

NON-SPECIFIC PREVENTION OF CORONAVIRUS INFECTION

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The lecture is devoted to non-specific prevention of coronavirus infection. Various measures are described to prevent the spread of COVID-19 to both the public and healthcare providers. The characteristic of various measures for the disinfection of medical and household waste is given. A detailed description of various personal protection methods with a description of the rules for their use is given. Attention is drawn to the rules for the use of personal protective equipment during a pandemic. Attention is drawn to common errors encountered when using personal protective equipment. The importance of their use in order to prevent the spread of infection outside medical institutions is emphasized.

Keywords: COVID-19; personal protective equipment; prevention of spread; medical organizations.

НЕСПЕЦИФИЧЕСКАЯ ПРОФИЛАКТИКА КОРОНАВИРУСНОЙ ИНФЕКЦИИ

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Лекция посвящена неспецифической профилактике коронавирусной инфекции. В статье описаны различные меры, направленные на предотвращение распространения COVID-19 как среди населения, так и среди медицинских работников. Охарактеризованы меры по обеззараживанию медицинских и бытовых отходов. Подробно рассмотрены способы индивидуальной защиты с описанием правил их использования. Обращено внимание на правила применения средств индивидуальной защиты в период пандемии. Приведены сведения о наиболее распространенных ошибках, допускаемых при использовании средств индивидуальной защиты, подчеркнута их важность для предотвращения распространения инфекции за пределами медицинских учреждений.

Ключевые слова: COVID-19; средства индивидуальной защиты; предотвращение распространения; медицинские организации.

Introduction

The first reports of a new coronavirus infection that was detected in the People's Republic of China emerged in December 2019. Since January 2020, many countries around the world have started to register the cases of this infection among people who have visited China. A sharp decline of the epidemiological situation in the world occurred in February 2020, and the World Health Organization was obliged to declare a global pandemic caused by a new strain of coronavirus-SARS-CoV-2 (from the English Severe acute respiratory syndrome – related coronavirus 2). Officially, the new infection was named COVID-19 (from the English COronaVIrus Disease 2019).

The following three components can be distinguished in the spread of any infectious disease: the source of infection, the path of transmission, and the susceptible organism. Therefore, the prevention of the spread of infection should mainly focus on all the three components. The main source of the causative agent of a new coronavirus infection is an infected person, so an effective countermeasure to the source of infection could be the complete isolation of sick people, but this is not possible in real practice because about 40% of people carry the infection without any clinical appearances or symptoms. Nowadays, it is also not possible to determine a susceptible organism. There are two ways to convert a susceptible

Table 1

Coronavirus persistence on various types of surfaces

| Type of a surface | Virus | Strain | Viral titer | Temperature | Time limits |
|---------------------------------|----------|-----------------------|-------------------------------------------------------|-------------|-----------------------|
| Steel | MERS-CoV | HCoV-EMC/2012 | 10 ⁵ | 30°C | 8–24 h |
| Metal | SARS-CoV | Strain P9 | 10 ⁵ | RT | 5 days |
| Wood | SARS-CoV | Strain P9 | 10 ⁵ | RT | 4 days |
| Paper | SARS-CoV | Strain P9 | 10 ⁵ | RT | 4–5 days |
| Glass | SARS-CoV | Strain P9 | 10 ⁵ | RT | 5 days |
| Surgical glove (latex) | SARS-CoV | Strains 229E and OC43 | 10 ³ | 21°C | ≤8 h |
| Disposable dressing gown / suit | SARS-CoV | Strain GUV6109 | 10 ⁶ 10 ⁵ 10 ⁴ | RT | 2 days 24 h 4 h |

Note. RT, комнатная температура; MERS, Middle East respiratory syndrome; HCoV, human coronavirus; SARS, severe acute respiratory syndrome.

organism into an unresponsive one. The first way is to develop natural immunity in the population, that is, about 90% of the population of the region should transfer this infection. From the economic point of view, this is a profitable method, but not humane. The second way is more humane, but economically very expensive—the use of a vaccine. However, the starting of commercial production of the vaccine cannot be expected earlier than 2021. In this regard, the only available method of non-specific prevention is the exposure to the pathway of virus transmission. It is known that the main routes of transmission of the SARS-CoV-2 virus are airborne and direct contact. Drops (from mouth) usually do not spread further than 2 meters and do not stay in the air. However, there is evidence that SARS-CoV-2 remained viable in aerosols under experimental conditions for at least 3 hours. It should be noted that these studies were conducted in closed rooms.

While coughing and sneezing, the source of the infectious agent creates an aerosol around itself with the drops of respiratory secretions containing viral particles that spread on average to about 2 meters. Therefore, the eyes and respiratory tract should be firstly and foremostly protected from contracting the virus. Given the possibility of a contact route of transmission, protection should also extend to the hands. In case of massive air contamination to clothing that can also receive viral particles, it is strongly advisable medical workers should not only move from the area of care for patients with COVID-19 to the clean area of the hospital in protective clothing, but also wear

the same on their way home. Viral particles can survive for a certain amount of time on various materials (Table 1).

Thus, if we consider the presented data, it can be stated that the method of effective prevention of COVID-19 infection today is to interrupt the path of virus transmission. Therefore, personal protective equipment is used for this purpose.

Personal protective equipment for personal use in the context of the COVID-19 pandemic

Personal protective equipment (PPE) refers to the personal equipment used to prevent or reduce the impact of harmful and/or hazardous production factors on employees, as well as to protect against fouling.

PPE include the following materials:

- 1) special clothing;
- 2) special shoes; and
- 3) other PPE (isolation suits, respiratory protection, hand protection, head protection, face protection, eye protection).

Health formalities for PPE is determined in accordance with Article 221 of the Labor Code, which states that at areas involving harmful and/or hazardous working conditions, employees are to be provided free of charge a certified special clothing, special footwear and other PPE, and washing and/or neutralizing means in accordance with the model rules, which are set according to the standard norms determined by the Government of the Russian Federation. The on-time delivery of PPE in accordance with the established standards, as

Table 2

Types of disposable respirators

| Types of respirator | Filtration degree | Nominal protection factor |
|---------------------|---------------------------------------------------------|---------------------------|
| FFP1 | Provide filtration of solid and liquid particles by 80% | 4 |
| FFP2 | Provide filtration of solid and liquid particles by 94% | 12 |
| FFP3 | Provide filtration of solid and liquid particles by 99% | 50* |

* A nominal protection factor of 50 means that the concentration of harmful substances under the face of the respirator is 50 times lesser than in the external atmosphere.

well as their storage, washing, drying, repair, and replacement must be provided by the employer at their own expense. The procedure for providing employees with PPE is also regulated by the order of the Ministry of Health and Social Development of Russia dated 01.09.2009 No. 290n. According to the order of the Ministry of Health of the Russian Federation dated 27.03.2020 No. 246N, medical organizations providing emergency care must be provided with PPE, such as glasses, disposable gloves, respirators of the appropriate protection class, anti-plague suits of the type 1 or disposable gowns, and shoe covers. The requirements of these rules apply to all employers, regardless of their organizational and legal forms and forms of ownership.

Personal respiratory protection equipment

The PPE of the respiratory tract includes disposable masks and respirators. The principle of the respirator activity consists of a highly effective filtration of the inhaled air that briefly reduces the risk of infectious aerosol penetration into the respiratory tract, including the terminal bronchioles and alveoli. Personal respiratory protection equipment is divided into disposable and reusable types according to the frequency of use, and non-insulating and insulating according to the degree of isolation from the environment (oxygen is supplied from an attached external source); the type of a dirt, from which you must protect the respiratory tract — on anti-aerosol (airborne pathway), antigas, antigas aerosolized respiratory masks; protection method may be filtration (have filters).

According to the level of air filtration, disposable breathing devices are divided into three types (Table 2).

A disposable half-face filter mask is changed to a new one after 6–8 hours. To work during COVID-19, the World Health Organization recommends the use of only a respirator with

a FFP3 degree of protection, which provides an effective barrier to 99% of viruses, bacteria, and mold spores. Moreover, it restricts small particles having a size of up to 2 microns in size. This respirator provides the highest protection. FFP3-type respirators can be both disposable and reusable. All respirators have a specific marking indicating their protection class and frequency of use. So, marking FFP3 means that this respirator has a high protection class, marking D indicates that the respirator corresponds to the requirements of the resistance to dust and high filtering capacity, and marking R means that the respirator can be used during multiple shifts, in contrast to the NR marks that indicate a single use of a respirator (not more than 8 hours).

The reusable PPE of the respiratory tract includes a device of a protection class P100 (HEPA) (see the figure). This is a full-face mask with a respirator. This respirator cleans the air from the smallest dust, allergens, viruses, bacteria, and unpleasant odors. These devices are divided into five classes: H10, H11, H12, H13,



Reusable breathing device of protection class P100 (HEPA)

and H14 according to GOST (All-Union State Standard) and a European standard. The higher the class, the more dust is restricted by the HEPA filter (from 85% to 99.5%).

Personal eye-protection equipment

The PPE of eyes includes open safety glasses. They protect from direct contact with droplets and splashes. They are made of light impact-resistant materials, equipped with an anti-fog coating, and have a special shape and brow obturators that reduce the possibility of throwing solid and liquid particles through the upper and side edges of the glasses. If there is a large amount of liquid on the face (e.g., gushing blood when a vessel is damaged), then the protection of open glasses may not be enough.

Closed protective glasses (glasses canned) come with direct ventilation, indirect ventilation, and are sealed. This type of a device, when properly fitted, fits snugly to the skin of the face and provides maximum protection of the conjunctiva from splashes, aerosols, and cough drops, but does not protect other parts of the face from splashes and aerosols. For this reason, making medical enhancements for the patients with COVID-19 or patients with suspected infection, it is advisable to use an additional PPE of the face in the absence of a HEPA-type respirator. Unlike glasses, PPEs or face screens protect both the eyes and other areas of the face. The screen should cover the face from the bottom to the chin, and from the sides to the level of the ears that prevent drops from falling on the face through the edges of the screen.

Personal protective equipment for the skin

Skin PPEs include medical gloves and are disposable or reusable protective clothing.

Reusable skin protection products are classic anti-plague suits, which are divided into three types in accordance with SR (Sanitary Rules) 1.3.3118-13.

Type I consists of a large anti-plague headscarf (120×120×150 cm) or a hood, an anti-plague dressing gown (as a surgical type, up to the lower third of the lower leg, the tails should go behind each other by at least 15 cm, at the collar-long ties), an anti-dust respirator with filter elements (protection class not lower than FFP3 in accordance with GOST R 12.4.191-2011), tight-fitting glasses or a full-face mask or filter gas mask with an anti-aerosol or combined box, rubber gloves (recommended use of rubber gloves with protection from punctures

and cuts), rubber boots (or waterproof shoe covers), and a towel. If necessary, you should additionally wear a rubberized (waterproof) apron, armbands, and a second pair of gloves or gloves with protection from punctures and cuts. You can work in this suit for no more than 3 hours.

Type II of the costume includes a large headscarf (hood), an anti-plague dressing gown, a respirator, rubber gloves, if necessary, gloves with protection from punctures and cuts, boots (or waterproof shoe covers), and a towel. The type II suit differs from the type I suit in terms of missing glasses. You can only use this type of a costume when working in a COVID-19 situation.

Type III of the costume consists of a large headscarf (hood), an anti-plague dressing gown, rubber gloves (if necessary, gloves with protection from punctures and cuts), protective shoes (deep galoshes, boots, or waterproof shoe covers), and towels. It differs from the type I suit in terms of missing glasses and a respirator.

Type IV of costume includes a medical cap (a small headscarf) and an anti-plague (surgical) robe.

Types III and IV of suits are not used while working in a COVID-19 situation.

Nowadays, modern types of protective suits are used while working with COVID-19. The disposable suit consists of a coverall (dressing gown) – a laminated apron and armbands; a hat-helmet; shoe covers with ties with a laminated sole; a respirator; two pairs of surgical gloves; and air-tight glasses. Reusable protective suit comprises pajamas from a cotton sheeting, protective gown; a four-layer cotton-gauze mask or protective mask, filter respirator, a helmet with a panoramic glass; non-sterile gloves; goggles; shoe covers made of rubberized fabric. Depending on the nature of the work, an apron may be included.

Rules for using personal protective equipment

Considering international experience in aiding for COVID-19 infection, there have been the formulation of rules for the use of PPE. Depending on the nature of the work, there are three levels of protection.

PPE of the level 1 of protection is used in the outpatient departments of a general profile for a preliminary examination and sorting of patients. In this case, PPE consisting of a disposable medical cap, a disposable surgical mask,

a work uniform, disposable latex gloves and a disposable isolation suit is used.

PPE of the level 2 of protection includes a disposable medical cap, a medical protective mask (class N95 or FFP3), a work uniform, a medical protective disposable uniform, disposable latex gloves (two pairs), and safety glasses. These PPEs are used while working in departments with patients with fever and in infectious departments (including isolated intensive care units). They are worn while analyzing biomaterials that are not associated with the collection of airway secretions taken from patients with suspected infection or with a confirmed diagnosis. Additionally, they are used for conducting tomographic examinations of patients with suspected infection or confirmed diagnosis while processing a surgical instrument used for patients with suspected infection or confirmed diagnosis.

PPE of the level 3 of protection includes a disposable medical cap, a medical protective mask (class N95 or FFP3), a work uniform, a disposable medical protective uniform, disposable latex gloves (two pairs), and a P100 respiratory protective device (HEPA) that covers the entire face or a filter respirator with forced air supply (the type of a respirator is chosen depending on the nature of the work performed). These PPE are used for the following manipulations: tracheal intubation, tracheotomy, bronchofibroscope, gastroenterological endoscopy, etc., during which respiratory tract secretions, biological fluids/blood may be released for patients with suspected infection or confirmed diagnosis, as well as during staff operations and autopsies on the patients with suspected infection or confirmed diagnosis; and during polymerase chain reaction testing to detect the presence of a new COVID-19 infection.

The rules for the use of PPE, regardless of the nature of the work performed, consists of the following provisions.

1. All medical personnel must wear surgical medical masks.
2. All personnel of emergency departments, outpatient departments profiled for infectious diseases, outpatient departments for respiratory diseases, dental departments, and offices/departments of endoscopic examination methods (gastroenterological endoscopy, bronchofibroscope, laryngoscopy, etc.) must be provided with the level 1 protection, but instead of surgical masks, you can use medical protective masks of N95 or FFP3 grade.

3. While taking biomaterials from the respiratory tract of patients with suspected infection or with a confirmed diagnosis of COVID-19, personnel should use HEPA-type respiratory protection in accordance with the level 2 protection rules.

Strict compliance with the rules for putting on and especially removing PPE should have a great importance in the prevention of COVID-19 infection.

Procedure for putting on a disposable protective coverall

1. Treat your hands with an alcohol-containing antiseptic.
 2. Wear gloves.
 3. Take the jumpsuit in your hands.
 4. Put on the trousers of the coverall.
 5. Put on the sleeves of the coverall in its turn. You cannot pull on both sleeves at the same time or the coverall may break.
 6. Put on shoe covers, tuck the trousers of the coverall under them, and tie the strings of shoe covers.
 7. To take the respirator in the palm of your hand and reveal it to the bowl shape.
 8. Take the lower elastic band and pull it over the head below the nape while applying the lower part of the respirator to the chin and the upper part to the bridge of the nose.
 9. Pull the upper elastic band of the respirator over the head and fix it on the back of the head.
 10. Press the nose clip to the nose.
 11. Inhale and exhale (leak test). Adjust the position of the respirator and elastic bands. The respirator must be checked for tightness. Positive test for leaks: to quickly exhale. Positive pressure is created inside the respirator. In case of air leakage, adjust the position of the respirator and/or the tension of the straps. Repeat the check again. Repeat until the respirator is sealed.
- A negative leak test is performed as follows. The user takes a deep breath. If the respirator does not pass air, negative pressure will press it to the face. Passing leads to a decrease in the negative pressure inside the respirator due to air ingress due to loose fitting.
12. To wear glasses on top of the respirator. To check the fit.
 13. Put on the hood.
 14. Close the coverall.
 15. Put on the second pair of gloves, tucking the sleeves of the coverall under them.

16. You must ensure that the elements of the protective set are put on correctly; excluding uncovered skin, there are no gaps between the elements.

Procedure for removing disposable protective coverall

1. Wash your hands with gloves in 3% chloramine solution.
 2. Remove the shoe covers while untying the string ties. Immerse them in a container with a disinfectant solution.
 3. Treat and wash your hands.
 4. Unzip the coverall.
 5. Remove the hood.
 6. Remove the sleeves of the coverall and the coverall itself along with the upper gloves, so that the wrong side is outside and the front side is inside.
 7. Without readjusting to plunge a coverall and gloves in a container of disinfectant solution.
 8. Treat your hands.
 9. Remove the glasses by taking them in on the inside. Moreover, remove the safety glasses by leaning forward.
 10. Place the glasses in a container for disinfection.
 11. Remove the lower rubber band of the respirator over your head. Then, lean forward slightly and remove the lower ribbon and then the upper ribbon.
 12. Remove the upper elastic band from the head and dump the respirator into a class B medical waste disposal tank.
 13. Remove the second gloves and turning them inside out.
- With the fingers of one hand, take the glove on the other hand for the work surface and remove it. Then, with the fingers of a hand without a glove, push the glove on the other hand from the inside.
14. Place dirty gloves in a class B waste bag.
 15. Treat your hands with an antiseptic.
 16. Take a shower and put clean clothes on.

Disinfection of a personal protective equipment. Since PPE is a class B medical waste, it must be decontaminated in accordance with the rules present in SanRaN (Sanitary regulations and standards) No. 2.1.7.2790-10 of 17.11.2011 "Rules for collection, storage and disposal of waste from medical institutions" (as amended in 2019). Medical waste of class B is waste that

is infected and potentially infected with pathogenicity groups 1–2 (SARS-CoV-2 virus is a pathogenicity group 2 microorganism): materials and tools, objects contaminated with blood and/or other biological fluids; pathoanatomic waste; organic operating waste (organs, tissues, etc.); food waste and materials that have come into contact with patients with infectious diseases caused by pathogenicity groups 1–2 microorganisms. In SanRaN no. 2.1.7.2790-10 of 17.11.2011 "Rules for collection, storage and disposal of waste of medical institutions" (as revised in 2019), paragraph 5.3 states that class B waste is only decontaminated in a decentralized way, and storage and transportation of non-infected class B waste is not allowed.

Paragraph 5.5 states that at a chemical method of decontamination of waste classes B and C, including the effects of solutions of disinfectants, bactericidal (including tuberculocidal), virucidal, fungicidal (sporicidal – as needed) properties in special modes, they use special units or use it by immersing the waste in labeled containers with disinfectant in the place of their formation. This means that the PPE should be removed in a specially designated room or in the same place where the manipulations were made after the complete disinfection of the room. Marked containers for class B waste must be provided in the room for the purpose of disinfecting the overalls, gloves, towels, helmet, and mask. Containers are filled with a 3% solution of chloramine a or 6% solution of hydrogen peroxide with the addition of 0.5% solution of surfactants (alkylbenzosulfonate).

Rules for using gloves. In the presence of two pairs of gloves, the upper pair of gloves is removed after removing the shoe covers along with the jumpsuit. All the manipulations including removing the medical gown, cap, glasses, medical mask/respirator are conducted in the second pair of gloves. After removing each item of protective clothing, the gloved hands are immersed in an antiseptic solution. The second pair of gloves is removed after removing all the items of protective clothing. After that, the hands are treated with an alcohol antiseptic. To prevent nosocomial infection, gloves must be changed between the contacts, that is, removed after contact with each patient. Before putting on and after removing the gloves, the hands must be treated with an alcohol antiseptic. Hands must also be treated after a contact with objects in the environment, even if there was

no contact with the patient. Disposable gloves are disinfected after the use and then should be disposed. When using gloves, single-use (one-use) gloves should be preferred because the protective layer of clearing multiple-use gloves (except chain gloves) is destroyed in a direct proportion to the multiplicity of clearing. It is not allowed to use the same pair of disposable gloves performing medical manipulations for several patients, even if the gloves are washed or treated with disinfectants. The disposable gloves should not be treated with alcohol-containing solutions because these solutions destroy the protective layer of the gloves. These rules apply to the use of disposable gloves made of latex, which is easily destroyed under the effects of various chemical factors, such as soap, alcohol, and alcohol-containing antiseptics.

Use of PPE in conditions of a scarcity. If there is a scarcity of respirators in a medical organization, it is possible to introduce a regime of a limited reuse (using the same respirator with a surgical mask on the top of it for multiple contacts with patients, and after each contact, it is necessary to change the upper surgical mask).

It is recommended to stop using respirators immediately after performing aerosol-generating procedures in case of contamination with the patient's secret, blood, and other biological fluids, after a contact with a patient with another infection, if there is a visible damage or difficulty in breathing through the respirator, then you should treat your hands before and after touching the respirator.

The repeated use of the respirator by the same medical personnel caring for patients with COVID-19 is possible if the following conditions are met:

- the respirator is not physically damaged;
- the respirator provides a tight fit to the face, thereby eliminating air leakage under the half-mask;
- the respirator does not create excessive resistance to breathing due to high humidity; the humidified mask loses its electrostatic properties and begins to work much less effectively, just as a mechanical filter;
- there are no visible signs of contamination with biological fluids on the respirator.

If at least one of the above conditions is not met, such a respirator cannot be safely reused and must be recycled.

To limit the consumption of PPE, it is necessary to rationally minimize the need for them in medical organizations, as well as ensure their proper use. To do this, you must:

- reduce the number of people who need to use PPE through technical and administrative measures (limit the number of medical professionals who have had contact with patients; minimize the number of ward entries);
- use an online consultation for patients and individuals with suspected COVID-19.

Conclusion

Summarizing all the information presented in this lecture, we can only conclude that PPE is currently the only method of an effective prevention of COVID-19 infection while working with patients with suspected or confirmed infection. It should also be remembered that only strict compliance with the rules for using PPE, namely the rules for putting on, removing, and working with them will prevent infection while working with COVID-19.

Recommended reading

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