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Original investigation

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Electronic Cigarette Exposures Reported to Texas Poison Centers

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Abstract

Introduction: Exposure to the liquid nicotine solutions in electronic cigarettes (e-cigs) may be dangerous because they are highly concentrated. Little is known about the impact of exposure on public health. This study describes e-cig exposures reported to poison centers.

Methods: All e-cig exposures reported to Texas poison centers during 2009 to February 2014 were identified. Exposures involving other substances in addition to e-cigs and exposures not followed to a final medical outcome were included. The distributions of exposures by demographic and clinical factors were determined.

Results: Of 225 total exposures, 2 were reported in January 2009, 6 in 2010, 11 in 2011, 43 in 2012, 123 in 2013, and 40 through February 2014. Fifty-three percent (n = 119) occurred among individuals aged <5 years old, 41% (n = 93) occurred among individuals aged >20 years old, and 6% (n = 13) occurred among individuals aged 6–19 years. Fifty percent were female. The route of exposure was 78% ingestion. Eighty-seven percent of the exposures were unintentional, and 5% were intentional. The exposures occurred at patients' own residences in 95% of the cases. The clinical effects reported most often were vomiting (20%), nausea (10%), headache (4%), ocular irritation (5%), dizziness (5%), and lethargy (2%).

Conclusion: E-cig exposures reported to poison centers are increasing. Most of the patients are young children, and the exposures most frequently occur through ingestion. Reported exposures often do not have serious outcomes.

Introduction

Poisoning after exposure to nicotine-containing products like cigarettes, patches, gums, traditional remedies, and nicotinic plants is well described.[1,2] In one study, 39% of 36 exposures to transdermal nicotine products in children younger than 16 years developed gastrointestinal distress, weakness, and dizziness after ingestion.[3] In a prospective review of 51 cases of tobacco ingestion, nine of ten children ingesting more than one cigarette or three cigarette butts developed symptoms.[4] However, little is known about exposures to the liquid nicotine solution (LNS) in electronic cigarettes (e-cigs). Electronic cigarettes were recently introduced in the US market; these devices have become very popular especially among young people.[5]

We theorize that the increasing popularity, frequency of use at home, flavoring, unregulated marketing, and limited evidence about safety may increase the risk for e-cig exposure, especially among small children. Reports of accidental ingestion of cigarettes and other nicotine-containing products are not uncommon among children <6 years old with few significant toxic responses.[6] Another group at risk of nicotine poisoning from e-cig exposure is suicidal individuals; there is one report of life-threatening poisoning using tobacco extract to commit suicide.[7] In a different report, an individual collapsed 2 min following ingestion of a brownish liquid that later was identified as nicotine alkaloid that he obtained from a fellow satanic cult member and died 64 hr after ingestion.[8]

Other than abstracts, there are no previous reports of nicotine poisoning related to e-cigs. The objective of this study is to describe the demographics, circumstances, and adverse events related to e-cig exposures reported to poison centers.

Materials and Methods

This study used the Texas Poison Center Network (TPCN) as a data source. The TPCN is a telephone consultation service that provides information on and assists in the management of potentially adverse exposures to many substances including nicotine products. The TPCN is comprised of six poison centers that together service the state's population of over 25 million. The six poison centers use a single computer database, enabling a consistent collection of demographic and clinical information. The data fields in the database are standardized by the American Association of Poison Control Centers.[9]

Cases were e-cig exposures reported during January 2009 to February 2014 (no exposures were reported prior to 2009). Calls received from outside of Texas were excluded because such calls are not consistently received by Texas poison centers. Exposures involving other substances in addition to LNS and exposures not followed to a final medical outcome were included. The distribution of cases was determined by year, patient age and gender, route, circumstances of (reason for) the exposure, exposure site, presence of additional substances, management site, medical outcome, reported clinical effects, and reported treatments. The circumstances of (reason for) the exposure are based on the intent of the exposure. Unintentional exposures result from unforeseen or unplanned events such as accidental exposures or therapeutic errors. Intentional exposures result from purposeful actions such as attempted suicide or abuse of a substance. Adverse reactions involve unwanted effects resulting from normal, recommended use of the product. A given exposure might involve multiple routes. For this investigation, such an exposure would be included in each route subgroup.

The medical outcome or severity of an exposure is assigned by the poison center staff and is based on the observed or anticipated adverse clinical effects. Medical outcome is classified according to the following criteria: no effect (no symptoms due to exposure), minor effect (some minimally troublesome symptoms), moderate effect (more pronounced, prolonged symptoms), major effect (symptoms that are life threatening or cause significant disability or disfigurement), and death. Some exposures are not followed to a final medical outcome because of resource constraints or the inability to obtain subsequent information on the patients. In these instances, the poison center staff records the expected outcome of the exposure. These expected outcomes are grouped into the following categories: not followed but judged as nontoxic exposure (symptoms not expected), not followed but minimal symptoms possible (no more than minor symptoms possible), unable to follow but judged as a potentially toxic exposure. For convenience, the medical outcomes also were grouped into those known or expected not to be severe (no effect, minor effect, not followed), and those known or expected to be severe (moderate effect, major effect, death, unable to follow and potentially toxic). An exposure where the medical outcome was considered "unrelated effect" was not included in either of these two categories.

The Texas Department of State Health Services institutional review board considers this analysis exempt from ethical review.

Results

Of 225 total exposures, two were reported in 2009, six in 2010, 11 in 2011, 43 in 2012, 123 in 2013, and 40 through February 2014. Fifty-three percent (n = 119) occurred among individuals age <5 years old, 41% (n = 93) >20 years old and 6% (n = 13) between 6–19 years. The genders were 49% male, 50% female, and 1% unknown. The route of exposure was 78% ingestion, 9% inhalation, 8% dermal, and 4% ocular; 10% involved multiple routes. Eighty-seven percent of the exposures were unintentional, 5% intentional, 6% adverse reactions, and 1% unknown reason. The exposures occurred at patient's own residence in 95% of the cases.

Sixty-eight percent of the patients were managed on site, 20% were already at/en route to a healthcare facility when the poison center was contacted, 12% were referred to a healthcare facility by the poison center, and 1% was managed at another unspecified site. The medical outcomes were 24% no effect, 19% minor effect, 4% moderate effect, 6% not followed-nontoxic, 35% not followed-minimal effects possible, 9% unable to follow-potentially toxic, and 3% unrelated effect; thus, 84% were known or expected to not be severe and 13% were known or expected to be severe. There were no fatalities.

The clinical effects reported most often were vomiting (20%), nausea (10%), headache (4%), ocular irritation (5%), dizziness (5%), and lethargy (2%). The most common reported treatments were dilution (59%), food (14%), and activated charcoal (3%).

During the same time period, 2,888 exposures to other tobacco/nicotine products were reported to the TPCN. These included exposures to cigarettes (n = 1,893), snuff (n = 272), chewing tobacco (n = 267), cigars (n = 56), filter tips/butts (n = 48), dissolvable tobacco (n = 3), and other/unknown products (n = 352). Electronic cigarettes were approximately 7% of the total tobacco/nicotine products exposures.

Discussion

We describe an increasing number of e-cig exposures reported to Texas poison centers annually since 2009. This likely reflects the growth in popularity of e-cigs. According to several surveys, people perceive that the e-cigs are a safer and cheaper alternative to smoking and help in dealing with withdrawal symptoms when they were trying to quit smoking.[10–12] The major concern about this product is the limited scientific information about the safety of the solution and the vapor inhaled by users. Vapor contents include cytotoxic substances, acrolein, acetaldehyde, and formaldehyde.[13,14] Propylene glycol and glycerin are also present in the LNS. While the Food and Drug Administration considers propylene glycol and glycerin to be safe, some studies found that they might produce slightly irritating effects by inhalation.[15,16] In our study, 5% of the cases presented ocular irritation that may be associated with propylene glycol and glycerin exposure. If ingested, propylene glycol is metabolized to potentially toxic compounds like lactate and propionic acid;[17] it is unknown if this is a potential risk from LNS ingestion.

In this study, over half of the patients were children five years or younger. Small children are susceptible to accidental ingestions because of their natural curiosity and oral exploration.[18] They are especially vulnerable for LNS exposure at home because 98% of daily users used their e-cigs at home and refilled the device at least five times a day.[19] This is consistent with our findings where almost all of the exposures occurred in the patient's home. Children may be at risk for nicotine exposure because the solutions contain many flavors that are attractive to infants and not all LNS bottles are childproof. Some companies make LNS bottles that are childproof, but there is no law

mandating all LNS bottles be childproof. In our study, not surprisingly, most of the exposures involved ingestion, reflecting the potential risk for nicotine exposure in small children by this route. Most of our cases had no effects or mild manifestations. Considering how highly concentrated the solutions might be, this relatively low toxicity was surprising. Similar outcomes have been found in previous reports after exposure to nicotine in children ingesting cigarettes.[20]

Acute nicotine poisoning has an early clinical phase characterized by nausea, vomiting, abdominal pain, salivation, bronchorrhea, tachypnea, hypertension, tachycardia, miosis, tremor, muscle fasciculations, and seizures. The delayed phase consists of respiratory depression, dyspnea, bradycardia, hypotension, shock, mydriasis, weakness, muscle paralysis, and coma.[21] In our study, the most frequently reported adverse clinical effects were mild manifestations of nicotine poisoning (nausea, vomiting, headache, and dizziness).

While most of the cases in our report had mild manifestations, the risk for severe toxicity cannot be underestimated. Bottles of 10–1000 ml with nicotine concentrations of 6–100 mg/ml can be easily bought in the internet (www.myfreedomsmokes.com). The lethal dose (LD) of nicotine is uncertain but an oral LD50 of 6.5–13 mg/kg in dogs, which exhibit responses to nicotine similar to humans, has been described.[22] Based on this LD50, the ingestion of only a few milliliters of some of the preparations could be toxic. The most popular concentration among users is 20 ml-bottle of 18 mg/ml.[19]The lack of clear regulation on e-cigs marketing may contribute to increased risk of nicotine exposures.

This study contributes to the discussion about potential risk of serious nicotine poisoning from this unregulated product. The popularity of e-cigs has clearly increased among young people in the United States; the increasing number of cases reported to poison centers may be correlated with the rise in the number of e-cig users. If this tendency continues, we expect a greater number of cases of nicotine poisoning in the coming years. Regulatory actions that address the risk of nicotine exposure may contribute to change this trend.

Conclusions

The number of e-cig exposures reported to TPCN, albeit currently small, is increasing. Fifty three percent were less than 5-years of age; 41% were ≥20-years of age. The exposures tended to be unintentional, occurred through ingestion, and occurred at the patients' homes. While serious exposures were uncommon, because of the high concentrations of the nicotine solutions and the increasing use of these products, there is still the potential for dangerous toxicity in the future and close surveillance is warranted.

Declaration of Interests

None declared.

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