

Vaping-related lung injury



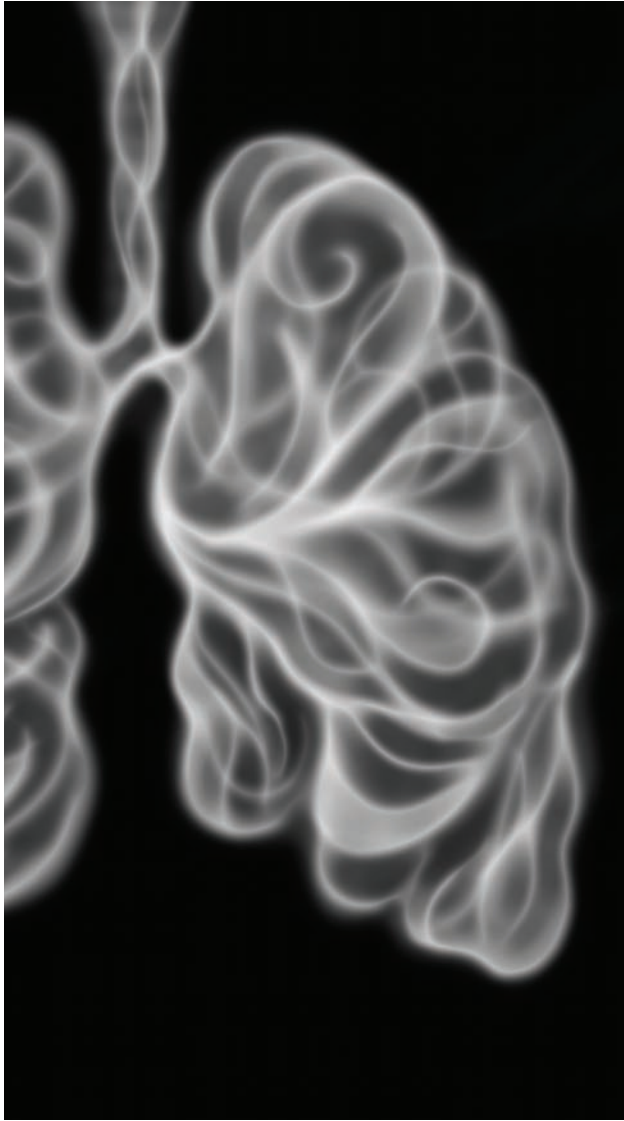
Nurses can help slow the growth of unsafe e-cigarette use through education and support.

By Amanda Perkins, DNP, RN

E-cigarettes became available in 2007 and by 2014, they were the most commonly used tobacco product by American youths. Between 2017 and 2018, e-cigarette use in the US increased from 11.7% to 20.8% among high school students, according to the FDA. In December 2018, the US Surgeon General declared the use of e-cigarettes

among youths to be an epidemic. At the time of that announcement, more than 3.6 million young people were using these products, according to the CDC; in 2019, that number increased to 5.4 million. Even more alarming, the CDC estimates that more than 1 in 4 high school students and 1 in 10 middle school students use e-cigarettes.

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As of 2019, it was believed that 3.7% of American adults are using e-cigarettes, according to the CDC.

Although e-cigarettes have been associated with negative outcomes, carefully planned advertising has increased the popularity of these products, especially among children and adolescents. These devices have been advertised as a safe alternative to smoking tobacco products or an aid to quit smoking, yet they don't appear to help with smoking cessation. In 2014, it was estimated that \$125 million a year is spent on advertising e-cigarette products.

E-cigarette or vaping product use-associated lung injury (EVALI) is lung damage that occurs after the use of e-cigarettes. EVALI cases have risen past 2,500 in the US, with June 2019 seeing an increase in lung injuries associated with vaping. This article provides a description of e-cigarettes, including the effects on children and adolescents, treatment of lung injuries such as EVALI, and the nurses' role.

What are e-cigarettes?

E-cigarettes are battery-operated devices that work by heating and aerosolizing liquids, which are then inhaled. These devices come in a variety of shapes and sizes, with some mimicking the look of a cigarette and some being more discrete. Individuals can even purchase cellphone cases with built-in e-cigarettes. E-cigarettes are sold at numerous places, including convenience stores, drug stores, grocery stores, and online retailers. They may also be sold by individuals making homemade vaporizers. This is an unsafe practice that can increase the risk of injury.

The use of e-cigarettes is known as vaping and the solution that's heated by these devices is called e-liquid or vape juice, which can contain nicotine, tetrahydrocannabinol (THC), cannabidiol, and butane hash oils. Additionally, these solutions may contain propylene glycol, vegetable glycerin, flavoring agents, and other additives. Propylene glycol is used to increase flavor and vegetable glycerin is used to increase vapor. Vaping can expose people to ultrafine particles, heavy metals, volatile organic compounds, and other harmful ingredients.

The inhalation of these solutions can negatively affect the body, especially the respiratory and cardiovascular systems. When heated, propylene glycol and vegetable glycerin decompose, generating dangerous carbonyl compounds such as formaldehyde. These carbonyl



EVALI signs and symptoms

cheat

sheet

- Shortness of breath
- Chest pain
- Hemoptysis
- Fever
- Cough
- Headache
- Myalgia
- Fatigue
- Tachycardia
- Tachypnea
- Hypoxemia

compounds have been associated with oxidative stress and the release of inflammatory mediators, both of which can increase cardiovascular risk and cause changes to platelet function, epithelial injury in the airway, and changes to gas exchange ability. Additionally, some vaping solutions contain flavoring, such as diacetyl, which has been associated with serious lung disease, and benzene, an organic compound found in car exhaust.

When cannabinoid concentrates are inhaled, it's referred to as "dabbing." Hash oil is made by separating the resins from marijuana, which is a hazardous process that's sometimes done illegally in homes or other places, increasing the risk of injury. Dabbing can foster hallucinogenic effects due to increased concentrations of THC. It's believed that 1 in 10 US high school students have dabbled. Dabbing may have the following negative effects:

- increased risk of respiratory tract infections
- voice disorders
- pulmonary barotrauma
- cystic lung disease
- emphysema
- twofold increase in lung cancer after chronic use.

These complications can be seen in users of all ages, including younger patients who we wouldn't typically see with some of these disorders.

The damaged lung

Although lung injuries can occur with vaping, a definitive cause hasn't been identified. However, there's evidence

that certain components or additives are problematic. The lung injuries that have been associated with vaping appear to be linked with THC and vitamin E acetate, which is used to dilute the concentrated THC oil. At this time, no single causative agent is known.

Researchers and healthcare professionals are unsure exactly how vitamin E acetate causes damage, but some possibilities are that it may interfere with surfactant in the lungs or be the byproduct of a toxic chemical. Additional problems associated with vaping include nicotine poisoning and intoxication from THC. Negative effects can also occur for individuals who are passively breathing in the solution through second-hand means. It's significant to note that most people with these lung injuries were previously healthy.

The signs and symptoms associated with EVALI develop rapidly and can mimic other respiratory disorders, such as influenza and pneumonia:

- shortness of breath
- chest pain
- hemoptysis (coughing up blood or blood-stained mucus)
- fever
- cough
- headache
- myalgia
- fatigue
- tachycardia
- tachypnea
- hypoxemia.

The shortness of breath/dyspnea that develops in the patient with EVALI may be severe, progressing to the point that the patient needs to be mechanically ventilated. Hemoptysis is more common in individuals using cannabis. Additional signs and symptoms include nausea, vomiting, diarrhea, abdominal pain, and weight loss.

The patient with EVALI may develop diffuse alveolar hemorrhage (DAH) and exogenous lipoid pneumonia (caused by

aspiration of oil), other types of pneumonia, respiratory bronchiolitis-associated interstitial lung disease, acute lung injury, acute respiratory distress syndrome, pleural effusion, and pneumothorax. DAH is a medical emergency in which patients may present with hemoptysis, anemia, diffuse alveolar infiltrates, and acute respiratory failure. This is a life-threatening condition and, as such, early recognition and diagnosis are important. Early diagnosis relies on bronchoscopy with bronchoalveolar lavage, which involves putting liquid into the lungs and removing the liquid for analysis.

When it comes to the diagnosis of EVALI, there's no specific test. According to the American Lung Association,

Treatment

Depending on the severity of the illness, the patient may be treated on an outpatient or inpatient basis. Typically, when the following criteria have been met, the patient can be treated as an outpatient:

- oxygen saturation greater than 95%
- no respiratory distress
- no comorbidities that increase the risk of respiratory difficulty
- appropriate access to care
- appropriate support
- ability to return for follow-up in 24 to 48 hours.

Although outpatient treatment is an option, hospital admission may be necessary for many patients, especially those with additional illnesses.

Nurses can play an important role in screening for e-cigarette use because we're often the first point of contact when patients enter the healthcare system.



diagnosis is based on a process of elimination because EVALI mimics many other disorders. When working up a diagnosis, evaluate the patient for a history of e-cigarette use. For patients with potential EVALI, you may see orders for a variety of tests, including influenza testing, chest X-ray, computed tomography (CT) scan, and bronchoscopy. It's important to rule out influenza, especially during flu season, because the signs and symptoms of influenza and EVALI are similar. If a chest X-ray is normal, the healthcare provider may order a CT scan for further investigation. With both of these tests, the radiologist is looking for opacities in the lungs. If an airway injury is suspected, a bronchoscopy may be ordered to allow for direct visualization.

When caring for these patients, it isn't uncommon for a broad-spectrum antibiotic to be ordered. When antibiotics are ordered, it's a good idea to encourage the patient to take probiotics to restore normal flora. If probiotics aren't ordered with antibiotics, the nurse can advocate for the patient and request probiotics. It also isn't uncommon to see steroids ordered for these patients. The use of corticosteroids in the outpatient setting hasn't been well researched and should be used with caution because they can increase the risk of worsening respiratory infections. In the hospital setting, corticosteroids have been associated with rapid improvements. When patients have had prolonged immobility due to illness,



consider this

The nurse working in a busy ED is assessing a 16-year-old young man accompanied by his mother who reports that he's been ill for the past week with "flu-like" symptoms. Upon assessment, the nurse finds the patient to be tachycardic and tachypneic, with a dry cough and fever. The patient's mother reports that he hasn't received a flu vaccine. The healthcare provider orders a rapid influenza diagnostic test, which is negative. While the nurse is admitting the patient, he becomes increasingly dyspneic and anxious. His history reveals that he's used vaping products for the past 2 years. When asked about the retailer used for these products, the patient reports that he purchases "vape juice" from his friend who "knows how to make it at home."

The school nurse working in a local high school was recently notified about two of the high school students being admitted to the hospital with EVALI. The nurse is concerned that more students within the high school may be vaping. The current e-cigarette policy in place at the high school is punitive in nature and discipline heavy. The nurse believes that the current policy won't effectively deter e-cigarette use and presents a new policy to school administration that incorporates education and interventions to prevent the use of e-cigarettes and assist students who use e-cigarettes with quitting.

treatment may also require physical therapy to regain lost mobility and help prevent complications associated with immobility.

In most cases, patients admitted to the hospital will need to be stable for 24 to 48 hours before being considered for discharge. After discharge, a follow-up appointment is recommended within 48 hours, with a pulmonary follow-up within 2 to 4 weeks once cortisone has been tapered off, and possible additional follow-up in 1 to 2 months. For more information on EVALI discharge guidelines, see the CDC's EVALI Discharge Readiness Checklist at www.cdc.gov/tobacco/basic_information/e-cigarettes/pdfs/evali-discharge-readiness-checklist-508.pdf.

Other complications associated with vaping

Complications may develop in pregnant women who use e-cigarettes. According to the CDC, e-cigarettes aren't safe to use during pregnancy. Many vaping products contain nicotine, which can damage the developing fetus's brain and lungs. Nicotine is also associated with decreased fetal growth due to placental vasoconstriction causing reduced blood flow to the fetus. Another potential risk

is the added flavorings in these products, which can also be damaging for the developing fetus.

Although these products may be used by pregnant women to aid in smoking cessation even though the FDA hasn't approved them for this purpose, some women will become dual users, using both e-cigarettes and regular cigarettes. Unfortunately, very little research has been conducted on vaping during pregnancy. Because pregnancy is a time when women may be motivated to change, nurses should work to help women to quit smoking both regular cigarettes and e-cigarettes.

In addition to the medical complications that can arise in patients who vape, there's a risk of injury from fires and explosions. Although uncommon, when they do occur, these incidents can cause serious injury. Defective e-cigarette batteries, specifically lithium-ion batteries, have been known to cause fires and explosions. At this time, e-cigarettes are the only products with lithium-ion batteries that are used so close to a person's body. If using e-cigarettes, it's important for individuals to purchase products that have been evaluated for safety. Consumers should look for products with a UL on the packaging, which stands for



Underwriters Laboratory, a nationally recognized test lab that checks lithium-ion batteries for safety. Many people purchase batteries from disreputable sellers or old batteries may be taken from laptop computers or power tool battery packs. When batteries are obtained in this way, they may not have the protective circuitry in place, increasing the risk of an explosion. Another problem is that some individuals construct their own devices or modify existing ones, potentially increasing the risk of an explosion or fire.

The US Fire Administration determined that between 2009 and 2016, 195 fires and/or explosions occurred related to e-cigarette use. Injuries occurred in 68% of these fires/explosions, with 19.5% of the injuries classified as serious, 41% as moderate, 7.7% minor, and the remaining having no injuries. Individuals classified as having severe injuries required hospitalization and potentially had a loss of body part, full-thickness burns, and facial injuries. Those having moderate injuries were seen in the ED and may have had smoke inhalation injuries, partial-thickness burns, and lacerations requiring stitches. When serious injuries occurred, they were typically the result of an explosion while the e-cigarette was in a pocket, in use in the patient's mouth or near his or her face, or charging. When an e-cigarette explodes, it tends to happen quickly, with reports that there was a loud noise, a flash of light, smoke, and flames, in addition to the ejection of the e-cigarette battery and other parts. Fire to nearby objects occurs when the ejected battery and other e-cigarette components fly across the room and come in contact with combustible objects.

Special consideration: Children and adolescents

There are myriad e-cigarette flavors available and the packaging is colorful, increasing the appeal of these products, especially for children and adolescents.

key points

Nursing assessment

If you suspect that your patient has EVALI, ask the following questions:

- Have you used e-cigarettes within the last 3 months?
- What device do you use for vaping?
- What type of liquid do you use?
- Where was the liquid purchased?
- Have you shared the device and/or liquid with others?
- Have you received a yearly flu vaccine?

In general, product design and packaging are geared toward younger consumers. Research has shown that the younger population is more likely to select fruit- or beverage-flavored products and that these flavored products may be viewed as less harmful than nonflavored ones. In fact, 68% of high school students who vape use flavored e-cigarettes, according to the FDA. E-cigarettes must carry a warning label, yet many young people believe that these products aren't harmful. Because vaping is relatively new, research regarding packaging is limited; additional studies need to be conducted.

The use of e-cigarettes by children and adolescents increases the risk of addiction, and there have been reports that products claiming to be nicotine-free contain nicotine. This is problematic because it can lead to nicotine addiction in people who don't have a nicotine addiction. E-cigarette use is also associated with the use of other tobacco products. Another factor to consider is that younger individuals are more likely to be impulsive and take risks, which may make them more likely to use products from unapproved sources or illegal for their age group.

For children and adolescents, the risks associated with vaping include nicotine addiction, mood disorders, and trouble with impulse control. It's been shown that vaping nicotine containing

products can potentially cause attention disorders and problems with memory and learning because the brain isn't fully developed in childhood and adolescence. Nicotine may act on the dopamine system, which is associated with desire, pleasure, reward, and impulse control, aiding in the development of nicotine addiction. Vaping has also been associated with substance use, including alcohol and marijuana. In fact, 7 out of 10 high school students who smoke cigarettes also use e-cigarettes.

Young children may accidentally ingest vaping liquid. Between 2010 and 2014, the rate of e-cigarette calls to Poison Control increased from 0.3% to 41.7%, according to the National Institute on Drug Abuse. Most often, the children exposed are younger than age 5. Common adverse reactions due to this exposure include nausea, vomiting, and eye irritation.

What can nurses do?

Per CDC recommendations, all patients should be screened for e-cigarette use. Nurses can play an important role in screening for e-cigarette use because we're often the first point of contact when patients enter the healthcare system. If your patient uses e-cigarettes, offer information on quitting and ask if he or she needs assistance quitting. Provide education about the dangers associated with vaping. Individuals who vape should be counseled on the importance of not buying the liquid from informal sources, such as friends, family members, or online dealers; not adding anything to products purchased from retailers; and not modifying e-cigarettes or associated products in any way. Parents and caregivers of young adults who vape can be guided to the US Surgeon General's website for access to a parent tip sheet (<https://e-cigarettes.surgeongeneral.gov>). The bottom line is that e-cigarettes should never be used

on the web

American Lung Association:

www.lung.org/quit-smoking/e-cigarettes-vaping

CDC: www.cdc.gov/tobacco/basic_information/e-cigarettes/index.htm

National Institute on Drug Abuse:

www.drugabuse.gov/related-topics/vaping

US Surgeon General:

<http://e-cigarettes.surgeongeneral.gov>



by anyone under age 18 or those who are pregnant.

When caring for a patient with suspected EVALI, a health history and assessment should be obtained. Ask the patient the following questions:

- Have you used e-cigarettes within the last 3 months?
- What device do you use for vaping?
- What type of liquid do you use?
- Where was the liquid purchased?
- Have you shared the device and/or liquid with others?
- Have you received a yearly flu vaccine?

Obtain the patient's vital signs, paying close attention to respiratory rate and oxygen saturation. Auscultate heart sounds, lung sounds, and bowel sounds and perform a full respiratory assessment/exam.

Lower the risk

The long-term effects of vaping and risk of EVALI recurrence are currently unknown. Yet the dangers associated with vaping are 100% preventable. Nurses can help decrease the risks related to e-cigarettes by educating patients and their families. We can also help patients quit using these products by providing emotional support and information on appropriate resources. Lastly, nurses should ensure that they're properly educated about e-cigarettes, including associated medical conditions and how to care for patients experiencing complications. ■

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Vaping-related lung injury

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