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Electronic cigarette, or Vaping, Product Use-Associated Lung Injury (EVALI): A Comprehensive Review of Biology, Management, and Outcomes

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ABSTRACT

Electronic cigarette, or vaping, product use-associated lung injury (EVALI) is an acute, noninfectious pulmonary syndrome linked to recent use of electronic nicotine-delivery systems and THC-containing vaping products, predominantly affecting adolescents and young adults. Clinically, patients usually present with a range of respiratory, gastrointestinal, and constitutional symptoms, while laboratory tests often reveal elevated inflammatory markers. In this review, the authors conducted a systematic review of original research, including clinical cohorts, epidemiological investigations, computed tomography (CT) pattern studies, bronchoalveolar lavage (BAL) toxicant analyses, experimental cell models, and prospective follow-up. The researchers identified relevant literature through database searches (PubMed; Google Scholar) to synthesize the most current evidence. Imaging studies such as chest CT most frequently disclose organizing-pneumonia-spectrum patterns with bilateral ground-glass opacities and subpleural or lobular sparing. Analysis of BAL fluid samples discloses the presence of vitamin E acetate (VEA), which appears to be one of the possible damaging factors. Additionally, experimental cell models demonstrated that similar substances may cause an inflammatory response, injury to alveolar epithelium, and surfactant dysfunction. Management should focus on the immediate cessation of vaping, symptomatic treatment, and administering selective systemic corticosteroids once infection is reasonably excluded. In severe cases, patients may require intensive care therapy. Although short-term survival is generally favorable with contemporary care, a substantial subset of survivors report persistent respiratory, cognitive, and mental health sequelae at one year. Despite these insights, evidence remains largely observational and heterogeneous; prospective, standardized studies are essential for validation biomarkers and evaluating structured survivorship interventions.

Keywords: E-cigarette, or vaping, product use-associated lung injury (EVALI)/ Vaping/ Electronic cigarettes

DISCOVERY SCIENTIFIC SOCIETY

1. INTRODUCTION

E-cigarette, or vaping, product use-associated lung injury (EVALI) denotes an acute lung injury syndrome due to recent use of electronic nicotine delivery systems or tetrahydrocannabinol (THC) cartridges. Recognition of EVALI accelerated during the 2019 outbreak in the United States (U.S.), when state and federal surveillance identified a sharp increase in cases among adolescents and young adults and recorded associated hospitalizations, during which intensive care management was frequently required (Layden et al., 2020). In clinical practice, patients most commonly experience respiratory (cough, dyspnea, pleuritic chest pain), gastrointestinal (nausea, vomiting, abdominal pain), and constitutional symptoms (fever, malaise, weight loss). This clinical presentation is usually accompanied by elevated inflammatory markers, which makes it difficult to differentiate from infectious causes (Aberegg et al., 2020).

The diagnostic challenge increases due to the lack of pathognomonic clinical signs and the variability of radiologic patterns observed at presentation; thus, diagnosis hinges on careful exposure history, compatibility of the imaging phenotype, and exclusion of competing causes - recognizing that incidental microbiologic positives may coexist (Girvin and Naidich, 2020; Kligerman et al., 2021). In parallel with clinical observations, analysis of toxicants in bronchoalveolar lavage (BAL) fluid converged on vitamin E acetate (VEA) as a signature exposure during the outbreak: the substance was identified directly in BAL specimens from EVALI case-patients and in any of the controls. Consistent with these findings, VEA was also prevalent in illicit THC cartridges sourced from informal supply chains (Blount et al., 2020; Layden et al., 2020; Lu et al., 2021).

Experimental models, including animal inhalation studies and primary human alveolar cell systems, successfully reproduced key biological features such as epithelial injury, inflammatory signaling, and the accumulation of lipid-laden macrophages (LLMs). Additionally, another study indicates that e-cigarette aerosols may degrade surfactant function (Matsumoto et al., 2020; Graham et al., 2022). These pathomechanisms of impaired gas exchange and alveolar instability seem to explain why the patients at the severe end of the spectrum can progress to acute hypoxemic respiratory failure necessitating invasive ventilation, with a minority requiring extracorporeal membrane oxygenation (ECMO), (Choe et al., 2020). Despite appropriate hospital management, many patients experience various persistent symptoms and functional limitations for 6 to 12 months. Therefore, organized follow-up and rehabilitation programs are crucial for recovery (Triantafyllou et al., 2021; Blagev et al., 2022).

2. MATERIALS AND METHODS

The authors conducted a systematic review of multicenter and single-center cohorts, case series, epidemiological investigations, bronchoscopy and BAL analyses, imaging pattern studies, animal and cell models, and prospective follow-up published up to July 2025. The literature was found via electronic databases (PubMed; Google Scholar), with an application of specific keywords: “EVALI”, “lung injury”, “E-cigarette”, “vaping”, “e-smoking cessation”. The article screening process followed the PRISMA guidelines (Figure 1).

3. RESULTS AND DISCUSSION

Epidemiology

E-cigarettes made their debut in the U.S. market around 2007 and have become the most widely used tobacco product among youth in the U.S. since 2014; between 2017 and 2018, current use among high-school students rose from 11.7% to 20.8%, whereas 3.2% of U.S. adults reported current use in 2018 (Layden et al., 2020). During the 2019 EVALI outbreak, most affected patients were male, <35 years old, and reported THC-containing vaping (Hartnett et al., 2020). Younger people were disproportionately affected: in 2019 U.S. surveillance, adolescents (13-17 years) comprised around 16% and young adults (18-24 years) approximately 38% of cases; among hospitalized/deceased adolescents (n=360), 81.7% reported THC-containing products, and 96.5% obtained them from informal sources (Adkins et al., 2020). In a consecutive series of 17 hospitalized patients from rural Appalachia (West Virginia), investigators recorded demographics, vaping behaviors, and hospital courses; many individuals were older than typical national cohorts (mean age around 37 years), with frequent combustible-tobacco use and mixed substance exposures. Reflecting the broader epidemiologic footprint, by February 18, 2020, the Centers for Disease Control and Prevention (CDC) had tallied 2,807 hospitalized EVALI cases and 68 related deaths across all U.S. states (Sangani et al., 2021).

Multiple convergent lines of evidence implicate VEA, an adulterant in illicit THC cartridges, during the 2019 surge. In a CDC-led analysis of BAL fluid from 51 EVALI cases across 16 states, VEA was detected in 48/51 (94%) patients and in none (0/99) of controls (including e-cigarette users and cigarette smokers). At the same time, other priority toxicants were largely absent, directly tying VEA exposure to the pulmonary toxicity. Complementary Illinois-Wisconsin interviews showed 87% THC-product use, with 89% of those

THC cartridges acquired from informal sources (friends/dealers/off the street), underscoring supply-chain risk (Ghinai et al., 2019; Blount et al., 2020). The Appalachian cohort further documented high burdens of volatile organic compounds (VOCs) in aerosols from patient-provided vaping devices and iron-positive macrophages on BAL analysis, suggesting additional injurious constituents (pyrolysis-derived VOCs; iron/metal shed from device heating coils) that seemed to be related to EVALI development and modification of disease severity (Sangani et al., 2021).

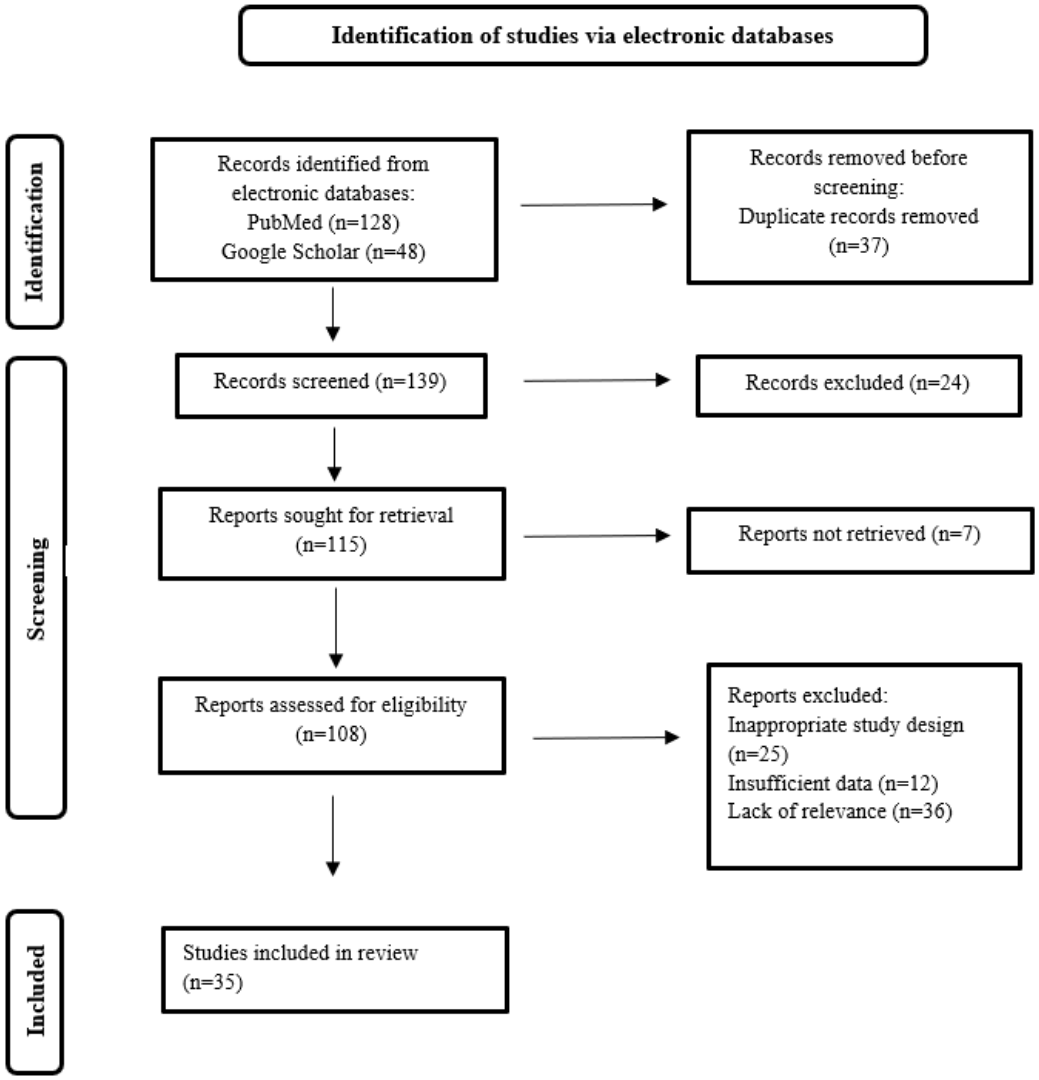

Figure 1. PRISMA flow diagram

Clinical Manifestation

Across settings, EVALI often presents subacutely over days to weeks, with antecedent constitutional (fever, night sweats, chills), respiratory (cough, dyspnea, pleuritic chest pain) and gastrointestinal symptoms (nausea, vomiting, diarrhea, abdominal pain), (Aberegg et al., 2020). The study of four patients conducted by Choe et al., (2020) suggests a 2-5-day prodromal phase and additional clinical manifestations such as myalgia, nasal congestion, and anorexia in some patients. Tachycardia, tachypnea, hypoxemia, and abnormal lung auscultatory findings were present in all cases on admission. During hospitalization, fever developed in all patients. Laboratory tests commonly show leukocytosis with a predominance of granulocytes and elevated levels of inflammatory markers. In a minority of cases, there is a mild increase in transaminases and the presence of hematuria (Aberegg et al., 2020).

Diagnostic Evaluation

Thoracic imaging

Chest radiography (CXR) typically reveals only bilateral opacities, while chest CT provides enhanced visualization of parenchymal lesions. However, it is important to note that no imaging findings are pathognomonic for EVALI, and the results remain nonspecific. A large multicenter cohort (n=160) revealed that 97.5% of CT images could be categorized into six phenotype patterns dominated by organizing-pneumonia (OP) spectra (parenchymal OP 55.6%, airway-centered OP 8.8%, mixed OP 20%), with minority presentations of diffuse alveolar damage, acute eosinophilic pneumonia (AEP)-like patterns, and diffuse alveolar hemorrhage. Characteristic signs included subpleural, lobular, and peribronchovascular sparing (78%, 59%, and 40%, respectively), septal thickening (51%), lymphadenopathy (63%), and centrilobular nodules (36%). More extensive parenchymal involvement was correlated with a greater vaping frequency, suggesting a dose-response relationship based on observable characteristics (Kligerman et al., 2021). Institutional case series from the U.S. 2019 outbreak period reported lower-lobe-predominant ground-glass opacities with or without consolidation, frequent subpleural sparing, and bronchial wall thickening (Girvin and Naidich, 2020).

In a pediatric cohort, Artunduaga et al., (2020) evaluated chest CT scans and found bilateral symmetric ground-glass opacities. Consolidation appeared in roughly two-thirds of the cases, along with frequent subpleural sparing. Moreover, a reversed halo sign was observed in approximately one-third of patients. Notably, excellent inter-rater reliability was observed, reinforcing the reproducibility of adolescent features despite the absence of pathognomonicity. In adolescent cases, additional findings included centrilobular ground-glass nodules, small pleural effusions, and reactive lymphadenopathy. These findings are crucial for contextualizing the severity of the disease and guiding appropriate follow-up imaging (Thakrar et al., 2020). Table 1 presents the comparison of the mentioned studies.

Table 1. Computed Tomography (CT) Findings in EVALI

Study (Year)	Cohort / Setting	Population	Dominant CT Pattern(s)	Common CT Findings
Kligerman et al., (2021)	Multicenter, n=160	Adolescents/young adults; mixed THC/nicotine use	OP pattern (97.5%)	Bilateral GGO ± consolidation; subpleural sparing lobular; peribronchovascular; septal thickening, lymphadenopathy; centrilobular nodules
Aberegg et al., (2020)	Single-center, n=31	Young adults; predominantly THC use	OP pattern (~89%)	Bilateral GGO with/without consolidation
Girvin & Naidich (2020)	Institutional case series, n=6	Adolescents/young adults; frequent THC use	OP pattern	Lower-lobe GGO/consolidation; subpleural and lobular sparing; bronchial wall and septal thickening; mild lymphadenopathy; small effusions; occasional centrilobular nodules
Choe et al., (2020)	ICU case series, n=4	Young adults; mixed THC/nicotine use	OP/ALI-pattern	Bilateral infiltrates
Artunduaga et al., (2020)	Pediatric center series, n=14	Adolescents (mean age 16); predominantly THC use	OP pattern (~50%)	GGO, consolidation; interlobular septal thickening; subpleural sparing; reversed halo sign

Bronchoscopy and Pathology

Owing to the lack of distinctive clinical signs and the resulting diagnostic uncertainty, some clinicians resorted to bronchoscopy in EVALI to evaluate alternative diagnoses. In the Aberegg et al., (2020) cohort study, 24 of 31 patients underwent bronchoscopy; endoscopic airway findings were nonspecific: bronchial mucosa commonly revealed diffuse erythema and edema with mucus plugging, and researchers did not identify any characteristic endobronchial lesions that could distinguish EVALI from other common

findings. Pathological examinations disclose changes comparable to lung injury. Butt et al., (2019) performed an analysis of 17 biopsies collected from patients with EVALI, which revealed the predominance of OP-like patterns. Moreover, diffuse alveolar damage, often with bronchiolocentric distribution, foamy macrophages, and pneumocyte vacuolization, was also observed. Crucially, the classic histologic picture of exogenous lipoid pneumonia is typically absent, reframing LLMs as supportive but nonspecific markers of exposure and injury. A U.S. multistate CDC series of 10 lung biopsies and 13 autopsies supported these injury patterns, and they identified additional pulmonary pathology not necessarily consistent with EVALI (e.g., bronchopneumonia, bronchoaspiration, and chronic lung disease) (Reagan-Steiner et al., 2020).

Bronchoalveolar-Lavage Fluid Analysis

Analysis of BAL fluid from patients with EVALI frequently reveals LLMs, likely indicating a cellular signature of aerosol exposure and alveolar injury. This finding differs from classic exogenous lipoid pneumonia, which may come to mind in the differential diagnosis due to partially overlapping histopathologic features and reported exposure to oil-based constituents in e-cigarettes/THC cartridges. In the Aberegg et al., (2020) cohort study, LLMs were present in approximately 90% of BAL specimens. During the 2019 outbreak in the U.S., De Jesús et al., (2020) analyzed BAL fluid samples from 51 EVALI and 99 non-EVALI cases employing gas chromatography-tandem mass spectrometry (GC-MS/MS) methods enabling high-sensitivity detection of terpenes - volatile, aroma-bearing hydrocarbons (e.g., monoterpenes such as limonene and linalool) commonly present in cannabis oils and used as flavorants in e-liquids - thereby broadening exposure screening. However, terpenes were not consistently identified in all cases, indicating that while these assays provided valuable insights for exposure assessment, they were not conclusive for diagnostic purposes.

As previously reported in the CDC report, VEA was present in 94% of BAL fluid samples collected from patients with EVALI and in none of the control specimens (Blount et al., 2020). Complementary physicochemical investigations revealed that under vaping-relevant temperatures, VEA can undergo pyrolysis to ketene, an acylating agent with high pulmonary toxicity. This conclusion is supported by atmospheric-pressure chemical ionization (APCI) mass spectrometry (MS) analyses. Moreover, Wu and O'Shea, (2020) also conducted a simulation of neat VEA vaping, during which they detected the release of harmful acetylation and additional volatile by-products, including benzene, propene, and 1,3-butadiene. In murine inhalation models, aerosolized VEA produced dose-dependent increases in albumin, leukocytes, accumulation of LLMs, multinucleated giant cells, and an increase in proinflammatory cytokines in BAL fluid samples. Researchers also observed that primary human type II epithelial cells may undergo changes in gene expression when exposed to VEA aerosol. Furthermore, there was a significant increase in chemokine secretion, and a sign of direct epithelial cytotoxicity (Matsumoto et al., 2020). Exposure to e-cigarette aerosol may also affect the biophysical properties of the alveoli. In another study, Graham et al. demonstrated that vaping may contribute to the deterioration of the surface-tension-reducing function of surfactant. Moreover, certain flavorants, such as menthol, can intensify this effect. These results therefore explain why the patients clinically present with alveolar instability and gas exchange disorders (Graham et al., 2022).

Due to the nonspecific clinical presentation, clinicians had to exclude an infectious etiology. Researchers conducted respiratory multiplex PCR panels and related microbiologic assays on BAL fluid and/or upper-airway specimens. Although these highly sensitive tests occasionally returned positive results, they were often deemed false positives or clinically noncontributory. Despite these signals, routine BAL fluid analysis rarely changed management in typical EVALI presentations; its role is chiefly exclusionary and is best reserved for atypical cases and differential diagnosis (Aberegg et al., 2020).

The diagnosis of EVALI can be very challenging for clinicians due to the lack of clear characteristics. Nevertheless, diagnosis should rely on a thorough history of exposure to e-cigarettes, including assessment of product types (THC, nicotine), cartridge sources (informal/commercial), and frequency of use. The overall assessment should also take into account the clinical picture with laboratory and imaging results (Navon et al., 2019).

Clinical Management

Many authors agree that clinical practice should include immediate cessation of vaping and symptomatic treatment, such as oxygen supplementation, antipyretics, and hydration. Additionally, clinicians may find it beneficial to administer empiric antimicrobials when there is uncertainty whether an infection can be excluded. Corticosteroids are commonly used after reasonable exclusion of contagion, reflecting the frequent organizing-pneumonia biology on imaging. Healthcare providers often observe clinical improvement; however, the lack of randomized trials necessitates individualized risk-benefit assessment (Layden et al., 2020). Observational cohorts reveal significant heterogeneity. In the Pittsburgh series (n=36), about 72% of patients received corticosteroid (with a median prednisone-

equivalent dosage of approximately 46mg/day for around 14 days); however, nearly one-third experienced improvement without steroid treatment. This result emphasizes the importance of thoughtful tapering strategies (Zou et al., 2020). Across the series mentioned by Lilley et al., clinicians most commonly initiated intravenous methylprednisolone 120-240 mg/day for 1-4 days, followed by oral prednisone 40-60 mg/day with a short taper (around 1-2 weeks); in more severe presentations, clinicians reported higher daily doses of methylprednisolone reaching up to 500 mg/day. Observational accounts describe rapid clinical and oxygenation improvement within approximately 24-72 hours after steroid initiation, with radiographic convalescence thereafter (Lilley et al., 2021). Taken together, these nonrandomized data do not provide head-to-head evidence favoring a specific corticosteroid; practitioners generally prescribe prednisone at a dosage of 40-60 mg/day (or intravenous methylprednisolone in an equivalent dose).

In more severe cases, with concomitant hypoxemic respiratory failure, patients may benefit from lung-protective ventilation such as this used in the treatment of acute respiratory distress syndrome (ARDS): low tidal volumes (4-6 mL/kg predicted body weight), plateau pressure ≤ 30 cm H_2O, driving pressure ≤ 15 cm H_2O where feasible, individualized positive end-expiratory pressure (PEEP) titration, conservative fluid management, and early prone positioning [e.g., 12-16h/ day when partial pressure of oxygen (PaO_2)/fraction of inspired oxygen (FiO_2) < 150) with consideration of short-course neuromuscular blockade (NMB) for ventilator synchrony. Inhaled pulmonary vasodilators may be used as rescue adjuncts. When refractory hypoxemia or injurious ventilatory pressures preclude adequate gas exchange despite optimized ARDS therapy, venovenous ECMO can facilitate ultra-protective tidal volumes and lung rest; case reports in EVALI describe successful cannulation, stabilization, followed by decannulation and hospital discharge when ECMO is instituted before multiorgan failure and after clinicians have attempted standard prerequisites (prone positioning/NMB/optimal PEEP) (Choe et al., 2020; Odish et al., 2020; Patterson et al., 2020). Since a significant number of rehospitalizations and deaths happen within days of discharge - especially in older patients with cardiopulmonary or metabolic comorbidities – it is essential to implement structured transition planning and follow-up within 48 hours (Mikosz et al., 2020).

Table 2. Post-EVALI Symptoms

Study (Year)	Design / Follow-up	Symptoms reported (post-EVALI)
Blagev et al., (2022)	Prospective cohort (n=64); 12 months	Exertional dyspnea/respiratory limitation; fatigue; cognitive complaints (concentration/memory); anxiety/depression; PTSD symptoms
Triantafyllou et al., (2021)	Retrospective cohort (n=41); 12 months	Persistent respiratory symptoms (e.g., dyspnea, cough); fatigue; anorexia; abdominal pain
Zhang et al., (2024)	Retrospective cohort (n=41); 36 months	Subset with ongoing respiratory complaints (details not uniformly quantified)

Outcomes and Survivorship

Short-term survival is generally favorable with contemporary supportive care. However, in CDC national analyses through January 7, 2020, fatal EVALI cases skewed older (median 51 vs 24 years in nonfatal cases) and had greater comorbidity burdens (cardiac/respiratory disease, mental health conditions). Notably, around 46-50% had an outpatient encounter before hospitalization or death, underscoring opportunities for earlier recognition and safety-netting (Werner et al., 2020). Long-term morbidity is also meaningful (Table 2): a prospective cohort study performed by Blagev et al., (2022) included a 12-month follow-up of 64 patients with EVALI (most did not require intensive-care-level care during the index admission). Nearly half of the survivors suffered from ongoing respiratory limitation at one year (around 48%). At the same time, substantial proportions endorsed cognitive difficulties (39%), anxiety/depression (59%), or post-traumatic stress disorder (PTSD) symptoms (63%). At the same time, only 38% of the patients achieved sustained abstinence from all smoking or vaping behaviors.

Complementing the prospective data, a 1-year retrospective series from the University of Pittsburgh Medical Center (n=41) revealed that around 50% reported persistent respiratory symptoms, but most became asymptomatic within the first year. Hospital readmission within 12 months occurred in 24.4% of cases, with the majority being due to respiratory diagnoses. Early post-discharge pulmonary

function tests (PFTs) were frequently abnormal [restrictive physiology/or reduced diffusion lung capacity for carbon monoxide (DLCO)], whereas imaging demonstrated substantial recovery by one year. All-cause 1-year mortality was low, but recurrent healthcare utilization remained nontrivial (Triantafyllou et al., 2021). Extending the horizon, a 3-year follow-up analysis (n=41) reported disproportionately high emergency-department (ED) service use up to 3 years after the index EVALI episode and an overall 3-year mortality of 7.3%, underscoring a sustained vulnerability and the need for structured survivorship care (pulmonary rehabilitation, programs to support e-smoking cessation, screening for cognitive impairment and mental health disorders) (Zhang et al., 2024).

Prevention methods

U.S. symptom-based monitoring showed vaping-related ED visits surging in mid-2019 and then falling by 88% by late November after targeted advisories and removal of implicated products - evidence that coordinated risk communication and enforcement can rapidly bend the curve (Hartnett et al., 2020). National outbreak updates characterized who was affected and how to target prevention: patients were predominantly male, <35 years, and most reported THC-containing product use - frequently from informal sources. At the state level, econometric analysis associated lower EVALI incidence with legal, regulated recreational-cannabis markets (Friedman and Morean, 2021). At the same time, Katchmar et al. had noted that in some states, information about the risks associated with e-smoking was insufficient. These observations underscore the need for harmonized, evidence-based messaging during product-linked outbreaks (Katchmar et al., 2022). Epidemiologic and analytic data indicate that measures aimed at disrupting illegal supplies of THC cartridges have led to a decline in the number of new cases. Continued regulatory oversight, the ability to trace products quickly, and effective communication of risks to adolescents and young adults are crucial for prevention (Moritz et al., 2019).

Food and Drug Administration's (FDA) youth e-cigarette prevention campaign "The Real Cost" (2023-2024) can be pointed to as an illustrative intervention that is estimated to have prevented around 444,252 U.S. adolescents from initiating e-cigarette use. The accompanying evaluation found that exposure to campaign advertisements (optimized for frequency and relevance to at-risk youth segments) lowered the likelihood that never-users would start vaping (MacMonegle et al., 2025). On the policy side, flavor restrictions have been associated with reductions in e-cigarette use (especially among young adults), albeit with signs of substitution toward cigarettes - highlighting the necessity of coupling flavor policies with comprehensive, multi-product tobacco-control strategies (Cheng et al., 2025). Pricing levers are complementary: e-cigarette excise taxes are passed mainly through to retail prices. They can dampen demand, particularly among youth, though tax design must account for unintended cross-product substitution (Cotti et al., 2022).

The reviewed evidence underscores the most crucial aspects concerning the epidemiology, clinical picture, therapeutic management, and prevention of EVALI (Table 3). Nevertheless, the literature remains sparse and mostly observational, with limited pediatric and pregnancy data, few standardized exposure metrics, no randomized trials of therapy, scarce biomarkers of exposure, and insufficient long-term (>3-year) outcomes beyond small cohorts. Prospective studies to define dose-response, validate diagnostic markers, compare therapeutic strategies, and map durable outcomes in diverse populations are still needed.

Table 3. Summary of Key Findings on EVALI

Category	Main Findings
Affected population	Predominantly adolescents and young adults with a history of THC-containing cartridges or electronic nicotine delivery systems use.
Clinical presentation	Combination of respiratory, gastrointestinal, and constitutional symptoms; subacute onset; variable severity.
Radiologic features	Bilateral ground-glass opacities with subpleural sparing; patterns consistent with organizing-pneumonia.
Histopathologic findings	Acute fibrinous pneumonitis and diffuse alveolar damage (DAD) with lipid-laden macrophages (LLMs).
Treatment	Early corticosteroid therapy; lung-protective ventilation or ECMO in severe cases.
Long-term outcomes	Persistent respiratory, cognitive, and mental health symptoms.

Prevention methods	Product regulation, risk communication, and cessation programs.
Limitations of the evidence	Predominantly observational data; limited pediatric and pregnancy studies; lack of standardized exposure metrics, biomarkers, and long-term (>3 years) follow-up; absence of randomized therapeutic trials.

4. CONCLUSION

EVALI is an acute lung injury linked to nicotine and THC vaping products. Clinical features remain nonspecific. The diagnosis should concentrate on detailed exposure history, compatible CT patterns, and exclusion of infectious or alternative causes. Management should be based on cessation of all types of vaping and implementing symptomatic treatment.

At the same time, patients may be treated with corticosteroids when an infection is excluded. In more severe cases, some people may benefit from intensive care treatments, such as invasive ventilation and ECMO. Most patients recover with appropriate hospital management; nevertheless, the persistence of long-term respiratory and neuropsychiatric symptoms in many survivors emphasizes the importance of avoidance. Prevention should rest on three pillars: surveillance and clear risk communication addressing e-smokers; supply-chain controls – disrupting informal THC markets, enforcing nicotine product standards, and widely available instruments, including digital tools and adolescent-focused programs to support smoking cessation. To improve the management of EVALI, further high-quality, prospective studies are essential to consolidate understanding of the pathogenesis, refine therapeutic approaches, and reduce disease burden in vulnerable populations.

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Informed consent

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Ethical approval

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Conflict of interest

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Data and materials availability

All data associated with this study will be available based on the reasonable request to corresponding author.

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