Dank or Disease? A Case of Vape Associated Pneumonitis in a 19-Year-Old Male

Jalla T Mustafa, DO, Amanda V Wright, DO, Jesse L Wolfe, OMSIII* and Anand Popuri, DO

Lake Erie College of Osteopathic Medicine, Millcreek Community Hospital, Erie PA, USA

*Corresponding author: Jesse Wolfe, Lake Erie College of Osteopathic Medicine, Millcreek Community Hospital, 4505 Washington Ave, Erie PA 16509, USA, Tel: 4846958616

Abstract
A 19 y/o male with no significant past medical history presented to the hospital in acute respiratory distress with SOB, dyspnea, chills, cough productive of green sputum, nausea and vomiting refractory to low dose steroids and broad spectrum antibiotics. Patient had no other significant history except for 2 years of vaping, including more recently the use of a THC-infused cartridge preceding the onset of his symptoms. Prior imaging was negative but now chest CT showed extensive bilateral ground glass, interstitial, alveolar infiltrates, confluent in the lower lung zones with resultant air bronchograms and chest x-ray showed bilateral diffuse opacities, with sparing of the apices. Vape induced pneumonitis was deemed a diagnosis of exclusion as patient had reported use of e-cigarettes within ninety days of presentation and bilateral opacifications on imaging with infectious, viral and autoimmune etiologies ruled out.

Case Presentation
A 19-year-old male with no significant past medical history presented to the emergency department with stable vital signs, cough, and slight pain with deep breaths. Initial two-view x-ray showed no acute cardiopulmonary process. He was discharged home with antibiotics, low dose oral steroid taper and albuterol inhaler for treatment of bronchitis vs. community acquired pneumonia with no relief. The patient returned to the emergency department five days later in severe respiratory distress with oxygen saturation of 37% on room air. He failed oxygen supplementation with low flow nasal cannula and non rebreather so was admitted to the Intensive Care Unit (ICU) for the management of acute hypoxic respiratory failure requiring humidified high flow oxygen at 40 L and 100% FiO2 with improvement of oxygen saturation to 90%. He was diagnosed with vape associated pneumonitis due to a two month history of vaping Tetrahydrocannabinol (THc) e-cigarettes, negative infectious and viral workup, and chest radiograph showing diffuse bilateral opacifications. On admission the patient appeared to be clammy,.. It has been speculated that Vitamin E acetate is an ingredient in vapes at the root cause of lung injury likely causing direct injury from a toxin exposure as well as a hypersensitivity reaction, but it is likely multiple ingredients are causing acute and subacute lung injuries. Other suspected components found in e-cigarettes include aldehydes, heavy metals and volatile organic compounds, which may also contribute to direct injury to lung epithelia.

Introduction
When the first cases of vape induced lung injuries were reported it was unclear if the illnesses were secondary to e-cigarette fluids contaminated with bacteria resulting in an infectious process or lung injury caused by heat and or toxin exposure [1]. Many of the first reported cases of lung injury in e-cigarette users were heat related secondary to device malfunctions.

As vaping has become more popular with a wide range of products now on the market most of which are not FDA approved, other potential mechanisms of injury are arising with reported e-cigarette associated acute respiratory distress syndrome, idiopathic acute eosinophilic pneumonia, alveolar hemorrhage, and lipid laden macrophages amongst other findings though pathophysiologic significance of this is not yet known [2].
pale and in severe respiratory distress. Reported symptoms included significant malaise, decreased appetite, fatigue, dyspnea and cough productive of thick, blood-tinged sputum. He was afebrile, had a heart rate of 113 beats/min, blood pressure of 118/68 mmHg, respiratory rate of 50 breaths/min and an oxygen saturation of 37% on room air. Breaths were shallow and labored. Wheezing was appreciated on auscultation with poor inspiratory depth. He was able to communicate in only one or two word sentences. His cardiac exam showed tachycardia to auscultation. His abdominal exam yielded normal active bowel sounds in all four quadrants, with no tenderness to palpation or rebound tenderness. There were no skin lesions and no external signs of trauma.

Complete blood count revealed a white blood cell count of 30.8 TH/μL (predominantly neutrophilic at 95.4% with a 29.4 TH/μL count). A complete metabolic panel revealed elevated carbon dioxide levels at 34 mmOL/L. Lactic acid levels were 1.4 mmol/L with a procalcitonin of 0.56 ng/ml. High sensitivity C-reactive protein levels were 225.6 mg/L. An arterial blood gas analysis showed a pH of 7.47, pCO₂ of 45.2 mmHg, pO₂

Figure 1: A) AP chest radiograph taken three days prior to presentation showing no obvious acute cardiopulmonary process; B) AP chest radiograph taken day of presentation showing diffuse patchy opacities and blunting of bilateral diaphragms with sparing of the apices; C) AP chest radiograph taken day of discharge with bilateral infiltrates, left greater than right, but with improved air space component compared to prior.

Figure 2: THC vaping devices used by the patient including the chambers that held the THC (bottom) as well as the cartridges for the NJOY device (top).
of 54.0 mmHg and a HCO$_3^-$ of 32.7 mmol/L. Sputum and blood cultures were negative for growth of any organism. Nasopharyngeal swab for influenza A/B, urine Legionella and S. Pneumoniae antigen tests, as well as HIV panel all came back negative. Both rheumatoid factor and anti-nuclear antibody screening came back negative. Drug toxicology was positive for THC only. Chest x-ray showed bilateral opacities as described in Figure 1B. CT Angiogram (CTA) chest was then performed for further evaluation which showed the extent of his lung injury as described in Figure 3.

Humidified high flow oxygen was employed because it provided theoretical PEEP for alveolar recruitment, and allowed the patient to improve without use of mechanical intubation. High dose IV methylprednisone was used due to the similarities seen on imaging with hypersensitivity pneumonitis. Steroids were tapered as patient’s respiratory status improved and was theorized to be the most influential factor in his improvement. Due to superimposed infiltrates on CT, an elevated procalcitonin and sputum production, broad spectrum antibiotic coverage was employed. Our patient was started on Ceftriaxone and Doxycycline, with Vancomycin added to cover MRSA and superimposed bacterial pneumonias as our patient had a recent history of antibiotic use. Nebulized bronchodilators were utilized for bronchospasm and wheezing; and aided the patient in breathing. Multiple agents for secretion clearance including an aca-pella valve, chest percussion and inhaled cough assistance were utilized as the patient had compromised the ability to clear secretions on his own. Chest CT two days prior to discharge shown in Figure 4 showing significant improvement. He was able to be discharged once oxygen needs were titrated to 2 L of oxygen via nasal cannula with close follow up.

**Discussion**

Vape induced pneumonitis was deemed a diagnosis of exclusion as patient had reported use of e-cigarettes within ninety days of presentation and bilateral opacifications on imaging with infectious, viral and autoim-
Vaping induced lung injuries require a diagnosis of exclusion due to the variety of reported illnesses and radiologic findings. Symptoms at patient presentation have included cough, shortness of breath, chest pain, nausea, vomiting, diarrhea, weight loss, and fatigue with disease onset ranging from mild, subacute illnesses treated in an outpatient setting with just a course of systemic glucocorticoids to severe, acute illnesses requiring mechanical ventilation [4]. The majority of cases have been reported in males with a median age of 19 [5]. Most have had no significant past medical history, though around 30% of patients did report past medical history of asthma [6].

A specific brand of products nor a potentially shared ingredient amongst products has been identified, though patients are reporting the use of THC infused e-cigarettes. One report of 53 cases recently published in the New England Journal of Medicine found that 94% of the patients required hospitalization and 32% of those patients required mechanical ventilation. THC containing vaping products were reported to have been used in 84% of the patients [6]. A common brand that has been prevalent in other case reports was the Dank Vapes ™ brand of THC vapes, which was also reported to be used exclusively by the patient in this case study. However, at the time of writing, we can neither confirm nor deny any specific brand to be the cause of disease.

Chest radiograph was negative at initial presentation, but five days later showed diffuse bilateral opacities and blunting of bilateral diaphragms with sparing of the apices suggestive of pneumonitis with possible superimposed infection. This initial misdiagnosis with rapid decompensation is a common presentation of those with vaping induced lung injury, suggesting that anyone with a history of vaping, particularly in those with history of vaping THC products, reporting respiratory complaints though mild might need a CT chest for further evaluation.

A CTA chest was ordered for further evaluation which was negative for acute pulmonary embolism with induced hypoxia and infarcts, but did show findings suggestive of an inflammatory pneumonitis with superimposed infection. CTA finding of traction bronchiectasis, a pathognomonic finding of lung fibrosis was concerning for possible irreversible disease. This would explain why the patient had difficulty clearing secretions with improvement of symptoms after initiating high frequency chest wall oscillation therapy. Whether or not patients with vaping induced lung injury will have chronic lung disease is still unknown.

A predominant radiologic finding of those presenting with presumed vaping induced lung injury is bilateral opacities in the lung bases, but a well described constellation of radiologic findings diagnostic of vaping induced lung injury has not yet been described. There have been a wide variety of lung findings reported including pneumomediastinum, pleural effusions, and pneumothorax, which make initial diagnosis difficult [7].

The pathophysiology behind vaping induced lung injuries is unclear, but likely multifactorial. With smoke inhalation injuries seen in burn victims, lung injuries are varied and can include upper airway injuries caused from excessive heat exposure, lower airway injuries resulting from toxin exposure, or a systemic response resulting in acute respiratory distress syndrome [8]. Pathologic findings with vaping induced lung injuries have also been varied with no specific histologic findings.

Fiberoptic bronchoscopy can be used to not only diagnosis and grade lung inhalation injuries, but also to gain more insight into the mechanism of lung injury. A bronchoscopy was avoided in this patient as it was felt the patient was too critically ill to tolerate with evidence based medicine showing patients with suspected inhalation injuries to be at an increased risk for developing pneumonia and to have an increased risk of mortality [9]. Performing a bronchoscopy should therefore be made on a case by case basis.

Conclusion

This case sheds light on a constellation of physical exam, laboratory, radiologic, and pathologic findings present in these patients, but the CDC has yet to report a specific cause of these lung injuries or to identify a specific e-cigarette or vaping product linked to all or a majority of cases. It is speculated that Vitamin E acetate is an ingredient in vapes at the root cause of lung injury. As such, recommendations or guidelines for treatment and supportive care have yet to emerge with expert opinions, discussions, and retrospective analysis needed to better care for future patients not only in an acute inpatient setting, but also in the outpatient setting. These patients will inevitably require hospital follow up, but also long term management to include possible supplemental oxygen, steroid tapers, repeat imaging, and pulmonary function testing. Whether or not these patients will have permanent lung damage is unknown.

Due to lack of literature on this disease, broad treatment was initiated. Antibiotics were used for empiric coverage; and steroids were used to help reduce inflammation. VapoTherm ™ high flow nasal cannula was used in lieu of intubation as patient was tolerating it well, and we believed that intubation was not clinically indicated during treatment. Duoneb treatment was used scheduled and PRN and seemed to help our patient ease some shortness of breath. We believe that the most influential treatment in the healing of this patient was the Solu Medrol 80 mg Q8H. Patient responded well to the IV steroid treatment, and we believe that it was the
steroids that helped push the patient towards regaining lung function.

Acknowledgements

Financial/Nonfinancial Disclosures: None.

Contributions

Jalla Mustafa helped write the discussion and case presentation. Amanda Wright helped write the discussion, conclusion, and do the resources section. Jesse Wolfe helped write the introduction, case presentation and put together images. Anand Popuri helped with describing the images, providing edits and was the doctor in charge of patients care.

References