

Electronic Cigarettes: A Nicotine Replacement Therapy?

Justin J. Hicks, Jonathan F. Barnett

Introduction

Electronic cigarettes (ECs), also known as electronic nicotine delivery systems (ENDS) and e-hookahs, are products designed to deliver nicotine without many of the disease-causing toxic products of conventional cigarette (CC) tobacco combustion. Invented in the early 2000s by a Chinese pharmacist whose father died of lung cancer,¹ ECs, upon a user's drag, heat a nicotine-containing mixture that produces an aerosol which is inhaled (Figure 1). They have become widely available and have risen in popularity, rapidly surpassing interest in many other tobacco and nicotine products in recent years.² Initially manufactured by smaller companies, major tobacco companies began to produce and market ECs in 2012 with Lorillard's purchase of blu eCigs, followed by Reynolds American's production of VUSE. Global sales of ECs in 2014 totalled \$7 billion compared to \$800 billion for other tobacco products.³

There is a variety of EC designs. It has been estimated that there are approximately 500 EC brands with more than 7700 flavors, including tobacco, menthol, and fruit-inspired flavors.⁵ Products have appearances that can range from tobacco paraphernalia, like cigarettes and cigars, to more distinctive or discrete options such as pens, bulbs and USB flash drives. There is also great variability in EC manufacturing techniques, chemical and mechanical composition as well as opportunities for modification.

FDA Regulation

Tobacco is the leading cause of preventable death in America. The U.S. Food and Drug Administration (FDA) reports that the annual number of deaths attributable to tobacco has risen to over 480,000. The Tobacco Control Act of 2009 empowered

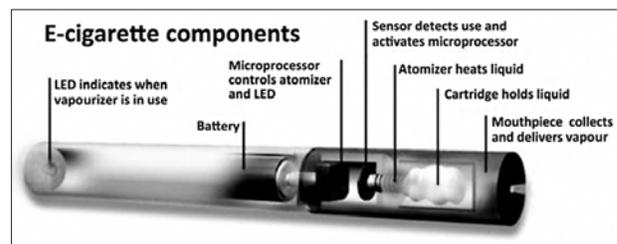


Figure 1. Diagram of electronic cigarette components.⁴

the FDA to regulate tobacco, though only certain forms of nicotine are regulated, not including ECs.² In April of 2014, the FDA sought to extend its regulatory power; however, it may be years before proposed rules are finalized. This is a public health concern as new products will continue to be marketed without regulation while popularity rises.

Smoking Cessation

In a four country survey, 79.8% of reported users of ENDS considered them less harmful than CCs, 75% stated that using ENDS will help them reduce smoking, and 85% reported using ENDS to help them quit smoking.⁶

Studies evaluating ECs efficacy in aiding cessation have been inconsistent.⁷⁻¹¹ A few studies have demonstrated that current smokers who use ECs have a greater reduction in CC use over time than those who do not.^{6,7} Still, there is concern that dual use of ECs in banned locations alongside CCs in smoking permitted areas may prevent smoking cessation and increase the prevalence of smokers.¹² Interestingly, in the United Kingdom, ECs have overtaken the use of nicotine replacement therapy (NRT). This trend coincides with increased successful quit attempts and decreased smoking prevalence over the same time period.¹³

It appears that EC use decreases CC consumption and may contribute to smoking cessation. However, findings vary and further studies are needed to confirm these effects, especially in comparison to FDA approved NRT, behavioral therapy and counseling. To address this issue a National Institute of Health consensus conference has outlined the necessity of and approach to future research efforts.¹⁴

Harm Reduction, Abstinence, and Renormalization

There are two general philosophies of tobacco control: abstinence and harm reduction. Harm reduction aims to mitigate the harm of the nicotine consumption behavior, especially in individuals unwilling or unable to quit smoking.¹⁵ In theory, ECs may decrease the risk of deleterious health effects, such as lung cancer and COPD. Although ECs do not produce the tar and many combustion toxins that are associated with tobacco smoke, certain types have generated toxic carbonyl compounds, like the carcinogen formaldehyde, yet at levels lower than CCs.¹⁶ At higher battery voltage certain ECs have produced significant amounts of formaldehyde hemiacetal that may release formaldehyde in the body, although the exact effects are presently unknown.¹⁷ Notably, toxin levels have been found to vary with the composition of the nicotine — containing solvent mixture in addition to differences in battery voltage.^{16, 17} Further investigation in this area would be of value and may inform future regulation.

Youth are historically the target of tobacco companies as most smokers begin using tobacco during adolescence.¹⁸ Youth use of certain unregulated tobacco products, such as ECs and cigars, is on the rise.^{2, 5} Young people who use ECs but never used CCs jumped to 263,000 in 2013 from 79,000 in 2011.¹⁹ It is therefore feared that the use and popularity of ECs may lead to a new generation of smokers following decades of social movements, political work, and litigation reversing the normalization of smoking in our culture. As such, any possible harm reduction with EC use on a population scale must be weighed against the increasing number of youth smokers.

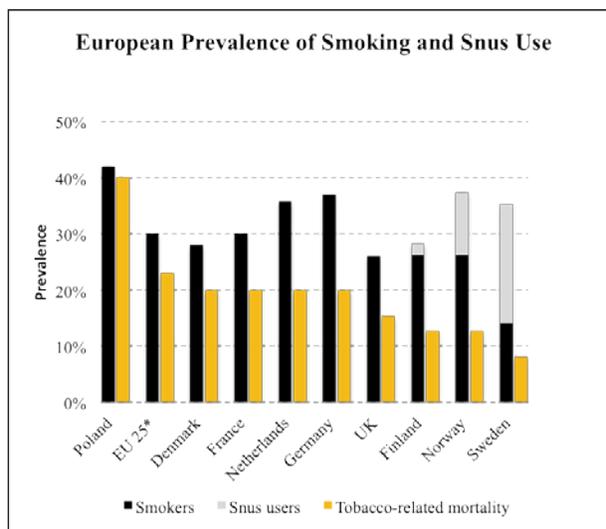


Figure 2. Comparison of smoking, snus, and tobacco — related mortality.²⁴

In 1976, Professor Michael Russell wrote that, “People smoke for nicotine, but they die from the tar.”²⁰ Nicotine is highly addictive and leads to compulsive smoking behavior; smokers often try and fail in their attempts at smoking cessation. Proponents therefore believe that if the consumption of nicotine is made less harmful, then cancer risk and other adverse effects of smoking can be reduced. Swedish “snus” is an example of the type of attempted harm reduction. Snus is an oral form of tobacco that is placed between the lips and gums. Swedish tobacco — related mortality is the lowest in the world, which correlates with a higher rate of snus use and a lower rate of smoking (Figure 2). Relative risk for pancreatic cancer in snus users is 2.0 vs 2.8 for cigarette smoking, likely due to decreased nitrosamines.²¹ Proponents argue that these findings support the theory that while nicotine delivery with less toxins and carcinogens is not completely safe, it is safer than CCs. They believe ECs will have similar effects. However, the American Thoracic Society and the Forum of International Respiratory Societies have both underscored that neither the health risk nor the potential benefits, including harm reduction and enhancing smoking cessation, have been adequately studied. It has been advised that ECs should be restricted or banned; if allowed, they should be regulated as medicines or tobacco products.^{22, 23}

Conclusion

ECs are rapidly growing in popularity and very little is definitively known about them. Current smokers and youth are among the groups most impacted by their rise. For current smokers, we recognize that ECs may provide another tool for smoking cessation, may decrease CC use and may provide a safer option to those unwilling or unable to stop smoking. Before clear conclusions can be drawn about the possible benefit of ECs further research must be done to ensure their safety and efficacy. Additionally, action must be taken to prevent the emergence of another generation negatively affected by nicotine addiction and associated health problems.

Authors

Author Affiliations: Wake Forest School of Medicine, Winston-Salem, NC 27157

Sources of Funding: There was no funding for this project.

Conflicts of Interest: The authors have no conflicts of interest to report.

Address correspondence to:

Justin Hicks
 Medical Student
 Wake Forest School of Medicine
 Winston-Salem, NC 27157
 Email: juhicks@wakehealth.edu

Acknowledgements

The authors would like to acknowledge Dr. Edward F. Haponik, Professor of Pulmonary, Critical Care, Allergy and Immunologic Diseases, Wake Forest University School of Medicine for his guidance and insightful discussions while completing this piece.

Sources

- Demick B, A High-Tech Approach to Getting a Nicotine Fix. Los Angeles Times, 2009. Accessed November 1, 2014. Available from: <http://articles.latimes.com/2009/apr/25/world/fg-china-cigarettes25>.
- Association AL, American Lung Association statement on e-cigarettes. 2013.
- Evans P, E-Cigarette Makers Face Rise of Fakes. The Wall Street Journal, 2015. Accessed March 9, 2015. Available from: <http://www.wsj.com/articles/e-cigarette-makers-face-rise-of-counterfeits-1424441348>.
- Foulds JS, Veldheer, and Berg A, Electronic cigarettes (e-cigs): views of aficionados and clinical/public health perspectives. *Int J Clin Pract*, 2011. 65(10): p. 1037-42.

- Etter JF, and C. Bullen. Electronic cigarette: users profile, utilization, satisfaction and perceived efficacy. *Addiction*, 2011. 106(11): p. 2017-28.
- Adkison, S.E., et al. Electronic nicotine delivery systems: international tobacco control four-country survey. *Am J Prev Med*, 2013. 44(3): p. 207-15.
- Caponnetto P, et al. Successful smoking cessation with electronic cigarettes in smokers with a documented history of recurring relapses: a case series. *J Med Case Rep*, 2011. 5: p. 585.
- Chapman S, Should electronic cigarettes be as freely available as tobacco cigarettes? *No. BMJ*, 2013. 346: p. f3840.
- Farsalinis KE, and G. Romagna. Chronic idiopathic neutrophilia in a smoker, relieved after smoking cessation with the use of electronic cigarette: a case report. *Clin Med Insights Case Rep*, 2013. 6: p. 15-21.
- Grana RA, Popova L, and Ling PM, A longitudinal analysis of electronic cigarette use and smoking cessation. *JAMA Intern Med*, 2014. 174(5): p. 812-3.
- Schneiderhan ME, A case report of patient-initiated e-cigarette use and resulting 5-months smoking cessation. *Journal of Pharmacy Practice*, 2012. 25(2): p. 297.
- McMillen R, Maduka J and Winickoff J, Use of emerging tobacco products in the United States. *J Environ Public Health*, 2012. 2012: p. 989474.
- West R, Brown J and Beard E, Electronic cigarettes in England - latest trends. *Smoking in England*. 2014.
- Walton KM, et al. NIH electronic cigarette workshop: developing a research agenda. *Nicotine Tob Res*, 2015. 17(2): p. 259-69.
- Abrams DB, Promise and peril of e-cigarettes: can disruptive technology make cigarettes obsolete? *JAMA*, 2014. 311(2): p. 135-6.
- Kosmider L, et al. Carbonyl compounds in electronic cigarette vapors: effects of nicotine solvent and battery output voltage. *Nicotine Tob Res*, 2014. 16(10): p. 1319-26.
- Jensen RP, et al. Hidden formaldehyde in e-cigarette aerosols. *N Engl J Med*, 2015. 372(4): p. 392-4.
- Services, U.S.D.o.H.H. 50 Years of Progress: A Report of the Surgeon General, 2014, 2014. Accessed November 15, 2014. Available from: <http://www.surgeongeneral.gov/library/reports/50-years-of-progress/sgr50-chap-1.pdf>.
- Prevention, C.f.D.C.A. National Youth Tobacco Survey, 2013. Accessed November 15, 2014. Available from: http://www.cdc.gov/tobacco/data_statistics/surveys/nyts/.
- Russell, M.A. Low-tar medium-nicotine cigarettes: a new approach to safer smoking. *Br Med J*, 1976. 1(6023): p. 1430-3.
- Foulds, J., et al. Effect of smokeless tobacco (snus) on smoking and public health in Sweden. *Tob Control*, 2003. 12(4): p. 349-59.
- Schraufnagel DE, et al. Electronic cigarettes. A position statement of the forum of international respiratory societies. *Am J Respir Crit Care Med*, 2014. 190(6): p. 611-8.
- Drummond MB, and Upson D, Electronic cigarettes. Potential harms and benefits. *Ann Am Thorac Soc*, 2014. 11(2): p. 236-42.
- ESTOC. The Swedish Experience. European Smokeless Tobacco Council, n.d. Accessed November 15, 2014. Available from: <http://www.estoc.org/key-topics/the-swedish-experience>.