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Side effects induced by using the protective equipment and tips for avoiding them

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Abstract

English:

Severe acute respiratory distress syndrome (SARS)-CoV-2, the cause of Coronavirus disease 2019 (COVID-19), has caused a global pandemic with worldwide morbidity, mortality and disruptions to society. Undoubtedly, the global spread of the COVID-19 pandemic had warranted universal precautions to slow the rate of infection. Hand hygiene, social distancing, regular disinfection of surfaces and avoidance of touching one's face are some of the measures which have been used in an attempt to decrease exponential disease spread. The epidemiology of SARS-CoV-2 had indicated that most infections were spread by respiratory droplets, through exposure to an infected individual at close range. For this reason, healthcare professionals are mandated to wear personal protective equipment (PPE) for a prolonged period of time when caring for COVID-19 patients. On the other hand, the COVID-19 pandemic has led to an increased use of face protection such as surgical masks and eye protection not only amongst healthcare workers but also now the general public. Prolonged use of N95 and surgical masks by healthcare professionals during COVID-19 has caused adverse effects such as headaches, rash, acne, skin breakdown and impaired cognition. This review delves into various adverse effects of prolonged mask use and provides recommendations to ease the burden on healthcare professionals. The magnitude of this condition is clinically significant and might worsen if the current outbreak further continues to spread widely and stays for a longer time, affecting the work performance of healthcare workers. Perhaps better strategies are needed for designing various PPE and reducing the duration for which healthcare workers are required to use them.

Keywords

COVID-19 • personal protective equipment • adverse effects

Efecte secundare induse de utilizarea echipamentului de protecție și sfaturi pentru a le evita

Rezumat

Romanian:

SARS-CoV2 cauza bolii Coronavirus 2019 (COVID-19), a provocat o pandemie globală cu morbiditate, mortalitate și perturbări pentru societate la nivel mondial. Fără îndoială, răspândirea globală a pandemiei de COVID-19 a impus precauții universale pentru a încetini rata infecției. Igiena mâinilor, distanțarea socială, dezinfectarea regulată a suprafețelor și evitarea atingerii feței au fost folosite pentru încercarea de a scădea răspândirea exponențială a bolii.

Epidemiologic majoritatea infecțiilor cu SARS-CoV2 au fost răspândite prin picăturile respiratorii, prin contact cu o persoană infectată. Din acest motiv, profesioniștii din domeniul medical sunt obligați să poarte echipament individual de protecție (EIP) pentru o perioadă lungă de timp, atunci când îngrijesc pacienții cu COVID-19. Pe de altă parte, pandemia de COVID-19 a condus la o utilizare sporită a echipamentelor de protecție facială, cum ar fi măștile chirurgicale și protecția ochilor, nu numai în rândul cadrelor medicale, ci și în rândul populației.

Utilizarea prelungită a măștilor chirurgicale sau de tip N95 de către cadrele medicale a produs diverse efecte adverse: dureri de cap, erupții cutanate, acnee, descuamarea pielii și afectarea cogniției.

Această lucrare se concentrează asupra diferitelor efecte adverse apărute ca urmare a utilizării prelungite a măștilor, oferind recomandări pentru a ușura povara acestora.

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Magnitudinea infecţiei este semnificativă clinic şi s-ar putea agrava dacă epidemia actuală încă se răspândeşte la nivel mondial, persistând o perioadă lungă de timp, afectând performanța profesională a cadrelor medicale. Sunt necesare strategii mai bune pentru proiectarea diferitelor echipamente de protecție personală și reducerea timpului de expunere a acestora de către profesionişti.

Cuvinte-cheie

COVID-19 • echipament de protecţie • efecte adverse

Introduction

Frontline healthcare workers in all major hospitals were mandated to wear personal protective equipment (PPE) while caring for suspected or confirmed Coronavirus disease 2019 (COVID-19) patients, which involved the donning of close-fitting N95 face masks, protective eyewear (mainly goggles), gowns and surgical gloves.

According to the Center for Disease Control and Prevention (CDC), different levels of PPE are used, and these are designed taking into account the need to address, variously, standard, contact, droplet and airborne precautions (1).

- Standard precautions include: hand hygiene, respiratory hygiene with cough etiquette, proper patient placement and handling/cleaning of equipment, devices, environment and laundry, as well as following sharp safety procedures.
- Contact precautions are used when the transmission is through direct contact with an infected individual or with contaminated items or bodily fluids.
- Droplet precautions are initiated in instances when the infection is spread through direct contact with contaminated droplets – i.e. talking, sneezing and coughing.
- Airborne precautions are necessary for airborne transmissible illnesses.

CDC recommends that PPE include N95 masks/respirator, eye protection, gloves and gowns, in addition to the standard precautions referenced previously (Figure 1) (2,3). Also, the CDC and WHO recommend wearing N95 masks during the care of patients with highly transmissible diseases such as tuberculosis, severe acute respiratory distress syndrome (SARS) and COVID-19. The 'N' in N95 stands for NIOSH, the National Institute for Occupational Safety and Health of the United States and '95' indicates filter efficiency of particles. Thus, an N95 mask is 95% effective at filtering airborne particles including very small ones (≥300 nm). The SARS Coronavirus is 100 nm in size, but when expelled from patients, is usually larger because it is enveloped in saliva as droplets (3,4).

In comparison, while surgical masks provide a barrier against large respiratory particles, they are ineffective at providing protection against entry of smaller particles. Surgical masks also do not prevent leakage around the mask when the user

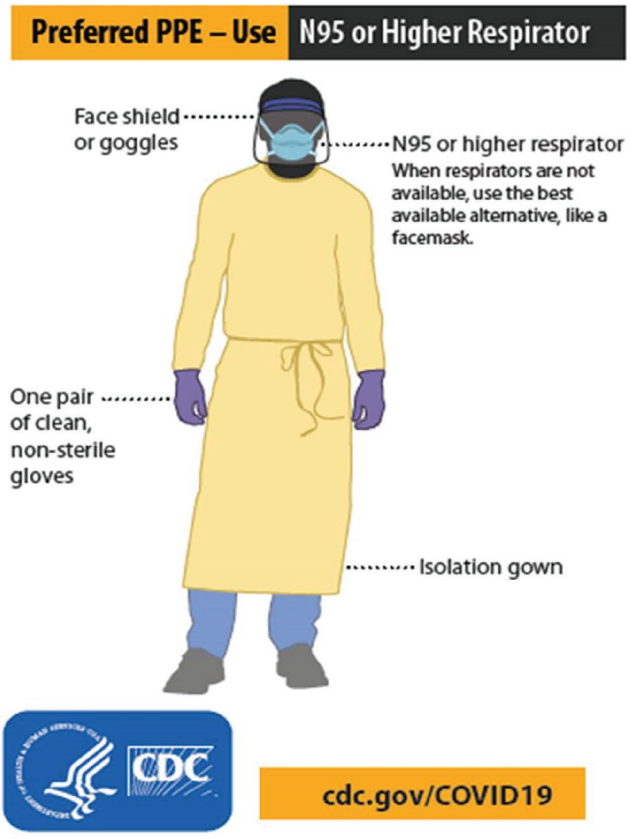


Figure 1. PPE. PPE, personal protective equipment; CDC, Center for Disease Control and Prevention; COVID-19, Coronavirus disease 2019.

inhales. Therefore, surgical masks are ineffective and do not provide enough protection when performing direct care for patients with COVID-19 (Figure 2).

Mask wearing and sensitivity

Wearing masks for a prolonged amount of time causes a host of physiological and psychological burdens and can decrease work efficiency. Activity cannot be performed as long or as efficiently while wearing masks as compared to when masks are not worn. Additionally, the timeframe that an activity can



Figure 2. Types of mask.

be sustained is decreased when wearing masks and PPE. Prolonged use of N95 or surgical masks and eye protection can cause the following adverse effects:

- Physical adverse effects: headaches, difficulty in breathing;
- Adverse skin reactions: acne, skin breakdown, rashes, contact dermatitis and skin injuries from pressure effects (redness and dryness), as well as exacerbation of any underlying skin conditions;
- Impaired cognition.

All of these reactions also interfere with vision, communication and thermal equilibrium (3).

The scientific literature mentions PPE-associated headaches, specifically those arising from the combined usage of the N95 face mask and protective eyewear (especially goggles).

Headaches

Headaches related to prolonged mask use can be attributed to mechanical factors, hypercapnia and hypoxemia. Tight straps and pressure on superficial facial and cervical nerves are mechanical features causing headaches. Cervical neck strain from donning PPE, sleep deprivation, irregular mealtimes and emotional stress are other causes of headaches among healthcare professionals required to undergo prolonged mask use. Tight fitting masks cause inadequate ventilation and increased levels of carbon dioxide (CO_2), known as hypercapnia. Symptoms of hypoxemia such as chest discomfort and tachypnea are also noted in healthcare professionals with prolonged mask use. Exhaled CO_2 builds up between the mask and face, and increased levels of CO_2 cause confusion, impaired cognition and disorientation (3,5).

A previous study among healthcare providers wearing the N95 face mask during the 2003 SARS epidemic in Singapore reported new onset face-mask–associated headaches with a prevalence rate of 37.3% (6,7). Another study among nurses working in a medical intensive care unit reported headache as one of the main factors accounting for suboptimal N95 face mask compliance (6,8).

To *prevent headaches and impaired cognition*, the following measures are recommended: frequent short breaks, neck massage, increased hydration especially before start of the shift, alternating between surgical and N95 masks (if possible), wearing an N95 mask with a filter to allow for better ventilation and wearing a mask that fits one's face best (5,9).

Acne

The most common adverse reaction reported to the N95 mask was acne, and this has two plausible explanations. First, a hot and humid microclimate found in the facial region covered by masks causes discomfort and hyperthermia. This may create a situation where the healthcare professional is unable to recognise dangers and perform manual tasks, and it also significantly affects motor skills. Second, the moist environment and pressure from tight-fitting masks also block facial ducts (6,10).

To manage acne, the following steps are recommended:

- moisturising skin and lips before and after shifts;
- avoiding facial makeup and using facial cleanser wipes throughout the shift to cleanse the skin;
- considering products with salicylic acid or anti-bacterial agents: benzyl peroxide gel or azelaic acid.
- avoiding comedogenic or occlusive makeup; mineral-based makeup may be preferable.

In severe cases, prescription products may be needed, such as topical retinoids or topical/oral antibiotics (9,11,12).

Pressure injuries

Pressure from the mask can cause skin indentation and minor injuries. Frequent PPE and mask changes may cause shearing and breakdown of the skin, and breakdown on the bridge of the nose and cheekbones can be attributed to tight-fitting masks and goggles that put pressure on these specific areas.

The general prevalence rate of skin damage caused by enhanced infection-prevention measures was 97% among first-line health care workers. The affected sites included the nasal bridge, hands, cheek and forehead, with the nasal bridge being the most commonly affected (83.1%). Among a series of symptoms and signs, dryness/tightness and desquamation were the most common symptoms (70.3%) and signs (62.2%), respectively (13).

However, the prolonged and continuous use of face masks, respirators and goggles/visors result in constant friction and pressure forces on tissues, causing skin lesions. Epidemiological data reveal that the injuries associated with the use of N95 masks most frequently reported by professionals are acne (59.6%), facial pruritus (51.4%) and rash (35.8%) (6,14).

It is known that standard soap is alkaline and has been shown to change skin pH; and also, it can damage the skin barrier function. Most of the indentations will be resolved spontaneously (11,14). To help prevent or minimise skin problems while wearing a mask:

- apply compresses with three to four layers of gauze soaked in cold water/normal saline applied to the skin for around 20 min every 2–3 h;
- use a mild skin cleanser (or soap substitute) or micellar water; moisturisers can be applied to intact skin before and after wearing a surgical mask;
- use a silicone dressing under your surgical mask and behind your ears ⇒to reduce pain, shear and friction;
- avoid fragranced products, hydrocolloids and greasy creams if you are prone to acne;
- avoid using hot water or ethanol or other irritants to clean your skin.

It is especially relevant to note that anti-ageing skin care products containing glycolic acids or retinoids can be very irritating, especially when the skin barrier is damaged or compromised. These products may also exacerbate skin sensitivity.

Allergic Reactions

Allergic Reactions are rare. There are very few chemicals used in masks, and reactions are most likely irritation rather than allergy (11). Monitor areas that may contribute to a reaction:

- the glue strip along the nose;
- nose bridge that contains a metal wire for moulding;
- where the mask is in contact with cheeks.

Urticaria and contact dermatitis

Urticaria and contact dermatitis can occur from sensitivity to components of masks and PPE. Increased temperature, moisture and friction cause skin barrier damage and make the skin more susceptible to irritation. This may cause mild redness and dryness where the mask touches the skin. Allergy from masks is very uncommon. Irritant contact dermatitis is nearly always the cause.

Formaldehyde is a chemical used in PPE that some are sensitive and/or allergic to. Others may react to thiuram which is found in the ear loops of surgical masks (3,15). Some masks contain harsher fabrics than others: try a ‘softer’ variety; different people react differently.

The very few reported allergic reactions to masks include isocyanates in a Chinese N95 mask, allergic contact dermatitis to rubber chemicals in the elastic of a Chinese mask and formaldehyde in a polypropylene facial mask in Belgium (9,11,14).

What should you do if the mask irritates your skin?

- Change the brand or type of mask to a softer variety if available.
- Put a soft dressing or a thin silicone pad or a barrier wipe under the surgical mask where irritation occurs.
- Increase moisturiser use, particularly at night when you might choose to use a greasier variety.
- If significant dermatitis persists, use low-strength topical steroids.

Note: If the irritation worsens ⇒ you need to see a dermatologist.

Other skin conditions aggravated by masks

Itchy skin – caused by various skin conditions or may be simply due to friction from the mask.

Dry skin – increased temperature, moisture and friction cause skin barrier damage.

Pressure urticaria – rarely, urticaria may be caused by pressure from masks, particularly in people with underlying dermographism (where there is histamine release causing skin whealing in response to light pressure).

Skin conditions such as *rosacea*, *seborrheic dermatitis* and *atopic eczema* can be aggravated by the heat and sweating which occur when wearing a mask. Previous studies have revealed that hand eczema is quite common in health care workers and the risk factors include frequent hand hygiene and wearing gloves for a long time (12).

The generalised hand-cleaning and prolonged wearing of PPE have exponentially increased the problem of adverse skin events, which was already common in health care workers, but became particularly relevant during the previous SARS outbreak. From the very beginning of the current COVID-19 outbreak, a Chinese study reported a prevalence of 97% of skin damage related to prevention measures among health workers. Exposure duration appears as the main risk factor for face dermatitis,

particularly wearing masks and goggles >6 h, while washing the hands more than ten times a day could increase hand damage risk (16).

Skin reactions to gloves included complaints of dry skin, itch and rash. Type I immunoglobulin E-mediated natural rubber latex hypersensitivity is an important, often undiagnosed, occupational health hazard for healthcare workers, especially in those with high exposure (6). In a previous study conducted in Singapore, a prevalence rate of latex sensitisation of 9.6% was reported among healthcare workers (17).

Conclusions

Aside from a major shortage of PPE across Romania causing stress to hospital administrators and healthcare professionals on the front lines, many expressed added stress from the adverse effects of prolonged PPE usage.

Healthcare professionals report side effects of prolonged use of PPE when caring for COVID-19 patients. Exposure duration appears as the main risk factor for face dermatitis, particularly wearing masks and goggles >6 h, while washing the hands more than ten times a day could increase hand damage risk. If the skin or mucous is damaged, contamination might be easier; they could harbour the virus and drive the viral transmission when touching the face while not wearing the PPE.

Recommendations have previously been addressed in the literature. The first is frequent work breaks to be incorporated into work shifts to allow for a shorter duration of mask use and reduction of PPE exposure. The second recommendation is preventative measures such as applying moisturisers, emollients and barrier creams to prevent skin breakdown. Caution should be taken that dressings, moisturisers and lotions do not interfere with the seal of the mask thereby causing decreased protection against COVID-19 particles. The third recommendation is improved mask design with a focus on safety, comfort and tolerability (e.g. an ear saver, paper clip or a headband with buttons to allow ear straps to rest on these items instead of behind the ears) (18).

In preparation for future pandemics, it is imperative to identify solutions to manage these adverse effects. Frequent breaks, improved hydration and rest, skin care and potentially newly designed comfortable masks are recommendations for future management of adverse effects related to prolonged mask use. Perhaps better strategies are needed for designing various PPE and reducing the duration for which healthcare workers are required to use them.

Author Contributions

Not applicable.

Acknowledgments

Not applicable.

Conflict of interest

The author has no conflict of interest to declare.

References

1. Woolley K, Smith R, Arumugam S. Personal protective equipment (PPE) Guidelines, adaptations and lessons during the COVID-19 pandemic. *Ethics, Medicine and Public Health.* 2020;14: 100546.
2. WHO. *Infection prevention and control during health care when COVID-19 is suspected. Interim Guidance*. March 19, 2020. Available from: https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-(ncov)-infection-is-suspected-20200125
3. Rosner E, Stanley M. Adverse effects of prolonged mask use among healthcare professionals during COVID-19. *Journal of Infectious Diseases and Epidemiology.* 2020;6(3): 130.
4. Centers for Disease Control and Prevention (CDC), Optimizing Personal Protective Equipment (PPE) Supplies, Updated July 16, 2020, Available from: https://www.cdc.gov/coronavirus/2019-ncov/hcp/using-ppe.html
5. Jy Ong J, Bharatendu C, Goh Y, Zy Tang J, Wx Sooi K, et al. Headaches associated with personal protective equipment – a Cross-Sectional Study among Frontline Healthcare Workers during COVID-19. *Headache.* 2020;60(5): 864–877.
6. Foo CC, Goon AT, Leow YH, Goh CL, Adverse skin reactions to personal protective equipment against severe acute respiratory syndrome – a descriptive study in Singapore. *Contact Dermatitis.* 2006;55(5): 291–294.
7. Lim EC, Seet RC, Lee KH, Wilder-Smith EP, Chuah BY, Ong BK. Headaches and the N95 face-mask amongst healthcare providers. *Acta Neurologica Scandinavica.* 2006;113(3): 199–202.
8. Rebmann T, Carrico R, Wang J. Physiologic and other effects and compliance with long-term respirator use among medical intensive care unit nurses. *American Journal of Infection Control*. 2013;41(12): 1218–1223.
9. Yan Y, Chen H, Chen L, Cheng B, Diao P, Dong L, et al. Consensus of Chinese experts on protection of skin and mucous

membrane barrier for health-care workers fighting against coronavirus disease 2019. *Dermatologic Therapy*. 2020;33(4): e13310.
10. Tan KT, Greaves MW. N95 acne. *International Journal of Dermatology*. 2004;43(7): 522–523.
11. Australasian College of Dermatologists and Occupational Dermatology Research and Education Centre, Keep your face healthy during COVID-19: Tips to avoid skin problems and allow you to keep wearing a mask, Last updated: 29 July 2020, Available from: https://www.dermcoll.edu.au/wp-content/uploads/2020/07/COVID-19_Face-masks-and-skin-problems_27-July-2020.pdf
12. Donovan J, Kudlar I, Holness LD, Skotnicki-Grant S, Nethercott JR. Skin reactions following use of N95 facial masks. *Dermatitis*. 2007;18(2): 104.
13. Lan J, Song Z, Miao X, Li H, Li Y, Dong L, et al. Skin damage among health care workers managing coronavirus disease-2019. *Journal of the American Academy of Dermatology*. 2020;82(5): 1215–1216.
14. Alves P; Moura A; Vaz A; Ferreira A; Malcato E; Sousa F; Afonso G; Ramos P; Dias V; Homem-Silva P; Prevention of skin lesions caused by Personal Protective Equipment (Face masks, respirators, visors and protection glasses). *Associação Portuguesa de Tratamento de Feridas 2020*. ISBN 978-989-54770-1-2
15. Al Badiri FM. Surgical mask contact dermatitis and epidemiology of contact dermatitis in healthcare workers. *Current Allergy and Clinical Immunology*. 2017;30(3): 183–188.
16. Atzori L, Ferreli C, Atzori MG, Rongioletti F. COVID-19 and impact of personal protective equipment use: from occupational to generalized skin care need. *Dermatologic Therapy*. 2020; e13598. Available from: https://doi.org/10.1111/dth.13598
17. Tang MB, Leow YH, Ng V, Koh D, Goh CL. Latex sensitisation in healthcare workers in Singapore. *Annals Academy of Medicine Singapore*. 2005;34(5): 376–382.
18. Kantor J. Behavioral considerations and impact on personal protective equipment (PPE) use: early lessons from the coronavirus (COVID-19) outbreak. *Journal of the American Academy of Dermatology*. 2020;82(5): 1087–1088.