TESTIMONY BY KALBERT K. YOUNG
DIRECTOR, DEPARTMENT OF BUDGET AND FINANCE
STATE OF HAWAII
TO THE HOUSE COMMITTEE ON FINANCE
ON
SENATE BILL NO. 2496, S.D. 2, H.D. 1

April 1, 2014

RELATING TO TOBACCO PRODUCTS

Senate Bill No. 2496, S.D. 2, H.D. 1, proposes an excise tax equal to an unspecified percentage of the wholesale price for tobacco products, other than cigarettes and large cigars, sold by a wholesaler or dealer on and after January 1, 2015. The bill also provides that an unspecified percent of the proposed revenues shall be deposited into 1) the Hawaii Cancer Research Special Fund and 2) the Hawaii Tobacco Prevention and Control Trust Fund.

We have concerns with this bill for the following reasons. First, with the recent Council on Revenues' reduced forecast for growth in State General Fund tax revenues, this bill has the potential of reducing tobacco tax receipts going to the general fund. Second, we are opposed, as a matter of general policy, to the practice of revenue earmarking for specific purposes. Finally, this proposal will, in effect, remove any proposed funding increases for the Cancer Research Special Fund and the Hawaii Tobacco Prevention and Control Trust Fund from the customary established budgetary process whereby all requests for funding must be justified and compete for limited public resources.

NEIL ABERCROMBIE
GOVERNOR

BARBARA A. KRIEG
DIRECTOR

LEILA A. KAGAWA
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF HUMAN RESOURCES DEVELOPMENT
235 S. BERETANIA STREET
HONOLULU, HAWAII 96813-2437

March 31, 2014

TESTIMONY TO THE
HOUSE COMMITTEE ON FINANCE

For Hearing on Tuesday, April 1, 2014
2:00 p.m., Conference Room 308

BY
BARBARA A. KRIEG
DIRECTOR

Senate Bill No. 2495, S.D. 3, H.D. 1

RELATING TO ELECTRONIC SMOKING DEVICES

WRITTEN TESTIMONY ONLY

TO CHAIRPERSON LUKE AND MEMBERS OF THE COMMITTEE:

The purpose of S.B. 2495, S.D. 3, H.D. 1 prohibits the use of electronic smoking devices in enclosed public areas and other specified locations under Chapter 328J, Hawaii Revised Statutes.

The Department of Human Resources Development supports this bill, whereby electronic smoking devices would be subject to the same statutory requirements for cigarettes and the use of electronic smoking devices would be prohibited in all enclosed and partially enclosed places open to the public and places of employment. We believe the regulation of electronic smoking devices would enhance the health of employees, including our State employees.

Thank you for the opportunity to provide testimony on this measure.

UNIVERSITY OF HAWAIʻI SYSTEM
Legislative Testimony

Written Testimony Presented Before the
House Committee on Finance
April 1, 2014 at 2:00 pm
by
Michele Carbone, MD, PhD
Director
and
Thaddeus Herzog, PhD
Associate Professor (Researcher)
Cancer Prevention and Control Program
University of Hawaiʻi Cancer Center
University of Hawaiʻi at Mānoa

SB 2495 SD3 HD1 – RELATING TO ELECTRONIC SMOKING DEVICES

Chair Luke, Vice Chairs Nishimoto and Johanson, and Members of the Committee:

The University of Hawaiʻi Cancer Center supports this bill.

The UH Cancer Center is one of only 68 institutions in the U.S. that hold the prestigious National Cancer Institute (NCI) designation, and is the only NCI-designated center in the Pacific. The NCI designation provides greater access to federal funding and research opportunities. More importantly, it gives the people of Hawaiʻi and the Pacific region access to innovative and potentially life-saving clinical trials without the necessity of traveling to the mainland.

Our consuming passion at the UH Cancer Center is to be a world leader in eliminating cancer through research, education and improved patient care. Because tobacco consumption is a leading preventable cause of cancer, we take all issues related to tobacco in Hawaiʻi very seriously. Whereas the UH Cancer Center always has supported strong tobacco control measures in Hawaiʻi, the recent emergence of e-cigarettes presents new challenges for tobacco control and tobacco-related legislation.

The UH Cancer Center perspective on e-cigarettes is informed by the scientific literature, including original published research by our own faculty. Despite the complexities of the larger debate regarding e-cigarettes, we believe this bill represents reasonable legislation that balances the rights of adults to use e-cigarettes in appropriate venues while restricting the use of e-cigarettes in public places where conventional cigarettes also are banned. We also support the prohibition of the sale of e-cigarettes to minors, and we support the provisions in this bill that enhance the ability of authorities to enforce these laws.

As scientific research on e-cigarettes progresses, we will have a stronger basis to adjust laws according to evidence. At the present time, however, caution is warranted. As others have noted, the FDA currently does not regulate e-cigarettes, and thus the consumer has no assurances regarding e-cigarette ingredients. Further, because of the novelty of e-cigarettes, the long term effects of using these devices are unknown. A further concern, not often discussed, is the potential for e-cigarettes to be used as drug delivery devices for substances other than nicotine.

For these reasons, we respectfully urge you to pass this bill.

Testimony of Professor Mark A. Levin *in strong support* for SB 2495, SD3, HD1

RELATING TO ELECTRONIC SMOKING DEVICES
House Committee on Finance
April 1, 2014

Chair Luke, Vice-Chairs Nishimoto and Johanson, and the Committee on Finance:

In the 1950's, the tobacco industry fooled the world by marketing filtered cigarettes. These weren't safer, though millions of people died having been led to believe they were. Meanwhile tobacco smoke pollution brought down those around them as well.

In the 1970's, the industry scammed the public by marketing light and mild cigarettes. Once again, not safer but this too was a great boost to keep people addicted, and paying for it with wallets and lives. Secondhand death and disease continued.

Finally, in the 1990's, lawmakers around the globe began stepping forward to right these wrongs. The work is incomplete, but in our State, our legislators, many of you among them, took important steps forward including our 2006 Smokefree Workplaces Law and with several significant tax increases.

Here we go again. New addictive vapor devices are pitched to be a route to safer use. Again these are simply a boost for the industry to keep people addicted *and even to hook new users among our youth*. But with Big Tobacco's deadly track record, in what right minds should we trust public health to the unregulated vapes of the latest devices?

Though you are getting much local testimony, addictive vapors are plainly Big Tobacco's 21st century hope. If these devices have therapeutic merit, let the sellers prove that to expert regulators in accordance with federal food and drug laws. But they haven't, won't, and can't.

SB2495, SD3, HD1 is a simple measure –being adopted by legislative bodies all around the country and around the world. Let's be smart, safe, cautious, and conservative here; let's have the rules be the same as for incendiary tobacco products. Please pass SB 2495, SD3, HD1.

Mahalo.

Professor Mark A. Levin
The William S. Richardson School of Law
The University of Hawai'i at Mānoa
2515 Dole St., Honolulu, HI 96822
Tel: 1-808-956-3302

Affiliations are given for identification purposes only. Opinions presented here are personal views and not the official views of the University of Hawai'i or any other organization or entity.

COALITION FOR A TOBACCO-FREE HAWAI'I

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance
From: Tiffany L. Gourley, Policy and Advocacy Director
Date: March 31, 2014
Hrg: House Committee on Finance; Tues., April 1, 2014 at 2:00 p.m. in Rm 308
Re: **Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices**

Thank you for the opportunity to offer testimony in **strong support of** SB 2495 SD 3 HD 1, which regulates electronic smoking devices (ESDs).

The Coalition for a Tobacco Free Hawaii (Coalition) is a program of the Hawaii Public Health Institute working to reduce tobacco use through education, policy and advocacy. Our program consists of over 100 member organizations and 2,000 advocates that work to create a healthy Hawaii through comprehensive tobacco prevention and control efforts.

The Coalition supports including ESDs in HRS section 328J-1, which will provide for further consistency and protection in the workplace.

SB 2495 SD 3 HD 1 adds and amends important definitions of the law, which are critical to allowing consistency among all of Hawaii's smoking laws. Confusion of smoking prohibitions results without such definitions in place. Furthermore, emerging research shows dual use where cigarette users switch to ESDs in locations they are not permitted to smoke.[1] Allowing the use of ESDs in locations where smoking is prohibited is problematic in that ESD use threatens the social norm, creates distractions in the workplace, and undercuts years of progress by tobacco control groups.

Currently in Hawaii, ESDs are not regulated at any level; therefore all emissions and chemicals released in exhalation are also unregulated. ESDs do not emit harmless water vapor, but emit an aerosol that contains nicotine, ultra-fine particles, volatile organic compounds, and other toxins.[2] The U.S. Food and Drug Administration (FDA) has not found consistent control processes within the manufacturing of ESDs. Restricting ESD use is a growing trend across the US. At least 110 counties restrict the use of ESDs, including New York City, Los Angeles, Long Beach, and San Diego.

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[1] Centers for Disease Control and Prevention (CDC). Notes from the field: electronic cigarette use among middle and high school students -- United States, 2011-2012. MMWR Morb Mortal Wkly Rep. 2013;62:729-730. Available at http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6235a6.htm?s_cid=mm6235a6_w

[2] Americans for Nonsmokers' Rights, "Electronic (e-) Cigarettes and Secondhand Aerosol", available at http://no-smoke.org/pdf/ecigarette-secondhand-aerosol.pdf.

Manufacturers and retailers acknowledge that ESDs contain nicotine, are addictive and habit-forming, are intended for committed smokers, and should not be used by women who are pregnant or persons with an elevated risk of any medical condition, including, but not limited to, heart disease, diabetes, high blood pressure or asthma.[3]

We respectfully ask you to pass this measure to ensure the safety of everyone. Thank you for the opportunity to testify on this matter.

Tiffany L. Gourley, esq.
Policy and Advocacy Director

[3] http://www.ejuiceusa.com/warnings---read-me.php; www.vapedudes.com/; http://www.vaportokers.com/; http://www.virginvapor.com/; http://www.volcanoecigs.com/about-us

Testimony in Strong Opposition to SB2495

Dear House Committee on Finance,

The Hawaii Smokers Alliance STRONGLY OPPOSES SB2495 relating to attacks on the e-cigarette market.

A large number of anti-e-cigarette bills are currently being pushed at this legislature, many states on the mainland, and overseas. As the old saying goes, if you want to find out the truth about something – follow the money.

At first it was a little surprising to see the ant-smoking lobby oppose these products that are a safe alternative to tobacco products.

Dr. Carmona, the Former Surgeon General from 2002-2006 recently made this statement. "I believe that it is essential that we provide adult smokers with high-quality, innovative alternatives to traditional cigarettes. The current data indicate that electronic cigarettes may have a very meaningful harm reduction potential, and NJOY [e-cigarettes] is committed to the further development of the science in this area. I look forward to working with NJOY in this important capacity."

However all is not well for giant pharmaceutical companies such as GSK/Johnson and Johnson, Pfizer and so on. Their expensive, unenjoyable, and sometimes dangerous NRT products are getting hit hard in sales by e-cigarettes. Let us keep in mind that the lobbyist ring called "Tobacco Free Hawaii" lists Pfizer as a "Major Funder" for their group. Most of the rest came from the settlement and from tax payers via the health dept. Pfizer is the manufacturer of Chantix, which carries a "Black Box Warning" due to significant dangers being found.

"Sophie Ragot, marketing manager at Glaxo Smith Klein laboratories [which markets J&J NRT products] confirms the latest figures, and adds that the situation of the NRT (nicotine replacement therapy) market in the last quarter alone is even worse. She claims sales in this time frame have dropped by 17% in general and 35% in the case of nicotine patches. The situation is very similar in other European countries as well, and I'm sure NRT sales in the US aren't what they used to be either." http://vaperanks.com/how-e-cigarettes-are-killing-the-nicotine-patch-market-in-europe/

Take for example this article pinning down what's going on from the Oklahoma Constitution newspaper.

"The funds that our state receives each year from Tobacco Master Settlement Agreement is invested and managed by Tobacco Settlement Endowment Trust or TSET. So far, the tobacco Master Settlement Agreement has provided $1.04 billion in payouts to Oklahoma and 75% of those funds go directly to TSET.
TSET uses the profits from its investments of MSA money to fund a range of endeavors including the Oklahoma Tobacco Helpline. According to a 2006 Tobacco Cessation Leadership Network document featuring the tobacco control accomplishments of TSET, the purpose for integrating the anti-tobacco policies (higher taxation, public prohibitions and insurance coverage for pharmaceutical cessation products) with smoking cessation service is to increase demands for these services and to create new demand for them. According to TSET, Oklahoma has systematically integrated its anti-smoking policies with tobacco cessation promotion. TSET also funds the Oklahoma Insurance Department, Oklahoma Hospital Association, Oklahoma Dept. of Mental Health and Substance Abuse, and Oklahoma Healthcare Authority."
"The smoking cessation drug market has been a lucrative one for the pharmaceutical companies, but the popularity of electronic cigarettes has them worried. Already in England, electronic cigarettes have surpassed conventional cessation product sales. I could write a book on the pervasive pharmaceutical influence present throughout our state's public health system, but it's not necessary because you can see it plain enough in our state and local anti-tobacco policies. However, if you'd like to further investigate their role in Oklahoma health policy, start with the Oklahoma Turning Point Initiative and the Robert Wood Johnson Foundation. The Robert Wood Johnson Foundation is one of Johnson & Johnson's largest shareholders. Johnson & Johnson just happens to own or manufacture a variety of pharmaceutical drugs including some of the very same smoking cessation products promoted by the state through the Oklahoma Tobacco Helpline."
http://www.oklahomaconstitution.com/ns.php?nid=534&commentary=1

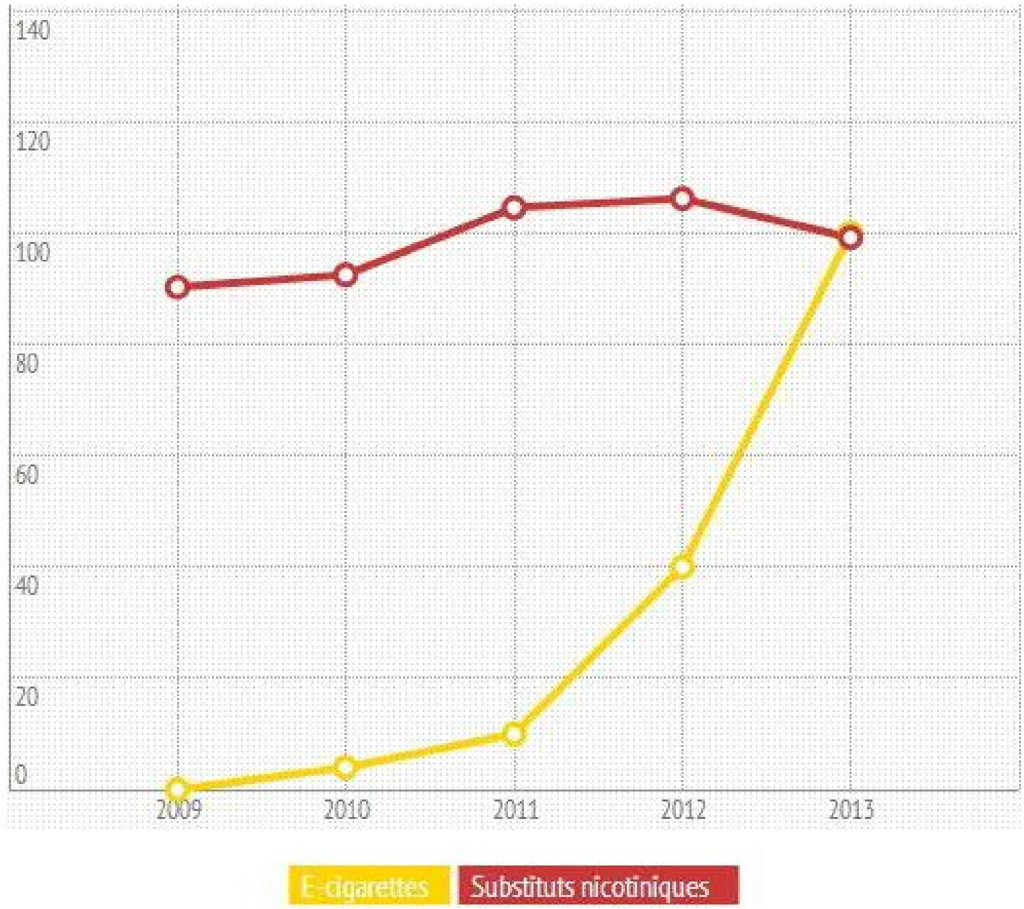
And From the Washington Examiner: Nov 19th, 2013.

"E-cigarette manufacturers, of course, lobbied like crazy to block the proposal, and it seems they won. But the drugmakers fought for stricter regulations, for obvious reasons: E-cigarettes compete with prescription drugs that are supposed to help people stop smoking.

GlaxoSmithKline sells Nicorette gum and Johnson & Johnson manufactures nicotine patches. The New York Times reported these companies helped lead "strong opposition" to e-cigarettes.

In the U.S., the Food and Drug Administration is about to announce new proposed rules on e-cigarettes. Big Pharma's shadow hangs over the rule-making."

https://www.google.com/search+pharmaceutical+companies+behind+e-cigarette+bans



This graph in millions of Euros shows the point where e-cigarette sales overtook NRT sales in France. Clearly the big pharma companies are pushing the anti-smoking groups they fund to crack down on the e-cigarette competition using legislation. Clearly this bill is an abuse of the free market system and the State legislative process.

The banning of E-cigarettes without proven research against the product is unfair and prejudicial. To be viable and not conjecture, the research MUST HAVE REGULATORY WEIGHT by a regulatory authority. For example the FDA would need to say that ABC brand e-cigarettes is harming non-smokers based on data from studies one, two, and three and provide a complete report including full funding disclosure. By not doing this, is the legislature trying to set a new precedence that all new products are to be deemed unsafe until proven otherwise? This is a very scary, neo-phobic attitude to have in a nation that previous prided itself on progress and innovation. Should the legislature's new motto be guilty until proven innocent?

For example this how the FDA handle “health supplements:

- *“Manufacturers and distributors of dietary supplements and dietary ingredients are prohibited from marketing products that are adulterated or misbranded. That means that these firms are responsible for evaluating the safety and labeling of their products before marketing to ensure that they meet all the requirements of DSHEA and FDA regulations.*
- *FDA is responsible for taking action against any adulterated or misbranded dietary supplement product after it reaches the market.”*
(http://www.fda.gov/Food/Dietarysupplements/default.htm)

Or for new cosmetic that could potentially contain harmful chemicals:

“Under the law, cosmetic products and ingredients do not need FDA premarket approval, with the exception of color additives. However, FDA can pursue enforcement action against products on the market that are not in compliance with the law, or against firms or individuals who violate the law.”

Or new flavors or type of alcoholic beverages provided they are not adulterated or mislabeled.

Without a doubt, e-cigarettes are being targeted for taxes and bans to destroy the competition for alternates to tobacco smoking. As this bill is currently written, it is now plainly obvious that the only tobacco alternates to tobacco that the drug companies want on the market is their products.

Sincerely,

Michael Zehner, Co-chair of the Hawaii Smokers Alliance.

808-952-0275. Hawaiismokersalliance.net

American Cancer Society
Cancer Action Network
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www.acscan.org

House Committee on Finance
Representative Sylvia Luke, Chair
Representative Scott Nishimoto, Vice Chair
Representative Aaron Ling Johanson, Vice Chair
Finance Committee Members

Hearing: April 1, 2014; 2:00 p.m.

SB 2495 SD3, HD1 – RELATING TO ELECTRONIC SMOKING DEVICES

Cory Chun, Government Relations Director – Hawaii Pacific
American Cancer Society Cancer Action Network

Thank you for the opportunity to provide testimony in **support** of SB 2495 SD3, HD1 which amends Hawaii's smoke-free laws to prohibit the use of electronic smoking devices in places open to the public and places of employment.

The American Cancer Society Cancer Action Network (ACS CAN) is the nation's leading cancer advocacy organization. ACS CAN works with federal, state, and local government bodies to support evidence-based policy and legislative solutions designed to eliminate cancer as a major health problem.

ACS CAN supports prohibiting the use of electronic smoking devices where smoking cigarettes is already prohibited. The use of e-cigarettes in public places normalizes the act of smoking and undermines Hawaii’s successful efforts to create a smoke-free environment that models healthy behavior, especially for a new generation of young people. This simulation of smoking also makes enforcement of the current smoke-free workplace law difficult because of the similarities between the two.

Thank you for the opportunity to submit testimony on this matter.

VOLCANO®
FINE ELECTRONIC CIGARETTES

March 31, 2014

To: The Honorable Sylvia Luke, Chair
Members, House Committee on Finance

From: Cory Smith, VOLCANO Fine Electronic Cigarettes®
CEO and Owner

RE: SB2495 SD3 HD 1 – oppose.

Thank you for the opportunity to submit testimony.

VOLCANO Fine Electronic Cigarettes® is the largest manufacturer and retailer of electronic cigarettes and vaping accessories in the State of Hawaii and is widely considered one of the fastest growing companies in the state. We currently own and operate 11 locations statewide and employ over 100 full-time workers to support sales of our products not only here in Hawaii, but to all 50 states as well as Japan and the UK. We stand in opposition to SB2495 SD3 for the following:

I. No Evidence Supports Restricting Electronic Cigarette Use by Adults

- Several million smokers in the US have quit smoking or sharply reduced their cigarette consumption by switching to or substituting with smoke-free electronic cigarettes. **To date, there is no evidence that electronic cigarette usage has harmed anyone**, which is logical since the product emits a tiny amount of vaporized nicotine and flavorings (similar to nicotine inhalers that are marketed as smoking cessation aids). Numerous studies conducted on e-cigarettes have found that e-cigarettes emit no hazardous levels of any constituents, and that levels of nitrosamines in e-cigarettes are nearly identical (i.e. very little if any) to those in nicotine gums and patches. Those studies are attached to this presentation.
    - Burstyn, I. Peering through the mist: What does the chemistry of contaminants in electronic cigarettes tell us about health risks? *BMC Public Health.* January 2014. http://www.biomedcentral.com/1471-2458/14/18/abstract
    - Goniewicz ML, et al. Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tobacco Control*. March 2013. http://tobaccocontrol.bmj.com/content/early/2013/03/05/tobaccocontrol-2012-050859.abstract
    - Siegel, M, et. al. Electronic cigarettes as a harm reduction strategy for tobacco control: A step forward or a repeat of past mistakes. Journal of Public Health Policy. December 2010. http://www.palgrave-journals.com/jphp/journal/v32/n1/full/jphp201041a.html

VOLCANO®

FINE ELECTRONIC CIGARETTES

  - Trehy, et. al. Analysis of electronic cigarette cartridges, refill solutions, and smoke for nicotine and nicotine related impurities. August 2011. http://www.tandfonline.com/doi/abs/10.1080/10826076.2011.572213

- Although electronic cigarettes emit NO smoke, the bill **falsely defines vapor products as "electronic smoking devices" and deceptively redefines "smoking" to include the use of electronic cigarettes** in an attempt to restrict their usage in the same places as tobacco cigarettes. Vapor products contain no tobacco, produce no smoke, and have not been demonstrated to have the detrimental effects of combustible tobacco products. In fact, the FDA has taken appropriate and proportional regulation seriously and to date has not issued regulations for the product because they seemingly understand the potential this product has to switch people over from actual tobacco, which kills 480,000 people per year. Further, Mitch Zeller, Director of the Center for Tobacco Products at the FDA recently stated:

  - "If a current smoker, otherwise unable or unwilling to quit, completely substituted all of the combusting cigarettes that they smoked with an electronic cigarette at the individual level, that person would probably be significantly reducing their risk." (http://thedianerehmshow.org/shows/2014-01-21/new-health-risks-cigarette-smoking/transcript)

- In sharp contrast to indoor smoke free policies/laws (which are largely self enforced because of broad public support), please note that **it is also impossible to enforce an e-cigarette usage ban** (since the products can be used discreetly without anyone else knowing). By simply waiting a few seconds before exhaling, no visible vapor is exhaled by e-cigarette users, and as such, nobody will know that anyone is even using an e-cigarette. Despite widespread usage in cities and states that have banned e-cigarette use where smoking is banned, there is no record of any fine or citation being given. **Enacting unwarranted and unenforceable regulations carries the risk of unintended consequences like sending former smokers back to combustible tobacco products; harming their health and undermining the mandate of the state to promote viable alternatives to known killers.**

- Many respected public health advocates do not support banning e-cigarette use where smoking is banned, including Dr. David Abrams of the Legacy Institute, Dr. Michael Siegel of the Boston University School of Public Health, Bill Godshall of Smokefree Pennsylvania, and the largest anti-smoking charity in the United Kingdom, Action on Smoking and Health (ASH). They and others oppose these bans for a simple reason -- they have no basis in science, and worse, the bans may serve to take away an important incentive for smokers to switch.

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- The FDA's Center for Tobacco Products has yet to issue any regulations exerting control over vapor products. In fact, a proposed regulation to do has thus far not gained approval by the Office of Management & Budget of the White House. Preliminary reports suggest that one issue that has created conflict in approaching regulations are the distinct differences between tobacco products and vapor products.

II. The Bigger Picture: Electronic Cigarettes Are a Plus For Public Health

- The available evidence indicates that all noncombustible tobacco / nicotine products (including e-cigarettes, nicotine gums, lozenges, patches) are about 99% less hazardous alternatives to cigarettes. **The concept of tobacco and nicotine harm reduction is being embraced by more public health professionals and academics each year.** Indeed, last year the FDA Center for Drug Evaluation & Research recognized that nicotine, disconnected from smoke, is not the killer in cigarette smoke when it voted to permit the makers of nicotine replacement therapy products to label their products for long-term use by smokers looking to quit.

- VOLCANO supports appropriate and proportionate regulation, and asks that Hawaii await guidance from the FDA on regulatory parameters for this product. The Tobacco Control Act of 2009 was enacted to counteract the known harm caused by combustible tobacco products and was never intended to cover vaporizing products like e-cigarettes.

Thank you for your time and consideration. If you have any questions, please feel free to contact me or Volcano's representative Celeste Nip at Celeste Nip at nipfire@me.com.

Sincerely,
Cory Smith
CEO and Owner
VOLCANO Fine Electronic Cigarettes®

1003 Sand Island Access Rd. Suite #1260, Honolulu, HI 96813

BMC Public Health

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The Open Access Publisher

Peering through the mist: systematic review of what the chemistry of contaminants in electronic cigarettes tells us about health risks

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Igor Burstyn (igor.burstyn@drexel.edu)

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Peering through the mist: systematic review of what the chemistry of contaminants in electronic cigarettes tells us about health risks

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Abstract

Background

Electronic cigarettes (e-cigarettes) are generally recognized as a safer alternative to combusted tobacco products, but there are conflicting claims about the degree to which these products warrant concern for the health of the vapers (e-cigarette users). This paper reviews available data on chemistry of aerosols and liquids of electronic cigarettes and compares modeled exposure of vapers with occupational safety standards.

Methods

Both peer-reviewed and “grey” literature were accessed and more than 9,000 observations of highly variable quality were extracted. Comparisons to the most universally recognized workplace exposure standards, Threshold Limit Values (TLVs), were conducted under “worst case” assumptions about both chemical content of aerosol and liquids as well as behavior of vapers.

Results

There was no evidence of potential for exposures of e-cigarette users to contaminants that are associated with risk to health at a level that would warrant attention if it were an involuntary workplace exposures. The vast majority of predicted exposures are < <1% of TLV. Predicted exposures to acrolein and formaldehyde are typically <5% TLV. Considering exposure to the aerosol as a mixture of contaminants did not indicate that exceeding half of TLV for mixtures was plausible. Only exposures to the declared major ingredients -- propylene glycol and glycerin -- warrant attention because of precautionary nature of TLVs for exposures to hydrocarbons with no established toxicity.

Conclusions

Current state of knowledge about chemistry of liquids and aerosols associated with electronic cigarettes indicates that there is no evidence that vaping produces inhalable exposures to *contaminants* of the aerosol that would warrant health concerns by the standards that are used to ensure safety of workplaces. However, the aerosol generated during vaping as a whole (contaminants *plus declared ingredients*) creates personal exposures that would justify surveillance of health among exposed persons in conjunction with investigation of means to keep any adverse health effects as low as reasonably achievable. Exposures of bystanders are likely to be orders of magnitude less, and thus pose no apparent concern.

Keywords

Vaping, e-cigarettes, Tobacco harm reduction, Risk assessment, Aerosol, Occupational exposure limit

Background

Electronic cigarettes (also known as e-cigarettes) are generally recognized as a safer alternative to combusted tobacco products (reviewed in [1]), but there are conflicting claims about the degree to which these products warrant concern for the health of the vapers (e-cigarette users). A vaper inhales aerosol generated during heating of liquid contained in the e-cigarette. The technology and patterns of use are summarized by Etter [1], though there is doubt about how current, complete and accurate this information is. Rather conclusive evidence has been amassed to date on comparison of the chemistry of aerosol generated by electronic cigarettes to cigarette smoke [2-8]. However, it is meaningful to consider the question of whether aerosol generated by electronic cigarettes would warrant health concerns on its own, in part because vapers will include persons who would not have been smokers and for whom the question of harm reduction from smoking is therefore not relevant, and perhaps more importantly, simply because there is value in minimizing the harm of those practicing harm reduction.

One way of approaching risk evaluation in this setting is to rely on the practice, common in occupational hygiene, of relating the chemistry of industrial processes and the emissions they generate to the potential worst case of personal exposure and then drawing conclusions about whether there would be interventions in an occupational setting based on comparison to occupational exposure limits, which are designed to ensure safety of unintentionally exposed individuals. In that context, exposed individuals are assumed to be adults, and this assumption appears to be suitable for the intended consumers of electronic cigarettes. "Worst case" refers to the maximum personal exposure that can be achieved given what is known about the process that generates contaminated atmosphere (in the context of airborne exposure considered here) and the pattern of interaction with the contaminated atmosphere. It must be noted that harm reduction notions are embedded in this approach since it recognizes that while elimination of the exposure may be both impossible and undesirable, there nonetheless exists a level of exposure that is associated with negligible risks. To date, a comprehensive review of the chemistry of electronic cigarettes and the aerosols they generate has not been conducted, depriving the public of the important element of a risk-assessment process that is mandatory for environmental and occupational health policy-making.

The present work considers both the contaminants present in liquids and aerosols as well as the declared ingredients in the liquids. The distinction between exposure to declared ingredients and contaminants of a consumer product is important in the context of comparison to occupational or environmental exposure standards. Occupational exposure limits are developed for unintentional exposures that a person does not elect to experience. For example, being a bread baker is a choice that does not involve election to be exposed to substances that cause asthma that are part of the flour dust (most commonly, wheat antigens and fungal enzymes). Therefore, suitable occupational exposure limits are created to attempt to protect individuals from such risk on the job, with no presumption of "assumed risk" inherent in the occupation. Likewise, special regulations are in effect to protect persons from unintentional exposure to nicotine in workplaces (http://www.cdc.gov/niosh/docs/81-123/pdfs/0446.pdf; accessed July 12, 2013), because in environments where such exposures are possible, it is reasonable to protect individuals who do not wish to experience its effects. In other words, occupational exposure limits are based on protecting people from involuntary and unwanted exposures, and thus can be seen as more stringent than the standards that might be used for hazards that people intentionally choose to accept.

By contrast, a person who elects to lawfully consume a substance is subject to different risk tolerance, as is demonstrated in the case of nicotine by the fact that legally sold cigarettes deliver doses of nicotine that exceed occupational exposure limits [9]: daily intake of 20 mg of nicotine, assuming nearly 100% absorption in the lungs and inhalation of 4 m^3 of air, corresponds to roughly 10 times the occupational exposure limit of 0.5 mg/m^3 atmosphere over 8 hours [10]. Thus, whereas there is a clear case for applicability of occupational exposure limits to contaminants in a consumer product (e.g. aerosol of electronic cigarettes), there is no corresponding case for applying occupational exposure limits to declared ingredients desired by the consumer in a lawful product (e.g. nicotine in the aerosol of an electronic cigarette). Clearly, some limits must be set for voluntary exposure to compounds that are known to be a danger at plausible doses (e.g. limits on blood alcohol level while driving), but the regulatory framework should reflect whether the dosage is intentionally determined and whether the risk is assumed by the consumer. In the case of nicotine in electronic cigarettes, if the main reason the products are consumed is as an alternative source of nicotine compared to smoking, then the only relevant question is whether undesirable exposures that accompany nicotine present health risks, and the analogy with occupational exposures holds. In such cases it appears permissible to allow at least as much exposure to nicotine as from smoking before admitting to existence of new risk. It is expected that nicotine dosage will not increase in switching from smoking to electronic cigarettes because there is good evidence that consumers adjust consumption to obtain their desired or usual dose of nicotine [11]. The situation is different for the vapers who want to use electronic cigarettes without nicotine and who would otherwise not have consumed nicotine. For these individuals, it is defensible to consider total exposure, including that from any nicotine contamination, in comparison to occupational exposure limits. In consideration of vapers who would never have smoked or would have quit entirely, it must be remembered that the exposure is still voluntary and intentional, and comparison to occupational exposure limits is legitimate only for those compounds that the consumer does not elect to inhale.

The specific aims of this review were to:

1. Synthesize evidence on the chemistry of liquids and aerosols of electronic cigarettes, with particular emphasis on the contaminants.
2. Evaluate the quality of research on the chemistry of liquids and aerosols produced by electronic cigarettes.
3. Estimate potential exposures from aerosols produced by electronic cigarettes and compare those potential exposures to occupational exposure standards.

Methods

Literature search

Articles published in peer-reviewed journals were retrieved from *PubMed* (http://www.ncbi.nlm.nih.gov/pubmed/) available as of July 2013 using combinations of the following keywords: "electronic cigarettes", "e-cigarettes", "smoking alternatives", "chemicals", "risks", "electronic cigarette vapor", "aerosol", "ingredients", "e-cigarette liquid", "e-cig composition", "e-cig chemicals", "e-cig chemical composition", "e-juice electronic cigarette", "electronic cigarette gas", "electronic cigars". In addition, references of the retrieved articles were examined to identify further relevant articles, with particular attention paid to non-peer reviewed reports and conference presentations. Unpublished results obtained through personal communications were also reviewed. The Consumer Advocates for Smoke-free Alternatives Association (CASAA) was asked to review the retrieved bibliography to identify any reports or articles that were missed. The papers and reports were retained for analysis if they reported on the chemistry of e-cigarette liquids or aerosols. No explicit quality control criteria were applied in selection of literature for examination, except that secondary reporting of analytical results was not used. Where substantial methodological problems that precluded interpretation of analytical results were noted, these are described below. For each article that contained relevant analytical results, the compounds quantified, limits of detection, and analytical results were summarized in a spreadsheet. Wherever possible, individual analytical results (rather than averages) were recorded (see Additional file 1). Data contained in Additional file 1 is not fully summarized in the current report but can be used to investigate a variety of specific questions that may interest the reader. Each entry in Additional file 1 is identified by a *Reference Manage ID* that is linked to source materials in a list in Additional file 2 (linked via *RefID*); copies of all original materials can be requested.

Comparison of observed concentrations in aerosol to occupational exposure limits

For articles that reported mass or concentration of specific compounds in the aerosol (generated by smoking machines or from volunteer vapers), measurements of compounds were converted to concentrations in the "personal breathing zone",[a] which can be compared to occupational exposure limits (OELs). The 2013 Threshold Limit Values (TLVs) [10] were used as OELs because they are the most up to date and are most widely recognized internationally when local jurisdictions do not establish their own regulations (see http://www.ilo.org/oshenc/part-iv/occupational-hygiene/item/575; accessed July 3, 2013). TLVs are more protective that of US Occupation Safety and Health Administration's Permissible Exposure Limits because TLVs are much more often updated with current knowledge. However, all OELs generally agree with each other because they are based on the same body of knowledge. TLVs (and all other OELs) aim to define environmental conditions to which nearly all persons can be exposed to all day over many years without experiencing adverse health effects. Whenever there was an uncertainty in how to perform the calculation, a "worst case" scenario was used, as is the standard practice in occupational hygiene, where the initial aim is to recognize potential for hazardous exposures and to err on the side of caution. The following assumptions were made to enable the calculations that approximate the worst-case personal exposure of a vaper (Equation 1):

1. Air the vaper breathes consists of a small volume of aerosol generated by e-cigarettes that contains a specific chemical plus pristine air;
2. The volume of aerosols inhaled from e-cigarettes is small compared to total volume of air inhaled;
3. The period of exposure to the aerosol considered was 8 hours for comparability to the standard working shift for which TLVs were developed (this does not mean only 8 hours worth of vaping was considered but, rather, a day's worth of exposure was modeled as being concentrated into just 8 hours;
4. Consumption of 150 puffs in 8 hours (an upper estimate based on a rough estimate of 150 puffs by a typical vaper in a day [1]) was assumed. (Note that if vaping over 16 hours “day” was considered then air into which contaminants from vaping are diluted into would have to increase by a factor of 2, thereby lowering estimated exposure; thus, the adopted approach is entirely still in line with “worst case” assessment.);
5. Breathing rate is 8 liters per minute [12,13];
6. Each puff contains the same quantity of compounds studied.

$$\left[\mathrm{mg/m^3}\right] = \mathrm{mg/puff} \times \mathrm{puffs}/\left(8\,\mathrm{hr\ day}\right) \times 1/\left(\mathrm{m^3 air\ inhaled\ in\ 8\ hr}\right) \quad (1)$$

The only exception to this methodology was when assessing a study of aerosol emitted by 5 vapers in a 60 m^3 room over 5 hours that seemed to be a sufficient approximation of worst-case “bystander” exposure [6]. All calculated concentrations were expressed as the most stringent (lowest) TLV for a specific compound (i.e. assuming the most toxic form if analytical report is ambiguous) and expressed as “percent of TLV”. Considering that all the above calculations are approximate and reflecting that exposures in occupational and general environment can easily vary by a factor of 10 around the mean, we added a 10-fold safety factor to the “percent of TLV” calculation. This safety factor accounts for considerable uncertainty about the actual number and volume of puffs since the number of puffs is hard to estimate accurately with reports as high as 700 puffs per day Farsalinos [14]. Details of all calculations are provided in an Excel spreadsheet (see Additional file 3).

No systematic attempt was made to convert the content of the studied liquids into potential exposures because sufficient information was available on the chemistry of aerosols to use those studies rather than making the necessary simplifying assumptions to do the conversion. However, where such calculations were performed in the original research, the following approach was used: under the (probably false – see the literature on formation of carbonyl compounds below) assumption of no chemical reaction to generate novel ingredients, composition of liquids can be used to estimate potential for exposure if it can be established how much volume of liquid is consumed in given 8 hours, following an algorithm analogous to the one described above for the aerosols (Equation 2):

$$\left[\mathrm{mg/m^3}\right] = \mathrm{mg}/\left(\mathrm{mL\ liquid}\right) \times \left(\mathrm{mL\ liquid}\right)/\mathrm{puff} \times \mathrm{puffs}/\left(8\ \mathrm{hr\ day}\right) \times 1/\left(\mathrm{m^3 air\ inhaled\ in\ 8\ hr}\right) \quad (2)$$

Comparison to cigarette smoke was not performed here because the fact that e-cigarette aerosol is at least orders of magnitude less contaminated by toxic compounds is uncontroversial [2-8].

The study adhered to the PRISMA guidelines for systematic reviews (http://www.prisma-statement.org/).

Results and discussion

General comments on methods

In excess of 9,000 determinations of single chemicals (and rarely, mixtures) were reported in reviewed articles and reports, typically with multiple compounds per electronic cigarette tested [2-8,15-43]. Although the quality of reports is highly variable, if one assumes that each report contains some information, this asserts that quite a bit is known about composition of e-cigarette liquids and aerosols. The only report that was excluded from consideration was work of McAuley et al. [24] because of clear evidence of cross-contamination – admitted to by the authors – with cigarette smoke and, possibly, reagents. The results pertaining to non-detection of tobacco-specific nitrosamines (TSNAs) are potentially trustworthy, but those related to polycyclic aromatic hydrocarbons (PAH) are not since it is incredible that cigarette smoke would contain fewer PAHs, which arise from incomplete combustion of organic matter, than aerosol of e-cigarettes that do not burn organic matter [24]. In fairness to the authors of that study, similar problems may have occurred in other studies but were simply not reported, but it is impossible to include a paper in a review once it is known for certain that its quantitative results are not trustworthy. When in doubt, we erred on the side of trusting that proper quality controls were in place, a practice that is likely to increase appearance of atypical or erroneous results in this review. From this perspective, assessment of concordance among independent reports gains higher importance than usual since it is unlikely that two experiments would be flawed in the same exact manner (though of course this cannot be assured).

It was judged that the simplest form of publication bias – disappearance of an entire formal study from the available literature – was unlikely given the exhaustive search strategy and the contested nature of the research question. It is clearly the case that only a portion of all industry technical reports were available for public access, so it is possible that those with more problematic results were systematically suppressed, though there is no evidence to support this speculation. No formal attempt was made to ascertain publication bias *in situ* though it is apparent that anomalous results do gain prominence in typical reviews of the literature: diethylene glycol [44,45] detected at non-dangerous levels (see details below) in one test of 18 of early-technology products by the US Food and Drugs Administration (FDA) [23] and one outlier in measurement of formaldehyde content of exhaled air [4] and aldehydes in aerosol generated from one e-cigarette in Japan [38]. It must be emphasized that the alarmist report of aldehydes in experiments presented in [38] is based on the concentration in generated aerosol rather than air inhaled by the vaper over prolonged period of time (since vapers do not inhale only aerosol). Thus, results reported in [38] cannot be the basis of any claims about health risk, a fallacy committed both by the authors themselves and commentators on this work [45].

It was also unclear from [38] what the volume of aerosol sampled was – a critical item for extrapolating to personal exposure and a common point of ambiguity in the published reports. However, in a personal exchange with the authors of [38] [July 11, 2013], it was clarified that the sampling pump drew air at 500 mL/min through e-cigarette for 10 min, allowing more appropriate calculations for estimation of health risk that are presented below. Such misleading reporting is common in the field that confuses concentration in the aerosol (typically measured directly) with concentration in the air inhaled by the vaper (never determined directly and currently requiring additional assumptions and modeling). This is important because the volume of aerosol inhaled (maximum ~8 L/day) is small compared to the volume of air inhaled daily (8 L/min); this point is illustrated in the Figure 1.

Figure 1 Illustrating the difference between concentrations in the aerosol generated by vaping and inhaled air in a day. *Panel* ***A*** shows a black square that represents aerosol contaminated by some compound as it would be measured by a "smoking machine" and extrapolated to dosage from vaping in one day. This black square is located inside the white square that represents total uncontaminated air that is inhaled in a day by a vaper. The relative sizes of the two squares are exaggerated as the volume of aerosol generated in vaping relative to inhaled air is much smaller than is illustrated in the figure. *Panel* ***B*** shows how exposure from contaminated air (black dots) is diluted over a day for appropriate comparison to occupational exposure limits that are expressed in terms of "time-weighted average" or average contamination over time rather than as instantaneous exposures. Exposure during vaping occurs in a dynamic process where the atmosphere inhaled by the vaper alternates between the smaller black and larger white squares in *Panel* ***A***. Thus, the concentration of contaminants that a vaper is exposed to over a day is much smaller than that which is measured in the aerosol (and routinely improperly cited as reason for concern about "high" exposures).

A similar but more extreme consideration applies to the exposure of bystanders which is almost certainly several orders of magnitude lower than the exposure of vapers. In part this is due to the absorption, rather than exhalation, of a portion of the aerosol by the vapers: there is no equivalent to the "side-stream" component of exposure to conventional cigarettes, so all of the exposure to a bystander results from exhalation. Furthermore, any environmental contamination that results from exhalation of aerosol by vaper will be diluted into the air prior to entering a bystander's personal breathing zone. Lastly, the number of puffs that affect exposure to bystander is likely to be much smaller than that of a vaper unless we are to assume that vaper and bystander are inseparable.

It is unhelpful to report the results in cigarette-equivalents in assessments that are not about cigarette exposure, as in [43], because this does not enable one to estimate exposures of vapers. To be useful for risk assessment, the results on the chemistry of the aerosols and liquids must be reported in a form that enables the calculations in Equations 1 and 2. It must be also be noted that typical investigations consisted of qualitative and quantitative phases such that quantitative data is available mostly on compounds that passed the qualitative screen. In the qualitative phase, presence of the compounds above a certain limit of detection is determined. In the quantitative phase, the amount of only the compounds that are detected in the qualitative phase is estimated. This biased all reports on concentration of compounds towards both higher levels and chemicals which a particular lab was most adept at analyzing.

Declared Ingredients: comparison to occupational exposure limits

Propylene glycol and glycerin

Propylene glycol and glycerin have the default or precautionary 8-hour TLV of 10 mg/m^3 set for all organic mists with no specific exposure limits or identified toxicity (http://www.osha.gov/dts/chemicalsampling/data/CH_243600.html; accessed July 5, 2013). These interim TLVs tend to err on the side of being too high and are typically lowered if evidence of harm to health accumulates. For example, in a study that related exposure of theatrical fogs (containing propylene glycol) to respiratory symptoms [46], "mean personal inhalable aerosol concentrations were 0.70 mg/m^3 (range 0.02 to 4.1)" [47]. The only available estimate of propylene concentration of propylene glycol in the aerosol indicates personal exposure on the order of 3–4 mg/m^3 in the personal breathing zone over 8 hours (under the assumptions we made for all other comparisons to TLVs) [2]. The latest (2006) review of risks of occupational exposure to propylene glycol performed by the Health Council of the Netherlands (known for OELs that are the most protective that evidence supports and based exclusively on scientific considerations rather than also accounting for feasibility as is the case for the TLVs) recommended exposure limit of 50 mg/m^3 over 8 hours; concern over short-term respiratory effects was noted [http://www.gezondheidsraad.nl/sites/default/files/200702OSH.pdf; accessed July 29, 2013]. Assuming extreme consumption of the liquid per day via vaping (5 to 25 ml/day and 50-95% propylene glycol in the liquid)[b], levels of propylene glycol in inhaled air can reach 1–6 mg/m^3. It has been suggested that propylene glycol is very rapidly absorbed during inhalation [4,6] making the calculation under worst case scenario of all propylene glycol becoming available for inhalation credible. It must also be noted that when consuming low-nicotine or nicotine-free liquids, the chance to consume larger volumes of liquid increases (large volumes are needed to reach the target dose or there is no nicotine feedback), leading to the upper end of propylene glycol and glycerin exposure. Thus, estimated levels of exposure to propylene glycol and glycerin are close enough to TLV to warrant concern. However, it is also important to consider that propylene glycol is certainly not all absorbed because visible aerosol is exhaled in typical vaping. Therefore, the current calculation is in the spirit of a worst case assumption that is adopted throughout the paper.

Nicotine

Nicotine is present in most e-cigarette liquids and has TLV of 0.5 mg/m^3 for average exposure intensity over 8 hours. If approximately 4 m^3 of air is inhaled in 8 hours, the consumption of 2 mg nicotine from e-cigarettes in 8 hours would place the vaper at the occupational exposure limit. For a liquid that contains 18 mg nicotine/ml, TLV would be reached upon vaping ~0.1-0.2 ml of liquid in a day, and so is achieved for most anyone vaping nicotine-containing e-cigarettes [1]. Results presented in [25] on 16 e-cigarettes also argue in favor of exceedance of TLV from most any nicotine-containing e-cigarette, as they predict >2 mg of nicotine released to aerosol in 150 puffs (daily consumption figure adopted in this report). But as noted above, since delivery of nicotine is the purpose of nicotine-containing e-cigarettes, the comparison to limits on unintended, unwanted exposures does not suggest a problem and serves merely to offer complete context. If nicotine is present but the liquid is labeled as zero-nicotine [25,44], it could be treated as a contaminant, with the vaper not intending to consume nicotine and the TLV, which would be most likely exceeded, is relevant. However, when nicotine content is disclosed, even if inaccurately, then comparison to TLV is not valid. Accuracy in nicotine content is a concern with respect to truth in advertising rather than unintentional exposure, due to presumed (though not yet tested) self-regulation of consumption by persons who use e-cigarettes as a source of nicotine.

Overall, the declared ingredients in the liquid would warrant a concern by standards used in occupational hygiene, provided that comparison to occupational exposure limits is valid, as discussed in the introduction. However, this is not to say that the exposure is affirmatively believed to be harmful; as noted, the TLVs for propylene glycol and glycerin mists is based on uncertainty rather than knowledge. These TLVs are not derived from knowledge of toxicity of propylene glycol and glycerin mists, but merely apply to any compound of no known toxicity present in workplace atmosphere. This aspect of the exposure from e-cigarettes simply has little precedent (but see study of theatrical fogs below). Therefore, the exposure will provide the first substantial collection evidence about the effects, which calls for monitoring of both exposure levels and outcomes, even though there are currently no grounds to be concerned about the immediate or chronic health effects of the exposure. The argument about nicotine is presented here for the sake of completeness and consistency of comparison to TLVs, but in itself does not affect the conclusions of this analysis because it should not be modeled as if it were a contaminant when declared as an ingredient in the liquid.

Contaminants

Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAH) were quantified in several reports in aerosols [5,6,43] and liquids [7,19,42]. These compounds include well-known carcinogens, the levels of which are not subject to TLV but are instead to be kept "as low as reasonably achievable" [10]. For PAH, only non-carcinogenic pyrene that is abundant in the general environment was detected at 36 ng/cartridge in 5 samples of liquid [7]; PAHs were not detected in most of the analyses of aerosols, except for chrysene in the analysis of the aerosol of one e-cigarette [43].

Tobacco-specific nitrosamines

The same risk assessment considerations that exist for PAH also hold for carcinogenic tobacco-specific nitrosamines (TSNAs) [48] for which no occupational exposure limits exist because (a) these exposures do not appear to occur in occupational settings often enough to warrant development of TLVs, and (b) it is currently accepted in establishing TLVs that carcinogens do not have minimal thresholds of toxicity. As expected, because the TSNAs are contaminants of nicotine from tobacco leaf, there is also evidence of association between nicotine content of the liquid and TSNA concentrations, with reported concentrations <5 ng/cartridge tested [7]. Smaller studies of TSNA content in liquids are variable, with some not reporting any detectable levels [18,33,35] and others clearly identifying these compounds in the liquids when controlling for background contamination (n = 9) [23]. Analyses of aerosols indicate that TSNAs are present in amounts that can results in doses of < ng/day [5,33] to µg/day [8] (assuming 150 puffs/day) (see also [43]). The most comprehensive survey of TSNA content of 105 samples of liquids from 11 manufactures indicates that almost all tested liquids (>90%) contained TSNAs in µg/L quantities [36]. This is roughly equivalent to 1/1000 of the concentration of TSNAs in modern smokeless tobacco products (like snus), which are in the ppm range [48]. For example, 10 µg/L (0.01 ppm) of total TSNA in liquid [36] can translate to a daily dose of 0. 025–0. 05 µg from vaping (worst case assumption of 5 ml liquid/day); if 15 g of snus is consumed a day [49] with 1 ppm of TSNAs [48] and half of it were absorbed, then the daily dose is estimated to be 7.5 µg, which is 150–300 times that due to the worst case of exposure from vaping. Various assumptions about absorption of TSNAs alter the result of this calculation by a factor that is dwarfed in magnitude compared to that arising from differences considered above. This is reassuring because smokeless tobacco products, such as snus, pose negligible cancer risk [50], certainly orders of magnitude smaller than smoking (if one considers the chemistry of the products alone). In general, it appears that the cautious approach in face of variability and paucity of data is to seek better understanding of the predictors of presence of TSNA in liquids and aerosols so that measures for minimizing exposure to TSNAs from aerosols can be devised.

This can include considering better control by manufactures who extract the nicotine from tobacco leaf..

Volatile organic compounds

Total volatile organic compounds (VOC) were determined in aerosol to be non-detectable [3] except in one sample that appeared to barely exceed the background concentration of 1 mg/m^3 by 0.73 mg/m^3 [6]. These results are corroborated by analyses of liquids [19] and most likely testify to insensitivity of employed analytic methods for total VOC for characterizing aerosol generated by e-cigarettes, because there is ample evidence that specific VOC are present in the liquids and aerosols.[c] Information on specific commonly detected VOC in the aerosol is given in Table 1. It must be observed that these reported concentrations are for analyses that first observed qualitative evidence of the presence of a given VOC and thus represent worst case scenarios of exposure when VOC is present (i.e. zero-level exposures are missing from the overall summary of worst case exposures presented here). For most VOC and aldehydes, one can predict the concentration in air inhaled by a vaper to be < <1% of TLV. The only exceptions to this generalization are:

Table 1 Exposure predictions based on analysis of aerosols generated by smoking machines: Volatile Organic Compounds

Compound	N#	Estimated concentration in personal breathing zone		Ratio of most stringent TLV (%)		Reference
		PPM	mg/m^3	Calculated directly	Safety factor 10	
Acetaldehyde	1	0.005		0.02	0.2	[5]
	3	0.003		0.01	0.1	[4]
	12	0.001		0.004	0.04	[8]
	1	0.00004		0.0001	0.001	[3]
	1	0.0002		0.001	0.008	[3]
	150	0.001		0.004	0.04	[40,41]
	1	0.008		0.03	3	[38]
Acetone	1	0.002		0.0003	0.003	[38]
	150	0.0004		0.0001	0.001	[40,41]
Acrolein	12	0.001		1	13	[8]
	150	0.002		2	20	[40,41]
	1	0.006		6	60	[38]
Butanal	150	0.0002		0.001	0.01	[40,41]
Crotonaldehyde	150		0.0004	0.01	0.1	[40,41]
Formaldehyde	1	0.002		0.6	6	[5]
	3	0.008		3	30	[4]
	12	0.006		2	20	[8]
	1	<0.0003		<0.1	<1	[3]
	1	0.0003		0.1	1	[3]
	150	0.01		4	40	[40,41]
	1	0.009		3	30	[38]
Glyoxal	1		0.002	2	20	[38]
	150		0.006	6	60	[40,41]
o-Methylbenzaldehyde	12		0.001	0.05	0.5	[8]
p,m-Xylene	12		0.00003	0.001	0.01	[8]
Propanal	3	0.002		0.01	0.1	[4]
	150	0.0006		0.002	0.02	[40,41]
	1	0.005		0.02	0.2	[38]
Toluene	12	0.0001		0.003	0.03	[8]
Valeraldehyde	150		0.0001	0.0001	0.001	[40,41]

average is presented when N > 1.

(a) acrolein: ~1% of TLV (average of 12 measurements) [40] and measurements at a mean of 2% of TLV (average of 150 measurements) [41] and

(b) formaldehyde: between 0 and 3% of TLV based on 18 tests (average of 12 measurements at 2% of TLV, the most reliable test) [40] and an average of 150 results at 4% of TLV [41].

Levels of acrolein in exhaled aerosol reported in [6] were below 0.0016 mg/m^3 and correspond to predicted exposure of <1% of TLV (Table 2). It must re-emphasized that all calculations based on one electronic cigarette analyzed in [38] are best treated as qualitative in nature (i.e. indicating presence of a compound without any particular meaning attached to the reported level with respect to typical levels) due to great uncertainty about whether the manner in which the e-cigarette was operated could have resulted in overheating that led to generation of acrolein in the aerosol. In fact, a presentation made by the author of [38] clearly stated that the "atomizer, generating high concentration carbonyls, had been burned black" [40,41]. In unpublished work, [40] there are individual values of formaldehyde, acrolein and glyoxal that approach TLV, but it is uncertain how typical these are because there is reason to believe the liquid was overheated; considerable variability among brands of electronic cigarettes was also noted. Formaldehyde and other aldehydes, but not acrolein, were detected in the analysis one e-cigarette [43]. The overwhelming majority of the exposure to specific VOC that are predicted to result from inhalation of the aerosols lie far below action level of 50% of TLV at which exposure has to be mitigated according to current code of best practice in occupational hygiene [51].

Table 2 Exposure predictions for volatile organic compounds based on analysis of aerosols generated by volunteer vapers

Compound	N#	Estimated concentration in personal breathing zone (ppm)	Ratio of most stringent TLV (%)		Reference
			Calculated directly	Safety factor 10	
2-butanone (MEK)	3	0.04	0.02	0.2	[4]
	1	0.002	0.0007	0.007	[6]
2-furaldehyde	3	0.01	0.7	7	[4]
Acetaldehyde	3	0.07	0.3	3	[4]
Acetic acid	3	0.3	3	30	[4]
Acetone	3	0.4	0.2	2	[4]
Acrolein	1	<0.001	<0.7	<7	[6]
Benzene	3	0.02	3	33	[4]
Butyl hydroxyl toluene	1	4E-05	0.0002	0.002	[6]
Isoprene	3	0.1	7	70	[4]
Limonene	3	0.009	0.03	0.3	[4]
	1	2E-05	0.000001	0.00001	[6]
m,p-Xyelen	3	0.01	0.01	0.1	[4]
Phenol	3	0.01	0.3	3	[4]
Propanal	3	0.004	0.01	0.1	[4]
Toluene	3	0.01	0.07	0.7	[4]

average is presented when N > 1.

Finding of an unusually high level of formaldehyde by Schripp *et al.* [4] – 0.5 ppm predicted vs. 15-minute TLV of 0.3 ppm (not given in Table 2) – is clearly attributable to endogenous production of formaldehyde by the volunteer smoker who was consuming e-cigarettes in the experimental chamber, since there was evidence of build-up of formaldehyde prior to vaping and liquids used in the experiments did not generate aerosol with detectable formaldehyde. This places generalizability of other findings from [4] in doubt, especially given that the only other study of exhaled air by vapers who were not current smokers reports much lower concentrations for the same compounds [6] (Table 2). It should be noted that the report by Romagna *et al.* [6] employed more robust methodology, using 5 volunteer vapers (no smokers) over an extended period of time. Except for benzene, acetic acid and isoprene, all calculated concentrations for detected VOC were much below 1% of TLV in exhaled air [6]. In summary, these results do not indicate that VOC generated by vaping are of concern by standards used in occupational hygiene.

Diethylene glycol and ethylene glycol became a concern following the report of their detection by FDA [44], but these compounds are not detected in the majority of tests performed to date [3,15,17,19,23]. Ten batches of the liquid tested by their manufacture did not report any diethylene glycol above 0.05% of the liquid [42]. Methods used to detect diethylene glycol appear to be adequate to be informative and capable of detecting the compound in quantities < <1% of TLV [15,17,23]. Comparison to TLV is based on a worst case calculation analogous to the one performed for propylene glycol. For diethylene glycol, TLV of 10 mg/m^3 is applicable (as in the case of all aerosols with no know toxicity by inhalation), and there is a recent review of regulations of this compound conducted for the Dutch government by the Health Council of the Netherlands (jurisdiction with some of the most strict occupational exposure limits) that recommended OEL of 70 mg/m^3 and noted lack of evidence for toxicity following inhalation [http://www.gezondheidsraad.nl/sites/default/files/200703OSH.pdf; accessed July 29; 2013]. In conclusion, even the quantities detected in the single FDA result were of little concern, amounting to less than 1% of TLV.

Inorganic compounds

Special attention has to be paid to the chemical form of compounds when there is detection of metals and other elements by inductively coupled plasma mass spectrometry (ICP-MS) [8,26]. Because the parent molecule that occurs in the aerosol is destroyed in such analysis, the results can be misleading and not interpretable for risk assessment. For example, the presence of sodium (4.18 μg/10 puffs) [26] does not mean that highly reactive and toxic sodium metal is in the aerosol, which would be impossible given its reactivity, but most likely means the presence of the ubiquitous compound that contains sodium, dissolved table salt (NaCl). If so, the corresponding daily dose of NaCl that arises from these concentrations from 150 puffs is about 10,000 times lower than allowable daily intake according to CDC (http://www.cdc.gov/features/dssodium/; accessed July 4, 2013). Likewise, a result for presence of silica is meaningless for health assessment unless the crystalline form of SiO_2 is known to be present. When such ambiguity exists, a TLV equivalence calculation was not performed. We compared concentrations to TLVs when it was even remotely plausible that parent molecules were present in the aqueous solution. However, even these are to be given credence only in an extremely pessimistic analyst, and further investigation by more appropriate analytical methods could clarify exactly what compounds are present, but is not a priority for risk assessment.

It should also be noted that one study that attempted to quantify metals in the liquid found none above 0.1-0.2 ppm levels [7] or above unspecified threshold [19]. Table 3 indicates that most metals that were detected were present at <1% of TLV even if we assume that the analytical results imply the presence of the most hazardous molecules containing these elements that can occur in aqueous solution. For example, when elemental chromium was measured, it is compared to TLV for insoluble chromium IV that has the lowest TLV of all chromium compounds. Analyses of metals given in [43] are not summarized here because of difficulty with translating reported units into meaningful terms for comparison with the TLV, but only mercury (again with no information on parent organic compound) was detected in trace quantities, while arsenic, beryllium, chromium, cadmium, lead and nickel were not. Taken as the whole, it can be inferred that there is no evidence of contamination of the aerosol with metals that warrants a health concern.

Table 3 Exposure predictions based on analysis of aerosols generated by smoking machines: Inorganic Compounds#

Element quantified	Assumed compound containing the element for comparison with TLV	N##	Estimated concentration in personal breathing zone (mg/m^3)	Ratio of most stringent TLV (%)		Reference
				Calculated directly	Safety factor 10	
Aluminum	Respirable Al metal & insoluble compounds	1	0.002	0.2	1.5	[26]
Barium	Ba & insoluble compounds	1	0.00005	0.01	0.1	[26]
Boron	Boron oxide	1	0.02	0.1	1.5	[26]
Cadmium	Respirable Cd & compounds	12	0.00002	1	10	[8]
Chromium	Insoluble Cr (IV) compounds	1	3E-05	0.3	3	[26]
Copper	Cu fume	1	0.0008	0.4	4.0	[26]
Iron	Soluble iron salts, as Fe	1	0.002	0.02	0.2	[26]
Lead	Inorganic compounds as Pb	1	7E-05	0.1	1	[26]
		12	0.000025	0.05	0.5	[8]
Magnesium	Inhalable magnesium oxide	1	0.00026	0.003	0.03	[26]
Manganese	Inorganic compounds, as Mn	1	8E-06	0.04	0.4	[26]
Nickel	Inhalable soluble inorganic compounds, as Ni	1	2E-05	0.02	0.2	[26]
		12	0.00005	0.05	0.5	[8]
Potassium	KOH	1	0.001	0.1	1	[26]
Tin	Organic compounds, as Sn	1	0.0001	0.1	1	[26]
Zinc	Zinc chloride fume	1	0.0004	0.04	0.4	[26]
Zirconium	Zr and compounds	1	3E-05	0.001	0.01	[26]
Sulfur	SO_2	1	0.002	0.3	3	[26]

The actual molecular form in the aerosol unknown and so worst case assumption was made if it was physically possible (e.g. it is not possible for elemental lithium & sodium to be present in the aerosol); there is no evidence from the research that suggests the metals were in the particular highest risk form, and in most cases a general knowledge of chemistry strongly suggests that this is unlikely. Thus, the TLV ratios reported here probably do not represent the (much lower) levels that would result if we knew the molecular forms.
average is presented when N > 1.

Consideration of exposure to a mixture of contaminants

All calculations conducted so far assumed only one contaminant present in clean air at a time. What are the implications of small quantities of various compounds with different toxicities entering the personal breathing zone at the same time? For evaluation of compliance with exposure limits for mixtures, Equation 3 is used:

$$\mathrm{OEL}_{\mathrm{mixture}} = \sum_{i-1}^{n} \left(C_i / TLV_i \right), \quad (3)$$

where C_i is the concentration of the i^{th} compound ($i = 1,\ldots,n$, where $n > 1$ is the number of ingredients present in a mixture) in the contaminated air and TLV_i is the TLV for the i^{th} compound in the contaminated air; if $OEL_{mixture} > 1$, then there is evidence of the mixture exceeding TLV.

The examined reports detected no more than 5–10 compounds in the aerosol, and the above calculation does not place any of them out of compliance with TLV for mixture. Let us imagine that 50 compounds with TLVs were detected. Given that the aerosol tends to contain various compounds at levels, on average, of no more than 0.5% of TLV (Tables 1 and 3), such a mixture with 50 ingredients would be at 25% of TLV, a level that is below that which warrants a concern, since the "action level" for implementation of controls is traditionally set at 50% of TLV to ensure that the majority of persons exposed have personal exposure below mandated limit [51]. Pellerino et al. [2] reached conclusions similar to this review based on their single experiment: contaminants in the liquids that warrant health concerns were present in concentrations that were less than 0.1% of that allowed by law in the European Union. Of course, if the levels of the declared ingredients (propylene glycol, glycerin, and nicotine) are considered, the action level would be met, since those ingredients are present in the concentrations that are near the action level. There are no known synergistic actions of the examined mixtures, so Equation 3 is therefore applicable. Moreover, there is currently no reason to suspect that the trace amounts of the contaminants will react to create compounds that would be of concern.

Conclusions

By the standards of occupational hygiene, current data do not indicate that exposures to vapers from contaminants in electronic cigarettes warrant a concern. There are no known toxicological synergies among compounds in the aerosol, and mixture of the contaminants does not pose a risk to health. However, exposure of vapers to propylene glycol and glycerin reaches the levels at which, if one were considering the exposure in connection with a workplace setting, it would be prudent to scrutinize the health of exposed individuals and examine how exposures could be reduced. This is the basis for the recommendation to monitor levels and effects of prolonged exposure to propylene glycol and glycerin that comprise the bulk of emissions from electronic cigarettes other than nicotine and water vapor. From this perspective, and taking the analogy of work on theatrical fogs [46,47], it can be speculated that respiratory functions and symptoms (but not cancer of respiratory tract or non-malignant respiratory disease) of the vaper is of primary interest. Monitoring upper airway irritation of vapers and experiences of unpleasant smell would also provide early warning of exposure to compounds like acrolein because of known immediate effects of elevated exposures (http://www.atsdr.cdc.gov/toxprofiles/tp124-c3.pdf; accessed July 11, 2013). However, it is questionable how much concern should be associated with observed concentrations of acrolein and formaldehyde in the aerosol. Given highly variable assessments, closer scrutiny is probably warranted to understand sources of this variability, although there is no need at present to be alarmed about exceeding even the occupational exposure limits, since occurrence of occasional high values is accounted for in established TLVs. An important clue towards a productive direction for such work is the results reported in [40,41] that convincingly demonstrate how heating the liquid to high temperatures generates compounds like acrolein and formaldehyde in the aerosol. A better understanding about the sources of TSNA in the aerosol may be of some interest as well, but all results to date consistently indicate quantities that are of no more concern than TSNA in smokeless tobacco or nicotine replacement therapy (NRT) products. Exposures to nicotine from electronic cigarettes is not expected to exceed that from smoking due to self-titration [11]; it is only a concern when a vaper does not intend to consume nicotine, a situation that can arise from incorrect labeling of liquids [25,44].

The cautions about propylene glycol and glycerin apply only to the exposure experienced by the vapers themselves. Exposure of bystanders to the listed ingredients, let alone the contaminants, does not warrant a concern as the exposure is likely to be orders of magnitude lower than exposure experienced by vapers. Further research employing realistic conditions could help quantify the quantity of exhaled aerosol and its behavior in the environment under realistic worst-case scenarios (i.e., not small sealed chambers), but this is not a priority since the exposure experienced by bystanders is clearly very low compared to the exposure of vapers, and thus there is no reason to expect it would have any health effects.

The key to making the best possible effort to ensure that hazardous exposures from contaminants do not occur is ongoing monitoring of actual exposures and estimation of potential ones. Direct measurement of personal exposures is not possible in vaping due to the fact the aerosol is inhaled directly, unless, of course, suitable biomarkers of exposure can be developed. The current review did not identify any suitable biomarkers, though cotinine is a useful proxy for exposure to nicotine-containing liquids. Monitoring of potential composition of exposures is perhaps best achieved though analysis of aerosol generated in a manner that approximates vaping, for which better insights are needed on how to modify "smoking machines" to mimic vaping given that there are documented differences in inhalation patterns [52] that depend on features of e-cigarettes [14]. These smoking machines would have to be operated under a realistic mode of operation of the atomizer to ensure that the process for generation of contaminants is studied under realistic temperatures. To estimate dosage (or exposure in personal breathing zone), information on the chemistry of the aerosol has to be combined with models of the inhalation pattern of vapers, mode of operation of e-cigarettes and quantities of liquid consumed. Assessment of exhaled aerosol appears to be of little use in evaluating risk to vapers due to evidence of qualitative differences in the chemistry of exhaled and inhaled aerosol.

Monitoring of liquid chemistry is easier and cheaper than assessment of aerosols. This can be done systematically as a routine quality control measure by the manufacturers to ensure uniform quality of all production batches. However, we do not know how this relates to aerosol chemistry because previous researchers did not appropriately pair analyses of chemistry of liquids and aerosols. It is standard practice in occupational hygiene to analyze the chemistry of materials generating an exposure, and it is advisable that future studies of the aerosols explicitly pair these analyses with examination of composition of the liquids used to generate the aerosols. Such an approach can lead to the development of predictive models that relate the composition of the aerosol to the chemistry of liquids, the e-cigarette hardware, and the behavior of the vaper, as these, if accurate, can anticipate hazardous exposures before they occur. The current attempt to use available data to develop such relationships was not successful due to studies failing to collect appropriate data. Systematic monitoring of quality of the liquids would also help reassure consumers and is best done by independent laboratories rather than manufactures to remove concerns about impartiality (real or perceived).

Future work in this area would greatly benefit from standardizing laboratory protocols (e.g. methods of extraction of compounds from aerosols and liquids, establishment of "core" compounds that have to be quantified in each analysis (as is done for PAH and metals), development of minimally informative detection limits that are needed for risk assessment, standardization of operation of “vaping machine”, etc.), quality control experiments (e.g. suitable positive and negative controls without comparison to conventional cigarettes, internal standards, estimation of%recovery, etc.), and reporting practices (e.g. in units that can be used to estimate personal exposure, use of uniform definitions of limits of detection and quantification, etc.), all of which would improve on the currently disjointed literature. Detailed recommendations on standardization of such protocols lie outside of scope of this report.

All calculations conducted in this analysis are based on information about patterns of vaping and the content of aerosols and liquids that are highly uncertain in their applicability to “typical” vaping as it is currently practiced and says even less about future exposures due to vaping (e.g. due to development of new technology). However, this is similar to assessments that are routinely performed in occupational hygiene for novel technology as it relied on “worst case” calculations and safety margins that attempt to account for exposure variability. The approach adopted here and informed by some data is certainly superior to some currently accepted practices in the regulatory framework in occupational health that rely purely on description of emission processes to make claims about potential for exposure (e.g. [53]). Clearly, routine monitoring of potential and actual exposure is required if we were to apply the principles of occupational hygiene to vaping. Detailed suggestions on how to design such exposure surveillance are available in [54].

While vaping is obvious not an occupational exposure, occupational exposure standards are the best available option to use. If there were a standard for voluntary consumer exposure to aerosols, it would be a better fit, but no such standard exists. The only candidate standard is the occupational standard, which is conservative (more protective) when considered in the context of voluntary exposures, as argued above, and any suggestion that another standard be used needs to be concrete and justified.

In summary, analysis of the current state of knowledge about the chemistry of contaminants in liquids and aerosols associated with electronic cigarettes indicates that there is no evidence that vaping produces inhalable exposures to these contaminants at a level that would prompt measures to reduce exposure by the standards that are used to ensure safety of workplaces. Indeed, there is sufficient evidence to be reassured that there are no such risks from the broad range of the studied products, though the lack of quality control standards means that this cannot be assured for all products on the market. However, aerosol generated during vaping on the whole, when considering the declared ingredients themselves, if it were treated in the same manner as an emission from industrial process, creates personal exposures that would justify surveillance of exposures and health among exposed persons. Due to the uncertainty about the effects of these quantities of propylene glycol and glycerin, this conclusion holds after setting aside concerns about health effects of nicotine. This conclusion holds notwithstanding the benefits of tobacco harm reduction, since there is value in understanding and possibly mitigating risks even when they are known to be far lower than smoking. It must be noted that the proposal for such scrutiny of “total aerosol” is not based on specific health concerns suggested by compounds that resulted in exceedance of occupational exposure limits, but is instead a conservative posture in the face of unknown consequences of inhalation of appreciable quantities of organic compounds that may or may not be harmful at doses that occur during vaping.

Key conclusions:

- Even when compared to workplace standards for involuntary exposures, and using several conservative (erring on the side of caution) assumptions, the exposures from using e-cigarettes fall well below the threshold for concern for compounds with known toxicity. That is, even ignoring the benefits of e-cigarette use and the fact that the exposure is actively chosen, and even comparing to the levels that are considered unacceptable to people who are not benefiting from the exposure and do not want it, the exposures would not generate concern or call for remedial action.
- Expressed concerns about nicotine only apply to vapers who do not wish to consume it; a voluntary (indeed, intentional) exposure is very different from a contaminant.
- There is no serious concern about the contaminants such as volatile organic compounds (formaldehyde, acrolein, etc.) in the liquid or produced by heating. While these contaminants are present, they have been detected at problematic levels only in a few studies that apparently were based on unrealistic levels of heating.
- The frequently stated concern about contamination of the liquid by a nontrivial quantity of ethylene glycol or diethylene glycol remains based on a single sample of an early-technology product (and even this did not rise to the level of health concern) and has not been replicated.
- Tobacco-specific nitrosamines (TSNA) are present in trace quantities and pose no more (likely much less) threat to health than TSNAs from modern smokeless tobacco products, which cause no measurable risk for cancer.
- Contamination by metals is shown to be at similarly trivial levels that pose no health risk, and the alarmist claims about such contamination are based on unrealistic assumptions about the molecular form of these elements.
- The existing literature tends to overestimate the exposures and exaggerate their implications. This is partially due to rhetoric, but also results from technical features. The most important is confusion of the concentration in aerosol, which on its own tells us little about risk to heath, with the relevant and much smaller total exposure to compounds in the aerosol averaged across all air inhaled in the course of a day. There is also clear bias in previous reports in favor of isolated instances of highest level of chemical detected across multiple studies, such that average exposure that can be calculated are higher than true value because they are “missing” all true zeros.
- Routine monitoring of liquid chemistry is easier and cheaper than assessment of aerosols. Combined with an understanding of how the chemistry of the liquid affects the chemistry of the aerosol and insights into behavior of vapers, this can serve as a useful tool to ensure the safety of e-cigarettes.
- The only unintentional exposures (i.e., not the nicotine) that seem to rise to the level that they are worth further research are the carrier chemicals themselves, propylene glycol and glycerin. This exposure is not known to cause health problems, but the magnitude of the exposure is novel and thus is at the levels for concern based on the lack of reassuring data.

Endnotes

[a]Atmosphere that contains air inhaled by a person.

[b]This estimate of consumption was derived from informal reports from vaping community; 5 ml/day was identified as a high but not rare quantity of consumption and 25 ml/day was the high end of claimed use, though some skepticism was expressed about whether the latter

quantity was truly possible. High-quality formal studies to verify these figures do not yet exist but they are consistent with report of Etter (2012).

[c]The term “VOC” loosely groups together all organic compounds present in aerosol and because the declared ingredients of aerosol are organic compounds, it follows that “VOC are present”.

Competing interests

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Author’s contribution

IB is responsible for all aspects of the report and was the sole contributor.

Author’s information

IB is trained in both occupational hygiene and epidemiology and thus is an expert in bring information that these two fields contribute to risk assessment and policy-making. IB does not and never has used any tobacco products. Current research was completed by him as independent research contract during otherwise unpaid summer months. IB is an Associate Professor at Drexel University and felt obliged to disclose his primary academic appointment but this work was completed outside of the structures of Drexel University.

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Additional files

Additional_file_1 as XLSX

Additional file 1 Summary of chemical analyses of e-cigarettes extracted from the literature.

Additional_file_2 as RTF

Additional file 2 Key to identifying articles listed in *Additional file 1*.

Additional_file_3 as XLSX

Additional file 3 Calculations conducted to compare reported results to threshold limit values. Spreadsheet that implemented calculations summarized in the article.

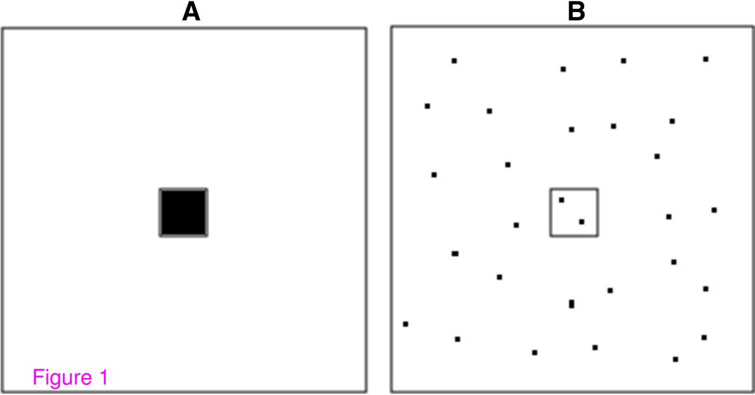

Figure 1

Additional files provided with this submission:

Additional file 1: 9759835901066082_add1.xlsx, 57K
http://www.biomedcentral.com/imedia/1731529015118196/supp1.xlsx
Additional file 2: 9759835901066082_add2.rtf, 60K
http://www.biomedcentral.com/imedia/1581997989118196/supp2.rtf
Additional file 3: 9759835901066082_add3.xlsx, 70K
http://www.biomedcentral.com/imedia/1576899991181967/supp3.xlsx

Levels of selected carcinogens and toxicants in vapour from electronic cigarettes

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ABSTRACT

Significance Electronic cigarettes, also known as e-cigarettes, are devices designed to imitate regular cigarettes and deliver nicotine via inhalation without combusting tobacco. They are purported to deliver nicotine without other toxicants and to be a safer alternative to regular cigarettes. However, little toxicity testing has been performed to evaluate the chemical nature of vapour generated from e–cigarettes. The aim of this study was to screen e-cigarette vapours for content of four groups of potentially toxic and carcinogenic compounds: carbonyls, volatile organic compounds, nitrosamines and heavy metals.

Materials and methods Vapours were generated from 12 brands of e-cigarettes and the reference product, the medicinal nicotine inhaler, in controlled conditions using a modified smoking machine. The selected toxic compounds were extracted from vapours into a solid or liquid phase and analysed with chromatographic and spectroscopy methods.

Results We found that the e-cigarette vapours contained some toxic substances. The levels of the toxicants were 9–450 times lower than in cigarette smoke and were, in many cases, comparable with trace amounts found in the reference product.

Conclusions Our findings are consistent with the idea that substituting tobacco cigarettes with e-cigarettes may substantially reduce exposure to selected tobacco-specific toxicants. E-cigarettes as a harm reduction strategy among smokers unwilling to quit, warrants further study. (To view this abstract in Polish and German, please see the supplementary files online.)

INTRODUCTION

An electronic cigarette, also known as e-cigarette, is a type of nicotine inhaler, imitating ordinary cigarettes. Although the majority of e-cigarettes look similar to other tobacco products, such as cigarettes or cigars, certain types resemble pens, screwdrivers or even harmonicas. E-cigarettes contain nicotine solution in a disposable cartridge. The cartridge is replaced when the solution is finished or might be refilled by the e-cigarette user. In contrast with ordinary cigarettes, which involve tobacco combustion, e-cigarettes use heat to transform nicotine solution into vapour. Processed and purified nicotine from tobacco leaves, suspended in a mixture of glycerin or propylene glycol with water, is vapourised. Nicotine present in such vapour enters the respiratory tract, from where it is absorbed to the bloodstream.[1–4]

Distributors of e-cigarettes promote the product as completely free of harmful substances. The basis for the claim of harmlessness of the e-cigarettes is that they do not deliver toxic doses of nicotine and the nicotine solution lacks harmful constituents. E-cigarettes are new products and, as such, require further testing to assess their toxic properties. Currently, the scientific evidence on the lack or presence of toxic chemicals in the vapour generated from e-cigarettes, and inhaled by their users is very limited. In August 2008, Ale Alwen, the Assistant Director-General for Non-communicable Diseases and Mental Health, stated that 'the electronic cigarette is not a proven nicotine replacement therapy. WHO has no scientific evidence to confirm the product's safety and efficacy. However, WHO does not discount the possibility that the electronic cigarette could be useful as a smoking cessation aid. The only way to know is to test.[5] Douglas Bettcher, Director of the WHO's Tobacco Free Initiative stated that only clinical tests and toxicity analysis could permit considering e-cigarettes a viable method of nicotine replacement therapy.[6]

The majority of tests carried out on e-cigarettes until now consist of analysing the chemicals in the cartridges or nicotine refill solutions.[7–18] The current tests show that the cartridges contain no or trace amounts of potentially harmful substances, including nitrosamines, acetaldehyde, acetone and formaldehyde. However, using e-cigarettes requires heating the cartridges and under such conditions chemical reactions may result in formation of new compounds. Such a situation takes place in the case of ordinary cigarettes, where a number of toxic compounds are formed during combustion. The US Department of Health and Human Services of the Food and Drug Administration agency carried out tests which showed the presence of trace amounts of nitrosamines and diethylene glycol in e-cigarette vapour. These tests were conducted in a manner which simulated the actual use of the products.[19]

We developed analytical methods and measured concentrations of selected compounds in the vapour generated by different brands and types of e-cigarettes. We focused our study on the four most important groups of toxic compounds present in the tobacco smoke: carbonyl compounds, volatile organic compounds (VOCs), tobacco-specific nitrosamines and metals (table 1).

MATERIALS AND METHODS

Electronic cigarettes and reference product (Nicorette inhalator)

Since the internet is currently the main distribution channel for the products, we searched price

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Table 1 Selected toxic compounds identified in tobacco smoke [20–23]

Chemical compounds	Toxic effects
Carbonyl compounds	
Formaldehyde*, acetaldehyde*, acrolein*	Cytotoxic, carcinogenic, irritant, pulmonary emphysema, dermatitis
Volatile organic compounds (VOCs)	
Benzene*, toluene*, aniline	Carcinogenic, haematotoxic, neurotoxic, irritant
Nitrosamines	
N′–nitrosonornicotine (NNN)*, 4-(methylnitrosoamino)-1-(3-pyridyl)-1-butanone (NNK)*, N′-nitrosoethylomethyloamine	Carcinogenic
Polycyclic aromatic compounds (PAHs)	
Benzo(a)pyrene, benzo(a)anthracene, dibenzo(a)anthracene	Carcinogenic
Free radicals	
Methyl radical, hydroxyl radical, nitrogen monoxide	Carcinogenic, neurotoxic
Toxic gases	
Carbon monoxide, hydrogen sulfide, ammonia, sulfur dioxide, hydrogen cyanide	Cardiovascular toxicants, carcinogenic, irritant
Heavy metals	
Cadmium (Cd)*, lead (Pb)*, mercury (Hg)*	Carcinogenic, nephrotoxic, neurotoxic, haematotoxic
Other toxicants	
Carbon disulfide	Neurotoxic

*Indicates compounds analysed in this study.

comparison websites, online marketplace (Allegro.pl auction service) and internet discussion forums for e–cigarette users to identify the most popular brands of e–cigarettes distributed from within Poland. The searching was limited to web pages from Poland, and only Polish language was allowed for in retrieval options. Some 30 brands were identified. The brands were entered into Google.pl, and ranked according to the number of hits they generated. The number of hits in the search engine for the selected 30 models allowed selection of the 11 most popular e-cigarettes brands. Additionally, one e-cigarette model purchased in Great Britain was used in the study. All e–cigarette models selected for the study were purchased online. Characteristics of the product tested in the study are shown in table 2.

The suitable cartridges of the same brand name were used for the study. They were purchased from the same sources as that of the e-cigarette and were matched to selected models. All cartridges were characterised by high nicotine content (16–18 mg). As a reference product the medicinal nicotine inhalator was used (Nicorette 10 mg, Johnson&Johnson, Poland). The inhalator for the study was purchased in one of the local pharmaceutical warehouses.

Generation of vapour from e-cigarettes and reference product

Vapour from e-cigarettes was generated using the smoking machine Palaczbot (Technical University of Lodz, Poland) as described previously.[3] This is a one-port linear piston-like smoking machine with adjustable puffing regimes in a very wide range, controlled by computer interface.

Pilot samples demonstrated that it was impossible to generate vapour from e–cigarettes in standard laboratory conditions assumed for conventional cigarettes testing (International Organization for Standardization (ISO) 3808).[24] Inhalation of a volume of 35 ml anticipated in conventional cigarette standard is insufficient for activation of most of the e-cigarettes. Thus, we decided to generate vapour in conditions reflecting the actual manner of e-cigarettes using, determined based on the results of inhalation topography measurement among 10 'e–smokers', who declared that they regularly use e-cigarettes for a period

Table 2 Characteristics of products tested in the study

Product code	Brand name	Model	Cartridge type	Flavour	Labelled nicotine content (mg or mg/ml)	Measured nicotine content (mg) [3]	Retailer	Country
EC01	Joye	510	Cartridge	Marlboro	4	4	Inspired s.c.	Poland
EC02	Janty	eGo	Cartridge	Marlboro	16	5	Janty	Poland
EC03	Janty	Dura	Cartridge	Marlboro	16	5	Janty	Poland
EC04	DSE	901	Cartridge	Regular	16	9	Fausee	Poland
EC05	Trendy	808	Cartridge	Trendy	18	2	Damhess	Poland
EC06	Nicore	M401	Cartridge	Marlboro	18	5	Atina Poland	Poland
EC07	Mild	201	Cartridge	Marlboro	18	19	Mild	Poland
EC08	Colinss	Age	Cartomizer	Camel	18	11	Colinss	Poland
EC09	Premium	PR111	Cartomizer	Tobacco	16	12	Premium	Poland
EC10	Ecis	510	Cartridge	Menthol	11	5	Arcotech	Poland
EC11	Dekang	Pen	Cartridge	Regular	18	18	Ecigars Polska	Poland
EC12	Intellicig	Evolution	Cartridge	Regular	8	8	Intellicig	UK

longer that 1 month.[3] All testing procedures in this work were carried out using the same averaged puffing conditions: puff duration of 1.8 s, intervals between puffs of 10 s, puff volume 70 ml and number of puffs taken in one puffing session was 15. A total of 150 puffs were taken from each e-cigarette in 10 series of 15 puffs with intervals between series of 5 min each. Each e-cigarette was tested three times on three following days after batteries were recharged during nights. A fresh cartridge was placed on the e-cigarettes each day they were tested. Vapour was visibly being produced during the full 150 puffs taken from each product tested.

Analytical chemistry

Note: The details of the sample preparation and analysis are given in the online supplementary materials.

It was planned to absorb the analysed vapour components in bulbs containing an organic solvent (extraction to liquid) or on suitable sorbents (extraction to solid phase). This required the modification of the system described above, in such a manner to enable quick connection of desirable sorption system. Carbonyl compounds and organic compounds due to their volatility were trapped in tubes packed with solid adsorbent. Metals and nitrosamines in turn, which are characterised by lower volatility, were to be absorbed in two gas washing bottles with methanol (50 ml in each bottle). Both washing bottles were immersed in acetone-dry ice bath in order to avoid any losses of volatile solvent. A picture of the set for vapour generation from e–cigarette and metals or nitrosamines absorption is presented in online supplementary figure S2.

The samples, after the preparation and condensation procedure, were analysed using analytical methods with high specificity and sensitivity allowing detection of even trace amounts of analysed compounds. Figure 1 shows the sample preparation procedure; and all analytical methods are described in details in the online supplementary materials. The following carbonyl compounds were analysed in this work using high-performance liquid chromatography with diode array detector (HPLC-DAD): formaldehyde, acetaldehyde, acrolein, acetone, propionic aldehyde, crotonaldehyde, butanol, benzaldehyde, isovaleric aldehyde, valeric aldehyde, m-methylbenzaldehyde, o-methylbenzaldehyde, p-methylbenzaldehyde, hexanal, 2,5-dimethylbenzaldehyde. VOCs included benzene, toluene, chlorobenzene, ethylbenzene, m,p-xylene, o-xylene, styrene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, naphthalene and were analysed with gas chromatography-mass spectrometry. Among tobacco-specific nitrosamines two compounds were measured: N′–nitrosonornicotine (NNN) and 4-(methylnitrosoamino)-1-(3-pyridyl)-1-butanone (NNK) with ultra-performance liquid chromatography-mass spectrometry. An inductively coupled plasma mass spectrometry technique was used to quantify following metals: cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), cadmium (Cd), lead (Pb), arsenic (As), chromium (Cr), selenium (Se), manganese (Mn), barium (Ba), rubidium (Rb), strontium (Sr), silver (Ag), thallium (Tl) and vanadium (V). All analytical methods used in this work were validated as per the International Conference on Harmonisation guideline Q2(R1).[25]

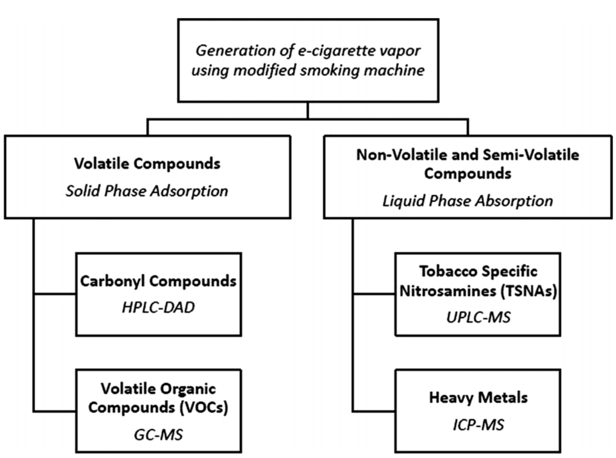

Figure 1 Analytical procedures applied in the study to test carcinogens and selected toxicants in vapour from e-cigarettes. GC-MS, gas chromatography-mass spectrometry; HPLC-DAD, high-performance liquid chromatography with diode array detector; ICP-MS, inductively coupled plasma-mass spectrometry; TSNA, tobacco-specific nitrosamine; UPLC-MS, ultra-performance liquid chromatography-mass spectrometry; VOC, volatile organic compound.

Statistical analysis

Results were presented as mean±SEM levels of selected compounds in vapour generated from e–cigarettes (per 150 puffs). The study aimed to compare the results obtained for aerosol from Nicorette inhalator with the results obtained for all examined e–cigarette models. Due to the small size of the groups, the difference between the mean from two groups was assessed based on Student's t test. All statistical analyses were conducted using the software for statistical data analysis Statistica V.9.0 (StaftSoft, Tulsa, USA). The significance level was established as $p<0.05$.

RESULTS

Carbonyl compounds

Among 15 carbonyls analysed, only 4 were found in vapour generated from e–cigarettes (table 3); and these compounds were identified in almost all examined e–cigarettes. The exception was one e-cigarette marked with code EC09, where acrolein was not detected. Three of the carbonyls have known toxic and irritating properties: formaldehyde, acetaldehyde and acrolein. The content of formaldehyde ranged from 2.0 μg to 56.1 μg, acetaldehyde from 1.1 μg to 13.6 μg, and acrolein from 0.7 μg to 41.9 μg per one e-cigarette (150 puffs). Trace amounts of formaldehyde, acetaldehyde and o-methylbenzaldehyde were also detected from the Nicorette inhalator. None of these compounds were detected in blank samples.

Volatile organic compounds

Among 11 VOCs analysed, only two were found in samples of vapour generated from e-cigarettes (table 3), and these compounds were identified in almost all examined e–cigarettes. The only one exception was e-cigarette marked with code EC02, where toluene and m,p-xylene were not detected. The content of toluene ranged from 0.2 μg to 6.3 μg per one e–cigarette (150 puffs). Although the m,p-xylene levels found in analysed samples of e–cigarette vapours ranged from 0.1 μg to 0.2 μg, it was also found on the same level in blank samples. In Nicorette inhalator in turn, none of the compounds analysed in that group were noted.

Tobacco-specific nitrosamines

Both nitrosamines analysed in the study were identified in all but three vapours generated from e-cigarettes (table 3). NNN was not found in e–cigarettes marked with codes EC01, EC04 and EC05 and NNK was not identified in products EC04, EC05 and EC12. The content of NNN ranged from 0.8 ng to 4.3 ng, and NNK from 1.1 ng to 28.3 ng per one e–cigarette

Table 3 Levels of selected compounds in vapour generated from e–cigarettes (per 150 puffs)

Compound	BS	Levels in vapour from electronic cigarettes†											Reference product
		Product code											
		EC01	EC02	EC03	EC04	EC05	EC06	EC07	EC08	EC09	EC10	EC11	EC12	Inhalator
Carbonyl compounds (μg)														
Formaldehyde	ND	44.2±4.1*	23.6±8.7*	30.2±2.3*	47.9±0.2*	56.1±1.4*	35.3±2.7*	19.0±2.7*	6.0±2.0	3.2±0.8	3.9±1.5	23.9±11.1	46.3±2.1*	2.0±1.1
Acetaldehyde	ND	4.6±0.2*	6.8±3.2	8.2±2.5*	11.5±2.0*	3.0±0.2*	13.6±2.1*	11.1±3.3*	8.8±1.6*	3.5±0.3*	2.0±0.1	3.7±1.5	12.0±2.4*	1.1±0.6
Acrolein	ND	41.9±3.4*	4.4±2.5	16.6±2.5*	30.1±6.4*	22.0±1.6*	2.1±0.4*	8.5±3.6	0.7±0.4	ND	2.7±1.6	1.1±0.6	7.4±3.2*	ND
o-methylbenzaldehyde	ND	1.9±0.5	4.4±1.2*	3.2±1.0*	4.9±1.2*	1.7±0.1*	7.1±0.4*	1.3±0.8	5.5±0.0*	6.0±0.7*	3.2±0.5*	5.1±0.1*	2.2±0.6*	0.7±0.4
Volatile Organic Compounds (VOCs) (μg)														
Toluene	ND	0.5±0.1*	ND	0.2±0.0*	0.6±0.1*	0.2±0.0*	ND	0.3±0.2	0.2±0.1	6.3±1.5*	0.2±0.1*	0.5±0.1*	0.5±0.0*	ND
p,m-xylene	0.1	0.1±0.0*	ND	0.1±0.0*	0.2±0.1*	0.1±0.0	ND	0.1±0.1	0.1±0.0	0.1±0.0*	0.1±0.0*	0.1±0.1*	0.1±0.0	ND
Tobacco-Specific Nitrosamines (TSNAs) (ng)														
NNN	ND	ND	2.7±2.2	0.8±0.8	ND	ND	0.9±0.4	4.3±2.4	1.9±0.3*	1.2±0.6	2.0±1.1	3.2±0.6*	1.3±0.1	ND
NNK	ND	2.0±2.0	3.6±1.8	3.5±1.8	ND	ND	1.1±1.1	21.1±6.3*	4.6±0.4*	28.3±13.2	2.1±2.1	13.0±1.4*	ND	ND
Metals (μg)														
Cd	0.02	0.17±0.08	0.15±0.03*	0.15±0.05	0.02±0.01	0.04±0.01	0.22±0.16	0.02±0.01	0.08±0.03	0.01±0.01	0.17±0.10	0.03±0.03	ND	0.03±0.01
Ni	0.17	0.28±0.22	0.29±0.08	0.21±0.03	0.17±0.07	0.14±0.06	0.11±0.06	0.23±0.09	0.26±0.10	0.19±0.09	0.12±0.04	0.11±0.08	0.11±0.05	0.19±0.04
Pb	0.02	0.06±0.01	0.06±0.03	0.07±0.01	0.03±0.01	0.05±0.01	0.03±0.01	0.04±0.01	0.57±0.28	0.09±0.04	0.06±0.02	0.04±0.03	0.03±0.03	0.04±0.01

Values are mean±SEM.
*Significant difference with Nicorette inhalator ($p<0.05$).
†Units are μg, except for nitrosamines units are ng.
BS, blank sample; ND, not detected; NNK, N′-nitrosonornicotine (NNN) and 4-(methylnitrosoamino)-1-(3-pyridyl)-1-butanone; NNN, N′-nitrosonornicotine; DL, detection limit.

(150 puffs). In Nicorette inhalator or in blank samples in turn, none of these compounds was noted.

Metals

Among 12 metals analysed in the study, cadmium, nickel and lead were identified, and were present in all vapours generated from e-cigarettes (except cadmium, which was not detected in a product of code EC12; table 3). The content of cadmium ranged from 0.01 μg to 0.22 μg, nickel from 0.11 μg to 0.29 μg and lead from 0.03 μg to 0.57 μg per one e-cigarette (150 puffs). The same metals in trace amounts were detected in Nicorette inhalator and in blank samples.

DISCUSSION

We examined vapours generated from 12 models of e-cigarettes for the presence of four groups of toxic compounds found in tobacco smoke. The Nicorette inhalator was used as a reference product. Such a choice was dictated by the premise that a therapeutic product like Nicorette inhalator should fulfil specified safety standards and should not contain significant levels of any of the analysed toxic compounds.

Our results confirm findings from the previous studies, in which small amounts of formaldehyde and acetaldehyde were detected in cartridges. [9 18] However, the presence of acrolein in a cartridge or nicotine solution has not been reported so far. Formaldehyde and acetaldehyde were also found in vapour exhaled to test chamber by volunteers who used e–cigarette filled with three various nicotine solutions.[26] Recently, Uchiyama *et al*[27] demonstrated that vapour generated from a single brand of e–cigarette contained low levels of formaldehyde, acetaldehyde and acrolein. There is a possibility that acrolein is present in vapour only, since this compound may be formed as a result of heating glycerin which is a component of the solution. Pyrolysis of glycerin has been studied in steam with acrolein, formaldehyde and acetaldehyde observed as the major products.[28 29] These products appear to result from dehydration and fragmentation of glycerin. Although energy calculations of the dehydration of glycerin by the neutral mechanisms indicate that these processes can only occur at relatively high temperatures such as in pyrolysis or combustion, the addition of acids allows substantially lower dehydration temperatures.[30]

All three carbonyl compounds found in the study and discussed above have been shown to be toxic in numerous studies: formaldehyde is classified as carcinogenic to humans (group 1 by International Agency for Research on Cancer, IARC)[31]; acetaldehyde as possibly carcinogenic to humans (group 2B),[31] and acrolein causes irritation to the nasal cavity, and damage to the lining of the lungs and is thought to contribute to cardiovascular disease in cigarette smokers.[32] Exposure to carbonyl compounds found in vapour might cause mouth and throat irritation which is the most frequently reported adverse event among e–cigarette users.[1 33] A study by Cassee *et al*[34] showed that sensory irritation in rats exposed to mixtures of formaldehyde, acetaldehyde and acrolein is more pronounced than that caused by each of the compounds separately. Future studies should evaluate possible adverse health outcomes of short term and long term exposure to these compounds among users of e–cigarettes and people involuntarily exposed to exhaled vapours.

We found that the vapour of some e-cigarettes contains traces of the carcinogenic nitrosamines NNN and NNK, whereas neither was detected in aerosol from the Nicorette inhalator. The studies conducted previously reported the presence of NNN and NNK in e–cigarette cartridges in amounts of 3.9–8.2 ng per cartridge,[18 19] which corresponds with the results on vapour obtained in the present paper. However some other studies have reported that some cartridges are free of nitrosamines.[12] This inconsistency of findings of various studies might be due to different analytical methodologies of variable sensitivity applied in the studies discussed above.

Two of the analysed VOCs were detected: toluene and m, p-xylene. None of the studies conducted until now reported the presence of these compounds in a cartridge, nicotine solution or e–cigarette vapour. None of these compounds were found in a study by Schripp *et al*[26] on passive exposure to e–cigarette vapours. Three toxic metals, cadmium, nickel and lead, were detected in the vapour of analysed e–cigarettes. Since the same elements were also detected in trace amounts in Nicorette inhalator and in blank samples it is possible that there were other sources of these metals. This limitation of the study does not allow us to conclude whether e–cigarette alone may be a significant source of exposure to these chemicals.

Recently, we published a study on tests for nicotine delivery of Polish and UK e–cigarette brands.[3] Many of the same brands in that paper have also been included in this study and tested for toxicants delivery. It should be mentioned that the leading brands with the highest nicotine delivery did not have the highest yields for toxicant delivery. This is important as while selecting the brands for nicotine the worst brands for toxicants generally can be avoided.

The results allowed us to compare the content of harmful substances between various e–cigarette models and conventional cigarettes (based on literature data).[35] To compare levels of selected toxins in e-cigarette vapour and mainstream smoke of a conventional cigarette we assumed that users of e-cigarettes take on overage 15 puffs during one session of product use, and it would correspond to smoking one conventional cigarette. In our study the vapours from e-cigarettes were generated from 150 puffs (10 series of 15 puffs each). For comparison purposes, we assumed that 150 puffs of an e-cigarette correspond to smoking 10 cigarettes. The comparison of toxic substance levels between conventional cigarettes and e-cigarettes is presented in table 4.

Table 4 Comparison of toxins levels between conventional and electronic cigarettes

Toxic compound	Conventional cigarette (μg in mainstream smoke) [35]	Electronic cigarette (μg per 15 puffs)	Average ratio (conventional vs electronic cigarette)
Formaldehyde	1.6–52	0.20–5.61	9
Acetaldehyde	52–140	0.11–1.36	450
Acrolein	2.4–62	0.07–4.19	15
Toluene	8.3–70	0.02–0.63	120
NNN	0.005–0.19	0.00008–0.00043	380
NNK	0.012–0.11	0.00011–0.00283	40

NNK, N′-nitrosonornicotine (NNN) and 4-(methylnitrosoamino)-1-(3-pyridyl)-1-butanone; NNN, N′-nitrosonornicotine.

As shown in table 4 levels of selected toxic compounds found in the smoke from a conventional cigarette were 9–450-fold higher than levels in the vapour of an e–cigarette. Smoking an e-cigarette (also referred to as 'vaping') can result in exposure to carcinogenic formaldehyde comparable with that received from cigarette smoking. Formaldehyde was also found in the vapour of medicinal inhalators, at levels that overlapped with those found in e-cigarette vapour. Exposure to acrolein, an oxidant and respiratory irritant thought to be a major contributor to cardiovascular disease from smoking, is 15 times lower on average in e-cigarette vapour compared with cigarette smoke. The amounts of toxic metals and aldehydes in e-cigarettes are trace amounts and are comparable with amounts contained in an examined therapeutic product.

The results of the study support the proposition that the vapour from e–cigarettes is less injurious than the smoke from cigarettes. Thus one would expect that if a person switched from conventional cigarettes to e-cigarettes the exposure to toxic chemicals and related adverse health effects would be reduced. The confirmation of that hypothesis however, requires further studies involving people using e-cigarette devices.

The primary limitation of our research is that the puffing profile we used may not reflect actual user puff topography. Hua *et al*[36] reported that e–cigarette users take longer puffs, and that puff duration varied significantly among e–cigarette brands and users. This suggests that actual doses of toxicants inhaled by e–cigarette users might be higher than measured in our study. Similarly to results of tobacco cigarette testing with smoking machines (International Organization for Standardization (ISO), Federal Trade Commission (FTC)) the values obtained in our study should be interpreted with caution. The other limitation of our research is that we have tested only 12 brands of e-cigarettes. There are numerous different brands in the market, and there is little information on their quality control.

CONCLUSIONS

The vapour generated from e-cigarettes contains potentially toxic compounds. However, the levels of potentially toxic compounds in e-cigarette vapour are 9–450-fold lower than those in the smoke from conventional cigarettes, and in many cases comparable with the trace amounts present in pharmaceutical preparation. Our findings support the idea that substituting tobacco cigarettes with electronic cigarettes may substantially reduce exposure to tobacco-specific toxicants. The use of e-cigarettes as a harm reduction strategy among cigarette smokers who are unable to quit, warrants further study.

What this paper adds

- Distributors of e–cigarettes promote the product as completely free of harmful substances. Currently, there is no comprehensive research on the presence of toxic chemicals in the vapour generated from e-cigarettes and inhaled by their users.
- This study of chemical composition of vapour generated from 12 brands of e-cigarettes revealed that the vapour contained some toxic substances.
- The levels of potentially toxic compounds in e-cigarette vapour were found to be from ninefold to almost 450-fold lower compared with smoke from conventional cigarettes, and in many cases comparable with trace amounts present in pharmaceutical preparations.

Contributors MLG and NB designed the study and wrote the paper. JK, MG and LK tested the products using smoking machine. AS and JK developed the analytical method and measured carbonyl compounds and VOCs. AP, MJC, and CRD developed the analytical method and measured metals. CH and PJ developed the analytical method and measured TSNAs. MLG and JK analysed the data. All contributors approved the final version of the manuscript.

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Original Article

Electronic cigarettes as a harm reduction strategy for tobacco control: A step forward or a repeat of past mistakes?

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Abstract The issue of harm reduction has long been controversial in the public health practice of tobacco control. Health advocates have been reluctant to endorse a harm reduction approach out of fear that tobacco companies cannot be trusted to produce and market products that will reduce the risks associated with tobacco use. Recently, companies independent of the tobacco industry introduced electronic cigarettes, devices that deliver vaporized nicotine without combusting tobacco. We review the existing evidence on the safety and efficacy of electronic cigarettes. We then revisit the tobacco harm reduction debate, with a focus on these novel products. We conclude that electronic cigarettes show tremendous promise in the fight against tobacco-related morbidity and mortality. By dramatically expanding the potential for harm reduction strategies to achieve substantial health gains, they may fundamentally alter the tobacco harm reduction debate.
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Keywords: electronic cigarette; harm reduction; nicotine regulation; tobacco control

Introduction

Harm reduction is a framework for public health policy that focuses on reducing the harmful consequences of recreational drug use without necessarily reducing or eliminating the use itself.[1] Whereas harm reduction policies have been widely adopted for illicit drug use (for example, needle exchange programs[2]) and alcohol use (for example, designated driver programs[3]), they have not found wide support in tobacco control. Many within the tobacco control community have embraced nicotine replacement therapy (NRT) and other pharmaceutical products, but these products are designed as cessation strategies rather than recreational alternatives. Recently, however, a new product that does not fit neatly into any previous category has entered the nicotine market: the electronic cigarette. Electronic cigarettes do not contain tobacco, but they are recreational nicotine devices and the user closely mimics the act of smoking. Thus, they are neither tobacco products nor cessation devices. The novel potential of electronic cigarettes warrants revisiting the harm reduction debate as it applies to these products.

In this article, we first explain what electronic cigarettes are and why they are difficult to categorize. Second, we examine the available evidence concerning the safety and efficacy of electronic cigarettes. Then, we review the most common arguments made against harm reduction in the tobacco control literature, followed by an analysis of each of these arguments in light of the recent emergence of electronic cigarettes. Finally, we identify conclusions from this analysis and their implications for the public health practice of tobacco control.

What are Electronic Cigarettes and Why are They Novel?

Electronic cigarettes are hand-held devices that deliver nicotine to the user through the battery-powered vaporization of a nicotine/propylene-glycol solution. The act of 'smoking' an electronic cigarette is called 'vaping' and it mimics smoking; but, there is no combustion and the user inhales vapor, not smoke. Although the nicotine is derived from tobacco, electronic cigarettes contain no tobacco. Theoretically, we would expect *vaping* to be less harmful than smoking as it delivers nicotine without the thousands of known and unknown toxicants in tobacco smoke. Moreover, a product that mimics the act of smoking, in addition to delivering nicotine, can address both pharmacologic and behavioral components of cigarette addiction. Electronic cigarettes are not manufactured or distributed by the tobacco industry or by the pharmaceutical industry. Hundreds of small distributors market them over the internet and in shopping mall kiosks. They have been on the market in the United States for more than 3 years and have become increasingly popular.

Review of Evidence Regarding the Safety of Electronic Cigarettes

As ~5300 of the estimated 10 000–100 000 chemicals in cigarette smoke have ever been identified,[4] we already have more comprehensive knowledge of the chemical constituents of electronic cigarettes than tobacco ones. We were able to identify 16 studies[5–17] that have characterized, quite extensively, the components contained in electronic cigarette liquid and vapor using gas chromatography mass spectrometry (GC-MS) (Table 1). These studies demonstrate that the primary components of electronic cigarette cartridges are propylene glycol (PG), glycerin, and nicotine. Of the other chemicals identified, the FDA has focused on potential health hazards associated with two: tobacco-specific nitrosamines (TSNAs) and diethylene glycol (DEG).[5]

TSNAs have been detected in two studies at trace levels.[5,6] The maximum level of total TSNAs reported was 8.2 ng/g.[6] This compares with a similar level of 8.0 ng in a nicotine patch, and it is orders of magnitude lower than TSNA levels in regular cigarettes.[18] Table 2 shows that electronic cigarettes contain only 0.07–0.2 per cent of the TSNAs present in cigarettes, a 500-fold to 1400-fold reduction in concentration. The presence of DEG in one of the 18 cartridges studied by the US Food and Drug Administration (FDA) is worrisome, yet none of the other 15 studies found any DEG. The use of a non-pharmaceutical grade of PG may explain this contamination.

Other than TSNAs and DEG, few, if any, chemicals at levels detected in electronic cigarettes raise serious health concerns. Although the existing research does not warrant a conclusion that electronic cigarettes are safe in absolute terms and further clinical studies are needed to comprehensively assess the safety of electronic cigarettes, a preponderance of the available evidence shows them to be much safer than tobacco cigarettes and comparable in toxicity to conventional nicotine replacement products.

Table 1: Laboratory studies of the components in and safety of electronic cigarettes[5–17]

Study	*Brand tested*	*Main findings*
Evaluation of e-cigarettes (FDA laboratory report)[5]	NJOY, Smoking Everywhere	'Very low levels' of tobacco-specific nitrosamines (TSNAs) were detected in 5 of 10 cartridges tested. Diethylene glycol (DEG) was detected about 0.1% in 1 of 18 cartridges tested.
Safety Report on the Ruyan e-Cigarette Cartridge and Inhaled Aerosol[6]	Ruyan	Trace levels of TSNAs were detected in the cartridge liquid. The average level of TSNAs was 3.9 ng/cartridge, with a maximum level of 8.2 ng/cartridge. Polyaromatic hydrocarbon carcinogens found in cigarette smoke were not detectable in cartridge liquid. No heavy metals detected. Exhaled carbon monoxide levels did not increase in smokers after use of the e-cigarette. The study concluded that e-cigarettes are very safe relative to cigarettes and safe in absolute terms on all measurements applied.
Ruyan E-cigarette Bench-top Tests[7]	Ruyan	None of the 50 priority-listed cigarette smoke toxicants were detected. Toxic emissions score for e-cigarette was 0, compared to 100–134 for regular cigarettes.
Characterization of Liquid 'Smoke Juice' for Electronic Cigarettes[8]	Liberty Stix	No compounds detected via gas chromatography mass spectrometry (GC-MS) of electronic cigarette cartridges or vapors other than propylene glycol (99.1% in vapor), glycerin (0.46%), and nicotine (0.44%).
Analysis of Components from Gamucci Electronic Cigarette Cartridges, Tobacco Flavour Regular Smoking Liquid[9]	Gamucci	GC-MS detected propylene glycol (77.5%), glycerin (14.0%), nicotine (8.5%), and cyclotene hydrate (0.08%) in e-cigarette liquid. Levels of cyclotene hydrate were not believed to be of concern.
Analysis of Components from Gamucci Electronic Cigarette Cartridges, Tobacco Flavour Light Smoking Liquid[9]	Gamucci	GC-MS detected propylene glycol (80.4%), glycerin (14.4%), and nicotine (5.3%) in e-cigarette liquid. No other compounds detected.

Analysis of Components from Gamucci Electronic Cigarette Cartridges, Ultra Light Smoking Liquid[9]	Gamucci	GC-MS detected propylene glycol (85.5%), glycerin (11.2%), and nicotine (3.3%) in e-cigarette liquid. No other compounds detected.
Analysis of Components from Gamucci Electronic Cigarette Cartridges, Tobacco Flavour Zero, Smoking Liquid[9]	Gamucci	GC-MS detected propylene glycol (84.3%), glycerin (7.6%), 1,3-bis(3-phenoxyphenoxy)Benzene (7.0%), 3-Isopropoxy-1,1,1,7,7,7-hexamethyl-3,5,5-tris(trimethylsiloxy)tetrasiloxane (0.77%), and α,3,4-tris[(trimethylsilyl)oxy]Benzeneacetic acid (0.39%) in e-cigarette liquid. No other compounds were detected. 1,3-bis(3-phenoxyphenoxy) Benzene is non-hazardous. The other two chemicals have an unknown safety profile, but are present at nominally low levels.
NJOY e-Cigarette Health Risk Assessment[10]	NJOY	The vapor constituents detected were propylene glycol, glycerin, nicotine, acetaldehyde, 1-methoxy-2-propanol, 1-hydroxy-2-propanone, acetic acid, 1-menthone, 2,3-butanediol, menthol, carvone, maple lactone, benzyl alcohol, 2-methyl-2-pentanoic acid, ethyl maltol, ethyl cinnamate, myosamine, benzoic acid, 2,3-bipyridine, cotinine, hexadecanoic acid, and 1'1-oxybis-2-propanol. No TSNAs, polyaromatic hydrocarbons, or other tobacco smoke toxicants were detected. On the basis of the amounts of these components present and an examination of the risk profile of these compounds, the report concludes that the only significant side effect expected would be minor throat irritation resulting from the acetaldehyde.
Characterization of Regal Cartridges for Electronic Cigarettes[11]	inLife	No DEG was detected in the cartridge liquid or vapors.
Characterization of Regal Cartridges for Electronic Cigarettes – Phase II[12]	inLife	No TSNAs were detected in the e-cigarette liquid (limit of detection was 20 ppm).

Table 1 *continued*

Study	*Brand tested*	*Main findings*
Analysis of Components from "e-Juice XX High 36 mg/ml rated Nicotine Solution": ref S55434[13]	e-Juice	GC-MS detected propylene glycol (51.2%), 1,3-bis(3-phenoxy phenoxy)Benzene (20.2%), glycerin (15.0%), nicotine (10.0%), vanillin (1.2%), ethanol (0.5%), and 3-cyclohexene-1-menthol,. α.,.α.4-trimethyl (0.4%). No other compounds detected. 1,3-bis(3-phenoxyphenoxy)Benzene is non-hazardous. Vanillin and 3-cyclohexene-1-menthol,.α.,.α.4-trimethyl have unknown safety profiles.
Analysis of Chemical Components from High, Med & Low Nicotine Cartridges[14]	The Electronic Cigarette Company (UK)	The compounds detected by GC-MS were propylene glycol, water, nicotine, ethanol, nitrogen, and triacetin. Triacetin is not known to be hazardous. No other compounds were detected.
Chemical Composition of "Instead" Electronic Cigarette Smoke Juice and Vapor[15]	Instead	No DEG was detected in e-cigarette liquid or vapor for the two products tested.
Gas Chromatography Mass Spectrometry (GC-MS) Analysis Report[16]	Not specified	GC-MS detected propylene glycol, glycerin, nicotine, caffeine, tetra-ethylene glycol, pyridine, methyl pyrrolyl, pyridine, methyl pyrrolidinyl, butyl-amine, and hexadecanoic acid in the e-cigarette liquid.
Super Smoker Expert Report[17]	Super Smoker	GC-MS detected propylene glycol, glycerin, nicotine, ethanol, acetone ethyl acetate, acetals, isobutyraldehyde, essential oils, and 2-methyl butanal in the e-cigarette liquid. No other compounds were detected.

Table 2: Maximum tobacco-specific nitrosamine levels[a] in various cigarettes and nicotine-delivery products (ng/g, except for nicotine gum and patch that are ng/patch or ng/gum piece)[6]

Product	*NNN*	*NNK*	*NAT*	*NAB*	*Total*
Nicorette gum (4 mg)[18]	2.00	ND	ND	ND	2.00
NicoDerm CQ patch (4 mg)[18]	ND	8.00	ND	ND	8.00
Electronic cigarettes[6]	**3.87**	**1.46**	**2.16**	**0.69**	**8.18**
Swedish snus[18]	980	180	790	60	2010
Winston (full)[18]	2200	580	560	25	3365
Newport (full)[18]	1100	830	1900	55	3885
Marlboro (ultra-light)[18]	2900	750	1100	58	4808
Camel (full)[18]	2500	900	1700	91	5191
Marlboro (full)[18]	2900	960	2300	100	6260
Skoal (long cut straight)[18]	4500	470	4100	220	9290

[a]The concentrations here represent nanograms (ng) of toxin detected in 1 ruyan 16-mg multi-dose cartridge (which contains approximately 1 gm of e-liquid). They are compared to the amount of toxin contained in approximately one tobacco cigarette (approximately 1 gm of tobacco) or one unit of nicotine replacement product.
Abbreviations: NNN=4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone; NNK=N′-nitrosonornicotine; NAT=N′-nitrosoanatabine; NAB=N′-nitrosoanabasine.
ND=Not detected.

Review of Evidence about the Effectiveness of Electronic Cigarettes in Smoking Cessation

No studies have measured directly the effectiveness of electronic cigarettes in helping smokers cease smoking. Two published studies have examined the effectiveness of the product by measuring their effect on cravings and other short-term indicators. We summarize them briefly in Table 3.[19,20] Bullen *et al*[19] demonstrated that electronic cigarettes deliver nicotine effectively, more rapidly than a nicotine inhaler. In this study, electronic cigarette use significantly reduced craving, a similar effect to what was observed with a nicotine inhaler. Nicotine delivery and reduction in cigarette craving was much less than with a regular cigarette. Eissenberg[20] found that 10 puffs on one brand of electronic cigarettes delivered a small amount of nicotine, again far less than a tobacco cigarette, whereas another brand delivered little to none. The first brand was able to significantly reduce cigarette craving.

Taken together, this evidence suggests that electronic cigarettes are capable of reducing cigarette craving, but that the effect is not due exclusively to nicotine. Bullen *et al* observe that ‘the reduction in

Table 3: Studies of the effectiveness of electronic cigarettes in reducing cigarette craving and other nicotine withdrawal symptoms[19,20]

Study	*Brand tested*	*Summary of findings*
Effect of an E-Cigarette on Cravings and Withdrawal, Acceptability and Nicotine Deliver: Randomized Cross-Over Trial[19]	Ruyan	The 16 mg electronic cigarette delivered nicotine more rapidly than a nicotine inhaler, but less rapidly than cigarettes. Electronic cigarette use significantly reduced craving, but less than cigarettes. The reduction of craving was similar to that observed with the nicotine inhaler. The electronic cigarettes produced fewer minor side effects than the nicotine inhaler.
Electronic Nicotine Delivery Devices: Ineffective Nicotine Delivery and Craving Suppression after Acute Administration[20]	NJOY and Crown Seven	After 10 puffs on an electronic cigarette, one of the two brands tested significantly reduced the craving for a cigarette. Nicotine delivery was found to be minimal.

desire to smoke in the first 10 min[utes] of [electronic cigarette] use appears to be independent of nicotine absorption' (p. 100).[19] The sizable craving reduction achieved by the 'placebo' – a nicotine-free electronic cigarette – demonstrates the ability of physical stimuli to suppress cravings independently.[19] Many studies have established the ability of *denicotinized* cigarettes to provide craving relief.[21,22] Barrett[21] found that denicotinized cigarettes reduce cravings more than a *nicotinized* inhaler, supporting Buchhalter *et al*'s[22] conclusion that although some withdrawal symptoms can be treated effectively with NRT, others, such as intense cravings, respond better to smoking-related stimuli.

Although more research is needed before we will know how effective electronic cigarettes are at achieving smoking abstinence, there is now sufficient evidence to conclude that these products are at least capable of suppressing the urge to smoke. There is also reason to believe that they offer an advantage over traditional nicotine delivery devices '[t]o the extent that non-nicotine, smoking-related stimuli alone can suppress tobacco abstinence symptoms indefinitely' (p. 556).[22]

The Most Common Arguments against Harm Reduction

Our review of the existing literature identified five primary arguments against harm reduction as a tobacco control strategy. These arguments explain why, in the past, harm reduction has not been accepted as a tobacco control strategy.

Promotion of safer alternatives will inhibit smoking cessation/ prevention efforts

The core fear is that smokers who might otherwise have quit smoking altogether will instead become addicted to another harmful product. In addition, a product that reduces harm to the individual may attract new, nonsmoking users, and thus undermine efforts to prevent tobacco use.[23]

Skepticism about the role of combusted products in harm reduction

The argument here, based on numerous related concerns, is that the combustion of tobacco produces inherently dangerous exposures and thus the search for a 'safer' cigarette is futile. It is impossible to assess the risks of a new product using machine measured delivery of smoke constituents, because there is no good way to simulate actual smoking behavior.[23] We cannot, moreover, easily infer human risk from chemical measurements because no reliable toxicity indices exist.[24] A widespread school of thought in tobacco control holds that the very nature of tobacco combustion precludes safer cigarettes, and therefore attempts to develop them should be abandoned.[25]

Alternatives promoted as safer may prove more dangerous, or they may be equally dangerous, leading to false or unsupported claims and to the misleading of the public

Experience with potentially reduced exposure products in the past has revealed that products promoted by the tobacco industry as potentially safer have ended up either not being safer or resulted in increased toxicant exposures.[23] In particular, a broad consensus within the public health community holds that 'light' cigarettes misled consumers into thinking that they were being exposed to lower levels of toxic chemicals.[26] Smokers ended up compensating for the reduced nicotine in 'lights' by smoking with greater frequency and intensity, resulting in higher exposures than originally reported.[23]

NRT has not been effective, meaning that harm reduction equals harm maintenance

Pierce[27] argued that using NRT for tobacco harm reduction is, in fact, harm maintenance because NRT is so ineffective that it essentially ensures that Big Tobacco (the large tobacco industry companies) will not lose its customers. Smokers simply do not like products that merely deliver nicotine, and therefore 'we should not assume that smokers would be willing and able to substitute a nicotine maintenance product for their cigarette smoking' (p. S54).

Big Tobacco cannot be trusted to develop and market a safer tobacco alternative

The final argument is that the tobacco companies, based on their history of lies and deception, simply cannot be trusted to develop and market a safer tobacco alternative.[28] Fairchild and Colgrove[28] make a related point, that 'prioritizing the reduction of harm, however great or minimal, may necessitate some level of cooperation with the tobacco industry and will *certainly prove lucrative for it*' (our emphasis added, p. 201) Thus, tobacco harm reduction will necessarily benefit the tobacco industry regardless of what else might be achieved.

Analysis of Arguments in Light of the Emergence of Electronic Cigarettes

With the emergence of electronic cigarettes, the harm reduction debate in tobacco control has changed. We now address the five major arguments against harm reduction in light of the emergence of electronic cigarettes.

Promotion of safer alternatives will inhibit smoking cessation/ prevention efforts

In contrast to reduced risk cigarettes or smokeless tobacco products, electronic cigarettes are not tobacco products. Thus, switching to electronic cigarettes is not an alternative to smoking cessation, but rather a form of smoking cessation akin to long-term use of NRT. Moreover, because 'low absolute abstinence rates suggest that nicotine alone may not be sufficient to suppress … abstinence symptoms effectively' (p. 551),[22] higher abstinence rates are likely to obtain from a product that better addresses these symptoms. Crucially, electronic cigarettes could entice smokers who were not otherwise inclined, to attempt to quit. Although the use of electronic cigarettes by nonsmokers is a theoretical concern, there is no existing evidence that youths or nonsmokers are using the product. Regulations can address the sale and marketing of these products to minors.

Skepticism about the role of combusted products in harm reduction

Electronic cigarettes, such as NRT, are not tobacco products and no combustion takes place.

Alternatives promoted as safer may actually be equally or more dangerous

Thus far, none of the more than 10 000 chemicals present in tobacco smoke,[4] including over 40 known carcinogens, has been shown to be present in the cartridges or vapor of electronic cigarettes in anything greater than trace quantities. No one has reported adverse effects, although this product has been on the market for more than 3 years. Still, the FDA struck a more ominous tone in its July 2009 press release, warning of the presence of carcinogens at 'detectable' levels.[29] Yet it failed to mention that the levels of these carcinogens was similar to that in NRT products (Table 2). Whereas electronic cigarettes cannot be considered safe, as there is no threshold for carcinogenesis, they are undoubtedly safer than tobacco cigarettes.

NRT is unappealing and ineffective

Pharmaceutical products for dispensing nicotine are unappealing 'by design' (p. S123)[30] to avoid 'abuse-liability'.[30] Electronic cigarettes, on the other hand, were designed with the express purpose of replicating the act of smoking, without using tobacco.[31] An investment newsletter reports that demand thus far has been explosive.[32] Intense consumer interest in electronic cigarettes has already spawned a vibrant online community of 'vapers' who compare and contrast the performance of various brands and models according to their durability, battery life, thickness of vapor, and other criteria.[33] No non-tobacco nicotine product has heretofore elicited such dedication among its users, suggesting the rare promise of the electronic cigarette as a smoking cessation tool.

Big Tobacco cannot be trusted

Electronic cigarettes are not tobacco products and not produced by tobacco companies. They were invented in Beijing by a Chinese pharmacist Hon Lik, whose employer, Golden Dragon Holdings, 'was so inspired that it changed its name to Ruyan (meaning "like smoke") and started selling abroad'.[31] Rather than being helpful to cigarette makers, electronic cigarettes compete directly against them.[32] Thus David Sweanor, adjunct law professor specializing in tobacco control issues at the University of Ottawa, says they are 'exactly what the tobacco companies have been afraid of all these years'.[31]

Conclusion

Tobacco cigarettes are the leading cause of disease in the United States, which is why the 'primary goal of tobacco control is to reduce mortality and morbidity associated with tobacco use' (p. 326).[23] Electronic cigarettes are designed to mitigate tobacco-related disease by reducing cigarette consumption and smoking rates. The evidence reviewed in this article suggests that electronic cigarettes are a much safer alternative to tobacco cigarettes. They are likely to improve upon the efficacy of traditional pharmacotherapy for smoking cessation.

In light of this evidence, it is unfortunate that in the United States, the American Cancer Society, American Lung Association, American

Heart Association, Campaign for Tobacco-Free Kids, Action on Smoking and Health, American Legacy Foundation, American Academy of Pediatrics, and the Association for the Treatment of Tobacco Use and Dependence have all issued statements supporting FDA efforts to take them off the US market.[34] In the United States, the courts will ultimately determine whether the FDA has the legal authority to do this, but we question the ethical and health policy merits of this approach.

Do products with established user bases warrant a different regulatory approach than entirely new products? This would seem to follow from consistent application of the principal of nonmaleficence – 'do no harm.' Products yet to enter the market have only *potential* beneficiaries, people who can only speculate about what the precise therapeutic effects of the product will be for them. In contrast, products already on the market have users who may already be deriving benefits. By definition, enacting a ban will harm current users, unless the evidence suggests that the harms outweigh the benefits *for those already using the product*. The burden of proof is on the regulatory agency to demonstrate that the product is unreasonably dangerous for its intended use.

How does this principle apply to electronic cigarettes? For the many vapers who report using them in place of cigarettes,[33] the benefits of the product are readily observable, already established. Simply demonstrating that electronic cigarettes are 'not safe' may not be sufficient grounds to ban them. Unless the evidence suggests that vaping does not yield the anticipated *reduction* in harm to the user, enacting an electronic cigarette prohibition will do harm to hundreds of thousands of vapers already using electronic cigarettes in place of tobacco ones – a clear violation of nonmaleficence.

The essential rationale for the FDA's pre-market approval process – to keep dangerous products out of the marketplace – may not easily extend to new nicotine products because a range of extraordinarily deadly nicotine products is already grandfathered into the market. This has led to an awkward nicotine regulatory structure where dirty tobacco products face few barriers to market entry whereas cleaner products are subject to oft onerous hurdles. The FDA contends that they can and should regulate electronic cigarettes as 'drug-device combinations' that are required to meet stringent Federal Food Drug and Cosmetic Act (FDCA) safety standards. The FDA reasons that electronic cigarettes do not qualify for the usual exemption from FDCA standards afforded to most other recreational nicotine products because 'much less is known about the safety of E-Cigarettes' and 'it may be possible for E-Cigarettes … to satisfy the FDCA's safety, effectiveness, and labeling requirements and obtain FDA approval' (p. 26).[35] Ironically, the only nicotine products exempted from FDCA safety requirements are those that are too obviously harmful to have any chance of meeting these requirements. Litigation presently before the US Court of Appeals for the District of Columbia may ultimately determine whether the FDA can legally regulate electronic cigarettes as drug-device combinations.[36] Regardless of the court's decision, we believe a better regulatory approach would not actively discourage producers of harm reduction products.

Fairchild and Colgrove[28] conclude that 'the later history of tobacco industry deception and manipulation was an important factor contributing to the erosion of public health support for harm reduction'(p. 201). With entrenched skepticism toward harm reduction now manifested as deep cynicism about electronic cigarettes – a distinct product that actually *does* reduce risk and threatens cigarette makers – the tobacco industry is ironically benefiting from its own past duplicity. The push to ban electronic cigarettes may repeat the mistakes of the past in the name of avoiding them. Regulatory policy for electronic cigarettes and other novel nicotine products must be guided by an accurate understanding of how they compare to tobacco cigarettes and NRT in terms of reducing toxic exposures and helping individual smokers quit.

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A Tool to Quit Smoking Has Some Unlikely Critics

By JOHN TIERNEY

If you want a truly frustrating job in public health, try getting people to stop smoking. Even when researchers combine counseling and encouragement with nicotine patches and gum, few smokers quit.

Recently, though, experimenters in Italy had more success by doing less. A team led by Riccardo Polosa of the University of Catania recruited 40 hard-core smokers — ones who had turned down a free spot in a smoking-cessation program — and simply gave them a gadget already available in stores for $50. This electronic cigarette, or e-cigarette, contains a small reservoir of liquid nicotine solution that is vaporized to form an aerosol mist.

The user “vapes,” or puffs on the vapor, to get a hit of the addictive nicotine (and the familiar sensation of bringing a cigarette to one’s mouth) without the noxious substances found in cigarette smoke.

After six months, more than half the subjects in Dr. Polosa’s experiment had cut their regular cigarette consumption by at least 50 percent. Nearly a quarter had stopped altogether. Though this was just a small pilot study, the results fit with other encouraging evidence and bolster hopes that these e-cigarettes could be the most effective tool yet for reducing the global death toll from smoking.

But there’s a powerful group working against this innovation — and it’s not Big Tobacco. It’s a coalition of government officials and antismoking groups who have been warning about the dangers of e-cigarettes and trying to ban their sale.

The controversy is part of a long-running philosophical debate about public health policy, but with an odd role reversal. In the past, conservatives have leaned toward “abstinence only” policies for dealing with problems like teenage pregnancy and heroin addiction, while liberals have been open to “harm reduction” strategies like encouraging birth control and dispensing methadone.

When it comes to nicotine, though, the abstinence forces tend to be more liberal, including Democratic officials at the state and national level who have been trying to stop the sale of e-cigarettes and ban their use in smoke-free places. They’ve argued that smokers who want an alternative source of nicotine should use only thoroughly tested products like Nicorette gum and prescription patches — and use them only briefly, as a way to get off nicotine altogether.

The Food and Drug Administration tried to stop the sale of e-cigarettes by treating them as a "drug delivery device" that could not be marketed until its safety and efficacy could be demonstrated in clinical trials. The agency was backed by the American Cancer Society, the American Heart Association, Action on Smoking and Health, and the Center for Tobacco-Free Kids.

The prohibitionists lost that battle last year, when the F.D.A. was overruled in court, but they've continued the fight by publicizing the supposed perils of e-cigarettes. They argue that the devices, like smokeless tobacco, reduce the incentive for people to quit nicotine and could also be a "gateway" for young people and nonsmokers to become nicotine addicts. And they cite an F.D.A. warning that several chemicals in the vapor of e-cigarettes may be "harmful" and "toxic." But the agency has never presented evidence that the trace amounts actually cause any harm, and it has neglected to mention that similar traces of these chemicals have been found in other F.D.A.-approved products, including nicotine patches and gum. The agency's methodology and warnings have been lambasted in scientific journals by Dr. Polosa and other researchers, including Brad Rodu, a professor of medicine at the University of Louisville in Kentucky.

Writing in Harm Reduction Journal this year, Dr. Rodu concludes that the F.D.A.'s results "are highly unlikely to have any possible significance to users" because it detected chemicals at "about one million times lower concentrations than are conceivably related to human health." His conclusion is shared by Michael Siegel, a professor at the Boston University School of Public Health.

"It boggles my mind why there is a bias against e-cigarettes among antismoking groups," Dr. Siegel said. He added that it made no sense to fret about hypothetical risks from minuscule levels of several chemicals in e-cigarettes when the alternative is known to be deadly: cigarettes containing thousands of chemicals, including dozens of carcinogens and hundreds of toxins.

Both sides in the debate agree that e-cigarettes should be studied more thoroughly and subjected to tighter regulation, including quality-control standards and a ban on sales to minors. But the harm-reduction side, which includes the American Association of Public Health Physicians and the American Council on Science and Health, sees no reason to prevent adults from using e-cigarettes. In Britain, the Royal College of Physicians has denounced "irrational and immoral" regulations inhibiting the introduction of safer nicotine-delivery devices.

"Nicotine itself is not especially hazardous," the British medical society concluded in 2007. "If nicotine could be provided in a form that is acceptable and effective as a cigarette substitute, millions of lives could be saved."

The number of Americans trying e-cigarettes quadrupled from 2009 to 2010, according to the

Centers for Disease Control. Its survey last year found that 1.2 percent of adults, or close to three million people, reported using them in the previous month.

“E-cigarettes could replace much or most of cigarette consumption in the U.S. in the next decade,” said William T. Godshall, the executive director of Smokefree Pennsylvania. His group has previously campaigned for higher cigarette taxes, smoke-free public places and graphic warnings on cigarette packs, but he now finds himself at odds with many of his former allies over the question of e-cigarettes.

“There is no evidence that e-cigarettes have ever harmed anyone, or that youths or nonsmokers have begun using the products,” Mr. Godshall said. On a scale of harm from 1 to 100, where nicotine gums and lozenges are 1 and cigarettes are 100, he estimated that e-cigarettes are no higher than 2.

If millions of people switch from smoking to vaping, it would be a challenge to conventional wisdom about the antismoking movement. The decline in smoking is commonly attributed to paternalistic and prohibitionist social policies, and it’s ritually invoked as a justification for crackdowns on other products — trans fats, salt, soft drinks, Quarter Pounders.

But the sharpest decline in smoking rates in the United States occurred in the decades before 1990, when public health experts concentrated on simply educating people about the risks. The decline has been slower the past two decades despite increasingly elaborate smoking-cessation programs and increasingly coercive tactics: punitive taxes; limits on marketing and advertising; smoking bans in offices, restaurants and just about every other kind of public space.

Some 50 million Americans continue to smoke, and it’s not because they’re too stupid to realize it’s dangerous. They go on smoking in part because of a fact that the prohibitionists are loath to recognize: Nicotine is a drug with benefits. It has been linked by researchers (and smokers) to reduced anxiety and stress, lower weight, faster reaction time and improved concentration.

“It’s time to be honest with the 50 million Americans, and hundreds of millions around the world, who use tobacco,” Dr. Rodu writes. “The benefits they get from tobacco are very real, not imaginary or just the periodic elimination of withdrawal.

“It’s time to abandon the myth that tobacco is devoid of benefits, and to focus on how we can help smokers continue to derive those benefits with a safer delivery system.”

As a former addict myself — I smoked long ago, and was hooked on Nicorette gum for a few years — I can appreciate why the prohibitionists fear nicotine’s appeal. I agree that abstinence is the best policy. Yet it’s obviously not working for lots of people. No one knows exactly what long-term benefits they’d gain from e-cigarettes, but we can say one thing with confidence: Every time they light up a tobacco cigarette, they’d be better off vaping.

The New York Times

December 8, 2013

The Case for Tolerating E-Cigarettes

By AMY L. FAIRCHILD and JAMES COLGROVE

DEBATE over e-cigarettes — battery-powered cigarette look-alikes that heat liquid nicotine but emit a harmless vapor — is raging. New York City and Chicago are considering adding e-cigarettes to their bans on smoking in bars, restaurants and parks, and Los Angeles is moving to restrict e-cigarette sales, even though e-cigarettes don't generate smoke and, while not proved to be entirely safe for users, are undoubtedly less hazardous than tobacco cigarettes.

The evidence, while still thin, suggests that many e-cigarette users, hoping to kick the habit, use e-cigarettes as a safer alternative to tobacco. Research also suggests that e-cigarettes may be better at helping to sustain smoking cessation than pharmaceutical products like nicotine patches or gums.

No one believes nicotine addiction is a good thing, and our qualified support for e-cigarettes is not one we reach lightly. Although some e-cigarette manufacturers have no links to the tobacco industry, Big Tobacco is consuming an ever-greater share of the e-cigarette market. It is hard for public health advocates like us to look favorably on anything the industry wants. But history shows that harm reduction — the doctrine that many risks cannot be eradicated and that efforts are best spent on minimizing the resulting harm — has had an important place in antismoking efforts and suggests that regulation is better than prohibition.

It's been only a half-century since the federal government took an interest in making tobacco products safer. In 1964, Surgeon General Luther L. Terry issued a watershed report definitively linking smoking with lung cancer. But he also described research into new kinds of cigarettes as "a promising avenue for further development." In the early 1970s, the government spent some $6 million a year to try to develop safer tobacco products. Even the health secretary Joseph A. Califano Jr., who called smoking "Public Enemy No. 1," saw, in 1978, a place for "research aimed at creating a less hazardous cigarette." As late as 1981, the surgeon general advised smokers who couldn't or wouldn't quit to switch to low-tar and low-nicotine brands.

The American Cancer Society, while worried that the development of less hazardous cigarettes might derail efforts to deter people from smoking or getting them to quit, supported "frank scientific discussion about the possibilities of developing cigarettes that will be less harmful and still satisfying to smokers."

This effort came to a halt in the 1980s, when stunning revelations from high-profile court cases demonstrated that the tobacco industry had lied about the dangers of smoking for decades and even manipulated the levels of nicotine in its products to ensure that smokers stayed hooked. The magnitude of the deception made it nearly impossible to consider the possibility of a “safer” tobacco product. It inspired, among advocates, opposition to anything less than total cessation.

This new stance was supported by the availability of over-the-counter nicotine replacement therapies and a focus on protection of bystanders from secondhand smoke. As the head of the American Heart Association put it in 2000: “There is no such thing as a safer cigarette.”

The irony is that, during these same years, AIDS prompted public health advocates to support needle exchange for users of intravenous drugs, a harm-reduction approach that also drew fire from those who favored complete elimination of drug use. Fears that such programs would lead to greater illicit drug use have been definitively put to rest.

Of course the analogy is not exact: Unlike clean needles, which present no independent harms to injecting drug users, less risky alternatives to smoking, like smokeless chewing tobacco and the moist tobacco product known as snus, carry a grave risk: oral cancers.

E-cigarettes potentially overcome that barrier. Most experts consider nicotine harmful only at extremely high doses. Tobacco control advocates tolerate the long-term use of therapies like the nicotine patch and nicotine gum despite their approval only as temporary smoking-cessation aids. In 2000, the chairman of a Public Health Service panel called tobacco dependence a “chronic condition that warrants repeated treatment,” even if that meant treating smokers “for the rest of their lives.”

Advocates fear that e-cigarettes will serve as a gateway to deadly cigarettes — or sustain smokers in public settings where lighting up is banned. “Waiting to act,” New York City’s health commissioner, Thomas A. Farley, said, “is a risk we should not take.”

But there is a price to such rigidity. Emotion should not rule out harm reduction, even if eradication of smoking is the ultimate goal. Banning vaping in public won’t help. Instead, e-cigarettes should be regulated by the Food and Drug Administration as products “sold or distributed for use to reduce harm or the risk of tobacco-related disease.” The industry can’t be trusted to provide safer products. The historical mistake was not the pursuit of a safer cigarette, but championing that cause with dishonest partners.

If e-cigarettes can reduce, even slightly, the blight of six million tobacco-related deaths a year, trying to force them out of sight is counterproductive.

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RESEARCH ARTICLE

Cytotoxicity evaluation of electronic cigarette vapor extract on cultured mammalian fibroblasts (ClearStream-LIFE): comparison with tobacco cigarette smoke extract

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Abstract

Context: Electronic cigarettes (ECs) are used as alternatives to smoking; however, data on their cytotoxic potential are scarce.
Objective: To evaluate the cytotoxic potential of 21 EC liquids compared to the effects of cigarette smoke (CS).
Methods: Cytotoxicity was evaluated according to UNI EN ISO 10993-5 standard. By activating an EC device, 200 mg of liquid was evaporated and was extracted in 20 ml of culture medium. CS extract from one cigarette was also produced. The extracts, undiluted (100%) and in five dilutions (50%, 25%, 12.5%, 6.25% and 3.125%), were applied to cultured murine fibroblasts (3T3), and viability was measured after 24-hour incubation by 3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide assay. Viability of less than 70% was considered cytotoxic.
Results: CS extract showed cytotoxic effects at extract concentrations above 12.5% (viability: 89.1 ± 3.5% at 3.125%, 77.8 ± 1.8% at 6.25%, 72.8 ± 9.7% at 12.5%, 5.9 ± 0.9% at 25%, 9.4 ± 5.3% at 50% and 5.7 ± 0.7% at 100% extract concentration). Range of fibroblast viability for EC vapor extracts was 88.5–117.8% at 3.125%, 86.4–115.3% at 6.25%, 85.8–111.7% at 12.5%, 78.1–106.2% at 25%, 79.0–103.7% at 50% and 51.0–102.2% at 100% extract concentration. One vapor extract was cytotoxic at 100% extract concentration only (viability: 51.0 ± 2.6%). However, even for that liquid, viability was 795% higher relative to CS extract.
Conclusions: This study indicates that EC vapor is significantly less cytotoxic compared tobacco CS. These results should be validated by clinical studies.

Keywords

Cytotoxicity, electronic cigarette, fibroblasts, *in vitro*, nicotine, smoking, tobacco harm reduction

History

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Introduction

There is overwhelming evidence that smoking is a major cause of respiratory and cardiovascular disease (Bartecchi et al., 1995). Even low cigarette consumption has significant effects on human health (Bjartveit & Tverdal, 2005). Complete cessation is the goal for all smokers; however, many of them are unwilling or unable to quit. Therefore, harm reduction strategies have been developed, aiming at substituting tobacco cigarettes with other products that deliver less harmful constituents to human organism (Stratton et al., 2001).

Electronic nicotine-delivery devices, commonly called electronic cigarettes (ECs), were invented in China and have been recently introduced to the market worldwide (Henningfield & Zaatari, 2010; Pauly et al., 2007) as an alternative and potentially safer habit. They consist of a battery-part, a cartridge containing liquid and an electrical resistance that gets warm by activation of the battery and evaporates the liquid. The liquid usually contains glycerol, propylene glycol, water, nicotine and a variety of flavors that the user can choose.

It is estimated that millions of people are using EC, and surveys suggest that they may be effective in smoking cessation (Etter, 2010). Although they do not contain or burn tobacco, which seems promising in avoiding delivery of harmful substances, no studies have specifically evaluated their toxicity. This has raised serious public health concerns (Cobb et al., 2010). Our research team has developed a series of protocols called ''ClearStream'' (CLarifying Evidence and Research on the Safety and The Risks of Electronic AtMos; atmos = vapor in Greek), to evaluate the toxicological, environmental and clinical effects of ECs. The purpose of this study (ClearStream-LIFE; LIFE = Living In-vitro Fibroblasts' Exposure) was to evaluate the *in vitro* cytotoxicity of vapor extract of 21 commercially available liquids used for EC and to compare it with the cytotoxicity of cigarette smoke (CS) extract.

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Materials and methods

Materials

A commercially available tobacco cigarette containing 1 mg of nicotine, 10 mg of tar and 10 mg of carbon monoxide was used for this experiment. Twenty-one commercially available liquids used for EC were obtained from the market in sealed bottles, each containing 10 ml of liquid (manufactured by FlavourArt s.r.l., Oleggio, Italy).The composition of EC liquids, as reported by the manufacturer, was (w/w) 46.17% propylene glycol USP, 44.92% glycerol USP, 8.11% water, 0.8% nicotine USP and <0.5% flavorings. The only difference between liquids composition was the flavorings used (Table 1). Twelve of the flavors were tobacco-like, while the rest were mostly fruit and sweet flavors. Each flavoring (including tobacco-like flavors) is a complex mixture of several physically extracted or chemically produced substances approved for use in food industry, for which no additional information was provided by the manufacturer. A commercially available EC device (510 T, Omega Vape, Manchester, UK) was used for vapor production. The device consists of a 3.7-volt lithium battery, an atomizer with a resistance of 2.2 Ohms wrapped over a fiberglass wick and a cartridge attached to the mouthpiece with a capacity of 1 ml of liquid. Care was taken to have the battery fully charged before each vapor extract was produced. Vacuum produced by inhalation (and by the vacuum pump during the experiment) leads to automatic activation of the battery, delivering 3.7 volts until the battery is discharged. The battery voltage was checked before and after use for the production of each EC extract with a digital voltmeter. A new atomizer was used for each vapor extract production; its resistance was measured with a digital multimeter and it was discarded if the resistance was found to differ by more than 0.1 volt. By applying 3.7 volts to a 2.2 Ohm resistance, the total energy for liquid evaporation in the experiment was 6.2 Watts.

An important issue was to test the function of the atomizer in conditions similar to the experimental setting, in order to ensure that no ''dry puff'' occurs. ''Dry puff'' is a phenomenon that occurs when the wick is insufficiently supplied with liquid, so that the evaporation rate is higher than the liquid supply rate to the wick; this leads to higher temperature of evaporation that is detected by the user as an unpleasant burning taste. This cannot be detected during any laboratory experiment. In addition, it is possible that the unpleasant taste is caused by substances that may form as a result of evaporation and that may or may not be toxic. Since the user detects and then avoids this phenomenon (by lowering device activation time and increasing puff intervals), the value of the experiment would be significantly undermined if ''dry puff'' was reproduced during the laboratory study. The only realistic way we found of testing this was to assign one of the researchers (who is a regular EC user) to test the EC device with three randomly selected atomizers from the pack delivered to the laboratory, using them in the same manner as during the experiment (2-second puffs, one puff every 60 s; see section ''*Production of extracts*''). Testing revealed that ''dry puff'' phenomenon was not reproduced when the EC atomizers were used in a way similar to the experimental setting.

Cell cultures

Cytotoxicity was measured by 3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide (MTT) assay on monolayer-cultured mouse BALB/3T3 fibroblasts derived from Swiss

Table 1. Fibroblast viability in electronic cigarette vapor and cigarette smoke extracts.

Extracts	Dilutions						p*
	100%[a]	50%[b]	25%[c]	12.5%[d]	6.25%[e]	3.125%[f]	
Tuscan[g]	94.5 ± 2.8	99.8 ± 5.7	104 ± 1.5	101.4 ± 4.1	100.7 ± 5.9	98.6 ± 3.8	0.216
Black fire[g]	96.3 ± 9.9	93.4 ± 2.5	94.4 ± 1.6	104.6 ± 2.9	95.3 ± 4.3	97 ± 3.2	0.159
Ozone[g]	90.7 ± 9.9	95.9 ± 9.1	96.2 ± 4.3	94.9 ± 6	96.7 ± 5.1	97 ± 4.9	0.879
Reggae night[g]	81.3 ± 5.1	90.3 ± 3.7	89.5 ± 4.2	89.7 ± 3.4	90.2 ± 5.7	91.6 ± 4.2	0.132
Vanilla	100 ± 2.4	98.5 ± 3.5	100.3 ± 2.0	100.1 ± 0.8	104.1 ± 3.1	98.3 ± 3.3	0.183
7foglie[g]	81.4 ± 2.9	87.5 ± 1.5	89.4 ± 4.0	87.1 ± 8.3	89.6 ± 12.1	93.2 ± 10.7	0.587
Max blend[g]	96.2 ± 6.0	97 ± 6.9	102.1 ± 7.4	111.8 ± 4.5	114.3 ± 1.7	115.5 ± 5.3	0.003
Virginia[g]	78.4 ± 14.4	86.1 ± 13.5	91.3 ± 15.6	96.4 ± 16.2	106.3 ± 9.7	104.4 ± 10.7	0.478
Perique black[g]	79.3 ± 1.5	89.8 ± 2.4	94.7 ± 1.2	95.3 ± 5.2	95.1 ± 2.4	93.9 ± 3.4	<0.001
Layton blend[g]	101.1 ± 1.0	103.7 ± 0.8	102.7 ± 2.8	100.6 ± 2.1	103.4 ± 5.5	97.9 ± 4.2	0.295
Hypnotic[g]	93.8 ± 10.8	95.2 ± 14.0	106.2 ± 6.5	97.4 ± 5.1	100.6 ± 7.4	98.5 ± 3.9	0.579
Hazelnut	88.7 ± 1.4	90.1 ± 5.6	93.5 ± 6.7	91.5 ± 1.5	115.3 ± 8.0	117.8 ± 13.4	0.001
Shade[g]	83.6 ± 5.1	92.5 ± 3.9	94.6 ± 5.0	97.8 ± 5.9	101.5 ± 2.5	101.9 ± 1. 3	0.002
RY4[g]	88.4 ± 8.1	96.1 ± 3.7	98.7 ± 6.4	95.8 ± 7.4	98.9 ± 6.3	98.9 ± 5.9	0.378
Strawberry	85.8 ± 2.8	95.4 ± 2.3	97.5 ± 1.5	104.0 ± 6.2	99.6 ± 1.4	107.5 ± 1.2	<0.001
Managua	79.1 ± 2.4	79.9 ± 3.3	79.1 ± 3.1	85.8 ± 2.0	86.4 ± 1.7	88.5 ± 3.5	0.002
Burley	102.2 ± 3.4	95.8 ± 2.9	97.6 ± 1.3	97.3 ± 3.4	106.2 ± 8.3	100.5 ± 6.2	0.171
Apple	95.2 ± 1.2	87.4 ± 2.7	100.8 ± 8.2	95.6 ± 3.9	101.8 ± 3.1	106.6 ± 15.6	0.106
Licorice	95.4 ± 3.9	93.9 ± 2.8	96.5 ± 2.6	98.5 ± 4.4	98.9 ± 2.0	99.6 ± 2.5	0.252
Chocolate	87.6 ± 2.2	89.6 ± 0.6	93.2 ± 1.3	93.4 ± 1.5	93.7 ± 1.9	98.9 ± 1.2	<0.001
Coffee	51.0 ± 2.6	85.9 ± 11.8	92.0 ± 8.9	101.5 ± 3.1	112.2 ± 3.6	114.5 ± 1.1	<0.001
CS	5.7 ± 0.7	9.4 ± 5.3	5.9 ± 0.9	72.8 ± 9.7	77.8 ± 1.8	89.1 ± 3.5	<0.001

Values are presented as mean ± standard deviation. Viability is expressed as percent, compared to untreated cells.
CS = cigarette smoke.
For electronic cigarette liquid extracts, dilutions represent (w/v): [a]1%, [b]0.5%, [c]0.25%, [d]0.125%, [e]0.0625% and [f]0.03125%.
*p value for comparison between different extract concentrations in each liquid and in tobacco cigarette (ANOVA).
[g]Tobacco flavors.

albino mouse embryos (NIH 3T3 Batch 2 051163, NIH AIDS Research & Reference Reagent Program), according to UNI ISO 10993-5 standard. Cells were grown in Dulbecco's basal medium (Euroclone), supplemented with fetal bovine serum (Euroclone), penicillin–streptomycin 0.1 mg/ml (Euroclone), kanamycin 0.1 mg/ml (SIGMA, St Louis, MO), non-essential amino acid 0.1 mg/ml (SIGMA) and 4 mM glutamine (Euroclone). The doubling time of this cell line was 16–20 h.

Production of extracts

Vapor extract was produced by simulating EC use. The EC device was connected to a flask containing culture medium through a sealed tube. Horizontal orientation of the device was chosen, because this is the orientation of the device during real EC use. The other end of the tube was inside the flask, just above the culture medium level. A vacuum pump was connected to the flask; vacuum from the pump automatically triggered the EC device. The vapor was allowed to flow into the flask, over the medium. The EC cartridge was filled with 400 mg of liquid, and a number of inhalation simulations were performed in order to consume 200 mg of liquid, therefore having a theoretical concentration of 1% (w/v) into the culture medium of the flask (denoted as 100% EC extract). Weighting of the EC cartridge was performed before and during the experiment by a precision scale (Mettler, model AB104-S, precision of 0.1 mg), in order to make sure that the quantity of liquid consumed did not exceed 200 mg. Each inhalation simulation lasted 2 s, with 60 s between inhalations. The medium inside the flask was kept swirling during the experiment. CS extract was produced by using a similar method. Inhalation simulations, consisting of 2-second puffs every 60 s, were performed until one cigarette was consumed. The resulting solution was denoted as 100% CS extract. Immediately after preparation, all EC vapor and CS extracts were used in cell cultures.

Treatment and exposure

Cells were seeded in 96-well plate with Dulbecco's basal medium plus 10% fetal bovine serum and maintained in culture for 24 h (5% CO_2, 37 °C, >90% humidity) in order to form a semi-confluent monolayer. In each well, 100 μl of a cell suspension of 1×10^5 cells/ml was dispensed. A different plate was prepared for each extract testing. On the next day, each plate was examined under the microscope to ensure that cell attachment was even across the plate. Then, the medium was aspirated and replaced by medium containing the CS and EC liquid extracts in one undiluted (100%) and five diluted samples (50%, 25%, 12.5%, 6.25% and 3.125%). For the EC extract, 100% EC extract equals to a vapor extract concentration of 1%. Three different wells were treated with each dilution, and columns 2 and 11 were used to culture cells with normal medium (without extract, untreated cells); then, they were incubated for 24 h at 37 °C. Subsequently, cells were tested for viability by MTT assay. Untreated cells were used as controls.

MTT assay

The assay was performed according to the method developed by Mossman (1983). After incubation, the culture medium was removed and replaced with 10 μl of 1 mg/ml MTT. The cells were then incubated for 2 h. MTT is cleaved by mitochondrial dehydrogenases of viable cells, leading to the formation of purple crystals, representing formazan metabolism, which are insoluble in aqueous solutions. The solution was then removed and replaced with 200 μl/well of isopropanol to extract and solubilize the formazan. It was incubated for 30 min at room temperature under medium speed shaking. Then, the solution was measured spectrophotometrically. The absorbance at 570 nm was measured with a microplate reader (Tecan, model Sunrise Remote), and background subtraction was adjusted with absorbance readings at 690 nm. The absorbance values were normalized by setting the negative control group (untreated cells) in each row to 100%. Subsequently, the viability of the treated cells was expressed as a percent of untreated cells.

Quality check of assay

According to UNI ISO 10993-5 standard, a test meets acceptance criteria if the left (column 2) and the right (column 11) mean of the blanks do not differ by more than 15% from the mean of all blanks; this criterion was met in all our experiments. Sodium lauryl sulfate (SLS; SIGMA) was used as positive control in order to demonstrate an appropriate test system response. Historically, inhibitory concentration 50 (IC_{50}) of SLS is 0.093 mg/ml with 95% CI of 0.070–0.116 mg/ml (Spielmann et al., 1991). A test meets acceptance criteria if IC_{50} for SLS is within the 95% CI; in our experiment, IC_{50} for SLS was 0.100 mg/ml. Finally, the absolute value of optical density, OD_{570}, obtained in the untreated wells indicates whether the 1×10^4 cells seeded per well have grown exponentially with normal doubling time during the 2 days of the assay. In our experiments, OD_{570} of untreated cells were ≥ 0.2, meeting the acceptance criteria of UNI ISO 10993-5.

Statistical analysis

All data are reported as mean ± standard deviation. One-way analysis of variance (ANOVA) was used for comparison of percent viability between different extract concentrations of the same liquid. If statistically significant differences were found, post-hoc analysis was performed with Bonferroni test to determine which extract concentrations had different effects on viability. No observed adverse effects level (NOAEL) was defined as the lowest extract concentration that showed statistically significant lower viability compared to the 3.125% extract concentration. The difference in percent viability between CS extract and each EC vapor extract was also assessed with one-way ANOVA. Linear regression analysis was used to determine whether tobacco flavoring was associated with a statistically significant difference in viability. IC_{50} (the concentration of extract that produced 50% viability) was estimated from regression plots. According to UNI ISO 10993-5 standard, viability of less than 70% by MTT assay was considered cytotoxic. All analyses were performed with commercially available software (SPSS v18, Chicago, IL), and a two-tailed P value of ≤ 0.05 was considered statistically significant.

Results

Fibroblast viability measurements for each EC liquid and CS extracts at different dilutions are displayed in Table 1. From the 21 samples examined, only ''Coffee'' exhibited a cytotoxic effect; this was observed at the highest extract concentration only. Figures S1–S7 (supplemental material) display fibroblast viability for all EC liquids together with the respective viability for CS extract. The range of fibroblast viability for all EC liquids was 88.5–117.8% at 3.125%, 86.4–115.3% at 6.25%, 85.8–111.7% at 12.5%, 78.1–106.2% at 25%, 79.0–103.7% at 50% and 51.0–102.2% at 100% extract concentration. CS extract exhibited significant cytotoxicity at extract concentrations > 12.5%. The viability rate of CS extract at each dilution was 89.1 ± 3.5% at 3.125%, 77.8 ± 1.8% at 6.25%, 72.8 ± 9.7% at 12.5%, 5.9 ± 0.9% at 25%, 9.4 ± 5.3% at 50% and 5.7 ± 0.7% at 100% ($p < 0.001$ compared to every EC liquid extract at 100%, 50% and 25% concentration). Viability rate of ''Coffee'' flavor, the only EC liquid that showed cytotoxic potential (according to ISO 10993-5 definition), was 114.5 ± 2.0% at 3.125%, 112.2 ± 3.6% at 6.25%, 101.5 ± 3.1% at 12.5%, 92.0 ± 8.9% at 25%, 85.9 ± 11.8% at 50% and 51.0 ± 2.6% at 100% extract concentration. Figure 1 displays the relative difference in viability between CS extract and ''Coffee'' extract at each dilution; statistically significant higher fibroblast viability was observed for ''Coffee'' extract at all extract concentrations. IC_{50} and NOAEL for each EC and for the CS extracts are displayed in Table 2. IC_{50} could not be determined for EC vapor extracts, since viability was >50% at all extract concentrations. For the majority of EC liquids (13 of 21), viability was not statistically different between extract concentrations, thus NOAEL for these samples was defined as 100% concentration. Twelve of the EC liquids tested were flavors mimicking tobacco. However, they were not associated with a statistically significant difference in fibroblast viability.

Discussion

This is the first study that has evaluated the cytotoxic effects of vapor produced from commercially available EC liquids. The main result of our study is that the vapor from only 1 of the 21 EC liquids examined had cytotoxic effects on cultured fibroblast according to protocol definition. CS extract had significant cytotoxic effects, and fibroblast viability was significantly lower at all extract concentrations compared to EC vapor extracts. It is important to note that, we tested the EC liquids by simulating the way they are used by every user, that is, by activating a commercially available EC device and producing vapor, which was subsequently tested. In addition, we used standardized protocols and procedures such as UNI ISO 10993-5 standard and MTT-assay, with cytotoxicity defined according to UNI ISO 10993-5 standard as viability <70% compared to untreated cells. Moreover, we used cells that have been commonly used in studies evaluating tobacco cigarette cytotoxicity (Lu et al., 2007; Yu et al., 2006). Finally, we performed a cytotoxic study on CS extract using the same methodology to generate the test article. This is particularly important since EC are marketed for the smokers only as an alternative option. Therefore, the main scientific question is whether the EC is less harmful compared to regular tobacco cigarette, and this was evaluated in our study.

CS is a complex suspension that contains more than 4000 chemicals according to EPA report (1992). Several of these are linked to cancer or cardiovascular and lung disease from *in vitro* studies, including tobacco-specific nitrosamines (Hecht & Hoffmann, 1988; Wu et al., 2003), polycyclic aromatic hydrocarbons (Besaratinia et al., 2002; Zedeck, 1980), metals like cadmium and lead (Ronco et al., 2005) and

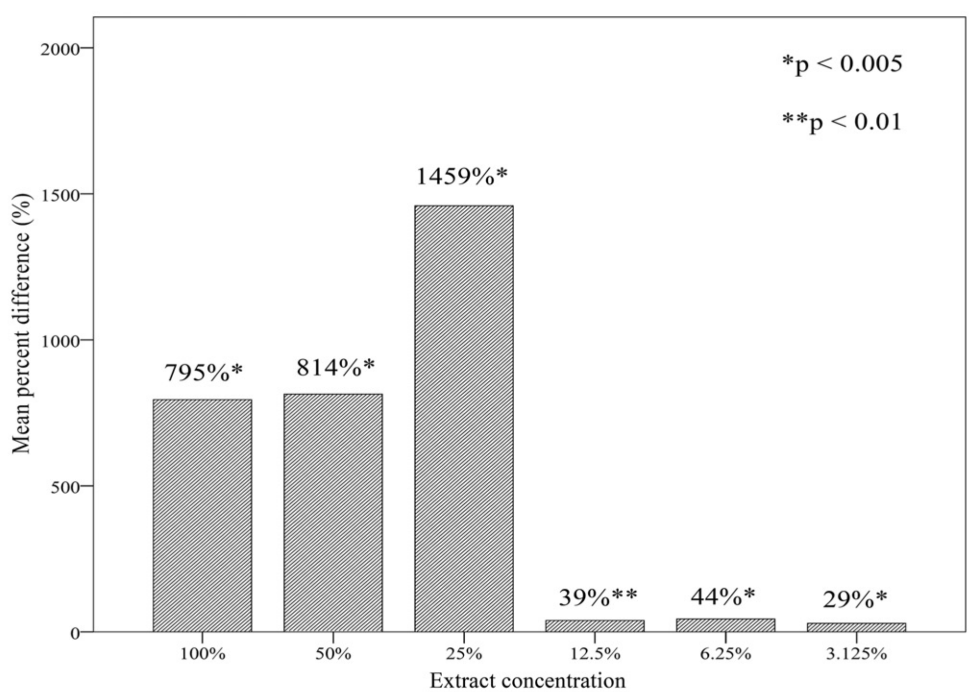

Figure 1. Relative mean differences between cigarette smoke extract viability and electronic cigarette ''Coffee'' vapor extract viability. Coffee was the only electronic cigarette liquid that showed cytotoxic effects according to the definition of UNI ISO 10993-5 standard.

Table 2. Inhibitory concentration 50 (IC_{50}) and no adverse effect level (NOAEL) for each electronic cigarette vapor extract and for the cigarette smoke (CS) extract.

Extracts	IC_{50}	NOAEL
Tuscan[a]	>100%	100%
Black fire[a]	>100%	100%
Ozone[a]	>100%	100%
Reggae night[a]	>100%	100%
Vanilla	>100%	100%
7foglie[a]	>100%	100%
Max blend[a]	>100%	25%
Virginia[a]	>100%	100%
Perique black[a]	>100%	50%
Layton blend[a]	>100%	100%
Hypnotic[a]	>100%	100%
Hazelnut	>100%	6.25%
Shade[a]	>100%	50%
RY4[a]	>100%	100%
Strawberry	>100%	12.5%
Managua	>100%	12.5%
Burley	>100%	100%
Apple	>100%	100%
Licorice	>100%	100%
Chocolate	>100%	3.125%
Coffee	>100%	12.5%
CS	16%	6.25%

[a]Tobacco flavors.

other compounds like acrolein, formaldehyde and phenol (Risner & Martin, 1994; Smith & Hansch, 2000). The major contributors to the *in vitro* cytotoxic effects of smoke are also responsible for the respiratory tract irritation in experimental animals and humans and cause histopathological changes in the upper respiratory tract (Lu et al., 2007). Therefore, in vitro cytotoxicity screening represents an important initial step in the toxicological evaluation of tobacco products.

There may be multiple mechanisms that lead to CS extract-induced cytotoxicity. For example, oxidative stress is an important mechanism that alters the balance between proliferation and apoptosis in fibroblasts (Müller & Gebel, 1998). Genetic damage is also induced by CS extract (Cui et al., 2012). Depletion of antioxidants by several CS extract components like acrolein and aldehydes compromises the defensive mechanisms of fibroblasts and promotes cell damage (Colombo et al., 2012; Ishii et al., 2003). Other chemicals cause direct cell-membrane damage (Thelestam et al., 1980). The end-result is fibroblast apoptosis and death (Kim et al., 2011; Park et al., 2010, 2008). This has important implications in the development of lung disease like emphysema (Baglole et al., 2006; Rennard et al., 2006).

We did not find any significant cytotoxic effects by any of the EC vapor extracts studied, except for ''Coffee'' at the highest extract concentration. Liquids consist mainly of glycerol, propylene glycol, water and nicotine; a wide variety of flavors are also available. Both glycerol and propylene glycol are classified by Food and Drug Administration and Flavor and Extracts Manufacturer Association (FEMA) as additives that are ''generally recognized as safe'' for use in food (FDA, 2012a,b-revised; FEMA GRAS numbers 2525 and 2940, respectively). Glycerol is also present in tobacco cigarettes and it is the main source of acrolein, produced by pyrolysis due to combustion. Acrolein has well-established cytotoxic effect on fibroblasts (Cattaneo et al., 2000; Jia et al., 2009). It is unlikely that acrolein can be produced by EC use because the temperature of liquid evaporation is considerably lower compared to combustion when smoking tobacco cigarette. Propylene glycol is a solvent used in oral, intravenous and topical pharmaceutical products. One study showed moderate cytotoxic effect on skin fibroblasts (Ponec et al., 1990). However, an animal study found that exposure to significant amounts of propylene glycol in air had no adverse effects on the respiratory system (Robertson et al., 1947). Propylene glycol is also present in tobacco cigarettes and is pyrolyzed to acetaldehyde during smoking, which has significant cytotoxic effects (Cattaneo et al., 2000; Krokan et al., 1985). Considering the fact that almost half of EC liquids content we examined was propylene glycol, the results of our study indicate that it is unlikely for propylene glycol to be pyrolyzed to acetaldehyde by EC use or to have any significant cytotoxic effect by itself. Concerning nicotine, there are studies showing that, at levels commonly found in cigarettes, it does not induce cell death (Laytragoon-Lewin et al., 2011) and may even have anti-apoptotic effects (Argentin & Cicchetti, 2006, 2004). It should be mentioned, however, that these effects have been suggested to facilitate the growth of tumors already initiated (Davis et al., 2009). Nicotine is not classified as a carcinogen by the International Agency for Research on Cancer (WHO-IARC, 2004), and the results of this study show that nicotine does not produce cytotoxic effects at the level present in the liquids tested.

Regarding the cytotoxicity observed for ''Coffee'', the manufacturer indicated that this flavor is a complex mixture of several natural and synthetic substances. Most of the natural substances come from roasted coffee beans. This processing of coffee beans may itself lead to production of some toxic elements, like ochratoxin A degradation products, which have cytotoxic and apoptotic properties (Cramer et al., 2008). Hegele et al (2009) found that coffee beans extract contains significant amounts of hydrogen peroxide, inducing cell death *in vitro*. It is possible that these substances are also present in the flavor used for preparing the ''Coffee'' EC liquid. However, we cannot exclude that the process of vapor formation from heating of the ''Coffee'' EC liquid may lead to production of other substances that have cytotoxic properties. It should be mentioned that the cytotoxic effect of this EC liquid extract was found only at the highest extract concentration, and, even at this concentration, fibroblast viability was 795% higher compared to CS extract.

Only one study has been published evaluating the cytotoxic effects of EC liquids (Bahl et al., 2012). Some of the liquids tested were found cytotoxic, mostly in embryonic cells and to a lesser extend in adult cells. This discrepancy in results may be attributed to several fundamental differences between the study by Bahl et al. and the study herein. The most crucial difference is that Bahl et al. tested the EC liquids in liquid form. It should be emphasized that the approach used by Bahl et al. does not deliver the EC liquid in the designated manner, which is less relevant than vapor generation of the liquid *via* activation of the electronic device. Herein, we simulated the exact mode of function of the EC and tested the extract of the resulting vapor. This may have significant implications on the results. Second, it is possible that not all liquid constituents evaporate at the same manner or in similar concentrations. Furthermore, the concentrations of various constituents (for example, flavorings) may be different in vapor compared to liquid, and this may influence the results.

From a public health perspective, the field of tobacco harm reduction is particularly important. Smoking can produce subclinical dysfunction even at a young age (Farsalinos et al., 2013); therefore, attempts to quit smoking should be performed as soon as possible. However, quitting rates are relatively low with currently approved means (Rigotti et al., 2010). Until recently, only products containing tobacco were available in tobacco harm reduction (smokeless tobacco, like snus). Epidemiological studies have shown that use of such products is promising regarding cancer and cardiovascular disease risk reduction (Janzon & Hedblad, 2009; Lee & Hamling, 2009). Likewise, EC may have an important role in harm reduction. Unlike other products, EC contain no tobacco. In addition, the fact that nicotine is administered by a method that resembles tobacco cigarette use (hand-to-mouth movement, visible ‘‘smoke’’ exhaled) make them unique in dealing both with the chemical and psychological (behavioral) addiction to smoking. Several studies have characterized the chemicals contained in EC, with results showing that they do not contain any toxic substances (Ellicott, 2009; Tytgat, 2007; Valance & Ellicott, 2008). Even in studies where nitrosamines were detected (Laugesen, 2008; Westenberger, 2009), the levels were similar to a nicotine patch and 500 to 1400-fold lower compared to tobacco cigarettes (Stepanov et al., 2006). The results of this study are in line with these findings, showing significantly higher cytotoxicity of CS extract compared to EC vapor extracts.

Limitations

There are some limitations applicable to this study. Cytotoxicity studies on cultured cells have been developed in order to reduce the use of experimental animals. Extrapolating these results to the human *in vivo* toxicity should be done with caution. There is no consensus on the methodology of preparing and testing EC vapor extracts, and this is the first study that has attempted to evaluate the cytotoxic potential of EC vapor. However, we provided a comparative measure of toxicity with CS extract, which has well-established *in vivo* toxic effects. We did not use automated whole smoke exposure systems such as VitroCell or RM20s Borgwaldt systems, which offer more *in vivo*-like exposures since the cells are present inside the chamber where CS is delivered (Fukano et al., 2006; Maunders et al., 2007). Moreover, we did not use the standardized ISO method for CS extract (35 ml of air aspirated in 2-second per puff). This was done because we wanted to produce CS extract with the same method as EC liquid extract; aspiration of 35 ml air from the EC device produced very small amount of vapor, which was minimal compared to the amount generated by real EC use. Therefore, we preferred to use the same methodology in both EC and CS extract production. It should be mentioned that the ISO method for CS production significantly underestimates real smokers’ exposure (Djordjevic et al., 2000).

We compared vapor extract from 200 mg of liquid with CS extract that was generated from one cigarette, both dissolved in 20 ml of culture medium. These are not similar exposure levels. In fact, there is no established method for comparing the amount of EC liquid and number of tobacco cigarettes. A practical and pragmatic way of comparing the two would be to measure how much liquid is consumed by users after using the EC device for similar time to that needed to smoke one cigarette. We have measured this as part of another protocol and we have found that the average EC liquid consumption was 60 mg. Therefore, we should have used the smoke extract of at least three cigarettes dissolved in 20 ml of culture medium in order to have a comparable exposure level to that of EC liquid extract we used. Unfortunately, this measurement was performed after the completion of this study. If three cigarettes had been used in this protocol, it is probable that the cytotoxicity of CS extract and the resulting differences in cell viability compared to effects induced by the EC liquid extracts would have been even higher than what was observed. However, this is an assumption and cannot be inferred unless explicitly tested.

It should be emphasized that our results do not necessarily apply to all EC liquids marketed. Nicotine is extracted from tobacco; therefore, if liquids contain non-pharmaceutical grade nicotine, several tobacco impurities may be present and adversely affect the results. The same applies for all other liquid constituents (Cahn & Siegel, 2011). We did not find an association between EC tobacco flavors and fibroblast viability. This was probably due to the fact that substances approved for food industry were used even for these flavors (according to manufacturer’s report). However, it is possible to use natural tobacco extract to mimic tobacco flavor, and some companies may use or produce themselves such extracts for use in EC liquids. The cytotoxicity potential of these extracts is currently unknown, and they are not approved for use in food industry. In any case, regulation is needed and specific standards should be implemented in order to ensure that quality products are available in the market. Although no standards have been implemented by public health authorities, several industry associations like Electronic Cigarette Industry Trade Association and American E-Liquid Manufacturing Standards Association have developed such standards.

Finally, another important issue not addressed in this study is the effect of different, modified EC devices that deliver higher voltage and wattage to the resistance. This would accelerate the rate of evaporation; and if the resistance is not sufficiently supplied with liquid, it might possibly result in overheating and production of toxic chemicals. We tested the EC device used in the experiment to make sure that no ‘‘dry puff’’ phenomenon occurs, but it remains to be examined whether this phenomenon is associated with the production of toxic substances.

Conclusions

In conclusion, from the 21 commercially available EC liquids we tested in vapor form, only one was found to have cytotoxic effects on cultured mammalian fibroblast cells according to ISO 10993-5 definition. Overall, EC vapor extracts showed by far higher fibroblast viability compared to CS extract. This supports the concept that EC may be less harmful compared to tobacco cigarettes and could be useful products in tobacco harm reduction. However, more research is needed, both in the laboratory with different cell lines and in clinical level, in order to better understand and evaluate the effects of EC use on human health.

Declaration of interest

No author has any financial interest in the outcome of this study.

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The Rest of the Story: Tobacco News Analysis and Commentary

...Providing the whole story behind tobacco news.

Tuesday, August 02, 2011

New Study Documents that Thousands of E-Cigarette Users are Having Success Quitting; Claim that E-Cigs are Ineffective is No Longer Tenable

A new study published online ahead of print in the journal *Addiction* suggests that electronic cigarettes have been effective in helping literally thousands of smokers to cut down or quit smoking entirely, refuting a claim in last week's *New England Journal of Medicine* that these devices are likely to be ineffective because they deliver very little nicotine (a claim which was based entirely on a single study in which subjects were instructed to take 10 puffs on an e-cig, but no more).

(see: Etter J-F, Bullen C. Electronic cigarette: users profile, utilization, satisfaction and perceived efficacy. *Addiction* 2011; doi:10.1111/j.1360-0443.2011.03505.x).

The study involved a survey of electronic cigarette usage patterns and results using two survey frames: one was subjects recruited through electronic cigarette-related web sites and forums. The other was subjects recruited though smoking or smoking cessation web sites having nothing to do with e-cigarettes. Although the first sampling frame would produce a biased sample (consisting of people with more successful experiences with e-cigarettes than in the population as a whole), the authors compared the results between the two samples to provide some indication of the extent to which the results were biased by the sampling scheme.

The most notable finding was that there were not marked differences between the experiences of e-cigarette users recruited via e-cigarette forums versus non-e-cigarette-related sites. Even among the subjects recruited from general smoking cessation sites or via Google, the overwhelming majority of ever users of electronic cigarettes (80.8%) reported that e-cigarettes helped them reduce smoking a lot (compared to 93.2% of subjects recruited via e-cigarette-related sites).

Among ex-smokers recruited at the general sites, 93.3% reported that e-cigarettes helped them quit smoking (compared to 96.1% of subjects recruited via e-cigarette sites).

About Me

Michael Siegel

Dr. Siegel is a Professor in the Department of Community Health Sciences, Boston University School of Public Health. He has 25 years of experience in the field of tobacco control. He previously spent two years working at the Office on Smoking and Health at CDC, where he conducted research on secondhand smoke and cigarette advertising. He has published nearly 70 papers related to tobacco. He testified in the landmark Engle lawsuit against the tobacco companies, which resulted in an unprecedented $145 billion verdict against the industry. He teaches social and behavioral sciences, mass communication and public health, and public health advocacy in the Masters of Public Health program.

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Among all e-cigarette users, 92.2% stated that the device helped them to reduce smoking a lot. An overwhelming majority (88.6) reported that it is easy to abstain from smoking when using the e-cigarette.

Interestingly, the overwhelming majority (82.7%) of electronic cigarette users are worried that these devices might be banned and 79.2% of those who quit smoking using e-cigarettes are afraid that they would return to smoking if such a ban occurred. Of those who stopped smoking while on e-cigarettes, 96.0% reported that the electronic cigarette played a definitive role in helping them quit smoking.

The paper's major finding is as follows: "e-cigarettes were used largely by former smokers as an aid to quit smoking, to avoid relapse and to deal with withdrawal symptoms, much as people use nicotine replacement therapy (NRT). ... Our data suggest that e-cigarettes may help smokers to quit smoking, reduce their cigarette consumption and attenuate craving and tobacco withdrawal symptoms. Users of nicotine-containing e-cigarettes reported only slightly superior effects on withdrawal than users of non-nicotine cigarettes, suggesting that nicotine delivery explains only part of the effect of these devices on withdrawal, and that sensory and behavioural components of the e-cigarette are also important."

Another important finding is that smokers who used e-cigarettes (but did not quit entirely) still improved their health: "current smokers who used the e-cigarette had fewer respiratory symptoms than smokers who did not use it ... which we speculate might be a consequence of reduced smoking. This difference is substantial ... and very close to the difference ... reported previously between patients with moderate and severe COPD."

The paper concludes: "E-cigarettes were used mainly by former smokers as an aid to quit smoking and avoid relapse. These products were perceived as satisfactory, useful, and efficacious, and almost all users preferred nicotine-containing e-cigarettes."

The Rest of the Story

Despite the fact that the sample is non-representative and the true efficacy of electronic cigarettes is certainly lower than reported here, the findings of the study nevertheless provide strong evidence that electronic cigarettes are being used with success by many smokers to quit smoking or cut down substantially on the number of cigarettes they consume, and that e-cigarettes are being used with success by many ex-smokers to remain off cigarettes.

Based on this survey alone, there are more than 2,000 ex-smokers who are electronic cigarette users who claim that the device played an instrumental role in their success in quitting smoking. Nearly 80% of these ex-smokers fear they would return to smoking if they discontinued the use of electronic cigarettes, as recommended by Cobb and Abrams in their *New England Journal of Medicine* perspective article.

Given these findings, along with previous data from other surveys and anecdotal evidence from numerous other sources, the claim that electronic cigarettes are completely ineffective in smoking cessation because they do not deliver nicotine effectively is now untenable.

It is now clear that there are indeed thousands of ex-smokers who successfully quit smoking because of electronic cigarettes and who would likely return to smoking if persuaded to discontinue using electronic cigarettes in favor of an "approved" form of smoking cessation pharmacotherapy.

It is also clear that there are thousands of ex-smokers who successfully quit smoking because of electronic cigarettes and who would likely return to smoking if e-cigarettes were banned or taken off the market, as recommended by numerous anti-smoking groups, including the Campaign for Tobacco-Free Kids, American Heart Association, American Cancer Society, American Lung Association, and the American Legacy Foundation.

While there is no question that more rigorous research is needed to study the effectiveness of electronic cigarettes for smoking cessation (e.g., clinical trials), there is also no question that these products can be effective and are effective among thousands of users. This may not mean that the proportion of users who are successful is high, but it does mean that the number of people who would be harmed by taking e-cigarettes off the market or by persuading people to discontinue their use is substantial.

Thus, promoting the removal of electronic cigarettes from the market pending further research and recommending that people refrain from using the product pending further research are both strategies that will almost invariably cause substantial health harm to the population. Therefore, I do not find either of these approaches to be responsible and appropriate ones.

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Electronic cigarette: users profile, utilization, satisfaction and perceived efficacy

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ABSTRACT

Aims To assess the profile, utilization patterns, satisfaction and perceived effects among users of electronic cigarettes ('e-cigarettes'). **Design and Setting** Internet survey in English and French in 2010. **Measurements** Online questionnaire. **Participants** Visitors of websites and online discussion forums dedicated to e-cigarettes and to smoking cessation. **Findings** There were 3587 participants (70% former tobacco smokers, 61% men, mean age 41 years). The median duration of electronic cigarette use was 3 months, users drew 120 puffs/day and used five refills/day. Almost all (97%) used e-cigarettes containing nicotine. Daily users spent $33 per month on these products. Most (96%) said the e-cigarette helped them to quit smoking or reduce their smoking (92%). Reasons for using the e-cigarette included the perception that it was less toxic than tobacco (84%), to deal with craving for tobacco (79%) and withdrawal symptoms (67%), to quit smoking or avoid relapsing (77%), because it was cheaper than smoking (57%) and to deal with situations where smoking was prohibited (39%). Most ex-smokers (79%) feared they might relapse to smoking if they stopped using the e-cigarette. Users of nicotine-containing e-cigarettes reported better relief of withdrawal and a greater effect on smoking cessation than those using non-nicotine e-cigarettes. **Conclusions** E-cigarettes were used much as people would use nicotine replacement medications: by former smokers to avoid relapse or as an aid to cut down or quit smoking. Further research should evaluate the safety and efficacy of e-cigarettes for administration of nicotine and other substances, and for quitting and relapse prevention.

Keywords E-cigarette, electronic cigarette, electronic nicotine delivery systems (ENDS), internet, nicotine, smoking, tobacco use disorder.

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INTRODUCTION

Electronic cigarettes (referred hereafter as e-cigarettes and by some authorities as electronic nicotine delivery systems, ENDS) look like tobacco cigarettes, but do not contain tobacco. Instead, they comprise a metal casing within which a battery-powered atomiser produces a vapour for inhalation from cartridges that contain humectants (e.g. propylene glycol or glycerol), flavours, nicotine or in some cases other medications (rimonabant, amino-tadalafil) [1–3]. Their appearance, size, handling and oral inhalation characteristics resemble those of tobacco cigarettes and may be important in their popularity and in assisting smokers to quit.

E-cigarettes are popular. Google searches for 'electronic cigarettes' have increased by 5000% over the past 2 years [4], and 9% of UK smokers and 9% of Polish teenage smokers report having used them [5,6]. Many smokers report using them to quit smoking [7,8], or to 'smoke' in smoke-free places [7]. However, because there are no data supporting the marketers' claim that e-cigarettes help smokers to quit, the World Health Organization (WHO) and the US Food and Drug Administration (FDA) have asked them not to make therapeutic claims [9,10].

Conference presentation: This study was presented at the European Conference on Tobacco or Health, Amsterdam, the Netherlands, 28–30 March 2011.

Few research reports on e-cigarettes are available [11–19]. In clinical studies, e-cigarettes appear to attenuate craving for tobacco, despite delivering very little nicotine to the blood [16,17,20]. Laboratory testing has shown that some e-cigarette cartridges may contain toxic components, including low levels of carcinogens [12,14,19]. Many questions remain unanswered: are e-cigarettes safe, are they addictive, who uses them, why and how are they used, are they effective for smoking cessation or reduction [21,22]? Also unanswered are questions about their wider impact: are they used by young non-smokers, could they be a gateway to tobacco use or nicotine dependence, and could their use in public places undermine smoke-free laws [4,6,19,22–24]?

Conducting clinical trials of these devices is challenging: there is a lack of safety data, the regulatory environment makes conducting trials of such novel devices difficult [14,22,25] and trials are expensive and time-consuming to conduct. Therefore, until trials can be undertaken, user surveys are a means of gathering information about the effects of this product on a range of outcomes [5–7]. The aim of this study was to describe e-cigarette users, assess how and why they used this product, their satisfaction with the product and its perceived effects.

METHODS

We posted a questionnaire on the smoking cessation website Stop-Tabac.ch [26–28], in English and French, and used data collected between March and October 2010 (data collection will continue until December 2011). We contacted discussion forums and websites informing about e-cigarettes or selling them, and asked them to publish links to the survey (http://www.stop-tabac.ch/fr_hon/ECIG_EN). Participants were aged >18 years, and current, past and never-users of e-cigarettes were eligible. We recorded IP addresses (i.e. computer numbers) to identify and delete duplicate records, and collected saliva vials in a subsample of participants for cotinine analysis (results reported separately) [29]. The sample size expected initially was 1500, but participation was greater than expected. The survey was approved by the ethics committee of the Geneva University Hospitals.

The questionnaire, based on previous work by the authors [7,17,22], assessed:

- Prior or current use of e-cigarettes, and intention to use them.
- Dosage, puffs/day, brand, flavours, cost and where obtained.
- Duration of use, delivery of nicotine, ease in staying off cigarettes.
- Effect on smoking cessation and on tobacco withdrawal symptoms (Minnesota Withdrawal Form) [30], in participants who had used the e-cigarette during a quit attempt.
- Respiratory symptoms [clinical chronic obstructive pulmonary disease (COPD) questionnaire] [31,32].
- Reasons for using and reasons for stopping use.
- Side effects, acceptability and satisfaction.
- Use of smoking cessation medications (nicotine therapy, bupropion and varenicline).
- Smoking status, cigarettes per day and time to first cigarette.
- Currently trying to quit or reduce smoking, intention to quit, confidence in ability to quit.
- Age, sex, income, education, country and, from May 2010 onwards, where respondents learned about the survey.

Statistical analyses

We compared current and former smokers, and users of e-cigarettes containing nicotine with those using e-cigarettes without nicotine. There is a concern that participants enrolled on forums and websites that defend the rights of e-cigarette users may deliberately answer in a way that is favourable to their agenda (e.g. exaggerating satisfaction or under-reporting side effects). To test this hypothesis, we compared two groups: (i) the 1005 users who learned about the survey on websites where the right to use e-cigarettes is often debated and advocated: E-cigarette-forum.com ($n = 782$), Vapersforum.com ($n = 129$), Casaa.org ($n = 32$), the UK Vapers forum ($n = 23$), Vapersclub.com ($n = 20$) or Forum-ecigarette.com ($n = 19$), with (ii) the 83 participants who learned of the survey on more neutral sites, including Stop-tabac.ch ($n = 26$) (a smoking cessation website with some factual, neutral information on e-cigarettes), on Google ($n = 30$) or on other sites unrelated to e-cigarettes ($n = 27$).We used analyses of variance (ANOVAs) to compare means, Mann–Whitney *U*-tests to compare medians and χ^2 tests to compare proportions. For most variables, we reported medians rather than means, because medians are less sensitive to extreme values. We used linear regression models to test associations between continuous variables, with 95% confidence intervals (CI) around the point estimates as a measure of precision. Prices in currencies other than $US were converted to $US. A *P*-value of <0.05 was used as the cut-off for judging statistical significance.

RESULTS

Participant characteristics

The raw data file included 3659 records, but we deleted 66 double entries (i.e. duplicate answers by the same people identified by computer numbers) and six records of people aged <18. The median age of the 3587 participants was 41 years (25th and 75th percentiles: 31 and 50 years), most were men (61%), former smokers (70%) and answered the English version of the questionnaire (79%) (Table 1). Distribution of respondents by country was: United States (62%), France (14%), United Kingdom (6%), Switzerland (4%), Canada (3%) and other countries (11%). Participants learned about the survey on the following websites: E-cigarette-forum.com (53%), Vapersforum.com (9%), the Sedansa website (3%), the Totally Wicked website (2%), Casaa.org (2%), Google (2%), Stop-tabac.ch (2%), the UK Vapers forum (2%) and other websites (25%). Most participants (58%) had obtained a diploma that would give access to university, and household income tended to be above average. Among current smokers, most reported currently trying to quit or to reduce their tobacco use. Very few ($n = 4$) never smokers used nicotine-containing e-cigarettes, but of these, three said they used them to deal with their craving for tobacco and to avoid relapsing to smoking, indicating that they were actually former smokers misclassified as never smokers. Most participants were current users of e-cigarettes, but 15.2% were never users and 1.3% were past users.

Daily users versus never users of e-cigarettes

There were more men (65% versus 46%, $P < 0.001$) and more former smokers (77% versus 42%, $P < 0.001$) among daily e-cigarette users than among never users. Daily users were more likely to have ever used bupropion (30 versus 19%, $P < 0.001$) and nicotine therapy (70 versus 64%, $P < 0.001$), but not varenicline. Among current smokers, daily e-cigarette users smoked fewer cigarettes than never users (13 versus 16 cigarettes/day, $P < 0.001$). However, *before* they first started using the e-cigarette, daily e-cigarette users smoked more tobacco than never users (25 versus 16 cigarettes/day, $P \leq 0.001$). Among smokers, e-cigarette users were also more likely than never users to be currently trying to quit smoking (71 versus 51%, $P < 0.001$) or trying to reduce their tobacco use (96 versus 72%), more confident in their ability to quit ('very sure': 17 versus 6%, $P < 0.001$), and had lower scores on the clinical COPD questionnaire (total score: 1.25 versus 1.79, $P < 0.001$). Among former smokers, the duration of smoking abstinence was shorter in daily users than in never users (105 versus 150 days, $P = 0.001$).

Utilization

The most-used brands varied by country. Among daily users living in the United States, the most-used brands were: Joye (40.5%), Vapor4Life (9.2%), Janty (5.8%), Totally Wicked (5.8%) and PureSmoker (5.3%); in France: Janty (27.5%), Joye (19.8%), Sedansa (13.7%), Kyozen (6.9%) and CigLib (6.9%); and in the United Kingdom: TECC (19.9%), Totally Wicked (17.6%), Titan (13.2%), Joye (11.8%) and Screwdriver (9.6%). The most-used models (sold under various brand names) were the 510 (40.5% of daily e-cigarette users), the eGo (11.3%), the KR808 (9.1%), the 901 (6.4%) and the Tornado (5.1%). The flavours used most were tobacco (39% of users), mint–menthol (15%), various fruit flavours (14%), coffee (9%), vanilla (5%) and chocolate (3%). The tobacco flavour was rated lower (83% 'good' or 'very good') than for all other flavours combined (93%, $\chi^2 = 115$, $P < 0.001$). The models tested in previous studies [14–19,24,33] were seldom or never used by respondents: Njoy ($n = 10$, 0.3%), Liberty ($n = 8$, 0.3%), Ruyan ($n = 5$, 0.2%), Smoking Everywhere ($n = 4$, 0.1%), Gamucci ($n = 4$, 0.1%), Crown Seven ($n = 0$), inLife ($n = 0$), Supersmoker ($n = 0$) and VapCig ($n = 0$).

Among daily users of the e-cigarette, the median duration of the current episode of use was 3 months, but 15% had been using it for 1 or more years. Daily users drew an average of 120 puffs per day (Table 2). Almost all daily users (97%) said their e-cigarette contained nicotine. The median capacity of refill bottles was 20 ml and the median nicotine concentration in the liquid, uniform across brands and models, was 18 mg/ml (Table 2). Daily users used two bottles of refill liquid per month, refilled their e-cigarette five times a day, and each refill or cartridge lasted 2 hours. The average price per kit was 60 $US, and daily users spent 33 $US per month for their e-cigarettes (including refill liquid and cartridges, batteries, components). Almost all daily users (96%) bought their e-cigarettes on the internet and about half (45%) intended to continue using them for another year or more. Daily users used their e-cigarette mainly at home (98% 'often' and 'very often'), in their car (90%) and at work (71%), but less frequently in cafes/restaurants/bars/discos (43%), in public transport (15%) or during business meetings (13%).

Satisfaction

Most current smokers reported that the e-cigarette helped them to reduce their smoking (92%), and most former smokers (96%) said that it helped them to quit smoking. Most ever users (89%) said that it was easy to abstain from smoking while using the e-cigarette (Table 3). Most users (94%) were willing to recommend it to a friend, and satisfaction ratings were high (mean = 9.3 on a 0–10 scale). Few (10%) still experienced the urge to smoke while using the e-cigarette, and most former smokers (79%) feared that they would relapse to smoking if they stopped using it.

Most ever users (91%) liked the e-cigarette's taste and the sensation while inhaling (Table 3). However, 22%

Table 1 Characteristics of study participants: internet (English and French), March–October 2010.

	All	Current smokers	Former smokers	Statistic	P-value	E-cigarette with nicotine	E-cigarette without nicotine	Statistic	P-value
Number of respondents	3587	1051	2508			2850	112		
Version (% English)	78.9	65.0	84.8	$\chi^2 = 176$	<0.001	91.9	67.9	$\chi^2 = 76.4$	<0.001
Age (years)[a]	41 (31, 50)	42 (31, 52)	40 (32, 50)	$U = 115\,164$	0.11	41 (31, 50)	42 (31, 51)	$U = 145\,209$	0.75
Sex (men, %)	61.3	58.2	62.5	$\chi^2 = 5.7$	0.017	64.6	47.3	$\chi^2 = 14.0$	<0.001
Household income (%)									
Below average	27.7	31.2	26.2	$\chi^2 = 17.6$	0.004	28.1	28.5	$\chi^2 = 10.1$	0.071
Average	30.9	29.8	31.5			30.9	25.0		
Above average	36.4	32.9	37.9			36.5	36.6		
E-cigarette use				$\chi^2 = 372$	<0.001			$\chi^2 = 42.8$	<0.001
Daily	80.8	61.7	89.2			96.7	84.8		
Occasional (not daily)	2.7	6.3	1.0			2.5	11.6		
Past users	1.3	2.6	0.8			0.8	3.6		
Never users	15.2	29.5	9.0			–	–		
Ever used nicotine therapy (%)	68.1	62.9	70.5	$\chi^2 = 36.1$	<0.001	69.4	60.4	$\chi^2 = 8.8$	0.031
Ever used bupropion (%)	28.0	25.3	29.1	$\chi^2 = 7.5$	0.058	29.9	32.4	$\chi^2 = 0.7$	0.86
Ever used varenicline (%)	18.4	16.2	19.4	$\chi^2 = 20.6$	<0.001	18.6	22.0	$\chi^2 = 18.5$	<0.001
Smoking status									
Daily smokers	19.0					12.1	12.5	$\chi^2 = 14.7$	0.002
Occasional (non-daily)	10.5					12.0	9.8		
Former smokers	70.2					75.8	75.9		
Never smokers	0.3					0.1	1.8		
Daily smokers									
Tobacco cigarettes/day now[a]		15 (10, 20)				15 (8, 20)	12 (7, 20)	$U = 2027$	0.37
Cigarettes/day before using e-cigarette[a]		25 (20, 30)				25 (20, 30)	17 (11, 21)	$U = 1049$	0.001
Minutes to first cigarette of the day[a]		15 (5, 30)				10 (5, 30)	15 (9, 38)	$U = 1886$	0.25
Sure they could quit smoking if they tried (very sure, %)		11.2				15.0	23.1	$\chi^2 = 2.4$	0.48
Decided to quit next 30 days (%)		35.4				34.4	38.5	$\chi^2 = 1.7$	0.63
Now trying to quit smoking (%)		60.1				68.2	64.3	$\chi^2 = 0.1$	0.76
Currently trying to reduce cigarettes/day (%)		84.4				94.7	92.9	$\chi^2 = 0.1$	0.76
Duration of most recent quit attempt (days)[a]		21 (3, 122)				21 (2, 91)	21 (1, 274)	$U = 1255$	0.42
Former smokers									
Days since quit smoking[a]			107 (41, 251)			105 (42, 238)	112 (35, 254)	$U = 81\,142$	0.69

[a]Median (25th and 75th centiles).

Table 2 Utilization patterns among daily e-cigarette users.

	All daily e-cigarette users	*Current smokers*	*Former smokers*	*Statistic*	*P-value*	*E-cigarette with nicotine*	*E-cigarette without nicotine*	*Statistic*	*P-value*
n daily users	2896	647	2234			2757	95		
Duration current episode of use (days)[a]	91 (28, 274)	49 (14, 152)	152 (49, 274)	$U = 498\ 148$	<0.001	91 (28, 274)	91 (16, 152)	$U = 108\ 394$	0.18
Use e-cigarette minutes after waking[a]	20 (10, 45)	20 (10, 60)	20 (10, 45)	$U = 658\ 777$	0.17	20 (10, 45)	30 (15, 90)	$U = 90\ 702$	<0.001
Puffs per day drawn on e-cigarette[a]	120 (80, 200)	100 (70, 200)	120 (80, 200)	$U = 611\ 447$	0.04	120 (80, 200)	100 (50, 200)	$U = 103\ 405$	0.011
Capacity of refill bottles (ml)[a]	20 (10, 30)	15 (10, 30)	30 (10, 30)	$U = 478\ 601$	<0.001	20 (10, 30)	15 (10, 30)	$U = 80\ 939$	0.20
Nicotine in liquid (mg per ml)[a]	18 (12, 24)	18 (13, 24)	18 (12, 24)	$U = 568\ 704$	0.88	18 (12, 24)	0 (0, 0)	$U = 4384$	<0.001
Bottles per month[a]	2 (1, 3)	2 (1, 3)	2 (1, 3)	$U = 517\ 168$	0.001	2 (1, 3)	1.3 (0.5, 4)	$U = 82\ 030$	0.003
Refills/cartridges per day[a]	5 (2, 10)	4 (2, 10)	5 (3, 10)	$U = 534\ 495$	<0.001	5 (2, 10)	3 (1, 10)	$U = 91\ 982$	0.001
Refill/cartridge lasts? (hours)[a]	2 (1, 5)	3 (1, 6)	2 (1, 5)	$U = 574\ 500$	<0.001	2 (1, 5)	3 (1, 12)	$U = 102\ 312$	0.019
Duration of battery (hours)[a]	6 (3, 10)	5 (3, 10)	6 (3, 10)	$U = 625\ 419$	0.37	6 (3, 10)	6 (3, 12)	$U = 116\ 736$	0.76
Price per kit ($US)[a]	60 (42, 80)	59 (40, 80)	65 (44, 80)	$U = 594\ 056$	0.002	60 (42, 80)	67 (41, 106)	$U = 108\ 436$	0.092
Monthly spending ($US)[a]	33 (20, 50)	30 (19, 50)	35 (20, 50)	$U = 483\ 114$	0.004	35 (20, 50)	25 (16, 36)	$U = 65\ 295$	<0.001
Intends to use for >1 year (%)	45.4	50.2	44.0	$\chi^2 = 21.2$	0.012	45.4	41.3	$\chi^2 = 44.8$	<0.001
Ever used e-cigarette and tobacco on the same day (%)	65.2	95.7	56.4	$\chi^2 = 707$	<0.001	65.7	50.0	$\chi^2 = 11.7$	0.11
If dual use: duration (days)[a]	5 (1, 19)	19 (5, 60)	1 (1, 5)	$U = 211\ 625$	<0.001	5 (1, 19)	5 (1, 19)	$U = 39\ 680$	0.71

[a]Median (25th and 75th centiles).

Table 3 Satisfaction with the e-cigarette, in ever users.

	All ever users	*Current smokers*	*Former smokers*	χ^2	*P-value*	*E-cigarette with nicotine*	*E-cigarette without nicotine*	χ^2	*P-value*
n ever users	3037	740	2279			2850	112		
E-cigarette helped reduce smoking? (a lot, %)	92.2	86.7	94.3	86.7	<0.001	99.0	88.7	33.0	<0.001
E-cigarette ever broke down? (often, %)	8.0	11.3	7.0	27.1	<0.001	8.0	5.4	3.9	0.27
Liquid leaks out? (sometimes + often, %)	18.4	21.9	17.2	17.8	0.001	18.1	24.9	9.2	0.057
Would recommend e-cigarette to a friend (absolutely, %)	94.3	89.9	95.8	44.0	<0.001	94.9	86.2	19.4	0.001
Satisfaction, 0–10 scale (mean)	9.3	8.7	9.5	$F = 261$	<0.001	9.4	9.1	$F = 8.8$	0.003
Burns throat (somewhat + strongly, %)	22.1	23.8	15.7	25.9	<0.001	18.0	10.8	8.9	0.012
Rather + strongly agree (%)									
Still feel urge to smoke when using it	9.5	22.5	5.4	545	<0.001	9.3	9.8	5.7	0.22
Easy to abstain from smoking when using e-cigarette	88.6	82.4	90.3	536	<0.001	89.3	75.7	32.6	<0.001
Fears that e-cigarette might be toxic	6.0	9.1	5.1	25.9	<0.001	5.8	8.9	8.4	0.077
Fear that e-cigarettes will be banned	82.7	80.2	83.5	5.2	0.27	83.6	64.3	36.8	<0.001
Wonders what is composition of e-liquid	25.7	32.2	23.7	35.1	<0.001	25.4	29.7	2.8	0.59
The battery is discharged too quickly	37.0	44.0	34.8	40.4	<0.001	36.9	35.1	4.8	0.31
Refill cartridges are emptied too quickly	44.2	51.2	41.8	28.0	<0.001	44.6	37.3	4.8	0.31
Difficult to adjust nicotine dose with it	8.3	12.9	6.7	119	<0.001	8.0	–	–	–
Likes the taste of e-cigarette	91.2	86.3	92.6	50.0	<0.001	91.7	85.7	10.3	0.036
Likes sensation when inhales vapour	91.4	87.3	92.8	79.7	<0.001	92.0	86.6	13.5	0.009
Uses it because it causes no bad odours	89.6	89.5	89.7	12.8	0.012	90.1	83.6	14.9	0.005
E-cigarette causes a dry mouth/throat	26.2	29.1	25.1	8.5	0.07	26.4	24.3	5.5	0.24
Should provide faster relief of craving	9.7	17.5	7.4	116	<0.001	9.6	9.3	8.3	0.080
E-cigarette should provide more nicotine	4.2	7.9	3.0	69.1	<0.001	4.4	0.9	32.8	<0.001
Vapour should be more concentrated	19.7	28.3	16.9	67.4	<0.001	19.2	27.0	12.1	0.017
It should be easier to draw on e-cigarette	20.4	29.3	17.5	75.7	<0.001	20.1	27.0	9.2	0.057
Is afraid of becoming addicted to e-cigarette	7.7	10.0	7.0	11.5	0.021	7.8	1.8	18.3	0.001
Former smokers: fears that will start smoking again if stopped using it	–	–	79.2	–	–	80.0	63.9	26.5	<0.001
Did e-cigarette help you stop smoking? (a lot + definitely, %)	–	–	96.0	–	–	96.4	90.6	62.2	<0.001

reported that it burned the throat or gave a dry mouth or dry throat (26%). Similar proportions suggested the vapour should be more concentrated (20%) and that it should be easier to draw (inhale) on the e-cigarette (20%). One-third thought that the cartridges and batteries ran out too quickly, 18% said that the liquid sometimes leaked from the device, and 8% reported that their e-cigarette had broken down at some stage. Only a small proportion expressed concerns that the e-cigarette might be toxic (6%) or could lead to dependence (8%), but most feared that it might one day be banned by authorities (83%).

Linear regression modelling showed that the price of e-cigarette kits was not associated with the length of battery life, but was associated with the duration that refill cartridges lasted: for each additional 10 $US spent per kit, refills lasted 0.5 hours longer ($t = 3.1$, 95% CI: 0.2–0.9 hours, $P = 0.002$). There were no statistically significant associations between price and technical problems such as breakdowns or leakage.

Reasons for use

E-cigarettes were used because they were perceived to be less toxic than tobacco (84%), to quit smoking or avoid relapsing (77%), to deal with craving for tobacco (79%) and tobacco withdrawal symptoms (67%), and because they were cheaper than smoking (57%) (Table 4). Other less common reasons were to avoid bothering other people with tobacco smoke (44%), to deal with smoke-free situations (39%) or to avoid having to go outside to smoke (34%). Fewer used the e-cigarette to reduce tobacco consumption (28%), and far fewer reported being unable to stop using it (4%).

Reasons for stopping use

Those who had stopped using e-cigarettes ($n = 47$) indicated that they had done so because they did not need them any more (41% 'rather' plus 'strongly agree'), because they thought they would not relapse to smoking even if they stopped (33%), because of the product's poor quality (35%), because it did not reduce cravings (33%), because they relapsed to smoking (25%), because it did not help them to quit smoking (21%), because they feared its side effects (21%) or because they replaced it with a smoking cessation medication (10%).

Withdrawal symptoms

For participants who had used the e-cigarette during a quit attempt and who reported withdrawal symptoms ('moderate' or 'severe') [30], Table 5 shows the proportion who also reported whether the e-cigarette relieved symptoms. Craving to smoke was the symptom most

Table 4 Reasons for using the electronic cigarette, among ever users.

Among ever e-cigarette users: I use (used) the e-cigarette . . . (very true, %)	*All ever users*	*Current smokers*	*Former smokers*	χ^2	*P-value*	*E-cigarette with nicotine*	*E-cigarette without nicotine*	χ^2	*P-value*
n ever users	3037	740	2279			2850	112		
E-cigarette less toxic than tobacco	83.5	81.1	84.3	5.2	0.16	84.5	64.2	55.3	<0.001
To deal with craving for tobacco	79.0	77.3	79.7	2.3	0.52	80.1	61.5	28.0	<0.001
To quit smoking or avoid relapsing	76.8	57.7	83.0	207	<0.001	77.2	69.6	6.9	0.075
To deal with withdrawal symptoms	66.5	60.2	68.7	17.8	<0.001	67.7	40.9	39.5	<0.001
E-cigarette cheaper than smoking	57.3	53.8	58.4	8.2	0.041	58.2	43.9	32.6	<0.001
To avoid bothering others with tobacco smoke	43.6	42.4	44.0	5.4	0.14	44.0	38.7	6.1	0.11
To deal with situations where one cannot smoke (at work, etc.)	39.4	45.6	37.4	22.5	<0.001	39.9	30.0	21.5	<0.001
To avoid having to go outside to smoke	34.4	36.9	33.6	14.0	0.003	34.9	29.1	24.7	<0.001
To reduce tobacco consumption in preparation of a quit attempt	27.8	42.4	23.0	169	<0.001	17.8	28.2	15.2	0.002
To reduce tobacco consumption with *no* intention to quit smoking	20.3	23.5	19.2	94.6	<0.001	20.5	15.6	13.7	0.003
Because is unable to stop using it	4.4	4.4	4.4	3.3	0.35	4.5	2.8	4.9	0.18

Table 5 Relief of withdrawal symptoms, in those who used e-cigarettes during an attempt to quit smoking.

In those reporting 'moderate' and 'severe' symptoms, did e-cigarette relieve it? % (n) 'a lot' on 5-point scale	*All ever users* % (n)	*Current smokers* % (n)	*Former smokers* % (n)	χ^2	*P-value*	*E-cigarette with nicotine* % (n)	*E-cigarette without nicotine* % (n)	χ^2	*P-value*
Craving to smoke	90.0 (1457)	75.7 (342)	94.5 (1112)	104	<0.001	90.7 (1378)	76.9 (52)	18.1	<0.001
Angry, irritable, frustrated	82.5 (1089)	70.5 (227)	85.8 (858)	30.6	<0.001	83.2 (1033)	78.1 (32)	3.4	0.33
Anxious, nervous	80.8 (1078)	64.5 (231)	85.4 (844)	52.8	<0.001	81.4 (1022)	71.4 (35)	11.7	0.009
Restless, impatient	77.9 (950)	65.0 (203)	81.6 (744)	42.2	<0.001	78.9 (889)	68.6 (35)	9.1	0.028
Difficulty concentrating	74.0 (773)	63.4 (161)	77.0 (609)	14.4	0.002	74.8 (731)	64.0 (25)	2.0	0.56
Depressed mood, sad	70.9 (622)	59.8 (123)	74.0 (497)	12.0	0.007	71.4 (581)	71.4 (21)	5.1	0.16
Insomnia, sleep problems	53.4 (573)	44.2 (114)	56.0 (455)	8.1	0.044	54.1 (532)	43.5 (23)	21.4	<0.001
Appetite, hungry, weight gain	52.7 (733)	42.1 (146)	55.7 (583)	9.5	0.023	52.8 (685)	48.4 (31)	0.7	0.87

relieved by the e-cigarette (90%). The effects of e-cigarettes on suppressing withdrawal symptoms were reported as being greater by former smokers than current smokers, and greater by users of nicotine-containing e-cigarettes than users of non-nicotine e-cigarettes (Table 5).

Use to inhale other substances

Very few ever users ($n = 27$, 0.9%) reported having used the e-cigarette to inhale other substances than the liquid designed for that purpose. The substances disclosed were cannabis ($n = 5$, 0.2%), vitamins ($n = 3$), flavours ($n = 2$), herbs ($n = 2$) and vodka ($n = 1$). The median duration of e-cigarette use to inhale these substances was five days, but only 1 day among those who used cannabis.

Comparing users of e-cigarettes containing or not containing nicotine

Compared with users of non-nicotine e-cigarettes, users of nicotine-containing e-cigarettes were more likely to be men and smoked more tobacco cigarettes per day before they first started using e-cigarettes (Table 1). However, there was no between-group difference for current smoking status. Those who used nicotine-containing e-cigarettes were more likely to be daily users, used their first e-cigarette of the day earlier in the day, drew more puffs on their e-cigarette, used more refills per day and more bottles per month, their refill cartridges lasted less, and more of them intended to use e-cigarettes for another year or more (Table 2). Users of nicotine-containing e-cigarettes were also more likely to answer that it helped them to quit or reduce their smoking, they were more satisfied with it, in particular with its taste and with the sensation while inhaling, more likely to say that they feared relapsing if they stopped using it, but they were also more likely to answer that e-cigarette use burned their throat (Table 3). Most of the reasons for using the e-cigarette were endorsed more frequently by users of nicotine-containing e-cigarettes than by users of non-nicotine e-cigarettes, in particular use to deal with craving and withdrawal (Table 4).

Comparing current and former tobacco smokers

Former smokers were more likely than current smokers to use the e-cigarette and to have ever used smoking cessation medications (Table 1). Among daily e-cigarette users, the duration of use was longer in former smokers than in current smokers (Table 2). Former smokers also took more puffs per day, were less likely to use the tobacco flavour, used larger refill bottles, their refills or cartridges lasted less and they spent more per month than current smokers. Former smokers were also more likely to say that the e-cigarette helped them to quit or reduce their smoking, to report that it helped improve their respiratory symptoms, and to use e-cigarettes to deal with tobacco withdrawal symptoms (Table 3).

Comparing participants enrolled on e-cigarette forums with those enrolled on neutral sites

The 1005 participants enrolled on e-cigarette forums/websites were more likely to be former smokers than the 83 participants enrolled on 'neutral' websites (72 versus 43%, $P < 0.001$), more likely to be daily e-cigarette users (93 versus 31%, $P < 0.001$), had used the e-cigarette longer (current episode of use: 91 days versus 14 days [medians], $P = 0.003$), were generally more satisfied with the e-cigarette, but indicated the same reasons for using them (Table 6). When analyses were restricted to former smokers, differences in several satisfaction variables were smaller and often non-significant: e.g. satisfaction rating (0–10 scale): mean = 9.6 in both groups ($t = 0.2$, $P = 0.8$), 'e-cigarette burns the throat' (16.3 versus 25.0%, $\chi^2 = 0.8$, $P = 0.7$) and 'fear e-cigarette might be toxic' (6.1 versus 0%, $\chi^2 = 2.0$, $P = 0.75$).

DISCUSSION

The main finding of this survey, which enrolled predominantly self-selected visitors of websites dedicated to e-cigarettes, is that e-cigarettes were used largely by former smokers as an aid to quit smoking, to avoid relapse and to deal with withdrawal symptoms, much as

Table 6 Comparison of participants enrolled on e-cigarette forums with those enrolled on other websites.

Selected variables	*Enrolled on e-cigarette forums*	*Enrolled on Stop-tabac or Google*	*Statistic*	*P-value*
n	1005	83		
Smoking status (%)				
Daily smokers	14.5	48.8	$\chi^2 = 72.5$	<0.001
Occasional (non-daily)	13.0	4.9		
Former smokers	72.3	43.9		
Never smokers	0.3	2.4		
E-cigarette use (%)				
Daily	93.2	30.1	$\chi^2 = 456.8$	<0.001
Occasional (not daily)	3.1	1.2		
Past users	1.0	1.2		
Never users	2.7	67.5		
In daily e-cigarette users				
Use e-cigarette containing nicotine (%)	97.6	100	$\chi^2 = 0.6$	0.45
Duration current episode of use (days)[a]	91 (21, 274)	14 (5, 152)	$U = 6164$	0.003
Puffs per day drawn on e-cigarette[a]	100 (70, 200)	200 (65, 300)	$U = 7696$	0.15
Bottles of e-liquid per month[a]	1.5 (1, 3)	1.5 (1, 3)	$U = 7546$	0.94
Refill/cartridge lasts? (hours)[a]	3 (1, 6)	3.5 (2, 8)	$U = 8876$	0.17
In ever users				
E-cigarette helped reduce smoking? (a lot, %)	93.2	80.8	$\chi^2 = 13.1$	0.011
Satisfaction, scale 0–10 (mean)	9.4	8.9	$t = 2.1$	0.03
Would recommend e-cigarette to a friend (absolutely, %)	95.5	88.5	$\chi^2 = 49.7$	<0.001
Burns throat (somewhat + strongly, %)	17.9	41.6	$\chi^2 = 34.5$	<0.001
Fears that e-cigarette might be toxic	6.3	18.5	$\chi^2 = 9.4$	0.052
In ex-smokers: e-cigarette helped quit smoking (a lot + definitely, %)	96.1	93.3	$\chi^2 = 11.5$	0.02
Opinions (agree, %)				
Fear that e-cigarettes will be banned	86.0	84.6	$\chi^2 = 4.5$	0.34
E-cigarette causes a dry mouth/throat	23.9	33.3	$\chi^2 = 4.7$	0.32
Should provide faster relief of craving	6.7	4.3	$\chi^2 = 3.5$	0.32
Afraid of becoming addicted to e-cigarette	6.8	14.8	$\chi^2 = 11.9$	0.02
Reasons for using e-cigarette (very true, %)				
E-cigarette less toxic than tobacco	85.4	77.8	$\chi^2 = 4.7$	0.20
To deal with craving for tobacco	82.4	88.9	$\chi^2 = 1.7$	0.64
To quit smoking or avoid relapsing	76.8	84.6	$\chi^2 = 2.4$	0.49
To deal with withdrawal symptoms	66.5	76.9	$\chi^2 = 3.5$	0.33

[a]Median (25th and 75th centiles).

people use nicotine replacement therapy (NRT). Use of e-cigarettes in smoke-free places was cited relatively less frequently, but many participants used them because they were perceived to be less toxic and cheaper than tobacco. Daily users spent 33 $US per month for e-cigarettes, which is much cheaper than smoking one pack a day (incurring a cost of about 150–200 $US per month in the respondents' countries). This is also substantially cheaper than smoking cessation medications (which, at the recommended dosage, cost about the same as smoking one pack a day). Thus, an important reason for the popularity of e-cigarettes [5,6] is most probably their price.

Several other findings raise questions needing further research. For example, it would be interesting to investigate why e-cigarettes have more appeal to men than to women. Only one never smoker used nicotine-containing e-cigarettes, a finding that could reflect the fact that under-age consumers were ineligible for the survey, or that contrary to the hypothesis expressed by some authors [4,23,24], e-cigarettes do not facilitate initiation to nicotine use in young never smokers.

The duration of use in former smokers (5 months) was substantially longer than use of NRT (usually a few days to a few weeks) [34,35, Etter & Schneider; unpublished data]. This suggests either that our sampling method resulted in the self-selection of long-term users, or that e-cigarettes are actually used longer-term than NRT, for reasons that deserve investigation.

It is not clear why one brand (Joye) and one model (the 510) dominated the market. This may result from successful marketing, or perhaps users may communicate about their preferred brands in online forums, and the best brands may gain popularity this way. It may be that some brands were over-represented in this survey because of links from websites selling these brands, in particular Totally Wicked and Sedansa. The models used in previous studies were seldom or never used by participants in this study [14–19,24]. To ensure validity and generalizability, future studies should use the most popular models.

Very few respondents (3% of users) used e-cigarettes without nicotine. This could suggest that, despite two studies showing very low absorption of nicotine [16,17], it may be an important ingredient of this product, perhaps because of its taste in addition to its pharmacological properties on withdrawal relief. Alternatively, users might have greater expectations for nicotine-containing products, so these products are purchased more commonly. Interestingly, the concentration of nicotine in the liquid was uniform across the various brands (18 mg/ml), suggesting that manufacturers reached a consensus. It is not clear how this particular concentration was arrived at, but few users said that e-cigarettes should provide more nicotine, despite the low nicotine absorption observed in the two clinical studies noted above [16,17]. The uniformity of nicotine content across the different brands makes it possible to compare them. The average content of nicotine per bottle, 360 mg (20 ml × 18 mg/ml), is of concern because the fatal dose of nicotine is estimated to be 30–60 mg for adults and 10 mg for children [2]. Thus, these refill bottles are extremely dangerous and should be replaced by sealed, tamper-proof, leak-resistant cartridges.

Daily use (120 puffs and five refills per day, that is, 24 puffs per refill) was in the range of the number of puffs inhaled by daily cigarette smokers. However, the average 24 puffs per refill is considerably less than the 170–300 smokeable puffs reported from *in vitro* tests (i.e. the number of puffs before the aerosol density decreased) [18]. This could mean that users switch cartridges when the flavour or the nicotine taste fade out, and this may occur much sooner than a decrease in aerosol density. A dosage of 120 puffs/day suggests a more intense use than the 10 puffs or 5 minutes puffing tested in clinical reports [15–17]. An implication of this is that laboratory tests should allow users to puff substantially more before outcomes are measured, to mimic actual utilization by experienced users.

The flavour used most was tobacco, even though this flavour rated lowest for satisfaction, possibly because some users did not sample all available flavours before choosing one. The sensation of a burning throat and dry mouth or throat was due in part to nicotine; whether it is also due to the humectants should be investigated.

Perceived effect on smoking and withdrawal symptoms

Our data suggest that e-cigarettes may help smokers to quit smoking, reduce their cigarette consumption and attenuate craving and tobacco withdrawal symptoms. Users of nicotine-containing e-cigarettes reported only slightly superior effects on withdrawal than users of non-nicotine e-cigarettes, suggesting that nicotine delivery explains only part of the effect of these devices on withdrawal, and that the sensory and behavioural components of the e-cigarette are also important. Of interest, current smokers who used the e-cigarette had fewer respiratory symptoms than smokers who did not use it (a difference of 0.54 points on the clinical COPD questionnaire), which we speculate might be a consequence of reduced smoking. This difference is substantial, as it is larger than the minimally clinically important difference for this questionnaire (0.4 points) [32], and very close to the difference of 0.6 points reported previously between patients with moderate and severe COPD [31].

Use for other substances

E-cigarettes represent a new way to administer substances to the respiratory tract. However, very few people reported using e-cigarettes to inhale substances other than the liquid designed for that purpose, and when they did, it was only briefly. Of course, some respondents may not have disclosed illicit drug use. Some e-cigarettes have been found to contain tadalafil analogues, rimonabant and several other substances and medications [3], with unknown effects.

Study limitations

This study was conducted in a self-selected sample of visitors of discussion forums and websites dedicated to e-cigarettes, some of which defend the right to use e-cigarettes in the face of mounting pressure for regulation or prohibition of this product [19,36,37]. However, organized multiple responding did probably not occur: a check of IP addresses showed that there were few double entries by the same participants, and double entries were deleted. Users enrolled on e-cigarette forums/websites differed from participants enrolled on 'neutral' sites on several accounts (mainly smoking status and current use of e-cigarettes), but when taking smoking status into account, the opinions of these two groups did not differ greatly. Nevertheless, it is still possible that some respondents gave the answers that they thought might help to defend their position (e.g. by reporting more satisfaction, more effects on smoking cessation, fewer concerns about safety). Whether we also over-sampled satisfied users, long-term users or heavy users of e-cigarettes is unknown. Thus, while our results provide new and interesting information, e-cigarettes are probably somewhat less satisfactory and less effective than reflected in these data, and our results should be interpreted with caution and may have limited generalizability. Finally, technology progresses rapidly, and our results may not apply to future models.

CONCLUSIONS

E-cigarettes were used mainly by former smokers as an aid to quit smoking and avoid relapse. These products were perceived as satisfactory, useful and efficacious, and almost all users preferred nicotine-containing e-cigarettes. Despite its limitations, this study adds to the still small body of knowledge about e-cigarettes and provides valuable additional information for smokers, clinicians, regulators and policy makers. Further research should address the safety and efficacy of using e-cigarettes to deliver nicotine and other substances, and assess their effectiveness as an aid to quitting and relapse prevention.

Declarations of interest

Jean-François Etter's salary is paid by the University of Geneva. He has served as an expert consultant for the World Health Organization regarding electronic nicotine delivery systems (ENDS). He consulted for Pfizer, a manufacturer of smoking cessation medications, in 2006–07 (on the Swiss varenicline advisory board), and received medications for a clinical trial from Pfizer in 2006; no competing interests since then. Chris Bullen's salary is paid by The University of Auckland and his research is supported by grants from the New Zealand Health Research Council (HRC), the University of Auckland and the NZ Heart Foundation. He has previously undertaken tobacco control research supported by the New Zealand Ministry of Health, and by Niconovum, Sweden, prior to the purchase of this company by RJ Reynolds. He is currently an investigator on a study involving reduced nicotine cigarettes in which the products were purchased by the University of Auckland from Vector Group Ltd, USA. He has previously undertaken research on ENDS funded by HealthNZ, in which the study products were supplied by Ruyan, Hong Kong; and he is the principal investigator on an HRC-funded efficacy trial of ENDS that will use products provided by a NZ-based ENDS retailer. Other than these relationships, he has no conflicts of interest to declare.

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Article

Impact of Flavour Variability on Electronic Cigarette Use Experience: An Internet Survey

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Abstract: *Background:* A major characteristic of the electronic cigarette (EC) market is the availability of a large number of different flavours. This has been criticised by the public health authorities, some of whom believe that diverse flavours will attract young users and that ECs are a gateway to smoking. At the same time, several reports in the news media mention that the main purpose of flavour marketing is to attract youngsters. The importance of flavourings and their patterns of use by EC consumers have not been adequately evaluated, therefore, the purpose of this survey was to examine and understand the impact of flavourings in the EC experience of dedicated users. *Methods:* A questionnaire was prepared and uploaded in an online survey tool. EC users were asked to participate irrespective of their current smoking status. Participants were divided according to their smoking status at the time of participation in two subgroups: former smokers and current smokers. *Results:* In total, 4,618 participants were included in the analysis, with 4,515 reporting current smoking status. The vast majority (91.1%) were former smokers, while current smokers had reduced smoking consumption from 20 to 4 cigarettes per day. Both subgroups had a median smoking history of 22 years and had been using ECs for 12 months. On average they were using three different types of liquid flavours on a regular basis, with former smokers switching between flavours more frequently compared to current smokers; 69.2% of the former subgroup reported doing so on a daily basis or within the day. Fruit flavours were more popular at the time of participation, while tobacco flavours were more popular at initiation of EC use. On a scale from 1 (not at all important) to 5 (extremely important) participants answered that variability of flavours was “very important” (score = 4) in their effort to reduce or quit smoking. The majority reported that restricting variability will make ECs less enjoyable and more boring, while 48.5% mentioned that it would increase craving for cigarettes and 39.7% said that it would have been less likely for them to reduce or quit smoking. The number of flavours used was independently associated with smoking cessation. *Conclusions:* The results of this survey of dedicated users indicate that flavours are marketed in order to satisfy vapers’ demand. They appear to contribute to both perceived pleasure and the effort to reduce cigarette consumption or quit smoking. Due to the fact that adoption of ECs by youngsters is currently minimal, it seems that implementing regulatory restrictions to flavours could cause harm to current vapers while no public health benefits would be observed in youngsters. Therefore, flavours variability should be maintained; any potential future risk for youngsters being attracted to ECs can be sufficiently minimized by strictly prohibiting EC sales in this population group.

Keywords: electronic cigarette; flavours; smoking; tobacco; nicotine; smoking cessation; public health

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1. Introduction

Cigarette smoking is considered the single most preventable cause of disease, affecting several systems in the human body and causing premature death [1]. The World Health Organisation predicts more than 1 billion deaths within the 21st century related to tobacco cigarettes [2]. Although there is overwhelming evidence for the benefits of smoking cessation [3], it is a very difficult addiction to break. Currently available nicotine replacement therapy have low long-term success rate, which may be attributed solely to psychological support [4], while oral medications are more effective [5] but are hindered by reports of adverse neuropsychiatric effects [6]. In this context, the tobacco harm reduction strategy has been developed, with a goal of providing nicotine through alternative methods in order to reduce the amount of harmful substances obtained by the user [7].

Electronic cigarettes (ECs) have been marketed in recent years as alternative to smoking products. They consist mainly of a battery and an atomiser where liquid is stored and gets evaporated by energy supplied to an electrical resistance. The liquid contains mainly propylene glycol and glycerol, with the option to include nicotine. A major characteristic of the EC liquid market is the availability of a variety of flavourings. Besides tobacco-like flavours, the consumer can choose flavours consisting of fruits, sweets, drinks and beverages and many more. The availability of so many flavours has been criticized by authorities such as the Food and Drug Administration (FDA), stating that there is a potential to attract youngsters [8]. Such a concern was probably raised by the experience with tobacco products, with studies showing that flavoured cigarettes were more appealing to young users [9]. A recent survey of electronic cigarette users found that almost half of participants were using non-tobacco flavours [10]. However, no survey was specifically designed to detect the impact of flavourings on EC experience by users. Therefore, the purpose of this survey was to evaluate the patterns of flavourings use and determine their popularity in a sample of dedicated adult EC users.

2. Methods

A questionnaire was prepared by the research team in two languages (English and Greek) and was uploaded in an online survey tool (www.surveymonkey.com). A brief presentation of the survey was uploaded in the website of a non-profit EC advocates group (www.ecigarette-research.com) together with informed consents in English and Greek. If the participant agreed with the informed consent, he was redirected to the questionnaire in the respective language by pressing the "I agree" button. The survey was available online for 15 days. The protocol was approved by the ethics committee of our institution.

EC users of any age, irrespective of current or previous smoking status, were asked to participate to the survey. The survey was communicated in internet social media and several EC users' forums and advocate groups worldwide. The IP address of the participants was recorded in order to remove double entries. There was an option for participants to report their email address for participation in future projects; unwillingness to report the email address was not a criterion for exclusion from the survey. Information about age, gender, country of residence and education level was requested. Past and present smoking status was asked and, based on the latter, participants were divided into two groups for the analysis: former smokers who had completely quit smoking and smokers who were still smoking after initiation of EC use. The questionnaire included questions about the type of flavours used regularly by the participants, whether the variety of flavourings was important in reducing or completely substituting smoking and defining the reasons for using multiple flavours. To assess difficulty in finding flavours of their preference at EC use initiation, the following question was asked: "Was it difficult to find the flavourings of your preference at initiation of EC use?". The answers were scored as: 1, "not at all difficult"; 2, "slightly difficult"; 3, "difficult"; 4, "very difficult"; and 5, "extremely difficult". To examine the importance of flavours variability in reducing or quitting smoking, the following question was asked: "Was the variability of flavourings important in your effort to reduce or completely substitute smoking?". The answer was scored as: 1, "not at all important"; 2, "slightly important"; 3, "important"; 4, "very important"; and 5, "extremely important".

3. Statistical Analysis

Participants were categorised into current smokers and former-smokers according to their reported status at the time of participation to the survey. Results are reported for the whole sample and for each of the subgroups. The sample size varied by variable because of missing data. In some questions, responders were allowed to choose more than one option; in these cases, each answer is presented separately and the sum of responses may exceed 100%. Kolmogorov-Smirnoff tests were performed to assess normality of distribution of variables. Continuous variables are reported as median (interquartile range [IQR]). Categorical variables are reported as number (percentage). Mann Whitney U test was used to compare continuous variables between current and former smokers, while cross tabulations with χ^2 test were used for categorical variables. Finally, a stepwise binary logistic regression analysis was performed, with smoking status (former *vs.* current smoker) as the independent variable and age, gender, education level, smoking duration, number of flavourings used regularly, and EC consumption (ml liquid or number of prefilled cartomisers) as covariates. A two-tailed P value of <0.05 was considered statistically significant, and all analyses were performed with commercially available statistical software (SPSS v. 18, Chicago, IL, USA).

4. Results

4.1. Baseline Characteristics

After excluding double entries, 4,618 participants were included to the analysis, with 4,515 reporting current smoking status (current *vs.* former smokers). The baseline characteristics of the study group and subgroups are displayed in Table 1. More than 90% were former smokers. The mean age was 40 years, with male predominance. No difference between former and current smokers was observed in age, while more males were former smokers. The vast majority were from America and Europe, with a small proportion residing in Asia and Australia. More than half of participants were educated to the level of university/college. Smoking duration was similar between subgroups. Interestingly, former smokers reported higher daily cigarette consumption before initiation of EC use, although the difference was not statistically significant. Current smokers reported a substantial reduction in cigarette consumption, from 20 to 4 cigarettes per day. The median duration of EC use was 12 months, with higher consumption (ml liquid or number of cartridges) reported by former smokers. Higher nicotine concentration liquids were used by current smokers ($P = 0.005$). In total, 140 participants (3.0%) reported using non-nicotine liquids, 2.8% of former and 1% of current smokers ($\chi^2 = 4.5$, $P = 0.033$); 21 users of non-nicotine liquids did not mention their current smoking status. Finally, more current smokers were using first (cigarette-like) and second generation (eGo-type) devices while more former smokers were using third generation devices (also called “Mods”, variable voltage or wattage devices).

4.2. Perceptions in Relation to Flavours

Responses to questions related to flavours are displayed in Table 2. At the time of participation, most commonly used flavours were fruits, followed by sweets and tobacco. Significant differences were observed between subgroups. Characteristically, more current smokers were using tobacco flavours compared to former smokers, while more of the latter were using fruit and sweet flavours. On a regular basis, participants reported using 3 (IQR: 2–4) different types of flavours. At initiation of EC use, most popular flavours were tobacco followed by fruit and sweet flavours. The median score for difficulty to find the flavours of their preference at EC initiation was 2 (IQR: 1–3), with no difference between subgroups. Most participants (68.3%) were switching between flavours on a daily basis or within the day, with former smokers switching more frequently. More than half of the study sample mentioned that they like the variety of flavours and that the taste gets blunt from long-term use of the same flavour. The average score for importance of flavours variability in reducing or quitting smoking was 4 (“very important”). Finally, the majority of participants stated that restricting variability of flavours would make the EC experience less enjoyable while almost half of them answered that it would increase craving for tobacco cigarettes and would make reducing or completely substituting smoking less likely.

Table 1. Baseline characteristics of the study population and subgroups.

Characteristic	Total	Former Smokers	Current Smokers	Statistic	*P*
Participants, n (%)	4,618	4,117 (91.2)	398 (8.8)		
English translation	4,386 (95.0)	3,915 (95.1)	369 (92.7)		
Greek translation	232 (5.0)	202 (4.9)	29 (7.3)		
Region of residence, n (%)					
America	2,220 (48.5)	2,007 (48.7)	157 (39.4)		
Asia	76 (1.7)	58 (1.4)	16 (4.0)		
Australia	80 (1.7)	75 (1.8)	4 (1.0)		
Europe	2,197 (48.0)	1,939 (47.1)	217 (54.5)		
Education, n (%)					
High school or less	1,037 (22.7)	917 (22.3)	98 (24.6)		
Technical Education	1,099 (24.1)	993 (24.1)	86 (21.6)		
University/College	2,425 (53.2)	2,170 (52.7)	206 (51.8)		
Age (years)	40 (32–49)	40 (32–49)	40 (32–49)	U = 754,278	0.624
Gender (male)	3,229 (71.8)	2,922 (72.7)	246 (62.5)	$\chi^2 = 18.0$	<0.001
Smoking duration (years)	22 (15–30)	22 (15–30)	22 (14–30)	U = 816,534	0.924
Cigarette consumption before EC use (/d)	24 (20–30)	25 (20–30)	20 (19–30)	U = 768,398	0.189
Cigarettes consumption after EC use (/d)			4 (2–6)		
EC use duration (months)	12 (6–23)	12 (6–23)	12 (5–23)	U = 790,219	0.373
EC consumption (ml or cartridges/d)	4 (3–5)	4 (3–5)	3 (2–5)	U = 677,862	<0.001
Nicotine levels in EC (mg/ml)	12 (6–18)	12 (6–18)	12 (8–18)	U = 722,563	0.005
EC devices used, n (%)					
Cigarette-like	84 (1.8)	61 (1.5)	20 (5.0)	$\chi^2 = 25.9$	<0.001
eGo-type	1,123 (24.7)	966 (23.5)	133 (33.4)	$\chi^2 = 19.5$	<0.001
"Mods" [a]	3,348 (73.5)	3,047 (74.0)	237 (59.5)	$\chi^2 = 38.3$	<0.001

Notes: Values presented as median (interquartile range) or number (percentage). Abbreviations: EC, electronic cigarette. [a] New generation devices, usually hand-made or with the ability to manually set the voltage or wattage delivery.

Table 2. Patterns of flavourings use in the study population and subgroups.

Characteristic	Total	Former Smokers	Current Smokers	Statistic	*P*
Flavours used now, n (%) [a]					
Tobacco	1,984 (43.9)	1,773 (43.1)	211 (53.0)	$\chi^2 = 14.6$	<0.001
Mint/menthol	1,468 (31.8)	1,339 (32.5)	129 (32.4)	$\chi^2 = 0.0$	0.964
Sweet	2,836 (61.4)	2,629 (63.9)	207 (52.0)	$\chi^2 = 21.8$	<0.001
Nuts	691 (15.0)	643 (15.6)	48 (12.1)	$\chi^2 = 3.5$	0.060
Fruits	3,203 (69.4)	2,953 (71.7)	250 (62.8)	$\chi^2 = 14.0$	<0.001
Drinks/beverages	1,699 (36.8)	1,562 (37.9)	137 (34.4)	$\chi^2 = 1.9$	0.167
Other	1,028 (22.3)	946 (23.0)	82 (20.6)	$\chi^2 = 1.2$	0.281

Table 2. *Cont.*

Flavours used at EC initiation, n (%) [a]					
Tobacco	3,118 (69.1)	2,846 (69.1)	272 (68.3)	$\chi^2 = 0.1$	0.746
Mint/menthol	1,086 (24.1)	1,004 (24.4)	82 (20.6)	$\chi^2 = 2.8$	0.092
Sweet	1,347 (29.8)	1,251 (30.4)	96 (24.1)	$\chi^2 = 6.8$	0.009
Nuts	203 (4.5)	186 (4.5)	17 (4.3)	$\chi^2 = 0.1$	0.821
Fruits	1,743 (38.6)	1,606 (39.0)	137 (34.4)	$\chi^2 = 3.2$	0.073
Drinks/beverages	808 (17.9)	748 (16.8)	60 (15.1)	$\chi^2 = 2.4$	0.124
Other	302 (6.7)	282 (6.8)	20 (5.0)	$\chi^2 = 1.9$	0.164
Switching between flavours, n (%)					
Daily/within the day	3,083 (68.3)	2,851 (69.2)	232 (58.3)	$\chi^2 = 20.1$	<0.001
Weekly	718 (15.9)	636 (15.4)	82 (20.6)	$\chi^2 = 7.2$	0.007
Less than weekly	465 (10.3)	412 (10.0)	53 (13.3)	$\chi^2 = 4.3$	0.038
At EC initiation, was it difficult to find the flavours of your preference? [b]	2 (1–3)	2 (1–3)	2 (1–3)	U = 760,068	0.054
Why do you feel the need to choose different flavours? n (%) [a]					
Like variety of choices	3,300 (73.1)	3,041 (73.9)	259 (65.1)	$\chi^2 = 14.3$	<0.001
They get "blunt" from long-term use	2,325 (51.5)	2,131 (51.8)	194 (48.7)	$\chi^2 = 1.3$	0.250
Other reasons	342 (7.6)	318 (7.7)	24 (6)	$\chi^2 = 1.5$	0.223
Was flavours variability important in reducing/quitting smoking? [b]	4 (3–5)	4 (3–5)	4 (3–5)	U = 731,547	0.455
How would your experience with EC change if flavours variability was limited? n (%) [a]					
Less enjoyable	3,111 (68.9)	2,886 (70.1)	225 (56.5)	$\chi^2 = 31.2$	<0.001
More boring	2,063 (45.7)	1,901 (46.2)	236 (40.7)	$\chi^2 = 4.4$	0.036
Increase craving for cigarettes	2,188 (48.5)	1,982 (48.1)	206 (51.8)	$\chi^2 = 1.9$	0.168
Less likely to reduce or quit smoking	1,793 (39.7)	1,617 (39.3)	176 (44.2)	$\chi^2 = 3.7$	0.054
No difference	285 (6.3)	253 (6.1)	32 (8.0)	$\chi^2 = 2.2$	0.138

Notes: Values presented as median (interquartile range) or number (percentage). Abbreviations: EC, electronic cigarette. [a] Participants were allowed to choose more than one answers. [b] Score reported (see text for details).

Binary logistic regression analysis showed that male gender (B = 0.373, *P* = 0.001), EC consumption (B = 0.046, *P* = 0.044) and number of flavours regularly used (B = 0.089, *P* = 0.038) were associated with complete smoking abstinence in this population of dedicated long-term vapers, while age, education level and smoking duration were not associated with smoking abstinence.

5. Discussion

This is the first survey that specifically focused on the issue of flavours and their impact in EC use. A substantial number of dedicated EC consumers participated; they reported that flavours play an important role in their EC use experience and in reducing cigarette consumption and craving, while the number of flavours regularly used was independently associated with complete smoking abstinence in this population.

The availability of a variety of flavours has been a controversial issue since the initial appearance of ECs to the market. Most companies offer a variety of flavours, from those resembling tobacco to a large number commonly used in the food industry. Public health authorities have raised concerns about this issue, and several statements have been released suggesting flavours could attract youngsters [8,11,12]. Such concerns are probably rooted back to the marketing of the tobacco industry for flavoured tobacco cigarettes. Internal industry documents and published surveys indicated that flavoured tobacco products are more appealing to youngsters and may be a gateway to maintaining smoking as a long term habit, while use by adults was quite low [13–16]. This is the main reason why the FDA decided to implement a ban on characteristic flavours in tobacco cigarettes [17]. It was expected that such concerns would be raised for ECs, although current vapers are overwhelmingly adults. Anecdotal evidence from EC consumers' internet forums and results from surveys [10] have shown that different flavours are very popular among dedicated users. The results of this survey confirm previous observations by finding that dedicated users switch between flavours frequently and the variability of flavours plays an important role both in reducing cigarette craving and in perceived pleasure. Moreover, the number of flavours used was associated with smoking cessation. Therefore, flavours variability is needed to support the demand by current vapers, who are in their vast majority adults. This survey also indicated that there is a switch in flavours preference of EC consumers; tobacco is the preferred flavour when initiating EC use, probably because smokers are used to this flavour and feel the need to use something that resembles their experience from smoking. However, different choices are made as time of use progresses. This may be a way to distract them from the tobacco flavour in order to reduce smoking craving; alternatively, it could indicate that they just don't need the tobacco flavour any more, but feel the desire to experiment with new flavours. In some cases, tobacco flavour may even become unpleasant, especially in those who have completely quit smoking. The improvement in olfactory and gustatory senses in these people can lead to both more pleasure perceived from different flavours and an aversion to tobacco flavour (in a similar way that it is unpleasant for a non-smoker); the latter has been reported in EC consumers' forums (http://www.e-cigarette-forum.com/forum/polls/209041-do-you-vape-tobacco-flavors.html). Such a phenomenon may contribute to lower relapse to smoking and may prevent the EC from being a gateway to smoking; however, this should be specifically studied before making any conclusions. Finally, the issue of taste buds "tolerance", which is anecdotally mentioned by vapers, was reported by almost half of the sample as a reason to switch between flavours, although it is most probably a type of olfactory rather than gustatory tolerance.

Besides information on the use of flavourings, this survey provides information on other issues related to EC use. A small minority of participants were using first generation cigarette-like devices. This has been observed in other surveys [10]. There was a higher prevalence of third-generation devices used in the subgroup of former smokers compared to current smokers. Such devices have the ability to provide higher energy to the atomiser, thus producing more vapour and delivering more pleasure to the user [18,19]. Until now, two randomised studies evaluating the efficacy of EC use in smoking cessation have used first-generation cigarette-like devices [20,21]. It is possible that newer generation devices may be more effective in substituting smoking, and this should be evaluated in future studies. Additionally, former smokers were using lower nicotine-concentration liquids compared to current smokers. It has been observed from previous studies that EC users who have completely substituted smoking try to gradually reduce their nicotine use [18]. Despite that, only 2.8% of former smokers were using 0-nicotine liquids at the time of survey participation, indicating that nicotine is important in smoking abstinence and that EC consumers remain long-term nicotine users. However, the possibility that several vapers may quit EC use shortly after switching to non-nicotine liquids cannot be excluded; such users would not participate to this survey, therefore overestimating the significance of nicotine on EC use. Finally, we observed a male predominance in participation to this survey, which is in line with previous studies [10,18]. In this survey, males were more likely to have completely quit smoking. Further studies are needed to explore this phenomenon and define whether females are less successful in smoking cessation with EC use, are less motivated long-term users or use ECs in the short term as smoking substitutes.

There are some limitations applicable to this study. The survey was announced and promoted in popular EC websites. Therefore, it is expected that dedicated users with positive experience with ECs would mainly participate, and the high proportion of former smokers confirms this. However, it is important to evaluate the patterns of use in smokers who have successfully quit smoking, since this can provide health officials with information on how to educate smokers into using ECs, especially during the initial period of use. Although a significant proportion stated that flavours play a major role in reducing or quitting smoking, this study was not designed to evaluate whether variability of flavours may promote smoking cessation in the general population; moreover our sample is not representative of the general population of smokers, who are generally less educated compared to the population evaluated here [22]. This should be evaluated in a randomised study. Finally, although the fact that flavours are important for existing EC users provides sufficient explanation for their current marketing, it does not exclude the possibility that they may also attract youngsters. However, currently available evidence indicates that regular use of ECs by non-smoking adults or youngsters is very limited [23–25]; thus, any restriction of flavours for the reason of protecting youngsters is currently not substantiated by evidence and no public health benefit would be derived. On the contrary, such a measure could have a negative impact and cause harm in current vapers, who are reporting that they enjoy flavours and that restrictions would make smoking reduction or cessation more difficult and would increase cigarette craving. Therefore, it would be more realistic and valuable to promote restrictions to the use of ECs by youngsters and to properly inform the public that ECs should be used only by smokers as a method to reduce cigarette consumption or completely substitute smoking.

6. Conclusions

The results of this survey indicate that EC liquid flavourings play a major role in the overall experience of dedicated users and support the hypothesis that they are important contributors in reducing or eliminating smoking consumption. This should be considered by the health authorities; based on the current minimal adoption of ECs by youngsters, it is reasonable to support that any proposed regulation should ensure that flavourings are available to EC consumers while at the same time restrictions to the use by youngsters (especially non-smokers) should be imposed in order to avoid future penetration of EC use to this population.

Acknowledgements

We would like to thank E-Cigarette Research Advocates Group for promoting the survey in their website (www.ecigarette-research.com). This is a non-profit group of electronic cigarette users with no relation to the electronic cigarette or other industry. The website does not promote or present any electronic cigarette product and do not accept any advertisements. The sole purpose of the group is to inform about research conducted on electronic cigarettes. Konstantinos E. Farsalinos has been allowed to present studies and post comments concerning electronic cigarette research on this website, without providing or receiving any form of payment. We would also like to thank all other websites and internet forums for promoting the survey and encouraging electronic cigarette users to participate. None of the websites promoting the survey had any access to the data collected from participants. No funding was received for this study.

Conflicts of Interest

The authors declare no conflict of interest.

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From:	mailinglist@capitol.hawaii.gov
Sent:	Monday, March 31, 2014 1:25 PM
To:	FINTestimony
Cc:	sean@blacklavavape.com
Subject:	Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Sean Anderson	Black Lava Vape	Oppose	No

Comments: Hi, my name is Sean Anderson. I own Black Lava Vape in Kona. I am writing in opposition to classifying E-cig's as Tobacco. Simply put, E-cig's contain no tobacco, so by definition it can't be classified as something that it's not, or isn't contained in what you are trying to classify. To classify something as a specific product, I would think it has to contain that specific product. I ask that you do exactly what common sense would dictate. Please remove from the bill or vote no on classifying e-cigarettes as something it's not. Tobacco.

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finance1

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Sent:	Sunday, March 30, 2014 8:47 PM
To:	FINTestimony
Cc:	chevyriderhhh@gmail.com
Subject:	*Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/30/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Chris Wells	Individual	Oppose	No

Comments:

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To: FINTestimony
Cc: jjw333333@gmail.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/30/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Jake J. Watkins	Individual	Oppose	No

Comments: This ban is completely unfair. Where's the evidence?!?

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finance1

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To: FINTestimony
Cc: konaking@live.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Jeff Stevens	Individual	Oppose	No

Comments:

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finance1

From:	mailinglist@capitol.hawaii.gov
Sent:	Monday, March 31, 2014 5:03 AM
To:	FINTestimony
Cc:	brianportal808@gmail.com
Subject:	Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Brian Santiago	Individual	Oppose	No

Comments: There's nothing dangerous in electronic cigarette smoke. This bill 2495 is hateful, pure and simple.

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From: mailinglist@capitol.hawaii.gov
Sent: Sunday, March 30, 2014 7:53 PM
To: FINTestimony
Cc: fred@ejlounge.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/30/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Fred Remington	Individual	Oppose	No

Comments: This is ridiculous. It's vapor. Doesn't hurt or harm anyone.

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finance1

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 10:00 AM
To: FINTestimony
Cc: susanlarson78@gmx.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Susan Larson	Individual	Oppose	No

Comments:

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Chair Luke, Vice Chairs Nishimoto and Johanson, and Members of the Committee,

Thank you for the opportunity to speak STRONGLY AGAINST SB2495 SD3 HD1, enacting a blanket ban on indoor vaping (aka electronic cigarettes) and classifying vaping as "smoking."

This bill would have significant negative effects on vaping, which is a public health breakthrough. Hawaii only stands to lose financially by enacting any kind of ban on vaping, and classifying vaping as "smoking" would leave it open to nearly unlimited regulatory attacks.

An indoor ban is not supported by scientific evidence. There is essentially no scientific evidence of harm from vaping, both to the users and bystanders. This is a totally different thing from tobacco smoke and represents one of the greatest public health breakthroughs of our time. Smoking bans were enacted to protect workers of establishments that allow smoking – there is no harm to protect workers from with vapor. I have attached a study showing that vapor is no worse than outdoor air in major US cities.

There are no known health costs, only benefits. Vapor, having no evidence of harm, thus has no evidence of health costs. However, insomuch as vaping often replaces smoking, it can **reduce** health costs. Forcing vapers into the same areas as smokers would tend to compromise the smoking cessation potential of vaping.

State income would be lost. There is a large and increasing number of Hawaii businesses engaged in this industry. This includes retail shops, vapor lounges and manufacturers. All of these businesses generate General Excise tax revenue. An indoor ban would have a negative impact on business, and in the case of vapor lounges, would destroy the businesses entirely, thus reducing tax benefit.

Businesses would lose opportunities to benefit. Businesses currently can set their own policies on vaping. Allowing vaping by employees can improve productivity by cutting out the need for smoke breaks. Allowing vaping by employees can reduce health costs by reducing smoking. Businesses would lose these options under this bill.

The current state of law is enough. Vaping is not a protected activity, so businesses, organizations and governmental entities can set their own policies regarding vaping. This is the appropriate level of regulation, allowing the industry to grow, preserving health and business choices, and respecting individual business and organizational philosophies.

Please consider the conclusions of the attached independent, peer-reviewed study:

> **(A)ny regulatory decisions should not compromise the variability of choices for consumers and should make sure that ECs are more easily accessible compared with their main competitor, the tobacco cigarette. Consumers deserve, and should make, informed decisions and research will definitely promote this. In particular, current data on safety evaluation and risk assessment of ECs is sufficient enough to avert restrictive regulatory measures as a consequence of an irrational application of the precautionary principle** [Saitta et al. 2014].

> **ECs are a revolutionary product in tobacco harm reduction.** Although they emit vapor, which resembles smoke, there is literally no fire (combustion) and no 'fire' (suspicion or evidence that they may be the cause for disease in a similar way to tobacco cigarettes). Due to their unique characteristics**, ECs represent a historical opportunity to save millions of lives and significantly reduce the burden of smoking-related diseases worldwide.**

The choice is literally between hurting people and helping them. The answer should be obvious. Thank you for your time.

P. Kuromoto, Honolulu, HI

A Comparison of Electronic Cigarette Emissions With Those of Human Breath, Outdoor Air, and Tobacco Smoke

John Madden
Ecigarette Reviewed
February 20th, 2014

Abstract

Background Local lawmakers across the United States have been amending their cities' smoke-free air acts to include e-cigarettes, ensuring the devices are regulated the same as tobacco cigarettes. While e-cig vapor has generally been found to be far safer than tobacco smoke with exposure to bystanders posing no apparent concern, the purpose of this paper is to compare existing data on its contaminants with those in other forms of air people may be exposed on a daily basis.

Methods Existing data on e-cigarettes was pulled from peer-reviewed studies analyzing both mainstream vapor using smoking machines and secondhand vapor generated by volunteer vapers in a cramped experimental chamber. That data was compared with particulate matter of three Los Angeles elementary schools, human breath emissions and cigarette smoke, also pulled from existing papers and studies. Threshold Limit Value (TLV) ratios were then calculated for each data point to show how each measured up to the most stringent workplace exposure standards.

Results The research used for the purpose of this paper found that electronic cigarettes contain levels of volatile organic compounds comparable to those found in human breath emissions, as many are naturally produced by the body. Most contaminants found in secondhand vapor and human breath were at levels <1% of TLV. However, isoprene was found both secondhand e-cig vapor and in human breath at levels in between 7-10% of TLV, although it wasn't detected in mainstream e-cig vapor. In n terms of trace elements (metals) found in e-cigs, levels were comparable those detected in outdoor air of a major US city. It should be noted that, outside of the reports on tobacco cigarettes used, the other three sources studied have contaminant levels well within what TLVs allow for.

Conclusions Several VOCs found in secondhand e-cig vapor are also found in human breath at similar levels. This shows that occurrence in e-cigarette vapor may be primarily a direct result of natural production by the human body. Due to variances in methods used to measure the air in each reference, comparisons can only be considered preliminary until a more uniform study is conducted. However, while passive vaping can be expected from electronic cigarette use, it may be no more injurious to human health than inhaling outdoor air or human breath emissions that occur naturally in public spaces. Further study is warranted to compare secondhand breath analysis with e-cig vapor in a crowded room using identical measurement methods. Hopefully this paper raises public awareness that e-cigarette vapor is relatively comparable to existing air in public places, especially in terms of safety.

Keywords: e-cigarettes, smoke-free air law, passive vaping, human breath, outdoor air

Background

The use of electronic cigarettes in public places has been a popular debate topic among city councils. Ordinances and amendments have passed in New York and Chicago have already voted to regulate e-cigarette usage the same way they treat tobacco smoking, meaning vaping, or use of e-cigs, is prohibited anywhere smoking isn't allowed in public places. Los Angeles city council has announced a plan to amend its own smoke-free law to include e-cigarettes, on the basis their vapor contains toxins and carcinogens. Recent studies have also found levels of lead, chromium, nickel, and nicotine in the second-hand vapor of e-cigs. Prohibiting electronic cigarette use wherever smoking is banned, Feuer contends, is necessary in order to protect bystanders from involuntary inhalation of the vapor they emit.

While recent studies on electronic cigarettes have indeed found trace elements and compounds in passive e-cig vapor, none have been detected at levels that warrant any concern to public health (Burstyn, 2014). Dr. Igor Burstyn's recent study analyzed over 9,000 observations of electronic cigarette vapor content reported in various peer reviewed and grey literature studies and concluded secondhand exposure poses no concern to bystanders. However, lawmakers seem to exclude these results from their proposals. Furthermore, they seem unaware that a high percentage of the constituents of secondhand e-cig vapor already exist in smoke-free air and can even be attributed to natural production by the human body.

The purpose of this review is to compare the results from Dr. Burstyn's analysis of e-cigarette vapor constituents with those of peer reviewed studies on other forms of air humans are exposed to on a daily basis. It is hypothesized that e-cigarette vapor, aside from its appearance, is not much more different or dangerous than the air one might already be exposed to from living in a city or eating at a crowded restaurant. If many of the same elements found in e-cigarette vapor are already present at similar levels in smoke-free air, the argument that they contaminant air in public spaces should not be used.

Materials and Methods

Literature search

In addition to having open access to a provisional PDF of Dr. Burstyn's analysis of e-cig vapor on Biomed Central (2014), references for human breath emissions, outdoor air quality and secondhand smoke were searched online and through Google Scholar. Keywords searched included "human breath emissions", "human breath vocs", "formaldehyde human breath", "los angeles vocs", new york vocs" "chicago vocs" "la air quality", "los angeles air quality", "secondhand smoke emissions", "secondhand smoke particulates", "secondhand smoke vocs", "cigarette vocs", and "environmental tobacco smoke", all with and without the search term "pdf" added. Several articles were researched but few met the criteria, explained below, in relation to the purpose of this paper. To fill in a few gaps and ensure more compatible cross-references, a few other previously researched articles on electronic cigarettes were used. In order to meet criteria for the purpose of this paper, articles needed to quantify data on either VOC emissions or inorganic compounds and metals contained in the air studied. One study was purchased through ScienceDirect (Charles, Batterman & Jia, 2007) and data from two others was accessed through reports on third-party websites. For example, formaldehyde content of secondhand e-cig vapor was not reported in the Burstyn study (2014), but it was detected by Schripp, Markewitz, Uhde, & Salthammer (2013). However the Schripp et al. paper was not purchased because the data on formaldehyde levels detected in e-cig vapor was reported by Tobacco Truth (Rodu, 2013). Likewise, data for formaldehyde emissions was reported by Moser et al. (2005) and accessed through a press release (MHARR, 2008).

Regulatory and Recommended Limit Calculations

All relevant data was imported manually into a spreadsheet, with a separate tab for each group of results. The spreadsheet included seven tabs for data entry and one tab for charts. For the study on outdoor air at three LA elementary schools (Resurrection, Central LA, the average of all three was used for volatile organic compounds. Since total suspended particulate matter for trace elements was only measured at one school (Resurrection) just those results were used.

After entering in previously reported VOC and inorganic compound results, all data was converted into either PPM or mg/m^3 if it wasn't reported as such. The lowest regulatory or recommended exposure limit for each was searched on either the OSHA (accessed Jan 30, 2014) or, in the case of Isoprene, the AIHA 2011 WEELs (accesed Jan 30, 2014) website. Lowest, or most stringent, exposure limits reported for each article in either PPM or mg/m^3.

For the Burstyn (2014) study, exposure limit ratios had already been calculated but ratios for all other groups of study results, except mainstream and sidestream cigarette smoke, were calculated in the spreadsheet for the purpose of this paper.

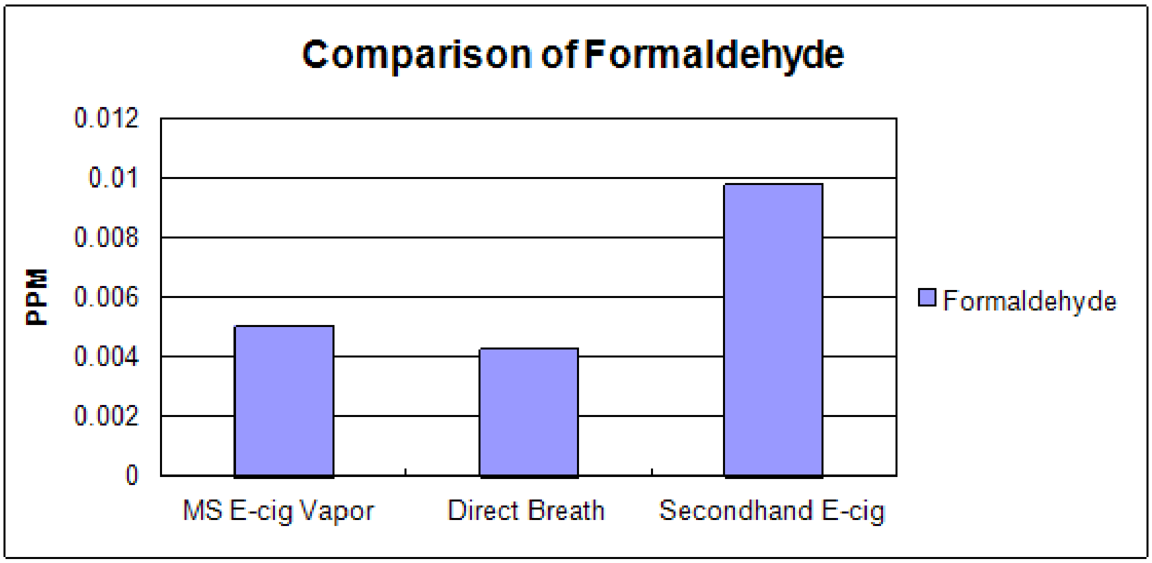
Comparison and Charts

Any relevant and comparable data was pulled into a separate tab on the spreadsheet to create charts. For elements and compounds with multiple results, the average was used for comparisons. The only problem with the comparisons was that the way human breath was measured made results directly incomparable to secondhand/passive vapor. Hence no charts were made comparing human breath solely with passive vapor. However, it could be used to show that breath combined with mainstream e-cig vapor could produce similar results to the those of passive vapor.

Results and discussion

Volatile organic compounds were found in all three sources compared. The results for formaldehyde provided an interesting comparison, as levels detected in mainstream e-cig vapor nearly matched those of human breath. Even those these results were detected in different studies, when added together they are comparable with formaldehyde levels found in secondhand vapor.

Fig. 1a



Acetone, while detected at levels below exposure limits for both mainstream e-cig vapor and human breath, was significantly higher in the latter. Results for passive vaping were actually below those of human breath.

Fig. 1b

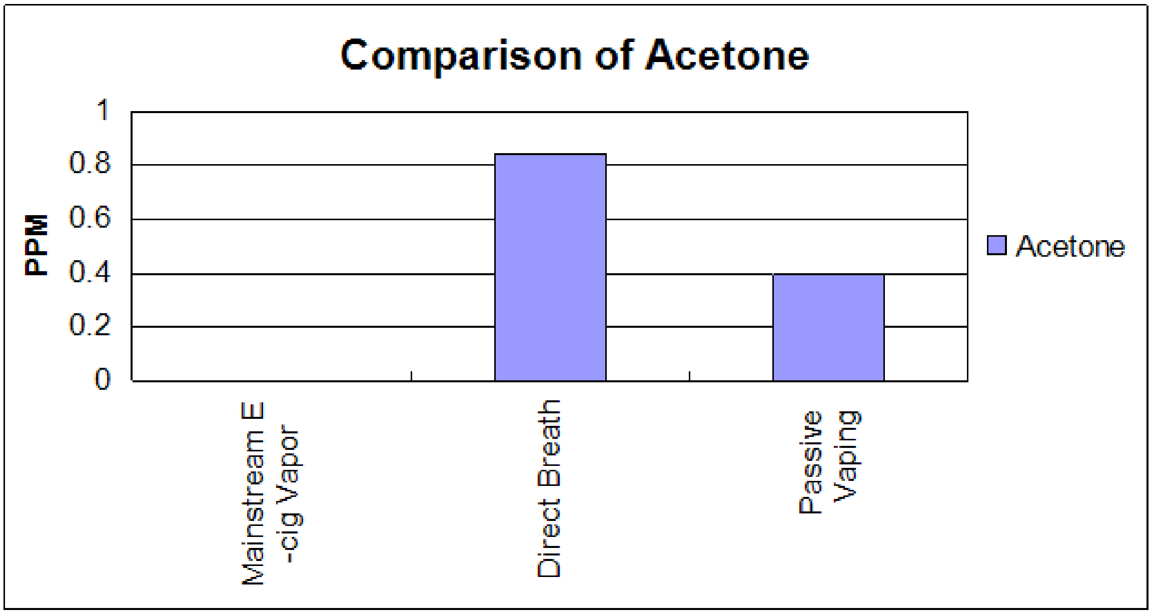
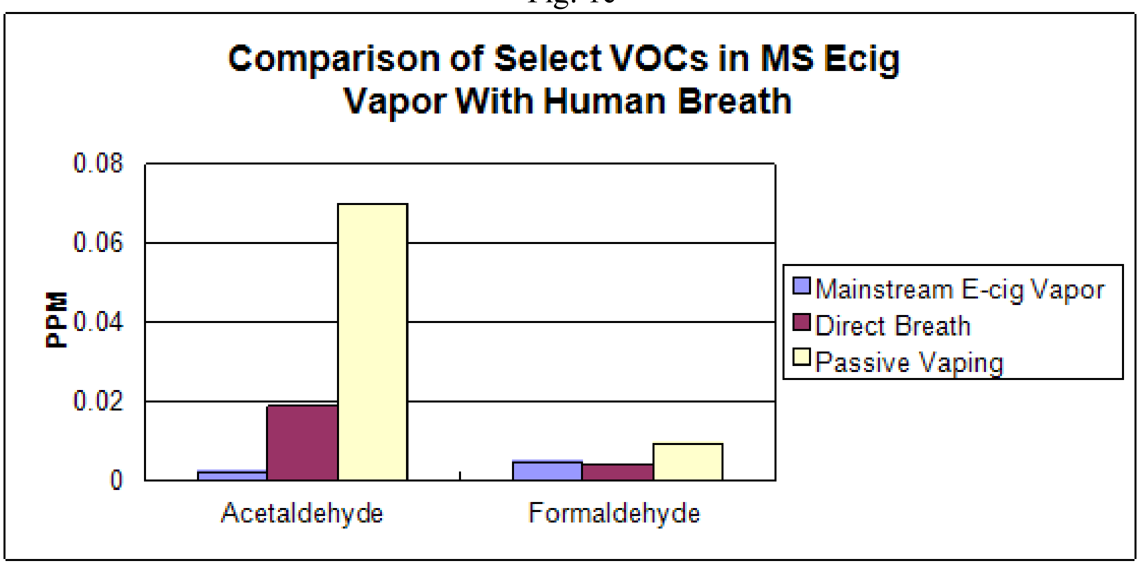


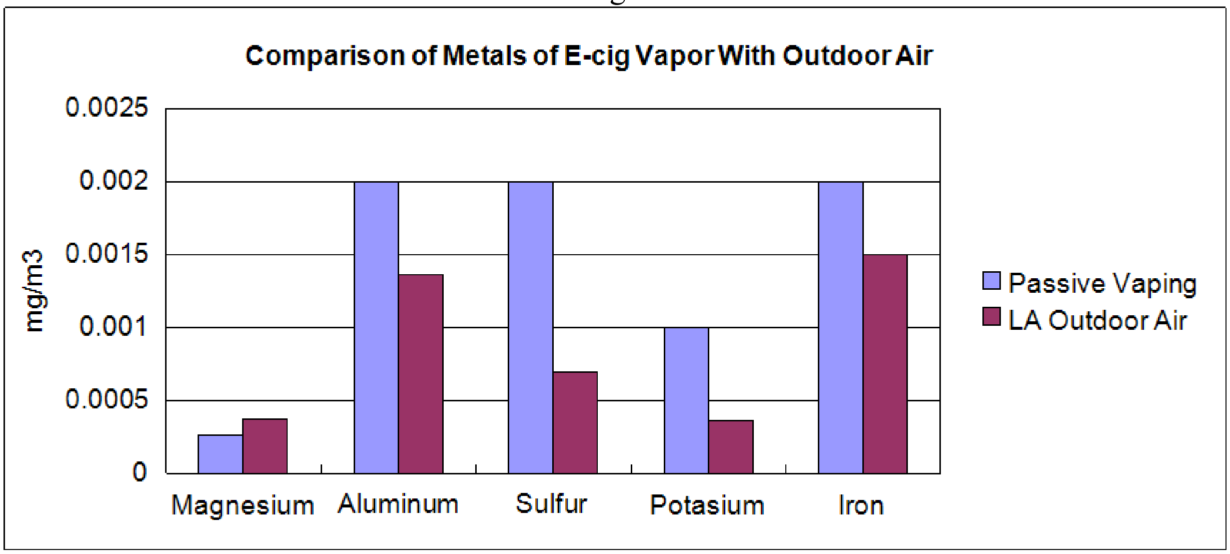
Fig. 1c



Acetaldehyde was also detected higher levels in direct human breath than in mainstream vapor. However, it was detected at significantly higher levels in passive vaping than in human breath. But in terms of exposure limits, all were well under 1%.

Figure 2 below shows comparisons of trace elements found in e-cig vapor with the same detected in Los Angeles outdoor air at Resurrection Catholic School in Boyle Heights. All trace elements found in both sources were at levels below .002mg/m^3 and well within exposure limits.

Fig 2


Comparison of Metals of E-cig Vapor With Outdoor Air
0.0025
0.002
0.0015
0.001
0.0005
0
mg/m3
Magnesium
Aluminum
Sulfur
Potasium
Iron
Passive Vaping
LA Outdoor Air

Tables

Volatile Organic Compounds

Table 1a: MS Exposure predictions based on analysis of e-cigarette aerosols generated by smoking machines

Compound	Estimated concentration in personal breathing zone: PPM	Estimated concentration in personal breathing zone: mg/m³	Most Stringent Limit (PPM)	Most Stringent Limit (mg/m³)	Ratio of most stringent TLV (%): Calculated directly	Ratio of most stringent TLV (%): Safety factor 10
Acetaldehyde	0.005		25		0.02	0.2
	0.003		25		0.01	0.1
	0.001		25		0.004	0.04
	0.00004		25		0.0001	0.001
	0.0002		25		0.001	0.01
	0.001		25		0.004	0.04
	0.008		25		0.03	0.3
Acetone	0.002		250		0.0003	0.003
	0.0004		250		0.0001	0.001
Acrolein	0.001		0.1		1	13
	0.002		0.1		2	20
	0.006		0.1		6	60
Butanal	0.0002		25		0.001	0.01
Crotonaldehyde		0.0004		0.86	0.01	0.1
Formaldehyde	0.002		0.3		0.6	6
	0.008		0.3		3	30
	0.006		0.3		2	20
	0.00024		0.3		<0.1	<1
	0.0003		0.3		0.1	1
	0.01		0.3		4	40
	0.009		0.3		3	30
Glyoxal		0.002		0.1	2	20
		0.006		0.1	6	60
o-Methylbenzaldehyde		0.001		0.5	0.05	0.5
p,m-Xylene		0.00003		434	0.001	0.01
Propanal	0.002		20		0.01	0.1
	0.0006		20		0.002	0.02
	0.0005		20		0.02	0.2
Toluene	0.0001		10		0.003	0.03
Valeraldehyde		0.0001		175	0.0001	0.001

Resource: http://www.biomedcentral.com/content/pdf/1471-2458-14-18.pdf

Table 1b: Environmental Exposure predictions for volatile organic compounds based on analysis of aerosols generated by volunteer vapers

Compound	Estimated concentration in personal breathing zone (PPM)	Most Stringent Limit (PPM)	Ratio of most stringent Exposure Limit (%)		Ref.
			Calculated directly	Safety factor 10	
2-butanone (MEK)	0.04	200	0.02	0.2	[1]
	0.002	200	0.007	0.07	
2-furaldehyde	0.01	2	0.7	7	
Acetaldehyde	0.07	25	0.3	3	
Acetic acid	0.3	10	3	30	
Acetone	0.4	250	0.2	2	
Acrolein	<0.001	0.1	<0.7	<7	
Benzene	0.02	0.5	3	30	
Butyl hydroxyl toluene	0.00004	1	0.002	0.02	
Isoprene*	0.1	2	7	70	
Limonene	0.009	30	0.03	0.3	
	0.00002	30	0.000001	0.00001	
m,p-Xyelen	0.01	100	0.01	0.1	
Phenol	0.01	5	0.3	3	
Propanal	0.004	20	0.01	0.1	
Toluene	0.01	10	0.07	0.7	
Formaldehyde	0.00978	0.3	3.26	32.6	[2]
Alkaloids					
Nicotine	0.0005	0.075	0.66	6.6	[3]

1. http://www.biomedcentral.com/content/pdf/1471-2458-14-18.pdf
2. http://onlinelibrary.wiley.com/doi/10.1111/j.1600-0668.2012.00792.x/abstract
3. http://ntr.oxfordjournals.org/content/early/2013/12/10/ntr.ntt203.short

* Limit 2 ppm per 8 hrs established by AIHA WEELs

Tables 1a and 1b show the results from Dr. Igor Burstyn's (2014) study on electronic cigarette vapor. The first table shows levels of mainstream volatile organic compounds detected by smoke machines while the second shows levels of VOCs detected in passive vapor generated by volunteer vapers. Formaldehyde wasn't reported for passive vaping by Burstyn but it had been previously measured by Schripp et al. (2012) at 12 ug/m^3, or .00978 ppm. Table 1b also shows measurement of nicotine detected in passive vapor in the Czogala et al. (2013) study.

Table 2: Concentrations of VOCs in Exhaled Human Breath

	Weighted Average		Most Stringent Limit[2]	Ratio of most stringent Limit		
Compound	ppm	mg/m3	ppm	Percentage	Safety Factor 10	Ref
Acetaldehyde	0.019	0.035	25	0.076	0.76	[1]
Acetone	0.84	2.30	250	0.336	3.36	
Butanone	0.016	0.047	200	0.008	0.08	
1-Butene	0.063	0.14	250	0.0252	0.252	
Dimethyl Sulfide	0.012	0.03	10	0.12	1.2	
Ethanol	0.77	1.40	1,000	0.077	0.77	
Ethyl Acetate	0.017	0.062	400	0.00425	0.0425	
Ethylene	0.023	0.026	200	0.0115	0.115	
Formaldehyde	0.0043	0.00528	0.3	1.43	14.33	[2]
Furan	0.014	0.039	None	n/a	n/a	[1]
Hexanal	0.011	0.045	None	n/a	n/a	
Isoprene*	0.21	0.59	2	10.5	105	
Isopropanol	0.15	0.37	200	0.075	0.75	
Methanol	0.33	0.43	200	0.165	1.65	
Methyl Ethyl Ketone	0.01	0.029	200	0.005	0.05	
Pentane	0.012	0.035	120	0.01	0.1	
1-Pentene	0.021	0.06	None	n/a	n/a	
n-Propanol	0.13	0.32	100	0.13	1.3	

1. http://www.tandfonline.com/doi/pdf/10.1080/10473289.1999.10463831
2. http://www.businesswire.com/news/home/20080404005660/en/

* Limit 2 ppm per 8 hrs established by AIHA WEELs

Table 2 shows the concentrations of volatile organic compounds detected in the Fenske & Paulson (1999) study. Formaldehyde levels were taken from a 2005 Moser et al. study and reported in a MHARR press release (2008). Isoprene levels detected from direct breath readings are actually pushing exposure safety, however when calculated for various enclosed public spaces (p. 596) they fall safely within limits.

Table 3: Concentrations of VOCs in Outdoor Air at Three LA Measuring Sites

Compound	Average found in air of 3 LA measuring sites (PPM)	Most Stringent Limit[1] (PPM)	Ratio of Most Stringent Limit	
			Percent	Safety Factor 10
Toluene	0.00124	10	0.0124	0.124
m+p-xylenes	0.00064	100	0.00064	0.0064
Benzene	0.00042	0.5	0.084	0.84
Methylene Chloride	0.00056	25	0.00224	0.0224
2-butanone	0.00065	200	0.000325	0.00325
o-xylene	0.00022	100	0.00022	0.0022
Ethylbenzene	0.00018	20	0.0009	0.009
1,3-butadiene	0.00008	1	0.008	0.08
Acetone	0.00684	250	0.002736	0.02736
Formaldehyde	0.0032	0.3	1.067	10.667
Acetaldehyde	0.0014	25	0.0056	0.056

Reference: http://www.aqmd.gov/tao/AQ-Reports/Resurrection_Catholic_School_Study.pdf

Table 3 reflects averages of volatile organic compounds captured using a gas chromatograph-mass spectrometer at three Los Angeles testing sites (Resurrection, Rubidoux and Central LA). All are well within recommended and regulatory limits.

Table 6 below contains the levels (in micrograms per cubic meter) of VOCs found in environmental tobacco smoke (ETS) from an IARC Monographs study (2004) and Schripp (2013). These make up just a small fraction of the contaminants found in secondhand cigarette smoke. Nicotine, an alkaloid, is shown at the bottom of the table.

Table 6: VOC Levels of ETS

VOC	Cigarette Emissions (µg/m3)	PPM	PPB	Most Stringent Limit (PPM)	Ratio of Most Stringent Limit: Percentage	Ratio of Most Stringent Limit: Safety Factor 10
Formaldehyde	143	0.117	117	0.3		
Benzene	30	0.00939	9.39	0.5	1.878	18.78
Toluene	54.5	0.01446	14.46	10	0.14	1.45
1,3-Butadiene	40	0.01808	18.08	1	1.81	18.08
Acetaldehyde	268	0.149	149	25	0.60	5.96
Isoprene	657	0.236	236	2		
Styrene	10	0.00235	2.35	20	0.01	0.12
Catechol	1.24	0.00028	0.28	5	0.01	0.06
3-Ethenyl pyridine	37.1	0.00863	8.63	Not listed	n/a	n/a
Ethylbenzene	8.5	0.00196	1.96	20	0.01	0.10
Pyridine	23.8	0.00736	7.36	1	0.74	7.36
Limonene	29.1	0.00522	5.22	30	0.02	0.17
Phenol	16.7	0.00434	4.34	5	0.09	0.87
m, p-xylene	28	0.00415	4.15	100	0.004	0.04
Acetone	64	0.02694	26.9	250	0.01	0.11
2-Butanone	19	0.00644	6.44	200	0.003	0.03
2-Furaldehyde	21	0.00534	5.34	2	0.27	2.67
Propanal	12	0.00488	4.88	20	0.02	0.24
Acetic Acid	68	0.02769	27.69	10	0.28	2.77
Alkalines						
Nicotine	90.8	0.01368	13.68	0.075	18.24	182.40

Inorganic Compounds

Table 4: Exposure predictions based on analysis of aerosols generated by smoking machines: Inorganic Compounds

Element quantified	Assumed compound containing the element for comparison with TLV	Estimated concentration in personal breathing zone (mg/m3)	Most Stringent Limit (mg/m^3)	Ratio of most stringent TLV (%)	
				Calculated directly	Safety factor 10
Aluminum	Respirable Al metal & insoluble compounds	0.002	10	0.2	2
Barium	Ba & insoluble compounds	0.00005	0.5	0.01	0.1
Boron	Boron oxide	0.02	10	0.1	1
Cadmium	Respirable Cd & compounds	0.00002	0.002	1	10
Chromium	Insoluble Cr (IV) compounds	3.00E-05	0.0002	0.3	3
Copper	Cu fume	0.0008	0.1	0.4	4
Iron	Soluble iron salts, as Fe	0.002	1	0.02	0.2
Lead	Inorganic compounds as Pb	7.00E-05	0.00015	0.1	1
		0.000025	0.00015	0.05	0.5
Magnesium	Inhalable magnesium oxide	0.00026	10	0.003	0.03
Manganese	Inorganic compounds, as Mn	8.00E-06	0.02	0.04	0.4
Nickel	Inhalable soluble inorganic compounds, as Ni	2.00E-05	0.015	0.02	0.2
		0.00005	0.015	0.05	0.5
Potassium	KOH	0.001	2	0.1	1
Tin	Organic compounds, as Sn	0.0001	0.1	0.1	1
Zinc	Zinc chloride fume	0.0004	1	0.04	0.4
Zirconium	Zr and compounds	3.00E-05	5	0.001	0.01
Sulfur	SO_2	0.002	0.25	0.3	3

Reference: http://www.biomedcentral.com/content/pdf/1471-2458-14-18.pdf

Table 4a shows the levels of inorganic compounds and metals from mainstream e-cig vapor detected in Burstyn's (2014) study. Again, all are well within exposure limits.

Table 5: Average Levels of Trace Elements in TSP at Resurrection Catholic School

Compound	Average found in TSP of Ressurection school (mg/m3)	Most Stringent Limit (mg/m3)	Ratio of Most Stringent Limit	
			Percent	Safety Factor 10
Magnesium	0.00037	10	0.0037	0.037
Aluminum	0.00136	10	0.0136	0.136
Silicon	0.00184	5	0.0368	0.368
Sulfur	0.00069	0.25	0.276	2.76
Potasium	0.00036	2	0.018	0.18
Calcium	0.00102	2	0.051	0.51
Iron	0.0015	1	0.15	1.5
Hexavalent Chromium	0.00000011	0.0002	0.055	0.55

Table 5 shows levels of trace elements detected in air at Resurrection Catholic School in the Boyle Heights area of Los Angeles. Five of these elements were comparable to levels of inorganic compounds detected in mainstream e-cig vapor. Levels of trace elements were not reported for human breath.

Fig 3

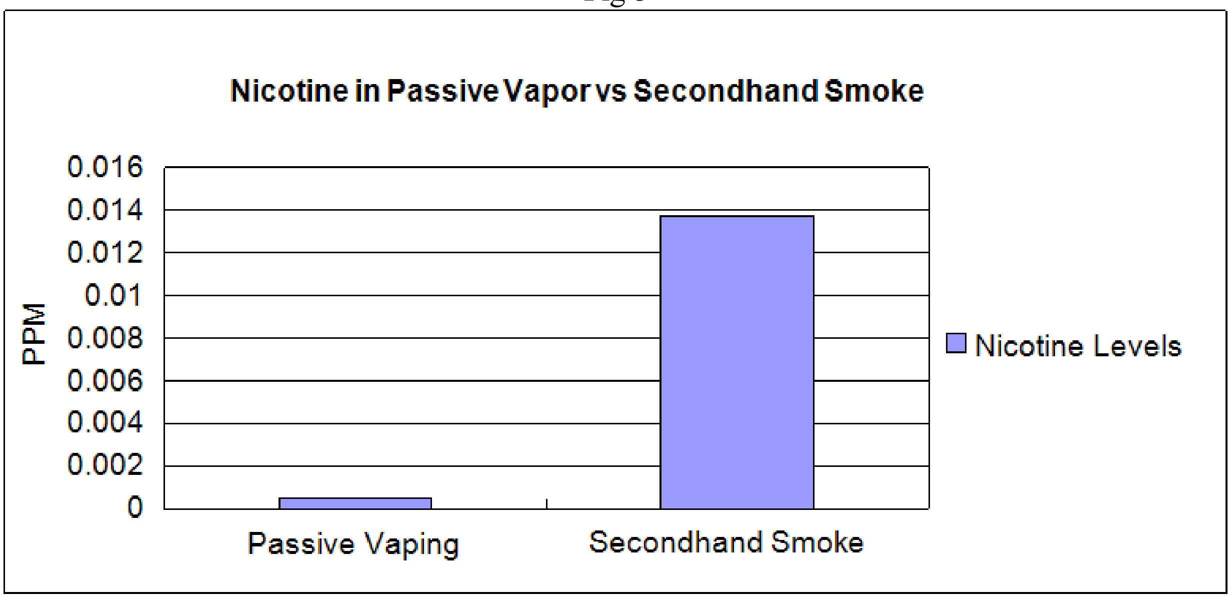


Figure 3 compares the levels of nicotine contained in passive vapor with those of secondhand smoke. Nicotine levels in ETS are ten times are 20 times more than they are in secondhand vapor. Further research is needed to assess nicotine levels of passive vaping from e-liquids with variety of nicotine strengths and from using different types of devices. However, the nicotine detected in secondhand vapor for the purpose of this study is significantly less than that of environmental tobacco smoke.

Conclusion

Prior to conducting research, it was hypothesized that volatile organic compounds of city outdoor air would be comparable to those of e-cigarette vapor, due to automobile, factory and other emission waste. However, results showed that it was the levels of metals detected in outdoor air that were actually more comparable to those of e-cig vapor. VOCs were still detected in the air of three measuring stations in Los Angeles, just not at significant levels in relation to this study.

On the contrary, VOCs detected on human breath were not only comparable to those of e-cigarette vapor, they provide a primary source for many of the chemicals found in the latter. In both indoor and outdoor public spaces, electronic cigarettes will not be the only source of air contamination. The human body emits many of the same volatile organic compounds, while outdoor air can contain many of the same trace elements found in e-cigarette vapor.

In terms of nicotine, secondhand smoke contains significantly more nicotine than passive vapor. In fact, while passive vapor has levels of nicotine well within both required and recommended exposure limits, those of ETS exceed these limits when calculating for a safety factor of 10. So while passive vapor has considerable differences with ETS, or secondhand smoke, it shares many similarities with air contaminants from sources that already exist in public places. It would be wise to consider this when drafting ordinances that single out e-cigarettes on the basis that they contain "harmful chemicals".

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Link to summary of this paper:

http://ecigarettereviewed.com/contaminants-in-e-cig-vapor-found-in-human-breath-and-outdoor-air

Therapeutic Advances in Drug Safety
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Safety evaluation and risk assessment of electronic cigarettes as tobacco cigarette substitutes: a systematic review

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Safety evaluation and risk assessment of electronic cigarettes as tobacco cigarette substitutes: a systematic review

Konstantinos E. Farsalinos and Riccardo Polosa

***Abstract*:** Electronic cigarettes are a recent development in tobacco harm reduction. They are marketed as less harmful alternatives to smoking. Awareness and use of these devices has grown exponentially in recent years, with millions of people currently using them. This systematic review appraises existing laboratory and clinical research on the potential risks from electronic cigarette use, compared with the well-established devastating effects of smoking tobacco cigarettes. Currently available evidence indicates that electronic cigarettes are by far a less harmful alternative to smoking and significant health benefits are expected in smokers who switch from tobacco to electronic cigarettes. Research will help make electronic cigarettes more effective as smoking substitutes and will better define and further reduce residual risks from use to as low as possible, by establishing appropriate quality control and standards.

Keywords: electronic cigarettes, e-liquid, e-vapor, harm reduction, nicotine, safety, tobacco

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Introduction

Complete tobacco cessation is the best outcome for smokers. However, the powerful addictive properties of nicotine and the ritualistic behavior of smoking create a huge hurdle, even for those with a strong desire to quit. Until recently, smokers were left with just two alternatives: either quit or suffer the harmful consequences of continued smoking. This gloomy scenario has allowed the smoking pandemic to escalate, with nearly 6 million deaths annually and a predicted death toll of 1 billion within the 21st century [World Health Organization, 2013]. But a third choice, involving the use of alternative and much safer sources of nicotine with the goal to reduce smoking-related diseases is now available: tobacco harm reduction (THR) [Rodu and Godshall, 2006].

Electronic cigarettes (ECs) are the newest and most promising products for THR [Polosa *et al.* 2013b]. They are electrically-driven devices consisting of the battery part (usually a lithium battery), and an atomizer where liquid is stored and is aerosolized by applying energy and generating heat to a resistance encircling a wick. The liquid used mainly consists of propylene glycol, glycerol, distilled water, flavorings (that may or may not be approved for food use) and nicotine. Consumers (commonly called 'vapers') may choose from several nicotine strengths, including non-nicotine liquids, and a countless list of flavors; this assortment is a characteristic feature that distinguishes ECs from any other THR products. Since their invention in 2003, there has been constant innovation and development of more efficient and appealing products. Currently, there are mainly three types of devices available [Dawkins, 2013], depicted in Figure 1. (1) First-generation devices, generally mimicking the size and look of regular cigarettes and consisting of small lithium batteries and cartomizers (i.e. cartridges, which are usually prefilled with a liquid that bathes the atomizer). Batteries may be disposable (to be used once only) or rechargeable. (2) Second-generation devices, consisting mainly of higher-capacity lithium batteries and atomizers with the ability to refill them with liquid (sold in separate bottles). In the most recent atomizers you can simply change the atomizer head (resistance and wick) while keeping the body of the atomizer, thus reducing the operating costs. (3) Third-generation devices (also called 'Mods', from modifications),

Figure 1. Examples of electronic cigarette devices currently available on the market.

consisting of very large-capacity lithium batteries with integrated circuits that allow vapers to change the voltage or power (wattage) delivered to the atomizer. These devices can be combined with either second-generation atomizers or with rebuildable atomizers, where the consumers have the ability to prepare their own setup of resistance and wick.

Awareness and use (vaping) of ECs has increased exponentially in recent years. Data obtained from the HealthStyles survey showed that, in the US, awareness of ECs rose from 40.9–57.9% from 2010 to 2011, with EC use rising from 3.3–6.2% over the same time period [King *et al.* 2013]. In the United Kingdom, EC use in regular smokers increased from 2.7% in 2010 to 6.7% in 2012 [Dockrell *et al.* 2013]. Similar findings were obtained from the International Tobacco Control Four-Country Survey [Adkison *et al.* 2013]. A recent prospective study in Swiss army recruits showed that 12% of smokers who tried ECs progressed to daily use [Douptcheva *et al.* 2013]. It must be noted that this increase in EC use has occurred despite the concerns raised by public health authorities about the safety and appropriateness of using these products as alternatives to smoking [National Association of Attorneys General, 2013; Food and Drug Administration, 2009; Mayers, 2009].

The popularity of ECs may be due to their ability to deal both with the physical (i.e. nicotine) and the behavioral component of smoking addiction. In particular, sensory stimulation [Rose and Levin, 1991] and simulation of smoking behavior and cigarette manipulation [Hajek *et al.* 1989] are important determinants of a product's effectiveness in reducing or completely substituting smoking. These features are generally absent in nicotine replacement therapies (NRTs) and oral medications for nicotine dependence, whereas ECs are unique in that they provide rituals associated with smoking behavior (e.g. hand-to-mouth movement, visible 'smoke' exhaled) and sensory stimulation associated with it [Farsalinos *et al.* 2013b]. This explains why these products can be effective in reducing consumption of tobacco smoking [Bullen *et al.* 2013; Caponnetto *et al.* 2013b; Polosa *et al.* 2011] and are efficient as long-term substitutes of conventional cigarettes [Farsalinos *et al.* 2013b].

Methods

For this systematic review (Figure 2), we searched the PubMed electronic database by using keywords related to ECs and/or their combination (e-cigarette, electronic cigarette, electronic nicotine delivery systems). We obtained a total of 354 results, and selected 41 studies we judged relevant to research on EC safety/risk profile. Reference lists from these studies were also examined to identify relevant articles. We searched additional information in abstracts presented at scientific congresses (respiratory, cardiovascular, tobacco control, toxicology), and in reports of chemical analyses on EC samples that were available online. We also looked for selected studies on chemicals related to EC ingredients (e.g. nicotine, propylene glycol, glycerol, cinnamaldehyde, microparticles emission, etc.), but not specifically evaluated in EC research. In total, 97 publications were found, from which 15 chemical analyses of single or a limited number of EC samples were excluded because they were discussed in a review paper [Cahn and Siegel, 2011]. In total, 114 studies are cited in this paper.

Risk differences compared with conventional cigarettes and the issue of nicotine

Conventional cigarettes are the most common form of nicotine intake. Smoking-related diseases are pathophysiologically attributed to oxidative stress, activation of inflammatory pathways and the toxic effect of more than 4000 chemicals and carcinogens present in tobacco smoke [Environmental Protection Agency, 1992]. In addition, each puff contains $>1 \times 10^{15}$ free radicals [Pryor and Stone, 1993]. All of these chemicals are emitted mostly during the combustion process, which is absent in ECs. Although the addictive potential of nicotine and related compounds is largely documented [Guillem *et al.*

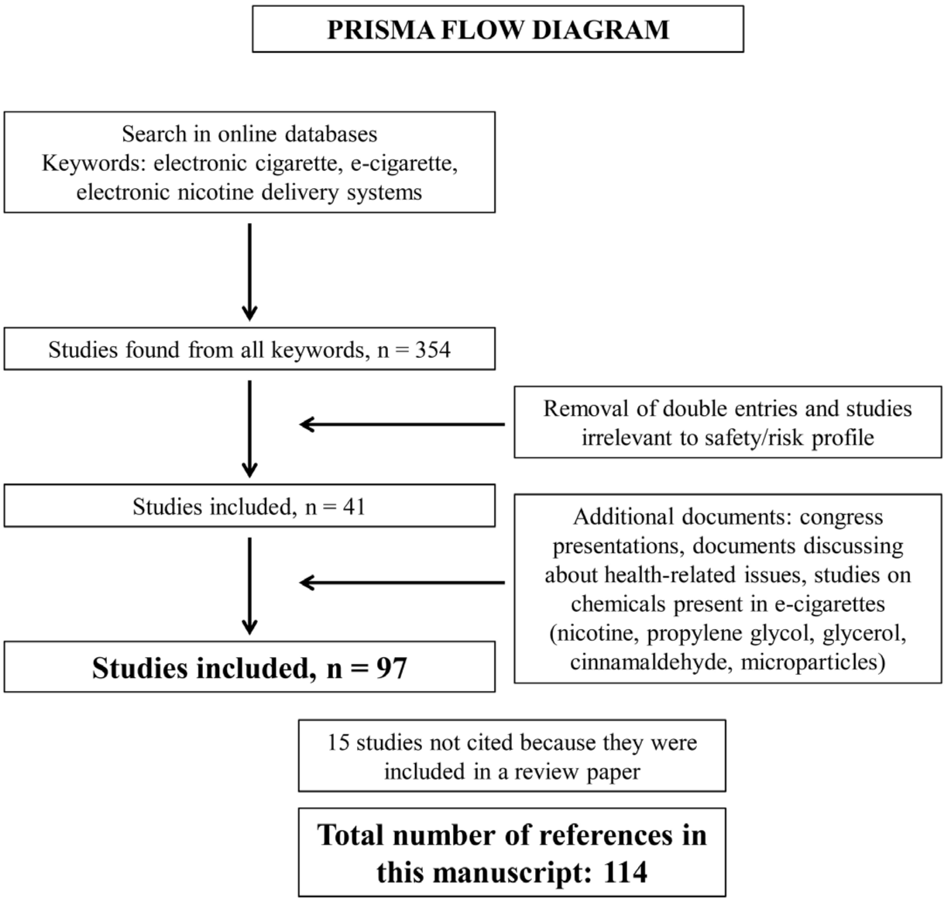

Figure 2. Methodology for literature research and selection of studies.

2005], much less dissemination has been given to the notion that nicotine does not contribute to smoking-related diseases. It is not classified as a carcinogen by the International Agency for Research on Cancer [WHO-IARC, 2004] and does not promote obstructive lung disease. A major misconception, commonly supported even by physicians, is that nicotine promotes cardiovascular disease. However, it has been established that nicotine itself has minimal effect in initiating and promoting atherosclerotic heart disease [Ambrose and Barua, 2004]. It does not promote platelet aggregation [Zevin *et al.* 1998], does not affect coronary circulation [Nitenberg and Antony, 1999] and does not adversely alter the lipid profile [Ludviksdottir *et al.* 1999]. An observational study of more than 33,000 smokers found no evidence of increased risk for myocardial infarction or acute stroke after NRT subscription, although follow up was only 56 days [Hubbard *et al.* 2005]. Up to 5 years of nicotine gum use in the Lung Health Study was unrelated to cardiovascular diseases or other serious side effects [Murray *et al.* 1996]. A meta-analysis of 35 clinical trials found no evidence of cardiovascular or other life-threatening adverse effects caused by nicotine intake [Greenland *et al.* 1998]. Even in patients with established cardiovascular disease, nicotine use in the form of NRTs does not increase cardiovascular risk [Woolf *et al.* 2012; Benowitz and Gourlay, 1997]. It is anticipated that any product delivering nicotine without involving combustion, such as the EC, would confer a significantly lower risk compared with conventional cigarettes and to other nicotine containing combustible products.

The importance of using nicotine in the longterm was recognized several years ago by Russell, indicating that the potential of nicotine delivery systems as long-term alternatives to tobacco should be explored in order to make the elimination of tobacco a realistic future target [Russell, 1991]. However, current regulations restrict the long-term use of pharmaceutical or recreational nicotine products (such as snus) [Le Houezec *et al.* 2011]. In other words, nicotine intake has been demonized, although evidence suggests that, besides being useful in smoking cessation, it may even have beneficial effects in a variety of disorders such as Parkinson's disease [Nielsen *et al.* 2013], depression [McClernon *et al.* 2006], dementia [Sahakian *et al.* 1989] and ulcerative colitis [Guslandi, 1999]. Obviously, the addictive potential is an important factor in any decision to endorse nicotine administration; however, it should be considered as slight 'collateral damage' with minimal impact to vapers' health compared with the tremendous benefit of eliminating all disease-related substances coming from tobacco smoking. In fact, smokers are already addicted to nicotine; therefore the use of a 'cleaner' form of nicotine delivery would not represent any additional risk of addiction. Surveys have shown that ECs are used as long-term substitutes to smoking [Dawkins *et al.* 2013; Etter and Bullen, 2012]. Although consumers try to reduce nicotine use with ECs, many are unable to completely stop its intake, indicating an important role for nicotine in the ECs' effectiveness as a smoking substitute [Farsalinos *et al.* 2013b].

Nicotine overdose or intoxication is unlikely to occur with vaping, since the amount consumed [Farsalinos *et al.* 2013c] and absorbed [Nides *et al.* 2014; Dawkins and Corcoran, 2013] is quite low. Moreover, although not yet proven, it is expected that vapers will self-titrate their nicotine intake in a similar way to tobacco cigarettes [Benowitz *et al.* 1998]. Last, but not least, there is evidence suggesting that nicotine cannot be delivered as fast and effectively from ECs compared to tobacco cigarettes [Farsalinos *et al.* 2014]. Therefore, it seems that ECs have a huge theoretical advantage in terms of health risks compared with conventional cigarettes due to the absence of toxic chemicals that are generated in vast quantities by combustion. Furthermore, nicotine delivery by ECs is unlikely to represent a significant safety issue, particularly when considering they are intended to replace tobacco cigarettes, the most efficient nicotine delivery product.

Studies on the safety/risk profile of ECs

Findings on the safety/risk profile of ECs have just started to accumulate. However, this research must be considered work in progress given that the safety/risk of any product reflects an evolving body of knowledge and also because the product itself is undergoing constant development.

Existing studies about the safety/risk profile of ECs can be divided into chemical, toxicological and clinical studies (Table 1). Obviously, clinical studies are the most informative, but also the most demanding because of several methodological, logistical, ethical and financial challenges. In particular, exploring safety/risk profile in cohorts of well-characterized users in the long-term is required to address the potential of future disease development, but it would take hundreds of users to be followed for a substantial number of years before any conclusions are made. Therefore, most research is currently focused on *in vitro* effects, with clinical studies confined into evaluation of short-term use or pathophysiological mechanisms of smoking-related diseases.

Chemical studies

Chemical studies are relatively simple and cheap to perform and provide quick results. However, there are several disadvantages with this approach. Research is usually focused on the known specific chemicals (generally those known to be toxic from studies of cigarette smoke) and fails to address unknown, potentially toxic contaminants that could be detected in the liquid or the emitted aerosol. Problems may also arise from the detection of the chemicals in flavors. Such substances, although approved for use in the food industry, have largely unknown effects when heated and inhaled; thus, information on the presence of such substances is difficult to interpret in terms of *in vivo* effects. In fact, chemical studies do not provide any objective information about the effects of use; they can only be used to calculate the risk based on theoretical models and on already established safety levels determined by health authorities. An overview of the chemical studies performed on ECs is displayed in Table 2.

Laugesen performed the first studies evaluating the chemical composition of EC aerosols [Laugesen, 2008, 2009]. The temperature of the resistance of the tested EC was 54°C during activation, which is approximately 5–10% of the temperature of a burning tobacco cigarette. Toxic chemicals such as heavy metals, carcinogenic polycyclic aromatic hydrocarbons and phenols were not detected, with the exception of trivial amounts of mercury (0.17 ng per EC) and traces of formaldehyde and acetaldehyde. Laugesen

Table 1. Types of studies performed to determine safety and to estimate risk from EC use.

Type of studies	Research subject	Advantages	Disadvantages
Chemical studies	Evaluate the chemical composition of liquids and/or aerosol. Examine environmental exposure (passive 'vaping').	Easier and faster to perform. Less expensive. Could realistically be implemented for regulatory purposes.	Usually targeted on specific chemicals. Unknown effects of flavorings when inhaled. No validated protocols for vapor production. Provide no objective evidence about the end results (effects) of use (besides by applying theoretical models).
Toxicological studies	Evaluate the effects on cell cultures or experimental animals.	Provide some information about the effects from use.	Difficult to interpret the results in terms of human *in vivo* effects. More expensive than chemical studies. Need to test aerosol and not liquid. Standards for exposure protocols have not been clearly defined.
Clinical studies	Studies on human *in vivo* effects.	Provide definite and objective evidence about the effects of use.	Difficult and expensive to perform. Long-term follow up is needed due to the expected lag from initiation of use to possible development of any clinically evident disease. For now, limited to acute effects from use.

evaluated emissions based on a toxicant emissions score and reported a score of 0 in ECs compared with a score of 100–134 for tobacco cigarettes (Figure 3). The US Food and Drug Administration (FDA) also performed chemical analyses on 18 commercially available products in 2009 [Westenberger, 2009]. They detected the presence of tobacco-specific nitrosamines (TSNAs) but did not declare the levels found. Small amounts of diethylene glycol were also found in one sample, which was unlikely to cause any harm from normal use. Another study identified small amounts of amino-tandalafil and rimonambant in EC liquids [Hadwiger *et al.* 2010]. Subsequently, several laboratories performed similar tests, mostly on liquids, with Cahn and Siegel publishing a review on the chemical analyses of ECs and comparing the findings with tobacco cigarettes and other tobacco products [Cahn and Siegel, 2011]. They reported that TSNA levels were similar to those measured in pharmaceutical NRTs. The authors concluded that, based on chemical analysis, ECs are far less harmful compared with tobacco cigarettes. The most comprehensive study on TSNAs has been performed recently by a South Korean group, evaluating 105 liquids obtained from local retailers [Kim and Shin, 2013]. On average, they found 12.99 ηg TSNAs per ml of liquid, with the amount of daily exposure to the users estimated to be similar to users of NRTs [Farsalinos *et al.* 2013d]. The estimated daily exposure to nitrosamines from tobacco cigarettes (average consumption of 15 cigarettes per day) is estimated to be up to 1800 times higher compared with EC use (Table 3). Etter and colleagues evaluated the accuracy of nicotine labeling and the presence of nicotine impurities and degradation products in 20 EC liquid samples [Etter *et al.* 2013]. They found that nicotine levels were 85–121% of what was labeled, while nicotine degradation products were present at levels of 0–4.4%. Although in some samples the levels were higher than those specified in European Pharmacopoeia, they are not expected to cause any measurable harm to users.

Besides the evaluation for the presence of TSNAs, analyses have been performed for the detection of carbonyl compounds. It is known that the thermal degradation of propylene glycol and glycerol can lead to the emission of toxic compounds such as aldehydes [Antal *et al.* 1985; Stein *et al.* 1983]. Goniewicz and colleagues evaluated the emission of 15 carbonyls from 12 brands of ECs (mostly first-generation) [Goniewicz *et al.* 2013]. In order to produce vapor, researchers used a smoking machine and followed a regime of 1.8-second puffs with a very short 10-second interpuff interval, which does not represent realistic use [Farsalinos *et al.* 2013c]; although the puff duration was low, interpuff interval was remarkably short, which could potentially lead to overheating. In addition, the same puff number was used in all devices tested, although there was a significant difference in the design and liquid content between devices. Despite these limitations, out of 15 carbonyls, only 3 were detected (formaldehyde, acetaldehyde and acrolein); levels were

Table 2. Summary of chemical toxicity findings.

Study	What was investigated?	What were the key findings?	
		Liquid	Vapor
Laugesen [2009]	Evaluation of 62 toxicants in the EC vapour from Ruyan 16 mg and mainstream tobacco smoke using a standard smoking machine protocol.	N/A	No acrolein, but small quantities of acetaldehyde and formaldehyde found. Traces of TSNAs (NNN, NNK, and NAT) detected. CO, metals, carcinogenic PAHs and phenols not found in EC vapour. Acetaldehyde and formaldehyde from tobacco smoke were 55 and 5 times higher, respectively.
Westenberger [2009]	Evaluation of toxicants in EC cartridges from two popular US brands.	TSNAs and certain tobacco specific impurities were detected in both products at very low levels. Diethylene glycol was identified in one cartridge.	N/A
Hadwiger *et al.* [2010]	Evaluation of four refill solutions and six replacement cartridges advertised as containing Cialis or rimonambant.	Small amounts of amino-tandalafil and rimonambant present in all products tested.	N/A
Cahn and Siegel [2011]	Overview of 16 chemical toxicity studies of EC liquids/vapours.	TSNAs levels in ECs 500- to 1400-fold lower than those in conventional cigarettes and similar to those in NRTs. Other chemicals found very low levels, which are not expected to result in significant harm.	
Pellegrino *et al.* [2012]	Evaluation of PM fractions and PAHs in the vapour generated from cartomizers of an Italian EC brand.	N/A	PM fractions were found, but levels were 6–18 times lower compared with conventional cigarettes. Traces of PAHs detected.
Kim and Shin [2013]	TSNAs (NNN, NNK, NAT, and NAB) content in 105 refill liquids from 11 EC brands purchased in Korean shops.	Total TSNAs averaged 12.99 ng/ml EC liquid; daily total TSNA exposure from conventional cigarettes estimated to be up to 1800 times higher.	N/A
Etter *et al.* [2013]	Nicotine degradation products, ethylene glycol and diethylene glycol evaluation of 20 EC refill liquids from 10 popular brands	The levels of nicotine degradation products represented 0–4.4% of those for nicotine, but for most samples the level was 1–2%. Neither ethylene glycol nor diethylene glycol were detected.	N/A
Goniewicz *et al.* [2013]	Vapours generated from 12 brands of ECs and a medicinal nicotine inhaler using a modified smoking machine protocol	N/A	Carbonyl compounds (formaldehyde, acetaldehyde and acrolein), VOCs (toluene and trace levels of xylene), trace levels of TSNAs (NNN and NNK) and very low levels of metals (cadmium, nickel and lead) were found in almost all examined EC vapours. Trace amounts of formaldehyde, acetaldehyde, cadmium, nickel and lead were also detected from the Nicorette inhalator. Compared with conventional cigarette, formaldehyde, acetaldehyde and acrolein were 9–450 times lower; toluene levels 120 times lower; and NNN and NNK levels 380 and 40 times lower respectively.

(Continued)

Table 2. (Continued)

Study	What was investigated?	What were the key findings?	
		Liquid	Vapor
Williams *et al.* [2013]	Vapour generated from cartomizers of a popular EC brand using a standard smoking machine protocol	N/A	Trace levels of several metals (including tin, copper, silver, iron, nickel, aluminium, chromium, lead) were found, some of them at higher level compared with conventional cigarettes. Silica particles were also detected. Number of microparticles from 10 EC puffs were 880 times lower compared with one tobacco cigarette.
Burstyn [2014]	Systematic review of 35 chemical toxicity studies/ technical reports of EC liquids/vapours.	No evidence of levels of contaminants that may be associated with risk to health. These include acrolein, formaldehyde, TSNAs, and metals. Concern about contamination of the liquid by a nontrivial quantity of ethylene glycol or diethylene glycol remains confined to a single sample of an early technology product and has not been replicated.	

Abbreviations. CO, carbon monoxide; EC, electronic cigarette; NAT, N-Nitrosoanatabine; NNK, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone; NNN, N-Nitrosonornicotine; PAHs, polycyclic aromatic hydrocarbons; PM, particulate matter; TSNAs, tobacco-specific nitrosamines; VOCs, volatile organic carbons.

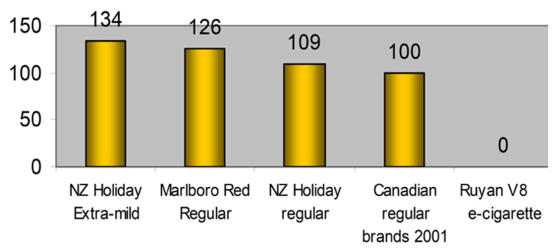

Figure 3. Toxic emissions score, adjusted for nicotine, for electronic cigarette and popular cigarette brands. (Reproduced with permission from Laugesen [2009]).

9–450 times lower compared with emissions from tobacco cigarettes (derived from existing literature but not tested in the same experiment). Formaldehyde and acetaldehyde were also emitted from the nicotine inhalator, although at lower levels. In addition, they examined for the presence of 11 volatile organic carbons and found only trace levels of toluene (at levels from 0.2–6.3 µg per 150 puffs) and xylene (from 0.1–0.2 µg per 150 puffs) in 10 of the samples; toluene levels were 120 times lower compared with tobacco cigarettes (again derived from existing literature but not tested in the same experiment).

Given that ECs have several metal parts in direct contact with the e-liquid, it is quite obvious to expect some contamination with metals in the vapor. Goniewicz and colleagues examined samples for the presence of 12 metals and found nickel, cadmium and lead emitted [Goniewicz *et al.* 2013]; the levels of nickel were similar to those present in a pharmaceutical nicotine inhalator, while lead and cadmium were present at 2–3 times higher levels compared with the inhalator. Still, the absolute levels were very low (few nanograms per 150 puffs). Williams *et al.* [2013] focused their research on the presence of heavy metals and silicate particles emitted from ECs. They tested poor quality first-generation cartomisers and found several metals emitted in the aerosol of the EC, specifying that in some cases the levels were higher compared with conventional cigarettes. As mentioned earlier, it is not unusual to find trace levels of metals in the vapor generated by these products under experimental conditions that bear little relevance to their normal use; however, it is unlikely that such small amounts pose a serious threat to users' health. Even if all the aerosol was absorbed by the consumer (which is not the case since most of the aerosol is visibly exhaled), an average user would be exposed to 4–40 times lower amounts for most metals than the maximum daily dose allowance from impurities in medicinal products [US Pharmacopeia, 2013]. Silicate particles were also found in the EC aerosol. Such particles come from the wick material, however the authors did not clarify whether crystalline silica oxide particles were found, which are responsible for respiratory disease. In total, the number of microparticles (< 1000 nm) estimated to be inhaled by EC users from 10 puffs were 880 times lower compared

Table 3. Levels of nitrosamines found in electronic and tobacco cigarettes. Prepared based on information from Laugesen [2009], Cahn and Siegel [2011] and Kim and Shin [2013].

Product	Total nitrosamines levels (ng)	Daily exposure (ng)	Ratio[4]
Electronic cigarette (per ml)	13	52[1]	1
Nicotine gum (per piece)	2	48[2]	0.92
Winston (per cigarette)	3365	50 475[3]	971
Newport (per cigarette)	3885	50 775[3]	976
Marlboro (per cigarette)	6260	93 900[3]	1806
Camel (per cigarette)	5191	77 865[3]	1497

[1]Based on average daily use of 4ml liquid
[2]Based on maximum recommended consumption of 24 pieces per day
[3]Based on consumption of 15 cigarettes per day
[4] Difference (number-fold) between electronic cigarette and all other products in daily exposure to nitrosamines

with one tobacco cigarette. Similar findings concerning microparticles were reported by Pellegrino and colleagues who found that, for each particulate matter fraction, conventional cigarettes released 6–18 times higher amounts compared with the EC tested [Pellegrino *et al.* 2012].

Burstyn has recently reviewed current data on the chemistry of aerosols and the liquids of ECs (including reports which were not peer-reviewed) and estimated the risk to consumers based on workplace exposure standards (i.e. Threshold Limit Values [TLVs]) [Burstyn, 2014]. After reviewing all available evidence, the author concluded that there was no evidence that vaping produced inhalable exposure to contaminants of aerosol that would warrant health concerns. He added that surveillance of use is recommended due to the high levels of propylene glycol and glycerol inhaled (which are not considered contaminants but ingredients of the EC liquid). There are limited data on the chronic inhalation of these chemicals by humans, although there is some evidence from toxicological studies (which are discussed later in this paper).

In conclusion, chemical studies have found that exposure to toxic chemicals from ECs is far lower compared with tobacco cigarettes. Besides comparing the levels of specific chemicals released from tobacco and ECs, it should be taken into consideration that the vast majority of the >4000 chemicals present in tobacco smoke are completely absent from ECs. Obviously, surveillance of use is warranted in order to objectively evaluate the *in vivo* effects and because the effects of inhaling flavoring substances approved for food use are largely unknown.

Toxicological studies

To date, only a handful of toxicological studies have been performed on ECs, mostly cytotoxicity studies on established cell lines. The cytotoxicity approach also has its flaws. Findings cannot be directly applied to the *in vivo* situation and there is always the risk of over- (as well as under-)estimating the interpretation of the toxic effects in these investigational models. An ample degree of results variability is to be expected from different cell lines and, sometimes, also within the same cell line. Comparing the potential cytotoxicity effects of EC vapor with those resulting from the exposure of cigarette smoke should be mandatory, but standards for vapor production and exposure protocols have not been clearly defined.

Bahl and colleagues [Bahl *et al.* 2012] performed cytotoxicity tests on 36 EC liquids, in human embryonic stem cells, mouse neural stem cells and human pulmonary fibroblasts and found that stem cells were more sensitive to the effects of the liquids, with 15 samples being moderately cytotoxic and 12 samples being highly cytotoxic. Propylene glycol and glycerol were not cytotoxic, but a correlation between cytotoxicity and the number and height of the flavoring peaks in high-performance liquid chromatography was noted. Investigations were just restricted to the effect of EC liquids and not to their vapors, thus limiting the importance of the study findings; this is not a trivial issue considering that the intended use of these products is by inhalation only and that it is unlikely that flavoring substances in the EC liquids will still be present in the aerosol in the same amount due to differences in evaporation temperature [Romagna *et al.* 2013]. Regrettably, a set of experiments with cigarette smoke extracts as comparator was not included. Of note, the authors emphasized that the study could have underestimated the cytotoxicity by 100 times because when they added the EC liquids to the cell, medium final concentration was 1%. However, cells were cultured for 48 hours with continuous exposure to the liquid, while in real use the lungs come in contact with aerosol instead of liquid, the contact lasts for 1–2 seconds per puff and most of the aerosol is visibly exhaled. Finally, Cinnamon Ceylon, the liquid found to be mostly cytotoxic in this study, was not a refill liquid but a concentrated flavor which is not used in ECs unless it is diluted to 3–5%.

Romagna and colleagues [Romagna *et al.* 2013] performed the first cytotoxicity study of EC vapor on fibroblast cells. They used a standardized ISO 10993-5 protocol, which is used for regulatory purposes of medical devices and products. They tested the vapor of 21 liquid samples containing the same amount of nicotine (9 mg/ml), generated by a commercially available EC device. Cells were incubated for 24 hours with each of these vapors and with smoke from a conventional cigarette. Only one sample was found to be marginally cytotoxic, whereas cigarette smoke was highly cytotoxic (approximately 795% more cytotoxic), even when the extract was diluted up to 25% of the original concentration.

The same group also investigated the cytotoxic potential of 20 EC liquid samples in cardiomyoblasts [Farsalinos *et al.* 2013a]. Vapor was produced by using a commercially available EC device. Samples contained a wide range of nicotine concentrations. A base liquid mixture of propylene glycol and glycerol (no nicotine and no flavorings) was also included as an additional experimental control. Four of the samples examined were made by using cured tobacco leaves in a steeping process, allowing them to impregnate a mixture of propylene glycol and glycerol for several days before being filtered and bottled for use. Of note, this was the first study which evaluated a limited number of samples with an EC device delivering higher voltage and energy to the atomizer (third-generation device). In total, four samples were found to be cytotoxic; three of them were liquids made by using cured tobacco leaves, with cytotoxicity observed at both 100% and 50% extract concentration, while one sample (cinnamon flavor) was marginally cytotoxic at 100% extract concentration only. In comparison, smoke from three tobacco cigarettes was highly cytotoxic, with toxicity observed even when the extract was diluted to 12.5%. The samples made with tobacco leaves were three times less cytotoxic compared with cigarette smoke; this was probably due to the absence of combustion and the significantly lower temperature of evaporation in EC use. Concerning high-voltage EC use, the authors found slightly reduced cell viability without any of the samples being cytotoxic according to the ISO 10993-5 definition. Finally, no association between cell survival and the amount of nicotine present in the liquids was noted.

A recent study evaluated in more detail the cytotoxic potential of eight cinnamon-flavored EC liquids in human embryonic stem cells and human pulmonary fibroblasts [Behar *et al.* 2014]. The authors found that the flavoring substance predominantly present was cinnamaldehyde, which is approved for food use. They observed significant cytotoxic effects, mostly on stem cells but also on fibroblasts, with cytotoxicity associated with the amount of cinnamaldehyde present in the liquid. However, major methodological issues arose from this study. Once again, cytotoxicity was just restricted to EC liquids and not to their vapors. Moreover, the authors mentioned that the amount of cinnamaldehyde differed between liquids by up to 100 times, and this raises the suspicion of testing concentrated flavor rather than refills. By searching the internet and contacting manufacturers, based on the names of samples and suppliers mentioned in the manuscript, it was found that at least four of their samples were not refills but concentrated flavors. Surprisingly, the levels of cinnamaldehyde found to be cytotoxic were about 400 times lower than those currently approved for use [Environmental Protection Agency, 2000].

Few animal studies have been performed to evaluate the potential harm of humectants in EC liquids (i.e. propylene glycol and glycerol) when given by inhalation. Robertson and colleagues tested the effects on primates of inhaling propylene glycol vapor for several months and found no evidence of toxicity on any organ (including the lungs) after post-mortem examination of the animals [Robertson *et al.* 1947]. Similar observations were made in a recent study in rats and dogs [Werley *et al.* 2011]. Concerns have been raised in human use, based on studies of people exposed to theatrical fog [Varughese *et al.* 2005; American Chemistry Council, 2003] or propylene glycol used in the aviation industry [Wieslander *et al.* 2001]. Irritation of the respiratory tract was found, but no permanent lung injury or other long-term health implications were detected. It should be reminded that, in these circumstances, nonpharmaceutical purity propylene glycol is used and in some cases oils are added, making it difficult to interpret the results in the context of EC use. Evidence for the potential harm of inhaled glycerol is sparse. A study using Sprague–Dawley rats found minimal to mild squamous metaplasia of the epiglottis epithelium in the high-dose group only, without any changes observed in lungs or other organs [Renne *et al.* 1992]. No comparative set of experiments with cigarette smoke was included, but it is well known that exposure to tobacco smoke in similar animal models leads to dramatic changes in the lungs, liver and kidneys [Czekaj *et al.* 2002].

In conclusion, toxicological studies have shown significantly lower adverse effects of EC vapor compared with cigarette smoke. Characteristically, the studies performed by using the liquids in their original liquid form have found less favorable results; however, no comparison with tobacco smoke was performed in any of these studies, and they cannot be considered relevant to EC use since the samples were not tested in the form consumed by vapers. More research is needed, including studies on different cell lines such as lung epithelial cells. In addition, it is probably necessary to evaluate a huge number of liquids with different flavors since a minority of them, in an unpredictable manner, appear to raise some concerns when tested in the aerosol form produced by using an EC device.

Clinical studies and research surveys

Clinical trials can be very informative, but they require monitoring of hundreds of users for many years to adequately explore the safety/risk profile of the products under investigation. Research surveys of EC users, on the other hand, can quickly provide information about the potential harm of these products and are much cheaper to run. However, self-reported data, highly self-selected study populations, and the cross-sectional design are some of the most common limitations of research surveys. Taken together, findings from surveys and follow-up studies of vapers have shown that EC use is relatively safe.

Polosa and colleagues followed up smokers for 24 months, after a 6-month period of intervention during which ECs were given [Polosa *et al.* 2013a]. Only mild symptoms such as mouth and throat irritation and dry cough were observed. Farsalinos and colleagues retrospectively evaluated a group of 111 EC users who had completely quit smoking and were daily EC users for a median period of 8 months [Farsalinos *et al.* 2013b]. Throat irritation and cough were the most commonly reported side effects. Similar findings have been observed in surveys [Dawkins *et al.* 2013; Etter *et al.* 2011]. However, it is expected that dedicated users who have more positive experiences and fewer side effects compared with the general population participate in such studies, therefore interpretation should be done with caution. The only two existing randomized controlled trials have also included detailed EC safety analysis. The ECLAT study [Caponnetto *et al.* 2013b], a three-arm, controlled, randomized, clinical trial designed to compare efficacy and safety of a first-generation device with 7.2, 5.4, or 0 mg nicotine cartridges, reported clinically significant progressive health improvements already by week two of continuous use of the device, and no serious adverse events (i.e. major depression, abnormal behavior or any event requiring an unscheduled visit to the family practitioner or hospitalization) occurred during the study. The ASCEND study [Bullen *et al.* 2013], a three-arm, controlled, randomized, clinical trial designed to compare the efficacy and safety of a first-generation device (with or without nicotine) with nicotine patches, reported no serious adverse events in any of the three study groups.

Few clinical studies have been performed to evaluate the short-term *in vivo* effects of EC use in current or former smokers. Vardavas and colleagues evaluated the acute effects of using an EC for 5 minutes on respiratory function [Vardavas *et al.* 2012]. Although they did not report the results of commonly-used spirometry parameters, they found that a sensitive measure of airways resistance and nitric oxide levels in exhaled breath were adversely affected. Similar elevations in respiratory resistance were reported by other research groups [Palamidas *et al.* 2013; Gennimata *et al.* 2012], who also documented some bizarre elevation in exhaled carbon monoxide levels after EC use; this finding has been challenged by several other studies [Farsalinos *et al.* 2013f; Nides *et al.* 2014; Van Staden *et al.* 2013]. Schober and colleagues found that EC use led to elevated exhaled nitric oxide [Schober *et al.* 2013], contradicting the findings from Vardavas and colleagues [Vardavas *et al.* 2012]. Characteristically, none of the above studies performed any comparative tests after smoking tobacco cigarettes. Flouris and colleagues found that only smoking had an acute adverse effect on respiratory function [Flouris *et al.* 2013]; no difference was observed after the group of smokers was exposed to active or passive EC use.

Two studies have evaluated the short-term effects of ECs on the cardiovascular system. Farsalinos and colleagues evaluated the acute effects of using ECs with an 11 mg/ml nicotine-containing liquid on hemodynamics and left ventricular function, in comparison with the effects of cigarette smoking [Farsalinos *et al.* 2012]. They found that EC use resulted in a slight elevation in diastolic blood pressure while, after smoking, both systolic and diastolic blood pressure and heart rate were significantly elevated. Obviously, this was due to the relatively low nicotine content of the EC (which is considered medium strength). Diastolic dysfunction was observed in smokers after smoking, which was in line with findings from previous studies. However, no adverse effects were observed in EC users after using the device *ad lib* for 7 minutes. Another study by the same group [Farsalinos *et al.* 2013f], evaluated the acute effects of EC use on coronary flow. In particular, they measured the flow velocity reserve of the left anterior descending coronary artery by echocardiography after intravenous infusion of adenosine, representing the maximal ability of the artery to deliver blood to the myocardium. Smoking was associated with a decline in flow velocity reserve by 16% and an elevation in resistance to flow by 19%. On the contrary, no difference was observed in any of these parameters after using the EC. Blood carboxyhemoglobin levels were also measured in participants; baseline values were significantly higher in smokers compared with vapers and were further elevated after smoking but were not altered after EC use. Similar observations for carboxyhemoglobin levels were observed by Van Staden and colleagues [Van Staden *et al.* 2013].

A clinical case report of a smoker suffering from chronic idiopathic neutrophilia was published. According to that report [Farsalinos and Romagna, 2013], switching from smoking to EC use led to a reversal of the condition after 6 months. In addition, C-reactive protein levels, which were consistently elevated for more than 6 years, decreased to normal levels. Another case report of a patient with lipoid pneumonia was published, with the condition attributed to glycerin-based EC liquids used by the patient [McCauley *et al.* 2012]. However, glycerin is an alcohol (polyol) and thus it is impossible to cause lipoid pneumonia. Only oil-based liquids could be the cause for this condition; such liquids should not be used with ECs.

One study evaluated the acute effects of tobacco and EC use on white blood cell count [Flouris *et al.* 2012]. Smoking one tobacco cigarette caused an immediate elevation in white blood cells, neutrophils and lymphocytes, indicating acute inflammatory distress. On the contrary, no differences were observed after using ECs.

In conclusion, clinical studies evaluating the effects of short-term EC use on selected cardiovascular and respiratory functional outcomes have shown that even if some harmful effects of vaping are reported, these are considerably milder compared with smoking conventional cigarettes. However, it is difficult to assess the prognostic implications of these studies; longer-term data are needed before any definite conclusions are made.

Passive vaping

Passive smoking is an established risk factor for a variety of diseases [Barnoya and Navas-Acien, 2013]. Therefore, it is important from a public health perspective to examine the impact of EC use on bystanders. Indirect data can be derived from chemical studies in vapor mentioned above, which show that the potential of any significant adverse effects on bystanders is minimal. In fact, since sidestream exposure is nonexistent in EC (aerosol is produced only during activation of the device, while tobacco cigarettes emit smoke even when no puffs are taken), such studies are undoubtedly overestimating the risk of environmental exposure.

Few studies have focused on second-hand vaping. McAuley and colleagues [McAuley *et al.* 2012], although mentioning indoor air quality in the title of their study and finding minimal health-related impact, did not in fact evaluate second-hand vaping because aerosol was produced from an EC device and was evaluated without previously being inhaled by any user. Moreover, there were some problems with cross-contamination with tobacco cigarette smoke, which made the results somewhat questionable, at least for some of the parameters tested. Schripp and colleagues [Schripp *et al.* 2013] evaluated the emissions from an EC by asking a volunteer to use three different EC devices in a closed 8 m^3 chamber. From a selection of 20 chemicals analyzed, only formaldehyde, acrolein, isoprene, acetaldehyde and acetic acid were detected. The levels were 5–40 times lower compared with emissions from a conventional cigarette. For formaldehyde, the authors specifically mentioned that the levels were continuously rising from the time the volunteer entered the room, even before he started using the EC. Moreover, no acute elevation was observed when the smoker used the three EC devices, contrary to the acute elevation and spiking of levels when a tobacco cigarette was lit. The authors concluded that formaldehyde was not emitted from the ECs but was due to human contamination, since low amounts of formaldehyde of endogenous origin can be found in exhaled breath [Riess *et al.* 2010]. Romagna and colleagues [Romagna *et al.* 2012] evaluated chemicals released in a realistic setting of a 60 m^3 room, by asking five smokers to smoke *ad lib* for 5 hours and five vapers to use ECs *ad lib* for a similar period of time on two separate days. Nicotine, acrolein, toluene, xylene and polycyclic aromatic hydrocarbons were detected in room air after the smoking session, with the amount of total organic carbon (TOC) reaching to 6.66 mg/m^3. In contrast, after the EC session, only glycerol was detected in minimal levels (72 μg/m^3), while TOC reached a maximum level of 0.73 mg/m^3. Characteristically, the amount of TOC accumulated after 5 hours of EC use was similar to the amount found after just 11 minutes of smoking. The study on heavy metals mentioned previously [Williams *et al.* 2013] could also be used to examine any potential risk of bystanders' exposure to toxic metals. The levels of heavy metals found in vapor were minimal, and considering the dispersion of these molecules in the whole room air, it is unlikely that any of these metals could be present in measurable quantities in the environment. Therefore, the risk for bystanders would be literally nonexistent. Contrary to that, Schober and colleagues [Schober *et al.* 2013] found that levels of aluminum were raised by 2.4 times in a 45 m^3 room where volunteers were asked to use ECs for 2 hours. This is a highly unexpected finding which cannot be supported by the findings of the study by Williams and colleagues [Williams *et al.* 2013]; because the levels found in the latter could not result in such elevation of the environmental levels of aluminum, unless nothing is retained in or absorbed from the lungs. Moreover, Schober and colleagues [Schober *et al.* 2013] found that levels of polycyclic aromatic hydrocarbons (PAHs) were raised by 20% after EC use. However, a major methodological problem of this study is that control environmental measurements were performed on a separate day and not on the same day of EC use. This is a major limitation, because the levels of environmental PAHs have significant diurnal and day-to-day variations [Ravindra *et al.* 2008]; therefore, it is highly likely that the differences in levels of PAHs (which are mainly products of combustion and are not expected to be emitted from EC use) represented changes due to environmental conditions and not due to EC use. Bertholon and colleagues [Bertholon *et al.* 2013] examined the EC aerosol exhaled from a user, in comparison with exhaled smoke from a smoker. The authors found that particle size diameters were 0.29–0.033μm. They observed that the half life of EC aerosol was 11 seconds compared with 20 minutes for cigarette smoke, indicating that risk of passive vaping exposure is significantly lower compared with passive smoking.

The recent findings by Czogala and colleagues [Czogala *et al.* 2013] led to similar conclusions. The authors compared the emissions of electronic and conventional cigarettes generated by experienced dual users in a ventilated full-sized room and found that ECs may emit detectable amounts of nicotine (depending on the specific EC brand tested), but no carbon monoxide and volatile organic carbons. However, the average ambient levels of nicotine of ECs were 10 times lower than those of conventional cigarettes (3.32 ± 2.49 *versus* 31.60 ± 6.91 μg/m^3).

In his review and comparison with TLVs, Burstyn found that emissions from ECs to the environment are not expected to pose any measurable risk for bystanders [Burstyn, 2014].

An issue that needs further clarification relates to the findings of microparticles emitted from ECs. In most studies, these findings are presented in a way implying that the risk is similar to environmental or smoking microparticles. In reality, it is not just the size but the composition of the microparticles that matters. Environmental microparticles are mainly carbon, metal, acid and organic microparticles, many of which result from combustion and are commonly called particulate matter. Particulate matter exposure is definitely associated with lung and cardiovascular disease [Peters, 2005; Seaton *et al.* 1995]. In the case of ECs, microparticles are expected to consist mostly of propylene glycol, glycerol, water and nicotine droplets. Metal and silica nanoparticles may also be present [Williams *et al.* 2013], but, in general, emissions from ECs are incomparable to environmental particulate matter or cigarette smoke microparticles.

Flouris and colleagues [Flouris *et al.* 2013] performed the only clinical study evaluating the respiratory effects of passive vaping compared with passive smoking. Researchers found significant adverse effects in spirometry parameters after being exposed to passive smoking for 1 hour, while no adverse effects were observed after exposure to passive vaping.

Although evaluating the effects of passive vaping requires further work, based on the existing evidence from environmental exposure and chemical analyses of vapor, it is safe to conclude that the effects of EC use on bystanders are minimal compared with conventional cigarettes.

Miscellaneous safety issues

Specific subpopulations: psychiatric and chronic obstructive pulmonary disorder patients

A challenging population subgroup with unique smoking patterns is that of psychiatric patients and in particular schizophrenic patients. This subpopulation is characterized by a very high smoking prevalence [De Leon and Diaz, 2005] with an excess of smoking-related mortality [Brown *et al.* 2000]. Currently, only NRTs are recommended to treat nicotine dependence in this specific subpopulation, but in general they are not particularly effective [Aubin *et al.* 2012]. ECs could be used as an alternative to smoking products in this group. Caponnetto and colleagues performed a prospective 12-month pilot study to evaluate the efficacy of EC use in smoking reduction and cessation in a group of 14 patients with schizophrenia [Caponnetto *et al.* 2013a]. In 50% of participants, smoking consumption went from 30 to 15 cigarettes per day at 52 weeks of follow up, while 14.3% managed to quit smoking. Importantly, no deterioration in their psychiatric condition was observed, and side effects were mild and temporary. The results were promising although an outdated EC device was used in this study.

There is also anecdotal evidence that successful smoking cessation could be attained by using an EC in smokers with other psychiatric conditions such as depression [Caponnetto *et al.* 2011a]. Both patients described in this case series stated that EC use was well tolerated and no adverse events were reported.

Considering that first-line oral medications for nicotine addiction are contraindicated in such patients (prescribing information for bupropion and varenicline carry a 'black-box' warning for certain psychiatric conditions), ECs may be a promising tool in these challenging patient groups.

Another subpopulation that may benefit from regular EC use is that of respiratory patients with chronic obstructive pulmonary disease (COPD), a progressive disease characterized by a persistent inflammatory response to tobacco smoke that generally leads to decline in lung function, respiratory failure, cor pulmonale and death. Consequently, smoking cessation plays a crucial part in the management of COPD patients. However, the available evidence in the medical literature indicates that COPD patients who smoke respond poorly to smoking cessation efforts [Schiller and Ni, 2006]. To date, no formal efficacy and safety assessment of EC use in COPD patients has been conducted. There is only evidence from a case report of inveterate smokers with COPD and a documented history of recurring relapses, who eventually quit tobacco smoking on their own by using an EC [Caponnetto *et al.* 2011b]. Significant improvement in quality of life and reduction in the number of disease exacerbations were noted. EC use was well tolerated with no reported adverse events.

Accidental nicotine exposure

Accidental ingestion of nicotine, especially by children, or skin contact with large amounts of liquid or highly concentrated nicotine solution can be an issue. However, the historically referenced lethal dose of 60 mg has recently been challenged in a review by Mayer [Mayer, 2013]; he found that the lethal levels currently reproduced in every document originated from dubious experiments performed in the 19th century. Based on post-mortem studies, he suggested that the acute dose associated with a lethal outcome would be 500–1000 mg. Taking into account that voluminous vomiting is the first and characteristic symptom of nicotine ingestion, it seems that far higher levels of nicotine need to be ingested in order to have lethal consequences.

A surveillance system of adverse events has been developed by the FDA, which identifies safety concerns in relation to tobacco products. Since 2008, 47 adverse events were reported for ECs

[Chen, 2013]. Eight of them were serious events such as hospitalizations for pneumonia, heart failure, seizures and hypotension and burns. A case of second-degree burns was caused by a battery explosion, which is generally a problem observed in lithium batteries and has occurred in other products (such as mobile phones). The author emphasized that the reported events were not necessarily associated with EC use but may have been related to pre-existing conditions or other causes. No condition was characteristically associated with EC use.

A recent review of the California Poison Control System database from 2010 to 2012 identified 35 cases (14 children) associated with EC exposure (accidental exposure in 25 cases) [Cantrell, 2013]. A total of five patients were evaluated in an emergency department and all were discharged within 4 hours. Nausea, vomiting, dizziness and oral irritation were most commonly reported. Taken together, data from surveillance systems of adverse events suggest that short-term adverse effects and accidental exposures to EC cartridges are unlikely to result in serious toxicity.

Notwithstanding, avoiding preventable contact with highly concentrated nicotine solution remains important; this can be achieved by specific labeling of the products, child-proof caps and proper education of consumers. There is no evidence that nicotine-containing EC liquids should be treated in any different way compared with other consumer products used every day in households (such as bleach, washing machine powder, etc.).

Electrical accidents and fires

The electronic equipment of ECs may be the cause for accidents. ECs are mainly composed of lithium batteries. There have been reports of explosions of batteries, caused either by prolonged charging and use of improper chargers or by design defects. Similar accidents have occurred with batteries of other popular devices, such as mobile phones. Therefore, this does not occur specifically with ECs, however, quality standards of production should be used in order to avoid such accidents.

Smoking is a major cause of residential fires. Between 2008 and 2010, an estimated annual average of 7600 smoking-related fires occurred in residential buildings in the US [US Fire Administration, 2012]. They account for only 2% of all residential building fires but for 14% of fire deaths. Since ECs are activated only when used by the person and there is no combustion involved, there is the potential to avoid the risk of smoking-related fires.

Use by youngsters and nonsmokers

Although beyond the scope of this review, it is important to briefly discuss the potential for addiction from EC use. It should be acknowledged that nicotine is addictive, although recent studies have shown that several other chemicals present in tobacco are associated with a significant enhancement of the addictiveness of nicotine [Lotfipour *et al.* 2011; Rose, 2006; Guillem *et al.* 2005]. Still, nicotine intake should not be recommended to nonsmokers. Smokers are already addicted to nicotine, thus ECs will be a cleaner form of nicotine intake, while at the same time they will maintain their sensory stimulation and motor simulation of smoking; these are important aspects of the addiction to smoking. Regulatory authorities have expressed concern about EC use by youngsters or by never-smokers, with ECs becoming a gateway to smoking or becoming a new form of addiction. However, such concerns are unsubstantiated; research has shown that EC use by youngsters is virtually nonexistent unless they are smokers. Camenga and colleagues [Camenga *et al.* 2013] examined the use of ECs and tobacco in a group of adolescents, in a survey conducted in three waves. In the first wave of the survey (February 2010), 1719 adolescents were surveyed from which only one nonsmoker was found to be using ECs. In the second and third wave of the surveys, only five nonsmoking adolescents were using ECs. In fact, these are adolescents who reported first ever use of ECs in the past 30 days; therefore they were not necessarily regular or daily EC consumers. The increased prevalence of EC use from 0.9% in 2010 to 2.3% in 2011 concerned smoking adolescents, therefore it should be considered a positive finding that smokers are experimenting with the significantly less harmful ECs. Similarly, the Medicines and Healthcare Products Regulatory Agency (MHRA) found that less than 1% of EC users are never-smokers [MHRA, 2013]. Data from the Centers for Disease Control [2013] National Youth Tobacco Survey reported doubling in EC experimentation by 13–18 year old students from 1.1% in 2011 to 2.1% in 2012; however, 90.6% of them were smokers. From the whole population, only 0.5% were nonsmokers experimenting with ECs.

Once again, participants were asked about ever experimenting with an EC in the past 30 days, not regular or daily EC use. Recently, a survey of more than 75,000 students in South Korea was published [Lee *et al.* 2013]. Although they found that 12.6% of them were daily smokers (8.6% were using only tobacco cigarettes and 3.6% were using both tobacco and ECs), only 0.6% of nonsmokers had used ECs in the past 30 days. Although the above mentioned data have been used as arguments to support the fact that a new epidemic of nicotine addiction through the use of ECs is appearing, in reality they are showing that any experimentation with ECs is done by smokers. This is in fact a positive finding, and could lead to reduced smoking prevalence through adoption of EC use. Therefore, ECs could serve as gateway from smoking; on the contrary, there is no evidence indicating that they could be a gateway to smoking. It is promising to see that penetration of EC use in youngsters is virtually nonexistent, especially when you take into consideration that there is currently no official regulation in most countries to prohibit the access to ECs by youngsters.

Conclusion

Existing evidence indicates that EC use is by far a less harmful alternative to smoking. There is no tobacco and no combustion involved in EC use; therefore, regular vapers may avoid several harmful toxic chemicals that are typically present in the smoke of tobacco cigarettes. Indeed, some toxic chemicals are released in the EC vapor as well, but their levels are substantially lower compared with tobacco smoke, and in some cases (such as nitrosamines) are comparable with the amounts found in pharmaceutical nicotine products. Surveys, clinical, chemistry and toxicology data have often been mispresented or misinterpreted by health authorities and tobacco regulators, in such a way that the potential for harmful consequences of EC use has been largely exaggerated [Polosa and Caponnetto, 2013]. It is obvious that some residual risk associated with EC use may be present, but this is probably trivial compared with the devastating consequences of smoking. Moreover, ECs are recommended to smokers or former smokers only, as a substitute for conventional cigarettes or to prevent smoking relapse; thus, any risk should be estimated relative to the risk of continuing or relapsing back to smoking and the low efficacy of currently approved medications for smoking cessation should be taken into consideration [Moore *et al.* 2009; Rigotti *et al.* 2010;Yudkin *et al.* 2003]. Nonetheless, more research is needed in several areas, such as atomizer design and materials to further reduce toxic emissions and improve nicotine delivery, and liquid ingredients to determine the relative risk of the variety of compounds (mostly flavorings) inhaled. Regulations need to be implemented in order to maintain the current situation of minimal penetration of EC use in nonsmokers and youngsters, while manufacturers should be forced to provide proof for the quality of the ingredients used and to perform tests on the efficiency and safety of their products. However, any regulatory decisions should not compromise the variability of choices for consumers and should make sure that ECs are more easily accessible compared with their main competitor, the tobacco cigarette. Consumers deserve, and should make, informed decisions and research will definitely promote this. In particular, current data on safety evaluation and risk assessment of ECs is sufficient enough to avert restrictive regulatory measures as a consequence of an irrational application of the precautionary principle [Saitta *et al.* 2014].

ECs are a revolutionary product in tobacco harm reduction. Although they emit vapor, which resembles smoke, there is literally no fire (combustion) and no 'fire' (suspicion or evidence that they may be the cause for disease in a similar way to tobacco cigarettes). Due to their unique characteristics, ECs represent a historical opportunity to save millions of lives and significantly reduce the burden of smoking-related diseases worldwide.

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Schripp, T., Markewitz, D., Uhde, E. & Salthammer, T. (2013). Does e-cigarette consumption cause passive vaping?. *Indoor Air*, 23 (1), pp. 25--31. doi:10.1111/j.1600-0668.2012.00792.x

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finance8-Danyl

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 8:42 AM
To: FINTestimony
Cc: surfmaster008@gmail.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Sean Higa	Individual	Oppose	No

Comments: SB2495 is discrimination!

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From: mailinglist@capitol.hawaii.gov
Sent: Sunday, March 30, 2014 5:21 PM
To: FINTestimony
Cc: starjenchan@gmail.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/30/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Jenny Chan	Individual	Oppose	Yes

Comments: This bill is an insult! E-cigs are safe.

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From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 10:05 AM
To: FINTestimony
Cc: antonchris10@gmail.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Chris Anton	Individual	Oppose	No

Comments: Banning electronic vapes isn't going to help people quit smoking. I might as well smoke real tobacco if that's the case.

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finance1

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 5:51 AM
To: FINTestimony
Cc: dustinandrewsoahu@gmail.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Dustin Andrews	Individual	Oppose	No

Comments:

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finance1

From: Rebecca Williams <rjwillia@hawaii.edu>
Sent: Monday, March 31, 2014 11:02 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

Thank you for the opportunity to submit testimony in strong support of SB 2495 SD 3 HD 1. I strongly support regulating electronic smoking devices (ESDs) by prohibiting the use of ESDs in places open to the public and places of employment.

I support including "electronic smoking devices" in the definition of "tobacco product" and "smoke or smoking" in the smoke-free workplace law, and to prohibit the use of electronic smoking devices in the places where smoking is prohibited. Prohibiting ESD use where smoking is prohibited will protect the public, reduce confusion within society, decrease distractions in the workplace, and maintain social norm.

SB 2495 SD 3 HD 1 is the first step to regulating ESDs and protecting employees, customers, and the public from inadvertent exposure to nicotine. ESDs are not FDA approved smoking cessation devices and do not emit harmless water vapor. They are currently unregulated and emit nicotine, ultra-fine particles, and other toxins into the air. Failing to act may set us back decades. Please pass SB 2495 SD 3 HD 1 and include ESDs in our smoke-free workplace law.

Mahalo.

Rebecca Williams
736 Hawaii St.
Honolulu, HI 96817

finance1

From: Koa Robinson <koa.robinson@gmail.com>
Sent: Monday, March 31, 2014 11:01 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Koa Robinson
3059 Seaview Rise
Honolulu, HI 96822

finance1

From: Michelle Gray <mmg2b@msn.com>
Sent: Monday, March 31, 2014 11:01 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Michelle Gray
430 Lanipuao Street
Honolulu, HI 96825

finance1

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 11:01 AM
To: FINTestimony
Cc: oakwoodh@hotmail.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Oakwood Hirata	Individual	Oppose	Yes

Comments:

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From: May Rose Dela Cruz <mdelacruz@papaolalokahi.org>
Sent: Monday, March 31, 2014 11:06 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

May Rose Dela Cruz
894 Queen Street
894 Queen Street
Honolulu, HI 96813

From: May Okihiro <mokihiro@me.com>
Sent: Monday, March 31, 2014 11:03 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

May Okihiro
46-193 Yacht Club St.
Kaneohe, HI 96744

finance8-Danyl

From: Daria Fand <daria@hawaiiantel.net>
Sent: Monday, March 31, 2014 11:09 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Daria Fand
1545 Kalakaua Ave., Apt. 709
Honolulu, HI 96826

finance1

From: Dawn Pung <satsp@aol.com>
Sent: Monday, March 31, 2014 11:08 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Dawn Pung
645 Ainako Avenue
Hilo, HI 96720

From: Nicole Spalding <nicolenanea@gmail.com>
Sent: Monday, March 31, 2014 11:08 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
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Mahalo.

Nicole Spalding

Nicole Spalding

Kula, HI 96790

finance8-Danyl

From: Marilyn Gagen <mgagen@gmail.com>
Sent: Monday, March 31, 2014 11:11 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Marilyn Gagen
59-398 Ka Nani Drive
N/A
Kamuela, HI 96743

finance8-Danyl

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 11:12 AM
To: FINTestimony
Cc: rbkarasuda@hotmail.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
RaeDeen Karasuda	Individual	Support	No

Comments:

Please note that testimony submitted less than 24 hours prior to the hearing, improperly identified, or directed to the incorrect office, may not be posted online or distributed to the committee prior to the convening of the public hearing.

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finance1

From: Boyd, Manager Richard Boyd <boyd.mgr.mterrace@gmail.com>
Sent: Monday, March 31, 2014 11:13 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

Thank you for the opportunity to submit testimony in strong support of SB 2495 SD 3 HD 1. I strongly support regulating electronic smoking devices (ESDs) by prohibiting the use of ESDs in places open to the public and places of employment.

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SB 2495 SD 3 HD 1 is the first step to regulating ESDs and protecting employees, customers, and the public from inadvertent exposure to nicotine. ESDs are not FDA approved smoking cessation devices and do not emit harmless water vapor. They are currently unregulated and emit nicotine, ultra-fine particles, and other toxins into the air. Failing to act may set us back decades. Please pass SB 2495 SD 3 HD 1 and include ESDs in our smoke-free workplace law.

Mahalo.

Boyd, Manager Richard Boyd
250 Kawaihae St
250 Kawaihae St
Honolulu, HI 96825

From: Marianne Yoshida <yoshidam@hawaii.edu>
Sent: Monday, March 31, 2014 11:16 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
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Mahalo.

Marianne Yoshida
1312 Honokahua St.
Honolulu, HI 96825

finance1

From: pamela verrey <pamverrey@gmail.com>
Sent: Monday, March 31, 2014 11:17 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
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Mahalo.

pamela verrey
1255 Kaluawaa St
honolulu, HI 96816

finance8-Danyl

From: Jennifer Hausler <Jenhausler@hotmail.com>
Sent: Monday, March 31, 2014 11:21 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
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Mahalo.

Jennifer Hausler
1429 kuloko st
Kuloko
Pearl city, HI 96782

From: Karli Bergheer <karli@pacificcancerfoundation.org>
Sent: Monday, March 31, 2014 11:15 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
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Mahalo.

Karli Bergheer
221 Mahalani Street, Suite 99
Wailuku, HI 96793

finance8-Danyl

From: Debbie Apolo <debz96789@gmail.com>
Sent: Monday, March 31, 2014 11:21 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Debbie Apolo
95-045 Waikalani Drive
#G104
Mililani, HI 96789

finance1

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 11:24 AM
To: FINTestimony
Cc: mikenakas@hotmail.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Michael S. Nakasone	Individual	Oppose	No

Comments:

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finance8-Danyl

From: Kristen Scholly <kristen@hawaii.edu>
Sent: Monday, March 31, 2014 11:32 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
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Mahalo.

Kristen Scholly
Health Promotion Office 2600 Campus Rd Room 313 Hononlulu, HI 96813

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 11:29 AM
To: FINTestimony
Cc: donnydonny13@hush.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Donald McCann	Individual	Oppose	No

Comments: The legislature needs to respect private property and personal choice. Just because an owner of an establishment elects to allow certain members of the public on their property, doen't make it public property. If you don't like people to enjoy e-cigs then don't patronize the business.

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From: Katherine Freer <Kbfreer@gmail.com>
Sent: Monday, March 31, 2014 11:35 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Katherine Freer
1515 avon way
Honolulu, HI 96822

From: Kim Swartz <kswartz@hawaii.edu>
Sent: Monday, March 31, 2014 11:41 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
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Mahalo.

Kim Swartz
98-1394 Hinu Pl, #B
Pearl City, HI 96782

finance1

From: Barbara Nosaka <barbrick@hawaiiantel.net>
Sent: Monday, March 31, 2014 11:42 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
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Mahalo.

Barbara Nosaka
2216 Hoonanea Street
Honolulu, HI 96822

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 11:28 AM
To: FINTestimony
Cc: regiedelacruz@gmail.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
regie dela cruz	Individual	Oppose	No

Comments:

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finance8-Danyl

From: Dan Domizio <dand@punahealth.org>
Sent: Monday, March 31, 2014 11:27 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Dan Domizio
15-2662 Pahoa Village rd
Suite 306, PMB 8741
Pahoa, HI 96778

finance8-Danyl

From: Sally May <sonyaniess@gmail.com>
Sent: Monday, March 31, 2014 11:53 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Sally May
495 Awalau Rd
Haiku, HI 96768

From: Cori Takesue <ctakesue@lanaicommunityhealthcenter.org>
Sent: Monday, March 31, 2014 12:00 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Cori Takesue
Lanai Community Health Center
478 Lauhala Pl.
Lanai City, HI 96763

From: Judith Mancini <jdusty@hawaii.rr.com>
Sent: Monday, March 31, 2014 12:06 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
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Mahalo.

Judith Mancini
35 `?kea Place
Kula HI, HI 96790

From: shay Chan Hodges <shay.chanhodges@gmail.com>
Sent: Monday, March 31, 2014 12:14 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

shay Chan Hodges
37 Puu Koa Place
Haiku, HI 96708

finance8-Danyl

From:	mailinglist@capitol.hawaii.gov
Sent:	Monday, March 31, 2014 12:10 PM
To:	FINTestimony
Cc:	tvs.chev@gmail.com
Subject:	Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

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Submitted By	Organization	Testifier Position	Present at Hearing
Chevys Ishikawa	Individual	Oppose	No

Comments: I support and oppose the following bill, I agree there should be some regulation as to where people do "vape" ie: inside restaurants, in stores. I also do believe that shops who sell vape related products should be able to offer their customers the privleage of vaping in their store fronts to sample different eliquids before actually purchasing.

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finance8-Danyl

From: Tyler Ralston <dgkahalas@gmail.com>
Sent: Monday, March 31, 2014 12:09 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Tyler Ralston
PO Box 10528
Honolulu, HI 96816

From: Janelle Kubo <janeltk@hotmail.com>
Sent: Monday, March 31, 2014 12:16 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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SB 2495 SD 3 HD 1 is the first step to regulating ESDs and protecting employees, customers, and the public from inadvertent exposure to nicotine. ESDs are not FDA approved smoking cessation devices and do not emit harmless water vapor. They are currently unregulated and emit nicotine, ultra-fine particles, and other toxins into the air. Failing to act may set us back decades. Please pass SB 2495 SD 3 HD 1 and include ESDs in our smoke-free workplace law.

Mahalo.

Janelle Kubo
2860 Waialae Ave.
Apt. 114
Honolulu, HI 96826

finance1

From: Chris Fukui <chrisfukuimd@gmail.com>
Sent: Monday, March 31, 2014 12:22 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Chris Fukui
380 Halaki St.
Honolulu, HI 96821

From: Allison Seales <Ahs@napuuwai.com>
Sent: Monday, March 31, 2014 12:29 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Allison Seales
Pob 1777
P.O. Box 1777
Kaunakakai, HI 96748

finance8-Danyl

From: Jo Ann Ikehara <jikehara@lava.net>
Sent: Monday, March 31, 2014 12:30 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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It is incumbent upon on us all that we do not allow "going down the path of cigarettes" when they first came on the scene. Smoking was promoted by the tobacco companies and encouraged by our government by their inclusion in the c-rations of our fighting forces. A generation became hooked in a big way. We have known for a long time that the continued use of these products can lead to debilitating illnesses and early death. Treatment of the resultant chronic illnesses is costly; and sadly, the suffering preventable.

Two "thumbs up" for this legislation!

Mahalo nui loa!

Jo Ann Ikehara
2515 North School St
2515 North School Street
Honolulu, HI 96819

finance1

From: Forrest Batz <fbatz@hawaii.edu>
Sent: Monday, March 31, 2014 12:42 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Forrest Batz
34 Rainbow Drive
Keaau, HI 96749

finance1

From: Jessica Yuen <yuenj@hawaii.edu>
Sent: Monday, March 31, 2014 12:51 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Jessica Yuen
Puahiohio Way
Kapolei, HI 96707

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 1:08 PM
To: FINTestimony
Cc: awatanabe67@gmail.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Alan Watanabe	Individual	Oppose	No

Comments:

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finance1

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 1:10 PM
To: FINTestimony
Cc: Jtenn10@aol.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Jolyn M. Tenn	Individual	Oppose	No

Comments: Honorable Chair and Committee Members, Unfortunately I am unable to attend your hearing today because I decided to spend my vacation in the Bahama's where they treat smokers with respect and dignity, no stupid 20 foot rule and they allow smoking in adult restricted establishments. I am a resident of Kaneohe , Hawaii and would love to have come to your hearing, but scheduling does not permit, I am on a plane in 3 hours so Bon Voyage… I do not smoke electronic cigarettes; however, I feel it is imperative to stop this insane persecution that is being perpetuated on the adults of the State of Hawaii. Once again we have a case of the nanny state trying to run amok. Hmmm let's see... First you say Cigarettes are bad, let's have nonsmoking areas... We say, okay. Then, you say, second hand smoke is bad... We say, okay no smoking in work places. So to help smokers deal with all your new regulations, the folks at the world health organization developed a new method of nicotine delivery called the e-cig that proved to be an amicable solution to everyone involved. No smell, no noxious chemicals for others to have to breathe in, etc... Everyone, that is except for the fanatical anti-smoker crowd, who for whatever their reasons can't even stand to see a smoker, because now, that's what we are talking about. It's the reason they are attaching to this legislation, it's all about the visual impact, and that my friend equates to a level of dare I say legal insanity? If you are going to apply the same logic and laws to Electronic Cigarettes and all tobacco products, that they must be banned from the workplace, then you must also include nicotine patches and chewing gum, for they are also purely designed as nicotine delivery systems that we also developed by our dear friends at the world health organization. Please use you heads this time and stop the madness. It is ever so tiring that we citizens have to fight this battle every single year, because a tiny few, whether they be, simply fanatical, or the well paid, special interest groups have nothing better to do with their time. It is truly a sad state of affairs when one group of the population wants to make the lives of the average, everyday hard working adults in this State unbearable simply because of the way that they look. Respectfully and Sincerely, Jolyn M. Tenn

Please note that testimony submitted less than 24 hours prior to the hearing, improperly identified, or directed to the incorrect office, may not be posted online or distributed to the committee prior to the convening of the public hearing.

finance1

From: Maxwell Adams <maxwelladams15@gmail.com>
Sent: Monday, March 31, 2014 1:13 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Maxwell Adams
68-1761
waikoloa, HI 96738

finance1

From: Howard Saiki <zhongxin51039@gmail.com>
Sent: Monday, March 31, 2014 1:19 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Howard Saiki
45-480 B Apiki Street
Apt. D1202
Kaneohe, HI 96744

finance1

From: Megan Chan <mmchan@hawaii.edu>
Sent: Monday, March 31, 2014 1:32 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Megan Chan
3310 Niolopua Drive
Honolulu, HI 96817

finance1

From: Diana Kahler <dkpuamana@hawaiiantel.net>
Sent: Monday, March 31, 2014 1:26 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Diana Kahler
12 West Naauao Place
Hilo, HI 96720

From: Wanya Ogata <wanya.ogata@heco.com>
Sent: Monday, March 31, 2014 1:31 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.
Wanya Ogata

Wanya Ogata
94-392 Keehuhiwa St.
Mililani, HI 96789

finance1

From:	mailinglist@capitol.hawaii.gov
Sent:	Monday, March 31, 2014 2:00 PM
To:	FINTestimony
Cc:	Josephsarabia18@yahoo.com
Subject:	Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495

Submitted on: 3/31/2014

Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Joseph Sarabia	Individual	Comments Only	No

Comments: I don't understand why ecigs should be banned in public places when Tobacco smokers have an area where there allowed to. Ecigs don't have bad odor and second hand smoke which is less harmful. Why categorize E juice when the only thing that has is nicotine. Tobacco has a thousand of chemicals and you try banned something that helps us quit cigarettes . Im Bradley Gebin from the big Island.

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From: Valerie Yontz <vyontz@hawaii.edu>
Sent: Monday, March 31, 2014 2:04 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo. Valerie Yontz

Valerie Yontz
677 Auwina Street
677 Auwina Street Kailua, HI 96734-3430
Kailua, HI 96734

finance1

From:	mailinglist@capitol.hawaii.gov
Sent:	Monday, March 31, 2014 2:12 PM
To:	FINTestimony
Cc:	jason.park1@aol.com
Subject:	*Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Jason Park	Individual	Oppose	No

Comments:

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From: Monika Young <monikaryoung@gmail.com>
Sent: Monday, March 31, 2014 2:14 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Monika Young

Kailua, HI 96734

finance1

From: Pualei Kaohelaulii <pualei.kaohelaulii@doh.hawaii.gov>
Sent: Monday, March 31, 2014 2:09 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
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Mahalo.

Pualei Kaohelaulii
3040 umi street
P.O. Box 52
Lihue, HI 96766

From:	mailinglist@capitol.hawaii.gov
Sent:	Monday, March 31, 2014 2:14 PM
To:	FINTestimony
Cc:	Billygebin@gmail.com
Subject:	Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Billy Gebin	Individual	Comments Only	No

Comments: E-juice is NOT Tobacco. And does NOT contain any Tobacco. Therefore it should NOT be categorized as a Tobacco product.

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finance1

From: Lynda Hirakami <diabeatit@aol.com>
Sent: Monday, March 31, 2014 2:17 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Lynda Hirakami
12-4265 Pahoa Kalapana Rd
Pahoa, HI 96778

From: Sheryl Shook <shooks@hawaii.edu>
Sent: Monday, March 31, 2014 2:36 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

Thank you for the opportunity to submit testimony in strong support of SB 2495 SD 3 HD 1. I strongly support regulating electronic smoking devices (ESDs) by prohibiting the use of ESDs in places open to the public and places of employment.

I support including “electronic smoking devices” in the definition of “tobacco product” and “smoke or smoking” in the smoke-free workplace law, and to prohibit the use of electronic smoking devices in the places where smoking is prohibited. Prohibiting ESD use where smoking is prohibited will protect the public, reduce confusion within society, decrease distractions in the workplace, and maintain social norm.

SB 2495 SD 3 HD 1 is the first step to regulating ESDs and protecting employees, customers, and the public from inadvertent exposure to nicotine. ESDs are not FDA approved smoking cessation devices and do not emit harmless water vapor. They are currently unregulated and emit nicotine, ultra-fine particles, and other toxins into the air. Failing to act may set us back decades. Please pass SB 2495 SD 3 HD 1 and include ESDs in our smoke-free workplace law.

Mahalo.

Sheryl Shook
3038 Woolsey Place
Honolulu, HI 96822

finance1

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 2:26 PM
To: FINTestimony
Cc: mauimoonflower@gmail.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Sabrina Spencer	Individual	Oppose	No

Comments: The legislature needs to stop taking our liberties away all the time. I strongly oppose sb2495!

Please note that testimony submitted less than 24 hours prior to the hearing, improperly identified, or directed to the incorrect office, may not be posted online or distributed to the committee prior to the convening of the public hearing.

Do not reply to this email. This inbox is not monitored. For assistance please email webmaster@capitol.hawaii.gov

finance1

From: Joan Loke <catnap@hawaii.rr.com>
Sent: Monday, March 31, 2014 2:45 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

Thank you for the opportunity to submit testimony in strong support of SB 2495 SD 3 HD 1. I strongly support regulating electronic smoking devices (ESDs) by prohibiting the use of ESDs in places open to the public and places of employment.

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Mahalo.

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PETITION TO STOP HAWAII SB 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill 2495

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PETITION TO STOP HAWAII SB 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill 2495

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PETITION TO STOP HAWAII SB 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill 2495

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PETITION TO STOP HAWAII SB 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill 2495

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PETITION TO STOP HAWAII SB 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill 2495

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PETITION TO STOP HAWAII SB 2496

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PETITION TO STOP HAWAII SB 2496

WE, the undersigned, OPPOSE Hawaii Senate Bill ~~2496~~ 2495

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PETITION TO STOP HAWAII SB ~~2496~~ 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill ~~2496~~ 2495

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PETITION TO STOP HAWAII SB ~~2496~~ 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill ~~2496~~ 2495

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PETITION TO STOP HAWAII SB 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill 2495

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PETITION TO STOP HAWAII SB 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill 2495

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PETITION TO STOP HAWAII SB 2495

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Kory Viernes	1048 A Kamehameha IV Road	koryv@yahoo.com	
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MICHAEL SALVADOR	1223 AH AHI ST APT 4 HON., HI 96817	DRFTER.XXX@yahoo.com	
Cheers Rivera	1514 Dillingham Blvd Apt 205, Hon, Hi 96817	one_voice_duh@yahoo.com	
RICHARD QUIOCHO	91-1055 PAAPAANA ST. EWA BEACH, HI 96706		
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Zachary Medeiros	1141 Hui St Kailua HI 96734	doomsdaydevice808@gmail	
Andrew Meixsell	111 Aekili St Kailua HI 96734	Ameixsell@Hotmail.com	
Lavon Smart	91-454 Kepipi Rd.	lavon.smar.76@gmail	
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Edward Borja	94-1972 Lanikuhana AVE 574 Mililani HI	edward.borja@hotmail	
Velasco Flor	Fort Shafter	velasco24[illegible]	
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Lyle Sarens	P.O. BOX 1555 Kaneohe, HI		
Gene Tugaoen	91-1066 Aipoola St. Ewa Beach, HI	gtugaoen808@gmail.com	
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CA Young Kim	1151 MAPUNAPUNA C6		
Smith, Henry T	74H Hendrickson Loop Wahiawa		
Dominic Shirley	1636 Cowslip lane honolulu 96819	dominic_594@Yahoo	
Jerome Radona	94-085 Alapoai Pl. Mililani Hi 96789		
Kenneth Ana	339 N vineyard Blvd Apt 104	kenneth.Ana.JR@gmail	
JACQUELINE AGREGADO	3404 LIKINI ST HONOLULU HI 96818	AGREGADO@GMAIL.COM	
Kris Ryan	87-885 Waapahi St - Waianae HI 96792	Krismryan@Hotmail.com	
John Newburn	1232 Luakalai St Kapolei HI 96707	JcNewburn@Hotmail.com	

PETITION TO STOP HAWAII SB 2495

WE, the undersigned, OPPOSE Hawaii Senate Bill 2495

NAME	ADDRESS	EMAIL	SIGNATURE
[illegible]	3161 Ala [illegible] St 307	phnelle@yahoo.com	[signature]
Jonathan Tamura	3451 A PAHALEA ST. Honolulu, 96816		[signature]
LeRoy McCullough	947 HOOMOANA ST. PEARL CITY HI 96782	LT.M0815199@GMAIL	[signature]
[illegible]	750 EAST [illegible] Drive Hnl, HI		[signature]
JORDAN TEETS	47-509 ALAWIKI ST.	jordan_teets@hotmail.com	[signature]
Froman Maneja	45-149 Popoki Street Kaneohe Hi		[signature]
Elizabeth Griffin	95-174 Kipapa Dr #49 Mililani Hi	griffin097@gmail	[signature]
Jeff Moran	432 Mananai PL Honolulu HI 96818	no-use-for-a-moan@yahoo	[signature]
Brandon [illegible]	86 193 [illegible] St. Waianae Hi. 96792		[signature]
RYAN [illegible]	1123 ALA OLOALO ST. HON. HI 96818		[signature]
Nate Lee	2002 St. Louis Dr 96816	natelee36@gmail	[signature]
Michael [illegible]	94-220 Pupukahi St 96797		[signature]
steven AKO	1215 [illegible] Rd. Hon. HI. 96819	[illegible]@[illegible].com	[signature]
Alex Shirley	1636 [illegible] Honolulu Hi 96813	muellers820@hotmail	[signature]
Reanne Marquez	91-1003 B. Hawea St. Kapolei, HI 96707		[signature]
Badua, Rayborn	" " " " "	Raybornbadua@yahoo.com	[signature]
[illegible]		[illegible]	[signature]

LATE

From: Michelle Kwock <michellek303@yahoo.com>
Sent: Monday, March 31, 2014 3:48 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

Thank you for the opportunity to submit testimony in strong support of SB 2495 SD 3 HD 1. I strongly support regulating electronic smoking devices (ESDs) by prohibiting the use of ESDs in places open to the public and places of employment.

I support including “electronic smoking devices” in the definition of “tobacco product” and “smoke or smoking” in the smoke-free workplace law, and to prohibit the use of electronic smoking devices in the places where smoking is prohibited. Prohibiting ESD use where smoking is prohibited will protect the public, reduce confusion within society, decrease distractions in the workplace, and maintain social norm.

SB 2495 SD 3 HD 1 is the first step to regulating ESDs and protecting employees, customers, and the public from inadvertent exposure to nicotine. ESDs are not FDA approved smoking cessation devices and do not emit harmless water vapor. They are currently unregulated and emit nicotine, ultra-fine particles, and other toxins into the air. Failing to act may set us back decades. Please pass SB 2495 SD 3 HD 1 and include ESDs in our smoke-free workplace law.

Mahalo.

Michelle Kwock
100 N. Beretania St.
Honolulu, HI 96817

LATE

From: Katherine Labiner <klabiner@hawaii.edu>
Sent: Monday, March 31, 2014 3:43 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Katherine Labiner

Honolulu, HI 96816

To: Representative Sylvia Luke, Chair, Representatives Nishimoto & Johanson, Vice Chairs
Members of Finance Committee

Hrg: Tuesday, April 1, 2014, House Finance Committee @ 2:00pm, Room 308

Re: **Testimony in STRONG SUPPORTof SB 2495, SD3, HD1, "RE Electronic Smoking Devices"**

By: Valerie Chang, JD, Executive Director
Hawaii COPD Coalition, www.hawaiicopd.org
733 Bishop Street, Suite 1550, Honolulu, HI 96813
(808)699-9839
copd.hawaii@yahoo.com

LATE

Thank you for this opportunity in STRONG support of SB2495, regarding the appropriate regulation of electronic smoking devices in the state of Hawaii. This topic is very important to our organization, as we help those who suffer the awful ravages of long-term exposure to tobacco, those with emphysema and chronic bronchitis. I support this measure because regulation of these products is URGENTLY needed in our State.

My name is Valerie Chang. I am Executive Director of the Hawaii COPD Coalition. Our organization provides services and support to Hawaii's people affected by Chronic Obstructive Pulmonary Disease, more commonly known as emphysema and chronic bronchitis. COPD is now the third leading cause of death in the US and second leading cause of disability. Over 46,015 people in Hawaii have already been diagnosed with COPD and it is estimated that at least 46,015 more people may suffer from COPD but remain undiagnosed. Many of these COPD patients were seduced by tobacco when they were very young and unable to quit the addiction for decades, causing irreparable harm. There are ***over $55.9 million in COPD ER and hospital charges in Hawaii each year***.

These electronic smoking devices are sold at lower and lower price points, as low as approximately $10 for a holder and nicotine/fluids for it. These devices are also sold in a huge array of flavors, including bubblegum, and many candy and other flavors. These devices are allowed to be sold in numerous flavors that are illegal for tobacco. At a recent Cessation Advisory Group meeting, one of the Tobacco Treatment Specialists shared that he was at a mall with **his three-year old daughter** who was attracted by the brightly colored display. To the father's horror, the seller offered to let the three year old try the electronic smoking device that the seller had for sale! Other specialists present indicated that many of the high school students on all islands that they work with indicate they have electronic smoking devices and have no trouble purchasing them.

Other tobacco treatment specialists at the meeting indicated that some of their clients shared that they use the electronic smoking devices to consume illegal substances (including "ice"). There is no information about how commonly the electronic smoking devices are used/misued in this manner, but it points out additional dangers.

One of the other big problems is that **NO ONE** knows what chemicals are in the vapors exhaled from the fumes of these electronic smoking devices (which can and do include high amounts of the poison, nicotine, and other substances, as well as many other additives), which are currently being used in a variety of enclosed and indoor spaces (including stores, restaurants and food preparation areas). This is big concern for people with compromised lungs, as vapors can be a strong irritant and inhaling the vapors given off by others can cause serious breathing problems. **No one** should have to e subjected to unknown vapors from others that they do not choose, which will continue to occur unless regulations to prohibit such exposure are passed now.

Thanks for the opportunity to testify about this issue that is so vital to the health of Hawaii. This issue is very important to our state and our Hawaii COPD Coalition is very glad that this committee has taken a leadership role in addressing this important matter. **Please vote in favor of SB 2495, SD3, HD1 to appropriately regulate electronic smoking devices.** Thank you.

From: Katherine Labiner <klabiner@hawaii.edu>
Sent: Monday, March 31, 2014 3:43 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

LATE

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Katherine Labiner

Honolulu, HI 96816

LATE

From: Jim Niess <Jim@mauiarch.com>
Sent: Monday, March 31, 2014 4:17 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Jim Niess
495 Awalau Rd.
Haiku, HI 96708

finance8-Danyl

LATE

From: Stephanie Austin <stephandjim@aol.com>
Sent: Monday, March 31, 2014 4:15 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Stephanie Austin
495 Awalau Rd.
Haiku, HI 96708

LATE

From: Kirsten Ralston <Ksmithralston@yahoo.com>
Sent: Monday, March 31, 2014 4:20 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Kirsten Ralston
PO box 10528
Honolulu, HI 96816

LATE

American Heart Association | American Stroke Association

Testimony in SUPPORT of SB 2495, SD3, HD1
"Relating To Electronic Smoking Devices"

The American Heart Association supports SB 2495, SD 3, HD1, "Relating to Electronic Smoking Devices."

The American Heart Association is dedicated to supporting state and local action to protect the public from the dire effects of tobacco. As you are undoutedly aware, tobacco use is one of the leading preventable risk factors for cardiovascular diseases. As we've learned through our policy efforts to restrict smoking in public and work places, such policies not only reduce exposure to non-smokers of deadly environmental tobacco smoke, but also have the added benefit of changing the public norms regarding tobacco use.

The emergence of e-cigarettes threaten to reverse those advances in de-normalizing tobacco use. The science around the safety of use of e-cigarettes has not yet been fully studied, and because e-cigarettes are not yet regulated by the U.S. Food and Drug Administration the nicotine levels and chemicals in the various brands being marketed vary. In addition, there is inadequate evidence to support the use of e-cigarettes as a smoking cessation strategy. In fact, it should be noted that one of the concerns about expanded and increased use of e-cigarette products in the general population is the dual use of cigarettes and e-cigarette products. The AHA recommends that clinicians should continue to discourage use of all tobacco products and emphasize prevention of tobacco initiation and tobacco cessation as primary goals for tobacco control.

Legislators are encouraged to support SB 2495, SD 3, HD1 to help reduce the exposure of e-cigarette particulate- and nicotine-laced aerosol by non-users, and to continue to denormalize sociatally nicotine addiction.

Respectfully submitted,

Donald B. Weisman

Donald B. Weisman
Hawaii Government Relations/Community Relations Director

Serving Hawaii since 1948

Mission Statement:
"Building healthier lives, free of cardiovascular diseases and stroke."

For more information on the AHA's educational or research programs, visit www.heart.org or contact your nearest AHA office.

Oahu:
677 Ala Moana Blvd., Ste. 600
Honolulu, HI 96813
Office: (808) 538-7021
Fax: (808) 538-3443

Maui:
Office: (808) 244-7185
Fax: (808) 538-3443

Hilo:
Office: (808) 282-3107
Fax: (808) 538-3443

Kauai:
Serviced by the Oahu office.

LATE

From: Cheryl Albright <hi.albrights@yahoo.com>
Sent: Monday, March 31, 2014 5:16 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Cheryl Albright
2344 Halekoa Drive
Honolulu, HI 96821

LATE

From: Don Weisman <don.weisman@heart.org>
Sent: Monday, March 31, 2014 5:23 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

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Mahalo.

Don Weisman
647 Akoakoa st.
Kailua, HI
Kailua, HI 96734

LATE

From: mailinglist@capitol.hawaii.gov
Sent: Tuesday, April 01, 2014 8:00 AM
To: FINTestimony
Cc: 4spiritnsoul@gmail.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 4/1/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Naomi C. Liu	Individual	Oppose	No

Comments: So the legislature now wants to ban people using electronic cigarettes to quit. This bill is soooooooo sick!

Please note that testimony submitted less than 24 hours prior to the hearing, improperly identified, or directed to the incorrect office, may not be posted online or distributed to the committee prior to the convening of the public hearing.

LATE

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 10:45 PM
To: FINTestimony
Cc: jchangworld@gmail.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Jessica Chang	Individual	Oppose	No

Comments:

Please note that testimony submitted less than 24 hours prior to the hearing, improperly identified, or directed to the incorrect office, may not be posted online or distributed to the committee prior to the convening of the public hearing.

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finance8-Danyl

LATE

From:	mailinglist@capitol.hawaii.gov
Sent:	Monday, March 31, 2014 8:04 PM
To:	FINTestimony
Cc:	wintersnicholas@rocketmail.com
Subject:	Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Nicholas Winters	Individual	Oppose	No

Comments: Oppose

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LATE

From: Angela Sy <sya@hawaii.edu>
Sent: Tuesday, April 01, 2014 9:12 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
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ESDs are currently unregulated and emit nicotine, ultra-fine particles, and other t oxins into the air. Failing to act may set us back decades in a state where we have been progressive in protection of the harmful and deadly effects of tobacco use . Please pass SB 2495 SD 3 HD 1 and include ESDs in our smoke-free workplace law.

Mahalo.

Angela Sy
2600 Campus Rd.
QLSSC #413, attn: Maile Goo
Honolulu, HI 96817

LATE

From:	mailinglist@capitol.hawaii.gov
Sent:	Monday, March 31, 2014 6:37 PM
To:	FINTestimony
Cc:	kathyk323@hotmail.com
Subject:	*Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Kathy Kim	Individual	Oppose	No

Comments:

Please note that testimony submitted less than 24 hours prior to the hearing, improperly identified, or directed to the incorrect office, may not be posted online or distributed to the committee prior to the convening of the public hearing.

Do not reply to this email. This inbox is not monitored. For assistance please email webmaster@capitol.hawaii.gov

LATE

From: Kelii Bandmann <kman08@hotmail.com>
Sent: Tuesday, April 01, 2014 8:16 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Kelii Bandmann

Mililani, HI 96789

LATE

From: Kauila Ho <kauila.npk@gmail.com>
Sent: Tuesday, April 01, 2014 7:45 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Kauila Ho
75-166 Kalani St
Kailua-Kona, HI 96704

LATE

From: Brent Tamamoto <btamamoto@gmail.com>
Sent: Tuesday, April 01, 2014 12:08 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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Mahalo.

Brent Tamamoto
98-1065 Kaamilo Street
Aiea, HI 96701

LATE

From: Bryan Mih <bmih@hawaii.edu>
Sent: Monday, March 31, 2014 9:14 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
Members, House Committee on Finance

Re: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

Dear Committee Members:

As a pediatrician in Honolulu and medical director of the HEALTHY Tobacco & Nicotine Cessation Program, I strongly support SB 2495.

Electronic smoking devices are clearly products meant to approximate the use of cigarettes and other tobacco products. The inclusion of electronic devices that vaporize nicotine is an important step in maintaining consistency in the laws. The definition of tobacco product and smoking must also include the use of these electronic smoking devices, which should be prohibited in the same places that smoking is prohibited, including smoke-free workplaces.

Electronic smoking devices take a mixture of chemicals, including nicotine, and vaporize it at high temperatures. These devices emit nicotine byproducts and a variety of other chemicals, and they have not been fully studied in regards to safety. E-cigarette vapor has been shown to include carcinogens and toxins including nicotine, nitrosamines, diethylene glycol, formaldehyde, and acetaldehyde. The U.S. Food and Drug Administration has exhibited concern regarding the safety of electronic smoking devices as well.

SB 2495 must be passed to provide protection for the public while science continues to emerge with more information about the emissions and chemicals released from the vapor. In the interest of public health, I urge you to pass SB 2495 and prevent electronic smoking devices from sneaking by current smoke-free laws.

Thank you for your consideration and support of this important measure.

Sincerely,

Bryan Mih, MD, MPH, FAAP
Pediatrician

Bryan Mih
1944 Naniu Pl
Honolulu, HI 96822

14 Electronic Cigarette Studies That Shame the Critics

LATE

Lack of research is one of the biggest myths we hear from e-cigarette critics. Many people assume that e-cigs have not been studied in detail because the research is not heavily published by the main stream media. However, there have already been many clinical trials and research projects conducted that found promising results for e-cigarettes. Here is a look at some of the most important studies we have seen to date.

Secondhand Vapor Contains Nicotine, But No Combustible Toxins

The **Oxford Journal** published a study in December 2013 where scientists looked at what toxins might be in secondhand vapor. They found that e-cigs have no combustion related toxins present in the vapor and only a small amount of nicotine was found in secondhand vapor. Researchers concluded that more studies were needed to determine if there was any risk involved with secondhand nicotine exposure.

E-Cigs Do Not Stiffen the Arteries

The **Onassis Cardiac Surgery Center** in Greece compared the impact of e-cigarettes and tobacco cigarettes on heart function. The researchers discovered that smoking even two tobacco cigarettes will cause the aorta to stiffen, but e-cigarettes caused no difference to the aorta and no stiffening of the arteries.

Flavored **E-Liquids Help Smokers Stop Using Tobacco**

Dr. Konstantino Farsalinos headed up **a study** to determine whether flavored e-liquids had any impact on the success rate of smokers seeking to quit. He concluded that e-liquid flavoring “are important contributors in reducing or eliminating smoking consumption.”

Smoking Kills, and So Might E-Cig Regulation

Dr. Gilbert Ross, medical and executive director of the American Council on Science and Health offered a comprehensive report on e-cigarettes, concluding that e-cigarettes are much healthier than tobacco cigarettes according to common sense. He suggested that regulating e-cigs could be a deadly decision for public health.

E-Cigs Are Effective for Smoking Cessation and Prevent Relapse

Researchers at the University of Auckland and the University of Geneva studied the impact of e-cigarettes on former smokers. They concluded that e-cigs could prevent former smokers from relapsing into tobacco use and they could effectively help current smokers quit.

E-Cigs Are Not a Gateway to Tobacco Use Among Teens

Dr. Ted Wagener from the University of Oklahoma Health Sciences Center studied the impact of e-cigarette use on 1,300 college students. He discovered that only one person that first used nicotine in the form of e-cigs went on to start smoking tobacco cigarettes. He concluded that e-cigs were not a gateway to tobacco use.

E-Liquid Has No Adverse Effects on Heart Health

The International Journal of Environmental Research and Public Health published a **study** on how e-liquids impact heart cells. After testing 20 different e-liquids, the researchers concluded that vapor had no adverse effect on cardiac cells.

E-Cig Use Has No Impact on the Oxygenation of the Heart

Dr. Konstantino Farsalinos studied how e-cig use impacted oxygenation of the heart. He concluded that vaping had no impact on oxygen supply and coronary circulation. These findings were revealed at the European Society of Cardiology Annual Congress in Amsterdam in 2013.

E-Liquids Pose No Concerns for Public Health

Professor Igor Burstyn of Drexel University School of Public Health studied e-liquids to determine if the chemicals in e-liquid could be dangerous. He concluded that e-liquids pose no health concerns whatsoever.

Health Improves After Smokers Switch to E-Cigarettes

Independent university researchers conducted a **study** to find out whether switching to e-cigs had any influence on health. They concluded that 91 percent of smokers that switched to electronic cigarettes had notably improved health. They also noted that 97 percent had reduced or completely eliminated chronic coughs.

E-Cigs Reduce Risk of Tobacco-Related Death

Boston University of Public Health **conducted a study** to see how e-cigarettes impacted mortality risks related to tobacco. Researchers concluded, "Electronic cigarettes are a much safer alternative to tobacco."

Electronic Cigarettes Are Effective for Smoking Cessation

The University of Catania conducted **a study** to learn whether e-cigs would be effective as smoking cessation devices. After six months, nearly 25 percent of participants had quit smoking completely. Over 50 percent had cut cigarette use in half.

E-Cigs Cause No Major Respiratory Impact

Researchers compared first and second hand impacts of exposure to e-cigarette vapor to learn how it would impact respiratory function. The result was that secondhand exposure to tobacco smoke was more damaging to lung function than first hand exposure to vapor from e-cigarettes. They concluded that e-cigs cause no acute respiratory impact.

Second Hand Exposure to E-Cig Vapor Poses No Risks

In a French **study**, researchers found that e-cig vapor dissipated within 11 seconds on average. In contrast, cigarette smoke lingered for an average of 20 minutes. They concluded that secondhand exposure to e-cig vapor causes no public risk.

These studies are just the beginning. Every month, we find out about new studies all over the world to discover the true impact of electronic cigarettes. So far, research clearly shows that e-cigarettes are a better alternative to tobacco use. What are other studies that you hope to see in the future?

LATE

From: kim Ora-a <koraa8@yahoo.com>
Sent: Monday, March 31, 2014 8:42 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
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Mahalo.

kim Ora-a
2864 Liholani St.
2864 Liholani St. Makawao
Makawao, HI 96768

LATE

From: kim Ora-a <koraa8@yahoo.com>
Sent: Monday, March 31, 2014 8:42 PM
To: FINTestimony
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Mahalo.

kim Ora-a
2864 Liholani St.
2864 Liholani St. Makawao
Makawao, HI 96768

LATE

From: Carol Kozlovich <carolkozdesigns@aol.com>
Sent: Monday, March 31, 2014 7:39 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
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Mahalo.

Carol Kozlovich
P.O. Box 25606
Honolulu, HI 96825

LATE

From: Abby Brown-Watson <abbykailua@gmail.com>
Sent: Monday, March 31, 2014 7:17 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
The Honorable Aaron Ling Johanson, Vice Chair, Committee on Finance
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Mahalo.

Abby Brown-Watson
769 N. Kainalu Drive
Kailua, HI 96734

LATE

From: Jill Friedman <jillf2184@yahoo.com>
Sent: Monday, March 31, 2014 7:15 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
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Mahalo.

Jill Friedman
PO Box 427
Hanapepe, HI 96716

LATE

From: pat fleck <pat.fleckconsulting@hawaiiantel.net>
Sent: Monday, March 31, 2014 7:12 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Respectfully,

Patricia Fleck

pat fleck
75-5660 Kopico Street, Ste. C7-330
kailua kona, HI 96740

Amy K. Halas
PO Box 925
Kane’ohe, Hawai’i 96744

LATE

March 31, 2014

Dear Representative Luke and Members of the House Committee on Finance:

I am writing to express my support of SB 2495, SD3, HD1 which would prohibit the use of electronic smoking devices in enclosed public areas and other specified locations under HRS 328J.

I have a 3 year old child. We used to visit Windward Mall on a regular basis. The reason why we reduced our visits to once a week is because Volcano Electronic Cigarette established an open-air kiosk that is located a few yards from the HMSA-sponsored Hokule'a soft-play area.

On more than one occasion, my 3 year old and I have walked past the Volcano Electronic Cigarette kiosk only to INHALE the fruity scent that was exhaled by various Volcano Electronic Cigarette employees and customers. This is VERY problematic because the dangers of liquid nicotine e-cigarette refills are becoming extremely apparent and the hazardous effects consequently widespread, sending many children and babies to the emergency room.

I find it ironic that one of the State's largest health care providers (HMSA) sponsors a play area that is located within extreme proximity to the Volcano Electronic Cigarette Kiosk. From my perspective, it appears that the Volcano Electronic cigarettes are marketed as glamorous, convenient, safe, and fun. Therefore, I ask you, WHAT KIND OF MESSAGE ARE WE SENDING TO OUR EXTREMELY IMPRESSIONALBE AND VULNERABLE BABIES, TODDLERS AND PRESCHOOLERS? What about the youth in elementary, middle and high school? A child will look at the attractive electronic cigarette and be drawn to the fruity smell, mistaking it for candy or something else pleasurable. This is WRONG.

Furthermore, I was recently at Windward City Shopping Center and passed by another electronic cigarette store located near the Department of Motor Vehicles. I was HORRIFIED to see the store FULL OF SMOKE, and worse yet: I saw at least ONE TODDLER running around INSIDE this electronic cigarette store surrounded by smoke. It appeared that there was no ventilation or circulation in this establishment and I can only wonder how the second-hand smoke affected this very young child.

FOR THE SAKE OF OUR CHILDREN AND YOUNG ADULTS, I URGE THE STATE OF HAWAI'I LEGISLATURE TO PASS AND ENACT THIS LEGISLATION IMMEDIATELY.

Thank you

Amy K. Halas

LATE

From: mailinglist@capitol.hawaii.gov
Sent: Monday, March 31, 2014 6:02 PM
To: FINTestimony
Cc: anthony_orozco@yahoo.com
Subject: *Submitted testimony for SB2495 on Apr 1, 2014 14:00PM*

SB2495
Submitted on: 3/31/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Anthony Orozco	Individual	Oppose	No

Comments:

Please note that testimony submitted less than 24 hours prior to the hearing, improperly identified, or directed to the incorrect office, may not be posted online or distributed to the committee prior to the convening of the public hearing.

From: Sharon Shigemasa <sshigemasa@cc.hawaii.edu>
Sent: Tuesday, April 01, 2014 11:29 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

LATE

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Sharon Shigemasa
1006 Leomele Street
Pearl City, HI 96782

LATE

From: Benjamin Gates <Activehi@live.com>
Sent: Tuesday, April 01, 2014 11:57 AM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

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The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Benjamin Gates
84-724 Moua St A
Waianae, HI 96792

LATE

From: Jacqueline Tellei <jtellei@waikikihc.org>
Sent: Tuesday, April 01, 2014 12:29 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
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Mahalo.

Jacqueline Tellei
3662 Alani Drive
Honolulu, HI 96822

LATE

From: Rebecca Knight <rknight@cc.hawaii.edu>
Sent: Tuesday, April 01, 2014 1:46 PM
To: FINTestimony
Subject: Strong Support for SB 2495 SD 3 HD 1, Relating to Electronic Smoking Devices

To: The Honorable Sylvia Luke, Chair, Committee on Finance
The Honorable Scott Y. Nishimoto, Vice Chair, Committee on Finance
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Mahalo.

Rebecca Knight
701 Ilalo Street
Honolulu, HI 96813

finance8-Danyl

LATE

From: mailinglist@capitol.hawaii.gov
Sent: Tuesday, April 01, 2014 2:23 PM
To: FINTestimony
Cc: k.sakumoto48@gmail.com
Subject: Submitted testimony for SB2495 on Apr 1, 2014 14:00PM

SB2495
Submitted on: 4/1/2014
Testimony for FIN on Apr 1, 2014 14:00PM in Conference Room 308

Submitted By	Organization	Testifier Position	Present at Hearing
Kevin	Individual	Oppose	No

Comments: I strongly oppose SB2495,SD3,HD1. Electronic smoking devices are a safer alternative to smoking actual cigarettes and it's industry creates more jobs for people in Hawaii. By increasing taxes on electronic smoking devices it will drive people back to cigarettes because it would be far more expensive than buying a pack of cigarettes.

Please note that testimony submitted less than 24 hours prior to the hearing, improperly identified, or directed to the incorrect office, may not be posted online or distributed to the committee prior to the convening of the public hearing.

Do not reply to this email. This inbox is not monitored. For assistance please email webmaster@capitol.hawaii.gov

PETITION TO STOP HAWAII SB 2495

We the undersigned, OPPOSE Hawaii Senate Bill 2495

NAME	ADDRESS	EMAIL	SIGNATURE
monica macbual	1524 meyers st. 96819	monica.jenna25@gmail.com	
Heather Casella	1720 Ala Moana Blvd	isis081902@gmail.com	
Mark Yacubovich	1720 Ala Moana Blvd	aloha1227@yahoo.com	
Leland Akau	2617 Namau Dr	Lakaujr@gmail.com	
Stan Nishimura	1142 S. King St #4014 Hon 96814	sflum@yahoo.com	
VAN PAIK	PO BOX 88614 Hon HI	RESERVATIONS@RAVALHAWAII.NET	
Matthew Kim	1610 KAMUNU ST #[illegible] HON, 96814	Mettyi_80@HOTMail.com	
Sam Hop	4205 Mana St [illegible] HI 96[illegible]	sam.hop@hotmail.com	
Robert Azevedo	1720 Ala Moana Blvd. Hon. Hi 96815	foodbloodline@yahoo.com	
Kim McDONALD	469 ENA RD HONOLULU	mclazzy@hotmail.com	
Noelle Lum	47002 Hui Iwa pl Kaneohe HI 96744	lum.noelle@gmail.com	
FLORENCE JEFFERSON	1545 Kalakaua Ave #903 Hon. HI 96826	flofloj0352@gmail	
Gilbert Braun	47 376 Kea[illegible] Pl. Kaneohe HI 96744		
Joseph Ting	3514 Pahoa St, Honolulu, HI 96816	synapse420@gmail.com	
Amris Kapaona	98-346 Ponohale St Aiea 96701		
Kevin Blitte	1746 Hunnaj St. #3 96817	greenlighthawaii@gmail	
Terrell Butler	652 [illegible] St Honolulu Hi.	TerrellButler.J.83@yahoo.com	
Cynthia Short	436 Ena RD Honolulu	cshort@live.com	
Aaron Castellan	66 CALIFORNIA AVE WAHIAWA	HawaiianAlliance78@gmail.com	
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Sofia Noriega	P.O Box 3475 [illegible] 96744	[illegible]777@gmail	
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SUSANNE N. SHIBATA	1245 - 7th AVE HONO. HI 96816		
Jon Colombo	2324 Lime St 96826 Hon.	jon.t@aol.com	
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