

E-Cigarettes for Quitting Tobacco: Not the Solution!



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Introduction

E-liquids are the solutions that are within, or used to fill, electronic nicotine delivery systems (ENDS), which include e-cigarettes. E-liquids are also known as e-juice by users or sellers of the product and are sold in vape shops, tobacco shops, head shops, and other tobacco retailers. E-liquids produce an aerosol when heated^{1,2} and users³ as well as nonusers¹ inhale this harmful aerosol^{1,4} into their lungs. E-liquids and ENDS usually, but not always, contain nicotine,¹ a highly addictive substance.⁴

When ENDS products were introduced to the market, many in the health care and lay communities speculated that these products could be an additional method of tobacco cessation and help people to stop smoking regular cigarettes. Unfortunately, research has shown that ENDS use does not lead to quitting tobacco or other nicotine products; more than half of those who started using ENDS for tobacco cessation simply transferred their nicotine dependence to ENDS.⁵ Often, ENDS are used as an additional source of nicotine by current smokers.⁶ Perhaps most concerning are the findings regarding ENDS use in adolescents, which is associated with increased initiation of cigarette smoking and increased frequency and intensity of both regular cigarette and e-cigarette usage. ENDS product use among adolescents leads to increased dependence upon nicotine products.⁷ In this paper, we discuss why ENDS products are not an effective, safe, or approved means of tobacco cessation for either adults or adolescents.

The Food and Drug Administration's (FDA) Family Smoking Prevention and Tobacco Control Act of 2009 gives FDA broad authority to regulate tobacco products.⁸ In 2016, the FDA finalized a rule to cover ENDS that meet the definition of a tobacco product.⁹ Thus, the FDA regulates the manufacture, import, packaging, labeling, advertising, promotion, sale, and distribution of ENDS, including components and parts of ENDS, but excluding accessories.¹⁰ However, the FDA states that "it is unable, as a practical matter, to take enforcement action against every illegally marketed tobacco product."^{11(p11)}

The FDA also regulates drugs used for smoking cessation under the Center for Drug Evaluation and Research. It is important to note that no ENDS product is FDA approved for smoking cessation. However, there are many FDA-approved products, three of which are available over the counter (nicotine patches [Nicoderm CQ, Habitrol, and generic versions], nicotine lozenges [Nicorette and generic versions], and nicotine gum [Nicorette and generic

versions]), and four by prescription, including two non-nicotine oral drugs (bupropion [Zyban] and varenicline [Chantix]), a nicotine nasal spray (Nicotrol NS), and nicotine inhalers (Nicotrol). These products have been designed and studied to be used based on specific smoking/nicotine consumption. For example, the nicotine products have a variety of doses that are based specifically on the number of cigarettes smoked and/or time to first morning cigarette to ensure the user experiences the least amount of nicotine withdrawal during the quitting process. Thus, there is no shortage of well-tested, FDA-approved products available to assist with smoking cessation.

Quality Control Concerns

Quality control of ENDS products is of great concern. We focus on two major issues here. One concern is the lack of accuracy between the labeled, or identified, nicotine concentration versus the actual amount of nicotine contained in the e-liquids. A second concern is the lack of quality control standards for e-liquids that are compounded in shops (CIS) by mixing of the e-liquids or the addition of extra nicotine to e-liquids.

Inaccurate nicotine content

The standards of the American E-Liquid Manufacturing Standards Association (AEMSA) state that all products must be within 10% of the labeled nicotine content.¹² A systematic review of 20 scientific articles, published worldwide, found that the labeled nicotine content of refillable e-liquids was not consistent with the actual content.¹³ Almost half the studies found that samples were labeled with incorrect nicotine content,¹³ with some samples varying more than 100% from the label.¹⁴⁻¹⁷ These samples were purchased in retail stores and over the Internet. Inaccurate labeling of nicotine content was more common in the United States (55% of the 289 e-liquids studied) than in the other 10 countries studied (39.5% of the 210 e-liquids studied).¹³

A 2019 study of nicotine-containing e-liquid products purchased from 35 vape shops and other tobacco specialty shops across the state of North Dakota supports these findings.¹⁸ Remarkably, only 3.8% of the 238 samples analyzed in this study contained a concentration of nicotine within the AEMSA guidelines of 10% of the content indicated on the label. This is down from the 48.6% found in a similar North Dakota study from 2015.¹⁴ On average, the actual nicotine content was 34% below the content indicated on the label, with differences ranging from 93% below the indicated content to 213% above the indicated content, which is more than three times the indicated amount.¹⁸ The sample with the highest percent difference was a CIS sample.

Additionally, none of the 25 CIS samples had an actual nicotine content within 10% of the identified content, and a higher percentage of CIS samples (16.0%) had an actual nicotine content more than 10% above the identified content compared with non-CIS samples (2.8%).¹⁸ Six samples purchased off the shelf were not labeled for nicotine; when asked, the shop staff stated that the nicotine content was the same for all products. However, the actual nicotine content ranged from just under 6 mg/ml to almost 20 mg/ml.¹⁸

CIS e-liquids lack quality control

The compounding of e-liquids in shops was observed during the data collection for the 2019 study.¹⁸ The ingredients used in compounding include nicotine, flavorings, and other chemicals. In one shop, vape shop staff were noted to visually estimate quantities of ingredients. Shop staff used bottles with handwritten marker lines and numbers as a visual reference for the quantities of nicotine and other ingredients added to the product; thus, the amount of nicotine added was estimated, not measured precisely. Relabeling of the nicotine content in the e-liquids did not happen in one third (two of six) of the shops where CIS processes were observed. In one case, the nicotine content was increased from 0 mg/ml to 12 mg/ml without relabeling the bottle.

In addition to imprecise mixing of e-liquids during CIS, there are other safety concerns related to CIS.¹⁸ Some staff did not wear protective gloves during the mixing process, and some staff were vaping as they worked. One shop was adjacent to a room designated for fish breeding.

Due to the inconsistencies in compounding and labeling of e-liquids, customers have no way of knowing if the product they purchase contains the amount of nicotine they believe it does. This has implications for individuals who are using e-liquids as a means of tobacco cessation and who may in fact be exposed to significantly higher or lower levels of nicotine than the label states. Exposure to higher levels of nicotine also increases the risk of addiction to these products. E-liquids with levels of nicotine lower than indicated on the label may cause unpleasant withdrawal symptoms. These issues are not concerning when individuals use FDA-approved smoking cessation products under the care of a health care provider.

Other labeling concerns

There are additional labeling concerns. Six e-liquids purchased off the shelf in one store did not identify the nicotine content.¹⁸ Six CIS e-liquids were sold without any labels or markings at all.¹⁹ Some e-liquids were past their labeled expiration dates. Of the 33 free-base e-liquids that had an expiration date on their labels, 24.2% were expired, with some expiring in

2015.¹⁹ E-liquids that were labeled by the manufacturer had inconsistent information about health warnings and product ingredients.¹⁹ Also, 15% did not list any ingredients.¹⁹

Quality control and FDA implications

As part of FDA regulations for tobacco, person(s) that “make, modify, mix, manufacture, fabricate, assemble, process, label, repack, relabel, or import ENDS” must meet certain requirements.^{10(para 11)} Specifically, manufacturers are required to (1) register with the FDA, (2) provide a list of products to the FDA, and (3) file a premarket review application and receive marketing authorization for each individual product.²⁰ It is illegal to market any new tobacco product without premarket authorization by the FDA.¹¹ Although we have not ascertained whether North Dakota shops that compound e-liquids in their shops have filed premarket authorizations, it seems unlikely. Also, whereas the FDA regulates ENDS, it does not perform quality testing of e-cigarettes.²⁰ Additionally, if there are no drug claims (such as for smoking cessation), then there are no specific quality standards or regulations in place for the manufacturing processes of e-cigarettes, nor for the end product.²⁰ At this point, no e-cigarette or similar product has been approved as a drug product; therefore, no e-cigarettes are bound by the restrictions and requirements that apply to FDA regulated drugs.²⁰ The shops in North Dakota that manufacture ENDS are doing so without any guidance from the federal or state government regarding quality standards that would require accurate measurement of nicotine content, accurate labels, or a sanitary manufacturing environment.²⁰

Concerns Related to Using E-Liquids and ENDS for Quitting Tobacco Use

E-cigarette use is a particularly compelling nicotine option for cigarette users because it mimics both the physiological satisfaction of a nicotine craving as well as the psychological satisfaction of the act of smoking and responding to external cues that lead to smoking (time of day, social situations, behavioral triggers). The sensory and physical stimuli associated with cigarette smoking is a deeply embedded aspect of smoking enjoyment and dependence (hand-to-mouth action, deep inhale/exhale, visual cues, throat hit, and tobacco flavor). The close imitation to cigarette smoking is one reason that cigarette users struggle with e-cigarette cessation, even when their original intention is to use e-cigarettes to stop all tobacco use.²¹

A study published in 2020²² found that 88% of employees in 121 Southern California vape shops advise customers on quitting smoking. This is another concerning safety issue. Almost half of these employees had no knowledge of vaping-related research, and 30% were

acquainted with pro-vaping research only. Those who provided advice were more likely than those who did not provide advice to be aware of pro-vaping research only or were unaware of any research studies at all. Fewer than half of these employees considered that the use of vaping products contributes to youth nicotine addiction. Vape shop employees do not have the expertise to counsel customers on tobacco cessation, nor do current clinical guidelines, described later, support their claims.

Tobacco cessation counseling requires training by a medical professional, and counseling is often performed by specialists who have received extensive training through an accredited tobacco treatment specialist training program. These programs are accredited by the Council for Tobacco Treatment Training Programs and are based on published core competencies.²³

Clinician Perspective and Clinical Guidelines

Clinicians practicing in the primary care setting, which can include physicians, physician assistants, nurse practitioners, pharmacists, and others, frequently encounter patients who use ENDS. Health care professionals can positively impact an individual's ability to achieve tobacco cessation, with research showing that health care practitioners' involvement in cessation leads to increased likelihood of success.²⁴ Desire to quit appears to be the strongest predictive factor for successful tobacco cessation, but beyond supporting the desire to quit, health care providers have a number of resources that can be used to assist in cessation efforts.²⁵ Individuals who seek evidence-based assistance, such as guidance from professionals (e.g., North Dakota Tobacco Quitline or NDQuits), nicotine replacement, or quit-smoking medication, are two to three times more likely to successfully quit smoking than those who do not use any form of assistance.²¹

Questions often arise from ENDS users about whether these products are safe and effective and whether they can be used as a tool to stop using traditional tobacco products. There have been many studies conducted worldwide attempting to answer that question; however, there are some problems that clinicians face when interpreting the information from those studies. First, because ENDS products are not actively regulated, this means that if one specific product was included in one study, the results from that study cannot be generalized to the next because of differences in the ENDS product device itself as well as in the liquid ingredients. Second, and as described above, literature has shown that the actual nicotine content in ENDS products can vary, sometimes significantly, from what is stated in the label.^{13,18} Finally, it is difficult to standardize the puff patterns of ENDS products among users (i.e., how much of and how fast

each puff is inhaled, which can lead to variable amounts of chemicals inhaled among users). This is often not standardized in ENDS clinical trials, thus leading to a study population that uses their ENDS products with wide variability. This means that the study participants are inhaling and absorbing different amounts of nicotine, making comparisons difficult.

Some clinical guidelines have tried to summarize all the studies to determine whether ENDS products can be recommended by clinicians in any way. In 2018, the American College of Cardiology published a Decision Pathway to guide practicing cardiology clinicians to help patients quit tobacco.²⁶ Specifically related to ENDS products, the document recommended that “given the uncertainties of the long-term effects of e-cigarettes on health, a clinician should advise cigarette smokers seeking to quit to use evidence-based, FDA-approved, safe, and effective smoking cessation pharmacotherapies as first-line treatments in preference to e-cigarettes.”^{26(p3355)} However, the document notes that some patients will choose to use ENDS products even if FDA-approved treatments are recommended. Therefore, if that is the case, the clinician should be supportive and help the patient to use the product in the safest way possible, with the ultimate goal of quitting both tobacco products and ENDS products.

In May 2020, the American Thoracic Society published a clinical practice guideline for clinicians focused on starting medication treatment in adult tobacco users.²⁷ One recommendation was that varenicline, a popular oral medication to assist with tobacco cessation, is recommended over ENDS products. The guideline suggests that based on current published evidence comparing varenicline with ENDS products, the benefit of varenicline over ENDS is uncertain; however, experience shows that varenicline had fewer adverse events than ENDS products, indicating that it is a safer option for tobacco cessation. Additional studies comparing varenicline with ENDS are needed to support the recommendation with more confidence.

In June 2020, the United States Preventive Services Task Force (USPSTF) published a draft recommendation statement that concluded that the “current evidence is insufficient to assess the balance of benefits and harms of electronic cigarettes (e-cigarettes) for tobacco cessation in adults, including pregnant persons. The USPSTF recommends that clinicians direct patients who use tobacco to other cessation interventions with proven effectiveness and established safety.”²⁴ This statement was drafted after performing a thorough review of all available studies to evaluate the benefits and risks of various health care provider efforts to assist adults with tobacco cessation.

Based on the available evidence and guidance from various clinically focused organizations, clinicians should be aware of the many risks associated with ENDS products, as well as the lack of proven benefit when using ENDS as a tobacco cessation method. Avoidance of ENDS products should be recommended; however, when that is not possible, approaching ENDS products in the same manner as a tobacco product would ensure that the patient will eventually achieve both tobacco cessation as well as ENDS abstinence.

Conclusion

The science is still developing on the short- and long-term effects of ENDS on health and tobacco cessation efforts. Quality control of ENDS products is lacking, as evidenced by inaccurate nicotine content and problematic CIS processes of e-liquids. The actual nicotine content in ENDS products is often unknown; this makes it difficult to calculate the replacement of regular cigarettes with e-cigarettes containing equivalent levels of nicotine. At this time, there are no health care provider guidelines that recommend ENDS as a safe or effective means to quit tobacco use, but instead recommend the seven products approved by the FDA that are proven to be safe and effective for smoking cessation. Because the FDA currently acknowledges that it cannot act against all illegal tobacco products, FDA regulations are unlikely to be effectively enforced in North Dakota. Therefore, at this time, the authors concur with current science-based guidelines that the use of ENDS for tobacco cessation is not recommended.

References

1. National Academies of Sciences, Engineering, and Medicine. (2018). *Public health consequences of e-cigarettes*. The National Academies Press. <https://doi.org/10.17226/24952>
2. U.S. Department of Health and Human Services. (2016). *E-cigarette use among youth and young adults*. https://www.cdc.gov/tobacco/data_statistics/sgr/e-cigarettes/pdfs/2016_sgr_entire_report_508.pdf
3. World Health Organization. (2019). *WHO report on the global tobacco epidemic, 2019*. <https://apps.who.int/iris/bitstream/handle/10665/326043/9789241516204-eng.pdf?ua=1>
4. Office on Smoking and Health. (2016). *E-cigarette use among youth and young adults: A report of the Surgeon General*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. https://www.cdc.gov/tobacco/data_statistics/sgr/e-cigarettes/index.htm
5. Pierce, J. P., Benmarhnia, T., Chen, R., White, M., Abrams, D. B., Ambrose, B. K., Blanco, C., Borek, N., Choi, K., Coleman, B., Compton, W. M., Cummings, K. M., Delnevo, C. D., Elton-Marshall, T., Goniewicz, M. L., Gravely, S., Fong, G. T., Hatsukami, D., Henrie, J., . . . Messer, K. (2020). Role of e-cigarettes and pharmacotherapy during attempts to quit cigarette smoking: The PATH study 2013-16. *PLoS One*, 15(9). <https://doi.org/10.1371/journal.pone.0237938>
6. Martinasek, M. P., Bowersock A., & Wheldon, C. W. (2018, July). Patterns, perception and behavior of electronic nicotine delivery systems use and multiple product use among young adults. *Respiratory Care*, 63(7), 913-919. <https://doi.org/10.4187/respcare.06001>
7. Selph, S., Patnode, C. D., Bailey, S. R., Pappas, M., Stoner, R., Hart, E., & Chou, R. (2020). *Primary care interventions for prevention and cessation of tobacco use in children and adolescents: A systematic review for the U.S. Preventive Services Task Force* (Evidence Synthesis No. 185). Agency for Healthcare Research and Quality. <https://www.ncbi.nlm.nih.gov/books/NBK556871/>
8. U.S. Food and Drug Administration. (2020, June 3). *Family Smoking Prevention and Tobacco Control Act - An overview*. <https://www.fda.gov/tobacco-products/rules-regulations-and-guidance/family-smoking-prevention-and-tobacco-control-act-overview>
9. Deeming tobacco products to be subject to the Federal Food, Drug, and Cosmetic Act, as amended by the Family Smoking Prevention and Tobacco Control Act; restrictions on the sale and distribution of tobacco products and required warning statements for tobacco products. <https://www.federalregister.gov/d/2016-10685>
10. U.S. Food and Drug Administration. (2020, September 17). *Vaporizers, e-cigarettes, and other electronic nicotine delivery systems (ENDS)*. <https://www.fda.gov/tobacco-products/products-ingredients-components/vaporizers-e-cigarettes-and-other-electronic-nicotine-delivery-systems-ends>
11. Center for Tobacco Products. (2020, April). *Enforcement priorities for electronic nicotine delivery systems (ENDS) and other deemed products on the market without premarket authorization (Revised)*. U.S. Department of Health and Human Services, Food and Drug Administration. <https://www.fda.gov/media/133880/download>
12. American E-Liquid Manufacturing Standards Association. (2017, March 8). *E-liquid manufacturing standards* (Version 2.3.3). <https://www.aemsa.org/wp-content/uploads/2017/03/AEMSA-Standards-v2.3.3.pdf>
13. Miller, D. R., Buettner-Schmidt, K., Orr, M., Rykal, K., & Niewojna, E. (2020). A systematic review of refillable e-liquid nicotine content accuracy. *Journal of the American Pharmacists Association*, 61(1), 20-26. <https://doi.org/10.1016/j.japh.2020.09.006>
14. Buettner-Schmidt, K., Miller, D., & Balasubramanian, N. (2016). Electronic cigarette refill liquids: Child-resistant packaging, nicotine content, and sales to minors. *Journal of Pediatric Nursing*, 31(4), 373-379. <http://doi.org/10.1016/j.pedn.2016.03.019>

15. Famele, M., Palmisani, J., Ferranti, C., Abenavoli, C., Palleschi, L., Mancinelli, R., Fidente, R. M., de Gennaro, G., & Draisci, R. (2017). Liquid chromatography with tandem mass spectrometry method for the determination of nicotine and minor tobacco alkaloids in electronic cigarette refill liquids and second-hand generated aerosol. *Journal of Separation Science*, *40*(5), 1049-1056. <https://doi.org/10.1002/jssc.201601076>
16. Goniewicz, M. L., Gupta, R., Lee, Y. H., Reinhardt, S., Kim, S., Kim, B., Kosmider, L., & Sobczak, A. (2015). Nicotine levels in electronic cigarette refill solutions: A comparative analysis of products from the U.S., Korea, and Poland. *The International Journal of Drug Policy*, *26*(6), 583-588. <https://doi.org/10.1016/j.drugpo.2015.01.020>
17. Peace, M. R., Baird, T. R., Smith, N., Wolf, C. E., Poklis, J. L., Poklis, A. (2016). Concentration of nicotine and glycols in 27 electronic cigarette formulations. *Journal of Analytical Toxicology*, *40*(6), 403-407. <https://doi.org/10.1093/jat/bkw037>
18. Buettner-Schmidt, K., Miller, D., Orr, M., Balasubramanian, N., Rykal, K., Steward, K. F., Swanson K., & Berry, M. (in press). Electronic cigarette refill liquids: Nicotine content, presence of child-resistant packaging, and in-shop compounding. *Journal of Pediatric Nursing*.
19. Buettner-Schmidt, K., Miller, D., Orr, M., Balasubramanian, N., & Mills, K. (2019, December 9). *E-liquids and shops: North Dakota, 2019*. School of Nursing, North Dakota State University.
20. Jenson, D. (2020, December 18). Personal communication. Lead Senior Staff Attorney for Federal Regulation, Public Health Law Center, Mitchell Hamline School of Law, St. Paul, MN.
21. Van Heel, M., Van Gucht, D., Vanbrabant, K., & Baeyens, F. (2017). The importance of conditioned stimuli in cigarette and e-cigarette craving reduction by e-cigarettes. *International Journal of Environmental Research and Public Health*, *14*(2), 193. <https://doi.org/10.3390/ijerph14020193>
22. Galimov, A., Meza, L., Unger, J. B., Baezconde-Garbanati, L., Cruz, T. B., & Sussman, S. (2020, October 22). Vape shop employees: Do they act as smoking cessation counselors? *Nicotine & Tobacco Research*. <https://doi.org/10.1093/ntr/ntaa218>
23. Sheffer, C. E., Payne, T., Ostroff, J. S., Jolicoeur, D., Steinberg, M., Czabafy, S., Foulds, J., Bars, M., Wassum, K., & Perry, B. (2014, December). Increasing the quality and availability of evidence-based treatment for tobacco dependence through unified certification of tobacco treatment specialists. *Journal of Smoking Cessation*, *11*(4), 229-235. <https://doi.org/10.1017/jsc.2014.30>
24. U.S. Preventive Services Task Force. (2020, June 1). *Tobacco smoking cessation in adults, including pregnant persons*. <https://uspreventiveservicestaskforce.org/uspstf/draft-update-summary/tobacco-smoking-cessation-in-adults-including-pregnant-women-interventions>
25. Klemperer, E. M., Mermelstein, R., Baker, T. B., Hughes, J. R., Fiore, M. C., Piper, M. E., Schlam, T. R., Jorenby, D. E., Collins, L. M., & Cook, J. W. (2020, September). Predictors of smoking cessation attempts and success following motivation-phase interventions among people initially unwilling to quit smoking. *Nicotine & Tobacco Research*, *22*(9), 1446-1452. <https://doi.org/10.1093/ntr/ntaa051>
26. Barua, R. S., Rigotti, N. A., Benowitz, N. L., Cummings, K. M., Jazayeri, M.-A., Morris, P. B., Ratchford, E. V., Sarna, L., Stecker, E. C., & Wiggins, B. S. (2018, December). 2018 ACC expert consensus decision pathway on tobacco cessation treatment: A report of the American College of Cardiology Task Force on Clinical Expert Consensus Documents. *Journal of the American College of Cardiology*, *72*(25), 3332-3365. <https://doi.org/10.1016/j.jacc.2018.10.027>
27. Leone, F., Zhang, Y., Evers-Casey, S., Evins, A., Eakin, M., Fathi, J., Fennig, K., Folan, P., Galiatsatos, P., Gogineni, H., Kantrow, S., Kathuria, H., Lamphere, T., Neptune, E., Pacheco, M., Pakhale, S., Prezant, D., Sachs, D. P. L., Toll, B., . . . Farber, H. (2020, July 15). Initiating pharmacologic treatment in tobacco-dependent adults. An official American Thoracic Society clinical practice guideline. *American Journal of Respiratory and Critical Care Medicine*, *202*(2), e5-e31. American Tobacco Society. <https://doi.org/10.1164/rccm.202005-1982ST>

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