

# Smoking and Vaping: is there a difference?

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## Introduction

Tobacco smoking is a major contributing factor in the development of most diseases and it poses major challenges in the perioperative period.<sup>1</sup> In 2015, the World Health Organisation (WHO) published the “global report on trends in prevalence of tobacco smoking”. It was reported that smoking is responsible for about six million deaths across the world. The report estimated that about 19% of the South African population smoked in 2010.<sup>2</sup>

Due to the adverse health effects attributable to traditional tobacco smoking, vaping or electronic cigarette (e-cigarette) use is becoming a popular nicotine alternative. The popularity of e-cigarette use is further promoted by the perception that they are healthier than tobacco cigarettes. It is also believed that they help smokers to quit.<sup>3</sup>

This review aims to describe the differences between cigarette smoking and vaping. For the purpose of this review, tobacco cigarette smoking will be referred to as cigarette smoking, whereas vaping will refer to the use of e-cigarettes. The two types of smoking will be described in terms of constituents and effects on the different organ systems.

## Cigarette smoking

Cigarette is defined in the English Oxford Dictionary as “a thin cylinder of finely cut tobacco rolled in paper for smoking”.<sup>4</sup> There are different ways of smoking tobacco, however this review will only focus on cigarette smoking.

### Constituents of cigarette smoke

More than 4000 substances are found in the cigarette smoke. These substances have various effects, ranging from being antigenic, cytotoxic, mutagenic and carcinogenic. The cigarette smoke constituents are found in two phases, namely, the gaseous and particulate. The gaseous phase represent 80–90% of the smoke and it consists of mainly of nitrogen, oxygen and carbon dioxide. Other gaseous constituents include carbon monoxide, which impairs oxygen transport, as well as hydrocyanic acid and hydrazine, which are carcinogenic.<sup>5</sup>

Formaldehyde, acrolein and certain nitrosamines represent chemicals that are contained in the liquid-vapour portion of the smoke,<sup>5,6</sup> and they are found to be ciliotoxins and irritants.<sup>5</sup> The particulate phase is composed of nicotine, as the main toxic ingredient.<sup>5</sup> Nicotine is also the psychoactive drug in a

cigarette smoke, which makes it addictive. Any attempts to quit smoking are then met with withdrawal symptoms, cravings and increased chances of relapse.<sup>6</sup> A traditional tobacco cigarette yields approximately 0.5 to 1.5 mg/cigarette.<sup>7</sup> Other particulate constituents are carcinogens, such as tar and hydrocarbons.<sup>5</sup>

### Effects of cigarette smoking on the organ systems

Cigarette smoking results in adverse health effects and those effects will be described according to the systems affected.

#### Cardiovascular system

Most cardiovascular effects of smoking are due to the effects of nicotine. Cigarette smokers have plasma nicotine levels reaching 15–50 ng/ml. Nicotine results in an increase in heart rate, peripheral vascular resistance and blood pressure. This is due to the stimulant effect of nicotine on the adrenal medulla resulting in adrenaline release, as well as the effect on the carotid and aortic receptors. There is also stimulation of the autonomic ganglia by nicotine, which results in an increase in sympathetic tone.<sup>5,8</sup>

Cigarette smoking accelerates atherosclerosis in the coronary arteries, the aorta, cerebral arteries and large peripheral arteries. Smoking therefore increases the risk of acute cardiovascular events, namely, acute myocardial infarction and stroke. The acute cardiovascular events are as a result of smoking-induced hypercoagulable state, increased myocardial work, carbon monoxide-mediated reduction in oxygen carrying capacity of the blood, coronary vasoconstriction and catecholamine release.<sup>9</sup>

Carbon monoxide is the other constituent of smoke that affects the cardiovascular system. The amount of carbon monoxide contained in the cigarette smoke is 400 parts per million. Carbon monoxide binds to haemoglobin (Hb) 200 times more than oxygen to form carboxyhaemoglobin (COHb). The amount of COHb in the blood ranges from 5–5% in smokers, as compared to 0.3–1.6% in non-smokers.

The formation of COHb reduces the amount of Hb available to bind oxygen, shifting the oxygen-haemoglobin curve to the left and this results in a decrease in the amount of oxygen available to the tissues.<sup>5</sup>

Carbon monoxide also affects intracellular oxygen transport. This is as a result of binding with cytochrome oxidase and myoglobin,

therefore inactivating mitochondrial enzymes in the cardiac muscle. These effects result in chronic tissue hypoxia. Carbon monoxide also results cardiac arrhythmias.<sup>5</sup>

### **Respiratory system**

Smoking results in increased mucous secretions as a result of the irritants present in cigarette smoke. This results in hyperviscous mucous and reduced elasticity.<sup>5,10</sup> The ciliotoxins present in smoke result in inactive cilia and impaired tracheobronchial clearance, therefore resulting in increased recurrent chest infections.<sup>1,5</sup> Smoking also leads to increased laryngeal and bronchial reactivity.<sup>1,5,11</sup> This increases the risk of laryngospasm. The epithelial lining of the lung is disrupted by cigarette smoke resulting in increased pulmonary epithelial permeability. The epithelial lining disruption leads easy penetration of irritants and stimulation of subepithelial irritant receptors, thus increasing pulmonary reactivity.<sup>1,5,8</sup>

Cigarette smoking leads to narrowing of the small airways, resulting in increased closing volume.<sup>1,5</sup> Smoking decreases pulmonary surfactant and causes an increase in proteolytic enzymes resulting in loss of lung elasticity.<sup>5</sup> This results in the development of chronic pulmonary disease<sup>1</sup> and emphysema.<sup>5,8</sup> Compared to non-smokers, chronic bronchitis occurs five times more often in smokers, with the incidence of 25%.<sup>5</sup>

### **Haematological system**

Smoking leads to increased hypercoagulability,<sup>1</sup> due to increased platelet activation and circulating fibronectin.<sup>3</sup>

### **Renal system**

Smoking results in an increase in antidiuretic hormone release, which leads to dilutional hyponatraemia.<sup>5,8,10</sup>

### **Gastrointestinal system**

Cigarette smoking results in gastro-oesophageal sphincter incompetence, which develops four minutes after the start of smoking but returns to normal within eight minutes of ending the smoking session. There is no effect on gastric volume and gastric secretions pH.<sup>5,10</sup>

### **Immune system and wound healing**

Smoking impairs both humoral activity and immune mediated immunity,<sup>1,10</sup> leading to increased risk of infection<sup>1,5,10</sup> and delayed wound healing.<sup>1,3</sup>

### **Cancer associations**

Smoking is associated with cancers of most organs: lung, gastrointestinal, head and neck, and genitourinary system.<sup>1,6</sup> Studies looking at condensates collected from cigarette smoke found that they cause mutations and damage to deoxyribonucleic acid. Smoking condensates also showed the ability to induce malignant changes in mammalian cells.<sup>6</sup>

### **Drug interactions**

Cigarette smoking increases the metabolism of some drugs by inducing liver microsomal enzymes. Chronic smokers require

more analgesic drugs. Fentanyl and pentazocine undergo quicker metabolism in smokers.<sup>5</sup>

In smokers, nicotine stimulates acetylcholine receptors. This is because nicotine concentration of smokers does not increase beyond 75 ng/ml and nicotine in smaller doses of < 100 ng/mL stimulates the acetylcholine receptors, as opposed to the blocking effect in larger doses. The stimulation of receptors results in the requirement of higher doses of muscle relaxants needed to block the receptors.<sup>5</sup>

### **Vaping**

Electronic cigarettes (e-cigarettes) are defined as “products that deliver a nicotine-containing aerosol to users by heating a solution”. This solution is made up of propylene glycol or glycerol, nicotine and flavouring agents.<sup>12</sup> E-cigarettes or electronic nicotine delivery systems (ENDS) simulate the cigarette smoking experience, and it has been portrayed as an alternative to reduce the amount of tobacco cigarette consumption. Heating of the solution leads to generation of a vapour, which is inhaled by the user, hence the term “vaping”.<sup>13</sup>

### **Chemical constituents**

The ingredients in the e-cigarette cartridges and solutions are relatively fewer than those found in traditional tobacco cigarettes. They are for the most part non-toxic and non-carcinogenic as compared to burned tobacco products, which contains thousands of compounds, many of which have been proven to promote carcinogenesis.<sup>14</sup> The major constituents of e-cigarettes include nicotine, propylene glycol, glycerine and flavouring.<sup>3,14</sup> Other constituents that may be emitted from e-cigarettes include aldehydes, such as formaldehyde, acetaldehyde and acrolein, which result from thermal degradation of propylene glycol and glycerol.<sup>15</sup> While there have been investigations showing the presence of some of the hazardous compounds normally found in tobacco smoke, in e-cigarettes cartridges, solution or mist, only a few reports detected high enough levels to pose a significant risk to humans.<sup>14</sup>

Manufacturers have claimed that e-cigarettes contain less or no nicotine as compared to combustible tobacco cigarettes. It is also claimed that e-cigarettes contain no tar or carcinogens found in tobacco cigarettes. However, these claims cannot be substantiated because of inadequate regulations regarding these products.<sup>13</sup> The amount of nicotine in most commonly available e-cigarettes ranges from 0–36 mg/mL.<sup>16</sup> Studies looking at the nicotine yield in different e-cigarette brands indicate that e-cigarettes deliver less nicotine than traditional cigarettes.<sup>7</sup> A study by Farsalinos et al.<sup>17</sup> showed that the nicotine delivery after using an e-cigarette with a nicotine content of 9 mg nicotine/mL for five minutes, was 0.46 mg. This was shown to be 54% lower than a traditional cigarette which yields about 1mg.<sup>7</sup>

### **Effects of vaping on the organ systems**

Vaping or e-cigarette use has been considered by many to be a healthier alternative to the traditional combustible tobacco cigarette. However, the health consequences and health benefits associated with e-cigarette use are still controversial.<sup>16</sup> The next

section of this article will review the effects of vaping on different organ systems.

### Cardiovascular system

Several studies showed that E-cigarette use increases heart rate acutely. Both diastolic blood pressure and heart rate were elevated after e-cigarette use, however to a lesser extent compared to tobacco cigarettes. The use of e-cigarettes has been associated with endothelial cell dysfunction and oxidative stress, but the effect was less pronounced in comparison with cigarette smoking. Acute exposure to e-cigarettes has been shown by some studies to have no immediate effects on coronary circulation, myocardial function and arterial stiffness.<sup>15</sup>

Studies relating to traditional tobacco cigarettes have shown that nicotine increased the risk of cardiovascular disease in smokers. E-cigarettes contain nicotine although the amount delivered is considerably less than conventional cigarettes. Studies showing the nicotine effects related to e-cigarettes are limited and controversial. Some studies have shown an increase in heart rate after e-cigarette use, whereas some found no changes in heart rate.<sup>15</sup>

In addition to nicotine, there are other potentially harmful components of e-cigarettes like carbonyls, including aldehydes, which may alter heart rate, blood pressure and cardiac contractility.<sup>15</sup>

### Respiratory system

The use of e-cigarettes results in upper and lower respiratory tract irritation, bronchitis, cough and emphysema.<sup>15</sup> The upper respiratory infection-like symptoms caused by e-cigarettes have been associated with propylene glycol, which is a constituent of e-cigarettes.<sup>16</sup>

### Haematological system

E-cigarette vapour extracts were shown to enhance platelet activation (aggregation and adhesion).<sup>15</sup>

### Gastrointestinal system

E-cigarettes may cause throat and mouth irritation as well as induce nausea and vomiting.<sup>15</sup>

### Immune system and wound healing

E-cigarettes may lead to inflammatory induction,<sup>15</sup> upregulation of certain inflammatory markers and acute phase reactants.<sup>3</sup> E-cigarettes also reduce immune efficiency.<sup>15</sup>

### Smoking cessation

A study looking e-cigarettes versus nicotine patches for perioperative smoking cessation, found that e-cigarettes are a feasible tool and acceptable aid for perioperative smoking cessation. The study showed that quit rates were comparable to those of nicotine replacement patches.<sup>18</sup>

### Conclusion

Cigarette smoke contains over 4000 substances, some of which are cytotoxic and carcinogenic,<sup>5</sup> while there have been investigations showing the presence of some of the hazardous

compounds normally found in tobacco smoke in e-cigarettes, only a few reports detected high enough levels to pose a significant risk to humans.<sup>14</sup>

The nicotine delivered by e-cigarettes has also been shown to be considerably less than that of tobacco cigarettes, as a result e-cigarettes were shown to produce fewer effects as compared to conventional cigarettes.

E-cigarettes have become very popular worldwide, but despite that, research regarding the effects of these devices on human health is limited.<sup>14</sup> Although there is limited data, e-cigarettes are not entirely harmless as promoted by their manufacturers.<sup>12</sup> When looking at the harmful effects of conventional tobacco smoking, vaping is considered by some studies as a possible harm reduction tool.<sup>14</sup> More studies focusing on the comparison of conventional tobacco smoking and vaping regarding their effects on the health of patients should be done in order to reach a comprehensive conclusion.

### Conflict of interest

There was no potential conflict of interest relevant to this article.

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