

Trends and Characteristics of Ocular Exposures Related to E-Cigarettes and E-Liquids Reported to Poison Control Centers in the United States, 2010-2019



Baoguang Wang, MD, DrPH, Sherry T. Liu, PhD, MPH, Moronke A. Johnson, MPH, Sarah Trigger, MPH

Food and Drug Administration, Center for Tobacco Products, Office of Science, 10903 New Hampshire Avenue, Silver Spring, MD 20993

Background

Ocular (eye) injuries due to unintended exposures, especially among children, may lead to long-term consequences with a negative impact on daily activities and poor quality of life. Electronic cigarettes, also known as e-cigarettes, are battery-operated electronic nicotine delivery systems (ENDS) that use e-liquid that may contain nicotine and other additives that are heated and inhaled by users in aerosol form. Prevalence of current ENDS use among adolescents and young adults has increased substantially in the U.S. in recent years.¹⁻³ ENDS-related injuries treated in U.S. hospital emergency departments and ENDS-related exposures reported to U.S. poison control centers (PCCs) have also increased substantially in recent years.^{4,5} Ocular injuries leading to corneal abrasion, eye irritation or pain, and other ocular symptoms related to ENDS exposures have been reported.⁵ However, trends and characteristics of ENDS-related ocular exposures at the population level are not well documented.

Objectives

- To describe trends and characteristics of ENDS-related ocular exposures reported to PCCs.
- To explore contextual information about the nature and circumstances of ENDS-related ocular exposure cases.

Materials and Methods

Data Source

- Data for this cross-sectional study were from the National Poison Data System (NPDS) between January 1, 2010 and December 31, 2019.
- NPDS is a data repository of injury and poisoning exposure cases to PCCs in the U.S. and its territories.
- NPDS contains data on injury and poisoning exposure cases involving more than 440,000 products, including e-cigarettes, e-liquids, and other tobacco products, reported to PCCs.
- During each telephone call to a PCC, the following information is collected and documented using a structured computer program: information on call time and call location, demographic characteristics of the person experiencing injury or poisoning exposure, product involved, route of exposure, clinical effect (i.e., symptom), level of care at a health care facility (HCF), and medical outcome.
- Selected case narratives were available for review.

Data Analysis

Descriptive statistics of exposure cases involving only ENDS products (i.e., no other products were involved):

- Number and percent of ENDS-related ocular exposure cases by year
- Number and percent of ENDS-related ocular exposure cases by age, gender, caller location, route of exposure, level of care at a HCF, medical outcome, and clinical effect
- Number and percent of ENDS-related ocular exposure cases for each level of care at a HCF by medical outcome

Case Narrative Review

Case narratives were reviewed and summarized to explore contextual information about the nature and circumstances of ENDS-related ocular exposure cases, including all cases with a major or moderate medical outcome and 10% of cases (randomly selected) with a minor medical outcome or no clinical effect.

Results

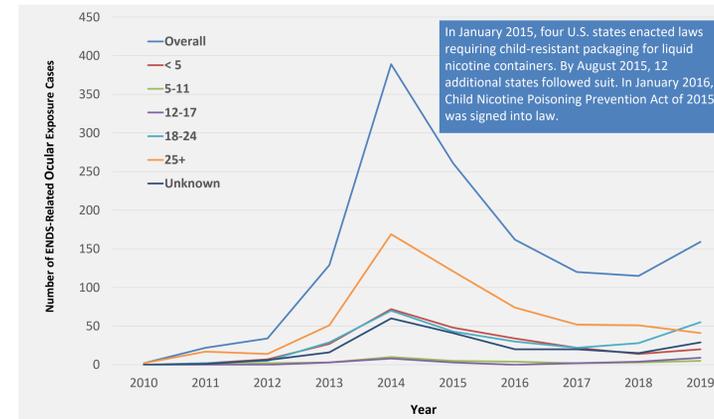
- During 2010-2019, 21,684 cases involving ENDS exposures were documented in NPDS. Of these cases, 1,393 (6.4%) were ocular exposure cases.
- Most ENDS-related ocular exposure cases occurred among adults (42.5%), followed by young adults (20.4%), and children younger than five years old (17.7%) (Table 1).
- Nearly on quarter (23.8%) of ENDS-related ocular exposure cases required medical attention (Table 1).
- More than half (56.5%) of individuals experiencing ENDS-related ocular exposure reported a minor symptom (Table 1).
- The number of ENDS-related ocular exposure cases increased substantially between 2010 and 2019 (Figure).

Characteristics	Number (%) of ENDS-Related Ocular Exposure Cases
	Overall N=1,393
Age (Years)	
< 5	246 (17.7%)
5-11	34 (2.4%)
12-17	29 (2.1%)
18-24	284 (20.4%)
25+	592 (42.5%)
Unknown or Exact Age Unknown ¹	208 (14.9%)
Gender	
Male	718 (51.5%)
Female	671 (48.2%)
Unknown	4 (0.3%)
Caller Location	
Residence	1,086 (78.0%)
Health Care Facility (HCF)	175 (12.6%)
Other	72 (5.2%)
School or Workplace	48 (3.4%)
Public Area	9 (0.6%)
Unknown	3 (0.2%)
Route(s) of Exposure	
Ocular Only	1,209 (86.8%)
Ocular and Dermal	75 (5.4%)
Ocular and Ingestion	56 (4.0%)
Ocular, Dermal, and Ingestion	45 (3.2%)
Ocular and Inhalation/Nasal	4 (0.3%)
Ocular, Dermal, and Inhalation/Nasal	3 (0.2%)
Ocular, Dermal, Ingestion, and Otic	1 (0.1%)
Level of Care at HCF	
Admitted to Hospital	4 (0.3%)
Treated, Evaluated, and Released	244 (17.5%)
Lost to Follow-Up or Left Against Medical Advice	53 (3.8%)
Refused Referral or Did Not Arrive at HCF	30 (2.2%)
Not Referred	1,062 (76.2%)
Medical Outcome²	
No Clinical Effect	49 (3.5%)
Minor Effect	787 (56.5%)
Moderate Effect	42 (3.0%)
Major Effect	1 (0.1%)
Death	0 (0.0%)
Not Followed or Unable to Follow	514 (36.9%)
Clinical Effects³	
Ocular Irritation/Pain	1,083 (77.7%)
Red Eye/Conjunctivitis	517 (37.1%)
Blurred Vision	80 (5.7%)
Lacrimation	55 (3.9%)
Edema	28 (2.0%)
Dermal Irritation/Pain	21 (1.5%)
Erythema/Flushed	17 (1.2%)
Nausea	16 (1.1%)
Vomiting	14 (1.0%)
Corneal Abrasion	13 (0.9%)

¹ Of these unknown or exact age unknown, 10 cases were reported to be in their 20s, four in their 30s, two in their 40s, two in their 60s, one teen, 167 were unknown adult (≥20 years), 20 were unknown age, and two were reported to be children with exact age unknown (≤19 years).
² Medical outcome was classified as no effect (no signs or symptoms as a result of the exposure); minor effect, (some signs or symptoms, but minimally bothersome and self-limited without residual disability or disfigurement); moderate effect (signs or symptoms that were more pronounced, more prolonged, usually required medical attention, but not life-threatening); and major effect (signs or symptoms that were life-threatening or resulted in significant residual disability or disfigurement).
³ Each case could have more than one clinical effect. Therefore, percentages do not total 100%.

Results (Continued)

Figure. Trends in the number of ENDS-related ocular exposure cases reported to poison control centers, United States, 2010-2019



- Approximately one in four ENDS-related ocular exposure cases with no effect for medical outcome (i.e., no symptoms) or with a minor effect for medical outcome (i.e., a minor symptom that resolved quickly) required medical attention (i.e., treated, evaluated, and released at a health care facility) (Table 2).
- More than half of ENDS-related ocular exposure cases with a moderate effect for medical outcome (i.e., a symptom that is more pronounced and prolonged than a minor symptom) were treated, evaluated, and released at a health care facility (Table 2).

Table 2. Level of care at health care facility for ENDS-related ocular exposure cases, by medical outcome¹, 2010-2019

Level of Care at Health Care Facility (HCF)	Medical Outcome				
	No Effect (n=49)	Minor Effect (n=787)	Moderate Effect (n=42)	Major Effect (n=1)	Not Followed or Unable to Follow (n=514)
Admitted to Hospital	0	1 (0.1%)	0	0	3 (0.6%)
Treated, Evaluated, and Released	14 (28.6%)	183 (23.3%)	23 (54.8%)	0	24 (4.7%)
Refused Referral or Did Not Arrive at HCF	0	5 (0.6%)	5 (11.9%)	0	20 (3.9%)
Lost to Follow-Up or Left Against Medical Advice	0	18 (2.3%)	2 (4.8%)	1 (100.0%)	32 (6.2%)
Not Referred	35 (71.4%)	580 (73.7%)	12 (28.6%)	0	435 (84.6%)

¹ Percentages are column percentages.

Case Narrative Review Findings

- Of 127 case narratives reviewed, nearly half (n=59; 46.5%) of ocular exposure cases were due, at least in part, to incorrect use and handling of ENDS products, such as adults mistakenly using e-liquid instead of eye drops for themselves or for their children and rubbing eyes while handling e-liquid with e-liquid on hands.
- Five cases were due to a potential product defect, including a leaky product and product explosions.

Conclusions

- Nearly 1,400 ENDS-related ocular exposure cases were reported to U.S. PCCs during 2010-2019.
- Majority of these cases occurred among adults and young adults aged 18-24 years old; approximately one in five of these cases was a child younger than five years old.
- Case narrative review indicated that nearly half of these cases were due, at least in part, to incorrect use and handling of the ENDS products by users.
- Future efforts to prevent ENDS-related ocular exposures may focus on improving the awareness of the potential harmful effects of ENDS products and the importance of appropriate handling of ENDS products, education programs about keeping ENDS products out of reach of children and correct use of ENDS products in addition to regulations of these products and child-resistant packaging.
- Health care professionals may play an important role in educating patients and improving surveillance of ENDS-related ocular exposure cases.

Acknowledgements

The authors thank Deborah Neveleff for assistance with technical editing. The authors are indebted to staff at the Headquarters of the American Association of Poison Control Centers and staff at Poison Control Centers across the United States for providing case narratives, which contain valuable information on ocular exposures and injuries involving e-cigarettes and e-liquids.

Some information in this poster presentation has been submitted to Clinical Toxicology for publication.

References

- Wang TW, Neff LJ, Park-Lee E, Ren C, Cullen KA, King BA. E-cigarette use among middle and high school students - United States, 2020. *MMWR Morb Mortal Wkly Rep.* 2020;69(37):1310-1312.
- Cullen KA, Gentzke AS, Sawdey MD, et al. E-cigarette use among youth in the United States, 2019. *JAMA.* 2019;322(21):2095-2103.
- Dai H, Leventhal AM. Prevalence of e-cigarette use among adults in the United States, 2014-2018. *JAMA.* 2019;322(18):1824-1827.
- Chang JT, Wang B, Chang CM, Ambrose BK. National estimates of poisoning events related to liquid nicotine in young children treated in US hospital emergency departments, 2013-2017. *Inj Epidemiol.* 2019;6:10.
- Wang B, Liu S, Persoskie A. Poisoning exposure cases involving e-cigarettes and e-liquid in the United States, 2010-2018. *Clin Toxicol (Phila).* 2019;1-7.