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The importance of reducing the viral load to diminish the risk of COVID-19 spread

La importancia de reducir la carga viral para disminuir el riesgo de contagio por COVID-19

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ABSTRACT

We carried out a systematic review on the importance of reducing viral load, as a strategy to reduce the risk of infection or to diminish the severity of the disease. We selected 113 publications and analyzed the theoretical concepts and recommendations we made with the best medical evidence available. Viral load is related to the attack rate and severity of COVID-19. It has been recognized that the production of aerosols is the main source of contagion among health personnel. The risk of contagion is higher in closed and poorly ventilated spaces, where people stay with several individuals for a long time, without due distance and without protection. The contagion rate is higher than 80% and there is a very high mortality. Another source of super spread occurs among health personnel who have to care for COVID patients for long periods of time, and inhale their respiratory secretions, without having appropriate protective equipment. Surgeons and other professionals have to attend the public: unknown people who may be carriers of the virus; therefore, are exposed to contagion. The main preventive protection that will help us reduce the viral load is: the widespread use of masks, eye protection, distancing, hand hygiene and sanitation of the environment. Even though there is a lack of evidence regarding their effectiveness, these should be used for precaution and must be compulsory and universal.

RESUMEN

Realizamos una revisión sistemática sobre la importancia de disminuir la carga viral como una estrategia para reducir el riesgo de contagio o para minimizar la severidad de la enfermedad. Seleccionamos 113 publicaciones, analizamos los conceptos teóricos y realizamos las recomendaciones con la mejor evidencia médica disponible. La carga viral está relacionada con la tasa de ataque y severidad del COVID-19. Se ha reconocido que la producción de aerosoles es la principal fuente de contagio entre el personal sanitario. El riesgo de contagio es más alto en espacios cerrados y mal ventilados donde se convive con varias personas por mucho tiempo sin el debido distanciamiento y sin protección. La tasa de contagio es mayor a 80% y la mortalidad es muy alta. Otra fuente de contagio alto se da entre el personal sanitario que tiene que atender pacientes COVID por largos períodos de tiempo, y aspiran sus secreciones respiratorias sin contar con el equipo de protección adecuado. Los cirujanos y otros profesionales tienen que atender al público: personas desconocidas que pueden ser portadoras del virus, por lo que están expuestos al contagio. Los principales cuidados preventivos que ayudarán a disminuir la carga viral son: el uso generalizado de mascarillas, protección ocular, distanciamiento, higiene de las manos y desinfección del ambiente. Aunque faltan evidencias de su efectividad, estos cuidados deben aplicarse por precaución y ser obligatorios y universales.

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OBJECTIVE

The COVID-19 pandemic will linger for a long time. Despite the risk of infection, we have returned to our activities, which must be done in a responsible and safe way. Some actions, carried out without adequate care will increase the risk of contagion. The objective of this work is to elaborate safety recommendations for plastic surgeons, which can also be used by other professionals who have to serve the general public and who are exposed to contagion by COVID-19. In order to reduce the viral load and, by doing so, reduce the risk of contagion or acquiring the disease, whether in its mild or asymptomatic form. The recommendations are based on the best available medical evidence and under the principle of precaution.

METHODOLOGY

We carried out a systematic review in Spanish and English, in the following information sites: PubMed, Embase, Cochrane, Medline, Fisterra, Medigraphic and Scholar Google. The keywords that we used in Spanish were: SARS-CoV-2, COVID-19 Viral load, contagion, prophylactic care, face masks, face respirators, distancing, eye protection, personal protective equipment, hand washing and environmental sanitation. We made basic questions related to the topic, we searched for the best available medical evidence to answer each question and we reached a consensus of a group of experienced surgeons. With the data obtained, we provided preventive recommendations for health personnel and patients and some infographics as quick, simple guides, but with enough information to allow the surgeon to reduce the viral load and reduce the risk of contagion.

FINDINGS

In PubMed we found 6,334 publications on viral load and COVID-19 and in Scholar Google: 23,700. We selected 113 articles that answered the questions we asked. We found 3 meta-analyzes (level of evidence I), 4 systematic reviews (level of evidence I and II), 2 prospective cohort studies (level of evidence II), 2 case reports (level of evidence IV), 3 guidelines or medical manuals (level of evidence IV) and 99 simple reviews or opinions (level of evidence V). One of the publications was carried out by the Cochrane group.

What is viral load and what is the use of quantifying it?

The amount of viral particles in the plasma and patient's respiratory secretions or excreta have been called viral load. It is calculated by estimating the amount of viral particles in body fluids.[1] The quantification of the viral load is very useful to evaluate the severity of the infection, to predict the evolution of viral infections and their relapses. It helps to assess the result of the treatment, to determine if the load increases or remains, or if the treatment has not been effective.[2] Quantification can be performed by different means. The simplest and most accessible is by quantitative PCR, which allows the detection of minimal viral loads in the blood and is more sensitive than qualitative PCR taken from exudate in the pharynx. The qualitative PCR test detects over 200 virus copies per milliliter, the quantitative one detects 20 virus copies per milliliter; hence, it is 10 times more sensitive.[1-3]

What is the relationship between viral load and severity of COVID-19?

There is evidence that SARS-CoV-2 can be easily transmissible in an early stage of infection and in asymptomatic patients, which suggests a high viral load at this stage. Asymptomatic cases are more frequent in children.[4-6]

In a study, determination of viral load in sputum and feces was performed in 96 patients, where the maximum viral spread was found between 10 and 12 days and the duration was 18 days. The most severe cases had a higher viral load. In samples from the upper respiratory tract, a higher load was found in the initial stages of the disease. In the lower tract samples, numbers were high up to 14 days. In feces, the time span was longer than in the respiratory tract. Feces can be an important vector of contagion, the importance of managing feces to avoid contagion is emphasized. In the patients' plasma, the virus was found in up to 59% of the cases. The load

was high even after the virus was no longer found in the respiratory tract. The virus was rarely found in urine. The application of steroids was related to a longer time of viral presence. Duration is longer in men than in women; so, the effect of hormones could be related. In patients over 60 years old, the permanence of the virus is longer, probably due to an immune deficit, characteristic of that age and due to higher levels of angiotensin-converting enzyme 2 in the alveoli, which is supposed to be a receptor for the different coronavirus.[7]

In recent studies, it was found that viral loads in severe cases were up to 60 times higher than in mild cases.[2] In the group of asymptomatic individuals, the average contagion time was 19 days, less than the symptomatic group ($p = 0.02$). The IgG of asymptomatic patients was 3.4 vs 20.5 in the symptomatic group ($p = 0.005$). Cytokines were lower in asymptomatic patients.[8]

During the course of infection, the virus has been identified in respiratory tract samples 1 to 2 days before symptoms appear and persists up to 2 weeks in severe cases.[9] Viral RNA shedding has also been detected in feces, pharyngeal exudate, blood, plasma, saliva, and urine, from 5 days on after the onset of symptoms and up to 4 to 5 weeks.[7,9-13]

Elimination of viral RNA is not equivalent to infectivity, but rather to the time that affected people continues to release viral particles.[2]

How do we get it?

A source of contagion of COVID-19 is by being close a symptomatic patient and in so coexisting without proper care; however, the most frequent cause is being with asymptomatic or pre-symptomatic people; since the disease is not obvious, there is a tendency to greater neglect with a greater risk.[5,13-19]

It is not known for sure how many viruses it takes for someone to become infected. Recent studies offer some clues. Results from a research recently published in *Nature*, scientists affirm that they could not cultivate the coronavirus alive if the swab or sputum of a patient contained less than one million copies of viral RNA; therefore, a higher quantity is necessary to be infectious; however, the virus is highly contagious under suitable conditions in the environment and a susceptible host is required. Ten percent of positive cases infect 80% of new cases; that is, one patient infects 8 people. The attack rate is highly variable and has yet to be defined; some patients infect many, while others do not.[8-11]

The proportion of asymptomatic people is a useful number to measure the true load of the disease and to interpret estimates of the potential for transmission better.[1] This proportion varies widely among infectious diseases, from 8% for measles, 32% for coronavirus infections, up to 90-95% for polio.[5-7] It is estimated that the percentage of asymptomatic individuals for SARS-CoV-2 should be greater than 80%.[9-12]

It is reported that transmission can be direct being in close contact, less than 1 meter with an infected patient producing small respiratory specks with a high viral load. in these circumstances, the particles are inhaled and deposited on the mucous. Another means is indirect transmission by fomites: the drops expelled by patients, deposited on surfaces or objects, from hours to days, depending on the material. When a person touches these fomites and then touches his or her face, he/she risks being infected. Another means of transmission is by air. Some actions can produce aerosols, with droplets with a diameter < 5 μm, which can remain in the air for long periods of time and reach people more than one meter away. Some aerosol generating procedures include: nebulizing with medication, endotracheal intubation, open suctioning, bronchoscopy, manual ventilation before intubation, turning the patient to the prone position, disconnecting the patient from a ventilator, non-invasive positive pressure ventilation, tracheostomy management, cardiopulmonary resuscitation, sputum induction techniques.[19-25]

Smoke from surgical procedures

Surgeons and operating room personnel are constantly exposed to smoke generated by the thermal destruction of tissues. The smoke generated represents a chemical and biological hazard: 1 g of flared tissue is equivalent to 6 cigarettes.[26] Abdominoplasty is the plastic surgery procedure that generates the most particles: up to 3,900 particles/cm^3 can be

produced, while in a hip replacement 400/cm^3 are produced; a large amount is also produced during breast reduction surgery.[27] Hepatitis and HIV viruses have been found in surgical smoke.[28,29] The size of the particles in the smoke range from 0.05 to more than 25 microns. The Hepatitis B virus measures 0.042 microns,[27] the HIV virus measures 0.1 to 0.12 microns[27] and the coronavirus measures 0.1 to 0.16 microns.[30] Face masks filter particles larger than 5 microns, being ineffective even when used correctly.[29,31] The SARS-CoV-2 virus could be present in surgical smoke and be transmitted by inhalation. There are no documented cases concerning this means of transmission. The operating room staff must take this liability into consideration and be properly protected from the effect of smoke and avoid the formation of aerosols by reducing the use of energy generating devices.[30-32]

What is the means of highest transmission of SARS-CoV-2 infection?

Many researchers maintain that it is rare to get coronavirus by coming into contact with a contaminated surface, as well as during a fleeting encounter with people who are infected. Contact with a patient's respiratory droplets and their aerosol effect have been identified as the main mode of transmission of COVID-19. Droplets smaller than 5 microns can remain in the air for a long time and be inhaled and deposited in the pulmonary alveoli; while large drops fall to the ground and quickly dry up. Poor ventilation systems in closed spaces make the viruses suspended in the air recirculate increasing the risk of contagion. The most common circumstances for infections would be face-to-face encounters and interactions among people for long periods of time.[19-22]

What is a super contagion?

The COVID attack rate is higher in closed and poorly ventilated spaces, where one stays with several people for a long time, without due distancing and without protection. Most of the time, the fact that one of them is already sick with COVID is ignored; besides, those are places where people speak loudly or sing. It has been estimated that speaking out loud for a minute generates at least *a thousand droplets with viral particles*, which could stay up to 8 minutes in the air. This set of conditions has been called super contagion and has appeared in members of musical choirs in churches, in people who go to restaurants or travel by bus or participate in parties; with a contagion rate higher than 80% and a very high mortality; whereas, the percentage of contagion is very low: from 4 to 19% in relatives of COVID patients who have been isolated and have used personal protection care during the disease.[19-22]

Another source of super contagion occurs with healthcare personnel who have to attend COVID patients for long periods of time, inhale their respiratory secretions and who do not have appropriate personal protective equipment. The attack rate of COVID-19 among health personnel was very high at the beginning of the pandemic; however, with improved care and exhaustive use of PPE, cases were considerably reduced.[20-22,33]

What is the risk of contagion in healthcare personnel?

Health personnel who carry out their work without adequate protection, are 3 times at a higher risk of contagion and it increases up to 5 times more when they are first-line health staff, who care for patients with COVID.

The risk also increases in the black community, Asians or ethnic minorities and with underlynig health risk.[33]

When should we consider that a person is a suspect case of disease?

All patients should be considered suspect cases of disease, until the disease is ruled out. They must be treated with extreme security protocols. There are many asymptomatic or presymptomatic patients who are unknowingly spreading viruses and exposing other patients and healthcare personnel to the risk of infection.[19-22,34-38]

How can we reduce the viral load?

During the pandemic, activities that involve an interpersonal relationship require effective regulations to avoid the spread of COVID-19.

Different health organizations and the consensus of various specialists have issued action protocols, in order to reduce infections. Work activities can be resumed if distinct mechanisms are implemented to prevent massive infections in the population, establishing strategies for viral containment, such as: to use face masks as a mandatory requirement, implement good ventilation systems, keep windows open, sanitize work rooms by physical or chemical means, reduce meetings in closed spaces, limit the use of public transport and elevators, prohibit hugs, handshakes and fist bumps, use plastic partitions walls between desks, keep a distance between workers of at least 1.8 meters and perform serial tests on personnel.[39-41]

What is the importance of using face masks, distancing and eye protection to reduce infections?

The widespread use of masks by the general population can serve to reduce community transmission of the coronavirus; since the excretion of respiratory droplets from infected individuals, who have not yet developed symptoms or who remain asymptomatic, is reduced. The use of masks in the community is indicated mainly in crowded places, closed spaces or when using public transport. The use of masks in the community should be considered as a complementary measure and not as a replacement for the other established preventive measures; such as: hand hygiene.[42,43]

The use of facial masks reduces the inoculum of the virus, which causes a milder and asymptomatic infection. It is useful for the population that has to stay in closed environments (for example: cruise ships, offices and work places). Asymptomatic infections can be detrimental for spread, but could actually be beneficial if they lead to higher rates of controlled exposure, without the unacceptable consequences of serious illness, which could lead to increased immunity in the community, with slower dissemination. Some masks have a viral containment effect or decrease its flow with a lower virus load, without reaching the LD50. There is a marked increase in mild or asymptomatic infection in populations that have opted for the generalized use of face masks.[44]

During patients' breathing or coughing or sneezing, particles of different sizes are expelled. Those that measure between 60 to 100 microns, fall to the floor. The smallest respiratory droplets form aerosols that contain large amounts of particles smaller than 5 microns; can reach distances between 7 and 8 meters and remain in the air for a long time. Being so small, they can be inhaled and deposited in the pulmonary alveoli, producing the disease. This mechanism explains one of the mechanisms of super contagion. The use of surgical masks is not enough to contain the virus. The use of respirators with a viral containment filter is required. Respirators can contain up to 97% of aerosol particles and reduce the risk of contagion. To prevent shortages, the World Health Organization and the United States Centers for Disease Control and Prevention (CDC) recommend that the public wear cloth masks and leave surgical masks and N95 masks or similar ones for the exclusive use of healthcare personnel.[45-53]

In the current COVID pandemic, contradictory advice has been given on care to prevent contagion. The biggest controversies are with the use of masks by the community and distancing. Masks have been used for decades for infection prevention, at present facing challenges amid scarcity and ignorance. Recommendations should be based on the best evidence available, many of them stem from other respiratory viral infections, but a comprehensive review of information on SARS-CoV-2 is not accessible.[54-72]

Surgical masks. A surgical mask is defined as a disposable device that is intended to create a physical barrier between the user's mouth and nose and possible contaminants in the immediate environment. These devices are intended to protect the user against splashes of bodily fluids generated during medical care procedures, and do not provide any type of respiratory protection, since they do not create a seal on the user's face.[67-73]

These devices are regulated by the Food and Drug Administration (FDA) and by the different ASTM standards (F2100, F2101, F2299, and F1862) in the United States of North America. These rules determine the quality and efficiency of masks and require performance evaluations

of the following parameters: fluid resistance, bacterial and particulate filtration efficiency, flammability and biocompatibility. Bacterial Filtration Efficiency is performed with a test aerosol of approximately 3.0 μm ± 0.3 μm, and is commonly confused with the particle filtration efficiency with which respiratory protection equipment is approved.[74]

Cloth masks. To avoids the shortage of surgical masks or the N95, the CDC (Centers of Disease Control and Prevention of United States of America) and the WHO have recommended cloth masks for use by the general public. The cloth mask catches the droplets that measure between 5 and 10 microns, which are released when the person wearing it: talks, coughs, or sneezes. When it is widely used in public places, they can help reduce the transmission of the virus. Countries that have accepted the use of masks, along with other measures; such as: screening tests, isolation, and physical distancing early in the course of the pandemic, have been successful in reducing the transmission of the virus. They can be made from plain materials, such as: tightly spun cotton sheets. It is easy to find instructions on the Internet to make them; cloth masks should be multi-layered. The CDC website includes instructions for making cloth masks.[42-45,65,66]

Respiratory protection equipment (respirators). A respirator is defined as personal protective equipment that purifies or supplies air to protect the user's respiratory tract from contaminants found in the work environment. Respirators can be classified as: negative or positive pressure air purifiers and air supplied with positive or negative pressure line systems. These devices are designed to provide protection against any pollutant dispersed in the environment, provided they have been selected according to the danger present in the environment, and on condition that the user uses them correctly and consistently during the entire time that he/she remains in the workplace.[67-78]

Health authorities worldwide suggest the use of N95 respirators or their equivalents for health care professionals who are in contact with people who have been confirmed with the SARS-CoV-2 virus (COVID-19), especially in those procedures in which the generation of aerosols is produced. It has been recommended to dispose of respirators, once their life span is over, normally a working day.[65-78]

In the United States of America, the National Institute for Occupational Safety and Health (NIOSH) through standard 42 CFR 84 established the guidelines for the approval of respirators. According to this standard, NIOSH classifies particulate respirators in different classes, according to the type of filtering medium, and filtration efficiency *(Tables 1 and 2)*.[67-78]

Respiratory protective equipment can be decontaminated by some methods approved by the FDA. This authorization is valid only during the declaration of sanitary emergency. For a decontamination method to be approved by the FDA, the following conditions should be met:[78]

- To inactivate the SARS-CoV-2 virus effectively.
- Not to damage the filter medium or any element of the respirator (nose clip, adjusting bands).
- Not to alter the fit provided by a disposable respirator.
- That the selected method does not represent a risk to the user of respirators.

Table 1: Classification of respirators according to the percentage of filtration and the type of particles (NIOSH).

Filtration efficiency (%)	N Does not resist oil sprays	R Partially resistant to oil sprays	P Oil aerosol proof
95.00	N95	R95	P95
99.00	N99	R99	P99
99.97	N100	R100	P100

Table 2: Some equivalents of N95 respirators.

Certification class (standard)	N95 NIOSH 42CFR84 USA:	N95 STPS NOM-116-STPS MEX	FFP2 EN-149 2001 UE	KN95 GB2626 2006 China	P2 AS/NZ 1716:2012 AUS NZ	1st Class KMOEL-2017-64 Korea	DS Japan JMHLW, Notification 214, 2018
Filter performance (%)	≥ 95	≥ 95	≥ 94	≥ 95	≥ 94	≥ 94	≥ 95
Test agent	NaCl	NaCl	NaCl Paraffin oil	NaCl	NaCl	NaCl Paraffin oil	NaCl
Test flow (L/min)	85	85	95	85	95	95	85

N95 masks. They are a type of respirator that offers more protection than a surgical mask because they can filter both large and small particles. As its name implies, the mask is designed to block 95% of small particles. Some N95 masks have valves that make it easier to breathe through them, as the valve releases unfiltered air. This type of mask does not prevent the person wearing it from transmitting the virus. For this reason, some places prohibit wearing them. Like surgical masks, N95s are intended to be disposable, but researchers are carrying out tests to find ways to disinfect the masks so they can be reused.[65,66]

In a meta analysis, they found that virus transmission was lower when the physical distance was larger than 1 meter; the risk decreases 2.02 times for each extra meter of distance ($p = 0.041$). NK95 or similar masks reduce the risk of infection by 14.3% compared to surgical masks ($p = 0.09$). Eye protection was also associated with less infection (10.6%); robust randomized trials are needed. In the light of inconsistent guidelines from various organizations based on limited information, the findings provide some clarification.[65,66]

What is the importance of hand hygiene to prevent COVID-19?

The SARS-CoV-2 virus is an encapsulated virus, with a membrane made up of lipids and glycoproteins. The outer layer allows them to identify and bind to receptor sites on the host cell membrane, to fuse with it and facilitate the entry to the cell, where it will reproduce. Encapsulated viruses are less stable and highly susceptible to soap action.[53-66,79-85]

Hand hygiene is considered one of the most effective means to avoid the spread of germs and to prevent the spread of COVID-19, especially after having been in public spaces or means of transport and having touched people and/or surfaces or objects, or after blowing one's nose, coughing, or sneezing. Organizations such as WHO, PAHO and the CDC recommend frequent hand washing with soap and water; or, if this is not possible, using an alcohol based hand sanitizer.[53-66,79-85]

Using soap to wash your hands is more effective than using plain water because the surfactants in soap remove dirt and microorganisms from the skin. In addition to this, it is considered that people tend to scrub their hands more thoroughly when using soap, which eliminates germs. Clean running water should be used for hand washing, as hands can become contaminated again if we use stagnant or recycled water. The CDC does not recommend the use of germicidal soaps, as they do not offer greater benefit.[53-66,79-85]

Hygienic treatment of the hands with antiseptics or alcohol based disinfectants at a concentration of 60 to 85% provides an additional benefit to washing with soap and running water and can be very useful in situations where there is no running water and soap. These alcohol products can quickly reduce bacteria, fungi, yeast, mycobacteria, and viruses. It is important to be aware that if the hands are dirty or greasy, they should be washed with soap and water before using the

antiseptic, as dirt can significantly reduce the action of the product.[53-66,79-85]

What is the importance of cleaning (sanitizing) and disinfection of public spaces?

Cleaning and disinfection are an important part of reopening public spaces and require meticulous planning. Frequent cleaning with soap and water will reduce the amount of virus on surfaces and objects that people often touch; disinfection will help their elimination. These precautions reduce the risk of exposure. Viruses that are found on surfaces and objects die naturally after hours or days; heat, ventilation and sunlight greatly reduce survival time.[53-66,79-85]

Evaluating the workplace, school, home or company is recommended to determine what types of surfaces and materials are present in that area. Most surfaces and objects will only need regular routine cleaning. Frequently touched surfaces and objects; such as: light switches and door handles should be cleaned and then disinfected to reduce the presence of germs on surfaces and objects further. If your workplace, school or business has been unoccupied for 7 days or more, it will only take a normal routine cleaning to reopen the area. This is because the virus that causes COVID-19 has not been shown to survive on surfaces longer than this time.[53-66,79-85]

Disinfectants help eliminate germs from surfaces. They are not a substitute for soap. If sanitizers are scarce, 1/3 cup of chlorine bleach diluted in 1 gallon of water or 70% alcohol solutions can be used. Chlorine bleach solutions will be effective for disinfecting for up to 24 hours. Store and use disinfectants responsibly and properly, as indicated on the label. Do not waste or stockpile disinfectants or other supplies. This can lead to a shortage of products that other people need to use in critical situations. Do not mix chlorine bleach with other cleaning and sanitizing products, which can cause very dangerous fumes. Keep all disinfectants out of children's reach.[53-66,79-85]

Some contaminated items (fomites) can be moved or removed, to reduce handling or contact. Soft, porous materials, such as: carpets and seats can be removed or put away so they don't have to be cleaned and disinfected. Carpets and rugs are not easy to disinfect. If you need to keep them, they should be washed in the washing machine, following the instructions on the item's label and with the highest possible water temperature setting, dry with heat or expose them to sunlight.[53-66,79-85]

Outdoor areas generally require normal routine cleaning and do not need to be disinfected. Spraying disinfectant on sidewalks and parks is not an efficient use of disinfectants and has not been proven to reduce the public's risk of contracting COVID-19. There is no evidence that the virus that causes COVID-19 can spread directly to humans from the water in swimming pools, hot tubs or spas, or water games areas. Proper use, maintenance, and disinfection (for example, with chlorine or bromine) should kill the virus that causes COVID-19; however, the situation is different in outdoor areas that are less frequently maintained, including playgrounds or other facilities located in local, state, or national parks.[53-66,79-85]

Is the use of ultraviolet light and ozone useful to eliminate the COVID-19 virus?

The use of short wavelength ultraviolet light can be useful for disinfecting work areas, applied prior to the beginning of activities.[40,41,85,86]

At UC Santa Barbara's Solid State Lighting and Power Electronics Center (SSLEEC), some researchers are developing ultraviolet LEDs that have the ability to decontaminate surfaces and potentially air and water, that have been in contact with the SARS-CoV virus. They have used it in the disinfection of personal protective equipment, surfaces and floors. Ultraviolet light for disinfection purposes had already been used for a long time, although demonstrating its effectiveness in the SARS-CoV-2 disinfection has not been completed. Its use for these purposes is very promising. An SSLEEC member company, Seoul Semiconductor, reported 99.9% sterilization of coronavirus (COVID-19) in 30 seconds with its UV LED products. Not all UV wavelengths are the same; one comes from the sun; that which is required to purify air and water, and that to inactivate microbes can only be generated

through man-made processes. UVC light in the range of 260-285 nm used for disinfection is harmful to human skin, so its application must be done when no one is present at the time of disinfection. Conventional germicidal UVC light (wavelength 254 nm) can be used to disinfect unoccupied spaces, such as: empty hospital rooms or empty subway cars, but direct exposure to these conventional UV lamps is not possible in busy public spaces, as this could be a health hazard. To disinfect occupied indoor areas continuously and safely, researchers at Columbia University Irving Medical Center have been investigating distant UVC light (wavelength 222 nm). Distany UVC light cannot penetrate the tear layer of the eye or the outer layer of dead skin; consequently it cannot reach or damage the living cells of the body. The researchers had previously shown that distant ultraviolet light can kill airborne flu viruses safely. The World Health Organization warns against the use of ultraviolet disinfection lamps to disinfect hands or other areas of the skin; even brief exposure to UV-C light can cause burns and eye injury. There are great technological advances in ultraviolet light generating devices. Mercury vapor lamps have been used, LED systems and alignment of various metals. The time will come when deeper, safer and more economical light can be obtained. Even with its limitations, the current use of ultraviolet light is safe and economical compared to other means of disinfection. More than 99.9% of seasonal coronaviruses in airborne droplets died when exposed to a specific wavelength of ultraviolet light that is safe to be used around humans, a new study at Irving Medical Center found. It could greatly reduce the level of virus in the air in human-occupied indoor environments. That study extends its research to seasonal coronaviruses, which are structurally similar to the SARS-CoV-2 virus that causes COVID-19.[40,86] During the course of the investigation, the researchers used a nebulizer device to disperse two common coronaviruses. The aerosols containing coronavirus were flowed through the air in front of a distant UVC lamp. After exposure to distant UVC light, the researchers tested to see how many of the viruses were still alive. They found that more than 99.9% of the exposed virus had been killed by very low exposure to distant ultraviolet light. Based on their results, these examiners estimate that continued exposure to distant ultraviolet light at the current regulatory limit would kill 90% of airborne viruses in about 8 minutes, 95% in about 11 minutes, 99% in approximately 16 minutes and 99.9% in about 25 minutes. The sensitivity of coronaviruses to distant ultraviolet light suggests that it may be feasible and safe to use distant ultraviolet overhead lamps in public places, busy indoors to reduce the risk of person-to-person transmission of coronavirus noticeably, as well as other viruses; such as: influenza. In a separate ongoing study, researchers are testing the effectiveness of distant UVC light against SARS-CoV-2 in the air. Preliminary data suggests that distant UVC light is successful in killing SARS-CoV-2. Since SARS-CoV-2 is transmitted largely through droplets and aerosols that are coughed and sneezed into the air, it is important to have a tool that can safely inactivate the virus while airborne, especially when there are people nearby. Distant UV light is safe in busy spaces like hospitals, buses, airplanes, trains, train stations, schools, restaurants, offices, theaters, gyms and anywhere people gather indoors. Distant ultraviolet light could be used in combination with other measures; such as: wearing masks and washing hands, to limit the transmission of SARS-CoV-2 and other viruses.[40,41,85,86]

Disposal of personal protective equipment is highly recommended; if it needs to be reused, it can be disinfected with ultraviolet light and ozone.[40,85-89] Ozone has been used for disinfection and to reduce the risk of infection by aerosols containing viruses; such as: COVID-19 It is a natural gas composed of three oxygen atoms (O_3), created by solar radiation it is used for protection against harmful effects of UV rays. It is inorganic, colorless, dry, with a strong and unpleasant odor, explosive, and soluble in pure water. It is the strongest natural oxidant in nature, with a short half life of 140 min at 0 ºC, 40 minutes at 20 ºC and 25 minutes at 30 ºC. It is produced by generators from pure oxygen as it passes through a high voltage gradient.[40,82-90] In organisms it is a part of oxygen free radicals and it participates in the

modulation of oxidative stress, with induction of pro-inflammatory cytokines. It participates in the modulation of the immune system, improves the phagocytic activity of neutrophils and the function of erythrocytes.[89-106]

The peroxidation produced by ozone damages the viral cell wall, alters the reproductive cycle, inhibits its growth, and interrupts the contact of the virus with the cell. It is involved in the oxidation of glycoproteins and glycolipids, blocking the enzymatic function of the virus. The coronavirus has a coating rich in cysteine, which must remain intact for viral activity; cysteine contains thiol or sulfhydryl groups (-SH), essential for cell fusion and entry; being vulnerable to ozone, with long-term antiviral effects. The effectiveness of ozone therapy is due to the decrease in the viral load.[5,88,89] Lipid-coated encapsulated viruses are the most sensitive, and coronavirus is one of them.[3,6] An exposure for 30 minutes at doses of 0.03 to 10 ppm inactivates the viruses contained in the aerosols. It has been used to inactivate several viruses; such as: hepatitis A, poliovirus, smallpox, HIV-1, cytomegalovirus, and Ebola.[87-91] The concentration for viral inactivation is not cytotoxic,[90] it disinfects spaces that are hard to reach. The extra benefit of this gas is its prompt transformation into molecular oxygen without toxic residues.[93-106]

To care for a patient or the general public, what protective equipment should be used according to the degree of contagion risk?

There are several guides for the use of personal protective equipment (PPE) and preventive care; the recommendations are made according to the risk and use of 4 grades *(see infographic)*.[107-109]

Low risk. Workers who do not have contact with people known or suspected of being infected with SARS-CoV-2. They can maintain a distance greater than 1.5 meters. They have minimal occupational contact with public and/or with their co-workers. Recommendations: *see infographic*.

Moderate risk. They are workers with a medium exposure risk; have frequent and/or close contact; that is, within 1.5 meters, with unknown people who may have the disease; frequent contact with travelers returning from places where the pandemic has widespread transmission; contact with the general public (e.g. schools, high-density work environments, some high-volume retail environments). Recommendations: *see infographic*.

High risk of exposure. High risk of exposure jobs are those with high potential for exposure to known or suspected sources of COVID-19. Workers in this category include:

- Healthcare and support personnel (e.g. doctors, nurses, and other hospital personnel required to enter rooms) exposed to known or suspected COVID-19 patients. (Note: when such workers perform procedures, their level of exposure risk becomes very high).
- Medical transportation workers (e.g. ambulance operators) moving known or suspected COVID-19 patients in closed vehicles.
- Mortuary workers involved in preparing (for example: for burial or cremation) the bodies of people known to have, or suspected of having COVID-19, at the time of death.

Very high risk. Very high exposure risk jobs are those with high potential for exposure to known or suspected sources of COVID-19 during specific medical, post-mortem, or laboratory procedures. Workers in this category include:

- Healthcare workers (e.g. physicians, nurses, dentists, paramedics, emergency medical technicians) performing aerosol generating procedures (e.g. intubation, induction procedures, bronchoscopies, some procedures and tests, or invasive specimen collection) in known or suspected COVID-19 patients.
- Healthcare or laboratory personnel collecting or handling samples from known or suspected COVID-19 patients (for example: handling cultures from known or suspected COVID-19 patients.)
- Mortuary workers who perform autopsies, which generally involve aerosol generating

procedures, on the bodies of people known to have, or suspected of having COVID-19, at the time of death.

DISCUSSION

There are a large number of publications regarding viral load and COVID-19; however, there are few studies with a level of evidence I or II that allow to issue care with a high level of recommendation; most are reviews that are simple or opinions. The theoretical concepts of this work consider recommendations with the best medical evidence. Such concepts will need to change or be adjusted once new evidence appears, forcing readers to remain up to date. We use the precautionary principle, which is a concept that supports the adoption of protective measures in the face ofreasonable grounds for suspicions that certain products, technologies or infections create a serious risk to public health. The recommendations that are given will be made without definitive scientific proof and the principle of therapeutic proportionality, which implies that preventive measures provide greater benefits and a very low or no risk, due to the use of these measures. In addition, these preventive recommendations are low cost, accessible, and easy to understand and apply.[110-112]

In daily clinical practice, plastic surgeons and other professionals have to serve the general public, people unknown to us, who may be carriers of the virus, so we are exposed to becoming infected with COVID-19. All patients should be considered positive to COVID-19 until the disease is ruled out through laboratory tests. The most frequent cause of contagion is asymptomatic or pre-symptomatic people; the disease not being apparent, there is a tendency to greater neglect at a higher risk.[5,13-22,34-38] We must perform our activities in a responsible and safe way; some practices not being scrupulous will increase the risk of contagion.

It has been recognized that the production of aerosols is the main source of contagion in health personnel. Aerosols are generated in different medical and surgical procedures. In the early stages of the pandemic, the percentage of health personnel who became infected was very high. Nowadays, they have better personal protective equipment and experience, which has made it possible to adopt preventive measures, achieving a considerable reduction in the number of infections.[19-25,33]

The COVID attack rate is higher in closed and poorly ventilated spaces, where people are with several persons for a long time, without due distancing and without protection. Most of the time, the fact that one of them is already sick with COVID is ignored. The contagion rate is higher than 80% and there is very high mortality. This type of spread has been called supercontagion.[19-22] Another source of supercontagion occurs with healthcare personnel who have to attend COVID patients for long periods of time, inhale their respiratory secretions and do not have the appropriate personal protective equipment.[20-22,33] The most common circumstances for infections would be face-to-face encounters and interactions with people for long periods.[19-22]

CONCLUSIONS

There is sufficient evidence to support the theory that by reducing the viral load, there is a lower probability of contagion and if infected, the disease is mild or asymptomatic. Reducing the viral load is imperative during our practice. The pillars of preventive care that will help us reduce the viral load are: the generalized use of masks, eye protection, distancing, hand hygiene and sanitation of the environment. Even when evidence is lacking, suspecting or confirming COVID, this attention should be applied under «*the principle of precaution*» in order to reduce community transmission of the coronavirus. All health authorities should opt for these preventive measures, as they are inexpensive, easy to apply and promise good results.[42-44,55-85] It is important that the application of these regulations is mandatory and universal; *(si es universal, ¿por qué repetir para todos?) They are regulations for everyone and everyone must comply with them!*[39-41]

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RECOMMENDATIONS OF SECURITY

1 HOW TO REDUCE THE VIRAL LOAD

VIRAL LOAD

Amount of viral particles present in body fluids

UTILITY OF QUANTIFYING VIRAL LOAD

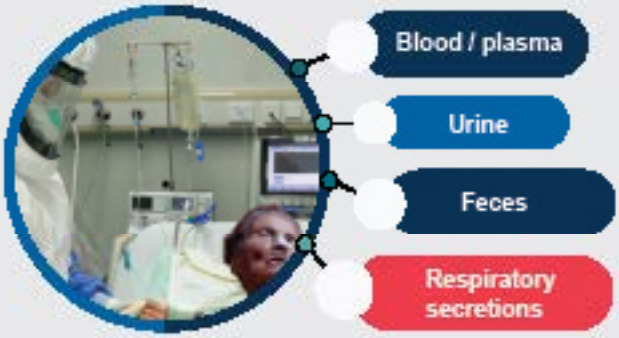
- Severity of the infection
- Prognosis of the disease
- Risk of transmitting the infection
- Severity of the disease
- Evaluate the treatment

HOW WE BECOME INFECTED

Asymptomatic or presymptomatic people are the main source of infection. As the disease is more ostensible in the group of symptomatic patients, they tend to be more careful with less risk

By reducing the viral load we can avoid contagion or make the disease milder.

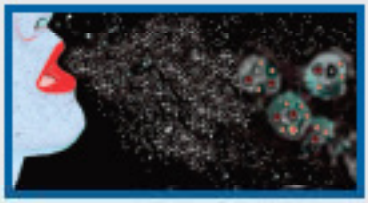
Several reports state that it is rare to get COVID by coming into contact with a contaminated surface or during a fleeting encounter with a sick person.



AIR TRANSMISSION Respiratory secretions are expelled by the patients; they form aerosols with microparticles (<5 microns) that remain in the air for several minutes and can be aspirated and deposited in the pulmonary alveoli.

Respiratory secretions and other body fluids are essential for the survival and transmission of the virus.

It has been considered as the main source of contagion of COVID 19.



DIRECT TRANSMISSION

CONTACT WITH FLUIDS WHERE THE SARS-COV 2 VIRUS HAS BEEN FOUND

AEROSOL FORMATION MECHANISM

- Talking out loud or singing generate microparticles that can stay in the air up to 8 minutes.
- During coughing or sneezing, respiratory droplets are produced which can reach a distance of up to 8 meters.
- Maneuvers on the upper airway or digestive tract produce large amounts of aerosols.

TRANSMISSION BY SURGICAL SMOKE

- It has been proved that surgical smoke particles measure from 0.05 to 25 microns.
- Surgical smoke can contain HIV and hepatitis viruses.
- It could contain SARS-CoV-2.
- There are no studies that demonstrate that surgical smoke is a vehicle of transmission.
- The use of energy generating devices should be limited.

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SAFETY RECOMMENDATIONS

2 HOW TO REDUCE THE VIRAL LOAD

CONDITIONS FOR SUPERCONTAGIONS IN HEALTH PERSONNEL

- COVID PATIENT CARE WITH HIGH VIRAL LOAD
- PLACEMENT OF OROTHRACHEAL TUBES
- LONG CONTACT PERIODS
- TRACHEOTOMIES
- SECRETIONS ASPIRATION
- SPUTUM INDUCTOR TECHNIQUE
- EXCRETES REMOVAL
- WITHOUT ADEQUATE PROTECTION
- CONTACT WITH AEROSOLS

- Closed spaces
- Poor ventilation
- Being together for a long time
- Not wearing protection

SUPERCONTAGIONS More than 80% of the people in a coexistence group acquire the disease. Mortality is very high. This form of contagion has appeared in: church choirs; diners in a restaurant, crowded offices, parties

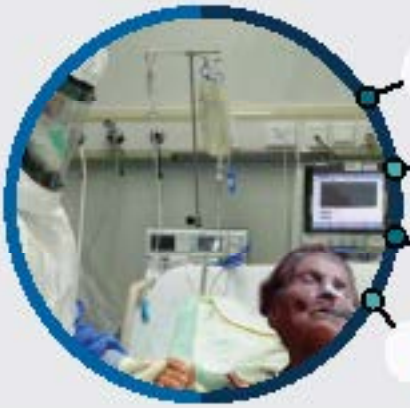
OTHER EVIDENCE OF THE IMPORTANCE OF THE VIRAL LOAD

Alterations found in severely affected COVID-19 patients, compared to mildly ill or asymptomatic patients

- 60 times higher viral load
- Longer contagion time
- Higher cytokines
- The virus stays longer in the respiratory tract
- High IgG

CONTAGION IN HEALTH PERSONNEL.

The risk of contagion is 3 times higher and it increases up to 5 times in front line staff who take care of patients with COVID. The risk increases in black, Asian or ethnic minority personnel and with comorbidities.



- WITH PROTECTION: SPOUSE 38% AND OTHER RELATIVES 17%
- MANDATORY USE OF MASKS IN COMMUNITIES INCREASED MILD AND ASYMPTOMATIC CASES AND DECREASED SEVERE AND FATAL CASES
- HEALTH PERSONNEL WITH APPROPRIATE PROTECTION HAVE LESS CONTAGION
- FRONT LINE HEALTH STAFF TAKING CARE OF PATIENTS WITH COVID HAVE A HIGHER CONTAGION RATE

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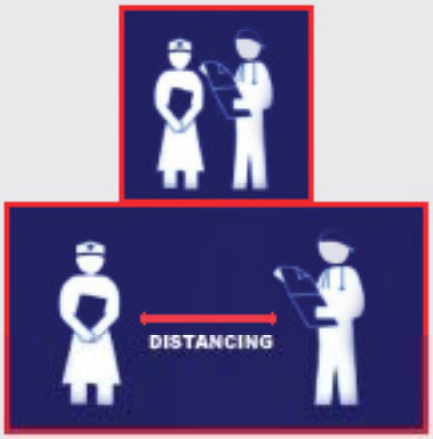
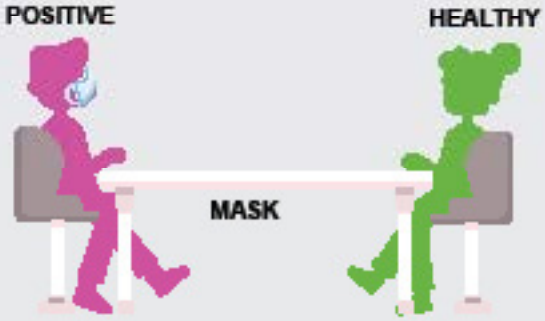
SAFETY RECOMMENDATIONS

3 HOW TO REDUCE THE VIRAL LOAD.



HOW TO REDUCE THE VIRAL LOAD

RISK OF CONTAGION
> OF 1 METER = 10.2% LESS CONTAGION
FOR EVERY 1 EXTRA METER = 2.02 TIMES LESS CONTAGION

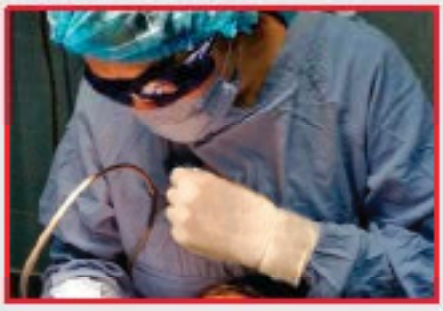


IF THE POSITIVE PERSON USES A MASK, THE RISK OF CONTAGION IS REDUCED 30%

iF THE POSITIVE AND THE HEALTHY PERSONS USE A MASK, **THE RISK OF CONTAGION IS LESS THAN 10%**

- Surgical masks retain particles > 10 microns.
- N95 and the like filter 95% of microparticles (5 microns).
- Respirators with viral containment filters can retain particles < 1 micron.

PRINCIPLES OF VIRAL CONTAINMENT OF MASKS AND RESPIRATORS
Filtration capacity
Electrostatic effect of the filter fibers
Entrapment of 1 to 5 micron microparticles containing virus



Eye protection with the use of goggles or glasses that reduce contagion by up to 10.6%

Masks retain particles between 5 to 10 microns.
Respirators with viral containment filters can retain particles < 1 micron

Respirators can contain up to 100 times more aerosol particles than a mask

Respirators filter up to 97% of 5 micron particles and have less effect on Eye protection with the use of goggles smaller particle

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SAFETY RECOMMENDATIONS

4 HOW TO REDUCE THE VIRAL LOAD.

ALL PATIENTS SHOULD BE CONSIDERED AS SUSPICIOUS UNTIL THE DISEASE IS DISCARDED.

FIGURE 1. PROTECTIVE EQUIPMENT AND RECOMMENDED CARE IN THE CARE OF A PATIENT

TYPE OF RISK	JOB CHARACTERISTICS	TYPE OF CASE	HAND HYGIENE	TYPE OF MASK	DISTANCE	OTHER MEASURES
MINIMUM	They have no contact with unknown or suspicious people or COVID +.	asymptomatic patients and general public without suspicion	washing and disinfection	clinical or surgical	greater than 1.5 meters.	disinfect offices, clinics and treatment rooms. Avoid using waiting rooms
MODERATE	frequent contact with unknown or suspicious people or COVID +	suspicious case respiratory tract infection patient non-aerosol producers	washing and disinfection	clinical o surgical	greater than 1.5 meters	eye protection gloves coat
HIGH	frequent exposure with suspicious or COVID positive patients	suspicious case respiratory tract infection patient producers of aerosols, including coughing and sneezing	washing and disinfection	N95 mask or similar	greater than 1.5 meters	eye protection gloves coat
VERY HIGH	frequent exposure to suspicious sources or positive COVID they perform procedures on COVID + patients	positive case producers of aerosols, including coughing and sneezing airway or digestive maneuvers	washing and disinfection	N95 mask or similar and face shield. respirators with viral containment filters	greater than 1.5 meters	eye protection gloves coat or overalls (preferable)

PILLARS TO REDUCE THE VIRAL LOAD

MASKS AND RESPIRATORS

DISTANCE GREATER THAN 1.5 mts.

EYE PROTECTION

HAND WASHING

SANITIZATION AND PREPARATION OF THE ENVIRONMENT

THE BEST RESULT IS OBTAINED WITH THE COMBINATION OF ALL RECOMMENDATIONS

MANDATORY AND UNIVERSAL RULES

We must apply the precautionary principle. Action protocols reduce the viral load, prevent doctors and their patients from getting COVID or, in case of infection, the disease is milder.

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