Cardiology in the Young

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Pre-existing pulmonary arterial hypertension decompensation associated with e-cigarettes in an adolescent

James Andrew Bishara and Patrick Evers

Oregon Health and Science University, Doernbecher Children's Hospital, Department of Pediatrics, Division of Pediatric Cardiology, Portland, OR, USA

Case Report

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Corresponding author:
James Andrew Bishara;
Email: bishara@ohsu.edu

Abstract

An adolescent girl with a long-standing history of pulmonary arterial hypertension experienced severe clinical decompensation after starting to use e-cigarettes. A combination of e-cigarette cessation, atrial septostomy, increasing treprostinil, and initiation of sotatercept led to clinical improvement. Her new baseline was improved over her pre-e-cigarette baseline.

Case

The patient is an adolescent with idiopathic pulmonary arterial hypertension (PAH). She was diagnosed with pulmonary hypertension (PH) at 5 years of age after an exertional syncopal event. Cardiac catheterisation at that time confirmed severe PAH. A chest CT at that time was normal. Genetic assessment revealed a variant of uncertain significance in the FOXF1 gene, but no pathogenic mutations have been identified in the years to follow on repeat testing. Subcutaneous (SQ) treprostinil and sildenafil were initiated with a slight improvement in disease severity by cardiac catheterisation a year later and marked improvement in functional class, returning to functional class I without limitations. In the following years, SQ treprostinil was uptitrated, transitioned from sildenafil to tadalafil at 7 years, and ambrisentan was added at 9 years of age. Serial cardiac catheterizations illustrated stable severe PAH at age 6, age 7, age 8, age 9, and age 11. At age 14 years, a cardiac MRI assessment revealed a normal cardiac index, 6-minute walk tests were stable, NT-proBNP biomarker assay was normal, and echocardiograms were stable, illustrating subsystemic but severe PH.

However, around the time the patient turned 15 years of age, there was an acute worsening of disease severity, as evidenced by the NT-proBNP rising to 515 pg/mL, and an increase in tricuspid regurgitation velocity by ~ 20 mmHg along with an interventricular septal position indicating isosystemic right ventricular pressure estimates. The patient also endorsed new exertional presyncope and shortness of breath with activities as limited as running across a parking lot. At this time, she endorsed the adoption of daily e-cigarette use in the months prior with a nicotine equivalent of 2 packs per day; there were no other identifiable changes in her exposures. Counselling on the importance of e-cigarette cessation by the treatment team and parents was unsuccessful, as well as offering nicotine replacement therapy. In the setting of continued daily vaping, follow-up over the following months illustrated declining 6-minute walk test distance, worsening right ventricular pressure to suprasystemic, new severely diminished right ventricular function, new pericardial effusion, rise in NT-proBNP value to 5,090 pg/mL, hypotension, resting tachycardia, and continued exertional presyncope.

Admission thereafter to the paediatric ICU was remarkable for atrial septostomy, uptitration on treprostinil, initiation of sotatercept off-label, and inpatient e-cigarette cessation. A month after this, she illustrated improvement across multiple vectors with right ventricular pressure lessening to isosystemic, right ventricular function improving to moderately diminished, resolved pericardial effusion, normalised vital signs, and no further exertional symptoms.

Within 6 months following her hospitalisation and the cessation of e-cigarettes, she had improved further with her right ventricular function improving to normal, her right ventricular systolic pressure estimate was less than half-systemic (mildly elevated), her functional class had improved to NYHA functional class 1, and the NT-proBNP had down trended to normal (51 pg/mL) (Figure 1).

Discussion

Our case describes the acute clinical decompensation in a patient with baseline severe PAH temporally associated with the initiation of e-cigarette use without other factors to explain the clinical decline. In addition, the patient showed rapid clinical improvement with the cessation of

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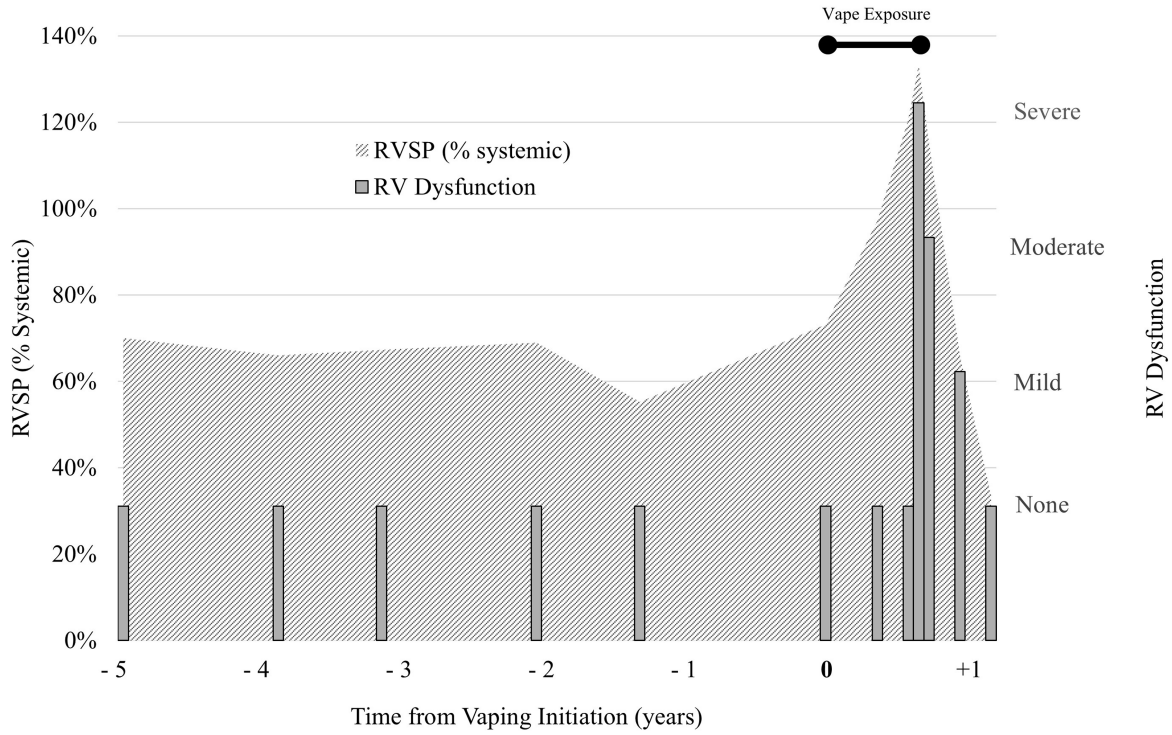


Figure 1. Timeline of patient right ventricular systolic pressure and magnitude of dysfunction. (--) indicates the time vaping was initiated. (-) indicates the time vaping was stopped. RVSP = right ventricular systolic pressure; RV = right ventricle.

vaping. However, this could have resulted from multiple simultaneous interventions, including adjustments in PH management and atrial septostomy. These factors likely contributed to varying extents to the observed clinical recovery.

E-cigarettes, often marketed as a safer alternative to traditional combustible tobacco products, have contributed to a misperception that their use poses minimal health risks.[1] A growing body of evidence suggests otherwise.

There is limited evidence on the impact of e-cigarettes and PH. Two mouse models propose a link between e-cigarette vapours and changes in pulmonary vasculature that may lead to PH.[2,3] A case report describes a young woman who was using e-cigarettes at the time of her PH diagnosis and temporarily stopped e-cigarettes before continuing to secretly use them as an inpatient after initiation of PH therapy. In contrast to our case, she developed an EVALI with diffuse alveolar haemorrhage with decompensation of her PH and right ventricular function, passing away from complications of her disease.[4] We are unaware of reports of worsening PH associated with e-cigarettes without EVALI or another substantial acute lung injury.

Many potential mechanisms may be responsible for changes in cardiopulmonary health in e-cigarette users. The aerosolized components of e-cigarette vapour, including propylene glycol, vegetable glycerine, flavouring agents, metallic nanoparticles released from heating elements, and various chemical byproducts generated during e-liquid heating, have been shown to exert harmful effects on health[5] with an eosinophil and inflammatory mediated direct injury to the lung parenchyma resulting in a vape-induced pneumonitis.[6] Additionally, e-cigarettes may worsen pre-existing respiratory conditions such as bronchitis, with studies indicating exacerbated asthma in adolescents[7] and the development of chronic bronchitis, asthma, and emphysema in adults.[8]

Formaldehyde, a byproduct of heating the most commonly used carrier fluids, propylene glycol, and vegetable glycerine, can cause endothelial dysfunction.[9] It is also a carcinogen and is known to cause asthma and bronchitis in children.[10]

We suspect that one or more disruptions to cardiac and pulmonary function from e-cigarettes were the primary trigger for the decline in clinical status and that cessation from inhaled nicotine products was a contributing force for clinical improvement.

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Competing interests. None reported.

Ethical standard. This project was granted approval by our institution's Institutional Review Board.

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