Analysis of Personal Protection Equipment for Upper Respiratory Tract to Prevent the Spread of COVID-19 Part I

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Abstract— *The number of countries where the infection by a new coronavirus has been identified is constantly increasing. Accordingly, the amounts of infected people in the individual countries are alarming. The purpose of the present article is to provide information on this new, highly infectious disease and describe potential methods for reducing the risk of the infection transmission in our environment.*

Keywords— COVID-19, coronavirus, symptoms of the disease, respirator.

I. INTRODUCTION

The term coronavirus refers to four viral genera that cause diseases of various severity degrees in animals and humans. The virus may cause common difficulties, such as cold, cough and elevated body temperatures. It may also contribute to the development of deadly diseases, such as the severe acute respiratory syndrome (SARS), or support other dangerous infections.

II. COVID-19

The virus which began to spread from China in late 2019 was named 2019-nCoV (SARS-CoV-2) and it belongs to coronaviruses. Later, its name was altered to COVID-19 (on 11 February 2020). SARS-CoV-2 causes the COVID-19 disease and it was first identified in the town of Wu-Chan.

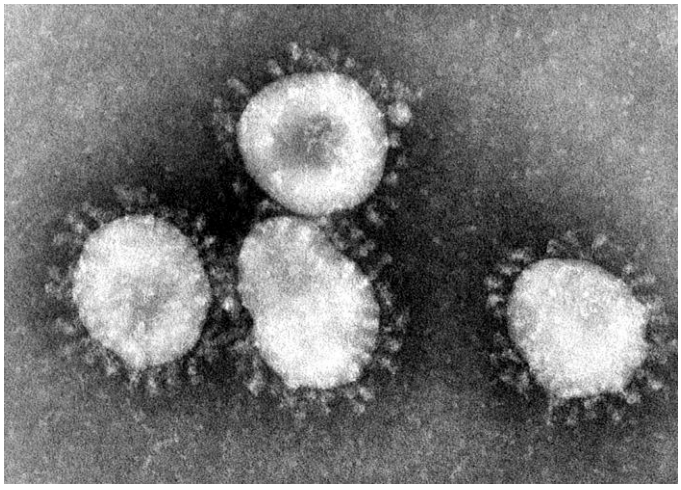

FIGURE 1: Coronavirus [1]

Covid-19 is a highly infectious disease. A median incubation period is 4–5 days, and the total reported range of the incubation period is 2–14 days. The primary transmission route is a direct contact between humans, and the disease is assumed to spread mainly via droplets during sneezing and coughing or by a body contact. There is also a risk of indirect transmission through contaminated hands, in particular by touching one's face, eyes, nose and mouth.

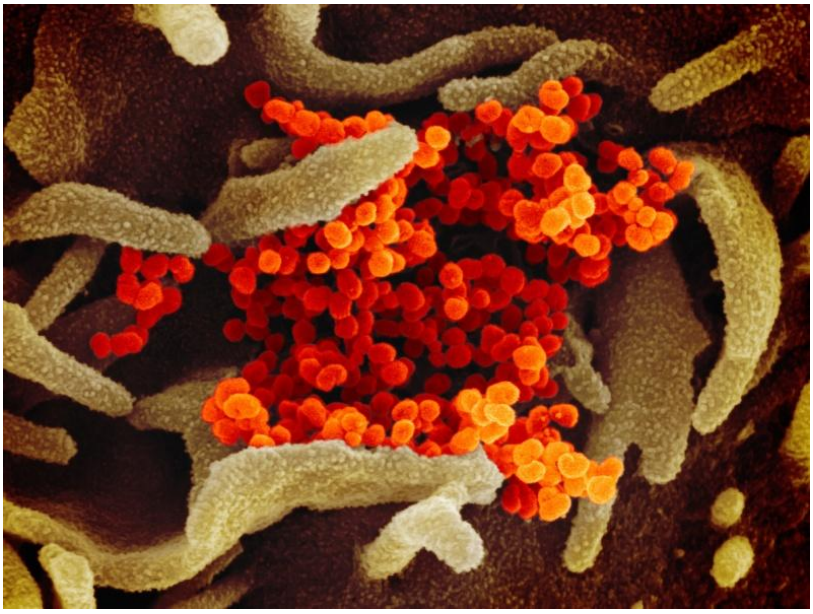

FIGURE 2: Coronavirus under an electron microscope [3]

This disease has symptoms similar to those of flu; that is why it is difficult to distinguish instantly between a coronavirus infection and flu. It typically affects mucous membranes of the upper and lower respiratory tracts and the conjunctiva. The most frequently reported symptoms include fever, shortness of breath, cough, fatigue and muscle pain. It may also cause the loss of smell (anosmia) and of hearing without any other signs present. In more serious cases, it may lead pneumonia, acute myocardial inflammation, organ failures and death [3].

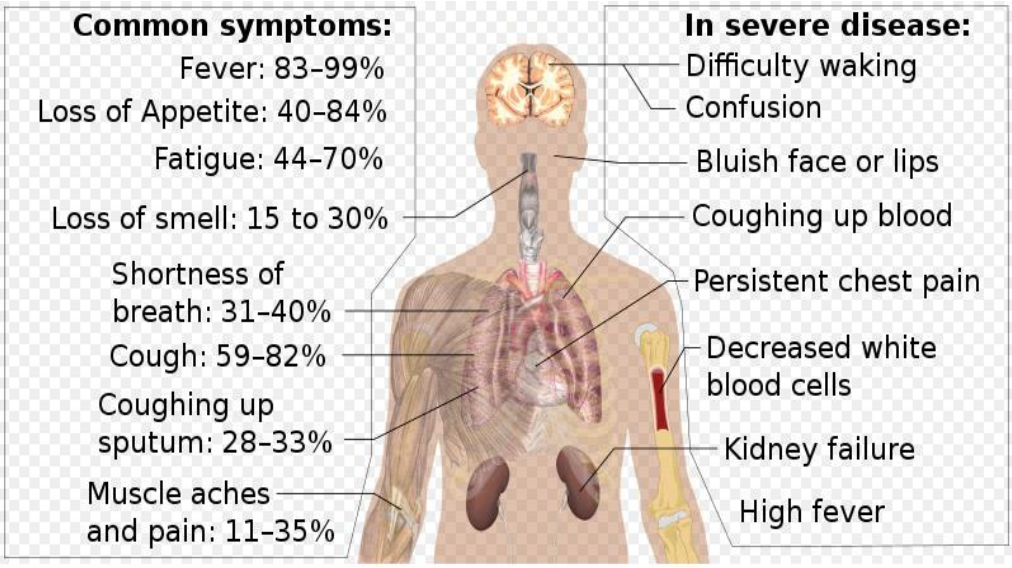

FIGURE 3: Symptoms of the coronavirus disease 2019 [4]

In order to suppress some of the symptoms of this disease, an adjunctive therapy with commonly available medications may be initiated.

III. RISK FACTORS OF THE COURSE AND DIAGNOSTICS OF THE DISEASE

More than 80% of symptomatic COVID-19 diseases have a mild course. In approximately 15% of affected individuals, clinically serious pneumonia develops, accompanied by shortness of breath, hypoxia and extensive bilateral infiltrates visible on radiographs 24–48 hours after the disease onset. In approximately 5% of cases, intensive care is required due to respiratory distress, shock or a multiple-organ failure [5]. A critical or even fatal course of the disease may also occur in young, otherwise healthy individuals, but it is usually associated with one or two risk factors, such as cardiovascular diseases, diabetes mellitus, obesity, chronic pulmonary disease, tumorous diseases etc. Higher mortality rate of this disease is associated with a higher age of a patient.

Early and precise diagnostics of COVID-19 plays an important role in the control and mitigation of the pandemic. The most reliable method is direct virus identification by a PCR test using a sample collected from the upper and lower respiratory tract and blood serum [6].

The diagnostics may also be carried out using rapid tests, in which the virus is not identified directly in a collected sample, as it is in a PCR test; instead, rapid tests detect antibodies created by the host's immune system as an immunity response to the presence of the virus in a body.

The identification of this disease is largely contributed by knowing the travel history, especially when a person returns from a high-risk country or had been in contact with a person who was present with COVID-19.

IV. PREVENTION AGAINST COVID-19

Prevention against an infection caused by the SARS-CoV-2 coronavirus is the same as the prevention against other viral diseases, such as flu. The key measures against COVID-19 is the strict adherence to the hygiene principles, for example washing hands with soap and disinfection, the use of facial protective equipment (face masks, respirators, protective masks and shields etc.) when interacting with other people, and social distancing. Other efficient measures against this disease include avoiding touching one's eyes, coughing and sneezing into a paper tissue, and avoiding journeys to high-risk countries.

A face mask acts as a mechanical barrier that prevents saliva and phlegm droplets or aerosols from penetrating out of the respiratory tract. The total service life of a disposable surgical face mask is approximately 3 hours.

Disposable surgical face mask **Cloth face mask**

FIGURE 4: Disposable face masks

A respirator protects a healthy individual against viruses from the surrounding environment. It filtrates the air inhaled by a wearer and traps harmful substances to prevent them from penetrating the respiratory tract. The face masks which are recommended for the protection against viruses are FFP2 or FFP3.

Disposable respirator FFP2 NR **Disposable respirator FFP3 NR**

FIGURE 5: Disposable respirators

A one-way exhalation valve makes breathing much easier. If a wearer is ill and sneezes, the valve lets the sneezed out droplets into the surrounding air, and this imposes a risk for the persons around. Therefore, these respirators are suitable mainly for the healthy front-line staff (healthcare professionals, police officers, fire-fighters).

Disposable respirator FFP2 **Disposable respirator FFP3**

FIGURE 6: Disposable respirators with a one-way inhalation valve

The staff providing prolonged healthcare are advised to use FFP3 respirators with replaceable filters, which exhibit lower resistance during breathing, but still maintain their filtration capacity (Fig. 7).

FIGURE 7: Reusable respirator with replaceable filters [7]

The Table below presents the efficiency data for the individual types of the personal protection equipment, which are recommended by the WHO.

TABLE 1
EFFICIENCY OF THE PERSONAL PROTECTION EQUIPMENT USED FOR THE FACE [8]

Equipment type	Cloth face mask	Surgical face mask	Respirator		
			FFP1	FFP2	FFP3
Efficiency (%)	30–60	50–80	80	94	99

Even though cloth or surgical face masks do not offer a hundred-percent efficiency of the protection against infections, wearing them is reasonable as it mitigates and minimises the spread of viruses. Protection efficiency may be increased by using these face masks in combination with protective shields or goggles and disposable rubber gloves.

V. CONCLUSION

The number of persons infected with coronavirus is constantly rising and this fact should not be underestimated. The infection may be transmitted as easy as just by being near a person who is present with symptoms like cough, fever or difficulties breathing, as well as by touching objects that such a person has recently touched. Despite the fact that efficient vaccines against COVID-19 have been developed, it is necessary to consistently implement the key measures that eliminate the transmission of this highly infectious disease.

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