



Rational Use of Personal Protective Equipment (PPE) among Health Workers in COVID-19 Frontline

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Abstract

The novel corona virus (COVID-19) is a viral air-borne disease caused by SARS-CoV-2 (severe acute respiratory syndrome corona virus). Due to the rapid widespread of the disease, so many countries continue to record a high number of cases and mortality rate among individuals and healthcare workers. One of the major factors that contributed to the widespread of this deadly virus in health facilities is indiscriminate use of personal protective equipment (PPE). We reviewed some of the challenges faced by healthcare workers on the use of PPE during pandemics as well as guidelines in the use of PPE. Healthcare providers highlighted several factors that influence indiscriminate use of PPE during pandemics. These factors include: PPE causes discomfort, trouble in breathing and hotness. Some healthcare workers reported emergency, non-availability of PPE and inadequate training on the use of PPE as the major reasons for indiscriminate use of PPE while others are negligent and fail to adhere to the guidelines on the use of PPE. Therefore, periodic reinforcements, proper educational knowledge, availability and trainings on the use of PPE, and the need to adhere to safety and precautionary guidelines by healthcare providers, will reduce the spread of the virus.

Keywords: COVID-19; SARS-CoV-2; Personal Protective Equipment (PPE)

Introduction

COVID-19 also known Corona virus disease 2019 is a viral, air-borne communicable disease that is caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) [1]. According to the World Health Organization Reports in January 2020, a reported case of the disease was first discovered in December 2019 in Wuhan, the capital of China's Hubei district, and has been declared as a global pandemic [1]. As at 19 April 2020, The John Hopkins University in a special issue titled "Coronavirus COVID-19 Global cases" reported 2.38 million cases in 185 countries, 165, 000 mortality, and 611,000 recovered from COVID-19 glob-

ally [2,3]. The commonest cases, the disease results in moderate symptoms, while in some severe cases, the patients have been reported to develop pneumonia and organ failure [4]. Some of the clinical manifestations of COVID-19 as previously reported include; pyrexia, dyspnea, and cough while in others, patients are presented with muscle weakness and pains, fatigue, anosmia, irritation of the throat, diarrhoea, and abdominal pain [1,4-6]. The time from incidence to inception of symptoms may ranges between 2 to 14 days [3,4]. The mode of transmission of this virus is through close contact with people or infected surfaces or through tiny droplets during talking, sneezing, and coughing [4-6]. In most cases individ-

uals' are infected by coming in contact with infected surface and then touching their eyes, nose, or mouth with the infected surface [4-9]. The SARS-CoV-2 has been reported to live on surfaces about 72 hours and it is highly contagious during the first three days of window phase and might still be communicable in the late phase of the disease [4,5].

Among all the methods employed in the diagnosis of SARS-CoV-2, analyzing DNA or RNA from a patient's nasopharyngeal swab using real-time reverse transcription polymerase chain reaction (rRT-PCR) is most accurate and reliable [4]. Besides, clinicians have also applied the use of Chest CT imaging techniques especially when there is a high indication of COVID-19 symptoms and risk factors but this is not used in the regular screening of COVID-19 patients [4,5]. To date, there is no medication for the treatment for Corona Virus disease although several drugs and vaccines have shown promising results [6]. Managing this deadly disease requires managing symptom and patients' underlying health conditions, compassionate care, isolation and experimental interventions [4].

On 30 January 2020, the WHO declared the COVID-19 pandemic as a Public Health Emergency of International Concern (PHEIC) and as a global epidemic in March 11, 2020 [4-6]. COVID-19 cases have also been reported amongst workers [7,8,10]. According to the International Council of Nurses (ICN), 230,000 medical personnel have contracted this deadly disease and more than 600 nurses have been reported dead from corona virus [10]. Furthermore, the ICN's analysis revealed that about 7% of all COVID-19 frontline healthcare personnel, meaning that medical personnel and the patients they care for are at a high risk of contracting the novel corona virus, globally affect cases [10]. Due to the rapid increase of COVID-19 incidence among healthcare workers, we reviewed the use of Personal Protective Equipment (PPE) among frontline medical officers by examining COVID-19 and its preventive strategies, indiscriminate use of PPEs, rational and appropriate use of PPEs and health risks associated with the irrational usage of PPEs.

Preventive measures of COVID-19

The recommended safety practices for the prevention of COVID-19 infection includes; regular hand washing and the use of hand sanitizers, keeping at least a distance of 2 meters from others, practicing excellent respiratory hygiene, coughing and sneez-

ing in inner elbow or with a tissue and proper hand washing after coughing and sneezing, and avoid touching our face with unwashed hands [4,5]. In addition, the use of facemask is recommended by Centre for Disease Control (CDC) and WHO, for caregivers and the public as a means of preventing the spread of the novel corona virus [4-7]. This mask may be a cloth mask covering and must be used in public settings to prevent the spread of the virus by asymptomatic patients [11]. Health institutes all over the world have also encouraged individuals to use bandanas or scarves while infected individuals are advised to be isolated and stay at home [12]. If they are to seek medical attention, they are called to frontline healthcare workers and wear a facemask before visiting a healthcare facility; they should also avoid personal contacts and sharing of household equipment with other households [13,14].

However, the CDC recommends effective hand washing with soap and water for 20 seconds, especially when hands are dirty, after toilet use, before eating and after coughing, sneezing and nose-blowing. In addition, the use of 60% alcohol-based sanitizer is advised especially when there is no access to soap and water [15]. Wiles (2020), suggested that inadequate preventive measures including relaxation of lock down may fuel the re-occurrence of the epidemics [16]. Physical distancing was incorporated as one of the strategies to mitigate the spread of the virus by temporary closing of academic and non-academic institutions, religious gatherings and workplaces, limiting travel and cancelling large public gatherings [17,18].

Personal Protective Equipment use among health care providers

Hakim, *et al.* (2016) described PPEs as tool, which serves as a barrier between a user and micro-organisms, and prevents the spread and infection of micro-organisms on the health care provider [19]. PPE protects healthcare workers from health hazards in the workplace; therefore, inadequate use of PPE and infection control measures may enhance transmission of infectious diseases from patients, attendants and health care providers [20]. According to WHO practical guidelines for infection control, all medical personnel and health attendants, laboratory staff, supporting staff and family members who care for patients should use PPE and it includes, gloves, masks, goggles, apron, gown, boots and hair cover [21].

The continual global increase in disease pandemics such as COVID-19, Ebola, Severe Acute Respiratory Syndrome (SARS), tuberculosis, Spanish flu as well as its effect among healthcare providers has led several countries to organize infection control programs targeted at standard precautions in the medical sector [22-24]. For instance, exposure to blood and body fluids (BBF), occurs through muco-cutaneous incidents or percutaneous injury (needle stick injury (NSI)). This led to the issue of CDC guidelines as a global safety measure in 1987 but was later incorporated in 1996. In 2001, WHO released a special issue entitled "Reducing risks, promoting healthy life" estimated that average risk of infection spread after NSI contact is 0.3% in HIV, 6 – 30% in hepatitis B and 1.8% in hepatitis c [24]. In addition, more than 90% of these infections occur in third world countries [24].

Consequently, in developing nations healthcare providers have a higher percentage of infection spread due to sub-optimal disease control practices including inadequate medical facilities, lack of expertise, and non-compliance with universal standard procedures [25]. Kermode., *et al.* (2005) in an article titled "Occupational exposure to blood and risk of blood borne virus infection among health care workers" which was carried out in a rural Indian setting reported that 37.1% and 63.2% of health workers practicing in rural communities are exposed to BBF [26]. A similar study reported that 91.43% attributed non-usage of PPE to emergencies, while busy schedules, risk of offending patients, discomfort and challenges in carrying out the job were 37.14%, 27.14% and 18.57% respectively [27].

A cross-sectional study carried out by Xiayoun., *et al.* (2012), on Chinese health care providers demonstrated that 87.5% of subjects believed that the use of appropriate PPE will protect healthcare providers from microorganisms, 50% were of the opinion that PPE causes discomfort, and while 21.2% of the subjects were of the opinion that PPE use disrupts patient care [28]. Xiayoun., *et al.* also reported that 63.2% of the subjects stated that their facility have sufficient PPE while 21% reported that some healthcare providers fail to use PPE during patient care, and forget to change PPE when attending to another patient [28].

A survey conducted on returning healthcare workers to the United Kingdom during the Ebola virus pandemic, showed that 8% of personnel had physical contact with patients with con-

firmed Ebola virus disease (EVD) without PPE [29]. Though these medical personnel were properly trained, about 17% reported an intermediate-to-high-risk exposure during patient care. Intermediate risk was described as potential contact of mucous membranes or broken skin with bodily fluids of a patient with EVD while High risk was defined as exposure of mucous membranes or broken skin with the bodily fluids of a patient with EVD [29]. Other healthcare workers reported that they became infected without a known exposure [30].

Individual factors on the indiscriminate usage of PPE

A special issue on healthcare personnel and use of PPE attributed three key factors to the non-compliance on the use of PPE; First, lack of training on proper use of PPE, mode of disease transmission and other safety practices associated with infection control [31]. Molinari., *et al.* (2010) reported that healthcare providers who use the adequate PPE do so incorrectly or incompletely [31]. For example, most healthcare workers fail to do a fit check after donning a respirator, continual use of familiar apparatus irrespective of the fit test results, and failure of annual fit test by health workers [31]. A study assessed composite observance and comfort scores on the use of N95 respirators, and eye protective devices among respiratory therapist, nurses and healthcare providers at a tertiary hospital in Canada [32]. Composite observance score on the use of respirators was 86% of full compliance while 74% of full compliance was observed in eye protective devices. Their findings also revealed that respondents felt well protected with the use of N95 respirators than with facemasks [32]. A similar study identified lack of expertise on the removal of PPE, and differences in the protection levels of different kinds of PPE and lack of knowledge on the use of new PPE as the factors that affect indiscriminate use of PPE [33]. According to this study, non-compliance behaviors exhibited by healthcare providers can vary under different circumstances [33]. Total and ideal compliance with PPE use is a daunting task under the unsurpassed circumstances [33].

Secondly, studies have revealed that healthcare workers depend on their personal risk assessment in deciding whether to use protective devices [34-36]. Visentin., *et al.* (2009) stated that in spite of administrative guidelines on the use of PPE, emergency medical technicians still fail to use certain protective devices especially when they are not convinced on the need to do so [34]. Shigayeva., *et al.* (2007) noted a similar observation, on the use of PPE dur-

ing SARS outbreak in Canada [35]. However, another study [32] reported that healthcare workers believe they know more about safety precautionary measures, the use of PPE and infection control than they actually do while a higher percentage of healthcare providers reported that one of the driving forces in willingness to work during periods of pandemic is having sufficient provisions of PPE [36].

Another reason that affects the use of PPE is believe that PPE interferes with patient-provider relationship and/or declines the quality of patient care; for example the use of PPE reduces vision and manual dexterity [37]. In an article by Seale, *et al.* (2009), 54 healthcare workers in an emergency unit were asked to put on a respirator (P2, an N95 equivalent) for a 4-week period during the influenza season whenever they were working within 1 meter of a patient with respiratory symptoms [38]. During the first week, 24.1% of the respondents put on the respirator “occasionally,” while 42.6% of the respondents never used any of the respirators. However, in week 2, only 3 out of 54 respondents used the respirator “on most shifts” while in the third week and fourth week only 1 out of 54 healthcare personnel used the respirator “on most shifts”. Surprisingly, by the end of the 4th week, 70.4% percent of the healthcare personnel reported that they never wore the respirator all through the study because it was hot, they had trouble in breathing, it interfered with patient-provider relationship and it has to be stored before and after usage [38].

Another aspect of individuals’ opinion on the use of PPE is patient expectations and PPE preferences [31]. Although this is still an ongoing research, a study employed the use of pictorial representations of physicians with traditional surgical masks and transparent face shields to seek parents and children aged 4 - 10 opinion on which set of physicians they would accept for patient care [39]. 62% of parents believed their children would prefer face shields while 59% of the children did not have any preference and rather did not find they two categories frightening [39]. Another dental cross-sectional observation survey reported that 72% of patients preferred physicians with the use of facemask for their dental care [40].

A more recent review by Houghton, *et al.* (2020), which focused on identifying the barriers and facilitators to healthcare workers’

adherence to IPC guidelines for respiratory infectious diseases, reported that healthcare providers highlighted several factors that affect their ability to adhere to guidelines when managing respiratory infectious diseases [40]. These include; the communication of the guideline, administrative support, Health facility culture, training, physical space, availability and trust in PPE, and a desire to deliver good patient care [41].

Ensure rational and appropriate use of PPE

All types of PPEs must be used according to engineering and administrative guidelines [42]. This implies that for a proper use of PPE, healthcare workers must consider; the target population, risk assessment, and the mode of transmission of the infection (e.g. contact, droplet, or aerosol). According to the WHO (2020) on the effective use of PPE in the COVID-19 pandemics, healthcare workers should observe the following recommendation [42]:

- The types of protective devices used when caring for COVID-19 patients should be dependent on the setting, type of activity and personnel (See figure 1 and 2).
- The type of PPE used by healthcare personnel should be according to indications and not by self-opinion.
- Healthcare providers should avoid overuse or misuse of PPE as this will drastically reduce or increase supply PPE and thus enabling one facility to have more or less PPE than another.

Proper ways to put on PPE

Effective trainings and practices of the proper ways to put on PPE is very important especially in this period of pandemic [42].

- **Identify and gather the adequate PPE.** Choose a suitable gown size (based on training).
- **Perform hand hygiene by washing hand with soap and water for at least 20 seconds or use alcohol-based hand sanitizers.**
- Wear an **isolation gown**. Tie up all the ties on the gown. If necessary, seek assistance from another medical officer.
- **Use NIOSH-approved N95 filtering face piece respirator or wear a facemasks where respirator is not available.** The respirator’s nosepiece should be well-fitted to the nose with both hands. It must not be covered or bent. Avoid pinch-



Figure 1: Standard Medecins Sans Frontiere ensemble. Adopted from: <http://www.bbc.com/news/health-29518703>.

ing the nosepiece with one hand. Note: respirator/face mask should be extended under chin and it must cover both the mouth and nose. Nevertheless, it should not be worn under your chin or stored in pockets. In addition, respirator top straps should be placed on the crown of head while the bottom straps should be at the base of neck. Always ensure you perform a user seal check time whenever you wear the respirator. As for mask, top ties should be secured on crown of head and bottom tie at the base of neck. Also, if mask has loops, hook them appropriately around your ears.

- **Wear eye protective devices such as face shield or goggles.** Face shields provide protection to the full face while goggles provide excellent protections to the eyes, but fogging is common.
- **Carry out hand hygiene either by washing or with hand sanitizers before wearing gloves.** Gloves should cover the cuff (wrist) of gown.
- **With all these in place, the healthcare worker may now enter the patient room.**



Figure 2: Center for Bioengineering Innovation and Design/Jhpiego personal protective equipment ensemble.

Proper ways of removing PPE

The PPE doffing process is believed to be associated with high-risk time in terms of self-contamination and subsequent infection [43]. Several clinicians stated that hand washing and the doffing of powered air-purifying respirator hoods have perhaps the highest level of infection risk [44-47]. More than one method of PPE removal may be suitable. Healthcare providers must stick to their facilities methods of doffing. Procedures for the removal of PPE in the COVID-19 pandemics include:

- **Gloves removal:** Ensure gloves are removed without causing additional hand contamination. Gloves can be removed by glove-in-glove or bird beak removal technique.
- **Gown removal:** Lose all ties or unsnap all buttons carefully to avoid forceful movement. Reach up to the shoulders and gently pull gown down and away from the body. Roll the gown and dispose in a trash container.
- **Healthcare provider may now leave the patient room.**
- **Carry out hand hygiene effectively.**

- Carefully remove face shield or goggles by grabbing the strap and pulling upwards and away from head, and avoid physical contact with the front of face shield or goggles. **Remove and get rid of respirator or facemask. Again,** avoid physical contact with the front of facemask or facemask. When removing respirators, remove the bottom strap by touching only the strap and bring it gently over the head. Hold the top strap and bring it gently over the head, and then pull the respirator away from the face and avoid contact with the front of the respirator. As for **facemask**, gently loosen the ties and pull away from face without touching the front.
- Finally, **perform hand hygiene after the removal of respirator/facemask and before use.**

Health risk associated with irrational use of PPE

Indiscriminate use of PPE results to an increase the transmission of infectious diseases. It endangers healthcare providers, their families and colleagues, patients, and communities [48]. For instance, prolonged usage of pair of gloves may lead to transfer of infection from one surface to another. On the other hand, prolonged usage of mask for long periods may cause contamination especially if the wearer pinches the mask and rubs his face, eyes or nose [48]. Also, improper disposal of PPE may pose a greater risk to the rural communities. In this regard, PPE should be discarded in a sealed separate bag before disposed into the general rubbish. In no circumstances must health care workers reuse masks, disposable aprons, and gloves [48,49].

The continual rise of COVID-19 cases among doctors and nurses, have led to an increase level of strain in the health care system and thereby affecting medical response to COVID-19 [49]. In pandemics, there is need for a huge number of medical personnel and if they fall sick, they add to the patient surge and therefore are not capable to respond as healthcare providers [48,49]. According to Rebmann, "It's an issue of a numbers game". [49].

Conclusion

This review has clearly demonstrated that one of the reasons for the spread of infections among healthcare workers especially during pandemics is the indiscriminate use of PPE. Moreover, to reduce the rate of new cases, healthcare workers should be provided better educational knowledge on the use of PPE, and hazards and safety measures in a facility.

Recommendations

Periodic rehabilitations and training programs are encouraged for all levels of healthcare personnel to enable them comply with the safety precautionary measures and the guidelines on the use of PPE to protect them and prevent the spread of infection. During pandemics, medical personnel endanger their lives to care for others therefore, they should always be oriented on they need to practice excellent safety measures and be trained periodically on the risks involved in the irrational use of PPE. Furthermore, PPE should be designed in a way that it does not cause discomfort to the healthcare worker or interferes with patient-provider relationship.

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