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# A review of vaping's health effects, treatment, and policy implications: Nursing's call to action

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## ABSTRACT

The emergence and subsequent surge in popularity of electronic nicotine delivery systems (ENDS), especially among adolescents and young adults, have reshaped the landscape of tobacco consumption, including use patterns and beliefs as well as therapeutic approaches to the condition. The health implications of ENDS are a cause for concern among NPs, as they include severe nicotine dependence, mental health consequences, and adverse effects on respiratory and cardiac systems, among other issues. This article focuses on the health implications of vaping across the lifespan and emphasizes the need for NPs to evaluate ENDS use consistently across age groups and offer age-appropriate treatment within the clinical setting. Importantly, although vaping is prevalent among various age groups, most tobacco use, including vaping, begins and becomes established during adolescence. This back-to-school season therefore marks an ideal time for NPs to educate their pediatric patients, along with their parents or caregivers, about the widespread effects of vaping on health, and it also serves as a reminder to screen for the condition in adults, regardless of smoking history. To combat this trend on a larger scale, NPs can further advocate for community health by promoting youth prevention programs and supporting policy initiatives aimed at curbing ENDS use.

**Keywords:** behavioral health, cessation, education, electronic nicotine delivery systems, pharmacology, policy, primary care, public health, vaping

Despite an overall decline in popularity over the past several decades, tobacco product use remains the leading cause of preventable disease and death in the US, and reducing tobacco use is a Healthy People 2030 objective.<sup>1</sup> Among other factors, decreased social acceptance of tobacco products and stricter regulations on cigarettes and other combustible smoking products have contributed to the decline. Healthcare professionals had been hopeful that the decreased popularity of cigarette-smoking among young people would translate to higher rates of tobacco product abstinence over the long term. Unfortunately, the growing line of tobacco and nicotine products, including delivery devices and flavor options, along with the common

perception that these newer products cause less harm, has led to a revival in tobacco and nicotine use. This revival entails in particular widespread use of the newer electronic nicotine delivery systems (ENDS) among adolescents and young adults specifically.<sup>2</sup>

The current landscape, informed by the novelty of ENDS, has complicated tobacco/nicotine dependence treatment efforts and resulted in a hazy picture of these products' effects. A clear understanding of what is currently known about the health and safety concerns of ENDS, as well as knowledge of evidence-based techniques for addressing tobacco use, will serve to increase the effectiveness of NP-led tobacco/nicotine dependence treatment efforts. This article aims to synthesize the available literature to provide a current overview of vaping's health effects across the lifespan and age-appropriate treatment, and it also reviews NP practice and policy implications.

## OVERVIEW

### ENDS

The term "ENDS" encompasses tobacco products such as electronic cigarettes (commonly called "e-cigs"), vapes, and tank systems.<sup>3</sup> Adolescents may use terms such as "stig," "nic sticc," or brand names (such as JUUL).<sup>4</sup> ENDS can be reusable/refillable or disposable.<sup>5</sup> They may look like combustible cigarettes or resemble other items, such as writing implements or USB storage devices.<sup>5</sup> The CDC website provides a visual dictionary of ENDS.<sup>6</sup> Confusion reigns when describing the continual emergence of various new tobacco products: among them are "non-combusted cigarette, non-cigarette, tobacco, non-tobacco, nicotine, non-nicotine, menthol and non-menthol products," as noted in a *Tobacco Control* editorial.<sup>7</sup>

ENDS use a liquid (known as "e-liquid" and also referred to as "e-juice" by youth) that is typically comprised of many ingredients, including nicotine, flavoring, and chemical compounds, from which atomizers create an aerosol or vapor for inhalation.<sup>3,5</sup> The nicotine content in the e-liquids delivered by ENDS can differ by as much as 200% from their labels.<sup>8</sup> One systematic review found that nearly half of 574 samples had nicotine concentrations that were more than 10% above or below the labeled content.<sup>9</sup> Although most ENDS contain nicotine from tobacco plants,

some devices contain nicotine that is not derived from tobacco, and some may not contain any tobacco or nicotine; however, the other ingredients and additives that they deliver can be toxic.<sup>10</sup> Unfortunately, some ENDS are marketed as a “safer” alternative to cigarettes.

Flavoring chemicals may be added to e-liquids to enhance the user’s experience through taste and smell. Although oral ingestion of some of the flavoring chemicals may be generally recognized as safe, inhalation risks are unknown.<sup>11</sup> A review of nine studies evaluated 670 flavored e-liquids and detected between 1 and 47 chemicals per sample.<sup>12</sup> ENDS e-liquids are constantly evolving. Sources for the latest information and other resources are listed in *Table 1*.

### **Addiction: Tobacco vs. nicotine**

Nicotine is a highly addictive substance present in all tobacco products.<sup>13</sup> Even when people want to stop using tobacco, nicotine makes it difficult to quit.<sup>14</sup> Some adolescents report symptoms of nicotine dependence with only 1 to 3 days per month of tobacco use.<sup>15</sup> Nicotine dependence levels among young adults who used e-cigarettes, based on the Fagerström Test for Nicotine Dependence (FTND) and its adapted version for e-cigarettes, were found in one study to be more than twice as high as those in young adults who smoked traditional cigarettes, suggesting that e-cigarettes have the potential to be more addictive than cigarettes among this population.<sup>16</sup>

ENDS can be either freebase or nicotine salts.<sup>17</sup> Freebase (unprotonated nicotine) formulations can cause an unpleasant user experience because of their harsh taste.<sup>17</sup> Nicotine salts (protonated nicotine) reduce the harsh taste, thereby allowing easier inhalation of high nicotine levels and increasing initiation and dependence among young people.<sup>17,18</sup> Additionally, the tobacco and nicotine industry now markets “tobacco-free” e-cigarettes that use lab-created synthetic nicotine, causing young people to assume incorrectly that these products are nicotine free and that therefore they confer lower risk than other available products.<sup>19-22</sup>

Although it is well accepted that tobacco causes great harm—annually resulting in more than 8 million deaths globally with 1.2 million more deaths from secondhand smoke exposure—it is important to understand that nicotine itself is harmful, especially to young people.<sup>23</sup>

### **Dual use**

Dual use refers to an individual’s use of two tobacco products, most commonly e-cigarettes and cigarettes. Young adults experience various trajectories leading to dual use and may switch products based on their current environments.<sup>24</sup> Pregnant women often begin dual use, which may continue throughout pregnancy, when attempting to quit cigarettes because of health concerns or stigma.<sup>25,26</sup> Others initiate e-cigarette use in an attempt to quit combustible cigarettes. However, dual use may make cessation more difficult.<sup>27</sup> Nicotine dependence levels have been found to be higher in those with dual use of both e-cigarettes and traditional cigarettes as compared with those using traditional cigarettes alone, based on the FTND and its adapted version for e-cigarettes.<sup>16</sup> Additionally, dual use of e-cigarettes and cigarettes may result in greater exposure to toxins and worse health than using either product alone.<sup>27-30</sup>

### **Alternative nicotine products**

Although youth and young adults most frequently use e-cigarettes out of all tobacco products and adults are using ENDS in increasing frequency, alternative nicotine products (ANPs) are gaining popularity.<sup>31,32</sup> ANPs may be classified as tobacco free but designed to deliver nicotine via routes that include smoking, chewing, or absorbing. Examples include recreational products such as lozenges, pouches, discs, tablets, and gums, which are not approved by the FDA.<sup>31,33</sup> The FDA has, however, authorized sale of a “heat-not-burn” tobacco product known as the IQOS Tobacco Heating System.<sup>34</sup>

Marketing strategies for ANPs emphasize freedom of use and promote them as smoke free, spit free, and tobacco free, thus implying a low risk; they are also available in many flavors. This ever-evolving market makes it difficult to know what is available to consumers, and product safety is often unknown. Currently, the FDA does not recommend any ANPs for tobacco/nicotine dependence treatment.

## **PREVALENCE**

### **Adult ENDS use**

In 2021, 18.7% of US adults used tobacco products, with ENDS use by adults (4.5%) second only to cigarette use (11.5%).<sup>32</sup> Among those who used tobacco, 18.1% reported dual use, with 31.4% of those individuals using e-cigarettes and cigarettes, the most frequent combination, and 7.0% using both e-cigarettes and cigars. Current dual use of e-cigarettes and cigarettes

was more likely in adults ages 18 to 44 years compared with those ages 45 years and older.<sup>35</sup> Finally, 14.0% of individuals who used tobacco reported using three or more products.

Use of e-cigarettes increased significantly between 2020 and 2021, from 3.7% to 4.5%, in contrast to significant declines in cigarette use.<sup>32</sup> In adults, e-cigarette use was highest among those ages 18 to 24 years (11.0%) compared with those ages 25 to 44 years (6.5%) and 45 years and older (2.0%).<sup>35</sup> Interestingly, in 2021, most individuals (61.4%) ages 18 to 24 years who used e-cigarettes had never smoked cigarettes.<sup>36</sup>

Generally, e-cigarette use in adults was found to decrease as family income increased, although for adults ages 18 to 24 years, the difference among those with family incomes of less than 200% of the federal poverty level was not significantly different from those with higher incomes.<sup>35</sup>

Geographically, e-cigarette use was higher in rural areas (5.3%) compared with urban areas (4.4%), which was similar to use of two or more tobacco products (5.1% in rural areas versus 3.1% in urban areas).<sup>32</sup> Individuals identifying as lesbian, gay, or bisexual had higher use rates of e-cigarettes (13.2% versus 4.1% of individuals identifying as heterosexual) and higher use of two or more tobacco products (7.2% versus 3.2% of the comparator). People with serious psychological distress also had high use rates of e-cigarettes (10.4% versus 4.3% of those who did not report such distress) and higher use of two or more tobacco products (9.8% versus 3.1% of the comparator).

### Youth ENDS use

Since 2014, ENDS have been the most commonly used tobacco product among US youth.<sup>37</sup> In 2022, more than 3 million youth reported using any tobacco product, with ENDS being the most commonly used.<sup>38</sup> In 2023, the National Youth Tobacco Survey reported a decline in tobacco use among high school students (from approximately 16.5% to 12.6%) but an alarming increase in tobacco use, including the use of multiple tobacco products, among middle school students (from 4.5% to 6.6%).<sup>31</sup> Among students who reported having ever used an e-cigarette, nearly half cited current e-cigarette use, indicating that youth who experiment with ENDS may be at risk for continuing to use ENDS. Approximately 90% of youth who used ENDS reported using a flavored product,

with fruit (63.4%) and candy (35.0%) flavors being most popular, followed by mint (27.8%) and menthol (20.1%). Elf Bar was the most commonly reported brand (at 56.7%), followed, in descending order, by Esco Bars, Vuse, JUUL, and MR FOG.<sup>31</sup> Prevention is imperative.<sup>39</sup>

## ENDS HEALTH EFFECTS

### Respiratory effects

ENDS use may have significant adverse effects on the respiratory system. The short-term physiologic effects of ENDS are similar to those of tobacco smoking because acute airway inflammation and bronchial hyperresponsiveness are seen immediately following inhalation of e-cigarette aerosols.<sup>40</sup> Even mild bronchial inflammation can be harmful and can lead to erythematous and irritated airway mucosa, a finding among those who use ENDS.<sup>41</sup> Exposure to ENDS also damages bronchial epithelium, as evidenced by elevated biomarkers of small airway injury suggestive of molecular changes.<sup>42</sup>

ENDS use is associated with acute alterations in pulmonary function, not only among individuals with respiratory disease but also among healthy individuals with no underlying disease.<sup>40</sup> Following ENDS use, reduced oxygen saturation and increased airway resistance have been found. Available evidence suggests that ENDS use may be associated with acute lung function impairment, which is elevated further among individuals with underlying respiratory disease.

Acute and chronic respiratory symptoms as well as higher self-ratings of dyspnea have been found with ENDS use.<sup>43</sup> Acute cough is commonly reported within 10 minutes of ENDS use.<sup>40</sup> Chronic cough may also be reported.<sup>44</sup> Past and current ENDS use has been associated with an increased risk of chronic

**TABLE 1. Vaping resources**

Organization	URL
Campaign for Tobacco-Free Kids	<a href="https://www.tobaccofreekids.org/">https://www.tobaccofreekids.org/</a>
CDC	<a href="https://www.cdc.gov/tobacco/e-cigarettes">https://www.cdc.gov/tobacco/e-cigarettes</a>
FDA	<a href="https://www.fda.gov/tobacco-products/products-ingredients-components/e-cigarettes-vapes-and-other-electronic-nicotine-delivery-systems-ends">https://www.fda.gov/tobacco-products/products-ingredients-components/e-cigarettes-vapes-and-other-electronic-nicotine-delivery-systems-ends</a>
Truth Initiative	<a href="https://truthinitiative.org/">https://truthinitiative.org/</a>

bronchial symptoms, including chronic cough, sputum, and bronchitis.<sup>45</sup> Additional health risks include status asthmaticus, pneumothorax, and e-cigarette or vaping product use-associated lung injury (EVALI).<sup>27</sup>

ENDS use may be a risk factor for chronic obstructive pulmonary disease (COPD). A cross-sectional survey found that individuals who used these devices were more likely to report a diagnosis of asthma, COPD, and asthma-COPD overlap syndrome than individuals who had never smoked e-cigarettes.<sup>46</sup> Case reports have also linked ENDS use to additional pulmonary diseases, including interstitial lung disease and hypersensitivity pneumonitis.<sup>47,48</sup> Additional studies are needed to understand the long-term impact of ENDS use on cancer development; the link between cancer and cigarette use was not identified for decades.<sup>27</sup>

### **Cardiac effects**

Use of ENDS may be a significant risk factor for cardiovascular disease, similar to traditional cigarette smoking.<sup>49</sup> Use of nicotine-containing ENDS trigger catecholamine release and activate cardiac beta-adrenergic receptors, resulting in increased heart rate, cardiac contractility, and cardiac workload.<sup>27</sup> Stimulation of the sympathetic nervous system also results in vasoconstriction and elevated BP, which may heighten the risk of acute cardiovascular events, particularly for those with established cardiac disease. Long-term overstimulation of the sympathetic nervous system may lead to vascular remodeling and contribute to the development of cardiomyopathy and arrhythmias.

Acute use of nicotine-containing and nicotine-free ENDS is associated with increased arterial stiffness and increased platelet activation, reactivity, and aggregation.<sup>27,49</sup> Increased inflammatory markers have been seen after 3 to 6 months of exposure to ENDS aerosols, increasing the risk of atherosclerosis and acute myocardial infarction. In fact, daily ENDS use has been independently associated with increased odds of an acute myocardial infarction.<sup>50</sup> Reduced ejection fraction has also been noted after chronic ENDS use of 3 or more months, which may contribute to the development of heart failure.<sup>49</sup>

Patients who use ENDS are more likely to report symptoms of chest pain and/or palpitations compared with those who do not use either ENDS or traditional

cigarettes.<sup>43</sup> People who use ENDS are also more likely to report a diagnosis of coronary artery disease and/or arrhythmias and have lower general health scores compared with those with no ENDS or cigarette use. Ultimately, exposure to ENDS may be a driver for the development of cardiac symptoms as well as acute and chronic cardiovascular diseases.<sup>27,49</sup>

### **Brain development**

Nicotine readily crosses the placental barrier and negatively affects fetal development, including brain development.<sup>51</sup> Although e-cigarette aerosols may have fewer toxins than cigarettes, they are not safe to use in pregnancy.<sup>52</sup> Multiple chemicals used in e-cigarettes are not found in traditional cigarettes; the consequences of inhaling these chemicals is unknown.<sup>53</sup> Unfortunately, pregnant individuals often believe that e-cigarette use is less harmful and that it may assist in cigarette cessation. Pregnant individuals may also experience more cravings for added flavorings and nicotine than the general population.<sup>53</sup>

Human brain development continues until the mid-20s. Nicotine affects areas of the brain that control mood, learning, attention, and impulse control.<sup>51</sup> Oxidative stress affects the developing brain. ENDS and ENDS components, such as e-liquids, flavoring chemicals, vapor, and metallic coil, all contribute to increased oxidative measures.<sup>54</sup> Multiple studies demonstrate that initiating nicotine use, including through ENDS, in preadolescence or adolescence, during which time the brain is in a developmental phase, can increase adult dependence and negative effects.<sup>55</sup> Many adolescents believe ENDS are safe, though they can be developmentally damaging to cognitive functioning and can lead to physical and mental health issues.<sup>56</sup> Furthermore, multiple components, even of nonnicotine e-cigarettes, such as e-liquids and flavorings, may be harmful to brain development.<sup>54</sup>

### **Mental health**

The mental health effects of ENDS are thought to be similar to the effects of cigarettes.<sup>57</sup> As with cigarettes, ENDS use likely negatively impacts attentiveness, learning abilities, cognition, and memory and increases impulsivity, suicidality, and risk of addiction to other substances. Cognitive effects may be particularly pronounced in youth because their brains are still at a vulnerable developmental stage.<sup>54</sup>

Among youth, increasing rates of depression and vaping appear to coincide nationwide.<sup>54</sup> Youth and young adults who vape nicotine reported higher levels of anxiety (58%), depression (53%), and suicidal thoughts (53%) than those who do not vape (43%, 25%, and 33%, respectively).<sup>58</sup> Additionally, a 2022 literature review found that youth who used ENDS had a higher prevalence of anxiety, depression, and attention-deficit hyperactivity disorder.<sup>59</sup>

Most youth and young adults between ages 15 and 24 years who use ENDS report initiating use to lower stress, relieve anxiety, or improve depression.<sup>60</sup> However, of youth who quit ENDS use, 90% report decreased stress levels, anxiety, or depression.

Among university students, e-cigarettes have been linked to mental health issues such as higher impulsivity, anxiety, depressive symptoms, suicidal ideation, and suicide attempts.<sup>59</sup> Suicide attempts in the general population were significantly higher among people who used ENDS compared with people who did not.<sup>61</sup>

Research suggests that individuals with a mental health disorder have increased initiation and use of ENDS. More research is needed to identify whether increased stress or mental health disorders cause ENDS use.<sup>62</sup> Considering the mental health crisis among US youth, coupled with the increasing adoption of ENDS use, health professionals should evaluate for ENDS use as an intensifying behavioral risk marker of mental health concerns.<sup>55</sup>

### Sleep

Sleep quality and quantity can be affected by nicotine, and nicotine-containing e-cigarette use may be linked to poor sleep health.<sup>63</sup> In adolescence, e-cigarette use has been linked with worse sleep quality compared with nonuse of e-cigarettes. Nicotine's effects on sleep quality are marked by a reduction in rapid eye movement sleep, decreased total sleep time, increased nightmares, and increased time to fall asleep, all of which worsen daytime sleepiness.<sup>63-65</sup>

### Poisonings

Poison centers throughout the US received reports of about 7,000 e-cigarette poisonings from April 2022 to March 2023.<sup>66</sup> The most common exposure routes were inhalation or nasal (61.0%) and ingestion or oral (40.0%); more than one exposure route was possible. Overall, about half these cases were not followed. Of those followed, few experienced major (0.2%) or

moderate (1.9%) effects, 8.3% required treatment at a healthcare facility, and less than 1% were hospitalized. Of all cases during this period, 87.8% occurred among children younger than age 5 years. Of cases reporting brands, one brand of disposable e-cigarettes was responsible for more than 60% of cases, with 90% of these involving children younger than age 5 years. One study found that child-resistant packaging was not present in one-third of e-liquid samples.<sup>8</sup> Underreporting of poisonings is likely because available data center on voluntary reports of exposures.<sup>66</sup>

### Explosions

A 2018 systematic review described 164 burn injury cases resulting from ENDS explosions.<sup>67</sup> Men ages 20 to 29 years accounted for 90% of cases, with most explosions occurring in pockets. The thigh, hand, genitals, and face were the most common areas of burn injury, typically second-degree or a combination of second- and third-degree burns, with one-third of patients requiring skin grafting. The FDA provides guidance for avoiding vape explosions.<sup>68</sup>

### Unknown health consequences

Although ENDS product use continues to grow worldwide, the toxicity of chronic exposure and associated long-term health consequences remain unknown. Toxic compounds released with ENDS use can directly modulate cellular mechanisms and lead to DNA strand breaks, cell death, alteration of vascular smooth muscle cells, and initiation of inflammation.<sup>40</sup> ENDS-associated cellular changes can trigger systemic conditions and predispose users to chronic health conditions, including diabetes mellitus, chronic kidney disease, hypertension, and additional cardiorespiratory diseases.<sup>69</sup> DNA damage and inflammation can promote rapid cellular replication, which may increase cancer risk. Long-term studies are needed to identify adverse effects of ENDS on health.

### SYSTEMS CHANGE

A US Public Health Service-sponsored clinical practice guideline, titled *Treating Tobacco Use and Dependence: 2008 Update*, outlines systems strategies to ensure that tobacco use is assessed and treated at every clinical encounter, with the goal of improving population-level abstinence rates.<sup>70</sup> Systems changes update clinicians on evidence-based interventions such as tobacco/nicotine dependence treatment and

support such practices' implementation. These strategies include, at various levels within different systems, executing an identification system (for example, Ask, Advise, Refer) for those who use tobacco; providing education, resources, and feedback to providers; dedicating staff for provision of tobacco/nicotine treatment; promoting tobacco/nicotine treatment policies; and providing insurance coverage for behavioral and medication treatment.<sup>70</sup> Since the time of publication of this guideline, ENDS has entered the US marketplace, requiring update of existing strategies, including, for example, use of a system designed to enhance identification of patients who use ENDS specifically.

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NP-level systems change for ENDS remains sparse, perhaps due in part to the paucity of systems change literature evaluating ENDS-specific efforts. Despite this knowledge gap, several agencies recommend against using ENDS as a tobacco cessation aid.<sup>18,71</sup> Furthermore, ENDS are commonly considered tobacco products because of their health effects and risks, particularly for youth. In view of these considerations, the FDA regulates ENDS as tobacco products.<sup>14</sup> Therefore, it is reasonable to consider adding ENDS to all tobacco-related systems change efforts. For example, adding an option to document ENDS use specifically in addition to tobacco use generally in EHR systems could help to measure and address the problem and foster systems change. As part of Ask, Advise, Refer, patients could be asked about ENDS use during assessment, could be advised on quitting ENDS use, and could be referred to a program that specifically assists patients with quitting ENDS use. Implementation of this practice is urgent, as evidenced by National Youth Tobacco Survey data showing that only 30% of youth are screened for ENDS use.<sup>72</sup>

## **IMPLICATIONS FOR NPS**

### **Practice**

The role of NPs in nicotine product assessment and tobacco/nicotine dependence treatment recommendations for patients has been well established. NPs are

often on the front lines of primary care, especially for rural and underserved populations, and they play an active role in opposing the ENDS epidemic.<sup>73</sup>

**Assessing and advising.** For any encounter, the US Preventive Services Task Force (USPSTF) recommends using the 5 As (Ask, Advise, Assess, Assist, and Arrange) as a guide to direct the conversation: 1) Ask about use; 2) Advise to quit through clear messages; 3) Assess for willingness to quit; 4) Assist in quitting; and 5) Arrange follow-up and support.<sup>71</sup> Although useful, the 5 As approach may be time-consuming; thus, the USPSTF also recommends an alternative as needed: Ask, Advise, Refer.

Ask, Advise, Refer is a brief but effective intervention for individuals who may be ready to quit.<sup>71</sup> For any patient who discloses ENDS use, after initial assessment, the NP should advise cessation using medication treatment options for adults and recommend counseling to all to bolster likelihood of success. NPs should likewise refer patients to quitlines or community-based resources; these services enhance treatment effectiveness. At every subsequent visit, NPs should continue to educate patients and offer cessation advice, resources, and counseling, depending on the patient's status. Motivational interviewing or other evidence-based techniques should be used to approach ENDS cessation.<sup>74</sup>

**Treating at different ages.** Treatment strategies targeting young adults and adolescents may differ slightly from those used for older adults. Most emerging adults have some desire to quit ENDS use.<sup>75</sup> A study assessing use of ENDS cessation methods among college students found that strategies used most frequently included quitting "cold turkey," using willpower, and replacing ENDS use with another activity.<sup>75</sup> Assisted strategies entailing use of digital tools (apps, text messaging), nicotine replacement, and social support were less frequently employed and represent potential areas for enhanced patient education, particularly among younger people. For younger patients and youth, behavioral counseling interventions, including in-person counseling, telehealth options, print-based interventions, and telephone counseling, have been shown to be effective in preventing tobacco initiation and continuation.<sup>39</sup>

The NP can initiate a conversation about vaping with patients and their families and incorporate behavioral counseling into wellness visits or at other opportunities, such as sports physicals or visits for

acute illness. Recommendations largely focus on behavioral interventions for children and adolescents under 18 years of age, noting the paucity of studies available that are focused on pharmacologic treatment of tobacco use in this population. Only three studies included in the USPSTF's review process for its recommendation on primary care interventions for tobacco use in children and adolescents addressed pharmacologic treatment options for individuals younger than age 18 years; of note, this USPSTF recommendation was being updated at the time this article went to press.<sup>39</sup> The American Association of Nurse Practitioners has related resources to support NPs in the practice setting.<sup>74</sup>

**Pharmacologic treatment.** Several pharmacologic options are available for treatment of adult patients. Of the six FDA-approved medications for treating tobacco dependence in adults, three are available over the counter and three require prescription. Adults can obtain several forms of nicotine replacement therapy (NRT)—nicotine patches, nicotine gum, and nicotine lozenges—over the counter, whereas nicotine nasal spray (another form of NRT), bupropion, and varenicline must be prescribed. Another NRT option, a prescription nicotine inhaler, had previously been approved but was discontinued in fall 2023.

Assisting an adult who uses ENDS to quit with FDA-approved medication therapy is difficult because of a lack of high-quality evidence recommending treatments and/or dosing strategies specifically relating to ENDS. However, because ENDS and cigarettes both contain nicotine, it is reasonable to conclude that the medications approved by the FDA for tobacco dependence should help a patient to quit ENDS use. Therefore, using NRT, bupropion, or varenicline are all viable treatment options for people who use ENDS. However, the dosing of these products needs close monitoring because ENDS deliver variable (often higher) amounts of nicotine, depending on the specific products and chemical composition, compared with the relatively consistent nicotine composition of cigarettes.

Generally, a nicotine patch plus a short-acting NRT product, such as gum or lozenges, is first-line therapy for ENDS cessation. In considering options for a patient, however, the NP should first inquire about the patient's ENDS product of choice; try to determine its nicotine content, which may be available on the package or product website; and then estimate the

patient's nicotine consumption. Next, the NP should convert the patient's ENDS use to the cigarette-smoking equivalent, using this information to inform NRT initiation. For example, one "pod" of the ENDS product JUUL generally contains approximately the equivalent amount of nicotine as one pack of cigarettes.<sup>76</sup> Therefore, if a patient is using one JUUL pod per day, a 21-mg nicotine patch plus as-needed nicotine gum or lozenges could be started. Close monitoring of the patient's response to this treatment is important because an individual's reaction may require adjusting the nicotine dose either up or down.<sup>77</sup> Because of a lack of evidence, bupropion and varenicline should likely be reserved for patients who fail NRT; however, they could be used on the basis of their efficacy in cigarette cessation.

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Supplemental Digital Content *Pharmacologic Product Guide: FDA-Approved Medications for Smoking Cessation*, available at <http://links.lww.com/NPR/A24>, provides additional guidance.<sup>77</sup> It is important to note that the dosing recommendations provided in this guide are specific to cigarette smoking.

**ENDS for tobacco use treatment.** Studies have compared ENDS to NRT for tobacco treatment. Some have shown successful quit rates using ENDS; however, long-term efficacy and safety compared with NRT remains unclear.<sup>78,79</sup> Further, the FDA does not recommend any ENDS product for tobacco use treatment, and the agency's stance is supported by several clinical practice guidelines. For example, the 2021 USPSTF recommendation statement on tobacco cessation in adults cited insufficient evidence to assess the benefits versus harms of using ENDS for this purpose and instead recommended that patients be directed to interventions with well-established safety and efficacy.<sup>71</sup> The American Heart Association's scientific statement on the cardiopulmonary impact of e-cigarettes declared only "low to moderate confidence" that ENDS are helpful for tobacco/nicotine dependence treatment compared with NRT or behavioral



**TABLE 2. Endgame strategies and policies<sup>31,82-86</sup>**

**1. Limit tobacco and nicotine product availability and accessibility.**

- a) Restrict/ban sales of all flavored tobacco and nicotine products.
- b) Support the FDA's proposed menthol ban on cigarettes and ban all flavors in cigars.
- c) Decrease nicotine concentrations in all combustible tobacco products. Prevent addiction to novel nicotine products.
- d) Limit levels of nicotine in all tobacco and nicotine products.
- e) Support the FDA's proposed rule to reduce nicotine levels in cigarettes.
- f) Restrict points of sale, including number, density, and location of tobacco retailers.
- g) License retailers and prohibit internet sales and delivery of all tobacco products.
- h) Phase out sales to younger generations.

**2. Limit tobacco and nicotine marketing and advertising.**

- a) Ban tobacco and nicotine industry advertising, promotions, and sponsorships to the extent legally possible.
- b) Restrict marketing of ENDS products, including on social media.
- c) Restrict the size, location, type, and/or number of advertisements in retail outlets, regardless of content.

**3. Increase the price of tobacco and nicotine products.**

- a) Enact price increases on all tobacco and nicotine products that are substantial enough to lower use rates.
- b) Ban or enact restrictions on tobacco and nicotine product price discounts and coupon redemption.
- c) Establish minimum "floor" prices for all tobacco and nicotine products.
- d) Establish minimum pack sizes for cigars, cigarillos, and other products, such as oral nicotine products (including snus, a smokeless tobacco product).

**4. Expand availability and increase use of tobacco/nicotine dependence treatment.**

- a) Advocate for reimbursement of NP-provided tobacco/nicotine dependence treatment.
- b) Provide barrier-free comprehensive tobacco and nicotine cessation insurance benefits.
- c) Encourage health systems to select tobacco-specific quality improvement metrics, such as through the alternative payment models outlined in the Medicare Access and CHIP Reauthorization Act.
- d) Improve tobacco/nicotine dependence treatment access and develop new interventions.

**5. Establish comprehensive smoke-free policies, inclusive of ENDS aerosols, in all indoor public places.**

Abbreviations: CHIP, Children's Health Insurance Program; ENDS, electronic nicotine delivery systems.

interventions.<sup>27</sup> Additionally, the 2024 Global Initiative for Chronic Obstructive Lung Disease (GOLD) Report recommends that ENDS not be recommended as a means for tobacco treatment in patients with COPD.<sup>80</sup>

**Public policy**

NPs have a professional responsibility to address the ENDS epidemic by advocating for public policy changes. Even before the 2014 US Surgeon General's report on the health consequences of smoking, those working in the field of tobacco prevention have been lobbying for "endgame" policies and strategies.<sup>81</sup> Endgame strategies are those that aim to end commercial tobacco and nicotine use (with the exception of FDA-approved medications), and they include "initiatives

designed to change permanently the structural, political and social dynamics that sustain the tobacco epidemic, in order to end it within a specific time."<sup>82,83</sup> These strategies are not prohibitive; rather, they rapidly advance progress in tobacco prevention and address tobacco industry influences.<sup>82</sup> Priority should be placed on preventing ENDS use initiation. Federal law requires consumers to be 21 years of age or older to purchase tobacco products, including ENDS.<sup>14</sup> Several endgame strategies and policies to address youth ENDS use are outlined in *Table 2*.

**Education**

Given the role of NPs in providing tobacco/nicotine dependence treatment, incorporating competency-based

treatment education into nursing and NP program curricula will address inadequate and insufficient student education.<sup>87-89</sup> Few recent studies exist on implementing tobacco/nicotine dependence treatment education into nursing programs. Sarna and colleagues previously recommended content for nursing education.<sup>87</sup> Doan provided a detailed summary of an effective curriculum incorporating tobacco/nicotine dependence treatment education into an NP program that showed increased student motivation, confidence, and comfort in relation to such treatment.<sup>90</sup>


## Research

Future research needs include studying how to best deliver tobacco/nicotine dependence treatment education, including on ENDS and public policy, into NP programs. The impact of this education should include measurements at the patient, provider, clinic, and systems levels.

Conducting research on effective tobacco prevention and treatment strategies for adolescents is critical. Particularly, the safety and effectiveness of certain pharmacologic options should be studied in adolescents. Pharmacologic treatment may in some cases improve outcomes in adolescents, who typically use ENDS with variable nicotine dosing, potentially intensifying their physiologic dependence.

Traditional cessation treatments are presumed to be effective for people who use ENDS. However, the various additives and components in ENDS products complicate the clinical picture. ENDS components and their effects on health require study to affirm efficacy of pharmacologic treatment options for tobacco dependence in ENDS use.

## CONCLUSION

ENDS use is a broad public health problem impacting not only youth but also families, schools, and communities. ENDS are the primary tobacco products used by youth, and ENDS use is also increasing among adults. NPs have an opportunity to impact community health dramatically through focused youth prevention efforts and advocacy work in favor of comprehensive tobacco/nicotine dependence treatment. 

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