 17 years were exposed to an average of 13 ENDS advertisements over the 1-year period. Driven in part by the significant increase in marketing and promotion, ENDS sales represented a billion-dollar industry in 2013, with some forecasters predicting they will eventually surpass sales for conventional cigarettes.[21]

ENDS SOLUTION COMPONENTS

The solutions used in ENDS products (often referred to as e-liquid or e-juice) can be purchased in prepackaged cartridges or by volume to fill a refillable cartridge. ENDS solutions are also available through Internet vendors, in stores, and places where ENDS products are sold. In addition to concentrated nicotine, components of the ENDS solutions generally include flavoring chemicals and carrier solvents, such as propylene glycol and glycerol.[1] Currently, there are no federal quality standards to ensure the accuracy of ENDS solution constituents as advertised or labeled. The refillable cartridges allow the user to deliver other psychoactive substances, including marijuana.[4]

In addition to nicotine, numerous toxicants and carcinogens harmful to human health have been found in ENDS solutions, including aldehydes, tobacco-specific nitrosamines, metals, tobacco alkaloids, and polycyclic aromatic hydrocarbons.[1,22,23] These quantitative and qualitative studies illustrate that there are additional components in ENDS solutions that are unknown to users.

Nicotine is the major psychoactive component of an ENDS solution.[1] In a study of 35 ENDS cartridges and refill solutions, there were substantial discrepancies (as much as 89%) between the label and the actual nicotine content.[24] The reported nicotine concentration in ENDS solutions ranges from 0 to 36 mg/mL with cartridges that vary in size.[5,17] In comparison, a single conventional cigarette contains from 10 to 30 mg of nicotine, although the absorbed nicotine yield for a user is far less, from 0.05 to 3 mg per cigarette.[25,26] The user's actual nicotine exposure is affected by many factors, including the delivery system, nicotine pharmacokinetics, and individual consumption behavior.[27,28]

More than 7760 unique flavors of ENDS solutions are advertised, the majority of which are confectionary in nature and appealing to children.[3,29] Popular options include fruit, candy, and dessert flavors such as "Belgian waffle" and chocolate.[3,17] The most commonly offered flavors are tobacco and menthol, which are offered by 93% and 92%, respectively, of ENDS brands.[3] Because cigarettes with candy and fruit flavoring encourage youth experimentation, regular use, and addiction,[30] flavorings (other than menthol) have been banned in conventional cigarettes since the Family Smoking Prevention and Tobacco Control Act of 2009. Although the flavoring chemicals used in ENDS solutions have been cited as "food grade" and "generally recognized as safe," under FDA guidelines, this certification relates only to ingestion, not inhalation.[29] A study of ENDS solutions found that many of the flavoring chemicals contain aldehydes (known respiratory irritants) in sufficient concentrations to be of toxicological concern.[29]

The carrier solvents propylene glycol and vegetable glycerin (glycerol) are used in ENDS solutions to produce an aerosol that, when heated, simulates conventional cigarette smoke.[1] Although these carrier solvents are used in other settings, insufficient data exist on the health effects of repeated long-term inhalation and exposure to these solvents.[31]

ENDS SECONDHAND AND THIRDHAND AEROSOL

The aerosol generated by ENDS is inhaled and then exhaled by the user, and some of the generated aerosol may be directly discharged into the surrounding environment. This aerosol, also referred to as secondhand aerosol or secondhand vapor, can be inhaled by bystanders in a manner similar to secondhand cigarette smoke. Although ENDS advertisers often claim the secondhand aerosol is "harmless water vapor," these claims are false: known harmful toxicants and carcinogens have been found in ENDS emissions.[4] These include polycyclic aromatic hydrocarbons[32] as well as nicotine, volatile organic compounds, ultrafine particles, and particulate matter.[32–34] Metal and silicate particles, some of which occur at higher levels than in conventional cigarettes, have also been detected in ENDS aerosol.[35,36]

Thirdhand aerosol, as with thirdhand smoke, is the residual aerosol that remains on surfaces and in dust after ENDS use; this residual may react with oxidants in the environment to yield secondary pollutants or be reemitted into the gas phase.[37] Because nicotine on surfaces has been shown to be increased after ENDS use,[38] thirdhand aerosol is another potentially harmful unintentional source of nicotine exposure for youth. ENDS use exposes nonusers, including at-risk populations such as children and pregnant women, to nicotine and other harmful toxicants from secondhand and thirdhand aerosol.

Downloaded from http://publications.aap.org/pediatrics/article-pdf/136/5/1018/1093898/peds_2015-3222.pdf by guest on 28 December 2021

In laboratory studies, neonatal mice exposed to the aerosol from a nicotine-containing ENDS solution had detectable levels of plasma cotinine, a metabolite of nicotine.[39] The mice exposed to the ENDS solution containing nicotine had decreased weight gain and impaired postnatal lung growth compared with mice exposed to room air. ENDS solutions have also been shown to be cytotoxic to human embryonic stem cells.[40] These studies raise concern for harm from in utero exposure and neonatal exposure to nicotine-containing ENDS solution.

THE EFFECTS OF NICOTINE ON THE DEVELOPING BRAIN

Nicotine is highly addictive and is the primary psychoactive component causing addiction in tobacco products.[25] Nicotine has neurotoxic effects on the developing brain.[41,42] In early adolescence, development of executive function and neurocognitive processes in the brain has not fully matured. Adolescents are more likely to engage in experimentation with substances such as cigarettes, and they are also physiologically more vulnerable to addiction.[43] Particularly in adolescence, nicotine also has an effect on the brain as a "gateway" drug for cocaine and other illicit drugs.[44]

UNINTENTIONAL ENDS EXPOSURE AND TOXICITY

Nicotine is derived from the tobacco plant and, in addition to being highly addictive, is toxic to humans.[25] Nicotine is well absorbed from the respiratory tract, mucosal surfaces, skin, and intestines; thus, nicotine exposure can occur from inhaling, ingesting, or coming in physical contact with a nicotine-containing ENDS solution.[25,45] Although symptoms of acute nicotine toxicity are generally mild and resolve within 12 hours with no treatment, large exposures can be fatal.[46] Symptoms of acute nicotine toxicity are similar to those in a nicotine-naive user and include fine tremor, nausea, tachycardia, and elevated blood pressure.[25] Severe poisonings generally have a biphasic reaction. Early symptoms occur within the first hour of exposure and are characterized by cholinergic excess (increased salivation, vomiting, and diaphoresis); other signs may include cardiac dysrhythmias, seizures, and muscle fasciculations. Late symptoms of severe nicotine poisoning occur between 0.5 and 4 hours and include hypotension, bradycardia, lethargy, and respiratory failure secondary to neuromuscular blockade.

Severe nicotine toxicity in children has been reported with nicotine doses as low as 2 mg.[25] ENDS solutions have been advertised to contain as much as 36 mg/mL of nicotine (3.6%).[17] The oral lethal dose of nicotine by body weight that is estimated to kill 50% of adults is projected at between 0.8 and 13 mg/kg.[25,46] Using the mid-range estimate (6 mg/kg) of a lethal dose of nicotine, an ingestion of the contents of 2 mL (<0.5 teaspoon) of an ENDS concentrated nicotine solution could be fatal to the average 12-kg, 20-month-old child. There is significant risk of pediatric morbidity and mortality with the current unregulated packaging and volume of nicotine concentrations available in ENDS solutions.

There has been an increase in unintentional exposures and poisonings from ENDS in the United States, including inhalations, eye and skin exposures, and ingestions. Calls to poison control centers for ENDS exposures increased from 1 exposure call per month in September 2010 to 215 calls in February 2014.[45] The majority of ENDS exposures were among children 0 to 5 years of age, and 57.8% of ENDS exposures produced adverse health effects, most commonly vomiting, nausea, and eye irritation.[45,47] As of publication date, there has been 1 reported child death in the United States from ingestion of a nicotine-containing ENDS solution.[48] There has also been 1 adult death in the United States from an intentional injection of a nicotine-containing ENDS solution.[47] In addition, the lithium-ion batteries used in ENDS have reportedly caused explosions and fires, most commonly while the battery is charging. The US Fire Administration has cautioned that, because of the shape and construction of ENDS, battery failure may be more likely to result in an explosion that is propelled like a "flaming rocket."[49]

DATA ON USE OF ENDS FOR SMOKING CESSATION

ENDS products have been promoted by some manufacturers, either explicitly or implicitly, as a smoking cessation aid, although they are not approved by the FDA as a smoking cessation product.[3,17] There have been limited studies on its use as a medical device. As of publication date, 1 randomized controlled clinical trial has compared nicotine-containing ENDS, nicotine-replacement therapy (21-mg nicotine patches), and placebo (no nicotine) ENDS.[50] Six-month cessation rates were low overall, and no statistically significant difference was found among the 3 groups. Notable limitations to the study included inadequate behavioral support for all groups and poor participant adherence with study treatments, which was particularly low in the nicotine patch group. Because these results are from a single study, they should be interpreted with caution, considering the low overall tobacco cessation rates in all 3 study groups. An earlier meta-analysis of tobacco dependence treatments (which did not include ENDS) found that the nicotine patch was effective for the treatment of tobacco dependence, with cessation rates of 23% with the nicotine patch alone.[51] Other population-based studies have found no association between ENDS use and successful cessation of conventional cigarette use.[4,52] Overall, there is insufficient evidence to recommend the use of ENDS for smoking cessation.

Downloaded from http://publications.aap.org/pediatrics/article-pdf/136/5/1018/1093898/peds_2015-3222.pdf by guest on 28 December 2021

FEDERAL AND STATE ENDS REGULATION

Although federal regulations ban the sale of conventional cigarettes to youth aged <18 years, there are no current federal age restrictions for purchasing ENDS or ENDS products. The American Academy of Pediatrics (AAP) recommends 21 years as the minimum age of purchase for all tobacco products.[53] In April 2014, the FDA issued a draft regulation that would extend the agency's tobacco authority to cover the sale and distribution of ENDS and other tobacco products similar to conventional cigarettes. Final action on this regulation is pending. Federal regulations on the content, labeling, and packaging of ENDS and ENDS solutions also do not exist as of publication date. Federal legislation is pending that would give the Consumer Product Safety Commission the authority to require child-resistant packaging on liquid nicotine containers sold to consumers. Some states have already enacted legislation mandating child-resistant packaging for ENDS solutions.

The majority of states have enacted laws prohibiting ENDS sales to minors, and a few states have enacted comprehensive laws that prohibit ENDS use in private worksites, restaurants, and bars.[54] Updated information on state ENDS laws is available by contacting the AAP Division of State Government Affairs at stgov@aap.org. There is no current federal regulation of Internet ENDS sales. No federal laws prevent ENDS and ENDS solutions from being purchased by anyone over the Internet, regardless of age.

RECOMMENDED ACTIONS FOR THE PEDIATRICIAN

1. Pediatricians should screen for ENDS use and provide prevention counseling in clinical practice.

a. Screen children and adolescents, parents, and caregivers for ENDS use.

Screening for ENDS use and exposure should be incorporated into the screening for tobacco use. Opportunities to screen include health supervision visits and visits for diseases that may be caused or exacerbated by tobacco smoke exposure, including ENDS secondhand or thirdhand aerosol. Because ENDS products vary widely and are referred to by many names, ask about use of these products by using specific names (eg, electronic cigarettes, e-cigarettes, e-cigs, electronic cigars, electronic hookah, e-hookah, hookah sticks, personal vaporizers, mechanical mods, vape pens, vaping devices). For more information (including an ENDS fact sheet), please refer to the AAP Julius B. Richmond Center of Excellence ENDS Web page (http://www2.aap.org/richmondcenter/ENDS.html).

b. Counsel children and adolescents about the harms of ENDS and the importance of remaining a nonuser of ENDS and all nicotine-containing products.

As part of tobacco use prevention counseling, pediatricians should include prevention counseling about the known hazards of ENDS and the importance of not initiating use of any nicotine-containing product. Personally relevant messages may include the severity and rapid development of nicotine addiction and health effects from ENDS use, lack of regulation of ENDS products and solutions, and the contaminants in the products.

2. ENDS use should not be recommended as a treatment product for tobacco dependence.

No current evidence supports the efficacy or safety of ENDS as a tobacco dependence treatment product. Tobacco-dependent parents, caregivers, and adolescents should be offered behavioral counseling and support and should be educated on, offered, and/or referred to evidence-based, FDA-approved, tobacco dependence treatment medications as appropriate for the individual's severity of tobacco dependence and readiness to quit.[51]

3. Parents, caregivers, and adolescents who use ENDS should be offered or referred for tobacco cessation counseling and FDA-approved tobacco dependence pharmacotherapies appropriate to their level of addiction and readiness to change.

For further information on tobacco cessation counseling and resources for adults and youth, please refer to the following:

- Clinical Practice Policy to Protect Children From Tobacco, Nicotine, and Tobacco Smoke[55]
- Treating Tobacco Use and Dependence (http://www.ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/tobacco/index.html)
- Clinical Effort Against Secondhand Smoke Exposure (http://www2.massgeneral.org/ceasetobacco/)
- American College of Chest Physicians Tobacco Dependence Treatment ToolKit (http://tobaccodependence.chestnet.org/)

4. Pediatricians should recommend to ENDS users that children should avoid contact with ENDS and ENDS solutions as well as secondhand and thirdhand aerosol exposure.

a. Counsel parents and caregivers that ENDS and ENDS solutions should be stored in child-resistant packaging and out of the reach of children.

Although some states have enacted legislation mandating child-resistant packaging, no current federal regulations exist for child-resistant packaging for ENDS and ENDS solutions. Although counseling should be targeted to prevention of ENDS use, if there are household users of ENDS, pediatricians should counsel parents and caregivers about child-resistant packaging, handling, and storage.

Downloaded from http://publications.aap.org/pediatrics/article-pdf/136/5/1018/1093898/peds_2015-3222.pdf by guest on 28 December 2021

b. Counsel parents and caregivers about strategies to reduce exposure to ENDS aerosol, such as instituting bans on ENDS use in the home and car.

The best protection from exposure to ENDS aerosol is for parents and caregivers to not use ENDS. If that is not possible, pediatricians should recommend ENDS-free policies for their home and car.

5. Pediatricians should be familiar with symptoms of acute nicotine poisoning and consider acute nicotine poisoning from ENDS solutions when treating a child with symptoms consistent with acute nicotine poisoning unexplained by other etiologies.

Although most exposures will not require treatment, medical management of severe acute nicotine ingestion is largely symptomatic and supportive. If an exposure occurs or there is concern for exposure, the American Association of Poison Control Centers (1-800-222-1222) should be contacted.

PUBLIC POLICY RECOMMENDATIONS

1. Reduce youth access to ENDS.

a. Ban the sale to and use of ENDS for children and youth younger than 21 years.

Banning the sale of ENDS to youth younger than 21 years will decrease youth access and the potential for nicotine addiction. The AAP recommends 21 years as the minimum legal age of purchase for all tobacco products.

b. Ban Internet sales of ENDS and ENDS solutions.

Prohibition of Internet sales can help regulate the ability to restrict the sale of ENDS to youth. Internet sales of ENDS and ENDS solutions can easily be accessed by minors and used to evade local tobacco control regulations and taxes.

2. Reduce youth demand for ENDS.

a. **Ban all flavors in ENDS.**

Because flavors have been shown to promote tobacco product use among youth,[30] flavoring chemicals, including menthol, should be banned in all ENDS products and solutions. Flavoring chemicals attractive to youth also have the potential to increase risk of ingestion of the ENDS solution by young children.

3. Ban advertising of ENDS in media/Internet/point-of-sale settings that can be viewed by youth.

ENDS advertisements in media, including television, radio and print, billboards, signage, Internet, and point-of-sale (advertisements located where ENDS are sold), promote a positive image of ENDS and encourage youth purchase and use of ENDS. Any promotional activities that can be accessed by children and/or adolescents should be considered advertising to youth.

4. Restrict depictions of ENDS and ENDS use in movies, television shows, and video games. Require any movie, television show, or video game with a depiction of ENDS or ENDS use to have an adult rating.

Tobacco advertisements and promotional efforts in media promote youth tobacco initiation and progression of smoking. Movies, television shows, and video games that depict ENDS or ENDS use should be rated a minimum of R, TV-MA, or Mature, respectively.

5. Protect youth from harms of involuntary ENDS, ENDS solution, and ENDS aerosol exposure.

a. Protect youth and other nonusers from secondhand and thirdhand aerosol exposure.

Because ENDS secondhand and thirdhand aerosol contains nicotine and other harmful toxicants, ENDS use should be prohibited in all public spaces. ENDS use should also be prohibited in all locations where children and youth are cared for, learn, work, and play, including workplaces, restaurants, health care facilities, child care settings, schools, dormitories, entertainment venues, parks, athletic facilities, shopping malls, restaurants, and leisure facilities. School and college campuses should prohibit the sale and use of ENDS. Prohibitions of ENDS should be included as part of tobacco-free and smoke-free laws and policies.

b. Protect children from unintentional nicotine exposure and poisonings.

i. The size of ENDS concentrated nicotine solution prefilled cartridges and containers should be limited to amounts that would not be lethal to a young child if ingested.

ii. ENDS solutions containing nicotine should be dispensed in child-resistant packaging.

iii. Child-resistant caps and other packaging technologies should be used to reduce the risk of exposure to children, including those that restrict the rate and amount of flow of liquid nicotine from a container.[56]

c. Tax ENDS at the same rate as conventional cigarettes.

Smokers, particularly youth, are very price-sensitive[57]; therefore, ENDS and ENDS solutions should be taxed at a rate sufficient to discourage their use among youth and at a level not less than state and federal taxes on conventional cigarettes.

d. Apply funds for public health initiatives to protect youth and to study the health effects of ENDS on users and nonusers.

Research demonstrating the adverse health effects of conventional cigarette use and exposure took decades, while millions of youth and adults died of tobacco-related diseases. It is critical that the funding and development of research on ENDS, ranging from basic science of exposure to effects on public health and youth initiation, progress as

Downloaded from http://publications.aap.org/pediatrics/article-pdf/136/5/1018/1093898/peds_2015-3222.pdf by guest on 28 December 2021

quickly as the increase in youth ENDS use. Research funding should also focus on public health initiatives, including outcomes evaluations.

CONCLUSIONS

ENDS use is rapidly increasing among youth and, according to the most recent data, ENDS are the most common tobacco product used among youth. ENDS use has the potential to addict youth to nicotine. There are potential health harms to nonusers of ENDS because of its toxicants, including nicotine, carcinogens, and metal particles found in the secondhand and thirdhand aerosol. There has been an increase in unintentional exposures of children with acute nicotine poisoning from a concentrated nicotine–containing ENDS solution, with at least 1 child death from unintentional ingestion of an ENDS solution.

The increasing use of ENDS among youth threatens 5 decades of public health gains in successfully deglamorizing, restricting, and decreasing the use of tobacco products. Health claims of ENDS as smoking cessation aids are currently unsupported by scientific evidence. There is a crucial need for effective local, state, and federal regulation to protect children and youth from ENDS use and exposure to ENDS secondhand and thirdhand aerosol and concentrated nicotine solution.

LEAD AUTHORS

Susan C. Walley, MD, FAAP
Brian P. Jenssen, MD, FAAP

PROVISIONAL SECTION ON TOBACCO CONTROL, 2014–2015

Ruth A. Etzel, MD, PhD, FAAP, Co-chairperson
Karen M. Wilson, MD, MPH, FAAP, Co-chairperson
Sophie J. Balk, MD, FAAP
Harold J. Farber, MD, MSPH, FAAP
Judith A. Groner, MD, FAAP
John E. Moore, MD, FAAP

STAFF

Janet Brishke, MPH

ABBREVIATIONS

AAP: American Academy of Pediatrics
e-cigarettes: electronic cigarettes
ENDS: electronic nicotine delivery systems
FDA: US Food and Drug Administration
NYTS: National Youth Tobacco Survey

REFERENCES

1. Cheng T. Chemical evaluation of electronic cigarettes. *Tob Control*. 2014; 23(suppl 2):ii11–ii17
2. Brown CJ, Cheng JM. Electronic cigarettes: product characterisation and design considerations. *Tob Control*. 2014; 23(suppl 2):ii4–ii10
3. Zhu SH, Sun JY, Bonnevie E, et al. Four hundred and sixty brands of e-cigarettes and counting: implications for product regulation. *Tob Control*. 2014;23(suppl 3): iii3–iii9
4. Grana R, Benowitz N, Glantz SA. E-cigarettes: a scientific review. *Circulation*. 2014;129(19):1972–1986
5. Collaco JM, Drummond MB, McGrath-Morrow SA. Electronic cigarette use and exposure in the pediatric population. *JAMA Pediatr*. 2015;169(2):177–182
6. Arrazola RA, Neff LJ, Kennedy SM, Holder-Hayes E, Jones CD; Centers for Disease Control and Prevention (CDC). Tobacco use among middle and high school students—United States, 2013. *MMWR Morb Mortal Wkly Rep*. 2014;63(45): 1021–1026
7. Centers for Disease Control and Prevention (CDC). Notes from the field: electronic cigarette use among middle and high school students—United States, 2011-2012. *MMWR Morb Mortal Wkly Rep*. 2013;62(35):729–730
8. Arrazola RA, Singh T, Corey CG, et al; Centers for Disease Control and Prevention (CDC). Tobacco use among middle and high school students—United States, 2011-2014. *MMWR Morb Mortal Wkly Rep*. 2015;64(14):381–385
9. Centers for Disease Control and Prevention (CDC). Tobacco product use among middle and high school students—United States, 2011 and 2012. *MMWR Morb Mortal Wkly Rep*. 2013; 62(45):893–897
10. Wills TA, Knight R, Williams RJ, Pagano I, Sargent JD. Risk factors for exclusive e-cigarette use and dual e-cigarette use and tobacco use in adolescents. *Pediatrics*. 2015;135(1). Available at: www.pediatrics.org/cgi/content/full/135/1/e43
11. Johnston LD, O'Malley PM, Miech RA, Bachman JG, Schulenberg JE. *Monitoring the Future: National Survey Results on Drug Use: 1975-2014. Overview, Key Findings on Adolescent Drug Use*. Ann Arbor, MI: Institute for Social Research, The University of Michigan; 2015. Available at: www.monitoringthefuture.org/pubs/monographs/mtf-overview2014.pdf. Accessed July 8, 2015
12. Lippert AM. Do adolescent smokers use e-cigarettes to help them quit? The sociodemographic correlates and cessation motivations of US adolescent e-cigarette use. *Am J Health Promot*. 2015;29(6):374–379
13. King BA, Patel R, Nguyen KH, Dube SR. Trends in awareness and use of electronic cigarettes among US adults, 2010-2013. *Nicotine Tob Res*. 2015;17(2): 219–227
14. McMillen RC, Gottlieb MA, Shaefer RMW, Winickoff JP, Klein JD. Trends in electronic cigarette use among US adults: use is increasing in both smokers and nonsmokers. *Nicotine Tob Res*. 2015;17(10):1195–1202
15. Dutra LM, Glantz SA. Electronic cigarettes and conventional cigarette use among U.S. adolescents: a cross-sectional study. *JAMA Pediatr*. 2014;168(7):610–617
16. National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General. Atlanta, GA: Centers for Disease Control and Prevention; 2012. Available at: http://pubmed.org/pubmed/?term=2012+Surgeon+General%27s+Report%E2%80%94Preventing+Tobacco+Use+Among+Youth+and+Young+Adults. Accessed July 8, 2015
17. Grana RA, Ling PM. "Smoking revolution": a content analysis of electronic cigarette retail websites. *Am J Prev Med*. 2014; 46(4):395–403

Downloaded from http://publications.aap.org/pediatrics/article-pdf/136/5/1018/1093898/peds_2015-3222.pdf by guest on 28 December 2021

18. Kim AE, Arnold KY, Makarenko O. E-cigarette advertising expenditures in the US, 2011-2012. *Am J Prev Med*. 2014; 46(4):409–412

19. Hodge JG Jr, Collmer V, Orenstein DG, Millea C, Van Buren L. Reconsidering the legality of cigarette smoking advertisements on television public health and the law. *J Law Med Ethics*. 2013;41(1):369–373

20. Duke JC, Lee YO, Kim AE, et al. Exposure to electronic cigarette television advertisements among youth and young adults. *Pediatrics*. 2014;134(1). Available at: www.pediatrics.org/cgi/content/full/134/1/e29

21. Robehmed N. E-cigarette sales surpass $1 billion as big tobacco moves in. *Forbes*. September 17, 2013. Available at: www.forbes.com/sites/natalierobehmed/2013/09/17/e-cigarette-sales-surpass-1-billion-as-big-tobacco-moves-in/. Accessed July 8, 2015

22. Goniewicz ML, Knysak J, Gawron M, et al. Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tob Control*. 2014;23(2): 133–139

23. Jensen RP, Luo W, Pankow JF, Strongin RM, Peyton DH. Hidden formaldehyde in e-cigarette aerosols. *N Engl J Med*. 2015 22;372(4):392–394

24. Goniewicz ML, Kuma T, Gawron M, Knysak J, Kosmider L. Nicotine levels in electronic cigarettes. *Nicotine Tob Res*. 2013;15(1):158–166

25. Soghoian S. Nicotine. In: Hoffman RS, Howland MA, Lewin NA, Nelson LS, Goldfrank LR, eds. *Goldfrank's Toxicologic Emergencies*. 10th ed. New York, NY: McGraw-Hill Education; 2015:1138–1143

26. Federal Trade Commission. Report on Tar, Nicotine, and Carbon Monoxide, Covering 1998. Washington, DC: Federal Trade Commission; 2000. Available at: www.ftc.gov/reports/2000-report-tar-nicotine-carbon-monoxide-covering-1998. Accessed September 15, 2015

27. Schroeder MJ, Hoffman AC. Electronic cigarettes and nicotine clinical pharmacology. *Tob Control*. 2014;23 (suppl 2):ii30–ii35

28. Evans SE, Hoffman AC. Electronic cigarettes: abuse liability, topography and subjective effects. *Tob Control*. 2014; 23(suppl 2):ii23–ii29

29. Tierney PA, Karpinski CD, Brown JE, Luo W, Pankow JF. Flavour chemicals in electronic cigarette fluids [published online ahead of print April 15, 2015]. *Tob Control*. doi: 10.1136/tobaccocontrol-2014-052175

30. Deyton L, Sharfstein J, Hamburg M. Tobacco product regulation—a public health approach. *N Engl J Med*. 2010; 362(19):1753–1756

31. Callahan-Lyon P. Electronic cigarettes: human health effects. *Tob Control*. 2014; 23(suppl 2):ii36–ii40

32. Schober W, Szendrei K, Matzen W, et al. Use of electronic cigarettes (e-cigarettes) impairs indoor air quality and increases FeNO levels of e-cigarette consumers. *Int J Hyg Environ Health*. 2014;217(6):628–637

33. Schripp T, Markewitz D, Uhde E, Salthammer T. Does e-cigarette consumption cause passive vaping? *Indoor Air*. 2013;23(1):25–31

34. Czogala J, Goniewicz ML, Fidelus B, Zielinska-Danch W, Travers MJ, Sobczak A. Secondhand exposure to vapors from electronic cigarettes. *Nicotine Tob Res*. 2014;16(6):655–662

35. Williams M, Villarreal A, Bozhilov K, Lin S, Talbot P. Metal and silicate particles including nanoparticles are present in electronic cigarette cartomizer fluid and aerosol. *PLoS One*. 2013;8(3):e57987

36. Saffari A, Daher N, Ruprecht A, et al. Particulate metals and organic compounds from electronic and tobacco-containing cigarettes: comparison of emission rates and secondhand exposure. *Environ Sci Process Impacts*. 2014;16(10):2259–2267

37. Matt GE, Quintana PJE, Destaillats H, et al. Thirdhand tobacco smoke: emerging evidence and arguments for a multidisciplinary research agenda. *Environ Health Perspect*. 2011;119(9): 1218–1226

38. Goniewicz ML, Lee L. Electronic cigarettes are a source of thirdhand exposure to nicotine. *Nicotine Tob Res*. 2015;17(2): 256–258

39. McGrath-Morrow SA, Hayashi M, Aherrera A, et al. The effects of electronic cigarette emissions on systemic cotinine levels, weight and postnatal lung growth in neonatal mice. *PLoS One*. 2015;10(2):e0118344

40. Bahl V, Lin S, Xu N, Davis B, Wang YH, Talbot P. Comparison of electronic cigarette refill fluid cytotoxicity using embryonic and adult models. *Reprod Toxicol*. 2012;34(4):529–537

41. Dwyer JB, McQuown SC, Leslie FM. The dynamic effects of nicotine on the developing brain. *Pharmacol Ther*. 2009; 122(2):125–139

42. Schraufnagel DE. Electronic cigarettes: vulnerability of youth. *Pediatr Allergy Immunol Pulmonol*. 2015;28(1):2–6

43. Pentz MA, Shin H, Riggs N, Unger JB, Collison KL, Chou CP. Parent, peer, and executive function relationships to early adolescent e-cigarette use: a substance use pathway? *Addict Behav*. 2015;42: 73–78

44. Kandel ER, Kandel DB. Shattuck Lecture. A molecular basis for nicotine as a gateway drug. *N Engl J Med*. 2014; 371(10):932–943

45. Chatham-Stephens K, Law R, Taylor E, et al; Centers for Disease Control and Prevention (CDC). Notes from the field: calls to poison centers for exposures to electronic cigarettes—United States, September 2010-February 2014. *MMWR Morb Mortal Wkly Rep*. 2014;63(13): 292–293

46. Mayer B. How much nicotine kills a human? Tracing back the generally accepted lethal dose to dubious self-experiments in the nineteenth century. *Arch Toxicol*. 2014;88(1):5–7

47. Vakkalanka JP, Hardison LS Jr, Holstege CP. Epidemiological trends in electronic cigarette exposures reported to U.S. Poison Centers. *Clin Toxicol (Phila)*. 2014; 52(5):542–548

48. Hughes C. Tot's fatal liquid nicotine ingestion brings call for action. *Times Union*. December 11, 2014. Available at: www.timesunion.com/local/article/Cops-Boy-died-after-swallowing-liquid-nicotine-5948066.php. Accessed July 8, 2015

49. US Fire Administration. Electronic Cigarette Fires and Explosions. Washington, DC: Federal Emergency Management Agency, US Department of Homeland Security; October 2014. Available at: https://www.usfa.fema.gov/downloads/pdf/publications/electronic_cigarettes.pdf. Accessed July 8, 2015

50. Bullen C, Howe C, Laugesen M, et al. Electronic cigarettes for smoking

Downloaded from http://publications.aap.org/pediatrics/article-pdf/136/5/1018/1093898/peds_2015-3222.pdf by guest on 28 December 2021

cessation: a randomised controlled trial. *Lancet*. 2013;382(9905):1629–1637

51. Fiore MC, Jaén CR, Baker TB, et al. *Treating Tobacco Use and Dependence: 2008 Update. Clinical Practice Guideline*. Rockville, MD: US Department of Health and Human Services. Public Health Service; 2008, Available at: www.ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/tobacco/clinicians/update/treating_tobacco_use08.pdf. Accessed July 8, 2015
52. McRobbie H, Bullen C, Hartmann-Boyce J, Hajek P. Electronic cigarettes for smoking cessation and reduction. *Cochrane Database Syst Rev*. 2014;12(12):CD010216
53. American Academy of Pediatrics Section on Tobacco Control. Policy statement: public policy to protect children from tobacco, nicotine, and tobacco smoke. *Pediatrics*. 2015;136(5):998–1007
54. Marynak K, Holmes CB, King BA, Promoff G, Bunnell R, McAfee T; Centers for Disease Control and Prevention (CDC). State laws prohibiting sales to minors and indoor use of electronic nicotine delivery systems—United States, November 2014. *MMWR Morb Mortal Wkly Rep*. 2014;63(49):1145–1150
55. American Academy of Pediatrics Section on Tobacco Control. Policy statement: clinical practice policy to protect children from tobacco, nicotine, and tobacco smoke. *Pediatrics*. 2015;136(5):1008–1017
56. Lovegrove MC, Hon S, Geller RJ, et al. Efficacy of flow restrictors in limiting access of liquid medications by young children. *J Pediatr*. 2013;163(4):1134–9.e1
57. Chaloupka FJ, Yurekli A, Fong GT. Tobacco taxes as a tobacco control strategy. *Tob Control*. 2012;21(2):172–180

Downloaded from http://publications.aap.org/pediatrics/article-pdf/136/5/1018/1093898/peds_2015-3222.pdf by guest on 28 December 2021