

Personal Protective Equipment (PPE) to Prevent the COVID-19. What Do Healthcare Workers Really Need to Protect Themselves and Survive?

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Abstract

Background: The healthcare workers are exposed to dangerous pathogen agents during the outbreak of the new coronavirus COVID-19. To minimize the risk of becoming infected by this virus, healthcare workers need to wear the most appropriate personal protective equipment (PPE).

Objective: The objective of this study was to analyze the guidelines that the World Health Organization (WHO) and the Centers for the Disease Control and Prevention (CDC) recommend for the rational use of EPP to protect healthcare workers against the novel coronavirus COVID-19.

Methodology: To learn how to effectively protect healthcare workers against the COVID-19, a detailed analysis and comparison of the WHO and CDC guidelines related to the proper use of personal protection equipment (PPE) in different healthcare settings was carried out.

Results: The results of this study based on an analysis of PPE recommended by the World Health Organization (WHO) and the Centers for the Disease Control and Prevention (CDC) indicated that the safety and protection of healthcare workers can be maximized if the guidelines

suggested by these institutions are followed. In general, the WHO and CDC recommendations based on medical practices are similar, and depending on the healthcare activities and settings where the healthcare workers perform their work, suggest wearing medical/surgical facemasks, respirators, goggles and face shields (eye protection), gloves, gowns and aprons.

Conclusions: The protection and safety of the healthcare workers can be maximized during the outbreak of COVID-19 by following the WHO and CDC recommendations described in this study. The general guidelines offered by these institutions are similar and based on medical practices.

Keywords: PPE, personal protective equipment, WHO, CDC, healthcare workers, COVID-19

Introduction

The COVID -19 is a respiratory disease associated with the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2).¹ The virus is transmitted from person to person through tiny droplets secreted when they speak, cough, sneeze, or interact with another person who is less than 1 meter away.¹ The virus-infected droplets can be directly inhaled by people or deposited on different surfaces. If people touch these contaminated surfaces, they can become infected with the virus if it reaches their mouth, nose, or eyes.¹ The virus can stay alive on different surfaces from several hours to a few days, and the estimated period for incubation of the virus is between 1 and 14 days.¹

To avoid being infected by this virus, it is necessary not to touch your face with unwashed hands, since the virus penetrates through the mouth, nose and eyes. Hands should be washed with soap and water for at least 20 seconds.¹ In addition, alcohol-based disinfectants can be used. Another rule of caution is to stay more than 1 meter away from people infected with the Covid-19 virus. Although there are some asymptomatic persons, most of people infected with the Covid-19 can present various symptoms such as sore throat, cough, fever, muscle pain,

general weakness, pneumonia, acute respiratory distress, septic shock, multi-organ failure, and other symptoms that can cause death.¹

The universal COVID-19 pandemic is evolving rapidly and has caused many deaths in different countries of the world.² For this reason, most health organizations worldwide make numerous efforts to stop the spread of the COVID-19. In this process, healthcare workers play an important role and must take all possible protective measures to protect themselves and prevent the spread of the virus in healthcare settings. In this sense, the use of personal protective equipment (PPE) is the most visible and obvious control to prevent the propagation of COVID-19.³

According to the World Health Organization (WHO) “the protection of health workers is paramount and PPE, including medical masks, respirators, gloves, gowns, and eye protection, must be prioritized for health care workers and others caring for COVID-19 patients.”³

Based on these comments, the main objective of this study was to analyze the guidelines that the World Health Organization (WHO) and the Centers for the Disease Control and Prevention (CDC) recommend for the rational use of EPP to protect healthcare workers against the COVID-19 virus.

Type of PPE used to protect healthcare workers against the COVID-19

In general, the World Health Organization (WHO) and the Centers for the Disease Control and Prevention (CDC) suggest using the following PPE equipment to protect healthcare workers against the COVID-19: medical/surgical face masks, respirators (N95, FFP1, FFP2, FFP3), goggles or face shield devices (eye protection), gloves, gowns, and aprons.^{3, 4}

Medical/surgical facemasks

Medical / surgical facemasks are designed to protect the face (mouth and nose) against droplets, splashes and sprays that may contain respiratory pathogens /CONAVID-19.⁵ They are devices that create a physical barrier between the user's face and possible infection agents located in the nearby surroundings. Also, the masks can prevent exposure of saliva and respiratory emissions to others. In general, medical/surgical masks are regularly used for protection against the spread of droplets from respiratory infections that fall to the ground within a short distance range (less than 1 meter).⁵ The surgical masks should not be worn for more than 6 hours of continuous use due to the risk of self-contamination by viral agents.⁵ The masks are not reusable.^{3, 4}

Respirators

These devices reduce the risk that droplets contaminated with infectious agents enter the human body through the mouth and nose. ⁶ There are various types of respirators such as N95, FFP1, FFP2, and FFP3. ⁶ The filtration capacities of these respirators exceed those of common medical/surgical facemasks. ⁴The N95 designation indicates that the respirator can block 95 % of liquid droplets or solid aerosol particles. ⁶ The terms FFP1, FFP2 and FFP3 designate filtering face piece (FFP) masks.⁶ These masks have a high filtration capacity due to an electrostatic mechanism generated within a network of polypropylene fibers. Filtering capacity increases in the following order: FFP1, FFP2, and FFP3. The N95 has less filtration performance than the FFP2 respirator.⁶ In general, respirators (N95, FFP1, FFP2, and FFP3) are utilized for pathogens agents smaller than common drops. ⁵ These airborne agents can remain suspended in the air for a long time. ⁵

The CDC recommends taking precautions when reusing respirators.^{7, 8} Until now, it is not known whether respirators can be reused effectively. ⁹ The WHO recommends using respirators for a maximum of 4 hours of continuous use.¹⁰

Eyes protection: goggles and face shields.

There are no specific guidelines to protect the eyes against pathogens of biological origin, such as the COVID-19.¹ However, the use of goggles and face shields are recommended during any personal contact with suspected or infected people with respiratory agents / COVID-19.^{3,4} These devices prevent drops, splashes and sprays from the nasal and oral secretions of people with respiratory infections / COVID-19 from entering the body of healthcare workers through the mucous membranes of the eyes.¹²

The goggles and face shields can be reused after cleaning and disinfecting properly.⁴

Gloves

The gloves provide a physical barrier that prevents pathogen agents/COVID-19 from infecting the hands of healthcare workers.¹³ Disposable non-sterile gloves can be used for caring of infected or suspected COVID-19 patients.¹⁴ After use, the gloves should be throw out in a unlined garbage trash. They shouldn't be reused.¹⁴

Gowns

The gowns are loose flowing garments that protect clothing of healthcare workers against droplets, sprays and splashes. Disposable gowns should be thrown away after use. However, cloth gowns should be washed, cleaned and disinfected after use.³

Aprons

Aprons are garments worn over the front of the body to protect the clothes of the health care providers from droplets, splashes or sprays. Aprons should be used if gowns are not resistant to splashes and sprays of fluids.³

Methodology

To learn how to effectively protect healthcare workers against the COVID-19, a detailed analysis and comparison of the WHO and CDC guidelines related to the proper use of personal protection equipment (PPE) in different healthcare settings was carried out.^{3,4}

Results

A comparison of the WHO and CDC guidelines related to the use of PPE by the healthcare workers during the outbreak of the COVID-19 is shown in Tables 1-4.^{3,4} The tables indicate the health care setting, activity and the type of recommended PPE to ensure the protection of healthcare workers. These tables were adapted from the WHO recommendations described in reference 3.³

Table 1 Recommended PPE by the WHO and CDC during the outbreak of COVID-19 in inpatient facilities

Healthcare facilities	Activity	WHO	CDC
Inpatient facilities			
Screening /Triage	Preliminary screening not involving direct contact with patients by using a physical barrier (glass or plastic windows). Physical distance at least 1 meter.	No PPE is required	N95 respirator (facemask if respirator is not available) Gloves Eye protection (goggles or face shield)

	Preliminary screening not involving direct contact with patients by using a physical barrier (glass or plastic windows) . Physical distance less than 1 meter.	Medical/surgical facemask Eye protection (goggles or face shield)	N95 respirator (facemask if respirator is not available) Gloves Eye protection (goggles or face shield)
Patient room/ward	Providing direct care to COVID-19 patients in absence of aerosol-generating procedures	Medical/surgical facemask Gown Gloves Eye protection (goggles or face shield)	N95 respirator (facemask if respirator is not available) Gown Gloves Eye protection (goggles or face shield)
	Providing direct care to COVID-19 patients in settings where aerosol-generating procedures are taking place	Respirator N95 (or FFP2 or FFP3) Gown Gloves Eye protection (goggles or face shield) Apron	N95 Respirator (or higher level) Gown Gloves Eye protection (goggles or face shield)

Table 2 Recommended PPE by the WHO and CDC during the outbreak of COVID-19 in outpatient facilities

Healthcare facilities	Activity	WHO	CDC

Outpatient facilities			
Screening /Triage	Preliminary screening not involving direct contact with patients by using a physical barrier (glass or plastic windows). Physical distance at least 1 meter.	No PPE is required	N95 Respirator (facemask if respirator is not available) Gloves Eye protection (goggles or face shield)
	Preliminary screening not involving direct contact with patients by using a physical barrier (glass or plastic windows) . Physical distance less than 1 meter	Medical/surgical facemask Eye protection (goggles or face shield)	N95 Respirator (facemask if respirator is not available) Gloves Eye protection (goggles or face shield)
Consultation room	Physical examination of patients with symptoms suggestive of COVID-19	Medical/surgical facemask Gown Gloves Eye protection(goggles or face shield)	N95 Respirator (facemask if respirator is not available) Gown Gloves Eye protection (goggles or face shield)
	Physical examination of patients without symptoms suggestive of COVID-19	Medical/surgical facemask Gown Gloves Eye protection (goggles or face shield)	N95 Respirator (facemask if respirator is not available) Gown Gloves Eye protection (goggles or face shield)

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Table 3 Recommended PPE by the WHO and CDC during the outbreak of COVID-19 in home care and alternate care sites

Healthcare facilities	Activity	WHO	CDC
Home care			
Home	Providing direct care or assistance to COVID-19 patients at home	Medical/surgical facemask Gown Gloves Eye protection (goggles or face shield)	N95 respirator (facemask if respirator is not available) Gown Gloves Eye protection (goggles or face shield)
Alternate care sites			
Care sites			N 95 Respirator (or facemask if respirator is not available) Gown Gloves Eye protection (goggles or face shield)

Table 4 Recommended PPE by the WHO and CDC during the outbreak of COVID-19 in points of entry at airports and other transportation systems

Healthcare	Activity	WHO	CDC
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facilities			
Points of entry at airports, and other transportation systems			
Temporary isolation area	Assisting suspected COVID-19 passenger being transported to a healthcare facility	Medical/surgical facemask Gown Gloves Eye protection (goggles or face shield)	
Ambulance or transfer vehicle	Transferring suspected COVID-19 patients to a health care facility	Medical/surgical facemask Gown Gloves Eye protection (goggles or face shield)	

Table 1 depicts the health care setting, activity and the type of recommended PPE in inpatient facilities (screening/triage, patient room/wards). Table 2 describes the health care setting, activity and the type of recommended PPE in outpatient facilities (screening /triage, consultation room). Table 3 shows the activity and the type of recommended PPE at home and alternate care sites. Table 4 presents the activity and the type of recommended PPE in entry points at airports, ports and other transportation systems (temporary isolation area, ambulance or transfer vehicle facilities)

Also, Tables 1-4 indicate the activities carried out by the healthcare workers such as: 1) preliminary screening of patients affected by the COVID-19 (triage);2) physical examination of

patients with symptoms suggestive of COVID-19 (consultation room); 3) providing direct care to the COVID-19 patients in absence of aerosol-generating procedures (patient room/ward); 4) providing direct care to the COVID-19 patients in settings where aerosol-generating procedures are performed; 5) providing direct care or assistance to the COVID-19 patients at home; 6) providing medical assistance when transferring suspected patients of COVID-19 in ambulances or vehicles.

Discussion

Overall, the results of this study indicated that the recommended PPE for the healthcare workers by the WHO and CDC during the outbreak of the COVID 19 are similar, but depends on the healthcare settings, and activities carried out by the healthcare workers.^{3,4}

The information given in Tables 1-4 describes the activities and the settings where healthcare workers wear medical /surgical masks, respirators, goggles and face shields (eye protection), gloves, gowns and aprons.^{3,4} Below is a detailed description of the PPE required for the activities performed in each healthcare setting.

Regarding the use of medical/surgical facemasks, the WHO indicates that the facemasks should be used by the healthcare workers in the following activities: 1) preliminary screening (triage) of the COVID-19 patients in healthcare settings where physical barriers are used (glass or plastic windows) and physical distance is less than 1 meter; 2) physical examination of patients with symptoms suggestive of the COVID-19 (consultation room); 3) physical examination of patients without symptoms suggestive of the COVID-19 (examination room); 4) providing direct care to the COVID-19 patients in absence of aerosol-generating procedures (patient room/ward); 5) providing direct care or assistance to COVID-19 patients at home; 6) assisting suspected COVID-19 passenger being transported to a healthcare facility (airport); 7) transferring suspected COVID-19 patient to a health care facility (ambulance or transfer vehicle).³ Instead, the Centers for the Disease Control and Prevention (CDC) suggests

using N95 respirators for the cases mentioned above. However, the CDC indicates that if N95 respirators are not available, then medical/surgical mask (called facemask by CDC) can be used.⁴

In relation to the use of respirators, the CDC recommends to use N95 respirator in the following activities: 1) preliminary screening of patients affected by the COVID-19 (triage); 2) physical examination of patients with symptoms suggestive of COVID-19 (consultation room); 3) providing direct care to COVID-19 patients in absence of aerosol-generating procedures (patient room/ward); 4) providing direct care or assistance to COVID-19 patients at home. ⁴The CDC suggests using the medical/surgical mask (called facemask by CDC) in all the cases mentioned above, if there are not available N95 respirators.⁴ As an alternative, the WHO recommends wearing a medical / surgical mask in the activities described above, and when it is necessary to transfer patients suspected of COVID-19 in ambulances or vehicles. ³ When providing direct care to COVID-19 patients in settings where aerosol-generating procedures are performed, the WHO recommends using N95, FFP2 and FFP3 respirators.³ In this case, the CDC suggests using N95 or higher level respirators (not specified).⁴

About the utilization of gloves, goggles or face shields, the WHO and CDC consider that these devices should be used in any of the following activities carried out by healthcare workers: 1) preliminary screening of patients affected by the COVID-19 (triage); 2) physical examination of patients with symptoms suggestive of COVID-19 (consultation room); 3) providing direct care to COVID-19 patients in absence of aerosol-generating procedures (patient room/ward); 4) providing direct care to COVID-19 patients in settings where aerosol-generating procedures are performed; 4) providing direct care or assistance to COVID-19 patient at home. ^{3,4} Also, the WHO advises to use gloves, goggles or face shields when it is necessary to transfer patients suspected of COVID-19 in ambulances or vehicles. ³

Concerning gowns, the WHO and CDC suggest that health care workers should use gowns in the following activities: 1) providing direct care to COVID-19 patients in absence of aerosol-generating procedures; 2) providing direct care to COVID-19 patients in settings where

aerosol-generating procedures are taking place ; 3) physical examination of patients with symptoms suggestive of COVID-19; 4) providing direct care or assistance to COVID-19 patients at home.^{3,4} As well, the WHO advises to use gowns when it is necessary to transfer patients suspected of COVID-19 in ambulances or vehicles. ³ Also, the WHO advises to use aprons in settings where aerosol-generating procedures are taking place.³

On the other hand, the WHO, the CDC, and other authors have considered that due to the shortage of PPE in several countries of the world, it is necessary to guarantee a rational and suitable utilization of PPE. This situation requires an effective management strategy to optimize the availability of these resources. ^{3, 4,6,10} In this sense, the following recommendations may contribute to this purpose.

- 1) The healthcare workers should use PPE according to the guidelines described in Table 1.
- 2) Whenever possible, to minimize the use of PPE, evaluation (preliminary screening and triage) of suspected cases of COVID-19 should be conducted in spaces with physical barriers such as plastic or glass windows. These barriers prevent direct contact between healthcare workers and suspected patients.
- 3) Similarly, the evaluation of suspicious cases can be done using m-Health technologies, telephones, and telemedicine systems to avoid that suspected patients go to the healthcare settings.
- 4) It is important to avoid misuse or inappropriate use of equipment. For example, using a higher level of respirator than it is required is a form of misuse of PPE. Another misuse is to use two gowns, three masks or double gloves, when you only need one piece of them.
- 5) To minimize the use of PPE, it would be desirable to cohort COVID-19 patients in the same room in an suitable area of a hospital. Similarly, cleaning activities can be carried out in a specific area by one worker using the same PPE.

7) Respirators should be prioritized for aerosol generating procedures.

8) If there are not N95 respirators, other types of respirators can be used such as powered air-purifying respirators (PAPR), filtering face piece respirators (FFP), face piece air-purifying respirators, elastomeric half-mask, and medical/surgical facemasks with a high level of filtering.

9) If there is a shortage of gowns, they should be used primarily for aerosol generating procedures, and care activities that can produce droplets, sprays and splashes, or require high patient contact (3).

10) Also, if there are insufficient quantities of gowns, wear aprons.

11) In the absence of goggles and face shields, it would be appropriate to decontaminate and reuse them.

Finally, According to the WHO and CDC, if the healthcare workers follow the guidelines described in Table 1, the risks to be infected by the COVID-19 are minimized.^{3,4}

Conclusion

The protection and safety of the healthcare workers can be maximized during the COVID-19 outbreak by following the WHO and CDC guidelines described in this study. In general, the WHO and CDC recommendations based on medical practices are similar, and depending on the healthcare activities and settings where the healthcare workers perform their work, suggest wearing medical/surgical facemasks, respirators, goggles and face shields (eye protection), gloves, gowns and aprons.

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