Electronic Cigarettes: A Burn Case Series
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ABSTRACT
This case series describes injuries and the associated morbidity resulting from electronic cigarette (e-cigarette) use. E-cigarette use is a popular and dangerous fad. A single institution case series is reviewed. Literature from 2011 to 2016 was identified from the following databases: (a) Cumulative Index to Nursing and Allied Health Literature; (b) Medline; and (c) the Cochrane Library. Nurse practitioners should provide patient-centered information describing the hazards of using e-cigarette. The cases described detail the morbidity associated with e-cigarette use. The Health Belief Model serves as a guide for education.

Keywords: burn, cigarette, debridement, electronic, graft, Health Belief Model
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INTRODUCTION
Electronic cigarettes (e-cigarettes) provide an alternative to traditional cigarette smoking, assuming a wide variety forms and offering battery-powered nicotine delivery systems that have gained increasing popularity since their arrival in the United States market in 2007. These devices are widely advertised as a safe, even desirable, choice for smoking cessation. However, recent statistics reveal that the majority of e-cigarette users continue to smoke cigarettes, with no intention of quitting. Equally concerning is the steady increase in e-cigarette use among tobacco-naive adolescents and young adults. Emerging research has documented known hazards associated with e-cigarette use that include: thermal/chemical burn injuries, traumatic injuries to the teeth and eyes, nicotine toxicity, carcinogen exposure, pulmonary toxicity, and risks from second-hand exposure. Unfortunately, the literature is contradictory and findings are inconsistent, making establishment of definitive warnings and more restrictive regulations difficult to establish.

BACKGROUND
The World Health Organization attributes over 5 million deaths each year to tobacco use. With greater than 1 billion smokers worldwide, tobacco use remains a major cause of preventable death. In light of these devastating statistics, efforts to identify effective methods for smoking cessation is an international health care priority. Despite the well-documented benefits of smoking cessation, only 3%-5% of smokers successfully abstain for 6 months or more. Many products have been marketed over the years to assist with cessation efforts. E-cigarettes were introduced as a nicotine-free smoking alternative using a device that was not initially restricted in any way from public use. The realistic smoking experience made e-cigarettes a desirable and, reportedly, safe alternative.

The first e-cigarette was developed in 2003 by Hon Lik, a Chinese pharmacist. It was not until 2007 that e-cigarettes made their way into the US marketplace. The basic e-cigarette device consists of a battery unit, rechargeable lithium batteries, and a heating coil or atomizer. The heating component warms liquid containing flavors, nicotine, propylene glycol, and glycerin (for the vapor). The devices can be activated by inhaling or by pressing an ignition switch. Disposable, closed, and open system modular designs are common, in addition to the customizable box style.

Of the more than 10 million reported e-cigarette users around the world, most are former or current tobacco cigarette smokers. Use of the device requires the “hand-to-mouth” motion that is second nature to traditional smokers. In fact, e-cigarette use...
closely mimics many smoking behaviors, such as holding, puffing, and creating a smoky vapor.6 Equally appealing to users appears to be the perceived social acceptance of device use.10,11

Detailing all reported and speculated hazards associated with e-cigarette use is beyond the scope of this article. Emerging literature supports that inhalation of these toxins leads to significant morbidity.9,12,13 The following is a brief description of the harmful byproducts produced by use of the device and the resultant illness. First, the vapor smoke produced includes numerous noxious components. Williams et al studied the particulates present in e-cigarette fluid and aerosol and found that the mechanism’s design is responsible for much of the metal and silicate pollutants produced. Tin particles in the prefilled vapor cartomizers have escaped from solder joints during testing and have been shown to be cytotoxic.9 Iron, lead, nickel, chromium, and silver are also present in the vapor, originating from the wires. Of these, lead, nickel, and chromium are included on the US Food and Drug Administration’s “harmful and potentially harmful list.”14 In their systematic review, Hua and Talbot reported that respiratory compromise after e-cigarette encompasses a broad spectrum of debilitating symptoms and illnesses including: shortness of breath, cough, bronchiolitis, and pneumonia.12,13

While the harmful effects of nicotine are well established, the use of e-cigarettes as a nicotine delivery system has given rise to many new safety concerns. Benowitz and Burbank concluded that the nicotine in e-cigarettes is potentially harmful to patients with cardiovascular disease.15 Indeed, it is not surprising that early data indicate a correlation exists between e-cigarette use and the development of atherosclerosis and symptoms consistent with cardiovascular disease in otherwise healthy individuals.16 Although it is generally known that nicotine is a dangerously potent stimulant, the lack of appreciation for the potential threat posed by e-cigarette paraphernalia has left our most vulnerable populations at risk. In 2013, the number of calls to the US Centers for Disease Control and Prevention to report accidental ingestion by young children had risen dramatically, with this frightening trend expected to continue.17 Adolescents and young adults are particularly vulnerable to the extensive advertising funded by e-cigarette manufacturers and the tobacco industry, especially through social media and elsewhere on the internet, leaving them at risk of becoming addicted to nicotine at an early age.18,19

The purpose of this case series report is to highlight yet another in the growing list of hazards resulting from e-cigarette use. The volatility of the device and the lithium batteries have been the cause of an unquantified number of serious burn and traumatic injuries. In fact, this “new” mechanism for burn injuries is being reported in the literature worldwide, yet little is known about the overall detrimental impact of using these devices.20-24 This case series adds to the experience of a single center, highlighting not only the physical impact but also the financial and social impact related to time away from work and the expenses associated with extended hospitalizations and surgical procedures.

RESULTS

Thermal Injuries: Case Series

A retrospective review of medical records was conducted to identify the reported occurrence of burn injuries attributed to use of e-cigarettes in adult patients admitted to a single burn center from December 1, 2015 to October 31, 2016. There were 219 inpatient burn admissions during this period. Our single center case series identified 10 adult patients, all male, between age 20 and 47 years old. The total body surface areas of the burn injuries ranged from 0.5% to 15.6%, with a mean of 4.2%. The average hospital length of stay for treatment of e-cigarette related injuries was 4.9 days. Location of injuries included face, fingers, hands, wrists, forearms, upper arms, thighs, knees, lower legs, feet, and buttocks. The thigh and ipsilateral fingers were the most common sites of injuries and skin grafts were required by 80% of the patients. Two patients were initially evaluated for their injuries in our outpatient burn clinic. Five patients were transferred to our facility for treatment. One patient left after evaluation and debridement in the emergency department. Initial management for patients included nonsurgical debridement with soap and water. After reviewing work by Nicoll et al, our process was modified to include initial