

An Adolescent with Respiratory Distress



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Overall Purpose/Goal: To provide excellent case-based reviews on key aspects of allergic disease to those who research, treat, or manage allergic disease.

Target Audience: Physicians and researchers within the field of allergic disease.

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List of Design Committee Members: Priya Patel, MD, Thomas Ferkol, MD (authors); Robert S. Zeiger, MD, PhD (editor)

Learning objectives:

1. To recognize the powerful addicting effects of nicotine and how it has contributed to the growing popularity of vaping among adolescents.
2. To appreciate the association between vaping and the use of other tobacco products in adolescents and young adults.
3. To understand the harmful respiratory effects of vaping and e-cigarette use, including in children with asthma.
4. To identify the clinical presentation of e-cigarette- and vaping-associated lung injury (EVALI).

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The Difficult Cases Feature is based on the *Difficult Cases* Course presented at the AAAAI Annual Meeting and coordinated by the AAAAI New Allergist-Immunologist Assembly (NAIA). View the entire presentation and obtain CME or MOC credit by visiting the *JACI: In Practice* homepage www.jaci-inpractice.org.

Key words: Adolescent; Dyspnea; Refractory cough

CASE PRESENTATION

A 17-year-old adolescent male with a history of well-controlled mild intermittent asthma requiring infrequent albuterol use, allergic rhinitis, and severe allergies to sesame seeds, tree nuts, and shellfish presented with cough, fever, and emesis for 5 days. Hospitalized for management of an asthma exacerbation and atypical pneumonia, he was treated with systemic

corticosteroids, inhaled albuterol, and empirical antibiotic therapy. On the second hospital day, however, he became increasingly dyspneic and hypoxemic, and diffuse coarse breath sounds were appreciated on auscultation of the lungs. He was subsequently transferred to the pediatric intensive care unit for supplemental oxygen and noninvasive positive pressure support.

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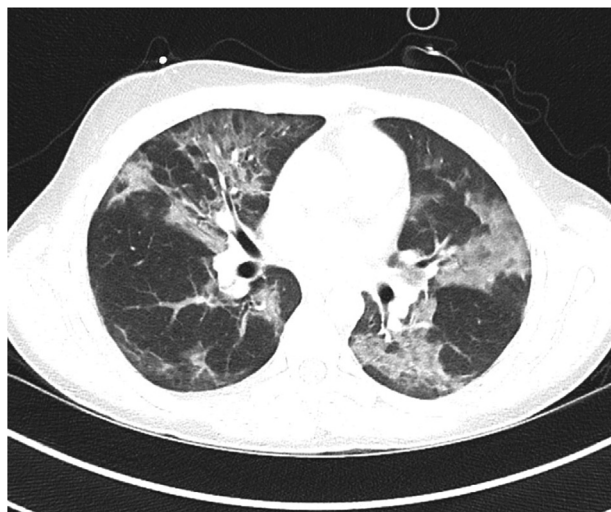


FIGURE 1. Computed x-ray tomographic imaging of the patient's chest, showing asymmetrical ground glass opacities with subpleural sparing.

Computed tomography of the chest showed diffuse ground-glass opacities, predominantly involving the upper lobes (Figure 1). Laboratory studies revealed peripheral neutrophilia (absolute neutrophil count 15,060/mL) and elevated inflammatory markers (erythrocyte sedimentation rate 75 mm/hour), but no respiratory pathogens were identified. The airways appeared normal, but lipid laden macrophages were found on bronchoalveolar lavage. Urine drug screen was positive for cannabinoids, and additional history was obtained regarding electronic cigarette use. He reported beginning JUUL and NJOY e-cigarettes 2 years ago, and more recently tetrahydrocannabinol (THC)-containing product. Diagnosed with e-cigarette or vaping product associated lung injury (EVALI), he was treated with high-dose intravenous methylprednisolone and had rapid clinical improvement with resolution of hypoxemia. He also began nicotine and THC cessation therapies.

DISCUSSION

Electronic cigarettes, or electronic nicotine-delivery systems (ENDS), are products that deliver aerosols of nicotine, THC, and other volatile organic chemicals to the lung.^{1,2} First introduced in the United States approximately 15 years ago and more recently touted as a smoking cessation tool, there has been a dramatic increase in e-cigarette use in middle and high school students.³ Although e-cigarettes are thought to generate fewer toxicants than combustible cigarettes, their aerosols are not "harmless" and contain potentially noxious ingredients, including formaldehyde, acetaldehyde, and acrolein.⁴ Users can also be exposed to microbial contaminants and heavy metals generated by heating the solution. However, given the diversity of currently available products, it is difficult to quantify these emissions.⁵ Numerous studies have shown that adolescents and young adults who use e-cigarettes have more respiratory symptoms, and exposure to vaping aerosols causes inflammation and oxidative stress, and can be toxic to pulmonary and endothelial cells.⁶ Proteomic analyses of bronchoalveolar lavage have demonstrated extensive biological effects

on the human airway from chronic use of e-cigarettes, though distinct from combustible cigarettes.⁷

The emergence of EVALI further underscores the dangers associated with these products. Generally, EVALI is defined by use of ENDS within the previous 90 days.⁸ However, there can be varying durations of product use before development of symptoms, ranging from a few hours to years of chronic use. Indeed, the duration of vaping may be less relevant than the specific products used. There have been over 15,000 flavor-infused, nicotine-containing vaping solutions in the market, and some adolescents use different products at different times.

EVALI is considered a diagnosis of exclusion and should be suspected on the basis of vaping history and clinical presentation. Patients may become hypoxemic, and laboratory findings can include elevated inflammatory markers.⁸ Chest imaging often reveals bilateral ground-glass opacities with subpleural sparing.⁹ Lipid laden macrophages may often be seen in BAL of those with EVALI, though this is a nonspecific finding. Although the specific etiology of EVALI has yet to be determined, many affected used THC-containing products, and there is concern for vitamin E acetate as a causative agent.⁸

It is important for health care providers to recognize the complications of vaping. Several studies have shown that electronic cigarette use was associated with later combustible cigarette use in youths, leading to nicotine addiction.¹⁰⁻¹² Further, compared with cigarette-only users, dual users are more likely to have diagnosis of asthma. Indeed, emerging studies suggest a higher than expected occurrence of EVALI in asthmatics.¹ Asthmatics who use e-cigarettes are more likely to experience airway irritation and longer recovery times after exacerbations.¹ Treatment is difficult and requires a multifaceted approach involving patient education, pharmacologic interventions, and smoking cessation programs. Thus, prevention is key.

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