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Parental Use of Electronic Cigarettes

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Abstract

Objective—To describe parental use of electronic cigarettes (e-cigs) to better understand the safety risks posed to children.

Methods—Between June 24 and November 6, 2014, parents completed a self-administered paper survey during an office visit to 15 pediatric practices in a Mid-western practice based research network. Attitudes towards and use of e-cigs are reported for those aware of e-cigs before the survey.

Results—Ninety-five percent (628/658) of respondents were aware of e-cigs. Of these, 21.0% (130/622) had tried e-cigs at least once and 12.3% (77) reported e-cig use by 1 person in their household (4.0% exclusive e-cig use, 8.3% dual use with regular cigarettes). An additional 17.3% (109) reported regular cigarette use. Most respondents from e-cig using homes did not think e-cigs were addictive (36.9% minimally/not addictive, 25.0% did not know). While 73.7% believed that e-liquid was very dangerous for children if they ingested it, only 31.2% believed skin contact to be very dangerous. In 36.1% of e-cig using homes, neither childproof caps nor locks were used to prevent children's access to e-liquid. Only 15.3% reported their child's pediatrician was aware of e-cig use in the home.

Conclusions—E-cig use occurred in 1 in 8 homes, often concurrently with regular cigarettes. Many parents who used e-cigs were unaware of the potential health and safety hazards, including nicotine poisoning for children, and many did not store e-liquid safely. Pediatricians could provide education about e-cig associated safety hazards, but are unaware of e-cig use in their patient's homes.

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Keywords

Electronic cigarettes; practice-based research network; patient safety

Introduction

Easily available and widely advertised as an alternative to regular cigarettes and a smoking cessation aid,² electronic-cigarettes (e-cigs) are battery powered nicotine delivery systems that are either refillable or single use devices.³ E-cigs use e-liquid that typically contains nicotine and flavorings that are usually dissolved in propylene glycol and water, vaporized and delivered in aerosol form (e-vapor).^{4,5} In the absence of manufacturing regulations, widespread discrepancies between reported and actual concentration of nicotine in e-liquid can occur.^{6,7} Since being introduced into the United States (U.S.) in 2007, the use of e-cigs has dramatically increased among adults as well as middle and high school students, with high-levels of dual use of e-cigs and regular cigarettes.⁸⁻¹⁵ E-cig sales were estimated as 1.7 billion in 2013 and are projected to exceed sales of conventional cigarettes by 2023.^{4,16}

The health implications of e-cigs are uncertain, especially for children. E-cigs may be effective in helping parents to reduce their cigarette consumption and stop smoking^{5,17,18} and thereby reducing the health risks associated with conventional cigarettes for parents and children. However, there is concern that e-cig use may perpetuate nicotine addiction in smokers who may otherwise have quit, or induce nicotine addiction in e-cig users who do not use regular cigarettes.^{5,9,12,19,20} Also, the particles and toxicants produced in the e-liquid vapor, although much lower than in regular cigarettes, may pose health risks to users and bystanders.^{5,21} An immediate concern for children is that the concentrated nicotine present in e-liquid can be toxic if absorbed through the skin or ingested.^{22,23} U.S. poison centers reported a dramatic increase in calls related to e-cig exposures from 1/month in 2010 to 215/month in 2014, mostly related to exposure of children less than five years old,²⁴ and in December of 2014, a one-year-old child died after drinking e-liquid.²⁵ The objective of this study was to assess the prevalence of e-cig use in the home and to describe children's household exposure to e-cigs and e-liquid in order to better understand the health and safety risks posed to children.

Methods

Study Population

Pediatrician members of the Washington University Pediatric and Adolescent Ambulatory Research Consortium (WU PAARC) were asked if they would permit a research assistant (RA) to recruit study participants in their practice waiting room. WU PAARC is a practice-based research network (PBRN) of 33 community-based pediatric practices in St. Louis, MO that is affiliated with Washington University School of Medicine. Fifteen WU PAARC practices agreed to participate. The study was approved by the Washington University Human Research Protection Office, requiring verbal consent from a parent for study enrollment.

Participants were parents or legal guardians (referred to as parents in the manuscript) with a child attending the pediatrician's office. Parents who were not proficient in English or had already completed the survey were excluded. The RA was present at a site on weekdays when they invited parents to participate in the study, explained participation requirements, and answered questions. The RA did not approach parents if they were immediately called to see the physician, were preoccupied with an administrative task, or if the RA was busy with another parent.

Survey Tool

The 46-item self-report questionnaire, developed by the study team, was based on the literature and informal discussion with parents and was modified after pilot testing. Questions addressed attitudes towards and use of regular and electronic cigarettes. Parents reported if they had ever used regular cigarettes or e-cigs and if they or anyone in the home currently used e-cigs or regular cigarettes. They used categorical scales to indicate their perception of the addictiveness of these products (very, moderately, minimally, not addictive, and don't know), the danger of e-cig exposure for children via inhalation, skin absorption and ingestion (very, moderately, minimally, not dangerous, don't know), and their agreement with statements about the safety of e-vapor and e-liquid (strongly agree, agree, disagree, strongly disagree, don't know).

If e-cigs were used in the home, participants selected from lists to indicate the frequency of use, where e-cigs were used and stored, and what type of e-cig product was being used (disposable or refillable; with or without nicotine). Additional questions inquired about the pediatricians' awareness of home use of e-cigs and parent's desire to receive information about e-cigs from their child's pediatrician. Those who reported personal e-cig use indicated agreement with statements regarding the reasons for use and desire to quit. Each survey took approximately three minutes to complete and had a Flesch-Kincaid reading level of 6.3, indicating the survey should be understandable by an average individual with a 6th grade education or higher. Demographic information was also obtained.

Statistical Analysis

Summary statistics are reported as percentages for categorical variables and mean and standard deviation (SD) for continuous variables. We used Fisher's Exact test to compare characteristics of e-cig users and non-users. For these analyses, race was dichotomized as white vs. all other races; health insurance as Medicaid vs. other health insurance; respondents' educational attainment as some college or higher vs. less education; and family income as < \$60,000/year vs. \$60,000/year. A probability of $p < 0.05$ (two-tailed) was used to establish statistical significance. All statistical analyses were performed using STATA 12 (StataCorp LP, College Station, TX).

Results

Study Participants

The 15 participating WUPAARC practices were located throughout the St. Louis metropolitan area (13 Missouri, 2 Illinois; 12 group practices, 3 solo practitioners). An RA

was present at each site for a median of 3.8 days (range 1.5 to 5 days) between June 24, 2014 and November 6, 2014. During the time the RA was present, 1,651 individuals had an appointment. Of these, 1,155 were invited to participate: 496 were not approached by the RA, most often because they were immediately called back to see the physician. Of the 1,155 invited to participate, 418 were ineligible (143 non-legal guardian, 72 minor, 27 repeat appointment, 25 non-English speaking, 6 pregnant women with no other children, and 145 had no appointment e.g., were collecting a prescription). Of the 737 eligible to participate, 59 (8.0%) declined, and 678 (92.0%) completed the survey (median 33 surveys/practice, range 11 to 122).

The majority (95.4%, 628/658) of respondents were aware of e-cigs prior to the survey. Further analyses about e-cigs were restricted to these 628 participants. Data are reported as percentages and there were few missing data. Denominators are provided in the tables and also in the text if needed for clarification or if more than 5% responses are missing. Respondents were the child's parent (78.7% mother, 21.0% father) and 87.7% had at least some college education; 22.7% were African American, and 22.6% had Medicaid coverage (Table 1).

Parental perceptions about regular cigarettes and e-cigs

Overall, most (78.1%) survey participants agreed regular cigarettes were very or moderately addictive (9.5% minimally/not addictive, 12.4% don't know). In contrast, most (54.3%) were unsure if e-cigs were addictive (33.8% very/moderately, 12.1% minimally/not addictive) and 36.4% were unsure whether e-cigs were a safer alternative to regular cigarettes (32.2% agreed e-cigs were safer, 31.4% disagreed)(Table 2). Parents (n=77) from e-cig using homes were less likely than other parents to select "don't know" for these items (Table 2). Among these 77 parents, 73.7% believed that e-liquid was very dangerous for children if they ingested it, but only 31.2% believed skin contact to be very dangerous (Table 2).

Use of e-cigs in the home

Twenty-one percent of respondents (130/622) had tried e-cigs at least once. Twelve percent (77/628) reported current use of e-cigs by either the respondent or someone else in the home (25 exclusive e-cig use, 52 dual use of e-cigs and regular cigarettes). An additional 17.4% (109/628) reported exclusive use of regular cigarettes in the home.

In the 77 e-cig using homes, e-cigs were most commonly used in the house (67.5%), outdoor spaces (58.4%), the car (57.1%), at work (41.6%), and in places where regular cigarette use was banned (29.9%)(percentages add to more than 100% as multiple locations could be selected). Forty-one percent (30/74) estimated children saw daily e-cig use, with 13.5% weekly, 16.2% monthly, 16.2% <monthly, and 13.5% never. The type of e-cig devices used most commonly were nicotine-containing (64.9%) and refillable (66.2%), and 57.1% reported sweet-flavored e-liquids were used at least some of the time. Storage of e-liquid most commonly occurred in a drawer or cupboard (33.8%), a purse or bag (22.1%), and on an open counter or shelf (13.0%). Thirty-six percent neither locked up e-liquid bottles or used childproof caps (19.7% used childproof caps, 8.2% locked up e-liquid, 31.1% did both, and 4.9% did not know if these safety measures were used, n=61). Nine (11.7%)

respondents reported a child had attempted to smoke an e-cig and 2 (2.6%) that a child had attempted to drink e-liquid.

Only 15.3% (11/72) reported their pediatrician was aware of e-cig use in the home (47.2% pediatrician was unaware, 37.5% did not know), 5.6% (4/71) had discussed e-cig use and safe storage of e-liquid with their pediatrician, and 27.8% (20/72) would like to do so.

Characteristics of e-cig users

Household use of e-cigs was more commonly reported in homes with regular cigarette smokers (32.3% smokers, 5.4% nonsmokers, $p<0.001$). Also, e-cig use was more common among households where the respondent had not received any college education (27.3% no college, 10.2% college, $p<0.001$), the household had a lower annual income (17.2% $< \$60,000$, 8.4% $\geq \$60,000$, $p=0.002$), and Medicaid insurance (19.3% Medicaid, 10.0% other insurance, $p=0.005$) but did not vary by other respondent characteristics including race, ethnicity, age, employment status or family type.

Among the 37 respondents who reported they were current e-cig users, 56.8% also smoked regular cigarettes. The most commonly selected reasons for e-cig use were to aid smoking cessation (89.7%) and to avoid second hand smoke exposure for others (89.7%) (Table 3). Forty-one percent did not want to quit using e-cigs.

Discussion

The present study is the first to examine household exposure of children to e-cigs. We found e-cig use was common among families attending community-based pediatric practices in St. Louis, MO. One in 5 parents had tried e-cigs and, at the time of the survey, e-cig use occurred in 1 in 8 homes. These estimates for ever use and current use of e-cigs by adults are higher than previous studies^{8,10} and support predictions of rapidly increasing use of this product.^{9,26} Although parents reported they used e-cigs as an aid to quit smoking regular cigarettes and to reduce second-hand smoke exposure of their children, the majority of children in e-cig using households were also exposed to regular cigarettes, although perhaps at a reduced level.

Widespread use of e-cigs by parents raises concern about the health and safety risks posed to children in the home. E-cigs generate little side-stream emissions⁶ but the vapor exhaled by an e-cig user may contain nicotine, particles, heavy metals, and other constituents.²⁷ However, the health implications of bystander exposure to exhaled e-vapor remain unclear, particularly regarding children. More worrisome for children's safety is the risk of acute nicotine toxicity through unintentional exposure to concentrated nicotine in e-liquid. At the 2014 Senate hearing on e-cig marketing and potential consequences to youth, representing the American Academy of Pediatrics Dr. Susanne Tanski described e-liquid as a "likely candidate for ingestion by young children because it is colorful, candy flavored and scented, and there is no requirement for child-proof packaging."²⁰ As she predicted, parents from 3% of e-cig using homes in this study reported children had ingested e-liquid, and data from poison control hotlines corroborates that such exposures are becoming increasingly common.²⁴ The concentrated nicotine solution in e-liquid can be quickly absorbed through

the skin or oral ingestion, and small doses (less than a teaspoon) can be fatal to children.²³ The effect of maternal e-cig use during pregnancy and breastfeeding is unknown, but there is concern that exposure of the fetus and neonate to nicotine may contribute to pediatric lung disease and behavioral abnormalities.⁶

Many parents from e-cig using homes were unaware of the potential health and safety risks of e-cigs for themselves or their children. Parents saw e-cigs as safer than regular cigarettes for themselves and others and fewer thought they were addictive. Although nicotine delivery by e-cigs can vary with the device used and the user's technique, nicotine absorption from newer e-cigs in experienced users can be similar to regular cigarettes^{5,27-29} and may pose similar risks for nicotine addiction. Dual use of e-cigs and regular cigarettes was common in this study population and 41% of current e-cig users did not want to quit using e-cigs. Dual use has been reported in larger, population-based studies of adults and adolescents.⁸⁻¹² Although the long-term impact of dual use on smoking behavior is not known, there is a concern that e-cig use may increase duration of smoking in adults who would have otherwise quit.^{5,27} This could prolong children's exposure to tobacco products. Parental e-cig use may also increase children's risk of nicotine addiction through role modeling and normalization of another mode of nicotine use.^{3,4,6,27} Indeed, in our study, 41% of children from e-cig using homes saw daily e-cig use. Cigarette use by the parent, particularly before the child reaches adolescence, increases the likelihood of regular cigarette use in children.^{30,31} It is worrisome that many parents from e-cig using homes were unaware that a small amount of e-liquid is potentially fatal for children through skin contact.²³ This lack of knowledge may explain the infrequent use of strategies to prevent harmful exposure to e-liquid such as safe storage practices and use of childproof caps.

Although few parents had discussed e-cig use with their pediatrician, the frequency of use of e-cigs in our study population suggests pediatricians should enquire about use of both regular and e-cigarettes in the home.³² Pediatricians could support and promote both smoking cessation efforts and safe use and storage of e-liquid.^{20,32} Provider education or further training may be needed as a recent survey suggests few pediatricians are knowledgeable about e-cigs and e-liquid.³³ More intensive, targeted efforts may be needed for parents with less education and lower household incomes, the highest users of both e-cigs and regular cigarettes.^{9,10,34} Also, regulations to improve product safety would help to reduce children's exposure to e-liquid. Unfortunately, the regulations proposed by the U.S. Food and Drug Administration (FDA) that are expected to be finalized in June 2015 do not address child safety issues such as requiring childproof caps, limiting nicotine concentration, and regulating the manufacturing process to assure consistency of content across products on the market.⁹ Regulations requiring these safety practices were implemented in the European Union in 2014.^{9,35}

Several study limitations should be noted. Although the survey was anonymous to minimize social desirability bias, the data are self-reported and may not accurately represent smoking status, e-cig use, and childhood exposure to e-cigs and e-liquids in the home. The study population was large, but excluded non-English speaking parents and the sample of e-cig users was small, limiting our ability to examine differences among racial groups. Subjects were recruited on weekdays from pediatric practices in the St. Louis metropolitan area and

use of regular and e-cigarettes may be different in other communities. These factors may bias our findings and limit the generalizability of study findings. In 2014, the smoking prevalence among adults in Missouri was 20.6% (95% CI 19.0% to 22.2%) (healthmo.gov), slightly higher than the national prevalence (17.8%) (cdc.gov). Finally, the cross-sectional design precludes our ability to determine causation or confirm trends in use.

Conclusion

In our community, many children are exposed to e-cigs through parental use. E-cigs may provide benefit by reducing parental use of regular cigarettes. However, exposure of children to e-cigs often occurs in addition to exposure to regular cigarettes thus providing additional risks for nicotine poisoning and possible future addiction. The frequency of parental e-cig use suggests that pediatricians should assess children's exposure to both regular and e-cigarettes and provide advice about risk reduction. Risks also could be mitigated by legislation to improve manufacturing, limit the concentration of nicotine in e-liquid, and require childproof caps.

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Study data were collected and managed using REDCap electronic data capture tools hosted at Washington University.¹ REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing: 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources.

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Abbreviations

AAP	American Academy of Pediatrics
CI	confidence interval
E-cig	electronic cigarette
IQR	Interquartile Range
NIH	National Institutes of Health
OR	odds ratio
PBRN	Practice-based research network
RA	Research Assistant
SD	Standard deviation
US	United States
WU PAARC	Washington University Pediatric and Adolescent Ambulatory Research Consortium

What's New

Electronic-cigarettes (e-cigs) were used in 1 in 8 homes with young children, often concurrently with regular cigarettes. Many parents who use e-cigs are unaware of the potential health and safety hazards for themselves or their children, including nicotine poisoning.

Table 1
Characteristics of survey respondents who were aware of e-cigs before the survey (Total N=628)

Characteristic*	Percentage or mean (SD)
Relationship to child	
Mother	78.7%
Father	21.0%
Other	0.3%
Age in years, mean (SD)	35.3 (7.6)
Racial group (n=622)	
White	71.2%
Black	22.7%
Mixed race	1.0%
Asian	2.7%
Other	2.4%
Hispanic or Latino (n=621)	2.6%
Education level (n=624)	
High school, no diploma	2.2%
High school graduate or GED	10.1%
College- no degree	22.9%
Associate's degree or equivalent	14.7%
Bachelor's degree	28.0%
Graduate or professional degree	22.0%
Employment Status	
Full-time (40 or more hours/week)	57.8%
Half-time (20-39 hours/week)	10.2%
Employment status (cont)	
Part-time	7.2%
Student	3.0%
Stay-at-home parent	20.9%
At least one child <5 years old (n=626)	64.5%
Family type (n=624)	
Two-parent family	83.7%
One-parent family	15.5%
Other	0.8%
Family income/year (n=587)	
<\$30,000	21.3%
\$30,000 to <\$60,000	24.2%
\$60,000 to <\$100,000	27.1%
\$100,000 or more	27.4%
Health insurance (n=620)	
Work-related insurance	72.3%

Characteristic*	Percentage or mean (SD)
Medicaid	22.6%
Self-pay	1.1%
Other	4.0%
Someone smokes regular cigarettes (n=625)	25.8%

Abbreviations: SD, standard deviation

If the number of respondents <628, n for the sample who responded is provided

Table 2
Parent's knowledge of and attitudes towards e-cigarettes and regular cigarettes

Characteristic	All	E-cig homes	Non-E-cig homes	*P-Value
Total N	628	77	551	
Addictiveness of regular cigarettes	n=618	n=73	n=545	
Very	69.9%	69.7%	69.9%	0.05
Moderately	8.2%	9.2%	8.1%	
Minimally	2.1%	6.6%	1.5%	
Not	7.4%	7.9%	7.3%	
Don't know	12.4%	6.6%	13.2%	
Addictiveness of e-cigs	n=620	n=73	n=547	
Very	23.0%	22.4%	23.0%	< 0.001
Moderately	10.8%	15.8%	10.1%	
Minimally	5.0%	21.1%	2.7%	
Not	7.1%	15.8%	5.9%	
Don't know	54.3%	25.0%	58.3%	
E-cigs are a safer alternative to regular cigarettes	n=618	n=74	n=544	
Strongly Agree	7.4%	27.3%	4.6%	< 0.001
Agree	24.8%	49.4%	21.3%	
Disagree	20.3%	7.8%	22.1%	
Strongly Disagree	11.1%	2.6%	12.3%	
Don't know	36.4%	13.0%	39.7%	
Perceived danger to children from e-cigs and e-liquid by route of exposure				
<u>Inhalation</u>	n=616	n=74	n=542	
Very	24.9%	10.4%	26.9%	< 0.001
Moderately	13.9%	11.7%	14.2%	
Minimally	11.6%	16.9%	10.9%	
Not	7.4%	26.0%	4.8%	
Don't know	42.2%	36.1%	43.2%	
<u>Swallowing</u>	n=620	n=73	n=547	
Very	69.0%	73.7%	68.4%	0.019
Moderately	7.9%	10.5%	7.5%	
Minimally	1.9%	5.3%	1.5%	
Not	0.2%	0.0%	0.2%	
Don't know	21.0%	10.5%	22.5%	
<u>Skin contact</u>	n=621	n=74	n=547	
Very	35.4%	31.2%	36.0%	< 0.001
Moderately	16.7%	18.2%	16.5%	
Minimally	9.1%	22.1%	7.3%	
Not	3.0%	6.5%	2.6%	
Don't know	35.7%	22.1%	37.7%	

* Reported p-values are for the comparisons of responses for e-cig using homes and non-using homes. The p-value refers to each 2×5 table and was calculated using Fisher's Exact test.

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Table 3
Parental reasons for using e-cigs (n=29)

	Strongly Agree	Agree	Disagree	Strongly Disagree
To avoid putting others at risk of second-hand smoke	48.3%	41.4%	6.9%	3.5%
To help me quit smoking	48.3%	41.4%	10.3%	0.0 %
Because they are less expensive than regular cigarettes	37.9%	24.1%	34.5%	3.5%
For places where regular smoking is banned	31.0%	31.0%	34.5%	3.5%
I would like to quit using e-cigs	14.8%	44.4%	37.0%	3.7%
To improve my children's health	27.6%	27.6%	34.5%	10.3%