Electronic cigarettes and cardiovascular risk: hype or up in smoke?

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"A custom loathsome to the eye, hateful to the nose, harmful to the brain, dangerous to the lungs, and in the black, stinking fume thereof nearest resembling the horrible Stygian smoke of the pit that is bottomless."
– James I of England, A Counterblaste to Tobacco (1604) [1]

Smoking damages almost every organ in the human body [2,3]. Smokers have a two to fourfold increased risk for developing coronary artery disease and stroke [2]. There is a 25-fold increased risk of lung cancer [2,3]. In addition numerous respiratory illnesses, congenital malformations, immune dysfunctions and other co-morbidities are seen more frequently in smokers [2,3]. The annual economic costs due to smoking related diseases in the USA are estimated to be between US\$289–332.5 billion for the years 2009–2012 [2].

Quitting smoking is extremely difficult for most smokers. Nicotine is highly addictive and cessation is associated with withdrawal symptoms. 85% of people relapse within a week [4].

To cope up with withdrawal symptoms and to obtain relief, various forms of nicotine replacement therapies and

coping adjuncts like nicotine gums 1984, nicotine nasal patches 1991, nicotine nasal spray 1996, nicotine inhaler 1998, pharmacotherapy: Zyban® (bupropion) 1997, Chantix® (varenicline) 2006, electronic cigarettes 2007 and cognitive behavioral therapies have been released in the last 30 years [5].

The potential of targeting the access of nicotine to the brain by developing antibodies and thereby preventing the nicotine reinforcing effects is being studied, however the newest available nicotine replacement therapy is the electronic cigarette [5].

Electronic cigarettes (e-cigarettes) were invented by Hon Lik, a Chinese pharmacist in 2003. An electric ultrasound-emitting element was used to vaporize a pressurized jet of nicotine liquid. E-cigarettes were introduced into the US markets in 2007 and their usage has increased significantly in the recent years [6,7].

In the latest CDC reports, e-cigarette use among youth who never smoked traditional cigarettes increased threefold from 2011–2013. In addition, the intention to smoke traditional cigarettes was twice that in youths who had tried e-cigarettes versus nonusers [8,9].

KEYWORDS

- cardiovascular risk • e-cigarette
- nicotine withdrawal • tobacco addiction

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E-cigarettes have an estimated market value of approximately US\$1.5 billion in 2014 and are set to grow at a rate of 24% per year for the next 4 years while the traditional cigarette market has fallen by 29.6% in the last decade [7]. The amounts of toxic substances emitted from e-cigarettes vary with brands and sometimes even within the same brand. A lack of regulations and easy availability through the internet are concerning and warrant further investigation into the side-effect profile and adverse effects of e-cigarette usage [10,11].

There are a number of various chemical compounds found in e-cigarettes. Some of these are acetaldehyde (carcinogen, respiratory toxin, addictive), lead (carcinogen, cardiovascular toxin, reproductive toxin), acetone (respiratory toxin), nicotine (addictive), cadmium (carcinogen, respiratory toxin, reproductive toxin) and formaldehyde (carcinogen, reproductive toxin) [12,13]. Some have teratogenic/mutagenic potential and others are known to be addictive [12,13].

Several recent studies looked at the immediate effect of e-cigarette use on cardiovascular parameters with conflicting results [14–17]. In two serial studies a significant increase in plasma nicotine and heart rate 5 min after the first puff of an e-cigarette was seen. The overall conclusions were that user experience and device characteristics such as size influence the nicotine delivery and resultant adverse effects of e-cigarettes [14,15].

A more recent study by Battista *et al.* showed increased cardiac output and lower systemic vascular resistance after 2 and 4 min, respectively, of smoking e-cigarettes. Increased diastolic blood pressure and mean arterial pressures were also seen after 4 min of e-cigarettes smoking in 12 healthy volunteers [18].

Per the latest CDC reports, there is an increase in number of calls to the poison centers regarding e-cigarette liquid poisoning ranging from one per month in Sep 2010 to 215 per month in Feb 2014, with approximately 42% occurring in children less than 5 years old and 51% in children greater than 20 years old [19].

Mild e-cigarette liquid poisoning is associated with symptoms of tachycardia, tremor, chest pain and hypertension. More serious symptoms reported are bradycardia, hypotension, nausea, respiratory paralysis, atrial fibrillation and dyspnea. The exact causal relationship between these symptoms and e-cigarettes is not well established [20–23].

Conclusion

The majority of the studies done to assess the cardiovascular effects due to e-cigarettes are focussed on the acute effects of e-cigarette use on the heart. There is a need for further studies to establish the exact causal relationship. In addition research is needed into the longer term cardiovascular sequelae of e-cigarette use. It will then be possible to determine whether e-cigarettes can be used safely in patients who have risk factors for, or a history of cardiovascular diseases.

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