UDK 614.7:351.777:663.977

POTENTIAL RISK ASSESSMENT OF THE ELECTRICALLY HEATED TOBACCO SYSTEM (EHTS) USE

M. Prodanchuk, A. Podrushnyak, O. Malysheva, A. Stroy, V. Zavalnaya, T. Moroz, V. Krook, T. Shutova
L.I. Medved's Research Center of Preventive Toxicology, Food and Chemical Safety, Ministry of Health of Ukraine, Kyiv, Ukraine

ABSTRACT. Objective. *To conduct an assessment of electronically heated tobacco system EHTS based on toxical and hygienical experiment with involvement of volunteers in comparison with conventional filtered cigarettes smoking and define quantitative and qualitative difference in air composition in the room, where these products were used.*
Materials and Methods. *Given toxical and hygienical characteristics of indoor air inhaled, where 80 volunteers were present (active and passive users), with carbon monoxide, carbon dioxide, formaldehyde, nicotine, benzo(a)pyrene and ammonia content assessment using chemical, analytical and organoleptic research methods.*
Results. *It has been found that during EHTSs indoor usage benzo[a]pyrene, nicotine and ammonia were not detected – the result was at the response limit of the analytical detection method or n/a. The content of carbon monoxide, carbon dioxide and formaldehyde increased slightly. The actual content of the above air safety indicators in indoor air during and after EHTSs consumption by no means exceeded the TLVs for atmospheric air in contrast with indoor air during conventional filtered cigarette smoking, when nearly all air safety indicator concentrations were found to be increased. Carbon monoxide content was nearly 10 times higher than the TLV for atmospheric air; formaldehyde content was 3 times higher than the TLV for atmospheric air; benzo(a)pyrene content was nearly twice higher than the work area TLV; 80 conventional cigarettes brought nicotine content up to a value nearly 2 times higher than the reference safe exposure level (RSEL) for work area air nicotine; while ammonia content of the room reached TLV m.s-t. for atmospheric air.*
Findings. *Recognized reduced risk potential for active and passive smokers' health while using EHTSs in comparison with conventional filtered cigarette smoking is based in reduced level of air pollution in the room, where these products were used.*
Key words: *EHTS, ths, risk assessment, tobacco, nicotine , benzo (a) pyrene , ammonia, formaldehyde, carbon monoxide, carbon dioxide, pollution*

The WHO Framework Convention on Tobacco Control is the first international health agreement. It was adopted by the World Health Assembly in May, 2003, and came into effect in February, 2005. Parties to the agreement include over 170 countries as well as the European Union. Ukraine ratified the WHO Framework Convention on Tobacco Control in 2006. The WHO Framework Convention on Tobacco Control contains recommendation for efficient implementation of the WHO Framework Convention on Tobacco Control (further referred to as the WHO FCTC) by countries to protect nowadays' and future generations from the destructive health, social, environmental, and economical consequences of tobacco smoke.

Most European countries (about 50 countries), from which Ukraine is not an exception, have already adopted or drafted laws for further implementation to the effect of prohibiting tobacco product smoking in indoor or outdoor public places [1]. People's protection from the tobacco smoke is one of the six strategies of the WHO to overcome smoking prevalence in the world. Ukraine should accomplish international agreements; in particular, according to Cl. 8 of the FCTC, countries should "protect their people from tobacco smoke influence on their work places, in public places and in transport".

According to WHO recommendation [2, 3] for protection from the impact of sidestream tobacco smoke, there is no safe level of exposure. Ensuring ventilation and providing separate smoking areas with additional ventilation systems does not reduce the exposure to a safe level and is not recommended.

The potential reduction of tobacco harm and addiction to tobacco products should be based on scientific understanding of factors that determine tobacco products nature and available evidence on specific design and manufacturing method as well as ingredients of tobacco products that can cause a reduction or increase of harm, addiction and/or potential dependence. The key substance that determines dependence from tobacco is nicotine. Nicotine is delivered to the consumer's body in a way to ensure maximum nicotine dependence potential [4, 5]. Evidence obtaineds over decades of research prove that nicotine dependence effect are determined directly by the dose and delivery speed of nicotine as well respective stimuli specific to certain sensory organs and environment conditions [5, 6]. Numerous tobacco product design features can control, for instance, nicotine content, tobacco pH, tobacco smoke suspended particle size, and other factors that may affect the speed at which nicotine is released and absorbed. Besides, other components and nicotine metabolites, including anabasine, nornicotine, and monoaminooxidase inhibitors, can potentially increase dependence of tobacco products [7-9].

In terms of cigarettes it should be noted that tobacco combustion during smoking created mainstream and sidestream smoke. Mainstream is formed when the cigarette is pulled at. It passes all across the tobacco product before it is inhaled and exhaled by the smoker. Sidestream is formed of the smoke exhaled and also released from the charred part of the cigarette (mouthpiece cigarette, cigar, pipe, etc.) to the environment in between draws. Over 90% of mainstream smoke is composed of 350 to 500 gas components and particulate matter containing various toxic compounds. 35% of each cigarette combusted forms mainstream smoke; 50% is released to the ambient air, thus forming the side stream; 5 to 15% of the cigarette components are retained by the filter. For instance, sidestream smoke contains 4–5 times as much carbon oxide, 50 times as much nicotine and tar, and 45 times and much ammonia as mainstream smoke. Therefore, the amount of toxic components released to the air around the smoker is many times more than that delivered to the smoker's body. It is the fact that makes passive or "involuntary" smoking risky for the population surrounding the smoker [10-12].

According to WHO statistics, about one third of the population is exposed to "second-hand" and "third-hand" tobacco smoke. The most dangerous combination is passive smoking plus infection. Asian and European countries are responsible for the greatest number of passive smoking victims, while East Mediterranean countries, Africa, South and North America have the smallest number of them reported. The study also showed passive smoking to be extremely harmful to women's health; the number of fair sex representatives dying of it worldwide is 281,000. The reason is that the number of men suffering from passive smoking is 50% less than that of women [10-16].

A person spending time in a room where smoking is allowed is exposed to toxins. Studies have shown confined spaces where smoking is allowed to have higher pollution level than that of major traffic arteries and closed garages [20].

Smoking indoors greatly increased sidestream tobacco smoke concentration even where no smoking is actually practiced. In 2005, the American Society of Heating, Refrigerating and Air-Conditioning Engineers presented findings that ventilation devices do not fully remove tobacco smoke, which makes smokeless environment laws an efficient way to eliminate the risk related to sidestream tobacco smoke exposure.

That is why the next step Ukraine took was to approve Law No. 4844 "On Complete Prohibition of Smoking in Public and Workplaces, Including Catering Premises" with effective date December 16, 2012. On the other hand, tobacco product manufacturers began to develop more tobacco products - electronic devices of various models to ensure nicotine delivery to the human body without tobacco consumption or eliminating combustion processes and generation of tobacco smoke.

Work Purpose was to analyze the situation if acting sanitary-and-epidemiological monitoring and control of the levels and components of a chemical air pollution are kept in places, where different means of nicotine delivery were used.

Materials and Methods. An experimental research was conducted to identify the factors determining the level and composition of air pollution for rooms where alternative tobacco products that deliver nicotine are used, in particular an electrically heated tobacco system EHTS as compared to that of a premises where conventional filter cigarettes are smoked. The research is expected to demonstrate the specific consumption and risk features of various tobacco products, including EHTS's.

The EHTS is a new type of product. It has three distinct components that perform different functions: an electrically heated tobacco product (EHTP) - a novel patent pending tobacco product with specially processed tobacco, a holder into which the EHTP is inserted and which heats the tobacco material by means of an electronically controlled heater, and a charger that is used to recharge the holder after each use. The electrically heated tobacco product differs from a combustible cigarette in a number of significant ways. There is no tobacco cut-filler (tobacco leaf cut in small pieces found in cigarettes). All of the tobacco is reconstituted (cast-leaf) tobacco made from tobacco powder, water, glycerin, guar gum and cellulose fibers. There is a much smaller amount of tobacco in the EHTP compared to a cigarette. The weight of the tobacco plug in the EHTP is about 320 milligrams. In comparison, the weight of the cut filler in a standard cigarette rod ranges from 550 to 700 mg. The reconstituted tobacco is formed into a small tobacco plug through a proprietary process known as "crimping." Unlike a cigarette, the EHTP has two unique and independent filters: a polymer-film filter and a low-density cellulose acetate mouthpiece filter. The EHTP has a hollow acetate tube which acts as a mechanical spacer between the tobacco plug and the polymer-film filter. When used, the EHTP is inserted into the Holder and the user turns on the electronics by means of a switch to initiate the heating of the tobacco. The tobacco neither ignites nor burns. The electronically controlled heating, in combination with the uniquely processed tobacco, prevents combustion from occurring. When a combustible cigarette is lit, the combination of tobacco (fuel) and oxygen in the air generate a self-sustaining combustion process that consumes the tobacco. During the natural smolder period of a combustible cigarette in between puffs, temperatures of between 600 to 800 oC occur in the center of the burning cone. During a puff the temperature increases to more than 900 ^{o}C at the periphery of the burning zone. The combustion of tobacco results in the formation of smoke (which contains a range of chemical compounds), heat and ash but the operating temperature of the tobacco is significantly below that needed for a self-sustaining combustion process to occur. Contrary to the increase in temperature that occurs when a puff is taken with a lit cigarette, there is significant drop in the temperature of the tobacco in the EHTP. Since combustion does not occur, the structural integrity of the EHTP is retained after use. The tobacco is not consumed like in a combustible cigarette, and no ash is formed. The aerosol chemistry is much simpler compared to cigarette smoke. Operating the EHTP in an atmosphere of nitrogen - where one of the essential elements for combustion (oxygen) is excluded, yields substantially equivalent results in terms of aerosol composition compared to experiments run in air.

Identification and Description of Substances Studied. The objects of this study are products formed during tobacco product consumption and human breathing, i.e. tobacco smoke and тobacco heating system emissions, indoors ambient air and working area air composition in places where people are present.

Tobacco smoke is a complex mixture of thousands of components as gases, drops, and particulate matter, which cause addiction as well as general toxicity and carcinogenic effect. The direct indicator of tobacco smoke is nicotine, though the effect of smoke is not limited to the single substance. In fact, it contains over 4,000 chemicals of varying toxicity, over 50 of which (formaldehyde, ammonia, cyanide acid, lead, carbon monoxide, etc.) cause cancer, whether directly or indirectly. Tobacco smoke also contains such harmful chemicals as pesticides, heavy metals, and toxic gases [18, 19].

Tobacco smoke entering a room contains a) mainstream smoke, which the smoker inhales with each draw, and b) sidestream smoke entering the room directly from the glowing end of the cigarette, cigar, or smoking pipe.

The highest tobacco temperature combustion found at draws means that mainstream smoke is formed with a complete combustion as compared to sidestream smoke. Certain mainstream combustion product are never released to the environment as they are decomposed within the human body. Thus, sidestream smoke contains a higher level of harmful substances than mainstream smoke.

Many components of tobacco smoke are emitted to the ambient air by other sources, including industrial emissions, transport, and construction finish materials. However, nicotine is emitted to the air exclusively during tobacco combustion and indicate tobacco smoke. Therefore, air concentration of nicotine could be an efficient indicator of air quality and protection efficiency.

When a non-smoker is exposed to tobacco smoke, among unpleasant smell the person may also experience other kinds of discomfort including eye, nose, and throat irritation. Besides, exposure to tobacco smoke can provoke asthma attacks in people suffering from the disease or cause acute heart failure in those with heart diseases. Long-term exposure to tobacco smoke can increase the risk of developing bronchitis, pneumonia, lung cancer, and cardiovascular diseases. Moreover, some people can develop hypersensitivity to tobacco smoke that even short-term exposure would cause dyspnea, cough, mucosal irritation, and other reactions.

We do not know the threshold limit value of tobacco smoke concentration that would ensure an acceptable level of health risk. The values below present expert of legal recommendations for certain components of tobacco smoke approved in certain countries.

Tobacco smoke components in the air inspected while consuming tobacco products are carbon monoxide, carbon dioxide, formaldehyde, nicotine, benzo(a)pyren and ammonia.

Carbon monoxide. Tobacco smoke contains about 0.5% CO, while the average value for exhaust gases of internal combustion engines is 3.0%. The accepted threshold limit value of CO concentration in industrial plant air is 20.0 mg/m^3.

Carbon monoxide is produced endogenously during hemopigment metabolism. When protoporphyrin is transformed into bilirubin, CO is released. This accounts for 75.0% of endogenous CO; serum HbCO [CO+hemoglobin complex] concentration is under 1.0%.

Tobacco smoking is a major CO source. Smokers usually have a serum HbCO concentration of 5.0–15.0%, though it can be as high as 20.0%. Such concentration value can be extremely harmful to patients with lung or heart diseases. CO intoxication from cigarette smoking is considered as a possible major cause of atherosclerosis. Besides, it provokes cardiac angina, myocardial infraction, and cardiac arrhythmias. Smoke emitted by the glowing cigarette end contains 2.5 times as much CO as that inhaled by the smoker. In a poorly ventilated room, much smoking can cause CO intoxication in non-smokers, too.

Carbon dioxide. Carbon dioxide [CO_2] is a stable chemical compound found in natural gases in a concentration from several percent to practically pure carbon dioxide. It is colorless and has a slightly sour taste and odor. It is the end product of carbon oxidation, noncombustible. It does not sustain combustion or breathing. The toxic effect of carbon dioxide occurs with 3.0–4.0% air concentrations and is manifested as respiratory tract irritation, dizziness, headache,tinnitus, psychic excitement, and loss of consciousness.

Formaldehyde. At room temperature, formaldehyde is a colorless highly flammable gas with a specific strong odor. It is also known as methylene oxide, oxymethylene, methyl aldehyde, and oxomethane. A small amount of formaldehyde is naturally formed in the human body. Formaldehyde is used in fertilizer, paper, plywood, and urea formaldehyde resin production. It is also used as a preservative in certain foods, household agents and objects, antiseptic agents, drugs, and cosmetics. Cigarettes and other tobacco products, gas stoves, and open fireplaces also generate formaldehyde. Formic acid and carbon monoxide are formaldehyde dissociation products. Formaldehyde is not accumulated in plants and animals.

Benzo(a)pyrene. It is one of the most powerful and also very common carcinogenic agents. Being chemically and thermally stable as well as bioaccumulative, it has a constant and powerful effect when accumulated in the body. Apart from being carcinogeic, benzo(a)pyrene has mutagenicity, embryotoxicity, and hematotoxicity.

There are many ways in which benzo(a)pyrene can enter the body: with food and water, through skin and inhalation. The hazard level is independent of the way in which benzo(a)pyrene enters the body.

Nicotine (CAS 54-11-5)(8)-3-(1-methyl-2-pirrolidinyl)pyridine). An alkaloid, hygroscopic oily liquid with unpleasant odor and burning taste, readily mixed with water in its basic form. Chemical formula: $C_{10}H_{14}N_2$.

Basic nicotine combustion temperature is under the boiling point; its fumes flare at an air temperature of 95.0°C in spite of low steam pressure. Nicotine can cause nervous system paralysis (apnea, heart arrest, death). Nicotine is an alkaloid, one of the most powerful plant toxins, found in tobacco (0.3–10.0% dry weight) and some other solanaceous plants. Nicotine lethal dose (LD) is 50.0 mg/kg for rats and 3.0 mg/kg for mice. The average human lethal dose of nicotine is 40.0–70.0 mg (0.5–1.0 mg/kg). Its excretion half-life is two hours.

The International Agency for Research of Cancer has not assessed the carcinogenicity of pure nicotine, and not as tobacco smoke; so nicotine is not on the official list of carcinogenic agents; it is a class 4 hazardous substance [18, 19]. It is found in the atmosphere as vapor or dust. No threshold limit value (TLV) for atmosphere nicotine has been established in Ukraine. Its atmosphere reference safe exposure level (RSEL) is 0.001 mg/m^3 [23, 24]. In Finland, a limit value of nicotine air concentration of 0.5 mg^3 was accepted. Before smoking in public places was prohibited in Norway, the threshold limit value for nicotine was 1 mg/m^3. The grounds underlying the regulation are unknown.

Ammonia (CAS 7664-41-7). Ammonia – NH_3, hydrogen nitride, colorless gas with strong odor (aqueous ammonia), almost two times lighter than air, boiling point at 33-35°C. Ammonia is a suffocate and a neurotropic toxin. Thus, it causes toxic pulmonary edema and severe damage to the nervous system when inhaled. Ammonia vapor is irritant to eye and respiratory organ mucosae as well as skin, causing increased lacrimation, eye pain, chemical burns of the conjunctiva and the cornea, loss of sight, coughing fits, skin redness and itching. The threshold limit value (TLV) of work area air concentration of ammonia is 20.0 mg/m^3 [20, 21]. According to hygienic standards GN 2,1.6.1338-03, atmosphere ammonia TLV in populated areas is as follows: average daily exposure - 0.04 mg/m^3; maximum short-term exposure - 0.2 mg/m^3. Chronical gas ammonia intoxication causes headache, metabolic disorders, arterial hypotension, neurataxia, chronical inflammatory diseases of the upper respiratory tract, suppressed immune and hematopoietic systems, etc. [22].

Methodological Approaches to Air Composition Study

Sampling is an important part of toxic impurity detection in polluted air. Its importance is determined by the fact that incorrect sampling brings about meaningless analysis data. Air is either aspiration sampled or sampled by filling limited volume containers. Both methods are suitable to study gaseous impurities, while aerosol impurities and dust should be examined using the aspiration method.

Experiment conditions: a parallel experimental (within the parameters of the same indoor workplace) evaluation of 6 workplace air safety and quality indicators related to human health with two types of tobacco products consumed (conventional filtered cigarettes and EHTSs). Tables 1 and 2 present the contents and organization diagram of the experimental research.

The study included 80 volunteers, of which 20 (25.0%) consumed tobacco products, while the rest stayed within the specified room throughout the experiment period in an uncontrolled way. Air CO, CO_2, benzo(a)pyrene, nicotine, formaldehyde, and ammonia were measured.

Air sampling in our situation fully suited the type, amount, and connection order of absorption containers, filter holders, and other devices, meeting the requirements to absorbing solution volume, volumetric air flow rate,

Table 1

Sampling Scheme with EHTSs (first day)

Time unlimited	10.00-11.00 (A)	11.00-12.00 (B)	12.00-13.00 (C)	13.00-14.00 (D)	Time unlimited
Cleaning and airing	Air sampling without volunteers	Air sampling with 80 volunteers present and no EHTSs used	Air sampling with 80 volunteers present, 20 of which are using EHTSs	Air sampling with 80 volunteers present and no EHTSs used	Cleaning and airing

Table 2

Sampling Scheme with conventional cigarettes (second day)

Time unlimited	10.00-11.00 (A)	11.00-12.00 (B)	12.00-13.00 (C)	13.00-14.00 (D)	Time unlimited
Cleaning and airing	Air sampling without volunteers	Air sampling with 80 volunteers present and no cigarettes used	Air sampling with 80 volunteers present, 20 of which are using cigarettes	Air sampling with 80 volunteers present and no cigarettes used	Cleaning and airing

air sample volume, and sampling period under GOST 12.1.005-88. Sample Storage Period and Conditions.

All methods and equipment used to measure chemical concentrations comply with all applicable regulations and ensure concentration evaluation at a level of 0.5 TLV with a relative standard deviation. Chemical concentration relative standard deviation at the TLV level was not more than 25.0%.

The amount of air sampled was brought to the standard conditions. For this purpose, micro-climate parameters (temperature, atmospheric pressure, and relative air humidity) were measured. Air sampling devices were placed in typical fixed locations of the specified room (stationary method). The aspiration sampling method was practiced by blowing the air through an aspirator with air volume recording using a flow meter. Aerosol filters to pass the specified air volume were used for gaseous and vaporous substances, as well as absorption containers with absorbing solutions, in which the substance dissolves or is chemically bound.

The period required to obtain one air sample was estimated analytically with allowance for the probable concentration of the compound in the work area air. A number of measures were taken to minimize error and increase the sensitivity of the method - the volume of air passing through the container was increased; the period between sampling and the beginning of sample preparation was minimized; the duplicate sample summation method was used in some cases. Samples from a certain location with the same passing rate were summed. In that case, the average value of the sample results over the specified period was measured; the weighted average of the results was calculated for further comparison with the threshold limited values.

Following sample preparation aliquots of the substances were extracted from filters and vials containing liquid absorber and then analyzed.

Thus, sampling was performed in catering and entertainment establishment having a total floor area of 250 square meter and a volume of 625 cubic meters. During the experiment, all volunteers could move around the establishment freely, communicating and behaving casually. During the experiment, 20 volunteers consumed 4 to 5 units of the study products each from 12.00 to 13.00, both on Day 1 and Day 2. Moderators were present during the experiment ensuring that the tobacco product consumption scheme be implemented and controlling the room micro-climate.

Sampling was performed with a Tayfun-MK two-channel portable electrical aspirator. Flow rate was set at 2.0 L per minute. It is designed for air sampling for dust and aerosol concentration measurement by passing specific air sample volumes through AFA VP 10/20 (or other) filters. Suitable filter holders with tubes were used as connectors. The aspirator is used for sanitary and environmental workplace and atmosphere air control.

No natural or forced room ventilation was used during the experiment. Samples were laboratory tested using standard methods according to the accreditation scope under ISO 17025:2006 (see Table 3)

STUDY RESULTS

Threshold limit values for substances studied in this experiment while using EHTSs and conventional cigarettes: TLVw.a..- according to SN No. 4617-88 All-Union Sanitary, Hygienic, and Anti-Epidemic Rules and Standards "Threshold limit values (TLV) of hazardous substances in work area air"; TLVm.s-t., TLVa..d. - according to DSP-20-97 "State sanitary rules for the protection of atmospheric air in populated areas (from chemical and biological pollution") and Threshold limit values of chemical and biological substances in atmospheric air in populated areas, approved on 03.03.2015 by acting Head State Sanitary Doctor of Ukraine (see Table 4).

Study Results Analysis

Following a survey among the participants and experimental examination of certain air safety and quality indicators, such as ammonia, nicotine, formaldehyde, benzo(a)pyrene, carbon mono- and dioxide concentrations in a room where EHTSs have been used as compared to the air where conventional filter cigarettes have been smoked, the following findings were obtained:

Table 3

Work area air hazardous substance concentration measurement methods

Study substance	Study method
Nicotine (CAS 54-11-5)	ISO 10315:2010
Ammonia (CAS 7664-41-7)	GOST 17.2.4.03-81
Bezo(a)pyrene (CAS 50-32-8)	ISO 12884:2000
Formaldehyde (CAS 50-00-0)	MUK "Detection of formaldehyde using gas liquid chromatography with 2,4 dinitrophenylhydrazone"
Carbon monoxide CO (CAS 630-08-0)	ISO 8554:2007
Carbon dioxyde CO_2 (CAS 124-38-9)	

Table 4

Sampling Scheme with conventional cigarettes (second day)

Ser. No	Substance	TLV in ambient atmospheric air Daily	Maximum short term TLV in ambient atmospheric air	Work area TLV
1	Carbon monoxide	3,0	5,0	20,0
2	Carbon dioxyde	0,1-0,5%	1,0%	- (n/a)
3	Nicotine	0,0004	0,0008	0,001 (RSEL)
4	Benzo(a)pyrene	0,000001	- (n/a)	0,00015
5	Formaldehyde	0,003	0,035	0,5
6	Amonia	0,04	0,2	20,0

- subjectively, indoor air during and after the consumption of EHTSs is perceived as practically the same as before the consumption of EHTSs;

- subjectively, the indoor air was smoke-laden, suffocating, and choking, sometimes causing mild eye irritation during and after the consumption of conventional cigarettes;

- objectively, practically no benzo(a)pyrene, nicotine, and ammonia were detected in the indoor air where 20 volunteers had consumed 20x4 times EHTSs - the result was at the response limit of the analytical detection method or n/a. During and after the consumption of EHTSs, a slight increase of carbon monoxide and formaldehyde air concentration was detected, which might have been caused by intensified breathing resulting from active behavior like billiards, coffee consumption, and active communication. The actual content of the above air safety indicators in indoor air during and after EHTSs consumption by no means exceeded the TLVs for atmospheric air.

- nearly all air safety indicator concentrations were found to be increased in the indoor air during and after the consumption of 20x4 times conventional cigarettes by 20 volunteers. In such a room, the human health hazard would be increased by carbon dioxide, formaldehyde, benzo(a)pyrene, and ammonia high concentrations. Carbon dioxide content was nearly 10 times high than the TLV for atmospheric air; formaldehyde content was 3 times high than the TLV for atmospheric air; benzo(a)pyrene content was nearly twice higher than the work area TLV; 80 conventional cigarettes brought nicotine content up to a value nearly 2 times higher than the RSEL for work area air nicotine; while ammonia content of the room reached TLV m.s-t. for atmospheric air.

Thus, consumption of 80 conventional cigarettes in a confined space, contrary to EHTSs consumption, worsened the air safety and quality significantly, presenting real risk to all the 80 people in the room, including the 60 non-smokers.

Therefore, increased governmental and public activities of the Parties to the Framework Convention on Tobacco Control in terms of controlling the consumption of cigarettes and other combustible tobacco products resulted in a large number of industrially produced electronic means of nicotine delivery, consumption of which must be studied closely to assess the real health risk to the consumer.

It was the first comparative study on consumption of different types of tobacco product conducted by the Laboratory of L. I. Medved's Center for Preventive Toxicology, Food and Chemical Safety, Ministry of Health, Ukraine. We believe the preliminary evidence obtained to suggest the following findings:

1. We have suggested and approved experimental conditions on studying the consumption of tobacco products with different nicotine delivery mechanisms. Standard operating procedures, as well as those for sampling and analytical research, developed a complete model for a comparative study on the consumption of various types of tobacco products, which can ensure a more complete and profound assessment of the risks related to different types of tobacco products in further research foreseen the objects and safety indicators to be optimized.

2. Contrary to conventional cigarettes, the actual content of the air safety indicators in indoor air during and after EHTSs consumption by no means exceeded the TLVs for atmospheric air.

3. For a comparative risk assessment and possible health damage caused by consumption of different types of tobacco product, further research on safety, composition, and consumption parameters that are more specific to EHTSs are required. First of all, electronic devices of nicotine delivery that heat processed tobacco, as well as the number of electronic cigarettes and other tobacco free nicotine delivery devices.

4. Key factors for electronic nicotine delivery system's risk assessment include product composition and material, aerosol composition, combustion or sublimation products, nicotine delivery technology used in the tobacco product or electronic cigarette.

REFERENCES

1. Air Quality Guidelines for Europe/WHO.-[v.2] Moscow; Ves Mir, 2004. — P.5–89.
2. WHO, 2006: Air Quality Guidelines – Global Update 2005. World Health Organisation, Regional. Office for Europe, Copenhagen. – 484 c.
3. [Electronic resource]: http://www.interfax.com.ua; www.euro.who.int/ru/what-we-do/health-topics/.../smoking-cessation; www.who.int/tobacco/resources/.../index.html.
4. US Department of Health and Human Services. The Health Consequences of Smoking - Nicotine Addiction: A Report by the Minister of Health, Washington, DC, US Government Publishing Office, 1988.
5. Henningfield JE, Benowitz NL. Pharmacology of Tobacco Addiction. Boyle, P et al Tobacco: Science, Policy and Public Health, 2nd edition. Oxford, Oxford University Press, 2010. —№155. — P. 170.
6. Scientific Committee on Emerging and Newly Identified Health Risks Addictivity and Appeal of Tobacco Additives. Brussels, European Committee, 2010.
7. US Minister of Health Health Consequences of Smoking: How Tobacco Products Cause Diseases. Report by the US Health Minister. Washington, DC, US Public Health Service, Center for Disease Control, Health and Education Center, Office on Smoking and Health, Department of Health and Human Services, 2010.
8. Rabin R.C. A New Cigarette Hazard: "Third-Hand Smoke" /R.C. Rabin. – Electronic resource //New York Times, Retrieved, 2009. – http://healthcareresearch.suite101.com/article.cfm/study-reveals-new-cigarette-smoke-dangers-risk
9. Abuse liability of nicotine. Edited by Benowitz Stitzer M.L., DeWitt H. / NL. Safety and Toxicity of Nicotine. New York, Oxford University Press, 1998. — P. 119–131
10. Conference on drug formulations and abuse liability. Sellers E.M., Schuster C.R. / Drug and Alcohol Dependence, 2006, 83 (Enlarged edition). — P. 81–83.
11. Manipulating product design to reinforce tobacco addiction. In: Boyle P Wayne G.F., Carpenter C.M. [et al.], Tobacco Science, Policy, and Public Health. Oxford University Press; Oxford: 2010. — P. 171–195.
12. Spillane J, McAllister WB Keeping the lid on: a century of drug regulation and control. Drug and Alcohol Dependence, 2003, 70(Enlarged edition). — P. S5–S12.
13. Expert panel. Abuse liability assessment of CNS drugs: conclusions, recommendations, and research priorities. Drug and Alcohol Dependence, 2003, 60 (Enlarged edition). — P. S107–S114.
14. Henningfield JE, Schuster CR. Risk management and post-marketing surveillance of CNS drugs. Drug and Alcohol Dependence, 2009, 105 (Enlarged edition). — P. S56–S64.
15. U.S. Surgeon General's Report on Secondhand Smoke. – 2010. — Chapter 9. – P. 555–558.
16. Guidelines on the Protection from Exposure to Secondhand Smoke. Framework Convention for Tobacco Control //World Health Organization. – 2007. – Retrieved 2009.
17. [Electronic resource]: www.sigarets.ru, www.nosmoking.ru, www.adic.org.ua, www.mv.ru.
18. Beliefs about the health effects of "thirdhand" smoke and home smoking bans /[J.P. Winickoff, J. Friebely, S.E. Transki, et.al]. //Pediatrics 123. – 2009. – P.74–79.
19. [Electronic resource]: http://www.segodnya.ua/health/14214292.html.
20. [Electronic resource]: http://www.euromate-air.ru/cabins/
21. [Electronic resource]: http://www.km.ru/news/v_aeroportu_pulkovo_poyavilis_ka.
22. [Electronic resource]: http://www.newsland.ru/News/Detail/id/467917/.
23. Invernizzi G et al. Particulate matter from tobacco versus diesel car exhaust: an educational perspective. Tobacco Control, 2004. — №13. – С. 219–221.

ОЦІНКА ПОТЕНЦІЙНИХ РИЗИКІВ ЗАСТОСУВАННЯ СИСТЕМИ ЕЛЕКТРИЧНОГО НАГРІВАННЯ ТЮТЮНОВИХ ВИРОБІВ (СЕНТВ)

М.Г. Проданчук, А.Є. Подрушняк, О.Є. Малишева, А.М. Строй, В.В. Завальна, Т.І. Мороз, В.І. Крук, Т.В. Шутова

ДП "Науковий центр превентивної токсикології, харчової та хімічної безпеки імені академіка Л.І. Медведя Міністерства охорони здоров'я України", м. Київ, Україна

РЕЗЮМЕ. Мета*. На підставі токсиколого-гігієнічного експерименту із залученням добровольців провести оцінку використання систем електричного нагріву тютюнових виробів СЕНТВ у порівнянні з тютюнопалінням традиційних сигарет з фільтром і виявити кількісну і якісну відмінність складу повітря в приміщенні, де використовувались ці вироби.*

Матеріали і методи. *Токсиколого-гігієнічна характеристика повітря, що видихається в закритому приміщенні, де були присутні 80 добровольців (активних і пасивних курців) з оцінкою вмісту монооксиду вуглецю, діоксиду вуглецю, формальдегіду, нікотину, бенз (а) пірену та аміаку з використанням хіміко-аналітичних і органолептичних методів дослідження.*

Результати*. Виявлено, що при використанні СЕНТВ у повітрі закритих приміщень практично не було виявлено: бенз (а) пірену, нікотину, аміаку - результати на межі або нижче межі чутливості методу аналітичного визначення. Незначним чином збільшився вміст монооксиду та діоксиду вуглецю, формальдегіду. Реальний рівень вмісту зазначених показників безпеки повітря в приміщенні, де споживались СЕНТВ, у жодному разі не перевищував гранично допустимої концентрації (ГДК) атмосферного повітря на відміну від повітря приміщення, де споживали традиційні цигарки з фільтром, де було виявлено достовірно підвищення вмісту практично всіх досліджуваних показників безпеки повітря. Рівень монооксиду вуглецю перевищив ГДК атмосферного повітря майже в 10 разів, рівень формальдегіду перевищив ГДК атмосферного повітря у 3 рази, рівень бенз(а)пірену майже вдвічі перевищив ГДК повітря робочої зони, рівень нікотину майже у 2 рази переви-*

щив орієнтовно безпечний рівень впливу (ОБРВ) нікотину у повітрі робочої зони, а рівень аміаку в приміщенні досягнув ГДК м.р. атмосферного повітря.

***Висновки**. Виявлено менший потенційний ризик для здоров'я активних і пасивних курців при використанні СЕНТВ у порівнянні з курінням традиційних цигарок з фільтром, який грунтується на більш низьких рівнях забруднення повітря в приміщенні, де використовувалися ці вироби.*

***Ключові слова:** СЕНТВ, тютюнові вироби, оцінка ризиків, нікотин, бенз (а) пірен, аміак, формальдегід, монооксид вуглецю, діоксид вуглецю, забруднення.*

ОЦЕНКА ПОТЕНЦИАЛЬНЫХ РИСКОВ ИСПОЛЬЗОВАНИЯ СИСТЕМЫ ЭЛЕКТРИЧЕСКОГО НАГРЕВА ТАБАЧНЫХ ИЗДЕЛИЙ (СЭНТИ)

Н.Г. Проданчук, А.Е. Подрушняк, Е.Е. Малышева, А.Н. Строй,
В.В. Завальная, Т.И. Мороз, В.И. Крук, Т.В Шутова
ГП "Научный центр превентивной токсикологии, пищевой и химической безопасности имени академика Л. И. Медведя Министерства здравоохранения Украины", г. Киев, Украина

***РЕЗЮМЕ**. **Цель.** На основании токсиколого-гигиенического эксперимента с привлечением добровольцев провести оценку использования систем электрического нагрева табачных изделий (СЭНТИ) по сравнению с курением традиционных сигарет с фильтром и выявить количественное и качественное отличие состава воздуха в помещении, где использовались эти изделия .*

***Материалы и методы.** Токсиколого-гигиеническая характеристика выдыхаемого воздуха в закрытом помещении, где присутствовали 80 добровольцев (активных и пассивных курильщиков) с оценкой содержания монооксида и диоксида углерода, формальдегида, никотина, бенз(а)пирена и аммиака с использованием химико-аналитических и органолептических методов исследования.*

***Результаты**. Выявлено, что при использовании СЭНТИ в воздухе закрытых помещений практически не было обнаружено: бенз (а) пирена, никотина, аммиака - результаты на грани либо ниже границы чувствительности метода аналитического определения. Незначительно увеличилось содержание монооксида и диоксида углерода, формальдегида, однако ни один показатель не превысил предельно допустимую концентрацию (ПДК) атмосферного воздуха, в отличие от воздуха после употребления традиционных сигарет, где отмечается повышение содержания практически всех исследуемых показателей безопасности воздуха. Уровень монооксида углерода превысил ПДК атмосферного воздуха почти в 10 раз, уровень формальдегида превысил ПДК атмосферного воздуха в 3 раза, уровень бенз (а) пирена почти вдвое превысил ПДК в воздухе рабочей зоны, уровень никотина почти в 2 раза превысил ориентировочный безопасный уровень воздействия (ОБУВ) никотина в воздухе рабочей зоны, а уровень аммиака в помещении достиг ПДК м.р. атмосферного воздуха.*

***Выводы**. Выявлен более низкий потенциальный риск для здоровья активных и пассивных курильщиков при использовании СЭНТИ по сравнению с курением традиционных сигарет с фильтром, который основан на более низких уровнях загрязнения воздуха в помещении, где использовались эти изделия .*

***Ключевые слова:** СЭНТИ, табачные изделия, оценка рисков, никотин, бенз (а) пирен, аммиак, формальдегид, монооксид углерода, диоксид углерода, загрязнения.*

Received on December 1, 2016