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Electronic nicotine delivery systems: is there a need for regulation?

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ABSTRACT

Purpose Electronic nicotine delivery systems (ENDS) purport to deliver nicotine to the lungs of smokers. Five brands of ENDS were evaluated for design features, accuracy and clarity of labelling and quality of instruction manuals and associated print material supplied with products or on manufacturers' websites.

Methods ENDS were purchased from online vendors and analysed for various parameters.

Results While the basic design of ENDS was similar across brands, specific design features varied significantly. Fluid contained in cartridge reservoirs readily leaked out of most brands, and it was difficult to assemble or disassemble ENDS without touching nicotine-containing fluid. Two brands had designs that helped lessen this problem. Labelling of cartridges was very poor; labelling of some cartridge wrappers was better than labelling of cartridges. In general, packs of replacement cartridges were better labelled than the wrappers or cartridges, but most packs lacked cartridge content and warning information, and sometimes packs had confusing information. Used cartridges contained fluid, and disposal of nicotine-containing cartridges was not adequately addressed on websites or in manuals. Orders were sometimes filled incorrectly, and safety features did not always function properly. Print and internet material often contained information or made claims for which there is currently no scientific support.

Conclusions Design flaws, lack of adequate labelling and concerns about quality control and health issues indicate that regulators should consider removing ENDS from the market until their safety can be adequately evaluated.

INTRODUCTION

Electronic nicotine delivery systems (ENDS) have gained worldwide usage¹ with little information available on their health effects.² Nicotine is an addictive and dangerous chemical that can cause death of adults at doses of 60 mg,³ promote tumour growth^{4 5} and be converted to carcinogens.⁶ In many US states, ENDS are readily available to anyone, including children, in shopping malls and on the internet. Despite worldwide use, little is known about the properties of ENDS, potential hazards or effects on health.

Investigations of the composition of ENDS aerosol have reached different conclusions. In an FDA report, the levels of carcinogens and diethylene glycol, a toxic contaminant, were sufficient to question safety and quality control,⁷ while a study supported by an ENDS manufacturer concluded that these products are safe.⁸ In a preliminary study involving humans, ENDS unexpectedly failed to elevate nicotine levels in the blood of smokers,

calling into question their usefulness as nicotine delivery devices.⁹ The paucity of information on ENDS limits policymakers' ability to appraise the potential public health consequences of their widespread use. While some countries have banned ENDS, other countries, including the USA, are wrestling with regulation.¹⁰ More information about ENDS is needed to inform government decision-making.

We compared the design, labelling, packaging and accompanying print material for six brands of ENDS. Our data suggest that design improvements and regulation are needed to minimise potential hazards from ENDS.

MATERIALS AND METHODS

Six brands of ENDS were evaluated (table 1). Cigarette kits and replacement cartridges were purchased from internet vendors. Design, nicotine content, labelling, leakiness, defective parts, disposal, errors in filling orders, instruction manual quality and advertising were evaluated for each brand. Some information in table 1 was solicited by us in emails to vendors, and some parameters were evaluated using a smoking machine.¹¹

RESULTS

Variations in design

While all ENDS had a battery, atomiser and cartridge, design details of each brand differed (figure 1A). Battery length, cigarette colour and size of the air holes (not visible) near the red indicator light varied among brands. Manufacturers' names were printed on each battery, but it was sometimes difficult to distinguish between types of batteries within a brand. For example, the Crown Seven battery was not identified as the 'Hydro' model, and one Smoking Everywhere battery was not identified as the 'Platinum' model.

Atomisers had threads that screwed into the battery at one end and a U-shaped heating element that inserted into the cartridge at the opposite end. Atomisers from Liberty Stix, Crown Seven, Smoking Everywhere Gold and VapCigs were similar in design, but differed in length. Atomisers were not labelled, and some were interchangeable among brands. The Smoking Everywhere Platinum atomiser came embedded in the cartridge and was disposable.

Cartridges consisted of a reservoir that holds ENDS fluid and a mouthpiece. Reservoirs, varied in size, were open only at one end, and generally had flat surfaces that allowed aerosol to pass around the reservoir and into the mouthpiece. When assembled, the atomiser tip projected into the reservoir. Mouthpieces were generally cylindrical (NJOY was

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Table 1 Brands of ENDS and their properties* †

Brand models	Relative nicotine content	Nicotine (mg)‡	Cigarette equivalent§	Puffs per cartridge	Available flavours
NJOY NCIG	Website: regular	18	Website: 40 Email: 30	Website: no information Email: no response	Regular (traditional), menthol, vanilla, strawberry, and apple
	Email: regular				
	Website: light	12			
	Email: medium				
Liberty Stix	Website: ultra light	6	Website: 1 battery starter kit: 30 2 battery starter kit: 20 cartridges & packs:15-20 Email: 15-20	Website: 60-80 Email: 60-80	Tobacco, mint, vanilla, cherry, chocolate, and coffee
	Email: low				
	Website: none	0			
	Email: zero				
Crown Seven Hydro	Website: high	24	Website: 10 Email: 8-10	Website: no information Email: 150	Regular (tobacco), menthol, vanilla bean, strawberry, untamed cherry, coffee (espresso), and many others
	Email: high				
	Website: medium	18			
	Email: med				
Smoking Everywhere Gold and Platinum	Website: light/low	11	Website: 15–20 Email: no response	Website: no information Email: no response	Tobacco, menthol
	Email: low				
	Website: zero	0			
	Email: zero				
Smoking Everywhere Gold and Platinum	Website: high	16	Website: 15–20 Email: no response	Website: no information Email: no response	Tobacco, menthol
	Email: high				
	Website: medium	11			
	Email: med				
Smoking Everywhere Gold and Platinum	Website: low	6	Website: 15–20 Email: no response	Website: no information Email: no response	Tobacco, menthol
	Email: low				
	Website: none	0			
	Email: none				
VapCigs	Website: extra high (platinum only)	24	Website: no information Email: no response	Website: no information Email: no response	Tobacco, menthol, cherry, java, grape
	Email: no response				
	Website: high	16			
	Email: no response				
VapCigs	Website: medium	11	Website: no information Email: no response	Website: no information Email: no response	Tobacco, menthol, cherry, java, grape
	Email: no response				
	Website: low	6			
	Email: no response				
VapCigs	Website: none	0	Website: no information Email: no response	Website: no information Email: no response	Tobacco, menthol, cherry, java, grape
	Email: none				
	Website: none	0			
	Email: no response				

*ENDS starter kits and refill cartridges were purchased from internet distributors: Liberty Stix (Liberty Stix, Cleveland, OH, USA), Smoking Everywhere Gold and Platinum (Smoking Everywhere, Inc, Sunrise, FL, USA), Crown Seven Hydro (Crown Seven Shop, Scottsdale, AZ, USA), NJOY NCIG (Sottera Inc, Scottsdale, AZ, USA) and VapCigs (VapCigs, Norco, CA, USA).

†Website information and email correspondence were obtained in March 2010.

‡Nicotine dose (mg) was provided by the manufacturer. The 'Relative Nicotine Content' (preceding column) describes the dose in the 'Nicotine' column. 'Content' given on websites and in responses to our email inquiries sometimes varied.

§'Cigarette Equivalent' = the approximate number of conventional cigarettes/one ENDS cartridge as reported on the company's website or in response to an email enquiry.

tapered), had a small air hole at one end and were wide open at the opposite end which slid into (NJOY) or over (all others) the atomiser.

To prevent fluid from escaping, cartridges had plastic plugs or caps at the large open end, except for VapCigs which had reservoirs sealed by aluminium foil. The open end of NJOY cartridges had a small rubber cap which was covered by a larger plastic cap. Prior to smoking, the plugs/caps were removed, and for VapCigs, the foil was punctured by the atomiser when the cigarette was assembled. Replacement cartridges came in plastic wrappers, except for Smoking Everywhere Platinum, which had only plastic caps on both ends.

Nicotine

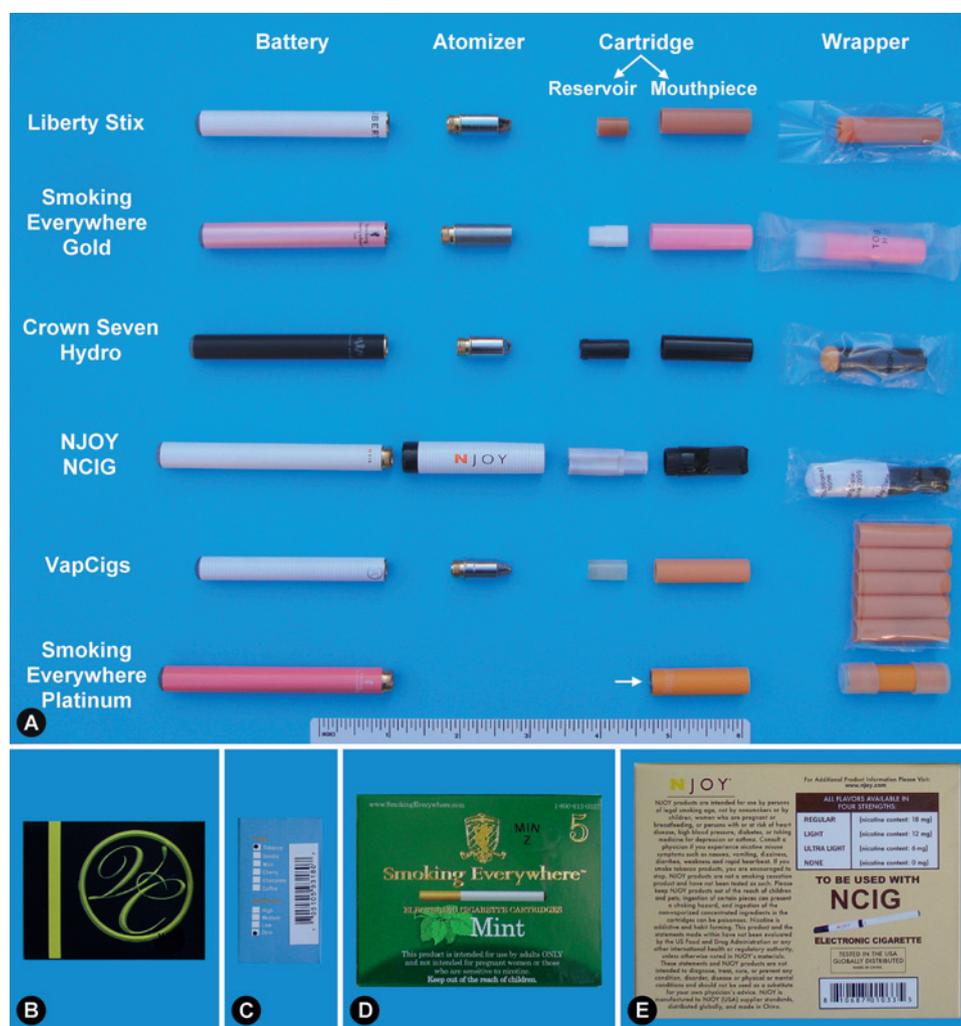
All brands were sold with ambiguous amounts of nicotine/cartridge. Nicotine was usually indicated by a number followed by 'mg' (eg, 24 mg). It was not clear if this was mg/cartridge or mg/ml. Values for nicotine ranged from 6 mg (NJOY) to 24 mg (Liberty Stix, Smoking Everywhere Platinum). Some cartridges

claimed no nicotine (0 mg). Manufacturers used terms such as zero/no, low/light, medium, high and extra high to categorise nicotine strength. However, these terms usually referred to different nicotine concentrations when comparing across brands. For example, Liberty Stix high cartridges had 24 mg of nicotine, while Crown Seven Hydro high had 16 mg (table 1).

Labelling of cartridges

None of the cartridges was clearly labelled with the manufacturer's name, nicotine concentration, expiry date and flavour (figure 1A). Cartridges with no nicotine looked identical to those with high nicotine and were indistinguishable once removed from their wrappers or packs. Liberty Stix had the word 'Liberty' on a few cartridges. Smoking Everywhere Platinum had 16 mg or 24 mg stamped on cartridges with no indication of its meaning. The Liberty Stix, Crown Seven, Smoking Everywhere Gold and VapCigs cartridges looked similar and often could be interchanged among brands. The Smoking Everywhere Platinum starter kit was reported on its website and the starter kit case to

Figure 1 Design and labelling of six models of ENDS. (A) All models have a battery, atomiser and cartridge (reservoir plus mouthpiece). The end of the VapCigs reservoir adjacent to the atomiser is sealed by foil. The Smoking Everywhere Platinum cartridge contains a disposable atomiser (arrow). Reservoirs vary in size with approximate volumes ranging from 386 mm³ (Liberty Stix) to 1176 mm³ (NJOY). Examples of wrappers containing replacement cartridges are at the far right. Most replacement cartridges come sealed in unlabelled wrappers and have plugs or caps covering the end that attaches to the atomiser. Smoking Everywhere Platinum was capped at both ends but not in a wrapper. (B–E) Labelling of packs of replacement cartridges showing minimal labelling on VapCigs pack (B), handwritten marks indicating flavour and strength on a Liberty Stix pack (C), more complete labelling on the front of a Smoking Everywhere pack (D) and very detailed labelling and warnings on the back of an NJOY pack (E).



come with high strength (16 mg) cartridges; however, the pack inside one kit was labelled '24 mg'.

Labelling of wrappers

Replacement cartridge wrappers were more informative than cartridges, although none clearly included the amount of nicotine and manufacturer's name (figure 1A). NJOY wrappers included strength (high, medium, low nicotine), flavour and expiry date. Smoking Everywhere Gold wrappers had flavour and a letter indicating strength, although labels were confusing (eg, 'MIN Z' or 'TOB H' or 'Tobacco Original NO'). Crown Seven wrappers had strength (eg, 'High') with no indication of flavour. Only Crown Seven's assorted pack wrappers indicated the specific flavour with strength. NJOY, Smoking Everywhere Gold and Crown Seven wrappers were labelled with small stickers that could easily fall off. Only a few Liberty Stix wrappers had the word 'Liberty' typed out, and none indicated strength or flavour. VapCigs starter kits included cartridges without wrappers, while replacement cartridge wrappers were unlabelled.

Labelling of packs

Replacement cartridges are sold in 'packs', which had labels with more information than cartridges and cartridge wrappers. However, packs in general were not uniformly labelled within or between brands (figure 1B–E).

Except for NJOY and Crown Seven, no packs indicated nicotine concentration, although all manufacturers attempted to

indicate strength (eg, high, medium, no nicotine) and flavour. VapCigs packs had only strength (on all packs) and flavour (some packs) plus the letters 'VC' to indicate brand (figure 1B). Liberty Stix packs had flavour and strength with a handwritten dot next to a checkbox (figure 1C). Crown Seven indicated strength with a handwritten dot and flavour with either a handwritten dot or a small sticker (not shown). Terminology was inconsistent on Crown Seven's packs. For example, one pack had a handwritten dot next to 'espresso', while another had a 'coffee' sticker. It was not clear if these were the same flavours. Although there was a checkbox for the Crown Seven 'assorted' pack, 'assorted' was handwritten on packs. The pre-printed choices on the Crown Seven packs did not fully correspond to choices on their website, and none of the Crown Seven packs indicated the cartridges were for the Hydro model only. Smoking Everywhere packs were not uniform in their design, information or colour (figure 1D). Smoking Everywhere Gold packs did not state that cartridges were for the Gold kit only, while Platinum packs had 'Platinum' on four faces. The Gold tobacco flavoured packs had a sticker on the back side stating the flavour and strength as 'TOB H' or 'Tobacco Original NO' which were confusing. Mint flavoured packs had 'Mint' on the pack faces, yet used stickers on the back to indicate the flavour and strength, and again the code was cryptic (eg, 'MIN H' or 'MIN L' or 'MIN Z'). NJOY had strength and flavour directly printed on packs.

Liberty Stix and Smoking Everywhere Platinum did not list cartridge ingredients. Smoking Everywhere Gold, Crown Seven

Research paper

and our original packs of NJOY listed ingredients as nicotine, water, flavouring (not specified) and propylene glycol. Recent shipments of NJOY included ethanol, glycerol, acetylpyrazine, guaiacol, mysomine, cotinine and vanillin. All packs listing ingredients included nicotine, even zero strength packs. All packs (including zero strength), except Crown Seven and VapCigs, had some form of warning regarding nicotine. Only some Smoking Everywhere Gold packs had a Surgeon General's warning. NJOY packs indicated the FDA had not approved the product, whereas Crown Seven and Liberty Stix packs had no FDA information. Some Smoking Everywhere packs mentioned the FDA, while others did not. Finally, some packs (NJOY and Smoking Everywhere Gold) indicated that the product was intended for adults and not pregnant women, but only NJOY, which had the most complete warning information, indicated possible side effects that may accompany use (figure 1E).

Leakiness of cartridges

Cartridges from most brands leaked nicotine-containing fluid from their reservoirs (figure 2A–F). When cartridges were removed from ENDS after smoking, beads of reservoir fluid were left adhering to the surface and heater tip of the atomiser and to the cartridges (figures 2A,B). Moreover, unused replacement cartridges (eg, NJOY and Liberty Stix) sometimes had beads of reservoir fluid on their surfaces and inside the sealed wrapper (figure 2C,D). It was difficult to load such cartridges onto an atomiser without getting reservoir fluid on our hands and other surfaces. When plugs were removed, reservoir fluid readily leaked out and if placed on a table, pools of reservoir fluid rapidly accumulated (figure 2E,F). NJOY instructions state 'Condensation and/or liquid may be seen inside the cellophane bag, which is a normal occurrence.' Smoking Everywhere Platinum, which had a disposable atomiser embedded in the reservoir, and VapCigs, which had a reservoir sealed by aluminium foil, presented the least potential for direct contact between the user's hands and reservoir fluid when assembling the cigarette. However, after use, even these better designs left reservoir fluid on the atomiser.

Defective parts and operation

The NJOY kit arrived with dead batteries, which were quickly replaced. The red indicator tip at the end of the battery flashes a variable number of times if the battery is low or if the smoker

is inhaling too many consecutive puffs. When ENDS were evaluated on a smoking machine, none of the flashing codes operated correctly all the time. Liberty Stix and VapCigs batteries were capable of lighting the red indicator light in the palm of our hands without the presence of an atomiser or cartridge. VapCigs released aerosol while held in our hands, apparently due to volatilisation of residual fluid on the surface of a new atomiser.

Disposal of spent cartridges

Cartridges stop producing aerosol after 100–200 puffs then need to be replaced by a fresh cartridge. Used cartridges contained liquid in their reservoirs (not shown). The amount of fluid left in spent cartridges was quite variable, with NJOY cartridges retaining the most fluid. None of the brands indicated a proper way to dispose of cartridges, wrappers, cartridge plugs, reservoirs, old batteries or old atomisers, and only NJOY and Crown Seven mentioned disposal at all in their instructions.

Errors in filling orders

Most errors in filling internet orders involved sending cartridges with the wrong strength of nicotine (eg, two of nine Crown Seven cartridges and two of 19 Liberty Stix cartridges were the wrong strength). Smoking Everywhere made numerous errors (eg, repeatedly sent the wrong kits and cartridges), and even after 6 months, their orders were not completely filled correctly. NJOY filled all orders without error.

Instruction manual

Instruction manuals were usually not complete and accurate. Instructions were specific for a brand, but not specific for the type of ENDS within a brand. For example, Smoking Everywhere's Platinum instructions included information for a different model (their 'Mini Electronic Cigarette'). We evaluated the instruction manuals using a 100-point questionnaire (25 yes/no questions each worth four points) (table 2). Based on this questionnaire, NJOY had the best manual and VapCigs had the least helpful.

Truth in advertisement

On both websites and in print material, we found numerous statements regarding ENDS that were not based on scientific

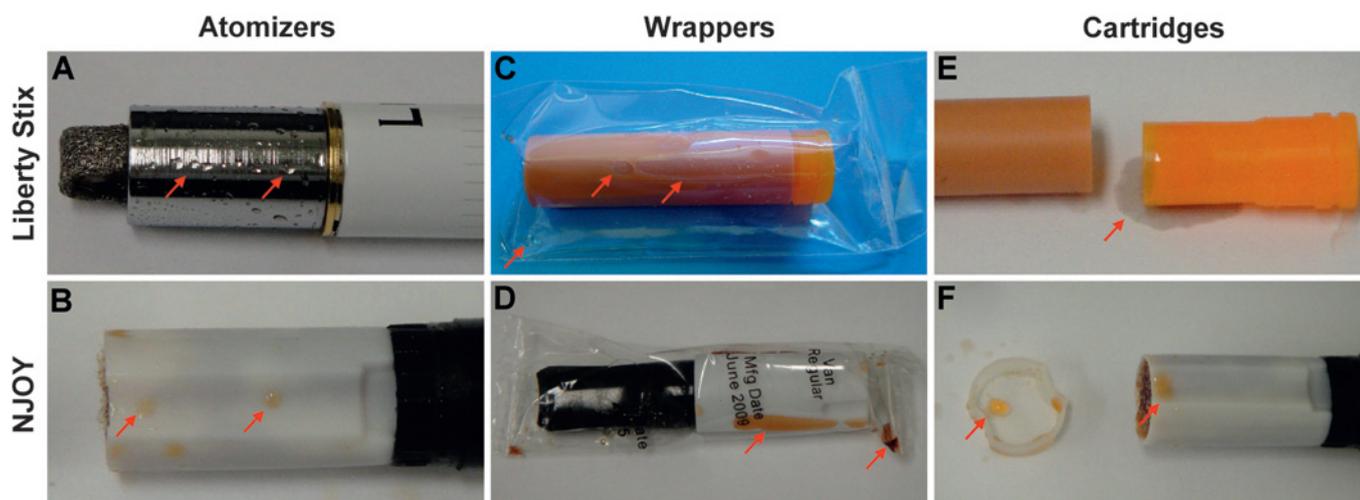


Figure 2 Leakiness of Liberty Stix and NJOY cartridges. (A–B) Show droplets of cartridge fluid (arrows) on the surface of atomisers after removal of a used cartridge. (C–D) Show fluid (arrows) inside the wrapper of unused cartridges. The NJOY fluid is brown-coloured. (E) Shows fluid (arrow) that has leaked from a fresh cartridge onto a counter top before the cartridge was assembled into the ENDS. (F) Shows fluid (arrows) on the surface of a fresh replacement cartridge and its cap before the cartridge was assembled into the ENDS.

findings and for which there is no rigorous supporting data. Examples of such statements include: 'Be careful to avoid inhaling any significant quantity of liquid. Although it gives you a slight tingling sensation, it is not harmful' (Liberty Stix); 'Within 2 weeks, your lung capacity will increase by 30%. Your energy levels will increase. Your throat and lungs will feel markedly better! Wrinkles in your skin will become less noticeable and colour will return to your skin' (Liberty Stix). One pack (Smoking Everywhere) was labelled 'Vitamin', although no indication of what this meant was given.

DISCUSSION

Our data show that ENDS labelling, design features, print material and disposal need improvement. Labelling of ENDS cartridges and wrappers was generally poor. Direct clear labelling of cartridges, wrappers and packs with accurate nicotine concentrations is needed to minimise inadvertent exposure to nicotine and is particularly important given the high number of errors made in filling orders with cartridges of incorrect strength. Non-smokers could easily mistake 24-mg cartridges for 0-mg cartridges and in the process become addicted to nicotine. Likewise former smokers could become re-addicted by inadvertently smoking nicotine-containing cartridges. Full warnings regarding nicotine (it can be deadly, addictive and converted to carcinogens) should appear on all packs, and instruction manuals should provide complete accurate information on the product.

It was difficult to avoid touching nicotine-containing reservoir fluid when handling cartridges, which presents health risks to ENDS users and non-users. Nicotine can be absorbed through the skin and cause harm, especially if amounts are large. Nicotine deposited on surfaces (skin, table, counters) can be converted into carcinogens, as shown with third-hand smoke.⁶ This point raises serious health issues relating to nicotine leakage from cartridges during and after use. What are the consequences of long-term handling of nicotine and conversion of nicotine into carcinogens on the skin or in the environment of ENDS users? These questions should be answered before use of ENDS is allowed.

Used cartridges contained fluid after they ceased producing aerosol. Regulatory agencies need to address how to safely dispose of used cartridges and minimise introduction of nicotine into the environment. Studies documenting hazards associated with disposal of cigarette butts^{12 13} led to regulation of butt disposal in Australia, where fines are issued to those who do not deposit butts in valid receptacles.¹⁴ Residual nicotine in spent ENDS cartridges can leak onto surfaces where conversion to carcinogens could take place.⁶ Furthermore, as nicotine from used ENDS cartridges leaches into water supplies, it may directly affect aquatic life and could be propagated through the food chain. Proper disposal of ENDS cartridges should be addressed before spent cartridges present a serious health problem.

Better regulation of ENDS sales and distribution is needed to protect children and adults from nicotine exposure and possible

Table 2 Evaluation of starter kit instruction manuals

Questions*	Liberty Stix	Smoking Everywhere gold	Crown Seven Hydro	NJOY NCIG	VapCigs	Smoking Everywhere Platinum
Set-up and general information	Initial battery charge: how and how long	✓	✓	✓	✓	✓
	Indicator light indicates need to recharge	✓	✓	✓	✓	✓
	Battery longevity	✓	X	✓	✓	X
	Atomiser longevity	✓	X	X	X	✓
	Cartridge longevity	X	X	X	X	✓
	Nicotine amount (mg) in available cartridges	X	X	X	X	X
	Storage information	✓	✓	✓	✓	X
	Warranty available	✓	✓	X	✓	X
	Company information †	✓	✓	✓	✓	X
	Problems and solutions of previous clients	✓	✓	X	✓	X
Disposal of cartridges and/or wrappers	X	X	✓	X	X	
Assembly	How to connect atomiser to battery	✓	✓	X	✓	X
	How to remove plug from cartridge	✓	X	✓	✓	X
	How to connect cartridge from atomiser	✓	✓	X	✓	X
	How to smoke	✓	✓	✓	✓	X
	Picture to help with assembly	✓	✓	X	✓	X
Warnings/cautions	Product to be used by adults only	✓	✓	✓	✓	X
	Identify locations where smoking is banned	X	✓	X	X	X
	Warn that nicotine is addictive	✓	X	X	✓	X
	Avoid direct contact with liquid	✓	X	X	✓	X
	Surgeon General warning	X	✓	X	X	X
	Medical side effects	X	X	X	✓	X
	Not FDA approved	X	✓	X	✓	X
	Keep away from children and/or pets	X	✓	✓	✓	X
	Temperature warnings	✓	✓	X	X	✓
Total score	66/100	61/100	37/100	72/100	12/100	56/100

XInformation not included in instruction manual.

✓Information included in instruction manual.

*Each question was equal to four points with 100 total points possible.

†One point each was given for address, phone, email and website.

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What this paper adds

- ▶ Batteries, atomisers, cartridges, cartridge wrappers, packs and instruction manuals lack important information regarding ENDS contents, use and essential warnings.
- ▶ ENDS cartridges leak, thereby creating the potential for unwanted nicotine exposure to children, adults, pets and the environment.
- ▶ There are currently no methods for proper disposal of ENDS products and accessories, including cartridges.
- ▶ Data indicate that regulation of manufacturing, quality control, sales and advertisement of ENDS is needed.

addiction. Our observations provide evidence that regulators should consider removing ENDS from the market until design features, quality control, labelling, disposal and safety issues have been adequately addressed.

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REFERENCES

1. **Flouris AD**, Oikonomou DN. Electronic cigarettes: miracle or menace? *BMJ* 2010;**340**:c311.
2. **Pauly J**, Li Q, Barry MB. Tobacco-free electronic cigarettes and cigars deliver nicotine and generate concern. *Tob Control* 2007;**16**:357.
3. **Benowitz NL**. Pharmacology of nicotine: addiction, smoking-induced disease, and therapeutics. *Annu Rev Pharmacol Toxicol* 2009;**49**:57–71.
4. **Davis R**, Rizwani W, Banerjee S, *et al*. Nicotine promotes tumor growth and metastasis in mouse models of lung cancer. *PLoS One* 2009;**4**:e7524.
5. **Heeschen C**, Jang JJ, Weis M, *et al*. Nicotine stimulates angiogenesis and promotes tumor growth and atherosclerosis. *Nat Med* 2001;**7**:833–9.
6. **Sleiman M**, Gundel LA, Pankow JF, *et al*. Atmospheric chemistry special feature: formation of carcinogens indoors by surface-mediated reactions of nicotine with nitrous acid, leading to potential thirdhand smoke hazards. *Proc Natl Acad Sci U S A* 2010;**107**:6576–81.
7. **Westenberger BJ**. *Evaluation of ENDS*. St Louis: Food and Drug Administration, 2009.
8. **Laugesen M**. *Safety report on the Ruyan ENDS cartridge and inhaled aerosol*. Christchurch: Health New Zealand, 2008.
9. **Eissenberg T**. Electronic nicotine delivery devices: ineffective nicotine delivery and craving suppression after acute administration. *Tob Control* 2010;**19**:87–8.
10. **Wollscheid KA**, Kremzner ME. Electronic cigarettes: safety concerns and regulatory issues. *Am J Health Syst Pharm* 2009;**66**:1740–2.
11. **Trtchounian A**, Willams M, Talbot P. Conventional and electronic cigarettes (e-cigarettes) have different smoking properties. *Nicotine Tob Res* 2010. doi:10.1093/ntr/ntq114.
12. **Micevska T**, Warne MS, Pablo F, *et al*. Variation in, and causes of, toxicity of cigarette butts to a cladoceran and microtox. *Arch Environ Contam Toxicol* 2006;**50**:205–12.
13. **Novotny TE**, Lum K, Smith E, *et al*. Cigarettes butts and the case for an environmental policy on hazardous cigarette waste. *Int J Environ Res Public Health* 2009;**6**:1691–705.
14. *National Drugs and Poisons Schedule Committee -record of reasons of meeting 54, Therapeutic Goods Administration (2008-10-15) document AGDoHaATGAN*. 2008. Contract No.: chapter 12.1.3.

The lighter side

