Determination of the Hazard of Medical Waste in the Convention of the Covid-19 Pandemic

Określenie zagrożenia związanego z odpadami medycznymi w okresie pandemii Covid-19

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Danusia M. Brezytska[1], Ihor V. Hushchuk[2], Vladyslav A. Smiianov[3], Oleg M. Vivsiannyk[4], Roman V. Safonov[5], Inna S. Khoronzhevska[5]

[1]SI «O.M. Marzieiev Institute for Public Health, Namn Ukraine», Kyiv, Ukraine
[2]National University of Ostroh Academy, Ostroh, Ukraine
[3]Sumy State University, Sumy, Ukraine
[4]Department of Civil Protection and Public Health, Rivne, Ukraine
[5]State Institution "Rivne Regional Center for Disease Control and Prevention of the Ministry of Health of Ukraine" Rivne, Ukraine

SUMMARY

Aim: To determine the infectious danger of medical waste from patients with COVID-19, by examining them for the presence of coronavirus SARS-CoV-2.

Materials and Methods: Regulatory – legal acts, foreign editions, results of the laboratory researches that we received served as materials for carrying out research. While researching such methods were used: descriptive, bibliographic, analytical, epidemiological, laboratory diagnostics, statistical.

Results: The study confirmed the presence of RNA of the coronavirus SARS-CoV-2 in 5 selected samples from protective masks of patients with COVID-19 (8.9%) by polymerase chain reaction (PCR). SARS-CoV-2 coronavirus was not detected in samples taken from medical masks. Separate studies of wastewater from the infectious disease hospital of Ostroh General Hospital and from the city sewer network for the presence of coronavirus SARS-Cov-2 were conducted. SARS-CoV-2 coronavirus was not detected in the selected samples by PCR.

Conclusions: The results of the study confirm the infectious potential of medical waste, mostly wrong treatment.

Key words: medical waste, COVID-19, risks, management, pandemic

Słowa kluczowe: odpady medyczne, COVID-19, zagrożenia, zarządzanie, pandemia

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INTRODUCTION

The problem of environmental pollution by waste, including hazardous waste, which includes medical waste, is a global threat to the entire population of our planet. Research in recent years has found a large number of medical and veterinary drugs in many ecosystems around the globe. More than half of the drugs consumed are excreted from the body in a biologically active form. The study has found that in small doses, in the United States, certain drugs are contained in tap water in almost all settlements. More than 180 of the 3,000 permitted active substances have already been detected in German waters, including antibiotics, psychotropic drugs, and hormonal drugs [1].

Today, the WHO plays a leading role in preventing the risks posed by hazardous medical waste. It has issued several policy documents to support countries to improve their health management system, which provides statistics, various regulations and solutions that are recommended for implementation and are already in use in many countries. These are programs such as "Medical waste management" in 2011 and "Safe management of wastes from health-care activities", published in 2013 and supplemented in 2014, where medical waste also included waste of medical origin generated at home. WHO also released a 2015 handbook, Status of Health Care Waste Management in Selected Countries of the Western Pacific Region, 2008-2013, which provides an example of Western Pacific countries' experiences in medical waste management, where they have been guided by WHO guidelines. and what impact this had on the region [2-5].

This article is the result of the 3rd stage of research work on the study of the peculiarities of medical waste management in the context of the COVID-19 pandemic in Ukraine, both from medical institutions and from the population. The results of a study on the detection of coronavirus SARS-CoV-2 RNA in rinses from used protective masks of patients with COVID-19 and medical workers who provide medical care to such patients are described. Searching for the presence of SARS-CoV-2 coronavirus and enterovirus group wastewater was also investigated. Thus, suggestions are made for the safe management of medical waste in a pandemic.

According to the State Statistics Service of Ukraine, the total accumulation of hazardous waste is 5 billion tons [6]. A significant share of hazardous waste is medical waste, which is a factor in both direct and indirect risk of environmental pollution, as well as the occurrence of infectious and non-infectious diseases among the population. According to the International Charitable Organization "Ecology-Law-Human", Ukraine produces about 400 thousand tons of medical waste annually. They are accumulated by medical institutions, pharmaceutical companies, ordinary citizens etc. [7].

The main requirements for the treatment of medical waste (collection, transportation, storage, sorting, treatment (processing), disposal, removal, disinfection, disposal, destruction) in health care facilities are defined by the order of the Ministry of Health of Ukraine from 08.06.2015 № 325 "On approval of the State sanitary and anti-epidemic rules and norms on medical waste management". However, this document does not apply to the procedure of medical waste management of pharmaceutical companies and medical waste generated at people's homes. Pharmacies and the public act at their own discretion and often dump such waste in landfills or dump it in the sewers [7].

With the development of the medical industry, the amount of medical waste that poses an environmental and infectious threat to the population is also increasing. Medical waste has different degrees of epidemiological and environmental hazard depending on its composition and the degree of contamination by biological, chemical and radioactive agents. Waste and by-products can cause injuries and damage to the environment.

Problems with medical waste management have existed for a long time. However, recently, with the onset of the COVID-19 pandemic, this issue has become particularly efficient. After all, the burden on the medical sphere has increased – the number of hospitalizations has increased, which has led to an increase in manipulations, the use of tools, medical supplies. And the population uses a huge number of personal protective equipment (masks, respirators, gloves) every day, which are not properly disposed of. And the current legislation classifies such waste as hazardous medical waste.

If the issue of medical waste from medical institutions is legally settled in some way, then medical waste generated in the home is ignored, so the population throws it to the general container for solid waste or landfills. Citizens are not always adequately informed about the dangers of mishandling medical waste, do not have information on possible methods of disposal of poor quality and expired medicines at home, and most importantly, the conditions for receiving medical waste generated at home are not created in order to further transfer them to the relevant structures that have licenses to carry out operations in the field of hazardous waste management [8].

Thus, it is very important to know how dangerous such waste is. As the global SARS-CoV-2 coronavirus pandemic continues, it was interesting to learn about the resistance of the virus to the environment. After analyzing a large number of publications, we processed data on the resistance of the coronavirus to environmental factors, chemical and physical ones. However, no information was found on actual time of its storage and for how long it stays on the used protective masks. Therefore, conducting research in this area is so relevant.

AIM

Determining the infectious hazard of medical waste from patients with COVID-19, by examining them for the presence of coronavirus SARS-CoV-2 and providing suggestions for the safe management of this category of waste.

MATERIALS AND METHODS

Regulatory – legal acts, foreign editions, results of the laboratory researches that we received served as materials for carrying out research. Such methods as: descriptive, bibliographic, analytical, epidemiological, laboratory diagnostics, statistical were used. Collection of materials for the study was carried out on the basis of "Ostroh General Hospital" of Rivne Regional Council. The research took place in the specialized virusological laboratory of the Rivne Regional Laboratory Center of the Ministry of Health of Ukraine. In the course of the work, a virusological study of samples taken from used medical masks and wastewater was performed by polymerase chain reaction (PCR) to detect RNA of the coronavirus SARS-CoV-2. Conditions of research: t. 20°C, atm. pressure – 750 mm of mercury, relative humidity – 67%. PCR was performed on a special equipment – an automatic station for the extraction of ribonucleic acid Auto-Pure96 (AllSheng, China). Statistical processing of the obtained materials was performed using the statistical package "MedStat", which is widely used for the analysis of biomedical information (Y.E. Lyakh et al., 2006). Absolute risks (AR) were calculated with 95% probable intervals (95% PI).

These methods meet ethical standards and fully disclose the objectives. The research was approved by the Commission on Bioethics of the National University «Ostroh Academy» in accordance with the European bioethics and bio-rights, Helsinki Declaration of the World Medical Association.

RESULTS

While planning and conducting this work, we confirmed the information about the significant accumulation of used personal protective equipment (hereinafter – PPE) in medical institutions from medical staff and patients. At the same time, we have established that there is currently no

objective information on the volume/number of PPE from the population. The main task in accordance with the set goal is to determine how dangerous PPE is and whether they pose an epidemiological threat to the population and may be a source of coronavirus spread in the future.

For this purpose, rinses from the masks of patients with COVID-19 were selected; rinses from masks of medical workers providing care to patients with COVID-19. The following were used for sampling: distilled water, silicone applicators for sampling and sterile cryotubes with a capacity of 2.5 ml. A total of 56 samples were taken.

Samples were taken three times for the study (Table 1). At the first selection – rinses were taken from the used protective masks: 1) patients with coronavirus disease, confirmed by PCR with severe clinical manifestations, who were hospitalized in the infectious department, in the amount of 30 samples; the rinses were removed from the inside of the masks using silicone applicators soaked in distilled water, after which they were placed in cryotubes (2.5 ml) filled with distilled water to the mark of 1.5 ml.; 2) medical workers who provide medical care to patients with covid-19, in the amount of 12 samples; rinses were taken from the outside and inside of the masks by the same method as rinses from the masks of patients.

The selection was carried out in compliance with hygienic and epidemiological safety measures. After the selection, the test tubes with the material were placed in a tripod and frozen at a temperature of -18°C, where they were stored for seven days.

On the day of the study, the samples were placed in a thermo-bag with cold cells and delivered to the laboratory for testing. As a result of the study, RNA of coronavirus SARS-CoV-2 was implemented in sample №1, which corresponded to washing from the mask of a patient with COVID-19. The other samples have not implemented the coronavirus. We assume that such a low detection rate of SARS-CoV-2 was obtained due to freezing of the samples. From the masks used by the medical staff, all the results were negative.

In the second selection, rinses from protective masks with COVID-19 in the amount of 5 samples were taken. The rinses were removed from the inside of the masks, which are in direct contact with the patient, using silicone applicators soaked in distilled water, and then placed in cryotubes (2.5 ml) filled with distilled water to the mark of 1.5 ml. After collection, the tubes were placed in a thermo-bag with cold cells and delivered to the virusological laboratory for tests that were performed on the day of collection. As a result, the coronavirus SARS-CoV-2 was detected in samples №1, №2, №5. Such an indicator points out on the reliability of the study. And if we compare it with the results of the first collection, where RNA of coronavirus was detected in one sample, we can assume that freezing of samples negatively affects the reliability of the results, and low temperatures contribute to the disruption of the RNA of coronavirus SARS-CoV-2.

At the third selection, 9 samples taken from protective masks of patients with COVID-19 were examined in the same way as in previous studies. The samples, placed in a thermo bag with cold cells, were delivered to the virology laboratory, where they were frozen. The study was conducted two days later. As a result, the coronavirus SARS-CoV-2 was detected in the sample №4. This study confirmed our assumptions about the negative effects of low temperatures on the RNA structure of the coronavirus.

It should also be noted that the absence of coronavirus SARS-CoV-2 on the masks used by medical workers who had direct contact with patients with coronavirus disease. This result indicates a high level of protection, by the usual surgical mask, against coronavirus infection, when used properly.

DISCUSSION

The results of the study show that PCR confirmed the presence of RNA of the coronavirus SARS-CoV-2 in 5 samples (Figure 1), where there were rinses from the masks of patients with coronavirus disease. The positive result at the first sampling

Table 1. The results of sanitary-microbiological examination for coronavirus SARS-CoV-2

Type of samples	Quantity of samples	Positive results	Risk assessment	Negative results	
Rinses from masks of patients with COVID-19	30	1(3,3%)	AP=3,3% 0,0<AP<13,1% p=0,05	29	1st selection
Rinses from masks of patients with COVID-19	5	3(60%)	AP=60% 6,9<AP<99,6% p=0,05	2	2nd selection
Rinses from masks of patients with COVID-19	9	1(11,1%)	AP=11,1% 0,0<AP<43,9% p=0,05	8	3d selection
Rinses from protective masks of medical workers providing care to patients with COVID-19	12	0		0	1st selection

was 3.3%, and 95% probable risk interval of detection of the pathogen on used medical masks from patients ranges from zero to 13.1%; at the second sampling, the risk of detecting coronavirus was 60%, and the probable risk ranged from 6.9 to 99.6%; at the third sampling – a positive result was in 11.1% of the samples taken with a probable interval in the range from zero to 43.9%. No coronavirus SARS-CoV-2 was detected in other RNA samples, but the results were questionable, which could not completely exclude the presence of the virus on the protective masks used. Low detection rates of SARS-CoV-2 coronavirus on the first and third samples may indicate that low temperatures contribute to damage to the RNA structure of SARS-CoV-2 coronavirus, so it was impossible to detect. We can even assume that the coronavirus mutates during freezing, but these are only assumptions that can be the basis for further research.

According to the study, medical waste, in particular personal protective equipment used, can be a potential source of infection in coronavirus disease and contribute to its prevalence among the population and in the environment. In addition, we must not forget about the negative impact of such waste on environmental safety. Therefore, appropriate recommendations should be developed at the state level on the safe handling of personal protective equipment used not only by medical institutions, but also by the population. Because a large number of patients are treated on an outpatient basis or generally transmit the disease asymptomatically, but are a source of infection. After preliminary laboratory tests, it was decided to examine the wastewater for the presence of coronavirus SARS-CoV-2. The collection was carried out three times from the sewage of the infectious diseases department, where inpatient care was provided to patients with COVID-19 and from the general sewerage network of the city. Two samples were taken in sterile, airtight glass containers (500 ml) from each site. After collection, the samples were delivered to the virusological laboratory. Virusological examination was performed by PCR test. As a result, SARS-CoV-2 coronavirus RNA was not detected. Such results may be due to wastewater disinfection and a small number of samples taken. However, we believe that it makes sense to conduct further research.

After studying a large number of materials on the methods of medical waste disposal, we came to the conclusion that the most effective method of disposal of hazardous medical waste is burning in incinerator furnaces. This is the method recommended by the World Health Organization. Enterprises with a license to conduct operations in the field of hazardous waste management and the ones that have the appropriate certified equipment must carry out neutralization. Unfortunately, there are very few such enterprises in Ukraine, so the best solution to this problem would be the introduction of mobile incinerators, which would serve a number of medical institutions in a separate area, and could accept medical waste from the population.

The main tasks currently emerging in medical waste management:

- create a basis for the introduction of proven methods and technologies for medical waste management (MWM);

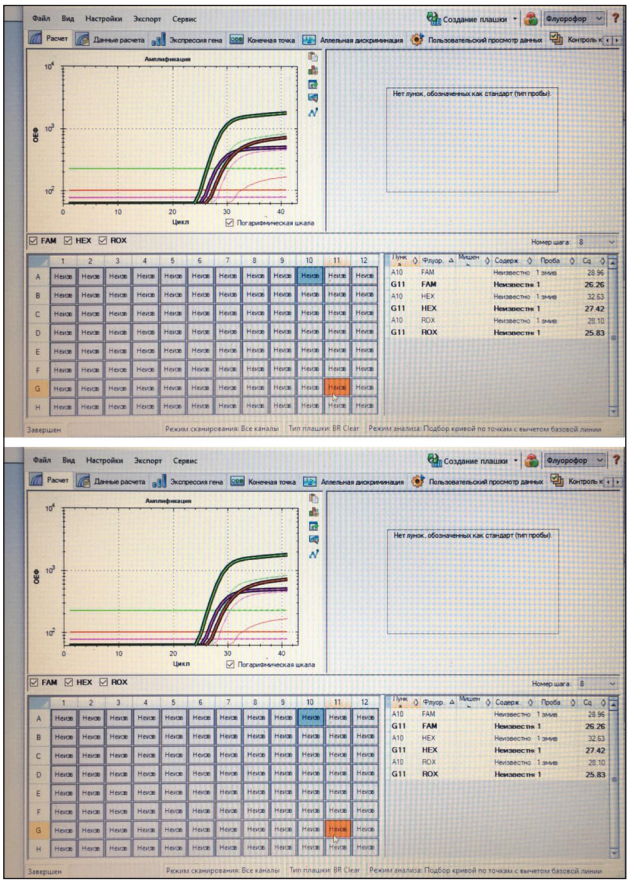

Figure 1. An example of a positive test result for coronavirus SARS-CoV-2, by PCR

- to develop a national disposal network for effective control of all infectious and other hazardous medical waste, and thus: to prevent further use of landfills for medical waste disposal; improve waste management standards to reduce pollution [9].

Until now, much of the medical waste falls into unauthorized landfills. Elimination of such landfills is a major challenge for Ukraine.

The management of many medical institutions is not aware of their responsibility for the environmentally sound disposal of generated waste. And the limited financial resources of medical institutions are the biggest problem on the way to improving the management of medical waste.

Thus, the most pressing problem in the field of medical waste management is that most of the current regulations are not fully implemented, are not implemented in practice, sometimes contradict each other. In addition, the management of medical waste from the population is not regulated, so the special attention should be given to this problem and it should be regulated by law.

Nowadays, the only way to overcome these problems is to implement the "National Waste Management Strategy in Ukraine until 2030" at all governmental levels [10].

Also, an important role is played by sanitary and educational work among the population. So we can recommend: before getting rid of used masks or gloves – disinfect them or soak

them in soap solution, pack in airtight packaging; to require from their local governments to organize hazardous waste collection systems as part of solid waste, placing special marked containers for this purpose; carefully collect and disinfect waste from infected patients and pack them in airtight containers; disinfect liquid waste from patients with COVID-19 or other infectious diseases before discharging it into both local and public sewer systems.

CONCLUSIONS

In the course of the study we found out that with the development of medicine the amount of medical waste that poses an infectious threat to the population increases. With the onset of the COVID-19 pandemic, this issue has become even more relevant. Therefore, there is a need to study the hazards of medical waste generated by patients with COVID-19.

As a result of the study, PCR confirmed the presence of RNA of the coronavirus SARS-CoV-2 in 5 samples taken from the masks of patients with coronavirus disease.

SARS-CoV-2 coronavirus was not detected on samples taken from medical workers' masks. This result indicates a sufficient level of protection against coronavirus infection, which gives the usual surgical mask when used properly.

The hypothesis of a negative effect of low temperatures on the coronavirus structure of

SARS-CoV-2. This issue is an important basis for further research.

It is confirmed that surgical masks can be a source of infection in coronavirus disease and contribute to its prevalence among the population and in the environment.

It is stated that the most effective method of disposal of hazardous medical waste, in particular used protective masks, is burning in incinerator furnaces.

The development of appropriate recommendations at the state level for the safe disposal of medical waste not only from medical institutions but also from the public, will be one of the effective methods of preventing the spread of coronavirus SARS-CoV-2.

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ADDRESS FOR CORRESPONDENCE:
Danusia M. Brezytska
OM Marzeev Institute of Public Health of the
National Academy of Medical Sciences of Ukraine
50 Popudrenko St., 02660 Kyiv, Ukraine
phone:+380966145329
e-mail: danusia.brezytska@oa.edu.ua

ORCID and contributionship:
0000-0001-8084-7313 – Danusia M. Brezytska (B, C, D)
0000-0002-8075-9388 – Ihor V. Hushchuk (A, F)
0000-0002-4240-5968 – Vladislav A. Smiyanov (E, F)
0000-0003-2441-9992 – Oleg M. Vivsiannyk (E)
0000-0002-9351-1218 – Roman V. Safonov (B, E)
0000-0002-1837-0443 – Inna S. Khoronzhevska (B, C)

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