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Electronic Cigarettes: A Literature Review

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University of North Georgia
College of Health Science & Professions
Department of Nursing
Master of Science

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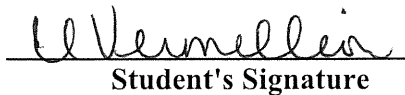
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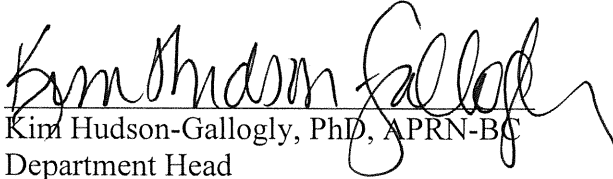

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ACCEPTANCE

This literature review, Electronic Cigarettes: A Literature Review by Laura Bruton, Sara Coker, and Iliana Vermillion, was prepared under the direction of the candidate's Advisor. It has been approved and accepted in partial fulfillment of the requirements for the degree of Master of Science in the Department of Nursing in the College of Health Science and Professions, University of North Georgia.

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ELECTRONIC CIGARETTES:

A LITERATURE REVIEW

by

Laura Bruton

Sara Coker

Iliana Vermillion

Presented in Partial Fulfillment of Requirements for the

Degree of Master of Science

Department of Nursing

University of North Georgia

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ABSTRACT

ELECTRONIC CIGARETTES: A LITERATURE REVIEW

by

Laura Bruton
Sara Coker
Iliana Vermillion

Objective This literature review aims to define electronic cigarettes (ECs) and to examine the safety and potential health effects of ECs. Using published articles performed using online databases with key words to define the searches, 222 articles were yielded. Of these 222 articles with manual review and elimination 18 articles were selected to complete the literature review. The literature review yielded discussions on key components and effects of ECs such as propylene glycol, nicotine, the respiratory system, the cardiovascular system, cytotoxicity, etc.

Conclusions Through review of 18 research articles, information saturation was reached to conclude that the use of ECs has multiple health risks comparable to traditional smoking, as well as new concerns specific to ECs alone. With increasing popularity of ECs, additional research is needed on safety and long-term effects.



College of Health Science & Professions
Department of Nursing
Master of Science Program

Project Proposal

Electronic Cigarettes: A Literature Review

This is a literature review of 18 articles pertaining to electronic cigarettes, their chemical components, and their health effects on the human body.

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Electronic Cigarettes: A Literature Review

Electronic cigarettes (ECs) are a nicotine delivery method that is currently not widely studied. ECs are very popular but have limited data concerning safety and effects. ECs contain a battery, vaporizer, cartridge, and heating element. Cooke et al. states the heating elements cause the release of chemical aerosol components in higher quantities than in traditional cigarettes (TCs).¹ Numerous articles mentioned that lack of regulation by the Food and Drug Administration (FDA) permits "nicotine-free" ECs to still contain nicotine and various levels of toxic products beyond the threshold limit values (TLVs).²

Potential exposures from ECs go beyond inhalation and pose increased risks to children and adolescents. Exposures with the liquid contained in the EC cartridge include ingestion, skin and ocular exposure. The lethal pediatric dose of nicotine is ~10 milligrams when absorbed through the skin/mucous membranes and ECs carry the potential concentration exceeding 100 mg/mL.³

Problem Statement

Studies have shown 12-14% of smokers who try ECs become daily smokers.⁴ Popularity of ECs has increased from marketing aimed at better taste and a tool for smoking cessation. Popularity of ECs over TC usage is on the rise and our goal in this literature review is to examine the safety and potential health effects of ECs.

Process of Discovery

The literature review included published articles on ECs between 2010 and 2015. Searches were performed using online databases: CINAHL, EBSCOHost, Medline Plus, ProQuest Nursing and Allied Health through Galileo. MeSH terms utilized to refine our search: "electronic cigarettes" "e-cigs", and "vaping" "health effects" and

“consequences”. The search was limited to articles published within the past 20 years, yielding 222 articles. After manual review and elimination based on title, abstract, and article content, 18 articles were selected. Ultimately, chosen articles consisted of literature published after 2010 and included twelve systematic reviews, three randomized control trials, one non-randomized control trial, two controlled cohort studies, and one case study.

Discussion

ECs are gaining popularity and are marketed as a “safer” alternative to TCs for those with preexisting lung diseases and as a smoking cessation tool. ECs are not without risks and contain some of the same toxins present in TCs including nicotine, even when marketed as “nicotine-free”. No standardization/regulation for ECs exists, which places consumers at risk for harm.¹ ECs contain toxins including propylene glycol, nicotine, polycyclic aromatic hydrocarbons, tobacco specific nitrosamines, volatile organic compounds and inorganic compounds.²

Propylene Glycol. Propylene glycol (PG) is used in the manufacturing of polyester compounds and often used as antifreeze. The FDA states that PG is “generally recognized as safe” but can cause lactic acidosis, intravascular hemolysis, renal failure, and central nervous system depression in high concentrations.⁵ PG has drying effects on mucous membranes causing decreased viscosity of bronchial secretions.⁶ With TCs, studies show that PG is “pyrolyzed to acetaldehyde during smoking” which damages cellular material. PG is found in over half of ECs reviewed, but the pyrolyzation to acetaldehyde needs to be investigated further.⁷ The vaporization process forms propylene oxide, a class 2B carcinogen.⁸ PG is a major culprit in the acute and chronic pulmonary

effects of EC use.⁹ Hajek et al., found that PG worsens rhinitis, asthma, atopic symptoms and overall lung function.⁴

Nicotine. Nicotine is an addictive chemical with many adverse effects including increased heart rate (HR) and blood pressure (BP), nausea, diarrhea and diaphoresis. Tobacco and nicotine increase cancer risk, lung disease, and myocardial infarction.¹⁰ Nicotine is the main chemical found within the liquid of ECs.¹³ A study conducted by Grana et al. stated that the average EC provides up to 35 micrograms of nicotine per puff compared to the average TC providing 1 milligram.⁹ Each puff of nicotine from an EC includes “formaldehyde, acetaldehyde, acrolein, o- methylbenzaldehyde, toluene, p,m- xylene, cadmium, nickel and lead”¹. Cooke et al. found that ECs marketed as “nicotine free” still contain various nicotine levels, largely due to the lack of regulation.¹ Nicotine effects include lightheadedness, dizziness, confusion, headache, nausea, nervousness and diaphoresis.¹¹ Experimental studies determined that nicotine increases the risk for atrial fibrillation.¹² Nicotine is easily absorbed through the skin and mucous membranes and can remain present in toxic amounts on fomites for weeks. Young children are at risk due to ingestion of EC liquid due to the appeal of flavoring.⁶

The Respiratory System. Vardavas et al. implemented a study to determine short-term pulmonary effects of ECs after five minutes of use and determined a decreased forced exhaled nitric oxide of approximately 16%, and an increase in lung resistance, peripheral pulmonary resistance, and overall central airway resistance.¹⁴ Other effects include increased airway resistance, decreased airway conductance, and increased peripheral airway resistance.¹² EC use can lead to the development of lipid pneumonia, which is associated with the “aspiration of mineral oil or lipid-based preparations”.¹⁵

The Cardiovascular System. Farsalinos et al. studied the effects of ECs and TCs by echocardiogram and Doppler studies before and immediately after seven-minutes of cigarette use. Both types of cigarettes demonstrated a significant increase ($p < 0.001$) in diastolic BP and increases in systolic BP, HR, mitral flow velocities, and myocardial performance index.¹⁶ After five minutes of EC use, HR can increase 10-15 beats.^{8,11,12}

Cytotoxicity. TCs are notorious for their cytotoxic nature and studies done on ECs have also shown evidence of cytotoxicity concerning fibroblasts, human embryonic stem cells and mouse neural stem cells. Cytotoxicity occurs to fibroblasts on the skin through use of flavored EC liquids such as coffee or cinnamon.¹² Oxidative stress is an additional component contributing to cytotoxicity and stimulates cellular damage, fibroblast apoptosis, and cell death.⁷ Cytotoxicity varies amongst ECs due to differences in chemical formulation of liquid nicotine cartridges.⁹

Smoking Cessation and Withdrawal. Several studies show “no established association between e-cigarette use and intention to quit smoking” and only 11% of those who intend to quit reach abstinence.¹⁷

Strengths and Limitations. Strengths of our literature review included a variety of high-level evidence with strong, supported information. Our information reached saturation with cross-linked information, providing sound data. Limitations of our review included some largely generalized information, limited information on long-term studies and small sample sizes in control studies. Our biggest limitation, however, was that ECs are new, thus creating limitation of supporting evidence.

Conclusion

ECs are currently marketed as a “safer” alternative to smoking and as an aid for smoking cessation. EC use has become increasingly popular, however, further research is necessary concerning the long-term health effects.⁴ Through review of 18 research articles, information saturation was reached to conclude that the use of ECs has multiple health risks comparable to traditional smoking, as well as new concerns specific to ECs alone.

The respiratory and cardiovascular systems are the main organ systems impacted through the presence of PG and nicotine within ECs. Further, tobacco and nicotine use increases the risk of developing cancer, lung disease, and myocardial infarction.¹⁰ A potential outcome of EC use is lipoid pneumonia, caused by lipid build up within the interstitium after the uptake of the lipids by macrophages.¹⁵ Other adverse effects include mouth and throat irritation, nausea, headache and dry cough.¹⁸

The chemical effects of ECs include oxidative stress causing cell damage to occur, ultimately leading to cellular death.⁷ The cytotoxicity of ECs varies amongst brands due to differences in chemical formulation of liquid nicotine cartridges.⁷ ECs are potentially lethal when liquid cartridge contents are absorbed through skin or ingested.⁴ With increasing popularity of ECs, additional research is needed on safety and long-term effects. Hopefully, more research will be conducted and the risks and hazards of ECs will be more clearly understood.

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