

Protocol

COVID-19 Pandemic: Prevention and Protection Measures to Be Adopted at the Workplace

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Abstract: SARS-CoV-2, identified in Wuhan, China, for the first time in December 2019, is a new viral strain, which has not been previously identified in humans; it can be transmitted both by air and via direct and indirect contact; however, the most frequent way it spreads is via droplets. Like the other viruses belonging to the same family of coronaviruses, it can cause from mild flu-like symptoms, such as cold, sore throat, cough and fever, to more severe ones such as pneumonia and breathing difficulties, and it can even lead to death. Since no effective specific drug therapy has been found yet, nor any vaccine capable of limiting the spread of this pathogen, it is important for ways of preventing the spread of this infection to be established. The purpose of our research was to provide a protocol to prevent the spread of SARS-CoV-2 infection in light of the limited information related to this coronavirus. In detail, we analysed and searched targeted evidence-based guidelines issued in the various countries affected by this epidemic up till now. In addition, we analyzed the recommendations for the prevention and control of other epidemics caused by other pathogens belonging to the same family of coronaviruses or others that present the same mechanisms of transmission. General organizational measures regarding the containment and management of the epidemiological emergency of COVID-19 have been imposed by the competent authorities for an adequate and proportionate management of the evolution of the epidemiological situation. The prevention and protection organizational measures therefore aim to minimize the probability of being exposed to SARS-CoV-2. For this purpose, measures must also be taken at work to avoid new infections or even the spread of the virus where it has already been present. Furthermore, environmental measures are aimed at reducing the risk of transmission of SARS-CoV-2 to individuals through contact with infected subjects, objects, equipment, or contaminated environmental surfaces. Protective devices must be used whenever there is potentially close contact with a suspect case, especially when the potentially infected person does not wear a surgical mask that could reduce the spread of viruses in the environment. By adopting this specific prevention and protection measures recommended in the workplace, it will be possible to help overcome this COVID-19 pandemic.

Keywords: organizational measures; environmental measures; pandemic; infection; work; occupational medicine; coronavirus; SARS-CoV-2; COVID-19; protection; prevention; protocol; PPE; DPI; mask; gloves; stress; competitive sport; fatigue; droplets; inanimate surface; transmission; aerosol

1. Introduction

Coronaviruses (CoV) are a large family of positive-stranded RNA respiratory viruses. Their name is owed to the crown-shaped tips present on their surface. Coronaviruses (CoV) are divided into four genera, including α - β - γ - δ -CoV. α - and β -CoV are able to infect mammals, while γ - and δ -CoV tend to infect birds. Previously, six CoVs have been identified as human-susceptible viruses, among them α -CoVs HCoV-229E and HCoV-NL63 and β -CoVs HCoV-HKU1 and HCoV-OC43, which have low pathogenicity, causing mild respiratory symptoms similar to a common cold. The other two, known as β -CoVs, SARS-CoV (Severe Acute Respiratory Syndrome—Coronavirus) and MERS-CoV (Middle East Respiratory Syndrome—Coronavirus) lead to severe and potentially fatal respiratory tract infections [1].

In December 2019, unexplained pneumonia (later named as coronavirus disease 2019, COVID-19) broke out in Wuhan, China [2–5]. The initial patient was related to a seafood wholesale market in Wuhan. A new type of coronavirus was isolated from human respiratory epithelial cells, which belongs to the subgenus Sabevirus of the subfamily Coronavirus [6]. Different from the previously isolated MERS-CoV and SARS-CoV, this virus is the seventh coronavirus that can infect humans and is named as SARS-CoV-2 [7,8].

It is speculated that the coronaviruses circulating in pangolin, bat, and other animal species are likely to be a “gene pool” for the generation of new recombinants [9]. Given the use of pangolins in traditional medicine and for food, frequent human–animal interaction has been supposed the major cause for viral cross-species transmission. The similarity analysis of SARS-CoV-2 and the animal-origin coronaviruses has demonstrated that recombination events were likely to occur in bat- and pangolin-origin coronaviruses [9]. In particular, the similarity between SARS-CoV-2 and the closest bat relative is very high: all proteins in the coronavirus proteome (with the exception of ORF10) have identities of above 85%, with full conservation of the genome length (~30 kb) [10].

The number of coronaviruses that affect people and which are known up to now, being common all over the world, are seven. The most lethal of the known coronaviruses is MERS-CoV, which often progresses to severe pneumonia and has an estimated mortality rate between 30% and 40%; SARS-CoV causes fever, chills and body aches, and often progresses to pneumonia, a severe condition in which the lungs become inflamed and fill with pus; this virus has an estimated mortality rate of 9.6%; and the most recent, SARS-CoV-2, has an estimated mortality rate of about 2.3% (Table 1) [6].

Table 1. List of viruses belonging to human coronavirus types divided by lethality [1].

LESS LETHAL KNOWN CORONAVIRUSES	MOST LETHAL KNOWN CORONAVIRUSES
229E (the alpha coronavirus)	MERS-CoV (the beta coronavirus that causes the Middle East Respiratory Syndrome)
NL63 (the alpha coronavirus)	SARS-CoV (the beta coronavirus that causes the Severe Acute Respiratory Syndrome)
OC43 (the beta coronavirus)	2019 new coronavirus (SARS-CoV-2)
HKU1 (the beta coronavirus)	

SARS-CoV-2 uses the same cell entry receptor—angiotensin converting enzyme II (ACE2)—as SARS-CoV [11], producing infection that can be totally asymptomatic or can present flu-like symptoms such as fever, cough, breathing difficulties [12]. This latter symptomatology, which is more frequent

and severe in elderly subjects also presenting concomitant pathologies [13], is believed to occur in young subjects too, who have a weak immune system, such as subjects undergoing acute or chronic immunosuppressive therapy, subjects epigenetically predisposed [14], or subjects facing excessive environmental psychophysical workload; for example, those who practice extreme or highly-demanding activities [15], or those who have a particularly stressful work with frequent night shifts, in which the clearly demonstrated irregularities of the normal circadian sleep–wake rhythm can be the basis of a decrease, even if transitory, in immune defense [16].

In severe cases, COVID-19 can ultimately manifest itself as pneumonia; patients can develop acute respiratory distress syndrome in a short period of time and die due to multiple organ failure [17]. Based upon these premises, the purpose of this review is to provide a protocol intended to prevent the spread infection of SARS-CoV-2, in light of the few knowledge about procedures to put in place to control critical events like the one we are experiencing. Furthermore, we also want to give an overview regarding SARS-CoV-2 and strategies used to fight this virus.

2. Materials and Methods

We searched and analyzed targeted evidence-based guidelines issued in various countries affected by this epidemic up to date. The recommendations for the prevention and control of other epidemics caused by other pathogens belonging to the same family of coronaviruses or others that present the same mechanisms of transmission also were searched and analyzed. Moreover, we checked and analyzed different scientific papers related to pharmacological approaches, clinical assessment of various Personal Protective Equipment (PPE) of the respiratory tract and epidemiological data regarding this virus. In detail, we looked into all the best reports of the World Health Organization, the U.S. Food and Drug Administration, the Italian Society of Pharmacology, and the Centers for Disease Control and Prevention (CDC). Furthermore, we have identified more than 100 articles that use two primary sources to classify relevant information: PubMed and SCOPUS (the latest access of PubMed and SCOPUS in March 2020).

2.1. Transmission

In the case of COVID-19, as reported by the World Health Organization (WHO) “Situation Report—12”, the modality of transmission can be similar to the previous epidemics caused by other coronaviruses (MERS, Middle Eastern Respiratory Syndrome, and SARS, Acute Respiratory Syndrome), for which human-to-human transmission occurs through droplets, aerosols and direct contact [18].

In particular, the droplets, generated during speaking, coughing and sneezing by symptomatic patients, can spread up to 1–2 m; a recent study demonstrated that the infection can also occur from asymptomatic people and before the onset of symptoms [19].

Another mode of transmission is enabled by the inhalation of aerosols, which are microparticles with a diameter smaller than 5 μm , containing pathogens, which after having been released in the air, are transported by the flow of the air current, thus being able to cause diffusion even at a considerable distance (with reverse ratio due to their dilution) (Figure 1) [20]. Currently, the literature cannot give information on the practicable concentration of SARS-CoV-2 to infect a human being; however, it has been quantified that SARS-CoV-2 remains practicable in aerosols after 3 h, with a reduction in the infectious titer from 103.5 to 102.7 TCID₅₀ per liter of air. This reduction was similar to that observed with SARS-CoV-1, from 104.3 to 103.5 TCID₅₀ per mL. The half-life of the viable virus was also estimated for aerosol based on estimated exponential decay rates of the virus titer in approximately 1 h [21].

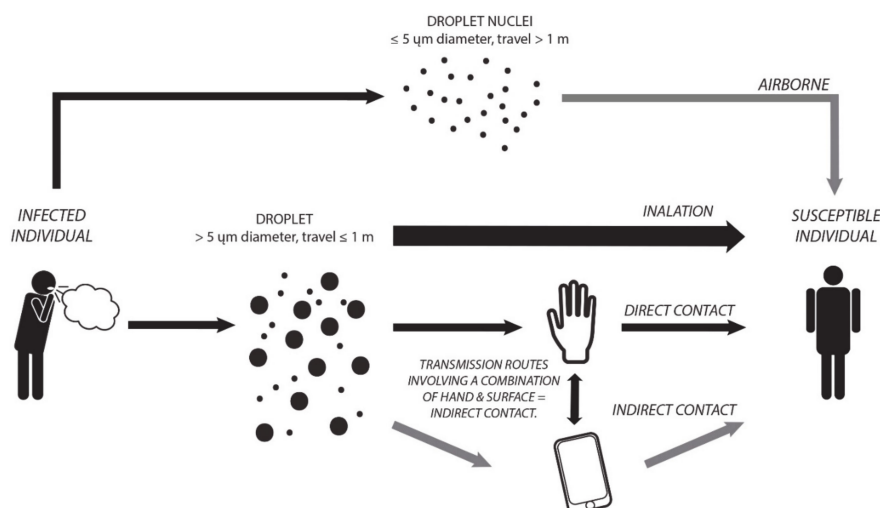


Figure 1. Transmission ways of COV-19.

Finally, SARS-CoV-2 can also be transmitted through direct or indirect contact with infected people or by depositing droplets containing the virus on any person (handshake, greeting, hug) or inanimate surface [22]; these droplets can contaminate the hands of other subjects by subsequently entering the body through access routes such as the oral cavity, the nasal cavity, the eyes and other mucous membranes (Figure 1) [20].

There are no studies in the literature that demonstrate in practice a vital concentration of SARS-CoV-2 necessary to infect a human being from inanimate surfaces. Instead, it has been shown how the half-life of SARS-CoV-2 varies on different surfaces such as plastic, stainless steel, copper and cardboard (Table 2) [21].

Table 2. Conditions of 21–23 °C and 40% relative humidity over 7 days [21].

SURFACE MATERIAL	TITER OF VIABLE VIRUS	THE HALF-LIFE OF VIABLE VIRUS
Stainless steel	48 h	5 h
Plastic	72 h	7 h
Copper	8 h	1 h
Cardboard	48 h	3 h

2.2. Epidemiology

The epidemiological data related to SARS-CoV-2 infection are constantly evolving and are daily updated in the coronavirus disease (COVID-19) situation report of the WHO [23].

According to a first study conducted in Wuhan, on a small cohort of 99 subjects, the infection was more likely to affect older males with comorbidities, in whom it induced the appearance of symptomatic episodes of serious or even fatal respiratory pathologies such as the acute respiratory distress syndrome [24].

The data was confirmed by the major epidemiological study conducted by the Chinese Centre for Disease Control and Prevention, which found that the mortality rate grew from 0.2% in patients aged between 10 and 39 years to 14.8% in those over 80, and that the risk of death is greater among men (2.8%) than among women (1.7%).

Another lethality factor has been identified in the simultaneous presence of pre-existing diseases, especially cardiovascular ones, metabolic pathologies such as diabetes, chronic respiratory failure and hypertension.

However, among those who are in perfect health at the time of infection, the mortality rate is 0.9%. Furthermore, it has been shown that 80.9% of infections have no symptoms or a mild course, 13.8%

severe, while 4.7% of those infected developed critical pathological symptoms with symptoms such as respiratory failure, septic shock or multi-organ failure [25].

2.3. Testing and Pharmacological Approach

Appropriate and specific diagnostic techniques are important to detect the presence of the SARS-CoV-2 virus in the human body early. Although many laboratory tests have been implemented, nowadays, screening protocols should be adapted to the local situation and the guideline reviewed and update on the basis of the last information available.

In this regard, the World Health Organization reviewed and published a paper containing guidelines to follow and practice. Together, along with the ordinary tests, these provide further and specific information about the real existence of this specific virus in the samples analyzed [26].

In detail, we should proceed following different strategies in relationship to the individual. In particular, to assess the individuals who have had contact with a COVID-19 case, we can use the PCR test, which works by detecting specific genetic material within the virus. Depending on the type of PCR on hand, health care workers might swab the back of the throat; take a saliva sample; collect a liquid sample from the lower respiratory tract; or secure a stool sample. Furthermore, suspected cases should be screened for the virus with nucleic acid amplification tests (NAAT), such as the real-time reverse transcription polymerase chain reaction (rRT-PCR) test, specific for the qualitative detection of nucleic acid from SARS-CoV-2 in upper and lower respiratory specimens such as nasopharyngeal or oropharyngeal swabs, sputum, lower respiratory tract aspirates, bronchoalveolar lavage, and nasopharyngeal wash/aspirate or nasal aspirate [27]. Until now, serologic tests for COVID19 have not been developed [28].

At present, there are no specific treatments for infections caused by coronavirus and there are currently no vaccines available to protect us against these viruses. Most people with common coronaviruses heal spontaneously or are treated on the basis of the severity of their symptoms, either with conventional antiviral therapies (so called supportive therapy) or by providing mechanical respiratory support.

A variety of drugs already in use and experimental drugs likely to be useful for the treatment of COVID-19 patients have been identified in recent months. The screenings of the drugs approved by the National Medical Products Administration (NMPA) and other chemical entities have identified different agents.

Several clinical trials have been recently scheduled to take into consideration drugs with different mechanisms of action for the treatment of COVID-19 patients. Remdesivir [29], an antiviral drug already used for the treatment of Ebola [30], is a compound with a broad spectrum of antiviral activities [29,31–33]. In particular, this drug showed a good antiviral activity in both in-vitro and in-vivo studies of animal models against various RNA viruses genetically unrelated but similar to SARS-CoV-2, such as SARS-CoV and respiratory syndrome coronavirus of the Middle East (MERS-CoV) [34–37]. These studies provide further insight on the action of Remdesivir against coronaviruses, making it a promising agent for the treatment of COVID-19, in association with chloroquine.

Chloroquine, an agent already used as an anti-malarial drug and which has also been studied for its use in pulmonary system disease [38,39]; has been shown to be effective in SARS-CoV-2 infection in in-vitro experimental models. The antiviral action of this drug is attributed to its capacity to alter (increase) the endosomal pH, which is fundamental for virus–cell fusion, as well as to the interference on the glycosylation of SARS-CoV-2 cell receptors. Furthermore, it has been reported that chloroquine may be also able to block the viral replication of SARS-CoV-2 at usable doses in humans [34,40]. According to a recent study, hydroxychloroquine may be active against SARS-CoV-2 at lower concentrations than chloroquine. In addition to the antiviral action, these drugs have an immunomodulation activity that could synergistically enhance the antiviral effect in vivo [41].

Another antiviral drug object of studies for the treatment of COVID-19 is favipiravir. The drug has been used off-label in other countries to treat infections with new viruses including Ebola

and, more recently, it was approved in China for the treatment of flu by SARS-CoV-2. This agent, administered as prodrug, performs its antiviral action through its active metabolite favipiravir ribofuranosyl-5I-triphosphate [28]. It acts as an antiviral agent capable of inhibiting RNA-dependent RNA polymerase (RdRp) of RNA viruses [42]. In particular, it is a nucleoside analog, whose antiviral activity may be attributable primarily to its incorporation into viral RNA, which in turn exerts mutagenic activity in viruses, causing their death.

Besides antiviral agents, in recent days, other drugs are under investigation for the therapy of COVID-19. This includes tocilizumab, a humanized monoclonal antibody that binds and neutralizes IL-6R, resulting in the inhibition of various IL-6-mediated biological activities, including inflammation-related, immunomodulatory rheumatoid arthritis (RA) and systemic juvenile idiopathic arthritis, and the treatment of cytokine release syndrome induced by chimeric antigen receptor (CAR)-modified T cells. This agent is indicated for use off-label, in patients with infection of SARS-CoV-2. The rationale of its employing it is based on the evidence that COVID-19 infection induce an excessive and aberrant immune system response also associated with acute respiratory distress syndrome and, in most critically ill patients, with a “cytokine storm” (increased plasma and tissue levels of various cytokines that produce long-term damage and fibrosis of lung tissue) [43].

In the last days, different groups of researchers [44,45] have focused their attention on the role played by the angiotensin-converting enzyme 2 (ACE2) as a possible target for the treatment of SARS-COV-2. In detail, there are two different forms of ACE2 enzyme. The first one is known as full-length angiotensin-converting enzyme 2 (ACE2), and contains a structural transmembrane domain, able to mediate SARS-CoV-2 cell attachment and its subsequent fusion with membranes of lung cells [46,47]. The second one is a soluble circulating form, which lacks the domain portion able to anchor to cell membrane. In-vitro studies showed that this form binds the virus, making it impossible for it to fuse with cells. Through its mechanism of action, soluble recombinant ACE2 protein could play a prominent role in the new pharmacological approach for attenuation or eradication of COVID-19 [44,45,48,49]. Unfortunately, at the moment, there is limited research on the potential beneficial effect of the drugs reported above. On the other hand, the evaluation of drugs suitable for COVID-19 therapy requires adequate studies, randomized with realistic eligibility criteria and which would consider an adequate stratification of patients for clinical trials. Rapid completion of these studies is important in order to identify effective drug therapies.

3. Prevention and Protection

3.1. Organizational Measures

General organizational measures regarding the containment and management of the epidemiological emergency of COVID-19 have been imposed by the competent authorities for an adequate and proportionate management of the evolution of the epidemiological situation.

The prevention and protection organizational measures therefore aim to minimize the probability of being exposed to SARS-CoV-2. For this purpose, measures must be taken to avoid new infections or even the spread of the virus where it has already been present.

It is therefore useful for companies in which various persons come and go during the day to reduce visitors' entry strictly to the minimum, also limiting access to all subjects, including employees. They should also block persons with obvious flu-like symptoms, and census the employees who are allowed to enter.

In the case of the presence of travelling staff, they should be prevented from travelling in countries which are sensitive to SARS-CoV-2, in the so-called red areas; companies should apply a quarantine measure with active surveillance of those who have had close contacts with people affected by COVID-19, and the provision of the obligation for those coming from areas at risk of epidemiology to communicate it to the prevention department of the competent health company, in order to enable an eventual fiduciary home stay measure with active surveillance [50].

The measures to be taken are:

- Blocking all trips to and from all areas defined as “red”, in which cases of COVID-19 infections have already been ascertained.
- Possible 14-day home quarantine for those who live, work or return from these areas.
- Selective control and measurement of body temperature of all suppliers and external collaborators.
- Reduction of the number of operators within each confined environment.
- Prioritize, where possible, work from home (smart working).
- Composing, if possible, two or more closed and independent working groups, to be alternated every 14 days to work in the company or in smart working.
- Predisposition and maximum adherence to PPE dressing and undressing protocols.

3.2. Environmental Measures

Environmental measures are aimed at reducing the risk of transmission of SARS-CoV-2 infection to individuals through contact with infected subjects, with objects, equipment, or contaminated environmental surfaces.

Even if there are no disinfectants registered specifically as active on SARS-CoV-2, viruses with similar biochemical and physical properties are inactivated with detergents and disinfectants commonly used in hospitals; this ensures a low or intermediate disinfection, following the manufacturer’s instructions and the technical data sheet regarding dilution, contact time and handling [51].

In the literature, various evidence has shown how coronaviruses, including the viruses responsible for SARS and MERS, can persist, in optimal conditions of low humidity and low temperature [52], for up to 9 days on the inanimate surfaces of all shared rooms, especially bathrooms, changing rooms, canteens, rooms with distributors, smoking areas, and offices shared with several people. A role of contaminated surfaces in the transmission of SARS-CoV-2 infection is therefore to be considered as being possible, even if not yet demonstrated [53].

At the same time, available evidence has shown that the aforementioned viruses are effectively inactivated by adequate sanitization procedures, which include the use of disinfectants based on sodium hypochlorite (0.1%–0.5%), ethanol (62%–71%) or hydrogen peroxide (0.5%), for an adequate contact time, providing adequate ventilation of closed rooms [54]; or through the use of physical means such as ultraviolet irradiation (UV) [55]. Therefore, extraordinary cleaning and sanitization procedures must be adopted using the appropriate disinfectants/disinfectants (Table 3) and remembering to pay the utmost attention to the removal of any organic residues, intensifying the frequency with which these activities are normally carried out.

Table 3. List of disinfectants active on viruses and their related areas of application.

DISINFECTING SUBSTANCE	APPLICATION SCOPE
Alcohol	Cutaneous antiseptics Disinfection of small surfaces
Chlorine compounds (chloramine, hypochlorite)	Cutaneous and wound antiseptics Water treatment Surface disinfection
Glutaraldehyde	Disinfection of inanimate objects
Hydrogen peroxide	Cutaneous antiseptics
Iodophors	Skin and wound antiseptics
Acetic acid	Disinfection of inanimate objects

There are currently no studies on the effects of temperature and relative humidity on the viability of SARS-CoV-2 in the literature, but, similar to the effects on SARS-CoV-1, for which there are documents

demonstrating these effects, we can suggest that it is useful keep the confined spaces very airy, ensuring inside them a temperature of over 20 degrees and with a degree of humidity higher than 60% [56].

Reduce close contacts between work colleagues or other staff by applying these recommendations:

- Reduce direct physical contact (for example, shake hands);
- Avoid direct unprotected contact with secretions (esp. coughing, touching used paper tissues with bare hands);
- Avoid direct contact within 2 m and >15 min;
- Reduce contact with people in a closed environment (esp. classrooms, meeting rooms, hospital waiting rooms, etc.) beyond 15 min and at a distance of less than 2 m [57,58].

Finally, a suitable isolation room must be identified and prepared to bring any suspicious cases pending verification by the NHS. This isolation room must be kept clean and ventilated, and, after its use, sanitized with the removal of all organic and inorganic residues through a suitable disposal procedure.

3.3. Personal Measures

3.3.1. Hand Washing

Proper hand washing is the essential measure to prevent the transmission of SARS-CoV-2.

Hands should be washed with soap and water for at least 40–60 s; if soap and water are not available, a 62%–71% alcohol-based hand disinfectant can also be used (Figure 2).



Figure 2. Correct procedure for washing hands.

Hands must be washed:

- Before starting work, especially if this involves contact with the public;
- Frequently during the work shift, especially after contact with other staff or customers;
- After contact with secretions, excretions, biological liquids;
- After contact with potentially contaminated objects (gloves, clothing, masks, used tissues, waste);
- Immediately after removing gloves and other protective equipment.

Also remember to avoid close contact with people who suffer from acute respiratory infections by keeping at least one meter away, especially when they cough or sneeze or have fever.

Do not touch your eyes, nose, mouth or genitals, with your hands before having thoroughly washed and sanitized them. Although SARS-CoV-2 is mainly transmitted by the respiratory way, it can also enter the body through the mucous membranes; hands coming into contact with contaminated surfaces can act as a carrier.

Cover your mouth and nose if you sneeze or cough, remembering not to use the hand for this purpose but the crease of the forearm [58].

3.3.2. Personal Protective Equipment (PPE)

Gloves

Use devices that comply with the requirements of the technical standard EN 374, classified as third category PPE for protection from microorganisms (a CE certification must have been issued by the notification body for the manufacturer certifying the CE marking as PPE) [59].

The disposable protective nitrile gloves are made of a composition based on butadiene and acrylonitrile, which give it the characteristics of high comfort, ergonomics, elasticity and mechanical resistance, both to perforation and also if put in contact with some chemical substances. Finally, their hypoallergenic characteristic compared to latex gloves should not be underestimated.

Indications for the use of gloves:

- Must be clean gloves and they must cover the wrist well;
- Must be removed immediately after completing the procedures that they were used for; in particular, great care must be taken not to touch clean surfaces with contaminated gloves;
- Must be absolutely changed if dirty or not perfectly intact;
- Glove decontamination prior to glove removal with hypochlorite [60], after every contact with different inanimate surface, and during doffing procedures;
- Must not be reused or washed.

Disposable Masks/Respirators

Respiratory particles can be classified as droplets or aerosols based on the size of the particles and in particular in terms of their aerodynamic diameter. The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) consider the transmission of the disease with particles larger than 5 microns as a transmission via droplets, while in the case of a size of 5 microns or less as an aerosol transmission [61].

Both types of particles, droplets and aerosols, are generated by coughing, sneezing, speaking or simply exhaling; while droplets settle quickly, small aerosols can remain suspended in the air and can be transported over long distances by the air flow.

Compared to droplets that cause infection at a distance of less than one meter, aerosols can cause contagion at greater distances, but with a ratio inversely proportional to the space covered and the dilution suffered.

Filter Masks

The principle on which these masks are based is to adhere to the face by creating a slightly negative pressure inside the mask and thus filtering the incoming air.

In order for these devices to actually protect those who use them, it is essential to plan and implement a training program related to the use of them.

According to the American NIOSH regulations, the N95 masks must be used in environments potentially contaminated with SARS-CoV-2 (with a filtering capacity of at least 95%, a leakage of 10%,

a bacterial filtration efficiency of 99%). However, according to the European legislation, the masks that are closest to these standards are FFP2 and FFP3.

The average filtering power offered by respirators with an N95 facial filter against particles in the range of tested sizes is about 8–12 times greater than that provided by disposable surgical masks, whose filtering powers varied widely in the various studies, depending on the model and size of the aerosol particles (1.3 to 6.5 μm). This result is superimposable to that obtained by other studies, which claim that the protection provided by respirators with an N95 facial filter is approximately seven times greater than that of surgical masks [62].

The N95 respirators with an exhalation valve are designed to facilitate breathing. The results of the literature analyzed by us have shown that the respirator with an N95 facial filter and exhalation valve does not lose its ability to protect the wearer from exposure to airborne particles in the range of bacterial and viral dimensions. The aerosol penetration through the exhalation valve was also studied for negative pressure respirators, reaching the conclusion that the penetration values were about 0.03%–0.04% with no valve fault [62,63].

Disposable Surgical Masks (Facemasks)

Facemasks (surgical masks), with disposable fabric or not, are formed by four layers (type II or IIR): external, which is filtering; central, which is impermeable to liquids but air permeable; the internal layer, which is in contact with the hypoallergenic skin, with upper deformable nose bar to conform perfectly the face mask and with fastening system formed of ties or elastic bands.

They protect the nose and mouth from contamination with particles with an average diameter of 4.5 μm [64]. While originating from the need to protect the patient (surgical interventions, aseptic maneuvers), they constitute an effective barrier system for potentially infected liquids even for those who use them.

The use of the surgical mask is recommended:

- For those who work in contact with subjects with suspected airborne disease (flu syndrome, chicken pox, measles);
- In activities for which there is the possibility of generating splatters or splashes of blood or other body fluids;
- In technical and administrative support activities;
- By doctors, nurses, biologists, midwives and all healthcare personnel;
- By the staff of contracting firms (e.g., cleaning);
- By public assistance staff.

Data indicate that a surgical mask reduces virus exposure 1.1 to 55 times (on average six times), depending on the mask design [64]. They are currently indicated to be worn by the potentially infected subject.

Disposable surgical masks can confer a significant degree of protection, although less strong than FFP2 masks. However, surgical masks suffer less from limited supplies and do not need additional resources to supply on a large scale. Surgical masks are unlikely to confer much protection against the transmission of small particles such as droplet nuclei, but a partial reduction in the transmissibility of the virus may be sufficient to greatly reduce the number of infected and therefore to counter the pandemic [65].

Indications on the use of the facemasks:

Of course, no mask, be it the tight-fitting NIOSH-approved N95 respirator mask or the loosely worn surgical mask, provides perfect (100%) protection. But imperfect protection does not mean “completely useless” [66].

FFP2 and FFP3 filtering masks should be provided for all personnel, to be distributed and used after a training program; therefore, in this regard, the personnel must:

- Read the manufacturer’s instructions to verify the correct adhesion of the facial filter;

- Wear the mask, taking care that there are no structural alterations;
- Check adhesion by exhaling (if the mask has an exhalation valve) or inhaling (if the mask does not have an exhalation valve), thus checking for any abnormal passage of air.

In case of difficulty in finding the filter masks described above, surgical disposable masks can be used; even if with the limitations related to the imperfect adherence to the face, depending on the different design of the models on the market; these devices are to some extent protective, above all in preventing close contact with droplets, and even more effective if associated with other PPE (nitrile disposable gloves, protective glasses).

Safety Goggles and Splash Guard Visor

The conjunctiva is susceptible to the entry of microorganisms. For this reason, it is important to protect the eyes from exposure to SARS-CoV-2 when in close contact with an infected person.

These PPE must possess the certification issued by the notification body for the manufacturer as regards the CE marking as PPE for the “protection against splashing liquids” according to the requirements of the technical standard EN 166, elaborated for this purpose [67].

Devices for which the certifications of compliance with the aforementioned technical standard also certify the “protection from droplets” are preferred.

Visors are not able to be used if an FFP2 mask is worn. Therefore, in the procedures that involve splashes, goggles that guarantee protection from droplets must necessarily be provided.

These protective devices must be used whenever there is potentially close contact with a suspect case, especially when the potentially infected person does not wear a surgical mask that could reduce the spread of viruses in the environment.

It is important to decontaminate them after having been used, as they can act as a SARS-CoV-2 transmission vector themselves.

All the PPE described above must be removed and disposed of by following the correct procedures by the wearer. Correct removal is essential to prevent recontamination of the wearer’s clothes or hands. Here is the recommended sequence for safely removing PPE:

- Removing the gloves by rolling them down from the wrist, without touching the skin;
- Removing the protective clothing, being careful to fold it with the contaminated external part inside and disposing of it in a container with a lid;
- Hand washing;
- Removing the safety goggles or the splash guard goggles;
- Removing the facemask/respirator, taking care to touch only the strings and not the contaminated surface, and disposing of it in a container with a lid.

In the event of the identification of a potentially infected person, the following measures must be applied while awaiting the health care personnel:

- Avoid close contact with the sick person; if possible, accompany the subject in the isolation room especially prepared;
- If available, provide the person with a surgical facemask and disposable nitrile gloves which he must put on by himself;
- Wash your hands thoroughly;
- Pay particular attention to the body surfaces that have possibly come into contact with the patient’s fluids (respiratory secretions, urine, faeces);
- Have the subject eliminate, directly in a waterproof bag, both the masks and the gloves, as well as any used paper tissues. The bag will then be disposed of in an appropriate manner, together with the infected materials used during the medical assistance procedure offered by the healthcare personnel.

Isolation Gowns

Disposable (single-use) isolation gowns are designed to be discarded after a single use and are typically constructed of nonwoven materials alone or in combination with materials that offer increased protection from liquid penetration, such as plastic films. They can be produced using a variety of nonwoven fiber-bonding technologies (thermal, chemical, or mechanical) to provide integrity and strength rather than the interlocking geometries associated with woven and knitted materials [68].

4. Discussion

The recommendations set out so far for the prevention of COVID-19 in the workplace (Table 4) can be implemented by integrating the information based on the degree of the spreading risk of this virus in the company, determined by its location in relation to the areas of greatest risk and by the type of work carried out, as suggested by the Guidance on Preparing Workplaces for COVID-19 [69,70].

Our proposal for risk classification is:

- **Companies with a low probability level of infection spreading:**
 - Located in areas where there are no reported cases of disease contamination in the entire province;
 - With a maximum of 10 employees;
 - Which mainly carry out office activities with a limited flow of customers.
- **Companies with a medium probability level of infection spreading:**
 - Located in areas where there are reported cases of disease contamination in the province;
 - With a maximum number of 50 employees;
 - Which mainly carry out commercial activities;
 - Which expose employees to sporadic contact with customers.
- **Companies with a high probability level of infection spreading:**
 - Located in areas in which in the neighboring cities or in the same city of the workplace, there are clear cases of disease contamination;
 - With a maximum number of over 50 employees;
 - Which carry out front-office activities in continuous contact with customers;
 - With travelling staff;
 - Which operate in the health sector.
- **Companies with a very high probability level of infection spreading**
 - 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 (doctors, nurses, dentists, paramedics, emergency medical technicians) performing aerosol-generating procedures (e.g., intubation, cough induction procedures, bronchoscopies, some dental procedures and exams, or invasive specimen collection) on known or suspected COVID-19 patients.
 - Healthcare or laboratory personnel collecting or handling specimens from known or suspected COVID-19 patients (manipulating cultures from known or suspected COVID-19 patients).

Table 4. Summary of the prevention and protection measures proposed according to the risk level.

RISK L.	ORGANIZATIONAL MEASURES	ENVIRONMENTAL MEASURES	INDIVIDUAL MEASURES
Low	<ul style="list-style-type: none"> Informing all employees about the risk. Strict control over external access (suppliers, contractors, customers), to limit contacts with their employees to a minimum. Selective control and measurement of body temperature of all suppliers and external collaborators. 	<ul style="list-style-type: none"> Take extraordinary cleaning and sanitization measures, using the appropriate disinfectants/sanitizers. Cleaning at the end of shift of keyboards, touch screens, mouse and inanimate surfaces Reduction of the number of people inside the same room, considering a density of 1 person every 10 square meters. Keep a distance of 2 m between 2 or more people. 	<ul style="list-style-type: none"> Hand washing with soap or hand sanitizer
Medium	<p>All measures indicated for the previous level</p> <ul style="list-style-type: none"> Limitation to the bare minimum of front-office activities with external users Evaluation of the concession of working methods such as smart-working Blocking all journeys to and from all areas defined as “red”, in which cases of COV-19 infections have already been ascertained, Possible 14-day home quarantine for those who live, work or return from these areas; Composing, if possible, two or more closed and independent working groups, to be alternated every 14 days to work in the company or in smart working 	<p>All measures indicated for the previous level</p> <ul style="list-style-type: none"> Indoor temperature >20 °C, indoor humidity >60%. Adopt extraordinary cleaning and sanitizing procedures for all shared rooms, in particular: bathrooms, changing rooms, canteens, rooms with distributors, smoking areas, offices shared with several people Preparation of special bins for the collection of gloves, clothing, masks, used handkerchiefs, waste and other similar contaminated materials with biological liquids, to be disposed of as biological waste 	<p>All measures indicated for the previous level</p> <ul style="list-style-type: none"> Use of disposable nitrile gloves by workers who have to interact with shelf materials/products, permanently exposed to customers. Provide, only to workers involved in front-office activities, filtering face masks of type FFP2 or FFP3, after having been informed on their use. In case of difficulty in finding the aforementioned filtering face masks, make available disposable surgical masks.
High	<p>All measures indicated for the previous level</p> <ul style="list-style-type: none"> Assessing the possibility of suspending the activity, within the limits of the law and without prejudicing the free entrepreneurial initiative in the private sector, and the execution of essential and public utility services in the public and private sectors. 	<p>All measures indicated for the previous level</p> <ul style="list-style-type: none"> Increase the frequency of cleaning and sanitizing of the premises. Identify and prepare a suitable room for the isolation of any suspicious cases pending verification by the NHS. 	<p>All measures indicated for the previous level</p> <ul style="list-style-type: none"> Frequent hand washing and sanitizing. Provision of masks, as described in the previous scenario, for all workers. Provision of safety goggles (measure necessary in the health sector). Glove decontamination with hypochlorite after every contact with different inanimate surface, and during doffing procedures.
Very high	<p>All measures indicated for the previous level</p> <ul style="list-style-type: none"> Predisposition and maximum adherence to PPE dressing and undressing protocols 	<p>All measures indicated for the previous level</p> <ul style="list-style-type: none"> Ensure appropriate air-handling systems are installed and maintained in healthcare facilities. The work area must be kept at a negative pressure compared to the atmospheric one Sanitization of the premises through the use of physical means such as ultraviolet irradiation (UV). 	<p>All measures indicated for the previous level</p> <ul style="list-style-type: none"> Provision Isolation gowns

Morgue workers performing autopsies, which generally involve aerosol-generating procedures, on the bodies of people who are known to have, or suspected of having, COVID-19 at the time of their death [70].

5. Conclusions

An outbreak of corona virus was recognized in early January 2020 in Wuhan, China. This virus has been spreading throughout China for at least two months and has been exported to at least 180 more other countries [71,72]. The virus has been named SARS-CoV-2 and the disease has been named COVID-19 (Coronavirus Disease 2019).

Considering the lack of knowledge about how and by whom SARS-CoV-2 is transmitted, our goal was therefore to develop a guide on the application of preventive and protective measures, useful in the workplace, for all activities that involve a relationship with both customers and colleagues, after analyzing the latest publications on SARS-CoV-2 and the other coronaviruses and on the prevention of respiratory diseases.

Among the organizational, environmental and personal preventive measures, as shown in Table 3, the control of the physical conditions, by detecting the temperature, and of flu-like symptoms of the workers, considering that the period of maximum infectivity is the symptomatic one, is a rule that also in the future can be used as an effective preventive measure for any subsequent endemic SARS-CoV-2 waves. Composition, when it is possible, of two or more closed and independent work groups, to be alternated every 14 days to work in the company or in smart working, could help the company to isolate only one group in case of infection and quarantine.

We considered the same for PPE, considering the way in which its use, even in the absence of scientific evidence, prevents the main transmission routes used by the virus through the large droplets emitted with speaking, coughing and sneezing, and through inanimate surfaces.

For this purpose, the combined use of respiratory mask, protective visor and gloves constitutes a useful mechanical barrier to be adopted in work activities where it is not always possible to maintain the recommended safety distances.

For donning and doffing procedures, following CDC doffing guidance, one-step glove and gown removal, double-gloving, spoken instructions during doffing, and use of glove disinfection with hypochlorite may reduce contamination and increase compliance [60–73].

By adopting these organizational, environmental and personal measures, emergency management can be optimized, ensuring the continuation of normal activities and ultimately contributing to reducing the risk of contamination of the workforce and the entire population.

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