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Comparison of the Effectiveness of Different Types of Protective Masks in Reducing the Transmission of the SARS-CoV-2 Virus: A Review Paper

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Abstract

Introduction. Protective equipment has become globally used to protect against respiratory infections in healthcare workers and sick patients. With the emergence of the SARS-CoV-2 virus and the global pandemic, the role of protective masks in reducing the transmission of the new virus has become the subject of much research. Although the protective mask has a significant role in reducing the transmission of infections, wearing it also has certain adverse effects.

Aim. The aim of this review is to show the effectiveness of different types of protective masks in reducing the transmission of the SARS-CoV-2 virus, as well as the comparison of adverse effects when wearing protective masks.

Methods. The method for analyzing the topic of the effectiveness of protective masks included reviews of papers found on the Google search engine, Medline database (via PubMed) and Hrcak. Included in the analysis are scientific papers with clinical trials or review papers, in English and Croatian, regardless of methodology, published since 2020. Included works include topics such as medical masks, respirators, cloth masks and their materials, effectiveness and importance of use, and adverse effects of wearing protective masks. A total of 2,110 articles, original and review papers were found, of which, after a detailed reading and analysis of several authors, 11 were selected that meet the eligibility criteria of this review paper.

Results. There are filter half-masks with/without valve, surgical masks and hygienic or cloth masks. A surgical mask may provide better protection than a cloth mask, although this may depend on the layers and material the masks are made of. Respirator masks are somewhat more effective than surgical masks, but the difference turned out to be insignificant. The most common side effects of wearing masks for a long time are increased secretion of sputum, cough, dyspnea, difficulty when communicating, lack of closeness and feelings of insecurity.

Conclusion. A face mask protects against infection and is associated with a reduced risk of infection. The habit of wearing a mask and the correct way of wearing it proved to be important factors in reducing the risk of infection.

Introduction

Protective masks and respirators have become globally used for protection from respiratory infections in healthcare workers and sick patients. In December 2019, several health facilities in Wuhan, China, reported clusters of patients with pneumonia of unknown cause and similarly to patients with SARS and MERS, these patients showed symptoms of viral pneumonia, including fever, cough, chest discomfort and, in severe cases, dyspnea and bilateral lung infiltration (1,2). When SARS-CoV-2 virus started to appear and caused a global pandemic, it also became an important addition to our arsenal in the fight against the virus and a normal routine for healthy population to wear protective masks (3,4). Coronaviruses have globally affected populations since the early 21st century, but this new SARS-CoV-2 virus caused coronavirus disease (COVID-19) which appeared in Wuhan, China and was declared a pandemic by the World Health Organization (WHO) on March 11, 2020, after the identification of >118 000 cases in 114 countries. COVID-19 started to be a major health burden in many countries around the world and more specifically a burden for the healthcare system (5-7). The role of protective masks in decreasing transmission of SARS-CoV-2 virus started to be the subject of many researches given the global shortages of personal protective equipment during the pandemic. One of the main reasons is that this particular respiratory pathogen is transmitted through direct/indirect contact, through the air with respiratory droplets containing the virus or dispersed aerosol (8-10). Hypothesis is that when a person with COVID-19 breathes heavily, sneezes or coughs, the virus could be excreted in the air. Coughing and sneezing in close contact can potentially cause mucosal or conjunctival infection by infective droplets. If droplets are <5 μm in diameter, they are dispersed hundreds of meters in the air and they can also stay there for a long time. SARS-CoV-2 virion is 0.1 lm in diameter, but it is carried in respiratory droplets that also contain salts, proteins and other components of respiratory fluid (11). To reduce the number of infected people, first advice was physical distancing, but face masks have shown to be potentially effective as they have been used for decades for prevention of viral and bacterial infections, therefore they became mandatory for people during the COVID-19 pandemic next to hand washing, distancing in poorly ventilated settings and eventually vaccination (12,13). Healthcare workers are significantly at risk for a range of infections and various infectious agents that can be transmitted from patients to healthcare workers and vice versa (5). As government officials and public health stakeholders implement measures to slow the spread of SARS-CoV-2, healthcare workers treating COVID-19 patients are among those at highest risk of infection. During the severe acute respiratory syndrome (SARS) pandemic in 2003, healthcare workers made up 21% of global cases. As of February 11, 2020, China's Infectious Disease Information System has reported COVID-19 in 1716 healthcare workers (6).

According to the recommendations of Croatian Institute of Public Health (*Hrvatski Zavod za javno zdravlje - HZJZ*), filter half-masks with/without valves, surgical masks, and hygienic or cloth masks are distinguished. In the community, regular cloth masks and surgical masks can be useful and protective, but in healthcare settings sometimes there is a need for use of respirators (8). The WHO recommended the usage of medical masks for healthcare workers on their workplace, symptomatic people, people infected with SARS-CoV-2 virus, people that were in close contact with COVID-19, elderly and people with preexisting medical condition (3,13,14). Filtering and protection ability from pathogens depends on the type of masks and the materials that are used to make the mask.

Besides that, position of the mask against the skin and face is also important when choosing a mask. It is necessary to consider the porosity of materials and the ability of filtering viruses and respiratory droplets that contain the virus. Size of respiratory droplets can vary but according to current knowledge, aerosol containing droplets smaller than 5 μm are the primary source of respiratory infections and can remain in the air for about 3 hours. Factors that affect efficacy of face masks against COVID-19 are the size of respiratory droplets, mode of the expulsion of respiratory droplets, materials, fit of face masks and lastly technique used in removing and reusing masks. Considering that SARS-CoV-2 is expelled from the respiratory tract while talking, sneezing or coughing, for a mask to be effective, it must be able to filter particles of various sizes. The combination of material, number of layers, the presence of filters and how tightly the material is woven will also affect the efficacy of the face mask (7). Masks are a key to stop or to slow down viral transmission and they can be used either as a protection, or as a prevention of future transmission and many different types of masks offer different levels of protection. They can be reusable or disposable. Reusable ones include industrial half face or full face respirators with filters attached and homemade or commercial cloth masks; disposable ones include surgical masks, N95 respirators, and KN95 respirators. They all serve the general purpose of providing some form of protection against contaminants in the air (15). Despite the positive side of protective masks, in another aspect they can represent some kind of a barrier and can have a negative impact on therapeutic interventions and patient-clinician relationships, as well as the well-being and resilience of both patients and staff. They can create a physical barrier to effective communication, create a psychological barrier to the development of therapeutic relationships, and disrupt non-verbal communication (16,17).

Methods

The method for analyzing the topic of the effectiveness of protective masks included reviews of papers found on the Google search engine, Medline database (via PubMed) and Hrčak. Included in the analysis are scientific papers with clinical trials or review papers, in English and Croatian, regardless of methodology, published since 2020. Included works include topics such as medical masks, respirators, cloth masks and their materials, effectiveness and importance of use, and adverse effects of wearing protective masks. The total of 2,110 articles, original and review papers were found, of which, after a detailed reading and analysis of several authors, 11 were selected that meet the inclusion criteria for the needs of this review paper.

Analysis

The selected works were analyzed in four steps. In the first step, those articles whose titles corresponded to the selected keywords that were entered in the Medline (Via PubMed) database, Google search engine and Hrčak were analyzed. In the second step, those works that were published in the period from 2020 were analyzed. In the third step, summaries of papers corresponding to the title and year of publication were analyzed. In the fourth step, the articles are divided into groups, depending on the subject area they cover (types of protective masks, effectiveness of protection and side effects of long-term wearing of masks). Content analysis was done by several authors. The connection between the effectiveness of protective masks in the transmission of the virus and the type of protective mask was investigated.

Results

Medical/ Surgical masks

Coronaviruses are found in aerosol particles compared to large droplets and can be expelled by normal breathing and wearing a surgical mask can prevent the virus from being exhaled into the environment (3). They are made of 3 layers of non-woven textile. Non-woven polypropylene, 20 grams per square meter (gsm) made by a spun-bond process is commonly used for the outer and inner layers whereas 25 gsm made by melt-blown technology is used for the filter.

Polystyrene, polyethylene, polycarbonate, polyester can also be used (8,18). The inner layer is made of material that absorbs drops of saliva and respiratory secretions of the user, which also increases the comfort of wearing the mask. The middle layer forms a filter that prevents the passage of pathogens of certain sizes. The efficiency of the bacterial filtration of the surgical mask, the standard size of particles with a diameter of about 3.0 μm and larger, is 95% for type I and 98% for type II. The outer layer of the mask is water-repellent to ensure the repellency of body fluids and larger respiratory droplets. They are mostly made of polypropylene fibers, and the filter layer is made of finer microfibers (8,15).

FFR / FFP

FFR (respirators) and FFP (Filtering Face Piece) are particle filters that provide protection against particles of solid and liquid aerosols and bioaerosols. They work on the principle of negative pressure and filter the inhaled air; whereby particulate contamination is retained on the outer surface and inside the filter structure and are designed to closely fit without leaving spaces around borders. Exhaled air is also filtered in a mask without a valve, and in this way, they ensure self-protection and external protection, while masks with a valve for exhaled air that goes out unfiltered into the external atmosphere ensure only self-protection of the user. FFP masks are divided into three classes: FFP1, FFP2, FFP3. In the mentioned masks, the efficiency of filtering particles smaller than 300 nm, with an average size of filter pore diameter of ~300 nm (necessary for unhindered breathing of the user), is ensured by the multi-layered non-woven three-dimensional structure of the mask made of extremely fine micro- and nanofibers of small diameter and the application of electrostatically charged filter, whose action is based on the binding mechanism of electrostatically oppositely charged small particles (primarily viruses, including SARS- CoV-2). All of the above makes them applicable in the context of protection against the coronavirus, unlike the FFP1 class mask, which provides effective protection only against dust and sand. Filter protective masks of class FFP2 and FFP3 are made of a minimum of 4 layers. An example of an N95 mask shows an outer layer made of a hydrophobic polypropylene fiber material that prevents the passage of moisture, droplets and aerosols, followed by a filter layer and an intermediate layer that strengthens the mask and increases its thickness. The inner layer is also made of a hydrophobic material, the task of which is to minimize the intake and passage of moisture inside the mask and thereby increase the filtering efficiency. FFR and FFP masks are regulated and are tested for fluid resistance, filtration efficiency (particulate filtration efficiency and bacterial filtration efficiency), flammability and biocompatibility (7,8,15).

Cloth masks (non-medical masks)

Cloth masks (also known as barrier masks, community face-coverings, non-medical face masks) cover the user's nose, mouth and chin and are made from one or more layers of commercially available textile materials (woven, knitted, non-wove, etc.) and like the others masks must have a part that attaches to the head or ears. They can be disposable or reusable. Cloth masks for single use are most often made from non-woven textiles, and cloth masks for multiple use from fabrics or knits (8). Non-medical masks are readily available from many local sources and therefore impossible to adequately regulate, which seems to be a problem in managing materials and protection assessment. Many versions provide an inadequate seal to the mouth and nose so there is poor fluid resistance and frequent readjustment. The efficacy of a cloth mask can depend on the material used. The most protective cloth face masks require at least three layers with a hydrophilic inner layer to consume moisture from the wearer's breathing and hydrophobic outer layers (7,18).

Efficiency and differences of masks, and their importance of wearing

Wanting to test efficiency and difference between medical mask and respirator, C. Raina MacIntyre et al. carried out research on preventing upper respiratory tract bacterial colonization and co-infections in hospital health care workers. Subjects were randomized to mask or respirators and had to wear it properly and correctly on every shift (8- 12 h) for four weeks. Participants were given three masks every day for the medical mask group or two N95 respirators. They had to store the mask in a paper bag once they removed it. They were also instructed to observe proper hand hygiene prior to/after removal of the mask. All participants were followed up for four weeks for development of respiratory symptoms and for an additional week after mask wearing had ceased (to account for incubation of infections acquired in week 4). The rates of bacterial detection were lower for N95 respirators compared to medical masks (2.8% and 5.3% respectively). N95 respirators were significantly more protective than medical masks against the laboratory-confirmed presence of bacteria. N95 (but not medical masks) demonstrated efficacy against multiple bacterial pathogen colonization as well as co-infection with a virus and bacteria and against dual virus infection. They demonstrated 59% efficacy of N95 respirators against any co-infection and 67% against bacterial/viral co-infection (5). Furthermore, JJ Bartoszko et al. in their systematic review of preventing COVID-19 with medical masks or respirators found that when seasonal coronavirus was tested for by PCR in this non-cluster randomized trial of medical masks versus N95 respirators, 4.3% of nurses in the medical mask group had PCR confirmed coronavirus infection compared with 5.7% in the N95 respirator group. On the other side, no convincing evidence was found showing that medical masks are inferior to N95 respirators for protecting healthcare workers routine care and non-aerosol-generating procedures. Medical masks performed similarly to N95 respirators in preventing laboratory confirmed influenza infection. For influenza-like illnesses and clinical respiratory illnesses, the point estimates favored N95 respirators; the findings support preliminary epidemiological data from a case-report of respiratory protective devices for COVID-19. Forty-one healthcare workers were exposed to aerosol-generating procedures from a patient with severe pneumonia, who later tested positive for SARS-CoV-2 during COVID-19 surveillance. These procedures included endotracheal intubation, extubation, non-invasive ventilation and exposure to aerosols in an open circuit. All of the exposed healthcare workers tested negative 14 days after their date of exposure, despite 85% having worn surgical masks during the high-risk procedures and not respirators (6). According to another study, there was also a minimal difference in protection between N95 masks and surgical masks, with a hazard ratio of 0.84 and a 95% confidence duration of 0.36–1.99, indicating no significant difference in risk (19). In 2013, laboratory studies have demonstrated the ability of surgical masks to provide inward and outward protection against viruses. They tested eight different surgical masks against influenza virus in droplets/aerosols of size 1–200 lm and found that the amount of virus detected behind the mask was reduced by an average 83%. In another research, a variety of cloth materials removed 49% to 86% of aerosolized bacteriophage MS2, compared to 89% removal by a surgical mask. According to fit tests on 21 adults in the same study, homemade, 100% cotton masks provided inward filtration efficiencies of 50%, compared to 80% for surgical masks. Homemade masks made from tea cloths had an inward filtration efficiency of 60%, compared to 76% for a surgical mask. At the most penetrating particle size, the vacuum bag, microfiber cloth, and single-layer surgical type mask had material filtration efficiencies >50%, while the other materials had much lower filtration efficiencies. However, these efficiencies increased rapidly with particle size, and many materials had efficiencies >50% at 2 lm and >75% at 5 lm. The vacuum bag performed best, with efficiencies of 54–96% for all three metrics, depending on particle size. The thin acrylic and face shield performed worst. Inward protection efficiency and outward protection efficiency were similar for many masks; the two efficiencies varied for stiffer materials and those worn more loosely (e.g., bandana) or more tightly (e.g., wrapped around the head) compared to an ear loop mask. It was indicated that the fit of the mask was important (11). Another study demonstrated that homemade masks made of tea cloth delivered safety during short and long-term activities. Ma et al. demonstrated that while N95 respirators blocked 99.98 % of avian influenza virus, cloth homemade masks and surgical masks were comparative 95.15 % and 97.14 %. These homemade masks were created from polyester and kitchen towels and were used in the experiment. A more comprehensive study was conducted by Davies et al., to test the efficacy of homemade masks against bacterial and viral aerosols with a size of 0.95–1.25 μm, and bacteriophage MS2 with a size of 0.023 μm. The masks were made from different common household materials, including 100% cotton T-shirt, scarf, tea towel, pillowcase, antimicrobial pillowcase, vacuum cleaner bag, cotton mix, linen and silk. All materials were able to block the microorganisms in some ways and they all worked better in the case with particles that were larger in size. Although the surgical mask as a control sample has the highest efficacy, the vacuum cleaner bag, tea towel, and cotton mix also showed filtration efficiency of higher than 70%. The ones with the lowest efficiency were the scarf, pillowcase, and silk, most of which however still had >50% efficacy (15).

Possible side effects after long use of masks

According to the study conducted by Dimitra S. Mouliou et al. that researched masking preference and respiratory side effects, amongst 4107 participants, 63.4% of the mainly female responders preferred medical/surgical masks, 20.5% responders who were mainly men preferred cotton cloth masks; and lastly 13.8% preferred FFP/(K)N95 masks. COVID-19 history was less common in FFP/(K)N95 compared to medical/surgical (9.2% vs. 15.6%, $p < 0.001$) or cloth masks (9.2% vs. 14.4%, $p = 0.006$). Compared to the control group (rare mask-wearing, non-smokers and without lung conditions), those wearing one medical mask were more likely to report frequent sputum production (4.4% vs. 1.9%, p=0.026) and frequent cough (4.4% vs. 1.6%, p=0.013), and those wearing FFP/(K)N95 masks were more likely to report frequent cough (4.1% vs. 1.6%, p=0.048). Compared to the control group, those preferring cotton cloth masks were more likely to report a frequent cough (7.3% vs. 1.6%, p=0.0002), sputum production (6.3% vs. 1.9%, p=0.003) and dyspnea (8% vs. 1.3%, p=0.00001) (13). Other research suggests that wearing masks acts as a physical barrier and affects the implementation of therapeutic procedures and the relationship between health professionals and patients (20). In addition to the physical, masks are also associated with psychological barriers, alienation and reduced communication (16,17).

Discussion

With the emergence of a new SARS-CoV-2 virus, wearing protective equipment, specifically protective masks, has played an important part in lowering the risk of an infection. Many COVID-19 transmissions arise from people who are pre-symptomatic or asymptomatic. Infected patients can transfer SARS-CoV-2 just a few days before manifesting clinical symptoms or during the incubation period. Wearing a mask when keeping a safe distance is not possible most likely reduces the spread of virus containing droplets and therefore the risk of transferring SARS-CoV-2 decreases. Wearing a protective mask in the community and in medical settings has been recommended as a straightforward and low-cost strategy to decrease virus transmission by preventing the droplets from leaving the infected wearer and coming into the environment and also in preventing the droplets from entering the respiratory tract. Numerous governments and public health agencies around the world have advocated the wearing of masks in public settings (19,21,22). Mathematical modelling on the 2009 (H1N1) influenza concluded that if masks were enforced early at 100 versus 1000 infectious people, the number of outbreaks would be reduced significantly. Everyone, not only infectious individuals, should wear masks to significantly reduce the number of cases. In this model, the effectiveness of surgical masks was low and insignificant (15). For N95 respirators operating at 20% effectiveness, a significant reduction of influenza (20%) was achieved if only 10% of the population wore them. If 25% and 50% of the population complied, the reduction would be 30% and 36%. Similar conclusion was made for COVID-19 theoretical model. When a minimum of 80% of people wore masks, the impact on the pandemic was significant. However, this intervention failed when 50% or less of the population wore masks (15). It is recommended using protective masks for general population, especially for health care workers and people caring for COVID-19 patients. Respirators and surgical masks hold monopoly over cloth masks because of their materials and layers, but a cloth mask made of specific material with layers was shown to be useful too. The number of layers, the properties of the fibers including diameter and electrostatic charges, and the material composition all contribute to differences in filter quality factors (11). Medical/surgical masks are primarily used for medical purposes, in operating rooms and healthcare institutions with similar requirements and serve to prevent the spread of droplets from the user's exhaled air to the patient or another person and in certain circumstances to protect the user from blood splashes and other potentially contaminated body fluids. Their use is one-time use, and they can to a certain extent protect the mouth and nose area of the user from the direct impact of larger droplets from another person, as well as from the transmission of pathogens by direct contact with the hands (8). Regarding respirators and filtering face piece, particle filtering efficiency size around 0.3 μm in the filter material of FFP2 masks is at least 94% and FFP3 masks at least 99%. Approximately the same effectiveness of respiratory protection is provided by filter half-masks from the United States of America (compliant with NIOSH 42 CFR 84) marked N95, N99 or N100, and from China compliant with the requirements of the national standard GB 2626:2019 and marked with KN95, KN99 or KN100. The mark N indicates that they are non-oil resistant, whereby the efficiency of filtering particles with a size of about 0.3 μm in the filter half-masks marked N95 and KN95 at least 95%, the filter half-masks marked N99 and KN99 at least 99%, and filter half-masks marked N100 and KN100 at least 99.97% (8). Cloth masks are intended for users who do not have clinical symptoms of a viral or bacterial infection and do not come into contact with people who have such symptoms. They slow down and reduce the range of respiratory droplets of saliva and secretions from the user's nose, mouth and airways that occur when speaking, coughing and sneezing, and can limit the penetration of larger respiratory droplets containing the virus from external sources into the user's nose and mouth area, although they do not guarantee their protection (8, 20). They have filtration ability at 3-60%. Considering both filtration efficacy and pressure drop, the best material for a cloth mask, especially when homemade, was found to be 100% cotton t-shirt material or pillow case material. People can be instructed to use these cloth masks for protection if medical masks are unavailable in stocks because it can provide basic protection (19). Given the size of the SARS-CoV-2 virus, surgical masks cannot completely prevent the inhalation of such small particles and thus do not provide complete protection against biological agents of the disease (8,15). Looking at many studies on the differences between masks, one thing has proven to be certain, they are necessary in controlling infection, specifically useful for reducing the risk of contracting SARS-CoV-2. Emergence of the virus initiated the need for wearing masks and assessing their ability to protect against the spread of the infection. The virus, which primarily originated from animals, began to spread from person to person. SARS-CoV-2 virus is primarily transmitted through droplets when sneezing and coughing, but it can also spread indirectly and these particles can remain in the air for some time. It is assessed as a virus that spreads rapidly, although its spread can be significantly influenced with the help of preventive measures such as hand washing, avoiding contact with the infected, early detection and isolation of the infected patient. Five hospitals participated in a SARS study conducted in Hong Kong and it was revealed that staff who adopted all four protective measures like masks, gloves, gowns and handwashing remained healthy. Staff who disregarded at least one of these practices became infected, but the wearing of masks was the most significant measure given that other three measures showed no additional significant protection to mask wearers, therefore stopping droplet transmission at the face level is critical (15). Given that the incubation period is estimated between 2 and 14 days and due to the occurrence of asymptomatic cases, they declared wearing protective masks an important preventive measure. Many studies and systematic reviews with meta-analysis had shown significant association between face mask use and SARS-CoV-2 infection. The results are showing that face mask provides protection from infections and is linked with a reduced risk of an infection. In addition, airborne simulation experiments have shown that cotton masks, surgical masks and N95 masks had a protective effect in terms of transmission droplets/aerosol and that the protective efficiency was higher when masks were worn by the spreader of the virus (3,12,23). Furthermore, habit of wearing a mask and the correct way of wearing it was showed to be an important factor for decreasing a risk of an infection. In studies from 2011, 2013, 2015 and 2019, the results showed that respirators should be worn during the entire shift in order to provide the best protection (3). Use of respirators and masks only when it comes to high-risk procedures has not been shown to be protective. Several studies have found the SARS-CoV-2 virus in air samples in surroundings in intensive care units and COVID-19 wards for at least 3 hours after aerosolization, which supports the results that protective masks and respirators must be used continuously (3). However, aerosol generating procedures have not been shown to increase infection associated with aerosol transmission, and in some cases the high infection rate can be related to poor adherence to standard precautions, and may also be related to high levels of exposure to virus from droplet clouds rather than transmission of indications by air route (24,25). Also, the fit of the masks is very important to consider for protecting yourself against COVID-19. It should fit tightly enough to create a seal but comfortably enough to prevent frequent repositioning. In general, a mask is less helpful if it is not covering the nose and mouth. Frontline healthcare workers have significant exposure to SARS-CoV-2 during the work and infected healthcare workers can further transmit the virus to patients if protective equipment is not worn correctly or if hand hygiene is poor (26). Moreover SARS-CoV-2 droplets can be transmitted by direct contact or smear transfection modality when hands are contaminated by touching the nose or face, thereby coming into direct contact with others, e.g. by shaking hands or touching the mask and touching nearby objects (27). Masks should also be disposed after some time of wearing, after single use for 4-6 hours if continuously used. Breathing dampens the mask, and when there is excessive moisture, the mask becomes airtight so it loses its protective effect for the wearer and the environment, also pathogens can accumulate in the mask which means masks should be replaced regularly (18,22). If the mask gets moist or wet, it should be thrown away and replaced immediately and should never be washed with soap and water or disinfected with alcohol and reused, because it neutralizes the electrostatic charge of the filter layer and compromises its structural integrity (18). The cloth masks can be washed with soap and water and reused till the fabric is intact (7). In reviewed researches, it was shown that respirators are slightly more effective than surgical masks, but the difference has shown itself unsignificant. Surgical mask can be more protective than cloth masks, although it all depends on the layers and material that masks are constructed of. Any mask can decrease the number of microorganisms in some manner. Measurement of material filtration efficiencies can provide initial guidance on potential mask effectiveness for preventing outward and inward transmission (28). There is a need for additional researches and studies with a higher number of subjects, control groups and types of masks positioned in various conditions. Masks and respirators made of materials with larger pore sizes, such as cotton and synthetic fabric, will not be able to effectively filter viruses compared to those made of materials with smaller pore sizes. Masks and respirators made of or coated with water-resistant materials are more effective against large virus-laden respiratory droplets and fluid spills (15,28,29). Regarding non-medical masks made of different materials, giving general indications on the choice of materials and their composition is difficult because it is not possible to evaluate the efficiency for filtering different liquids or particles that can be emitted when breathing, sneezing or coughing in different environmental conditions. This is important to point out because the air flow rate, temperature, humidity and duration of use of the mask can affect the efficiency of the filter media (30). According to the American Society of Testing and Materials (ASTM) F2100 standard, there are specific performance requirements for materials used in medical face masks (15). These are particulate filtration efficiency (PFE), bacterial filtration efficiency (BFE), fluid resistance, differential pressure and flammability. As face masks are important part of the personal protective equipment for medical use, these characteristics ensure consistency in mask production and valid efficiency of face masks (15,30). While the wearing of masks is undeniably vital in reducing the risk of viral respiratory illness, staff on the ground have noted consequences with regards to the feasible application of therapeutic interventions and patient-clinician relationships as well as the well-being and resilience of both patients and staff (20). In covering a significant proportion of the face, which creates a physical barrier to effective communication, masks could pose a substantial psychological barrier to the development of therapeutic relationships, as relentless lack of familiarity and personal connection can evoke feelings of loneliness and isolation, the disruption of non-verbal communication due to the loss of facial expression recognition under the mask can also increase feelings of insecurity and discouragement (16,17). It can lead to misjudging situations as well as delayed and incorrect response. Also, some perceived interferences of integrity, self-determination and autonomy, coupled with discomfort, often contribute to substantial distraction and may ultimately be combined with the physiologically mask related decline in psychomotor abilities, reduced responsiveness and an overall impaired cognitive performance. To compensate for the effects of mask wearing, the staff should invest more time and effort to establish effective channels of communication (31,32).

Conclusion

For preventing droplet transmission from infected individuals, surgical mask should be the first choice for the community and a cloth mask should only be advised as a last resort if surgical masks are not available. However, cloth masks are better than no mask at all. For a health care worker, the double layer surgical mask or a respirator are advised in all routines and general procedures. Following other protective measures is also important in reducing a risk of spreading the infection, as wearing masks responsibly and correctly during all times that is needed. The most common side effects when wearing masks for a long time are increased production of sputum, cough and dyspnea. In addition to the physical barrier and difficult communication, masks are associated with difficulties in the implementation of therapeutic procedures and disrupt the connection between patients and health professionals.

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USPOREDBA UČINKOVITOSTI RAZLIČITIH VRSTA ZAŠTITNIH MASKI U SMANJENJU PRIJENOSA VIRUSA SARS-CoV-2: PREGLEDNI RAD

Sažetak

Uvod. Zaštitna oprema postala je globalno korištena za zaštitu od respiratornih infekcija kod zdravstvenih radnika i bolesnih pacijenata. S pojavom virusa SARS-CoV-2 i globalnom pandemijom, uloga zaštitnih maski u smanjenju prijenosa novog virusa postala je predmetom mnogih istraživanja. Iako zaštitna maska ima važnu ulogu u smanjenju prijenosa infekcija, njezino nošenje ima i određene neželjene učinke.

Cilj. Prikazati učinkovitost različitih vrsta zaštitnih maski u smanjenju prijenosa virusa SARS-CoV-2, kao i usporedbu neželjenih učinaka pri nošenju zaštitnih maski.

Metode. Analiza teme o učinkovitosti zaštitnih maski uključivala je preglede radova na tražilici Google te baza podataka Medline (putem PubMeda) i Hrčak. U analizu su uključeni znanstveni radovi s kliničkim ispitivanjima ili pregledni radovi, na engleskom i hrvatskom jeziku, bez obzira na metodologiju, objavljeni od 2020. Uključeni radovi sadrže teme kao što su medicinske maske, respiratori, platnene maske i njihovi materijali, učinkovitost i važnost korištenja te neželjeni učinci nošenja zaštitnih maski. Pronađeno je 2110 članaka, originalnih i preglednih radova, od kojih je nakon detaljnog čitanja i analize više autora odabrano 11 koji zadovoljavaju uključujuće kriterije za potrebe ovog preglednog rada.

Rezultati. Razlikuju se filtarske polumaske s ventilima ili bez njih, kirurške maske te higijenske ili platnene maske. Kirurška maska može biti bolja zaštita od platnene maske, iako to može ovisiti o slojevima i materijalu od kojeg je maska izrađena. Maske respiratori nešto su učinkovitije od kirurških maski, no razlika se pokazala neznatnom. Najčešći su neželjeni učinci pri dugotrajnom nošenju maski pojačana produkcija sputuma, kašalj, dispneja, otežana komunikacija, nedostatak bliskosti i osjećaj nesigurnosti.

Zaključak. Maska za lice štiti od infekcija i povezuje se sa smanjenim rizikom od infekcije. Navika nošenja maske i pravilan način nošenja pokazali su se važnim čimbenikom za smanjenje rizika od infekcije.

Ključne riječi: zaštitna oprema, učinkovitost zaštitnih maski za lice, nuspojave nošenja maski, SARS-CoV-2, infekcija