

“Vaping:” Emergence of a New Paraphernalia

Subrata Naskar, Praveen Kumar Jakati

ABSTRACT

As research, has progressed through ages, we have been able to uncover the true nature of nicotine addiction. Humankind is now aware of the various ailments that it brings with it. As the slogan for a smokeless world for a better world has been raised, a new practice called “vaping” has come to the forefront. The use of electronic cigarettes (EC) has been on the rise recently. Claims have been made over its role for nicotine deaddiction as well as reducing harmful use for chronic nicotine abusers. In the current review, we searched the PubMed database for available literatures on this practice. We conclude that though EC has the potential to work wonders in smoking cessation, the unforeseen adverse effects needs to be evaluated first before its large-scale introduction in market through solid evidence-based research.

Key words: Addiction psychiatry, electronic cigarettes, nicotine replacement therapy, smoking cessation

INTRODUCTION


“Giving up smoking is the easiest thing in the world. I know because I’ve done it thousands of times.”

– Mark Twain

Smoking as we know it dates back in human civilization to almost 5000 B.C. When it was a part of shamanistic rituals of ancient America. With the advent of tobacco in Europe in the 16th century, it rapidly gained popularity among the general population. With the addiction, came various methods of enjoying it, and nicotine paraphernalia is evolving throughout the ages. “Paraphernalia most commonly refers to a group of apparatus, equipment, or furnishing used for a particular activity.”^[1] The most well-known tool for tobacco users

is definitely cigarettes, and it was Washington Duke from North Carolina, United States, who produced the first commercial cigarettes in 1865. More than a millennium has passed by since its advent. The world has changed dramatically with the advent of electronic revolution. To keep in pace, man’s paraphernalia have evolved. In 2003, Hon Lik a Chinese pharmacist developed the earliest model of e-cigarettes (EC).^[2] The very next year (2004), Ruyan Group (Holdings) Ltd., from China patented the very first EC or “e-cigarettes” or “electronic nicotine delivery device” (ENDD).^[3] The device vaporizes a liquid which is inhaled by the user, from which the term “vaping” has emerged.

While the world is now more aware on the implications and consequences of long-term smoking, the marketing

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strategy for the “tobacco hungry” population has changed. Now, focus is more on “safe smoking” or “tobacco cessation tool.” Because of the realistic look, taste, and sensory satisfaction with an added promise of smoking cessation, EC has been accepted by the population in many parts of the globe. However, the real question still stands! Is it really effective or is it just a marketing gimmick?

THE ELECTRONIC NICOTINE DELIVERY DEVICE

EC is a battery powered device that emerged as an alternative to other traditional nicotine delivery systems such as cigars, pipes, or cigarettes. The idea is nicotine delivery without combustion in vapor form that provides a physical sensation and flavor similar to that of inhaled tobacco smoke. It is usually a tube of stainless steel inside which there are multiple micro-electric components with an outward appearance of a cigarette. One end contains a light connected with a battery while the other end contains an inhaler cartridge connected to container containing a liquid preparation. Other micro-components such as control circuit, pneumatic airflow sensor switch, and vaporizer, are present in the tube. Battery connects the light on one end and on the other it is connected with a vaporizer which has a heating device connected with a pneumatic switch and smoking liquid container.^[4]

Electronic-cigarette cartridge

An EC cartridge is usually a refillable or replaceable cylinder which contains numerous chemicals that produces the aerosol. Chemicals that are usually found in the cartridges are nicotine, menthol, safrole, propylene glycol, 1,3-butanediol, 1,3-propanediol, ethylene glycol, glycerol, ethyl vanillin, camphor, α -thujone, coumarin, and diethylene glycol.^[5]

Mechanism of operation

When the battery is turned on the pneumatic switch gets activated by inhaler pressure which further activates the electronic circuit by magnetic induction. When the circuit gets activated two things occur simultaneously. The light of the EC turns red, and the vaporizer atomizes the liquid present in the container. When individual stops inhaling, the inhaler pressure falls turning off the pneumatic switch, thus, disabling the circuit. Most parts of the EC are replaceable and reusable. When the light at the front becomes dimmer, one needs to change the battery; the cartridge needs replacement when the smoke quantity decreases.^[4]

Method of literature search

A search of PubMed database was made with keyword “EC*” and search filters were set to “Title” only and

“Clinical Trials.” The search conducted on September 20, 2016, resulted in 13 articles. Full-text articles were obtained by the authors and reviewed separately. Finally, all the 13 studies were included in the study.^[6-18]

RESULTS

The 13 studies included in this review are summarized in Table 1. Seven among the 13 included studies commented on the desire to smoke of study individuals and possibility of its role in smoking cessation.^[6,11,13,14,16-18] Three studies commented on the acceptability and tolerability of EC.^[6,16,18] Only one study^[11] commented on the overall awareness of EC in their study participants. Four articles studied on the risk factors of getting addicted to EC,^[9,11,12,14] two articles on user satisfaction and acceptance^[15,16,18] commented on the safety of the device, whereas two other studies studied on the possible adverse effects of EC.^[8,10]

DISCUSSION

According to the studies included in the review, the lifetime prevalence of EC use is 4.7%.^[12] The various aspects of EC use as evaluated by various included studies are presented as follows.

Electronic-cigarettes in smoking cessation and modifying desire to smoke

Most of the included studies in this review has given positive comments on the possible role of EC in smoking cessation and decreasing the desire to smoke. A 2010 study conducted in New Zealand using a 16 mg V8 ENDD commented that only overnight abstinence from smoking it reduced the desire to smoke significantly. Another clinical trial conducted in Italy in 2011 on adult-dependent smokers commented that a trial with EC showed 50% reduction in number of cigarettes/day in 32.5% of the test participants, sustained reduction of 80% was obtained in 12.5% of participants and 22.5% reported complete sustained abstinence after 24 weeks. Another Italian study conducted in 2014 by Gallus *et al.*^[11] reported a 67.7% reduction in traditional cigarette consumption, and reported that 10.4% of their study participants quit smoking. Steinberg *et al.*^[16] found that 76% of their study participants were willing to make a quit attempt using an EC in sharp contrast to 24% of participants who preferred an inhaler. Furthermore, abstinence rate was much higher after a 3-day trial with EC over inhalers. Wagener *et al.*^[17] reported that there was a 44% reduction in regular cigarette smoking while using the EC, provided that the total tobacco use/day was same.

In contrast to these finding, King *et al.*^[13] reported a statistically significant finding that passive exposure

to EC cues increases the urge to smoke an EC unlike that of a regular cigarette. Probably, the “coolness” tag associated an EC along with the added technology flash guides a nonsmoker to try an EC. Similarly, Prochaska and Grana, 2014^[14] reported no significant change in smoking status or reduction in cigarettes/day among smokers with the use of EC in their trial conducted over a period of 18 months.

Acceptance and tolerability

Steinberg *et al.*,^[16] and Polosa *et al.*, 2011^[18] both commented on the higher acceptance and tolerability of EC. When compared with other ENDD, EC has higher acceptability than inhalers.

Risk factors

Prochaska and Grana^[14] in their study with 956 participants found the use of EC increased rapidly over a period of 4 years (2009–2014) from 0% to 25%. Hence, the risk of getting addicted to this tool of deaddiction is strongly present. The use was significantly higher among the smokers in the preparation phase of quitting. Risk factors that are found to have a positive association with EC addiction are male gender (however, Gallus *et al.*^[11] found no significant differences in sex), having family (especially siblings), or friends on traditional cigarettes and older age group.^[12] Adolescents who are

exposed to commercial advertisements of EC were at a higher risk of future EC use,^[9] especially because of the “coolness” factor^[16] associated with it. Protective factors were higher levels of literacy, physical exercise,^[12] female gender, and nonsmokers.^[11]

Safety and adverse effects

Schober *et al.*^[15] performed a safety profile study on EC consumers and commented that, though not combustible, EC is not totally emission free. EC liquid produces supersaturated 1,2-propanediol vapor that causes increased production of nitric oxide (an inflammatory signaling molecule). The use of EC causes significant cough reflex suppression as shown by Dicipinigitis *et al.*^[8] An Italian study by Ferrari *et al.*^[10] however, claims that though there are side effects, those are not immediate.

CONCLUSION

The popularity of EC has increased over past few years rapidly. Owing to its technological bling and marketing tag of being “a safe alternative to traditional cigarettes, modern man has accepted it readily.” However, as we can see, a search of quality research work on this new paraphernalia yielded only a handful of articles. In this review, we have tried to bring out the main

Table 1: Details of included studies in the review

Study name	Clinical trial number	Place where conducted	Number of participants	Study design	Findings
Bullen <i>et al.</i> , 2010 ^[6]	12607000587404, Australia and New Zealand Clinical Trials Register	Auckland, New Zealand	40 adult-dependent smokers of 10 or more cigarettes per day	Participants were randomized to use ENDDs containing 16 mg nicotine or 0 mg capsules, Nicorette nicotine inhalator or their usual cigarette on each of four study days 3 days apart, with overnight smoking abstinence before use of each product	“The 16 mg Ruyan V8 ENDD alleviated desire to smoke after overnight abstinence, was well tolerated and had a pharmacokinetic profile more like the Nicorette inhalator than a tobacco cigarette. Evaluation of the ENDD for longer-term safety, potential for long-term use and efficacy as a cessation aid is needed” ^[6]
Polosa <i>et al.</i> , 2011 ^[18]	ClinicalTrials.gov NCT01195597	Catania, Italy	n=40 regular smokers	Study participants were invited to attend a total of five study visits: at baseline, week 4, week 8, week 12, and week 24. Product use, number of cigarettes smoked, and eCO levels were measured at each visit. Smoking reduction and abstinence rates were calculated. Adverse events and product preferences were also reviewed	“Sustained 50% reduction in the number of cig/day at week 24 was shown in 13/40 (32.5%) participants; their median of 25 cigarettes/day decreasing to 6 cigarettes/day ($P<0.001$). Sustained 80% reduction was shown in 5/40 (12.5%) participants; their median of 30 cigarettes/day decreasing to 3 cigarettes/day ($P=0.043$). Sustained smoking abstinence at week-24 was observed in 9/40 (22.5%) participants, with 6/9 still using the EC by the end of the study. Combined sustained 50% reduction and smoking abstinence was shown in 22/40 (55%) participants, with an overall 88% fall in cigarettes/day. Mouth (20.6%) and throat (32.4%) irritation, and dry cough (32.4%) were common but diminished substantially by week-24. Overall, 2-3 cigarettes/day were used throughout the study. Participants’ perception and acceptance of the product was good” ^[18]

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Study name	Clinical trial number	Place where conducted	Number of participants	Study design	Findings
Caponnetto <i>et al.</i> , 2014 ^[7]	ClinicalTrials.gov, NCT01979796	Catania, Italy	150 schizophrenic regular smokers	12-month randomized clinical study to evaluate smoking reduction, smoking abstinence and adverse events in schizophrenic smokers not intending to quit. Quality of life, neurocognitive functioning and measure participants' perception and satisfaction of the product has to be assessed	Trial is ongoing
Gallus <i>et al.</i> , 2014 ^[11]	-	Italy	3000 individuals, representative of the Italian population aged ≥ 15 years	Data from a face-to-face survey conducted in 2013	"Awareness of EC was 91.1%; it was lowest among women (87.8%), the elderly (78.4%), those with less education (84.1%), and never-smokers (89.0%). Ever EC use was 6.8% overall and was inversely related to age, whereas no significant difference was observed according to sex. With regard to smoking status, 2.6% of never-smokers, 7.0% of ex-smokers, and 20.4% of current smokers tried the EC at least once. Regular EC use was 1.2% overall, 1.5% among men, and 0.9% among women, and it was highest among young (2.4%) and current smokers (3.7%). Among 36 EC regular users, 22.0% did not change their smoking habit, 67.7% reduced traditional cigarette consumption, and 10.4% quit smoking" ^[11]
King <i>et al.</i> , 2015 ^[13]	-	USA	Young adult daily smokers (age 18-35 years; $n=60$) completed	Subjective ratings before and after exposure to a study confederate drinking bottled water (control cue) and then smoking either a combustible or EC (active cue) were given by study participants. Smoking desire and urge ratings were measured with visual analog scale items for desire for a regular and an EC and the brief questionnaire of smoking urges	"Passive exposure to both the EC and combustible cigarette cue significantly increased observers' ratings of desire and urge to smoke a regular cigarette ($P<0.05$). Exposure to the EC cue but not the regular cigarette cue also increased desire to smoke an EC ($P<0.01$)" ^[13]
Prochaska and Grana, 2014 ^[14]	-	Canada	$n=956$ (between 2009-2013)	Study aimed at evaluating frequency and correlates of EC use reported over the 18-month trial and changes in smoking behavior by EC use	"EC use was 11% overall, and by year of enrollment, increased from 0% in 2009 to 25% in 2013. In multiple logistic regression the likelihood of EC use was significantly greater with each additional year of recruitment, for those aged 18-26, and for those in the preparation versus precontemplation stage of change. EC use was unrelated to gender, psychiatric diagnosis, and measures of tobacco dependence at baseline. Further, over the 18-month trial, EC use was not associated with changes in smoking status or, among continued smokers, with reductions in cigarettes per day" ^[14]
Schober <i>et al.</i> , 2014 ^[15]	-	Germany	$n=9$	The study analyzed the levels of EC pollutants in indoor air and monitored effects on FeNO release and urinary metabolite profile of the participants. For comparison, the components of the EC solutions (liquids) were additionally analyzed	The study demonstrated that "EC are not emission-free and their pollutants could be of health concern for users and second-hand smokers. In particular, ultrafine particles formed from supersaturated 1,2-propanediol vapor can be deposited in the lung, and aerosolized nicotine seems capable of increasing the release of the inflammatory signaling molecule NO upon inhalation. In view of consumer safety, EC and nicotine liquids should be officially regulated and labeled with appropriate warnings of potential health effects, particularly of toxicity risk in children" ^[15]

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Study name	Clinical trial number	Place where conducted	Number of participants	Study design	Findings
Steinberg <i>et al.</i> , 2014 ^[16]	-	USA	n=41 (>18 years)	The objective was to compare the EC with the nicotine inhaler in terms of perceived benefits, harms, appeal, and role in assisting with smoking cessation. The mCEQ measured satisfaction, reward, and aversion. Participants were also asked about each product's helpfulness, similarity to cigarettes, acceptability, image, and effectiveness in quitting smoking. Cigarette use was also recorded during the product use periods	"The EC had a higher total satisfaction score (13.9 vs. 6.8 [$P<0.001$]; range for responses 3-21) and higher reward score (15.8 vs. 8.7 [$P<0.001$]; range for responses 5-35) than the inhaler. The EC received higher ratings for helpfulness, acceptability, and "coolness." More participants would use the EC to make a quit attempt (76%) than the inhaler (24%) ($P<0.001$). 18% (7/38) of participants abstained from smoking during the 3-day periods using the EC versus 10% (4/38) using the inhaler ($P=0.18$)" ^[16]
Wagener <i>et al.</i> , 2014 ^[17]	-	USA	Initial selection of n=20 as per selection criteria, n=19 completed experimentations, n=16 completed ad libitum phase measures	The aim was to study changes in smokers' readiness and confidence to quit smoking, smoking behavior, nicotine withdrawal symptoms, and tobacco product preference following EC experimentation and 1 week of ad libitum use. Outcome measures included readiness and confidence to quit smoking, nicotine withdrawal symptoms, product preference/satisfaction, and smoking behavior items	"Readiness and confidence to quit increased significantly during the experimentation period and continued to increase during ad libitum use. There were no significant differences in reported effectiveness in reducing smoking urges and cravings between OBC and EC though OBC were rated as more enjoyable and satisfying. During ad libitum use, regular cigarette smoking decreased by approximately 44% from baseline levels with overall tobacco use (EC + OBC) remaining the same" ^[17]
Farrelly <i>et al.</i> , 2015 ^[9]	-	USA	3655 adolescents aged 13-17 years who had never tried EC	Adolescents in the treatment group viewed four EC TV advertisements. Intention was to study whether exposure to EC TV advertisements influences intentions to use EC in the future and related attitudes	"Adolescents in the treatment group reported a greater likelihood of future EC use compared with the control group. ORs for the treatment group were 1.54 ($P=0.001$) for trying an EC soon; 1.43 ($P=0.003$) for trying an EC within the next year; and 1.29 ($P=0.02$) for trying an EC if a best friend offered one. Adolescents in the treatment group had higher odds of agreeing that EC can be used in places where cigarettes are not allowed (OR=1.71, $P<0.001$); can be used without affecting those around you (OR=1.83, $P<0.001$); are a safer alternative to cigarettes (OR=1.19, $P=0.01$); and are less toxic (OR=1.16, $P=0.03$)" ^[9]
Ferrari <i>et al.</i> , 2015 ^[10]	NCT02102191	Bologna, Italy	n=20 (n=10 healthy smokers, n=10 nonsmokers)	The aim was to compare the effects of standard commercial cigarettes or nicotine free EC for 5 min in healthy adult smokers (n=10) and nonsmokers (n=10). Outcome was measured using pulmonary function tests, FeNO and FeCO in exhaled breath	"The short-term use of the specific brand of NF EC assessed in this study had no immediate adverse effects on nonsmokers and only small effects on FEV1 and FEF25 in smokers" ^[10]
Hanewinkel and Isensee, 2015 ^[12]	-	Germany	n=2693 adolescents (mean age=12.5 years; SD=0.6)	The aim was to evaluate risk factors that are associated with EC use in adolescents. Sociodemographic details were collected, personal characteristic, sensation-seeking was assessed with three items questionnaire; Parent, sibling and peer conventional cigarette smoking were assessed as factors from social environment (no vs. any parent/sibling/peer smoking). Lifetime conventional cigarette smoking was assessed by asking how many cigarettes have ever been smoked in life	"Use of EC as well as use of conventional cigarette and dual use were associated with higher sensation seeking scores, and higher odds of having friends and parents who smoke conventional cigarettes, with conventional cigarette use additionally with male gender, being older, having higher odds of siblings who smoke conventional cigarettes, and less likely for adolescents who attend a gymnasium, secondary school with a strong emphasis on academic learning. The use of conventional cigarettes at baseline did not predict EC use at follow-up. Lifetime prevalence of EC use was 4.7%, of conventional cigarette use 18.4%. A quarter of EC users (23.8%) never smoked a conventional cigarette" ^[12]

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Study name	Clinical trial number	Place where conducted	Number of participants	Study design	Findings
Dicpinigaitis <i>et al.</i> , 2016 ^[8]	ClinicalTrials.gov; No.: NCT02203162	USA	n=30, healthy nonsmokers	Cough reflex sensitivity measurement was done using capsaicin cough challenge at baseline, 15 min, and 24 h after EC exposure (30 puffs 30 s apart). The end point of cough challenge is the concentration of capsaicin inducing C5. The number of coughs induced by each EC inhalation was counted. A subgroup of individuals (n=8) subsequently underwent an identical protocol with a nonnicotine-containing EC	“Cough reflex sensitivity was significantly inhibited (C5 increased) 15 min after EC use (-0.29; 95% CI, -0.43--0.15; P<0.0001); 24 h later, C5 returned to baseline (0.24; 95% CI, 0.10-0.38; P=0.0002 vs. post 15-min value). A subgroup of eight individuals demonstrating the largest degree of cough reflex inhibition had no suppression after exposure to a nonnicotine-containing EC (P=0.0078 for comparison of DC5 after nicotine vs. nonnicotine device). Furthermore, more coughing was induced by the nicotine-containing versus nonnicotine-containing device (P=0.0156)” ^[8]

ENDDs – Electronic nicotine delivery devices; eCO – Exhaled carbon monoxide; EC – Electronic cigarettes; FeNO – Fraction of exhaled nitric oxide; FeCO – Fractional concentration of carbon monoxide; NO – Nitric oxide; mCEQ – Modified Cigarette Evaluation Questionnaire; OBC – Own brand of cigarette; ORs – Odds ratios; FEV1 – Forced expiratory volume 1; SD – Standard deviation; C5 – Five or more coughs; CI – Confidence interval; FEF25 – Forced expiratory flow 25%; NF – Nicotine-free

headlines of current researches. Although marketed as a noncombustible nicotine delivery system with minimal side-effects, one study has shown that EC is not emission free and has certain adverse effects. Most of the other studies, however, has mentioned about its potential use in smoking cessation and nicotine deaddiction with good acceptability and satisfaction. However, most of them had one major limitation, i.e., they were conducted on a minimal sample. They all insisted on the requirement of further research to establish their findings. The FDA has reported the presence of harmful chemicals such as nitrosamines and diethylene glycol in the e-liquids and recommended that EC use should be controlled.^[19] Literature search could not find any relevant Indian studies on this issue. However, like other nations, EC has made its way in Indian market too. Hence, though EC has the potential to work wonders in smoking cessation, the unforeseen adverse effects needs to be evaluated first before its large-scale introduction in market through solid evidence-based research. Researchers from developing countries should take up a firm initiative too, to look into the matter and provide opinions.

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Conflicts of interest

There are no conflicts of interest.

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