

Research Article

Nicotine Liquid as a Potential Poison: Surveying Providers on the Risks of a Dangerous New Trend

Gwen Levitt, DO, DFAPA

Department of Psychiatry, District Medical Group, Phoenix AZ, USA

Maya Heck, MD

Department of Psychiatry, Maricopa Integrated Health System, Phoenix AZ, USA

Introduction

Electronic Cigarettes (EC) and the related products are a two-billion-dollar industry [1] and EC has been gaining in popularity over the last few years. A Center for Disease Control study conducted in 2014 [2] reported that 12.6% of adults have tried EC and 3.7% of those who have used EC, smoke almost every day. A study in New Zealand [3] found that most EC users had been smoking an average of 120 puffs per day, refilling the electronic nicotine delivery system (ENDS) an average of five times a day, and spending \$33 a month on electronic nicotine liquids (EL). As of 2014, [1] there were over 450 brands of ENDS and greater than 7700 flavors of EL on the market.

There are many reasons EC users cite for having opted to utilize this form of nicotine delivery. The novelty of a new product is enticing in this age of technology especially one that is electronic. Users believe that EC are less costly in the long-term after the initial investment in the ENDS. Manufacturers of the products promote EC as being less dangerous to one's health both directly and in relation to second-hand smoke. They also claim that EC will help a traditional cigarette smoker to quit tobacco products completely. Users feel that they can smoke in a wider variety of venues, despite many regulations for non-smoking areas including EC in this ban. Users tend to carry an odor identifying them as a cigarette smoker.

However, there may be health risks associated with use of EC. EL contain propylene, glycerine, flavors, nicotine, water and ethanol. The flavors are comprised of aldehydes that are reported to be safe by the Flavor Extract Manufacturer's Association as "food grade;" meant to be ingested not inhaled (Tierney). Vanillin is a common EL flavor ingredient and has been shown to be cytotoxic to human fibroblasts, embryonic stem cells and mouse neural stem cells [4].

EC vapor contains nicotine, particulate matter, glycerine, propylene glycol, formaldehyde, acetaldehyde, polycyclic aromatic hydrocarbons, and metals such as lead, cadmium and nickel. Polycyclic aromatic hydrocarbons are known carcinogens [5]. Aldehydes are considered primary irritants of the mucosal tissue and respiratory tract. Propylene glycol is

considered safe but is also a known irritant of the respiratory tract. Acetaldehyde has been shown to increase respiratory flow, peripheral resistance and oxidative stress, and decrease vasodilation and alter vascular function [5]. Cadmium can cause organ damage, and nickel causes lung inflammation. The level of voltage used in the ENDS also impacts potential toxicity; higher voltage releases more chemicals. Lastly, EL contains nicotine. EL is sold in vials of five to 30 ml, or in bottles of up to 120 ml. A 30 ml vial contains up to 36 mg of nicotine per ml. There are no quality standards for the manufacture of the EL.

At low doses, nicotine induces the central and peripheral nervous system by binding to acetylcholine receptors causing stimulation and arousal as well as increased heart rate and blood pressure. At higher doses of nicotine there is autonomic ganglion blockade which leads to seizures, bradycardia, hypotension, and mental depression. There is also a cholinergic reaction that can cause fasciculation, nausea, vomiting, salivation, dizziness, headaches, vision and hearing changes. There can be rapid onset of respiratory failure and cardiovascular collapse.

The standard amount of nicotine thought to be toxic was 30 to 60 mg; the equivalent of five conventional cigarettes or 10 ml of EL [6]. Currently it is believed that 500 mg of oral nicotine is lethal to an adult [7] and 70 mg would be fatal for a 10 kg toddler. Nicotine toxicity has a similar if not a higher risk of illness and death than cyanide [6]. Nicotine toxicity is often mitigated by the fact that a person will begin to vomit after ingesting nicotine products therefore decreasing the amount of nicotine in the stomach.

The Center for Disease Control and Prevention reports that from September 2010 to February 2014 [8] poison control centers in the United States, District of Columbia and the United States territories received 2405 calls regarding nicotine poisoning. Calls have gone from one a month to 215 a month. Almost 13% were calls made by hospitals. Fifty one percent of the calls were related to children up to the age of five years and 42% in adults over the age of 20 years. Almost 70% of the poisonings were related to ingestions and 57.8% reported adverse health effects. One incident was reported as a suicide by intravenous injection. Another study from five poison control centers in the United States [9] documented two suicide attempts by intravenous

injection. In two cases the amount ingested was considered Immediately Dangerous to Life or Health [9]. Of the patients that expired, the cause of death was related to significant cardiac events, arrhythmias and respiratory arrest.

A review of 34 poison control centers in 1992 to 1994 showed eight cases of intentional poisonings by use of two to 20 nicotine patches [10]. These were categorized as suicide attempts and often in the context of other illicit drug use.

Methods

A survey of the literature demonstrates an increase in reports of accidental deaths and suicides with the use of EL. The authors initiated a survey of medical providers at a large, urban government hospital. The aim was to assess provider's familiarity with this emerging medical crisis. Utilizing a computerized survey engine 95 responses were received out of 250 surveys; a 38% response rate. Forty-two percent (42%) of the respondents were from the Department of Psychiatry, 34% from the Department of Emergency Medicine (adult and pediatric), 11% were from the Department of Internal Medicine, and 13% were from the Department of Family Practice.

Results

Seventy eight percent (78%) of respondents were not aware that EL was a substance that a person might be prone to over-utilize. Eighty two percent (82%) of participants reported that they had treated patients with an accidental ingestion of EL. Physicians reported that over three quarters (76.19%) of these accidental ingestions were seen in adults (greater than 18 years of age) and 66.67% in infants/toddlers (up to five years of age). Rates of over 50% were seen in children (ages 6 to 12 years) and teens (13 to 18 years).

Respondents were asked what reason was given for the ingestion of EL. The smell, to obtain a "buzz", and "experimentation" were the most common reasons given in the survey. Surprisingly none of the respondents listed self-harm as a reason for drinking EL. Only 5% of respondents were aware that EL ingestion had the potential to be lethal.

Ninety eight percent of survey participants reported that they had not treated a patient who attempted suicide by ingesting EL. Of those that had encountered such a patient, 88% did not suspect that the patient had a diagnosable mental illness. Only one provider responded that he/she referred such a patient for a psychiatric consult. One other provider reported a referral of the patient for psychiatric admission.

Discussion

The results of this survey demonstrate that medical providers may have limited knowledge of EL's potential toxicity despite having treated patients with accidental ingestion. This might also suggest that as the popularity of EC use increases, awareness of the risks of exposure to EC and EL has not reached all providers. Knowledge of this newer method of overdose as

a suicide attempt is important to recognize along with the other potential harmful effects of EC use.

The use of EC is continuing to rise, especially in the population of young people. Overdose by nicotine ingestion is also increasing. There are yet to be determined medical complications related to EC usage. Lethal overdose, intentional or accidental, is one such adverse consequence that may not be commonly recognized by medical professionals. The aforementioned survey responses indicate that more education is needed for both patients and providers regarding the risks of exposure to EL.

Conflict of Interest Statement

I have no conflicts of interest to disclose. There was no funding provided for the research for this project.

References

1. Born H, Persky M, Kraus DH, Peng R, Amin MR, et al. Electronic cigarettes: A primer for clinicians *Otolaryn Head and Neck*. 2015; 153: 5-14.
2. Schoenborn CA, Gindi RM. Electronic cigarette use among adults: United States, 2014. NCHS Data brief. 2015; 217.
3. Etter JF, Bullen C. Electronic cigarette: users' profile, utilization, satisfaction and perceived efficacy. *Addict* 2011; 106: 2017-2028.
4. Tierney PA, Karpinski CD, Brown JE, Luo W, Pankow JF. Flavour chemicals in electronic cigarette fluids. *Tob Control* 2016; 25: 10-15.
5. Hess MR, Lachireddy K, Capona A. A systematic review of the health risks from passive exposure to electronic cigarette vapour. *Public Health Res Pract*. 2016; 26.
6. Mayer, B. How much nicotine kills a human? Tracing back the generally accepted lethal dose to dubious self-experiments in the nineteenth century. *Arch Toxicol*. 2014; 88: 5-7.
7. Srinivasan K, Smith L, Enja M, Lippmann, S. Have we done enough to educate patients about e- cigarettes? *J Fam Pract*. 2015; 64: 452.
8. Chatham-Stephens K, Law R, Taylor E, Melstrom P, Bunnell R, et al. Calls to poison centers for exposures to electronic cigarettes-United States: September 2010-February 2014. *MMWR*. 2014; 63: 13.
9. Payne JD, Michaels D, Orellana-Barrios M, Nugent K. Electronic cigarette toxicity. *J Prim Care Comm Health*. 2016; 1-3.
10. Woolf A, Berkhart K, Caraccio T, Litovitz T. Self-poisoning among adults using multiple transdermal nicotine patches. *Clin Toxicol*. 1996; 34: 691-698.

ADDRESS FOR CORRESPONDENCE:

Gwen Levitt, District Medical Group. 2619 E Pierce Street Phoenix, AZ, USA, Tel: 480-344-5862; Fax: 480-344-2157; E-mail: Gwen_Levitt@dmgaz.org

Submission: 17 December 2019

Accepted: 19 December 2019