

Бондарец О.А., Клышко И.А.

КУРИТЬ ИЛИ НЕ КУРИТЬ

Белорусский государственный медицинский университет

Минск, Беларусь

Аннотация. Английский король Джеймс I однажды сказал, что курение отвратительно для глаз, ненавистно носу, вредно для мозга и опасно для легких. И, тем не менее, люди продолжают курить. Поэтому необходимо убедить их бросить эту вредную привычку, объясняя им ужасные последствия курения. В этой статье приводятся примеры воздействия угарного газа и других ядовитых веществ табачного дыма на гемоглобин, которые могут быть использованы преподавателями химии и биологии.

Ключевые слова: вредные воздействия, болезни, рак, угарный газ, гемоглобин.

Bondarets O.A., Klyshko I.A.

TO SMOKE OR NOT TO SMOKE

Belarusian State Medical University

Minsk, Belarus

Abstract. King James I of England once said, "Smoking is a custom loathsome to the eye, hateful to the nose, harmful to the brain, dangerous to the lungs." And nevertheless, people continue smoking. So, it's necessary to persuade them to quit this bad habit explaining to them the terrible consequences of it. In this article we offer examples of the effects of carbon monoxide and other toxic components of tobacco smoke on hemoglobin. They can be used by teachers of chemistry and biology.

Keywords: harmful effects, diseases, cancer, carbon monoxide, hemoglobin.

It's a proper question especially for future doctors. There is a warning sign on the wall "NO SMOKING", and students in white medical gowns smoke and thoughtfully look at this sign. It's known that doctors and smoking are not compatible. That's why it's very important to develop a negative attitude towards this harmful habit among the students and a complete rejection of it in later life. To achieve the goal, it's necessary to inform students in classes about the danger of smoking, explain the mechanism of the harmful effect of individual components of tobacco smoke on various tissues and systems of human organs. It's important to emphasize that smoking can lead to the development of pathological conditions that can turn into serious chronic diseases. The harmful effects of smoking are undeniable: an increase in the incidence of coronary heart disease, myocardial infarction, chronic kidney disease, an increase in the number of malignant neoplasms, especially lung cancer, change and disorder of the activity of biochemical neurohumoral and immune systems of the body [4].

Currently it's known that there are more than 4200 substances in tobacco smoke. Many of them are carcinogenic: polycyclic aromatic hydrocarbons, nitroso compounds, aromatic amines. Some scientists believe that arsenic oxide (III) and

radioactive polonium – 210 have the strongest carcinogenic effect. According to statistics, lung cancer in smokers is 30 times more common than in non – smokers. 80–90% of patients with lung cancer are heavy smokers. Mortality from lung cancer increases proportionally to the number of cigarettes smoked daily. Smoking is also considered to be the main cause of cancer of the oral cavity, pharynx, larynx. Smokers have an increased risk of developing cancer of bladder and pancreas [5].

There are two phases in tobacco smoke, gas and solid. The gas phase contains 90% of all tobacco smoke components. The most toxic substances are: carbon monoxide, pyridine, ammonia, amines. The solid phase includes nicotine, water and tobacco tar. Smokers inhale about 800g of suspended particles of tobacco tar during the year. Carcinogens accumulate in deep, poorly ventilated areas of lungs. Acetic, propionic, butyric acids, present in tobacco smoke, easily dissolve carcinogens deposited in the respiratory tract and spread them through the blood throughout the body [3].

It has also been found that 2/3 of the smoke enters in the external environment, polluting it with nicotine, tar and other harmful substances. Both the smoker and non – smoker, so called the passive smoker, breathe tobacco smoke. And poor non – smokers suffer from difficulty in breathing, irritation of the eye mucous membrane, headache, dizziness, sore throat, nausea, loss of appetite.

The members of the smoker's family are always passive smokers. American and Japanese scientists have calculated that wives of heavy smokers die an average of four years earlier than wives of non – smokers [4].

When studying gas exchange in the lungs and tissues, it's important to explain the mechanism of action of individual chemical compounds that enter the body when smoking. In particular, normal gas exchange is disturbed, which contributes to the development of oxygen starvation of various organs. The smoker inhales air depleted in oxygen during puffs. The air inhaled with smoke contains only 12% oxygen instead of 21%, 3.3% CO₂ instead of 0.03% ! in addition, smokers inhale 3.3% CO during puffs, which is not contained in normal air.

It's shown that, if a person is in the room with a concentration of CO in the air as low as 0.4%, it can lead to death. Carbon monoxide CO is the main toxic substance in tobacco smoke. It readily binds to erythrocyte hemoglobin to form carboxyhemoglobin. As a result, hemoglobin loses its ability to attach oxygen and transport it to organs and tissues, which leads to oxygen starvation – hypoxia. Therefore, in long – term heavy smokers, due to a constant lack of oxygen in the body, severe diseases of systems and organs can occur, for example, narrowing of the peripheral blood vessels of the lower extremities [1].

Smoking of a pregnant woman has an extremely harmful effect on the developing embryo. Thus, the hemoglobin contained in the blood of the embryo binds to carbon monoxide CO easier than the hemoglobin of the mother. It has been shown that each cigarette smoked by a pregnant woman increases the contents of carboxyhemoglobin in the blood of the embryo by 10%, at the same time reducing the delivery of oxygen. This is one of the main reasons for stunting the growth and development of the embryo [2].

In addition to CO, tobacco smoke contains other substances that effect the hemoglobin of erythrocytes, so called methemoglobin formers: nitrates, aromatic amines (aniline, nitrobenzene, dinitrobenzene), toluidines, and other compounds that block hemoglobin in a slightly different way, forming methemoglobin. The transformation of hemoglobin to methemoglobin can cause more severe consequences since there is a different mechanism for binding to hemoglobin.

GLOBIN...Fe hemoglobin

GLOBIN...Fe – O₂ oxyhemoglobin

GLOBIN...Fe – CO carboxyhemoglobin

GLIBOIN...Fe – OH methemoglobin

Hemoglobin, iron – containing protein, is the substance that gives colour to red blood cells and transports oxygen throughout the body.

The reaction of adding an oxygen molecule to hemoglobin is not a true oxidation since the oxidation state of iron doesn't change. The correct name for this reaction is oxygenase. Oxyhemoglobin is the normal oxygen - carrying form of hemoglobin. In the case of carboxyhemoglobin formation, again the oxidation state of heme iron doesn't change, remaining +2. Carbon monoxide bonds to hemoglobin where normally oxygen bonds in the hemoglobin molecule with an affinity 200 times that of oxygen. Carbon monoxide saturates the molecule site that usually accommodates oxygen and prevents it from getting into the hemoglobin molecule. This is a reversible process, however, due to tight binding and high affinity, eliminating half – life in room air can be two hours or more [4].

When combined with methemoglobin formers, true oxidation of hemoglobin occurs and Fe⁺² is converted into Fe⁺³ so, it is no longer able to bind oxygen. Methemoglobin is a dysfunctional form of hemoglobin that is incapable of transporting oxygen, thus, reducing blood oxygenation and potentially inducing tissue hypoxemia. People with methemoglobin concentration 10%, show cyanosis, bluish discolouration of the skin and mucous membranes. A middle degree of poisoning, 15–20% of methemoglobin in the blood, causes general weakness, dizziness, cyanosis, headache. The concentration of 50–60%, leads to the damage to the central nervous system, fatigue, vertigo, respiratory failure, toxic insult, coma, and even death may occur. The blood takes on a chocolate – brown colour and doesn't revert back to normal red colour after oxygen exposure. Methemoglobin is a fairly stable compound and slowly turns into hemoglobin. Breathing pure oxygen can speed up this process [2].

Every year, world No Tobacco Day is observed in order to spread awareness of the dangers related to using tobacco. People around the world want to get rid of this tobacco pandemic and claim their right to health and healthy living in order to protect their future generation.

References

1. Reference module in Biomedical Science, 2014.
2. Roduh's Hemology, Sixth Edition, 2020. – 888 p.
3. Applied Chemistry, Third Edition. Toronto, 1994. – 675 p.
4. ХИМИЯ в ШКОЛЕ. 1990. №1.
5. ХИМИЯ в ШКОЛЕ. 1987. №6.