

Doffing personal protective equipment in times of COVID-19

Desparamentação em tempos de COVID-19

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ABSTRACT | COVID-19, a disease caused by a coronavirus (SARS-CoV-2), has worried health authorities in Brazil and worldwide because of its high infectivity and rapid spread. Within this context, health care workers are at greater risk of infection for being in close contact with patients, which is inherent to their work activities. To reduce the risk, protective measures must be adopted and personal protective equipment is essential. However, the process of removing personal protective equipment, named doffing, is as important as its correct use and can be a source of contamination for workers, especially when equipment is lacking in the market and lifespan is increased. Therefore, this review aimed to discuss the process of doffing personal protective equipment and its correct sequence based on data available in the literature.

Keywords | COVID-19; personal protective equipment; health personnel; occupational health; occupational exposure.

RESUMO | A pandemia da COVID-19, doença causada pelo coronavírus SARS-CoV-2, preocupa as autoridades de saúde no Brasil e no mundo, devido a sua alta infectividade e velocidade de disseminação. Nesse contexto, os profissionais de saúde apresentam maior risco de contágio devido à proximidade aos pacientes, o que é inerente às suas atividades laborais. Para reduzir esse risco, medidas de proteção devem ser adotadas, e os equipamentos de proteção individual são de fundamental importância. No entanto, tão importante quanto o uso dos equipamentos de proteção individual adequados e de forma correta, está o processo de retirada dos mesmos, denominado desparamentação, que pode ser fonte de contágio desses profissionais, principalmente em um cenário de escassez de equipamentos de proteção individual no mercado e aumento de sua vida útil. Sendo assim, o objetivo desta revisão foi discutir o processo de desparamentação, bem como a sua realização de forma correta, com base nos dados disponíveis na literatura.

Palavras-chave | COVID-19; equipamento de proteção individual; profissionais de saúde; saúde do trabalhador; exposição ocupacional.

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INTRODUCTION

Coronavirus disease 2019 (COVID-19), initially named 2019-n-CoV, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), appeared in the city of Wuhan, province of Hubei, People's Republic of China. It has spread across the world and was classified as a pandemic on March 11, 2020, by the World Health Organization (WHO).^{1,4}

The extent of COVID-19 infections follows an upward curve, and the WHO estimates that by July 21, 2020, 14,562,550 people had been infected and 607,781 deaths had been recorded worldwide.⁵ Brazil ranks second in the world in incidence of infections, after the United States, with a total of 2,159,654 cases, 81,487 deaths, mortality of 38.8 per 100 thousand population, and 1,465,970 recovered cases up to July 21, 2020.²

A major concern for all authorities during the pandemic is the rapid spread of COVID-19, caused by easy transmission. Because of the nature of their professional activity, which requires close contact with patients, front-line health care workers are at greater risk of contamination. For such reason, protective measures must be adopted to reduce the risk of contamination, and personal protective equipment (PPE) occupies a prominent position.⁶

Correct use of appropriate PPE is as important as its safe removal, since studies show that doffing is one of the most critical moments for worker contamination.^{7,8} Therefore, this review aims to discuss the process of doffing PPE and its correct sequence based on data available in the literature.

RISK OF HEALTH CARE WORKER CONTAMINATION

Health care workers are required to carry out their work activities in close contact with patients, especially those on the front line. Thus, the risk of contamination is high for them.⁹

A study conducted by Ye et al.¹⁰ demonstrated that a hospital environment can be contaminated during care for patients with COVID-19, and several items of daily use can become sources of virus spread, such as computers, handles, keyboards, PPE, and printers. In such cases, when contamination occurs in the

workplace and because of work activities, COVID-19 can be considered an occupational disease.

An occupational disease, or work-related disease, according to Brazilian Law no. 8,213 of July 24, 1991, is defined as a disease “contracted or triggered as a result of engagement in a particular work activity and included in the list prepared by the Brazilian Ministry of Labor and Social Security” [free translation].¹¹

It remains unknown to what extent constant exposure affects the health of workers, and the number of infected workers remains uncertain; however, the International Council of Nurses (ICN) gathered data from national associations and reported that around 90 thousand workers had been infected until the report was published on May 6, 2020.¹² According to the Brazilian Federal Nursing Council (Conselho Federal de Enfermagem, Cofen), 28,095 cases of COVID-19 had been reported among nursing workers, including 293 deaths due to COVID-19, in Brazil up to July 21, 2020.¹³

Therefore, health care workers, especially those on the front line to combat COVID-19, must strictly follow the established protocols and protective measures⁴ in an effort to reduce the risk of contamination, since contact with patients is often unavoidable. Within this context, use of PPE is recommended.

PPE

PPE, according to Brazilian Regulatory Standard no. 6, is defined as “any individual device or product used by the worker and designed to protect against risks that are likely to threaten health and safety at work” [free translation].¹⁴ In health care settings, especially during the pandemic, recommendation is to wear a gown, surgical mask, N95/PFF2 respirator or equivalent, goggles and/or face shield, cap, and gloves, according to the risk involved in each professional activity.¹⁵

Employers are responsible for providing appropriate PPE according to the risks of each professional activity, for guiding and training workers on proper use, storage, and conservation, as well as for providing replacement when equipment is damaged.¹⁴ However, there is a current lack of PPE because of high world demand, thus requiring a more rational use without jeopardizing the health of workers and their patients.¹⁶

It is worth noting that wearing PPE by itself does not provide workers with full protection, as correct positioning and good conditions of PPE are required. Also, the process of PPE removal, named doffing, is as important as its correct use.

THE RISK OF INCORRECT DOFFING

Wearing PPE and then doffing it correctly minimizes the chance of health care workers being contaminated by infectious diseases while they work and spreading pathogens.

During the Ebola outbreak, the importance of doffing became even more evident.¹⁷ Despite wearing the recommended PPE, two nurses in Texas, United States, were contaminated while they were treating a patient with Ebola in an intensive care unit, suggesting that contamination had occurred during the doffing sequence.¹⁸ Thus, North American health authorities intensified protective measures for workers treating patients with suspected Ebola and determined the use of N95/PFF2 respirators, instead of surgical masks, and face shields. They also recommended the presence of a trained observer to supervise each step of donning and doffing sequences.¹⁹

A study conducted by Tomas *et al.*²⁰ assessed the risk of infection during PPE removal using a bacteriophage MS2 (a nonpathogenic, nonenveloped RNA virus) together with a fluorescent lotion. For 2 weeks, employees from four hospitals were invited to participate in the study, which found that contamination was frequent during removal of gloves and gowns. Based on the results, training was provided and resulted in reduced contamination during doffing sequence.²⁰ This finding suggests that training focused on correct use and removal of PPE in health care settings can help reduce the risk of contamination and should be frequent.

Mitchell *et al.*²¹ assessed the behavior of health care workers who were treating patients with fever and respiratory symptoms. Regarding hand hygiene, 26% of workers performed it after removing their gloves, 46% after removing their gown, and 57% after removing their mask or eye protection. Regarding doffing sequence, only 54% of workers removed their PPE correctly.²¹

Cases of infection with Middle East respiratory syndrome virus in hospital settings accounted for more

than 40% of infections reported in Abu Dhabi, United Arab Emirates. Contamination generally occurred before patient diagnosis, and self-reported use of PPE among workers was contradictory.²²

A study conducted by Varia *et al.*²³ demonstrated how a single patient infected with SARS-CoV caused an outbreak in a hospital in Toronto, Canada. Of the infected patients, 36.7% were hospital employees, 14.1% were patients, 14.1% were visitors, and 29.6% were household contacts.²³

The risk of SARS-CoV-2 contamination during PPE removal also exists, since studies have demonstrated that high concentrations of viral RNA are present in PPE removal rooms.²⁴ Therefore, health care workers performing aerosol-generating procedures in patients with confirmed or suspected COVID-19 should be very careful to avoid contamination during PPE removal.⁶

The doffing sequence is so critical that international institutions, such as the Centers for Disease Control and Prevention (CDC), as well as national institutions, such as Cofen, have prepared guides for correctly donning and doffing PPE.^{19,25} However, it is extremely important that health care workers receive appropriate training, which is an employer responsibility.¹⁴

The CDC and Cofen recommendations for putting on PPE are as follows (Figure 1): 1) perform hand hygiene with soap and water or 70% alcohol solution; 2) put on gown and tie its straps on your back; 3) put on N95/PFF2 respirator or surgical mask; 4) put on goggles or face shield; 5) perform hand hygiene before putting on gloves; 6) put on gloves. Cofen also recommends the use of a cap in aerosol-generating procedures, which should be put on after goggles or face shield.

PPE removal, in turn, should follow this sequence: 1) remove gloves, being careful not to touch the front; 2) remove gown; 3) perform hand hygiene with soap and water or 70% alcohol solution; 4) remove goggles or face shield; 5) remove mask, not touching the front. When wearing a cap or mask, remove it after removing the gown.^{19,25}

FINAL CONSIDERATIONS

Even in critical periods such as that of the COVID-19 pandemic, health and safety of health care workers

must be prioritized and deserve due attention especially because of the high risk of infection inherent to their work activities. Therefore, it is of utmost importance that they have appropriate PPE available and that they are guided on its correct use, especially in relation to the doffing sequence, which is largely responsible for infections in workers.

Contamination of health care workers while carrying out their work activities is considered an occupational disease and, in addition to putting their families and other workers at risk, can impact the quality of

services, since their absence is necessary and may even culminate in their death.

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Figure 1. Sequence for putting on and taking off personal protective equipment (PPE).

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