SPECIAL ARTICLE

Cirujano General

April-June 2020
Vol. 42, no. 2 / p. 116-123

Personal protective equipment and COVID-19

Equipo de protección personal y COVID-19

Erick Servín-Torres,[*] Héctor Nava-Leyva,[‡] Ariadna Teresa Romero-García,[§] Francisco Javier Sánchez-González,[*] Gloria Huerta-García[‖]

Keywords:
Personal protective equipment, COVID-19, surgical masks, filtering respirators, elastomeric respirators, ocular protection, gowns, gloves.

Palabras clave:
Equipo de protección personal, COVID-19, mascarillas quirúrgicas, respiradores filtrantes, respiradores elastoméricos, protección ocular, overoles, guantes.

[*] General Surgery of the Hospital de Especialidades del Centro Médico Nacional La Raza, IMSS. Mexico City, Mexico.
[‡] General Surgery of the Infectious Diseases Hospital of the National Medical Center La Raza, IMSS. Mexico City, Mexico.
[§] General Surgery of the Hospital General de Zona Unidad de Medicina Familiar No. 1. La Paz, BCS.
[‖] Infectious Diseases, Hospital Ángeles Clínica Londres. Mexico City, Mexico.

Received: 06/15/2020
Accepted: 07/20/2020

ABSTRACT

Humans produce droplets and aerosols in various situations; transmission of the new SARS-CoV-2 virus is by inhalation and mucosal contact. A proper understanding of the equipment for the protection of healthcare personnel is indispensable. To provide adequate care to patients, it is essential to understand how the devices that make up the personal protective equipment prevent the entry of the virus into the body. It seems that airway protection is much better with respirators, either filtering or elastomeric with a minimum filtration rate of 95%, than with surgical masks, although the evidence is insufficient, and studies are underway to prove or disprove this. The care of the ocular mucosa plays a very important role in the transmission of the virus, so it is recommended the use of glasses or masks preferably airtight in case of being exposed to high aerosolization. Training in the use and removal of gloves and coveralls is essential to avoid contagion. It is concluded that the availability of adequate personal protective equipment is essential in the quality of care of patients with COVID-19.

RESUMEN

Los humanos producimos en diversas situaciones gotas y aerosoles, la transmisión del nuevo virus SARS-COV-2 está dada por inhalación y contacto con mucosas. La comprensión adecuada de cuál es el equipo para la protección del personal de salud es indispensable. Para brindar una atención adecuada a nuestros pacientes es fundamental el entendimiento de la manera en que los dispositivos que conforman el equipo de protección personal impiden la entrada del virus a nuestro organismo. Al parecer la protección de la vía aérea es mucho mejor con respiradores, ya sea filtrantes o elastoméricos con un mínimo de filtración de 95%, que con las mascarillas quirúrgicas, aunque la evidencia es insuficiente, hay estudios en marcha para demostrarlo o refutarlo. El cuidado de la mucosa ocular desempeña un papel muy importante en la transmisión del virus, por lo que es recomendable el uso de lentes o caretas de preferencia herméticos en caso de estar expuesto a alta aerosolización. La capacitación en la colocación y retiro de guantes y overoles es fundamental para evitar contagios. Se concluye que la disponibilidad de un adecuado equipo de protección personal es esencial en la calidad de atención de los pacientes con COVID-19.

INTRODUCTION

The concept of personal protective equipment (PPE) for the physician has a very ancient history; the objectives of protecting both the physician and the patient in the current context in which the WHO (World Health Organization) declared COVID-19 as of March 11 as a pandemic disease, healthcare workers are at high risk of infection, with an estimated 4.4 to 20% of those ill.[1]

The new SARS-CoV-2 coronavirus was identified in December in Wuhan province, China. It is a corona-like RNA virus. Transmission is thought to be predominantly by inhalation of droplets and aerosols; there is also transmission by contact with fomites contaminated with respiratory secretions and other body fluids such as feces, flatus, and saliva, whose role in transmission is not yet clear.

Transmission by virus-containing droplets (5-10 µm) and aerosols (smaller than 5 µm) occurs when the infected individual exhales, coughs, or sneezes. Traditional measures recommended to reduce such transmission are: 1. etiquette sneezing, 2. handkerchief sneezing, 3. keeping a

How to cite: Servín-Torres E, Nava-Leyva H, Romero-García AT, Sánchez-González FJ, Huerta-García G. Personal protective equipment and COVID-19. Cir Gen. 2020; 42 (2): 116-123.

certain distance, and 4. frequent hand washing. Unfortunately, a significant proportion of the spread of SARS-CoV-2 appears to be largely due to aerosols produced by the breathing and speech of asymptomatic individuals.

Humans produce droplets and aerosols in a variety of situations, and the relationship between various factors such as droplet size, gravity, inertia, evaporation and surface contamination and host susceptibility will determine contagion. It is suspected that the severity of the disease is directly related to the number of aerosols to which the person is exposed; and inversely, the smaller the size of the dispersing particle, the greater the probability of penetration into the lower airway.

The WHO recommendations for social distancing of 1 to 2 meters are based on studies carried out in 1930, in which it was shown that droplets fall to the ground by gravity, but these studies did not consider the effect of aerosols, mainly in closed places.[2]

It is difficult for health personnel to maintain a distance of more than one meter to carry out the examination and management of patients, especially if the patient is seriously ill, so this recommended distance cannot be the primary factor for their protection. So, for this high-risk group, there are special PPE recommendations.

A study conducted in China showed that infection of health care workers is directly related to the availability of adequate PPE. This study showed zero infections in a population of health care workers who used complete and adequate PPE.[3]

Despite the above, health care workers have had to face shortages of adequate protective equipment, lack of support from public health institutions, and overcrowded health services, which make them especially vulnerable to infection through both inadequate and excessive exposure.[4]

To prevent the spread of the SARS-CoV-2 virus among healthcare personnel, the following review of the evidence described to date on best practices in the use of PPE was carried out.

SURGICAL AND HYGIENIC MASKS

Home-made or hygienic masks are those recommended for the general population, their function is not to disseminate aerosols. They are the simplest and cheapest protective measures, and their use is not recommended in the clinical context of health personnel because there is no standard measuring their efficacy.[5]

Surgical masks are those that are proven to prevent the wearer from spreading bacteria. They are generally classified into three types depending on their quality which is measured in relation to bacterial filtration and splash resistance.[6]

They are used to reduce the possibility of surgical wound infections; they are designed to prevent the spread of bacteria that are present in the airway of the surgeon and the surgical team.

They are considered medical devices and the purpose of their design is not to protect the healthcare worker, but the surgical field so they are not considered personal protective equipment for healthcare personnel.

They are classified into three types depending on their bacterial filtration efficiency, for example, according to the European classification: type I with bacterial filtration of 95%, and type II with bacterial filtration of 98%, there is also a type II classification, some being splash resistant (IIR). In the United States they are classified with the same characteristics in levels I, II and III, the latter refers to the IIR of the European classification, according to the Centers for Disease Control and Prevention (CDC). There are few studies on their effectiveness in viral filtration.

In hospitals they are also used as a barrier measure, they are included in the standard precautions to protect the oral and nasal mucosa from splashes of blood or body fluids; another use is in droplet isolation (large droplets of more than 5 µm).

Surgical masks should not be confused with airway protection devices called filtering face masks, which are classified according to their ability to filter particles from the outside in. The classic example of these respirators is the N95 or KN95, which we will discuss later.

There is a study in which surgical masks vs. N95 respirators are compared in a medical context. This study describes the effectiveness to filter the entry of particles smaller than 5 µm, showing that the best surgical mask offers 75% protection compared to more than 95%

of an N95 respirator. Therefore, surgical masks cannot be considered as PPE for dealing with this SARS-CoV-2 pandemic.[7-9]

In cases of scarce resources, which could mean not having respirators or N95 filters, the CDC recommends the use of three-layer surgical masks that would fall into classification II or IIR in Spain and III in the USA, always remembering that their effectiveness is lost in less than 4 hours.

FILTERING RESPIRATORS

We will refer to them as filtering respirators to differentiate them from masks, although they are commonly known by that same name in our country. They differ from the medical or surgical masks described in the previous section in that the filtering is from the outside to the inside.

They are classified depending on the percentage of air filtered through them free of particles; there are studies that demonstrate the effectiveness depending on the size of such particles. The tests are performed with particles from 0.02 to 0.5 µm. These studies evaluate the adaptability to the face and mainly the airtight seal they produce; they also evaluate how the filtration efficiency remains during the usual movements of the face.[10]

National health institutions and some initial WHO announcements mention that there is no inferiority of medical-surgical masks with respect to N95 or equivalent respirators in situations where there is no airway manipulation, highlighting that some studies have not shown absolute advantage for respirators Although it is important to emphasize that these studies were conducted in the context of the influenza epidemic and in studies on adenovirus.[8]

Based on the results of a study conducted in Wuhan by Wang et al,[11] the CDC recommended that health professionals in contact with COVID-19 patients should have at least an N95 respirator during patient care, regardless of whether there was airway manipulation. It should be specified that training in the placement and even more so in the removal is very important, since inadequate technique is associated with a greater probability of contagion, and the recommendation for the use of these respirators is that it should not exceed eight hours.[12]

There is another trend that defends the superiority of respirators over surgical masks. The most recent meta-analysis states that according to the context compiled with similar diseases, such as SARS, and MERS, regarding the use of N95 respirators vs. surgical masks, there is a clear benefit in favor of the use of N95 respirators; however, there are two ongoing clinical trials that will surely provide much more information in this regard.[13]

The National Institute for Occupational Safety and Health (NIOSH) is responsible for certifying respirators in the United States (USA). N95 respirators provide respiratory protection against aerosols and splashes, and to avoid falsifications, an authorization number is given based on the test of the equipment, which appears on the mask with the initials TC. Other countries such as China, South Korea, Japan, and others in Europe have their own classifications and certifications *(Table 1)*.

Mexico according to its NOM-116-STPS-2009 uses the same classification of respirators as the United States giving class N for those that are not oil resistant, class R for those that are oil resistant, and P for those that are made for any particle.[14]

Table 1: List of countries with their respective registration and equivalents.[15,16]

USA (NIOSH)	Europe (EN)	China (GB)	South Korea (KMOEL)	Japan (JMHLW-2000)
Mexico (NOM-116-STPS-2009)				
N95	FFP2	KN95	KF94	DS/DL2
N99 and 100	FFP3	KN99 and 100		

ELASTOMERIC RESPIRATORS

Elastomeric half-mask or full facepiece respirators are made of synthetic or natural rubber, can be cleaned, disinfected, stored, and reused. They are alternatives to disposable filtering facepiece respirators. While elastomeric respirators are not FDA-cleared for fluid resistance, their NIOSH approval states that they can provide at least equivalent protection to an N95 filtering facepiece respirator.[17-19]

Some types of elastomeric respirators may offer greater protection than N95 respirators. They are equipped with replaceable filter cartridges or flexible filter cartridges, disc- or pancake-shaped (rectangular), which may or may not be housed in a cartridge body.

Because they are reusable, elastomeric particulate respirators provide an alternative respiratory protection option to N95 respirators. The disadvantage is that they require maintenance and a supply of replaceable components including straps, inhalation and exhalation valves, valve caps and filters, and cartridges.[20-22]

They have maintenance requirements that include cleaning and disinfection of facepiece components such as straps, valves, and valve cover. While it is often possible to decontaminate the outer casing of filters, the filter material cannot be cleaned and disinfected for reuse. Filter components should be discarded when they become damaged, soiled, or clogged.[23-25]

There are two types of elastomeric respirators: half mask and full mask. Precautions, limitations, and restrictions on use should be understood prior to use in health care. Full-mask respirators have the same filtering considerations but provide greater protection due to better face sealing characteristics and provide protection to the entire face.

In general, it is recommended that respirators be cleaned and disinfected immediately after removal to avoid contact transmission; precautions should be taken during removal and use. The materials from which the elastomeric components of NIOSH-approved respirators are made vary among manufacturers; consequently, recommended cleaning and disinfection solutions and procedures may also vary according to the manufacturer.

Companies provide limited time of use and other limitations or restrictions depending on the intended use of the respirator. The N-series (N-95) half-mask or 95% efficiency level filtering facepiece respirator has been determined to provide adequate protection in combination with other health care practice interventions such as hand washing, isolation, and physical distancing.

Filter cartridges should be removed from the facepiece prior to cleaning and disinfecting the elastomeric facepiece components. The facepiece components have basic steps for cleaning and disinfection: 1. Remove, 2. Clean, 3. Disinfect, 4. The order and details of each step are essential, and it is very important that respirators are thoroughly air-dried before storage.[26,27]

There is a study showing their systematic use in hospitals in the United States reporting 94% operational efficiency and a 10-fold decrease in costs compared to the use of filtering facepiece respirators, as well as ecological sustainability.[28]

Table 2 describes the scenarios in which respiratory protection devices are useful. They are classified into 1. surgical and home-made masks, 2. filtering facepieces (self-filtering) and 3. elastomeric respirators: industrial (elastomeric masks).

FACE AND EYE PROTECTION

According to the recommendations issued by the WHO, the PPE to be used by the surgeon is the one suggested for aerosol-generating activities, which includes eye protection with the use of glasses or face shield; however, the face shield can provide extra protection to the respirator, so its use is suggested without substituting the glasses.[30]

The recommended eye protection is the use of lenses that fit around the eyes, designed with plastic material such as polycarbonate so that they can be reused and are resistant to degradation that could be caused by disinfection; they should have a soft rim that adapts to the physiognomy of the user, fulfilling an airtight seal without indirect ventilation that could filter outside air into the interior; they should also have an anti-fogging coating and an elastic band that allows adjustment to the

user, compatible with the rest of the personal protective equipment.[30-32]

Frame lenses and contact lenses are not considered PPE. Care should be taken when putting on lenses, goggles, or protective glasses over them, as they can cause internal leaks and lead to fogging, and to ensure that even with the frame the protective lenses are correct before entering surgery with a COVID-19 positive patient.[33]

Personal protective eyewear should be placed on top of the coverall cap to prevent external splashes from falling under the hood as well as to fit the cap to the face and not cause leakage into the coverall; only if a full-face mask is used should it be placed under the coverall hood.[33]

Face protection such as face shields are intended to protect eyes, nose, and mouth from contamination by respiratory droplets, aerosols and splashes of secretions and body fluids. It is recommended that they offer coverage from the forehead to the chin including the lateral sides of the face. They are made of a reusable material such as plastic that is easy to disinfect, adapt to the physiognomy of the user and are comfortable to handle to avoid contamination of the surgical field when used; they offer extra protection to the disposable N95 or KN95 respirator to avoid splashes that could contaminate them.[30,34,35]

For disinfection, products that should be used are those identified as effective against the SARS-CoV-2 virus or authorized by the U.S. Environmental Protection Agency (EPA), which publishes a list of authorized disinfectants against this virus. The use of products containing alcohol or chlorine for disinfection is not recommended, as they degrade the anti-fogging product in most lenses.[36-38]

Strategies to optimize eye protection supplies should prioritize the fact that it is essential to have this resource in activities that generate aerosols or risk of splashes, as well as in those that take place in operating room areas. The use of their useful life should be extended according to the manufacturer's direct recommendations and reusable products should be considered.[30,32,34]

GLOVE WEARING

Regarding the use of gloves, the WHO recommends the use of two pairs of gloves in surgical procedures or activities that have a high risk of breakage.[32]

The composition of the gloves can be latex or nitrile; the advantage of nitrile is its resistance to degradation by the alcohol used for disinfection in the removal of protective equipment, but it has the disadvantage of being less flexible and of not being available in all health centers. The advantages of latex are that it is more flexible and adapts more easily to the user's physiognomy.[30,31]

It is suggested that the first pair be made of nitrile or latex and the second of sterile latex, and the appropriate size be available for the

Table 2: Types of masks and level of protection.[29]

Mask type	Division		Wearer protection	Patient protection
Surgical and home-made	Home-made		No	Yes
	Surgical	I, II y IIR	No	Yes
			Splashes	Yes
Filtering respirators	FFP1		No	Yes
	FFP2/N95	Without valve	Yes	Yes
		With valve	Yes	No
	FFP3/N100	With valve	Yes	No
Elastomeric (industrial)	Half face		Yes	No
	Full face		Yes	No

surgeon. Using different colors of gloves is a strategy that helps to identify more easily if there is any defect, at least one pair should cover more than the wrist, ideally up to the middle of the forearm, and if there is any doubt or evidence of breakage, the gloves should be changed immediately.[30,31] The use of different colors of gloves is a strategy that helps to identify more easily if there is any defect.[30,33,36]

PERSONAL PROTECTIVE CLOTHING

The international recommendations of both the WHO and the United States Centers for Disease Control and Prevention (CDC) dictate the use of protective clothing in aerosol-generating procedures, indicating the use of an impermeable surgical gown, which can be disposable or reusable, and in case it is not resistant to liquids, the use of a plastic apron underneath the gown.[30,33,39,40]

The CDC reports that there are no clinical studies to compare the efficacy of the use of waterproof surgical gown and the use of waterproof coveralls.[37,42]

The waterproof surgical gown should be resistant to liquid penetration with protection level 4 (resistant to liquids, liquid penetration with hydrostatic pressure, and resistant to virus penetration), have elastic or adjustment at the wrists, a length below the knees, completely cover the back of the user, be the correct size for the user and offer freedom of movement without compromising the integrity of the gown material. Its disadvantage is that it does not offer neck protection, but it can be used in conjunction with a disposable, waterproof scuba suit; it is not recommended to use extra protective equipment without proper training for donning and doffing.[33,41,42]

The coverall is a protective equipment that offers 360-degree coverage to the user. Some models can have a hood and boots included. It should be resistant to liquids and waterproof. Always the appropriate size that gives the user freedom of movement and does not compromise the integrity of the coverall in handling should be use; the closure should be covered by a flap and have elastic or adjustment at the wrists. Training is required in the placement and removal of this protective equipment to avoid contamination. Surgical areas that are not adequately ventilated may be hot, or the user may perceive a greater thermal sensation compared to other protective equipment. It is a good reusable option and should always be used with a sterile gown over it in surgical procedures.[33,41,42]

The WHO and the CDC establish strategies to optimize the supply of protective clothing during health crises, prioritizing the use of this resource in aerosol-generating activities, preferably reusable materials, trying to extend their useful life according to the manufacturer's direct recommendations, and in case of severe shortages, considering the use of a mixture of protective clothing such as reusable or cloth gowns, plastic aprons, sleeve covers, etc.[32,41]

There are clinical studies focused on proposing a third section of personal protective equipment for activities with production of super aerosols or high risk of aerosolization such as those involving manipulation of the patient's eyes, nose, mouth, and neck as well as endoscopic procedures; it is suggested the use personal protective clothing that offers full body coverage such as coveralls or a combination of gowns and skins.[40,42]

More clinical studies are still needed to identify the advantages of one type of personal protective equipment over another, specifically in the treatment of patients infected by the SARS-CoV-2 virus. Learning to use protective equipment correctly and choosing the appropriate components according to the physiognomy of the user is an essential activity for health care personnel, and training in the application and removal of protective equipment continues to be a fundamental part of preventing contagion among health care personnel.

REFERENCES

1. Friese CR, Veenema TG, Johnson JS, Jayaraman S, Chang JC, Clever LH. Respiratory protection considerations for healthcare workers during the COVID-19 pandemic. Health Secur. 2020; 18: 237-240.
2. Prather KA, Wang CC, Schooley RT. Reducing transmission of SARS-CoV-2. Science. 2020; 368: 1422-1424.
3. Wang W, Min YZ, Yang CM, Hong HO, Xue T, Gao Y, et al. Association of personal protective equipment

use with successful protection against COVID-19 infection among health care workers. medRxiv. 2020. doi: https://doi.org/10.1101/2020.04.24.20070169.
4. Delgado D, Wyss Quintana F, Perez G, et al. Personal safety during the COVID-19 pandemic: realities and perspectives of healthcare workers in Latin America. Int J Environ Res Public Health. 2020; 17: 2798.
5. Sipahi H, Esra F, Sezin S, Bayram D, Aydin A. Investigation of the biocompatibility of surgical masks. Pteridines. 2018; 29: 80-86.
6. Norma Europea UNE-EN 14683:2019 + AC.
7. Lepelletier D, Grandbastien B, Romano-Bertrand S, et al. What face mask for what use in the context of COVID-19 pandemic? The French guidelines. J Hosp Infect. 2020; 105: 414-418. doi: 10.1016/j.jhin.2020.04.036.
8. Vázquez-Vizoso F, García García J, Abraira García L, del Campo Pérez V. Uso se mascarillas quirúrgicas y máscaras FFP en las precauciones de aislamiento de los centros sanitarios. Guías de la SOGAMP. 2015.
9. Mueller A, Fernandez L. Assessment of fabric masks as alternatives to standard surgical masks in terms of particle filtration efficiency. medRxiv. 2020. doi: https://doi.org/10.1101/2020.04.17.20069567.
10. Bartoszko JJ, Farooqi MAM, Alhazzani W, Loeb M. Medical masks vs N95 respirators for preventing COVID-19 in healthcare workers: a systematic review and meta-analysis of randomized trials. Influenza Other Respir Viruses. 2020; 14: 365-373.
11. Wang X, Pan Z, Cheng Z. Association between 2019-nCoV transmission and N95 respirator use. medRxiv. 2020 [Epub ahead of print]. [Accessed March 29, 2020]. Available at: https://doi.org/10.1101/2020.02.18.20021881.
12. Radonovich LJ. Respirator tolerance in health care workers. JAMA. 2009; 301: 36-38.
13. Chu DK, Akl EA, Duda S, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. Lancet. 2020; 395: 1973-1987. doi: 10.1016/S0140-6736(20)31142-9
14. NOM-116-STPS-2009. Seguridad-equipo de protección personal-respiradores purificadores de aire de presión negativa contra partículas nocivas-especificaciones y métodos de prueba.
15. US Department of labor issues guidance for respirators certified under other countries standards during COVID-19 pandemic. OSHA national news release. 2020. Departamento del Trabajo de Estados Unidos. www.osha.gov/newsreleases/national/04032020-0
16. https://www.cdc.gov/spanish/niosh/docs/2013-138_sp/default.html
17. OSHA (Standards-29 CFR). Occupational Safety and Health Standards. Available from: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=12716&p_table=standardsexternalicon
18. WHO. Infection prevention and control of epidemic- and pandemic prone acute respiratory infections in health care. 2014. Available from: https://www.who.int/csr/bioriskreduction/infection_control/publication/en/external icon
19. CDC. Coronavirus disease 2019 (COVID-19): FAQ about PPE. 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirator-use-faq.html
20. CDC. Coronavirus disease 2019 (COVID-19): Optimize PPE supply. 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/index.html
21. 3M. Respiratory protection for airborne exposures to biohazards. 2020. Available from: https://multimedia.3m.com/mws/media/409903O/respiratory-protection-against-biohazards.pdfpdf iconexternal icon
22. Moldex. 7000 Series Reusable Half Mask Respirator. Available from: https://www.moldex.com/product/7000-series-half-mask-respirator/external icon
23. OSHA. Temporary enforcement guidance – healthcare respiratory protection annual fit-testing for N95 filtering facepieces during the COVID-19 outbreak. 2020. Available at: https://www.osha.gov/memos/2020-03-14/temporary-enforcement-guidance-healthcare-respiratory-protection-annual-fitexternal icon
24. NIOSH. NIOSH guide to the selection and use of particulate respirators (Certified Under 42 CFR 84). U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, DHHS (NIOSH) Publication 96-10. 1996. https://www.cdc.gov/niosh/docs/96-101/default.html
25. Pompeii LA, Kraft CS, Brownsword EA, et al. Training and fit testing of health care personnel for reusable elastomeric half-mask respirators compared with disposable N95 respirators. JAMA. 2020; 323: 1849-1852. doi: 10.1001/jama.2020.4806.
26. Bessesen MT, Adams JC, Radonovich L, Anderson J. Disinfection of reusable elastomeric respirators by health care workers: a feasibility study and development of standard operating procedures. Am J Infect Control. 2015; 43: 629-634.
27. CDC. Coronoavirus disease 2019 (COVID-19): decontamination and reuse of filtering facepiece respirators. 2020. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/decontamination-reuse-respirators.html
28. Chalikonda S, Waltenbaugh H, Angelilli S, et al. Implementation of an elastomeric mask program as a strategy to eliminate disposable N95 mask use and resterilization: results from a large academic medical center. J Am Coll Surg. 2020; S1072-7515(20)30471-3.
29. Stewart CL, Thornblade LW, Diamond DJ, Fong Y, Melstrom LG. Personal protective equipment and COVID-19: a review for surgeons. Ann Surg. 2020; 10.1097/SLA.0000000000003991.
30. OMS. Requerimientos de uso EPP para el nuevo coronavirus en establecimientos de salud. 2019. Disponible en: https://iris.paho.org/bitstream/handle/10665.2/51976/OPSPHEIHMCovid1920003_spa.pdf?sequence=1&isAllowed=y
31. American College of Surgeons. COVID-19: Consideraciones para la protección óptima de los cirujanos antes, durante y después de los procedimientos. 2020. Disponible en: https://www.facs.org/covid-19/clinical-guidance/surgeon-protection/proteccion-optima#uso
32. Organización Mundial de la Salud. Uso racional del equipo de protección personal frente al COVID-19 y aspectos a considerar en situaciones de escasez

grave. 2020. Disponible en: https://apps.who.int/iris/bitstream/handle/10665/331810/WHO-2019-nCoV-IPC_PPE_use-2020.3-spa.pdf
33. European Centre for Disease Prevention and Control. Safe use of personal protective equipment in the treatment of infectious diseases of high consequence. December 2014. Available in: https://www.ecdc.europa.eu/en/publications-data/safe-use-personal-protective-equipment-treatment-infectious-diseases-high
34. CDC. Strategies for optimizing the supply of eye protection. Coronavirus disease 2019. 2020. Available in: https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/eye-protection.html
35. CDC Strategies of optimizing the supply of facemask. Coronavirus disease 2019. 2020. Available in: https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/face-masks.html
36. List N. Disinfectants for use against SARS-CoV-2 (COVID-19). Available in: https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2-covid-19
37. CDC. Personal protective equipment: questions and answers. Coronavirus Disease COVID-19. 2020. Available in: https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirator-use-faq.html
38. Public Health England. Considerations for acute personal protective equipment (PPE) shortages. 21 Mayo 2020. Available in: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/managing-shortages-in-personal-protective-equipment-ppe
39. Public Health England. COVID-19 Personal protective equipment (PPE). 21 mayo 2020. Available in: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/covid-19-personal-protective-equipment-ppe
40. Lockhart SL, Duggan LV, Wax RS, Saad S, Grocott HP. Personal protective equipment (PPE) for both anesthesiologists and other airway managers: principles and practice during the COVID-19 pandemic. Can J Anaesth. 2020; 67: 1005-1015.
41. CDC. Strategies for optimizing the supply isolation gowns. Coronavirus Disease 2019. 2020. Available in: https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/isolation-gowns.html
42. CDC. Considerations for selecting protective clothing used in healthcare for protection against microorganisms in blood and body fluids. The National Personal Protective Technology Laboratory (NPPTL). Available in: https://www.cdc.gov/niosh/npptl/topics/protectiveclothing/

Ethical considerations and responsibility: Data privacy. In accordance with the protocols established at the authors' work center, the authors declare that they have followed the protocols on patient data privacy while preserving their anonymity. The informed consent of the patient referred to in the article is in the possession of the author.

Funding: No financial support was received for this study.

Disclosure: The authors declare that there is no conflict of interest in this study.

Correspondence:
Erick Servín-Torres
Hospital Ángeles Clínica Londres
Torre Frontera
Frontera Núm. 74, consultorio 520,
Col. Roma Norte, 06700,
Alcaldía Cuauhtémoc, CDMX.
E-mail: drerickservin@gmail.com