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Case Report

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Pulmonary Illness in Two Adolescents with a History of Vaping

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Abstract

The use of electronic nicotine delivery systems (ENDS, e-cigarette) has increased dramatically since their first introduction. Although advertised as a safer option than conventional cigarette smoking and oftentimes displayed as an acceptable method to aid in the process of smoking cessation, vaping is a relatively new fashion hence median and long term impact on health cannot be determined until further studies have been carried out. We report two adolescents who presented with pulmonary manifestations, both of them with a significant history of vaping.

Keywords: ENDS; e-cigarettes; Pediatrics; Vaping

Introduction

Although the adverse effects of cigarette smoking on health have been well established and significant progress has been made in the diagnosis and treatment of diseases related to it, smoking continues to be a burden in public health, being a global risk factor for leading causes of death such as, ischemic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease, lung cancer among others. Evidence has shown that successful nicotine addiction treatment regardless of the age of cessation will have a positive impact on mortality [1].

The use of electronic nicotine delivery systems (ENDS) has shown a rapid increase since their introduction in 2004, with a broad range of users from adolescents to adult individuals; being marketed as a healthier option for conventional smoking [1,2]. ENDS consists of a power source, an electronic heating element and a liquid nicotine cartridge or tank which contains a stabilizing compound such as propylene glycol or vegetable glycerin, variable amounts of nicotine and flavoring additives (e-liquid/ e-juice). When started by users, activation of the heating element causes atomization of the liquid and subsequently the production of

aerosolized nicotine, which will be inhaled into the lungs leading ultimately to nicotine absorption. Although nicotine and potentially harmful toxin levels present in ENDS have been proved to be less than those found in conventional cigarettes, concerns regarding potential adverse effects remain [1,3,4].

With a vast number of brands and flavors, making it appealing for new and existent consumers, a large portion of ENDS are sold through the internet causing difficulty in implementing regulations regarding their sales [5].

Case Presentations

Case A: Case (4) is a 16-year-old female with a PMH significant for asthma who presented to the ER due to sudden shortness of breath and wheezing for the past 24 hours despite bronchodilator use. She had a history of recent admission to the pediatric ICU. The patient was treated in the ER with magnesium sulfate 2 g, Solu-Medrol 125 mg, and nebulized albuterol. Due to the persistence of symptoms she was transferred to a Pediatric facility for readmission. She received routine asthma therapies. However, had a prolonged course and took nearly a week to wean. Her chest x-ray showed only increased interstitial markings. On review of history, she stated that she did not mention earlier that she had a

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habit of vaping. This would occur for approximately 20 minutes per day for the past 6 months. Upon outpatient follow-up, her spirometry suggested restriction with a FVC of 76%pred, a FEV1 of 78%pred, and a FEV1/FVC of 88%. Exhaled nitric oxide was 12 PPB showing no significant airways inflammation.

Case B: Case (B) is a 15-year-old male with no significant PMH admitted due to vomiting for 3 days. He also presented fever, LUQ abdominal pain and increasing shortness of breath. The patient had been seen in the ER 3 days before diagnosed with pneumonia and started on Azithromycin and Amoxicillin. The patient had a history of recent international travel, during which he developed vomiting and diarrhea for 1 week and again for four days upon his return to the United States. There was also a history of weight loss (20 lbs.) in the last two months.

Social history was relevant for daily marijuana vaping during the past year and occasional alcohol ingestion. He was started on Zofran, Reglan, gabapentin, Benadryl, and Pepcid; however, nausea persisted for some days. Laboratory workup revealed leukocytosis, hyperbilirubinemia, and elevated liver enzymes. Quantiferon was negative.

A gallbladder ultrasound displayed mild wall thickening. Due to the history of recent significant weight loss, the patient was tested for HIV, GC/chlamydia, syphilis; hepatitis viral panel and serial sputum AFB were also performed, all of which came back negative.

A CXR showed bilateral pneumonia and he was started on IV ceftriaxone, azithromycin and IV fluids. Azithromycin was later discontinued due to persistent vomiting and medication side effect concerns. He received nebulized Xopenex, Mucomyst, and O2 through a nasal cannula to treat shortness of breath. A CT of the abdomen and pelvic region were both normal and chest CT showed only bilateral pneumonia, same as the CXR.

Over the second day of hospital stay the patient exhibited increasing shortness of breath and tachypnea requiring high flow nasal cannula which was later escalated to BIPAP and being transferred to the ICU where he remained for three days. Ceftriaxone was switched to Zosyn and vancomycin for broader coverage.

On the seventh day of hospital stay, a bronchoscopy was performed and lavage fluid was sent for cytology, Pneumocystis, gram stain and cultures, fungal cultures and acid-fast smear and cultures; all of which were negative. The vomiting, abdominal pain and shortness of breath resolved and the patient remained afebrile and started tolerating PO intake. A decrease in WBC and liver enzymes were also observed. He was transitioned to oral antibiotics (Augmentin and Doxycycline). The patient was discharged after ten days of hospital stay and scheduled for follow up with gastroenterology and pulmonology services. He was doing much better. His FVC was 90%pred. His FEV1 was 103%pred. His FEV1/FVC ratio was 85%. His exhaled nitric oxide was 16 PPB showing no significant airways inflammation.

Discussion

There are more than 7000 compounds in cigarette smoke, being at least 70 of them known carcinogens, and while the inhalation of ENDS aerosols is considered less harmful than exposure to conventional cigarette smoking, recent studies have demonstrated the presence of nanoscale particles that may reach the alveolar epithelium having a role in the mediation of oxidative stress and inflammation, both of which are crucial for the development of chronic airways disease. Furthermore, varying detectable levels of metals with toxic materials such as aluminum, copper, manganese, zinc, lead, chromium, magnesium and nickel have been proved to be present in ENDS aerosols [1,6].

The varied presentations of ENDS with different and unique characteristics like the type of nicotine solvent, flavorings and battery voltage from one device to another allow them to produce different chemical actions while operated. Typically the level of nicotine in a smoked conventional cigarette ranges from 1.54 – 2.60 mg; on the other hand the levels of nicotine in ENDS have shown a wide variation going from 0.5 – 15.4 mg in 15 puffs; consequently the thought of ENDS as a safer alternative to nicotine replacement therapy should be taken into reconsideration [1,7,8].

When a user of an ENDS inhales, activation of the heating element occurs, vaporizing the e-liquid. This vaporization process occurs at various temperature ranges that may reach up to 350°C. At this temperature, it is possible to induce physical changes of the e-liquid and chemical reactions between its components such as thermal decomposition of solvents resulting in the emergence of compounds with likely toxic properties. It has been demonstrated that both, vegetable glycerin and propylene glycol decompose at high temperatures giving rise to toxic low molecular weight compounds such as acetaldehyde, acrolein, and acetone. Acetaldehyde is classified as possibly carcinogenic to humans (Group 2B), acrolein irritates the nasal cavity, it damages the lining of the lung and can contribute to cardiovascular disease; acetone is a mucous membrane irritant known to induce damage on olfactory neuroepithelium in mice after inhalation [8].

In the majority of murine in vivo and in vitro studies following exposure to ENDS vapor or e-liquid, some type of biological response has been observed [9]. Recently it has been demonstrated that the aerosol produced by ENDS would have a dose-dependent inhibitory effect over the CFTR (cystic fibrosis transmembrane regulator) in airways epithelial cells, affecting chloride anion transport hence causing impairment in mucociliary transport and clearance. Additionally ENDS decrease the response from airways epithelial cells to viral infections, increase inflammation and enhance pneumococcal adherence, although the exact mechanisms through which they carry out these reactions have not been yet elucidated [6,10].

Another aspect to take into consideration is the effect of the aerosol produced by ENDS on bystanders. While the main effects of ENDS passive exposure are relatively mild; irritation to

the upper respiratory tract and eyes as well as systemic effects of nicotine such as increased systolic blood pressure and heart rate, the presence of significant amounts of TSNA (tobacco-specific nitrosamines) has been found in a limited number of e-liquids, thus an increased risk for tumors could not be excluded either for users or bystanders [11].

Conclusion

In summary, although toxin levels in ENDS may be lower than those in conventional cigarettes there is not enough evidence to portray them as safe devices. More studies are required to have a better understanding of the hazards related to ENDS use.

Ethical statement

I testify on behalf of all co-authors that our case report, Pulmonary Illness in Two Adolescents with a history of Vaping has not been published in whole or in part elsewhere and not currently being considered for publication in another journal. All authors have been personally and actively involved in substantive work leading to the manuscript, and will hold themselves jointly and individually responsible for its content.

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