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Electronic cigarette use as a rare cause of diffuse alveolar hemorrhage

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Abstract:

The increasing use of electronic cigarettes (e-cigarettes) among young adults has led to the emergence of electronic cigarette or vaping-associated lung injury (EVALI), which includes a wide spectrum of pulmonary complications. Diffuse alveolar hemorrhage (DAH) is a rare but life-threatening manifestation of EVALI. We aim to present a fatal case of DAH in a previously healthy young adult following recent e-cigarette use. A 23-year-old Turkish male with no prior medical history presented with dyspnea, cough, and hemoptysis 2 days after initiating frequent e-cigarette use. He had no history of chronic illness, substance use, or allergies. On admission, he was hypoxic with bilateral rales and diffuse ground-glass opacities on chest computed tomography (CT). Laboratory tests revealed severe anemia, leukocytosis, and elevated inflammatory markers. Despite treatment with high-dose corticosteroids, tranexamic acid, antibiotics, and supportive therapy, the patient's condition deteriorated, and he died on the 7th day of hospitalization. E-cigarette use has been increasingly associated with severe lung injuries, including DAH. The exact pathophysiology remains unclear but may involve direct alveolar epithelial damage and inflammatory responses. Our case is consistent with previously reported cases of vaping-induced DAH and highlights the potential severity of this condition. E-cigarettes are not a safe alternative to traditional tobacco. Clinicians should maintain a high index of suspicion for DAH in patients presenting with hemoptysis and respiratory failure following vaping. Early recognition and aggressive management are critical to improve outcomes.

Keywords:

Diffuse alveolar hemorrhage, E-cigarettes, emergency department

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Introduction

The widespread use of electronic cigarettes and vaporizing devices, particularly among young adults, has introduced a new spectrum of vaping-associated lung injuries. While marketed as safer alternatives to conventional tobacco products, these devices have been implicated in various lung pathologies collectively known as electronic cigarette or vaping-associated lung injury (EVALI). Among these, diffuse alveolar hemorrhage[1,2] (DAH) is a rare but potentially fatal condition characterized by bleeding into the alveolar spaces. Electronic cigarettes have been associated with a range of lung injuries, including acute eosinophilic pneumonia, lipoid pneumonia, organizing pneumonia, and DAH. The pathophysiology of vaping-related DAH likely involves direct toxic injury to the alveolar epithelium, immune-mediated inflammation, and disruption of the alveolar-capillary membrane.[1,2]

We conducted a focused literature review using PubMed and EMBASE for English-language articles published between January 2010 and March 2024. Search terms included "electronic cigarette," "vaping," "diffuse alveolar hemorrhage,"

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and "EVALI." Reference lists of key articles were manually reviewed to ensure a comprehensive search. This case report demonstrates that intensive short-term e-cigarette use can indeed cause serious adverse events, contributing to a unique and fatal example of DAH, reinforcing the urgency for increased clinical awareness and regulation, and demonstrating e-cigarette use as a rare cause of DAH.

Case Report

A 23-year-old Turkish male with no known medical history presented to the emergency department with complaints of cough, shortness of breath, and hemoptysis for the past 2 days. He denied alcohol use, recreational drug use, and prior smoking. He was a university student and had begun using flavored electronic cigarettes 2 days before admission, reporting frequent use due to taste preference.

On presentation, the patient's height was 175 cm, and weight was 74 kg. Vital signs were as follows: blood pressure 117/53 mmHg, heart rate 147 bpm, respiratory rate 20 breaths per minute, and peripheral oxygen saturation 60% on room air. He was alert and oriented but in respiratory distress. Bilateral rales were auscultated in the middle and lower lung fields. The remainder of the physical examination was unremarkable.

Laboratory evaluation revealed hemoglobin 6.3 g/dL (reference range: 13.5–17.5), hematocrit 19%, white blood cell count 12.89 × 10^3/μL (neutrophils 87.4%), platelet count 334 × 10^3/μL, C-reactive protein 23.2 mg/L, prothrombin time 12.9 s, activated partial thromboplastin time 21 s, INR 1.13, and lactate 1.9 mmol/L. Arterial blood gases showed pH 7.38, pCO_2 35.2 mmHg, pO_2 43 mmHg, and HCO_3^- 21.1 mmol/L. Liver and kidney function tests were within normal limits.

Contrast-enhanced thoracic computed tomography ruled out pulmonary embolism but revealed diffuse bilateral ground-glass opacities predominantly in the middle and lower lobes [Figures 1 and 2]. Bronchoscopy and bronchoalveolar lavage (BAL) were not performed due to clinical instability. The patient was admitted to the intensive care unit and treated with intravenous methylprednisolone (1 mg/kg/day), tranexamic acid (1 g every 8 h), broad-spectrum antibiotics (piperacillin-tazobactam 4.5 g every 6 h), and red blood cell transfusion.

Despite high-flow oxygen therapy, his respiratory status worsened, requiring endotracheal intubation within 24 h. He remained hypotensive and unresponsive to vasopressors. The patient died on the 7th day of hospitalization due to refractory hypoxemia and circulatory failure.

No autopsy was performed. Based on clinical, radiologic, and laboratory findings, and the exclusion of other etiologies, a diagnosis of vaping-associated DAH was established. Consent to Participate: The author confirms that appropriate patient consent forms have been obtained. Consent was obtained from the patient's father due to the patient's poor consciousness. The patient's father agreed to report his son's images and clinical information in the journal under the assurance of anonymity measures.

Discussion

This case report illustrates a fatal instance of DAH following intense short-term e-cigarette use. DAH is a rare and life-threatening condition resulting from damage to the alveolar-capillary membrane, leading to hemorrhage into the alveolar spaces. Known causes include autoimmune diseases, infections, medications, coagulopathies, and inhalational exposures.[1,2] When evaluating a patient with DAH, obtaining a comprehensive medical history is critical to identify potential underlying causes. Key aspects include the presence of systemic autoimmune or collagen vascular diseases, as these may present with extrapulmonary manifestations suggestive of vasculitis or connective tissue disorders. Cardiac etiologies, particularly mitral stenosis or other conditions leading to elevated left-sided filling pressures, should also be considered. A detailed drug history is essential to identify potential culprits such as penicillamine, propylthiouracil, or illicit substances like crack cocaine. In addition, coagulopathies or the use of anticoagulant therapy must be assessed, as these can contribute to pulmonary hemorrhage. In our case, no clinical, laboratory, or imaging findings suggested an underlying autoimmune disease, vasculitis, or cardiac cause. There was no prior history of cardiac disease, and echocardiography revealed no structural abnormalities. The patient denied use of any medications known to induce DAH and had no history of anticoagulant use or bleeding diathesis. Furthermore, there was no evidence of infectious etiology. The strong temporal relationship between the onset of symptoms and recent intensive e-cigarette use, together with the absence of alternative explanations, supports the presumptive diagnosis of vaping-associated DAH.

Electronic cigarettes have emerged as a potential cause of DAH, although the exact pathophysiological mechanisms remain unclear. Proposed mechanisms include direct alveolar epithelial injury, inflammatory responses, immune-mediated damage, and disruption of the alveolar-capillary membrane due to exposure to aerosolized chemicals such as nicotine, flavoring agents, or vitamin E acetate. The association between

vaping and DAH is supported by several case reports describing similar clinical and radiological features.[3-7] E-cigarette aerosols may contain nicotine, tetrahydrocannabinol (THC), vitamin E acetate, and a variety of flavoring agents, all of which can induce toxic and inflammatory responses in lung tissue.[6-12] Although BAL is the gold standard for confirming DAH, our patient's critical condition precluded this diagnostic step. However, it is important to recognize that establishing causality is challenging in the absence of histopathological confirmation, toxicological analysis of the vaping liquid, or BAL, which could not be performed in our patient due to clinical instability.

A comparison with published literature shows a consistent pattern among patients developing DAH after vaping [Table 1].

Limitations of this report include the absence of histopathological confirmation, the unavailability of toxicologic analysis of the e-liquid used, and the lack of an autopsy. Nevertheless, the strong temporal relationship, clinical presentation, and exclusion of alternative diagnoses support the diagnosis of vaping-induced DAH.[8-10]

This case represents an instructive example highlighting the diagnostic challenges and potential pitfalls in attributing DAH to electronic cigarette use. While vaping is increasingly recognized as a potential cause of DAH, establishing a causal relationship requires careful exclusion of other etiologies, including autoimmune diseases, cardiac disorders, coagulopathies, and drug-related causes. Our report underscores the importance of a systematic and comprehensive approach in the evaluation of DAH. In this case, the temporal association with recent intense vaping, supportive radiological findings, and the absence of alternative explanations support the presumptive diagnosis of vaping-associated DAH. Clinicians should maintain a high index of suspicion for vaping-related lung injury in young patients presenting with unexplained respiratory failure and hemoptysis, and be aware of the diagnostic complexities inherent to such cases. This case emphasizes the need for healthcare professionals to inquire about e-cigarette use in patients presenting with unexplained respiratory symptoms, particularly in younger populations. Regulatory measures and further research into the toxicological effects of vaping are urgently needed.

Conclusion

Patient case reports are valuable resources of new and unusual information that may lead to vital research. This case reinforces the need for clinicians to consider vaping-associated lung injury in the differential diagnosis of acute respiratory distress. While no definitive causality can be established from a single report, the observed temporal association, clinical presentation, and exclusion of other etiologies support heightened clinical vigilance and justify further investigation into vaping-related pulmonary complications.

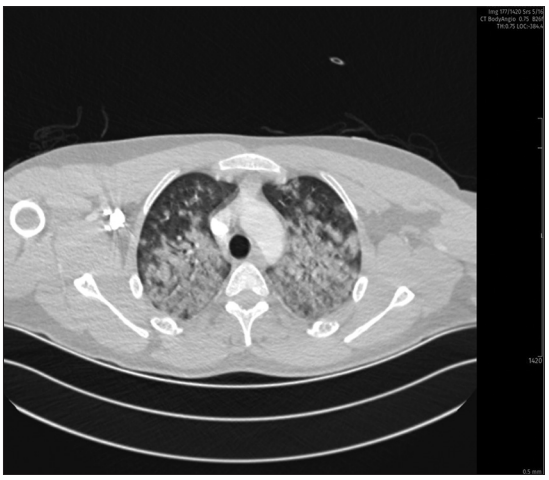

Figure 1: Patient's thorax computed tomography image (axial section)

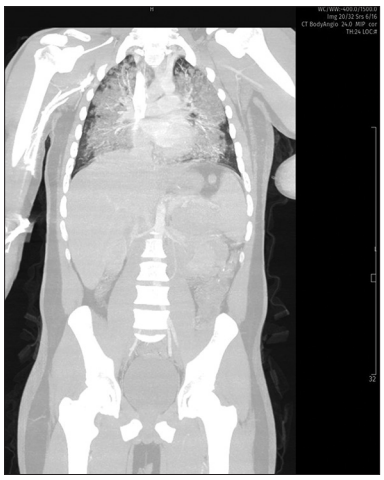

Figure 2: Patient's thorax computed tomography image (coronal section)

Table 1: Comparison of literature

Author (year)	Age/sex	Clinical presentation	Diagnostic findings	Outcome
Agustin *et al.* (2018)	31/male	Hemoptysis, hypoxia	DAH confirmed on BAL, CT: GGOs	Survived
Kalininskiy *et al.* (2020)	27/female	Cough, dyspnea	CT: GGOs, BAL not performed	Survived
Present case	23/male	Hemoptysis, hypoxemia	CT: GGOs, BAL not performed	Died

CT: Computed tomography, BAL: Bronchoalveolar lavage, GGO: Ground-glass opacities, DAH: Diffuse alveolar hemorrhage

Author contributions statement

FHÇ (Lead): Conceptualization (lead), reviewing, and editing the final draft (equal), supervised the case management (equal), NB: writing original draft (lead), supervised the case management (equal), reviewing and editing the final draft (equal). ÖS: reviewing and editing the final draft (equal). FÜ: Conceptualization (lead), reviewing, and editing the final draft (equal). ASA: writing original draft (lead), supervised the case management (equal), reviewing and editing the final draft (equal).

Conflicts of interest

None Declared.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understands that name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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