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REVIEW ARTICLE

Use of personal protective equipment during the COVID-19 era

Uso de equipo de protección personal durante la era COVID-19

Utilização de equipamentos de proteção individual em época de COVID-19

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Abstract

This article aims, mainly, to update health professionals about the individual protection equipment (PPE), the types of equipment, the way of use, in addition to its effectiveness and efficiency. Thus, we also seek to elucidate the consequences of using PPE and the scarcity of PPE and its consequences. We conducted a review study, starting in 2020, using the databases SciELO, PubMed and Medline. In total 38 articles were analyzed, and 21 articles were selected for the work. The criteria used for adding articles were: (1) Objectivity and specificity of the topic addressed; (2) Time since publication, searching for the most recent - these being from March 2020. The criteria for exclusion of articles were: (1) Little relevance of the bibliographic reference; (2) Poor reliability of the data presented in the references; (3) Studies that were later contradictory. The types of study selected were systematic review, narrative review, prospective study, manuals for the population and health professionals and guidelines.

Descriptors: Personal Protective Equipment; COVID-19; SARS-CoV-2; Coronavirus; Health Professionals; Pandemic

Resumén

Este artículo tiene como objetivo principal actualizar a los profesionales de la salud sobre el equipo de protección individual (EPP), los tipos de equipo, la forma de uso, además de su efectividad y eficiencia. Por lo tanto, también buscamos dilucidar las consecuencias derivadas del uso de EPP y la escasez de EPP y sus consecuencias. Realizamos un estudio de revisión, a partir de 2020, utilizando las bases de datos SciELO, PubMed y Medline. En total se analizaron 38 artículos y se seleccionaron 21 artículos para el trabajo. Los criterios utilizados para agregar artículos fueron: (1) Objetividad y especificidad del tema abordado; (2) Tiempo desde la publicación, buscando el más reciente, estos son de marzo de 2020. Los criterios para la exclusión de artículos fueron: (1) Poca relevancia de la referencia bibliográfica; (2) Mala confiabilidad de los datos presentados en las referencias; (3) Estudios que luego fueron contradictorios. Los tipos de estudio seleccionados fueron: revisión sistemática, revisión narrativa, estudio prospectivo, manuales para la población y profesionales de la salud y guías.

Descriptores: Equipo de Protección Personal; COVID-19; SARS-CoV-2; Coronavirus; Profesionales de la Salud; Pandemia

Resumo

Este artigo tem por objetivo, principalmente, atualizar profissionais de saúde quanto aos equipamentos de proteção individual (EPIs), os tipos de equipamentos, o modo de utilização, além de sua eficácia e eficiência. Assim, buscamos também elucidar as consequências decorrentes do uso de EPIs e a escassez de EPI e suas consequências. Conduzimos um estudo de revisão, a partir do ano de 2020, utilizando as bases de dados SciELO, PubMed e Medline. No total foram analisados 38 artigos e selecionados 21 artigos para o trabalho. Os critérios utilizados de adição de artigos foram: (1) Objetividade e especificidade do tema abordado; (2) Tempo desde a publicação, buscando os mais recentes - sendo estes a partir de março de 2020. Os critérios para exclusão de artigos foram: (1) Pouca relevância da referência bibliográfica; (2) Pouca confiabilidade dos dados apresentados nas referências; (3) Estudos que foram posteriormente contraditórios. Os tipos de estudo selecionados foram: revisão sistemática, revisão narrativa, estudo prospectivo, manuais para a população e profissionais da saúde e diretrizes.

Descritores: Equipamentos de Proteção Individual; COVID 19; SARS-CoV-2; Coronavírus; Profissionais de Saúde; Pandemia

Introduction

In December 2019, in the city of Wuhan, China, a wave of patients with severe pneumonia without an identified origin was reported. On January 7, 2020, the causative virus, called coronavirus or SARS-CoV-2, was identified. The virus is transmitted through droplets, aerosols or direct / indirect contact, the main source of spread being the infected individual (asymptomatic, symptomatic or in the incubation period)[1,2].

The rapid ability to spread the virus associated with its high lethality rate created a pandemic scenario, recognized by the World Health Organization (WHO) in March 2020, whose disease was called COVID-19. Since then, several countries have tried to develop a vaccine, but so far without success. With this, security protocols were developed to try to minimize the spread of the virus and protect those on the front lines against this outbreak[1,3].

Aiming at minimizing contagion, the National Health Surveillance Agency (ANVISA) issued a Technical Note on March 21, 2020 on "preventive measures that should be taken in assisting patients with suspected or confirmed COVID-19". These measures include the use of personal protective equipment (PPE) to prevent droplets, aerosols, or even direct / indirect contact in the care of patients suspected or confirmed of infection with the new coronavirus. They are surgical mask, apron, disposable gloves and face shield or glasses. An addendum is made that failure to place and remove PPE also implies the risk of biological contamination[4-6].

With the existence of protocols advocating the importance of PPE, it is known that, even minimizing the risk of infection by COVID-19, its use does not completely extinguish the contamination. However, the drop in the availability of PPE, coupled with the lack of equipment and exhaustion due to the risky work carried out, causes an overload of exposure to COVID-19, making health professionals even more vulnerable to the disease[2,3].

As for the general population, given the lack of PPE in the pandemic, the use of cloth masks - as a mechanical barrier - was permitted by the Brazilian Society of Infectious Diseases (SBI). It is emphasized, by the SBI, the adoption of educational measures in conjunction with the use of masks, which are: social distance; avoid touching the eyes, nose and mouth; in addition to hand hygiene with water and soap or alcohol gel 70%[1,3,7].

In this context, given the high progression of the disease, the dissemination of knowledge about PPE and its correct use becomes extremely important. In addition, the relevance of the topic is undeniable to elucidate the severity of the shortage of PPE, both for the general population and for health professionals.

The purpose of this article is, mainly, to update health professionals about the individual protection equipment (PPE), the types of equipment, the way of use, in addition to its effectiveness and efficiency. Thus, we also seek to elucidate the consequences arising from the use of PPE and its scarcity and consequences.

Methodology

We conducted a review study from the year 2020, using the SciELO, PubMed and Medline databases. We also used data from WHO, the Ministry of Health of Brazil, among other institutions, such as the Brazilian Medical Association (AMB), the Brazilian Emergency Medicine Association (ABRAMEDE) and the Brazilian Society of Infectious Diseases (SBI). In total, 38 articles were analyzed, and 21 articles were selected for the work. We use the terms "Personal Protective Equipment", "PPE", "COVID 19", "SARS-CoV-2", "Coronavirus", "Health Care Professionals" and "Pandemic", including all words translated into English.

The criteria used for adding articles were: (1) Objectivity and specificity of the topic addressed; (2) Time since publication, searching for the most recent - these being from March 2020. The criteria for exclusion of articles were: (1) Little relevance of the bibliographic reference; (2) Poor reliability of the data presented in the references; (3) Studies that were later contradictory.

The types of study selected were systematic review, narrative review, prospective study, manuals for the population and health professionals and guidelines. All information, mainly numerical, pointed out in the articles was analyzed individually and eligible after verification for veracity and updating.

Results and Discussion

"Personal protective equipment (PPE) is any device or product, individual, used by workers, intended to protect risks that may threaten their health and safety", according to Ordinance No. 3,214 of June 8, 1978 - NR -MTE. Currently, we understand PPE as devices intended not only for the safety of the individual who uses it, but also with the aim of preventing infection from third parties[6].

In the case of the risk of biological contamination, the PPE acts as a barrier (filter) that can prevent infection, in addition to reducing the range of the virus when expelled by the infected individual[6].

In the face of the current pandemic of COVID-19, the Brazilian Society of Infectious Diseases (SBI) recommended that health professionals in Brazil use PPE to prevent droplets in the care of suspected or confirmed individuals of the infection with the new coronavirus[1-3,5,8].

Examples of PPE are: surgical mask, waterproof apron and disposable gloves, cap and face shield or goggles[1-3,5,8]. In procedures where there may be aerosol (examples: nasal swab collection, bronchoscopy or even aspiration from an intubated patient), an N95 or PFF2 mask should be used. In ICUs reserved for COVID-19 patients, N95 or PFF2 mask

should always be worn. An addendum is also made that in the presence of dirt or moisture, the mask should be replaced, aiming at the care that will still be mentioned in this article[1,2,5,9].

The COVID-19 can be transmitted by direct or indirect contact (surfaces with droplet / aerosol residue) or droplet transmission, which is attributed to respiratory particles of a size considered large, subject to gravitational forces. Thus, the droplets travel through the air - considered the sick individual standing still - only approximately one meter from the patient, while there are studies proving that in motion (as an example, during a run), these droplets can reach ten meters from the infected individual[10].

Airborne transmission can occur if the patient's respiratory activity or even when medical procedures generate respiratory aerosols. These aerosols contain particles capable of traveling longer distances, remaining in the air for a longer period and, although with an uncertain infectious potential, they are relevant in the current pandemic[5,10].

In view of the forms of transmission, behavioral measures must be implemented to prevent the spread of the disease and the unrestricted use of PPE, which are already scarce and extremely necessary for various medical procedures. Among them, postponing consultations, and routine exams, as well as elective surgeries are recommended by WHO and the American Society of Surgery[2,11].

For patients with respiratory symptoms, emergency care screening protocols should be created, responsibly guiding potentially suspect patients to fast and safe isolation, and adequate guidance on the use of masks for everyone. It is known that the correct use of PPE is an important means of containment of COVID-19, however, basic personal hygiene guidelines should be associated for a better result[3,7].

Thus, adequate information on hand washing, frequent use of gel alcohol, greater care for direct contact with respiratory secretions and avoiding the handling of areas such as eyes, nose and mouth when sneezing and coughing can help to combat the current pandemic. Avoid close contact with symptomatic people, attitudes like using the inside of the elbow or tissue when coughing or sneezing are pertinent guidelines as complementary measures[2,7,12].

As the use of PPE reduces, but does not eliminate the risk of contamination, cleaning of surfaces must be performed frequently due to the favorable conditions of survival of the virus, as well as the isolation of suspicious individuals and social distance to contain agglomerations[2,13,14].

Correct way of dressing

In a technical note published by ANVISA, in which the agency proposes that health professionals who perform procedures less than a meter away which can be incorporated into the routines of individuals, with regard to the personal hygiene of suspected or confirmed patients for infection from COVID-19[2,3].

In May, ABRAMEDE published recommendations regarding the use of equipment, lack of equipment and cyclical reuse. Proper dressing must follow the following sequence: (1) hand antisepsis (can be done with 70% alcohol or soap and water); (2) wearing the recommended mask for the service situation; (3) a new hand antisepsis is performed so that the goggles are placed; (5) antisepsis of the hands is performed once more to make the (6) clothing of the propé; (7) new hand antisepsis is made for (8) clothing of overalls and hats; (9) another antisepsis is performed so that the (10) face shield is placed, if necessary; (11) new antisepsis is performed to perform (12) gloves, (13) waterproof aprons and (14) second gloves[15].

Correct way of undressing

Undressing done properly is just as important as dressing to reduce the chances of infection with COVID-19. Proper separation must follow the following sequence: (1) removal of the waterproof apron from the sides, followed by the first pair of gloves; (2) antisepsis of the gloved hands with 70% alcohol; (3) removal of the “face shield” visor if present; (4) cleaning the “face shield” with 70% alcohol solution or disinfectant solutions; (5) removal of the overalls starting with the cap; (6) withdrawal of the propes; (7) removal of the last pair of gloves; (8) hand antisepsis with 70% alcohol; (9) removal of goggles from posterior to anterior; (10) hand antisepsis with 70% alcohol; (11) removing the masks from posterior to anterior; (12) hand antisepsis with 70% alcohol[15].

Types of PPE and recommendations

As for masks, it is important to establish an initial pattern for use. First, whether for professional use, or for use by the general population, protective masks must have their structure completely intact, without moisture, and / or dirt[2,9].

We can relate the types of PPE with their proper use in each situation according to Chart 1.

Chart 1. Types of PPE according to the usage situation. Rio de Janeiro, RJ, Brazil, 2020

TRANSMISSION MODE	WHEN USE IN PATIENT WITH COVID-19	PPE
Contact precaution	> 2m from patient	Gloves, apron.
Droplet precautions	<2m from patient	Gloves, apron, fluid-resistant surgical mask, goggles *.
Aerosol precautions	Procedures that generate aerosols	Gloves, long-sleeve liquid-repellent apron, goggles *, EFP3 mask.

Note: *Goggles can be replaced with face shield.
Source: Adapted from the Association of Anaesthetists[10].

In Chart 2, we can see the relationship between the recommendations for each type of PPE.

Chart 2. Types of masks and recommendations. Rio de Janeiro, RJ, Brazil, 2020

TYPE OF MASK	PREVENTION	WHEN USE
Type IIR surgical face mask	Droplets up to 1-2m	Protection against transmission droplets
Objective: to avoid contamination of the professional's airways by the droplets, when acting at less than 1 meter from the suspected or confirmed patient. Making the mask: woven material - non-woven (TNT), have at least one inner layer and one outer layer and mandatory a filter element. The filter composition must have particle filtering efficiency (EFP)> 98% and bacteriological filtering efficiency (BFE)> 95%. The use of this mask should aim to provide direct care to the patient on the hospital premises. Patients with symptoms of respiratory infection (fever, cough, sneezing, dyspnea) should use this mask.		
Respiratory Protection Mask (Particulate Respirator - N95 or Equivalent)	Aerosol	Protection in procedures with risk of aerosol generation
Objective: to protect the health professional in procedures with risk of aerosol generation, such as intubation or tracheal aspiration, non-invasive ventilation, cardiopulmonary resuscitation, manual ventilation before intubation, nasotracheal collections and bronchoscopic secretions. It must have minimum efficiency in the filtration of 95% of particles up to 0.3µ (type N95, N99, N100, PFF2 or PFF3).		
In the hospital routine, the use of respirators or N95 masks or equivalent is considered, in addition to the expiration date given by the manufacturer for emergency care for suspected or confirmed cases of COVID-19. However, masks beyond their expiration date may not be as effective and may not meet the requirements for which they have been certified. Over time, components such as strips and nasal bridge material may degrade, which can affect the quality of the fit and seal. The surgical mask should not overlap with the N95 mask or equivalent, as in addition to not guaranteeing protection from filtration or contamination, it can lead to the waste of another PPE, which can be very harmful in a scarcity scenario. To reduce contamination of the N95 mask or equivalent, if available, the face shield can be used. If the mask is intact, without dirt or moisture, it can be used several times during the same shift by the same professional (up to 12 hours or as defined by the Hospital Infection Control Commission - CCIH of the health service). This recommendation may be updated. To remove the mask in order to use it, remove it by the elastics with extreme care not to touch the inner surface and put it in a paper bag or envelope with the elastics out, to facilitate the removal of the mask. Never put the mask for reuse in a plastic bag, as it may become damp and potentially contaminated.		
Fabric Mask	Aerosol	Protection by the population that needs to leave their homes
It serves as a mechanical barrier against spreading the virus by asymptomatic or pre-symptomatic people who may be transmitting the virus without knowledge. This mask does not protect the individual who is using it, as it does not have filtering capacity. It should be washed, dried and finally, ironing it on a hot iron will do a deeper cleaning. The use of the fabric mask must be individual and should not be shared. In health services, its use is not recommended. Here, the importance of social distance is highlighted, avoiding touching the eyes, nose and mouth, in addition to hand hygiene with water and soap or 70% alcohol gel.		

Note: *Particulate Filtering Efficiency: EFP2, EFP3 and N95: refer to the filtration performance of the masks. This filtration is done through the union of a polypropylene web (microfibers) and electrostatic charge. For FFP1, FFP2 and FFP3 the reduction in the concentration of the substance is 4, 10 and 20 times, respectively. ** N95: in test conditions, the respirator blocks at least 95% of the solids and liquids of the aerosol particles.
Source: Adapted from Brazilian Society of Infectious Diseases[4,9], Association of Anaesthetists[10], World Health Organization[16].

According to Chart 3, we see the list of other types of PPE and their recommendations.

Chart 3. Other types of PPE and their recommendations. Rio de Janeiro, RJ, Brazil, 2020

Gloves	They should be used, in the context of the COVID-19 epidemic, in any contact with the patient or his surroundings (Contact Precaution). Gloves must be put on before entering the patient's room or area where the patient is isolated. Never leave your room or isolation area with your gloves on.
Eye Shield or Face Shield	They should be used when there is a risk of exposure of the professional to blood spatter, body secretions and excretions.
Capote / Apron	The need to use an impervious coat or apron (impervious structure and minimum weight of 50 g / m2) depends on the patient's clinical condition (vomiting, diarrhea, orotracheal hypersecretion, bleeding, etc.).
Beanie	The cap is indicated for the protection of the hair and head of professionals in procedures that can generate aerosols.

Source: Adapted from the Brazilian Society of Infectious Diseases[4].

Consequences of inappropriate use and lack of clearance

According to the guide published by the WHO, on June 5, for PPE to be effective, it is necessary to follow the appropriate guidelines for use. Regarding surgical masks, when only one is used during the shift, it is necessary to guarantee its integrity, check for visible dirt or moisture. When adjusting it to the face, it must be removed safely from the sides, not being able to touch the front part of the same and the disposal done correctly with hand hygiene carried out in sequence[17].

Risks related to the misuse of PPE are self-contamination due to the mishandling of masks with contaminated hands and / or the false sense of security that reduces adherence to complementary preventive measures. The selective use of materials is also inappropriate. When used alone by healthcare professionals, masks do not shield all possible routes of contamination, as would be the case with associated eye protection[17].

In addition, the eye protection next to the mask reduces the possibility of accidentally touching your mask. As masks are the most accessible form for the public, much is specified about their maintenance[17].

Recommendations include not sharing masks between people; when wet, it must be disposed of properly and replaced after hand hygiene. There is no relevant specification regarding the time of use, but it exists on the composition of the material used and its conditions during use[17].

Skin injuries from the use of PPE

One of the consequences of the use of PPE for prolonged and continuous time is skin lesions, and the prevalence of skin damage can reach up to 97% among frontline health professionals. The skin is the first line of defense against the environment, so it is essential to keep this barrier intact to avoid contamination[18,19].

The inadequate and continuous use of PPE implies mechanical and chemical forces on the skin, attacking it and changing its protective characteristics. Physical factors, such as sustained pressure, tension forces friction, as well as humidity and temperature, are directly associated with the development of ulcers and friction injuries, especially in the nasal bridge, hands, cheek, and forehead regions. These injuries can increase the risk of infection, cause pain and scarring, resulting in reduced quality of life[18-20].

Another factor that can affect the health of the professional is the constant hygiene and the use of gloves, which increase the risk of dermatitis and dermatosis, which can cause erythema, dryness, flaking, cracks, itching, secondary infections and worsening of skin diseases[18-20].

To avoid skin-related PPE complications, the following are recommended: (1) skin care before and after using PPE, using moisturizing creams and barrier protectors; (2) use of interface material (such as bandage or tape) between the PPE and the skin in the areas of adhesion / pressure / friction; (3) perform hand washing associated with the use of cosmetic substances that can help in the process of retention and reduction of transepidermal water loss; (4) programming PPE pressure relief minutes, planning shorter rotation shifts in equipment with high protective intensity, always taking care with contamination; (5) treating, protecting and avoiding the use of a mask and goggles on affected areas[18-20].

Shortages due to high demand and inadequate planning

Another consequence of the crisis, according to studies, was related to the lack of supply of equipment, medicines, and protection instruments, in addition to human resources. It was indicated that the greatest shortage (38.2%) is related to PPE, in decreasing order of scarcity, N95 masks or similar, apron, face shield, surgical masks, caps and surgical gloves. In addition, there was a lack of alcohol gel (30.8%), tests for detecting the coronavirus (29.4%) and medications (21.9%)[21].

The shortage occurred, according to the British Journal of Surgery and Department of Anesthesia and Intensive Care Medicine, due to the high demand for these supplies in a short period associated with the lack of time for production and replacement, both for the health area and for the general population. Another reason was the chaos generated by the excess of information provided to the general population, for example with alcohol gel and medication (hydroxychloroquine, for example), leaving the population that needs the medicine without access to it (individuals with systemic lupus erythematosus, for example). The inappropriate and excessive use of inputs contributed to the scarcity of the material, because of this, guidelines were created and widely disseminated that address how the use, removal and preservation of the material should be made[1,10,21].

Intervention proposal

As an intervention proposal, we need health education and training of health professionals and the population and increased availability of free tests. In addition, several strategies can minimize the need to use PPE, such as: implementing physical barriers to reduce exposure, limiting the number of professionals who enter the bed where there is a suspected or confirmed case, offering common surgical masks to patients with flu-like symptoms. , advise on the correct use in the first verbal contact within the health service, use telemedicine more and postpone elective procedures[8,13].

The reuse of equipment whenever possible is also a functional measure[15].

Finally, better planning of the projection of the use of PPE must be made, that is, more efficient equipment logistics is necessary to avoid the lack of materials for health professionals. In addition, the institution must provide all its workers with free tests for the detection of the virus so that there is a reduction in the risk of contagion during screening.

Conclusion

The recent topic of the pandemic is still not fully understood, despite the progress achieved. When it comes to PPE, it is no different, despite being widely reported in labor and daily practice, there are still many doubts and flaws regarding the use related to the effectiveness of each equipment. In addition, the insufficient supply of PPE associated with the overload of exposure to COVID-19 means that health professionals are considered a population highly vulnerable to contagion.

It is recognized, mainly by the institutions, that there is an important distortion between the use recommended by the manufacturers of protective equipment and the way in which they are used. Thus, greater care for health professionals by the institution is necessary, given that many workers are unaware of the way PPE works and end up prolonging the time of use due to the insufficient number of available equipment.

It is concluded that, in addition to raising awareness among health professionals (as well as the general population), efficient planning must be implemented, covering public and private spheres, nationwide, in order to meet the current demands for equipment and supplies. Thus, it will be possible to prevent unnecessary contagions, safeguarding physical, emotional, and mental integrity.

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