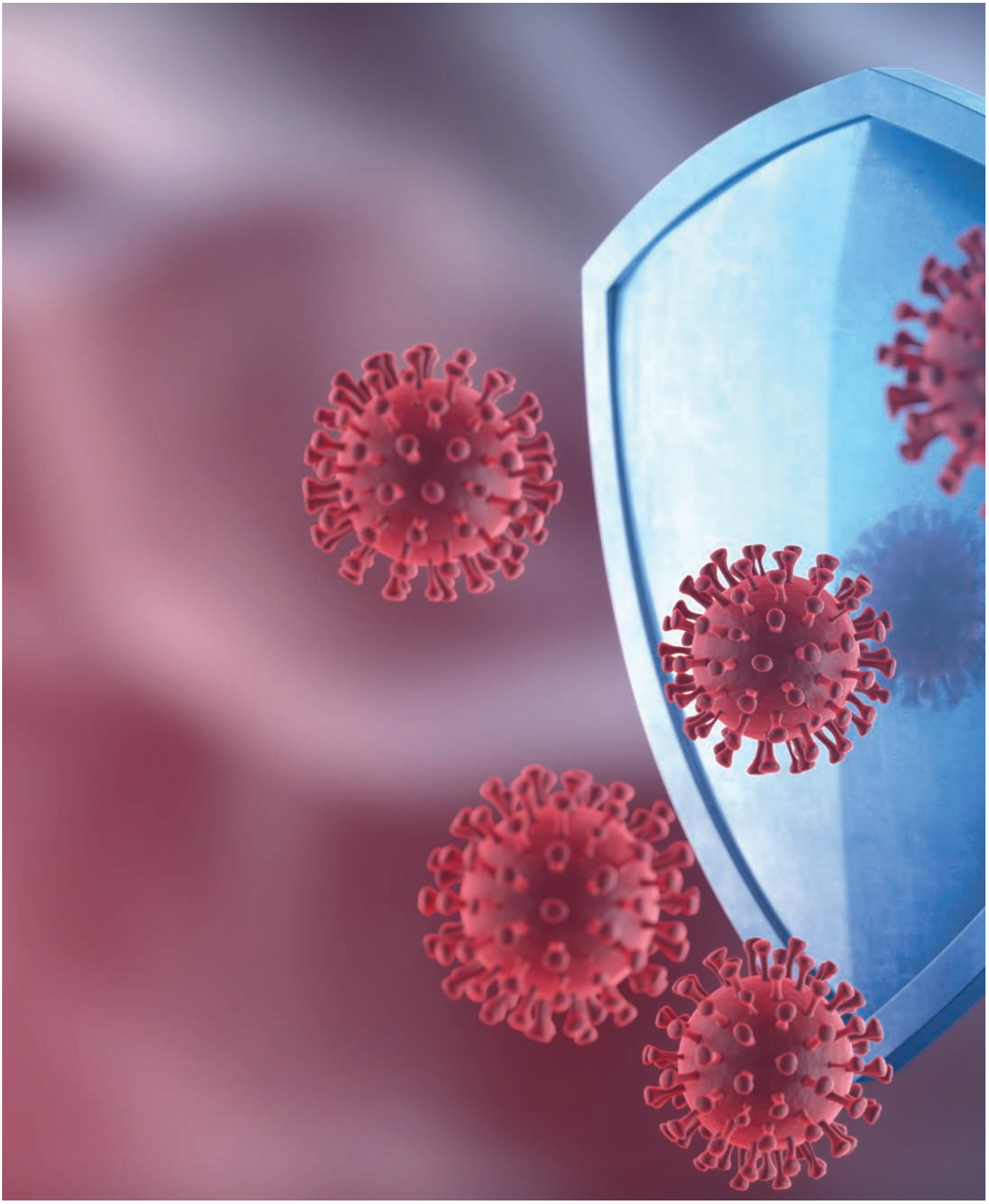

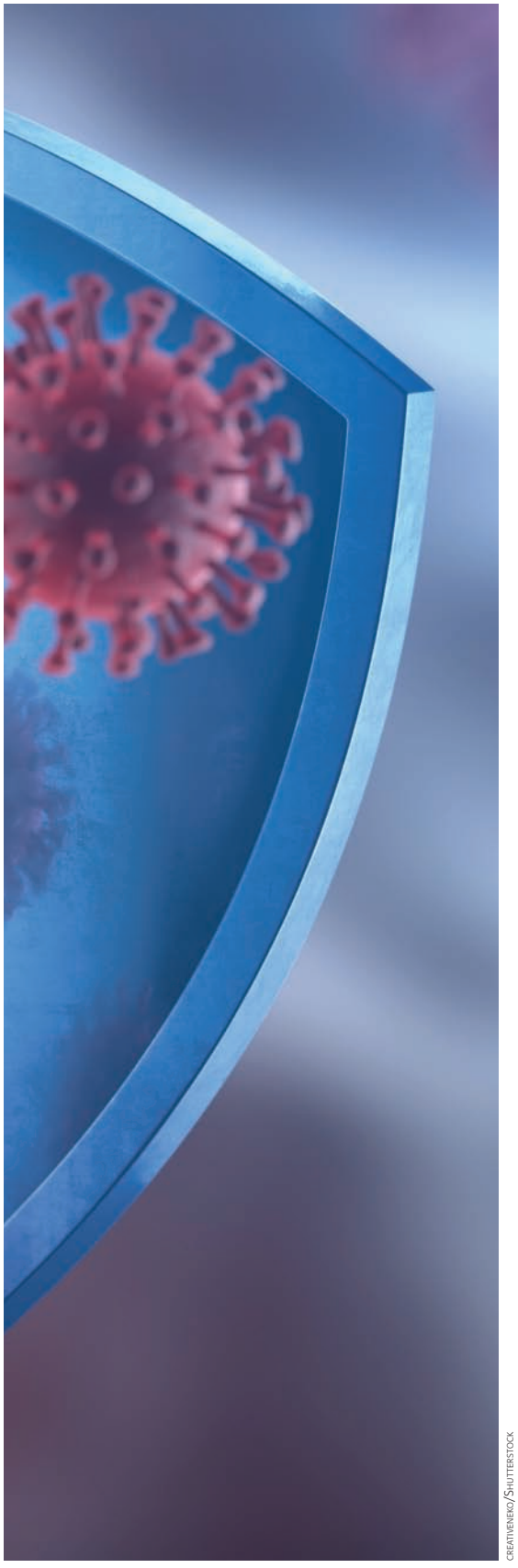

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SARS-CoV-2 safety: Guidelines for shielding frontline nurses

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Abstract: Protecting nurses in healthcare facilities from SARS-CoV-2 infection is essential for maintaining an adequate nursing force. Foundational guidelines, consistently utilized, protect the nursing staff from infection. This article describes guidelines designed to reduce acute infection and associated morbidity and mortality among nursing staff and improve compliance with infection prevention protocols.

Keywords: COVID-19, hand hygiene, hand sanitizers, heat fatigue, infection prevention, N95 respirators, novel coronavirus, personal protective equipment, PPE, respirator masks, SARS-CoV-2

SARS-CoV-2, THE NOVEL coronavirus that causes COVID-19, is highly contagious among humans. It is transmitted by direct contact with respiratory droplets and aerosols from an infected person. Viable SARS-CoV-2 particles have been detected on fomites (contaminated surfaces), although to date no specific reports have directly demonstrated fomite transmission. Viable SARS-CoV-2 particles have also been found in urine and feces; however, no evidence to date demonstrates transmission from these sources.[1]

Protecting nurses working in healthcare facilities from SARS-CoV-2 infection is important for the health of nurses and their families as well as for patient safety. When members of the nursing staff become infected, requiring quarantine and/or hospitalization, the number of nurses available to care for patients is reduced. Reductions in the nursing staff increase the risk that the number of nurses available to manage the rising numbers of infected symptomatic patients will be inadequate as this coronavirus pandemic continues.

Instituting and following guidelines designed to protect the nursing staff and other healthcare workers from COVID-19 is imperative. This article discusses guidelines designed to reduce acute infection, associated morbidity, and mortality among nursing staff.

Specific protocols concerning preshift clothing, use of personal protective equipment (PPE), and personal hygiene have been presented in detail

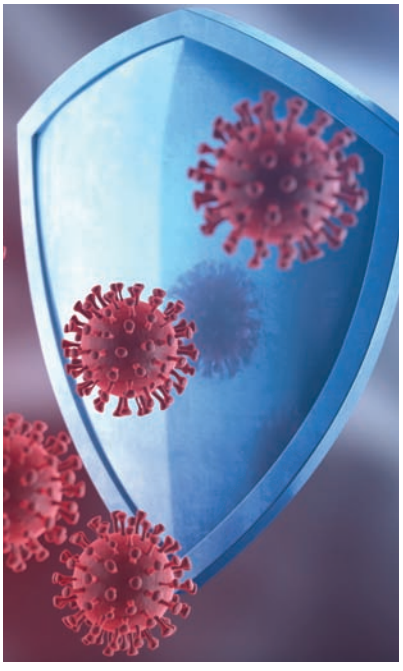
elsewhere.[2] The focus of this article is to provide practical guidelines nurses should make part of everyday practice to protect themselves from SARS-COV-2 and to offer recommendations that will help minimize the burden of working long hours in PPE and improve compliance with infection prevention measures.

Hand hygiene

Hand hygiene is a cornerstone of infection prevention for frontline nursing staff.[3] Washing hands with soap and water continues to be the preferred technique for hand sanitization.[4] Skin on hands, including all fingers, should be washed with soap and warm water for at least 20 seconds. Nurses working with gloves should wash hands and apply moisturizer as soon as gloves are doffed. Gloves should be applied only over dry hands. Because air hand dryers increase the number of airborne pathogens, the best method for drying the hands is with paper towels.

Although washing hands with soap and water is the preferred technique for hand hygiene, hand sanitizers containing at least 60% alcohol may be used on hands that are not visibly soiled. Nurses should be aware of the ingredients in hand sanitizers and in substituted sanitizing products and avoid those not recommended by the FDA. For example, the FDA has repeatedly warned consumers to avoid hand sanitizers containing methanol (also called wood alcohol), which is toxic when ingested or absorbed through the skin. Other products may not be recommended due to suboptimal potency or potential contamination.[5,6]

Frequent hand hygiene prolongs skin exposure to water and other chemical agents that can disrupt the protective epidermal barrier, change skin pH due to loss of normal flora, release inflammatory cytokines, activate the skin immune system, and induce delayed-type hypersensitivity reactions.[7,8] As such, hand sanitizers should be used cautiously to avoid dermatitis.[9,10] Avoiding scented hand sanitizer is also recommended.[11]



Nurses should be aware of the ingredients in hand sanitizers and avoid those not recommended by the FDA.

To prevent drying, cracking, and fissuring, rehydrate the skin with a moisturizer immediately after hand hygiene. Moisturizers do not interfere with the effectiveness of sanitizers.[9] Regular skin hydration is a key component to preventing hand dermatitis from frequent hand hygiene.

Respirator basic principles

In the context of this article, we use the terms "mask," "respirator," and "respirator mask" to refer to an N95 or equivalent respirator mask and not to surgical masks or nonmedical face masks unless otherwise specified. Tested for fluid resistance, filtration efficiency, flammability, and biocompatibility, N95 respirators are designed to efficiently filtrate airborne particles when fitted correctly with a tight seal around the nose and mouth. They should not be shared or reused.[12,13]

Nurses wearing respirators should keep two basic facts in mind: Wearing a respirator while performing patient care can reduce efficiency, and it can increase the amount of time necessary to complete a work activity or even impede a work activity. Wearing gloves, gowns, and other PPE, such as goggles and face shields, in addition to a respirator may further worsen this situation. Nurses may need to allot more time to perform certain tasks or work in teams. Additional time should be provided where necessary to conduct complicated multistep and complex tasks. For example, with a patient requiring incontinence care, maintenance of the integrity and cleanliness of PPE may become an extraordinary challenge. The increased frequency of doffing PPE, washing soiled skin, and donning new PPE results in additional time spent and the possible exhaustion of scarce supplies. Both the increased time commitment and scarce PPE supplies can increase staff stress and anxiety.

Respirator tolerance

Healthcare workers must have a medical evaluation and clearance before being fit tested to wear a respirator as discussed below. The medical evaluation identifies those with medical conditions or other contraindications to wearing a respirator.[13] Potential contraindications include severe pulmonary or cardiac disease, uncontrolled hypertension, claustrophobia, and facial abnormalities that prevent a tight fit.[14]

Some healthcare workers can become anxious about wearing respirators. Others cannot tolerate the

conditions of increased humidity and elevated temperatures that transpire inside the restricted prefacial space created by the respirator. These individuals must be reassigned to different work environments.

By restricting the supply of fresh air, respirators may cause the wearer to breathe with an open mouth. Mouth breathing can result in mucosal dehydration of the oropharyngeal cavity, which might cause the wearer to doff the respirator more frequently to take a drink.

The adverse effects of respirators are exacerbated by the practice of double-masking, such as donning a surgical mask over a respirator. Double-masking is practiced in some healthcare facilities to protect the respirator from being soiled and to prolong use when respirators are in short supply. Individual tolerability depends on the nurse's baseline physical condition and the respirator's effects on inspiratory and expiratory resistance.

Variable tolerability should be recognized by frontline nurses and managers. The nursing staff should be told that it is acceptable to alert managers or administrators if a level of intolerability exists and assured that they will not be penalized for reporting problems to the nursing team or nurse manager. In consideration of respirators' adverse effects, respirator-free breaks should be provided and encouraged whenever feasible.

In general, the use of respirators and PPE body coverings decrease the time that any level of activity can be sustained. As such, nursing care involving vigorous activity cannot be performed for extended times after the nurse dons a respirator and other PPE. Different activity levels have corresponding physiologic thresholds consistent with cardiovascular limitations, respiratory limitations, thermal limitation, and even limitations of anxiety.

Testing considerations[2,54,55]

SARS-CoV-2 testing is recommended on a regular basis and should be an established protocol in the healthcare facility. However, SARS-CoV-2 testing can yield a range of false-negative results. It has been recommended that interpretation of reverse transcriptase polymerase chain reaction test results for SARS-CoV-2 should consider the relationship of time of testing with date of exposure, as well as clinical and epidemiologic factors.

The CDC recommends testing of healthcare personnel if they are symptomatic or have been exposed to a patient with known or suspected infection with SARS-CoV-2. Although it would be ideal to test frontline staff every 3 days, we believe that this is impractical. In addition, no recommendations for ongoing regularly scheduled testing of frontline healthcare workers have been developed.

Despite precautions, nursing staff can become infected at home and in the community as well as on the job. Be conscious that adherence to regular handwashing, proper wearing of a respirator and other PPE, and social distancing are imperative and should be considered cornerstones for limiting SARS-CoV-2 infections.

These limitations must be taken into consideration when the nursing staff is asked to perform job responsibilities wearing protective respirators and body coverings.

Respirator fit testing and seal checks

A respirator that fits properly provides an airtight seal against the skin, preventing external air from entering around the respirator's edges. Before using a respirator, nurses should have a formal fit test to ensure proper fit.[15] Facial hair including stubble and beards must be removed to allow a tight seal between the face and respirator.[16]

Fit testing involves evaluating the model, style, and size of the respirator that each nurse should use. After fit testing identifies the respirator that fits best, the nurse should use a respirator having the same parameters for each shift. Changing respirator parameters requires repeating the fit test. A fit test can be conducted in 15 to 20 minutes and retesting is recommended at least annually.[15]

Do not confuse the respirator fit test with a respirator seal check.[2] The seal check is brief and performed each time the respirator is donned.[17] Seal checks should be performed regularly throughout a nurse's shift, but they are not a substitute for a formal fit test.[18] Nurses must be educated on how to don and doff the respirator properly and conduct seal checks as recommended by the respirator's manufacturer.[18,19]

Nurses wearing spectacles or goggles often experience fogging of lenses when their humidified breath escapes upward through the superior edge of the respirator. This phenomenon, which indicates a seal check failure, can be reduced by molding and reshaping the cross piece over the bridge of the nose to improve fit.[2,15] Failing a seal check indicates that the wearer is not adequately protected and the reason should be investigated. Possible reasons include wrong size or style of respirator and damage to the respirator's structural integrity.

Until the mask can be refitted, we recommend mitigating this problem using plastic tape to secure the entire upper edge of the respirator to the skin. A continuous piece of 1-in tape is preferred, applied in a horizontal orientation first to the bridge of the nose and then to the sides of the nose, then to the inferior periorbital skin nasally, and finally to the malar skin temporally. If applied correctly, this arrangement prevents escape of breath from the respirator during

exhalation and alleviates fogging of spectacle or goggle lenses.

Special considerations for nurses using respirators

N95 respirators or similarly certified respirators should be worn during all encounters with patients known or suspected to have COVID-19 for continuous protection against SARS-CoV-2 airborne particles. This is another cornerstone for the prevention of infection among frontline nursing staff.

Nurses should be aware that altered structural integrity due to physical deformation or contamination of the respirator may render it ineffective and increase the risk of infection.[2] Masks can be deformed and contaminated when they are touched with fingers or hands. If the nurse touches the respirator while caring for a patient, it must be removed and replaced. However, the CDC has developed contingency and crisis capacity standards for respirator use in shortage situations when respirators are used beyond the manufacturer-designated shelf life.[18]

Silent hypoxia and hypercapnia associated with respirator use can cause cognitive impairment.[20-22] Consequently, sustained respirator use can potentially affect a nurse's ability to function and perform required duties.[23] Understanding possible physiologic and psychological effects of respirator use requires an understanding of the wearer's baseline health.[20,22,24] Factors to be considered include:

• **respiratory function and headaches.** An increased respiratory rate can result from overheating, anxiety, stress, silent hypoxia, fatigue, hypercapnia, and the sensation of shortness of breath.[23] In addition, headaches associated with PPE are common.[25] Factors related to PPE headaches include preexisting primary headache diagnosis, sleep deprivation, physical stress, irregular diet (such as fasting or an inadequate diet), inadequate hydration, and wearing a mask and eye protection for more than 4 hours at a time. Nurses should be educated to recognize the potential adverse effects of prolonged PPE use, which can be mitigated with appropriately scheduled breaks that allow nurses to doff respirators.

• **thermal equilibrium (heat fatigue).** Wearing a respirator reduces the body's ability to effectively cool and not overheat. This inability to reduce temperature results in increased perspiration, increased respiratory rate, and fluid loss. Gowns, gloves, and other PPE impair the body's natural ability to cool via the palms of the hands and the axillary skin.[23,26] Wearing a respirator does not impose a significant thermal burden on core temperature; however, it can significantly increase the temperature of facial skin.[27]

The nursing staff should receive training to recognize heat fatigue, which can be mitigated by allowing rest periods, for example every 2 hours, during which PPE can be doffed to allow for restoration of body cooling.[26]

• **dermatologic reactions.** Respirators are associated with various skin reactions, including contact/irritant dermatitis, pressure-related skin injury, acneiform eruptions, and moisture-associated skin irritation.[11,28,29] Especially vulnerable areas are the skin of the nose (especially the bridge) subjected to the malleable nose guard, cheeks and chin subjected to microabrasions from the mask material, and skin behind the ears subjected to the respirator's elastic loops. Each of these areas serves an important function in keeping the respirator in proper position to maintain a seal.

Nurses should be educated to wash the face with gentle, fragrance-free noncomedogenic cleanser in the morning and at the end of the day, paying special attention to each region predisposed to skin breakdown. Increased skin temperature beneath the respirator contributes to breakdown of the skin's integrity (see *Protecting facial skin from injury*). Scheduled doffing of masks can relieve the sensation of being hot under the mask.

• **impaired communication.** Because masks muffle speech, nurses speaking to patients through a respirator may need to raise their voices to be heard. Increasing voice volume when speaking through a respirator requires more effort, as does communicating with patients speaking with a dialect, vernacular, or other challenges with speech sounds such as low volume. This difficulty with speech sounds is further exacerbated with aging when individuals often have less ability to exhale air forcefully from the lungs and eventually past the vocal cords due to reduced lung capacity. Enunciation and clarity of speech is more important than ever when nurses must speak through a respirator.

The greater effort required to speak through a respirator impairs nurse-patient communication. After hours of working with patients, the effort of speaking through a respirator becomes increasingly stressful. Additionally, with patients who have hearing difficulties, respirators not only decrease the volume of speech but prevent patients from seeing the lips, eliminating their ability to lip-read. Respirators and other masks also decrease the contribution of facial expression and voice tone to understanding. These issues may be mitigated with the use of transparent respirators if available and approved.

Training should be provided for the nursing staff to help them recognize the requirement for increased effort in verbal communication while using respirators. To mitigate speech difficulties, nurses should focus on both speaking distinctly and increasing volume. In addition, nurses

Protecting facial skin from injury

Although pressure injury can occur anywhere that PPE makes contact with the head and face, the most common site of PPE-related skin injury is the nasal bridge, which is most vulnerable to injury because it has little soft tissue to protect it. In addition, consider that speaking can cause the mask edges to shift, causing friction and shear; moisture accumulation also contributes to development of skin inflammation over time.

Inflammation is characterized by excoriation of the superficial epithelium, resulting in pain, erythema, increased temperature, and ulceration.[56] A similar inflammatory response is caused by tight-fitting goggles pressing on the periocular skin as well as skin of the cheeks and nasal bridge. This is the most frequent cause of this injury.[57]

Many providers prefer to wear face shields instead of goggles to avoid such inflammation, but even face shields can cause a band of pressure and inflammation on the skin of the forehead. Some clinicians wear both goggles and face shields.[58]

We recommend that the pressure from a face mask or other PPE be mitigated by off-loading this protective equipment for 15 minutes every 2 hours. However, with time constraints, this is not always possible. The following is a stepwise approach to prevention and management of PPE-related skin injury.

Step 1: Prevention is effective for both airtight and non-airtight PPE. After face-washing, we recommend moisturizing the skin at least daily with moisturizing skin creams. Products containing dimethicone are good options because of longer durability.

Skin cream moisturizer should be applied to areas of the face that have contact with PPE such as ears, forehead, nose, cheeks, and chin. The product used should be applied 1 to 2 hours before donning PPE to allow time for absorption and drying. Optimally, the time for application of a moisturizer is after showering or face-washing. Cosmetics are not recommended, but if used, avoid oil-based foundations.

Ointments that include zinc are not recommended because zinc aerosols can be created by rising skin temperatures and increased humidity beneath PPE. When this occurs in the retromask space, the nurse may inhale aerosols containing zinc particles, causing zinc toxicity and metal fume fever, a flulike illness.[59] Additionally, zinc soils the N95 mask.

Petroleum jelly and other petroleum-based products are not recommended because they may corrupt the mask seal and cause contact dermatitis from repeated daily use.[60] In addition, petroleum aerosols created in the retromask space are irritating to the nose, throat, and lungs. Over time, the nurse may develop systemic signs and symptoms including headaches, nausea, vomiting, vision changes, loss of balance, and mental status changes.[61]

Subsequent to moisturizing the skin and 5 minutes before applying a face mask, goggles, or face shield, apply an alcohol-free skin barrier wipe, also known as liquid skin protectant or sealant, to the face covering the cutaneous surfaces most likely to be affected. Allow the protectant or sealant to dry for 1 minute so that it is no longer tacky to the touch before donning PPE. Different brands of alcohol-free skin barrier products are available.

We recommend using wipes because they allow easy and localized application. We do not recommend the use of sprays on the face because it is more difficult to precisely localize the application.

It is important that nurses remain hydrated throughout their shift for general skin health. Dehydration increases breaks in the skin that may eventually result in open wounds. In order to maintain skin hydration, moisturization of the skin on which PPE is in contact is necessary to minimize friction. This not only necessitates use of topically applied moisturizers as described above, but also requires hydration via oral fluids. As noted elsewhere in this article, nurses may not drink enough fluids during 8- or 12-hour shifts.

Adequate hydration intake is often defined as eight 8-oz glasses of water per day. However, a more useful method of calculating adequate body hydration is to divide body weight in pounds by 2; the result is the minimum number of ounces an adult should drink daily.[62]

Step 2: For nurses with areas of persistent erythematous nonblanchable intact skin, recommendations are the same as described in Step 1. Use a moisturizer, allow it to dry, and apply a skin barrier wipe before donning PPE. The type of face mask being worn should dictate a decision about use of any additional protection between the skin and mask. Application of skin protectant using a skin barrier wipe will reduce shearing, but it won't alleviate pressure. Masks should be removed or adjusted for pressure relief every 2 hours.

Underneath N95 masks, a dressing can be used to cushion the skin from the pressure of mask edges. These dressings include a thin adhesive foam dressing, a silicone adherent sheet (perforated or nonperforated), and a thin hydrocolloid sheet.[63,64] It is important to use a thin low-profile semiocclusive dressing.

Regardless of what type dressing is used, it should be custom-cut to conform to the nurse's needs for pressure relief and to achieve as low a profile with the skin surface as possible. A low profile is important because a dressing beneath the N95 mask may elevate the contour of the mask edges such that it disrupts the airtight seal, interfering with the mask's effectiveness. Before applying a dressing, the nurse should check with the facility's health and safety department for approval and arrange for fit testing with the dressing in place.

Step 3: Skin lesions, if present, must be treated in order to mitigate the risk of wound infection. With the presence of open skin wounds, some type of a dressing is advised. We do not recommend the use of topical skin adhesives or glues, which may be difficult to remove.

Without appropriate treatment, an open wound is unlikely to heal if the nurse continues wearing the same PPE. Few nurses have enough consecutive days off between shifts for their skin to fully heal. In addition, newly healed skin is more fragile than undamaged skin, especially if it is stretched or moved by muscle contractions involved with facial expressions or speech. Newly healed skin may undergo recurrent breakdown when the nurse returns to work and employs PPE requirements. Nurses are encouraged to speak with their managers and health and safety supervisors regarding skin surface injury and abnormalities.

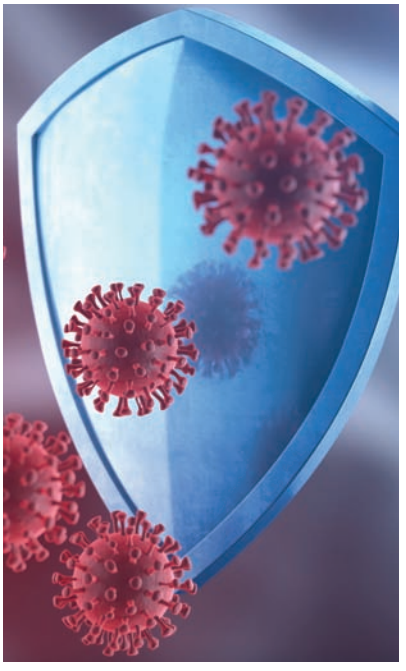
should be trained and encouraged to observe one another for fatigue. In some cases it may be helpful to assess fatigue after respirator use. The degree of hypoxia can be determined by measuring oxygen saturation with an oximeter.

• **decreased sense of well-being.** Nurses can experience situational anxiety, performance anxiety, and claustrophobia while performing routine duties and procedures wearing a respirator. Nurses experiencing these feelings of anxiety should acknowledge them and promptly employ appropriate action to avoid the potential for adverse outcomes.[30]

Nurses should be educated to recognize signs of anxiety related to wearing a respirator or other PPE. Anxiety may be mitigated with appropriate regularly scheduled breaks or nonscheduled breaks for nurses who are symptomatic. Instruction must be given to the nursing staff that such breaks and interruptions are not designed to be punitive but to promote safety of the patient and the staff.

• **dehydration and malnourishment.** Busy staff wearing respirators may not eat and drink enough, potentially resulting in dehydration, reduced caloric intake, and malnourishment. Reduction in fluid intake with eventual dehydration may result in urinary tract infections secondary to a reduced frequency of urination from involuntary urinary retention. Further compounding this involuntary urinary retention is voluntary retention of urine resulting from delaying use of the rest room. This delay may occur because of a nurse's commitment to caring for patients and apprehension regarding use of the rest room because of possible unsanitary conditions and the potential presence of SARS-CoV-2.[1,31]

As previously discussed, use of a respirator and other PPE elevates body temperature, resulting in perspiration, loss of body fluid, and dehydration. The body compensates by removing additional water from the colon, resulting in constipation and decreased frequency in defecation. Moreover, using the rest room requires additional time to doff and don PPE properly, taking more time away from patients.



Nursing staff should be informed that rest breaks and interruptions are not designed to be punitive but to promote patient and staff safety.

Although SARS-CoV-2 has been shown to be transmitted via respiratory droplets, these virus particles have been demonstrated in feces of patients, suggesting the possibility that this virus can be transmitted via the orofecal route.[1,32] Fecal shedding of SARS-CoV-2 has been demonstrated for 7 to 10 days after respiratory shedding is undetectable. Because SARS-CoV-2 particles have been demonstrated in both urine and feces, aerosolization of the virus could occur with toilet flushing.[1,33,34]

Staff should not use rest rooms utilized by infected patients. Staff who work in units with patients known or suspected of having COVID-19 should use a dedicated rest room separate from staff who are working with uninfected patients.

Regarding the rest room and use of respirators and other PPE, healthcare facilities must establish a protocol that includes specific instructions for doffing and donning PPE for staff using the rest room. Staff should assume that the rest room is contaminated with SARS-CoV-2.

The only PPE that staff should wear into the rest room is the respirator and eye protection. Other PPE such as gowns and gloves should be doffed when nurses leave patient-care locations and not worn into rest rooms to prevent self-contamination.[35] In summary, the nursing staff needs to be encouraged to use the rest room facilities as needed and not to prolong or delay such usage unnecessarily.

It is also recommended that PPE other than respiratory and eye protection be doffed and not worn in areas considered neutral zones or pass-through areas, such as hallways and lobbies that are not typically used by patients with COVID-19. Staff must then report to the area designated for donning new PPE. Before donning new PPE, staff must wash their hands and any other exposed and possibly contaminated skin with soap and water.

Wearing a respirator, goggles, and other PPE while performing common clinical procedures, such as endotracheal intubation and central venous access device insertion, can create challenging situations. While nurses use PPE, procedures involving the senses of vision and touch can become more difficult and provoke anxiety. The nursing staff must develop strategies to recognize challenges that are normally absent when they are not wearing PPE. Mitigation of these PPE complications is accom-

plished through the creation of protocols that address each procedure requiring equipment. This is accomplished by developing patterns of recognition and habits that include constant verification of steps while performing equipment-related procedures. Verification of steps can be more safely accomplished using the "time-out" procedure.

Protective eye coverings

Goggles or face shields are recommended to protect the eyes from contamination.[36] Although spectacle lenses might provide some level of eye protection, they are not considered adequate protection against SARS-CoV-2.[36,37] Use of protective lenses in goggles and face shields can also affect depth perception, which can lead to technical dysfunction in fine motor and hand-eye coordination.

Like respirators, goggles must fit to the skin without gaps.[38] It may be difficult to use goggles with the approximation of the lower rim of the goggles being in such close proximity or overlapping the upper edge of the respirator. To improve visualization, the inner surface of the goggles' plastic lenses can be treated with commercially available antifog sprays or wipes.

With daily continuous use, goggle lenses become less transparent and abrasions and discoloration of the lenses impair vision. Because alcohol cleansers can both abrade and discolor goggle lenses, lens cleaning is best accomplished with a liquid hand soap and water. Drying should be facilitated by vigorous shaking to avoid abrasions from towel drying.

Degradation in the optical clarity of the goggles or curved face shields can alter the refraction of light and may also impair depth perception, further impairing vision. A nurse experiencing such visual impairment must remedy it immediately to ensure safe patient care.

A slow degradation in vision is not always easy to recognize. An example of this can be appreciated by those using spectacle lenses for the correction of a refractive error or presbyopia. The reduction in vision in spectacle lens wearers can be so gradual as to be unrecognized until a coworker or patient comments that the lenses need cleaning. Nurses should be educated to recognize and monitor changes in visual acuity and take corrective action; for example, by periodically cleaning or replacing goggles and face shields.

Footwear and other protective coverings

Nurses should wear appropriate shoes, boots, or other foot coverings while working.[2] The surfaces of nondisposable footwear, including the soles, should be cleaned regularly as contamination with SARS-CoV-2 particles has been documented.[39]

Footwear for work should remain at the healthcare facility and not be worn in public or at home. Use a separate pair of shoes to travel from home to the healthcare facility and back. Travel shoes, including the soles, should also be cleaned regularly. Any foot coverings used in the home should be used only in the home and should not be worn in the community or the healthcare facility. Although SARS-CoV-2 has been recovered from the soles of shoes, no evidence to date demonstrates transmission of infection via contaminated shoes.

Protective coverings such as coveralls and gowns should be used by all healthcare staff in clinical facilities.[2] No clinical standards or studies have demonstrated any benefit of one form of protective covering over another. PPE should cover all skin as SARS-CoV-2 can attach to and remain attached to naked skin unless removed by washing with warm soapy water.[2,3]

Environmental hygiene

Environmental hygiene must include regularly scheduled cleaning of frontline workspaces, including all counter tops, work surfaces, walls, floors, rest rooms, and air filtration systems.[35,40-42] Although no specific reports have directly demonstrated fomite transmission of SARS-CoV-2, such a mode of transmission in the case of viable virus particles is considered likely.[1,43]

Rest rooms utilized by infected patients should be cleaned and disinfected between patients. The use of bleach or sodium hypochlorite, known to be excellent disinfectants, might be advantageous when added to toilet water before flushing. Commercial products, including bleach tablets for use in the toilet tank, are available for such an application. Toilets in healthcare facilities may not have tanks; however, most homes and medical office toilets do.

Postshift hygiene

Postshift hygiene requires that the entire PPE uniform be correctly doffed and placed in appropriate receptacles designated by the healthcare facility before leaving the facility.[2] Protocols for doffing and disposing of PPE should be established by each healthcare facility.

Nurses are advised to take a shower either at the facility or immediately upon arriving at home. Proper showering at the healthcare facility has been reviewed elsewhere.[2] If showering at home, doff all clothing into a plastic container and empty the contents into a washing machine for laundering. Shower with soap, head to toe, and don clean clothes at home.

All clothing worn to and from the facility should be washed daily in warm water with laundry detergent and bleach if possible.[2] Washing clothing should be promptly followed by drying in an electric or gas-powered dryer with temperature

setting on high heat to insure inactivation of viral particles.[2,44]

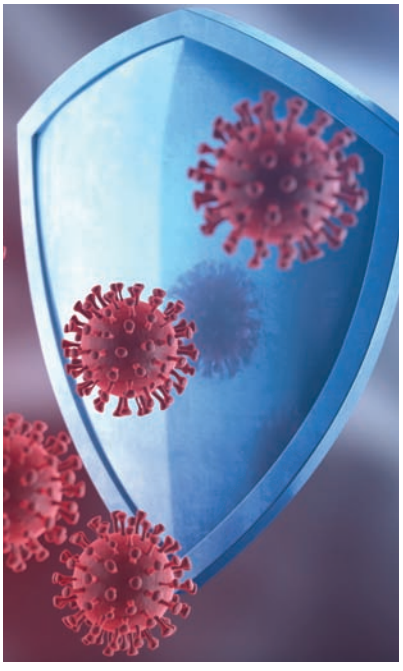
Vehicles

SARS-CoV-2 particles are likely to be found on interior vehicle surfaces when vehicles are used to transport patients testing positive for COVID-19. It is recommended that transport vehicles be regularly cleaned and disinfected.[45-47] We recommend that vehicles be parked in sunlight during the day. This may have a positive effect on reducing viral load of SARS-CoV-2: Because the vehicle acts as a closed box, its interior temperatures may be elevated to a level similar to temperatures reached in a clothes dryer.[48,49] Such temperatures are known to inactivate viruses.[2]

Nurses having to wear a respirator while exiting the healthcare facility should remove it before entering a vehicle if traveling alone. Driving while using the N95 respirator is not recommended due to the possibility of reduced oxygen saturation or increased CO_2 levels, which may result in cognitive impairment and vision disturbance.[23]

Once removed, respirators should be immediately contained in a plastic bag and cinched. After bagging the mask, promptly clean hands with an alcohol-based hand sanitizer. Masks should then be disposed of in an appropriate closed trash receptacle.[2] If the mask must be re-used, place the used mask in a plastic container. Reuse of an N95 mask should follow previously described guidelines;[10] for example, masks can be decontaminated by hanging them in an open-aired environment.[2,50,51]

It is not uncommon for nurses to enter a vehicle forgetting to doff a respirator. Doffing a respirator correctly requires two hands, so a respirator should never be doffed while driving.[50,52] In addition, we believe that incorrectly doffing a respirator that potentially contains SARS-CoV-2 could potentially aerosolize viral particles present on the respirator. Aerosolized viral particles could subsequently circulate in the vehicle's airstream, enter the heating or air-conditioning systems, and potentially infect occupants of the vehicle.



When possible, carpooling should be limited to people who are living in the same household where masks may not be necessary.

A healthcare worker who travels home alone does not need to wear a mask. However, if the vehicle is to be occupied by more than one person who is not a household member, it is recommended that all occupants in the vehicle wear masks.[1] Simple conversation without wearing a mask in an enclosed vehicle can spew aerosols of SARS-CoV-2 into the air. Some of these viral particles can remain airborne for hours, while others can remain and settle on the vehicle's interior surfaces. Passengers can shed a high viral load even before they have symptoms. This becomes important because social distancing is impractical or impossible in most vehicles. Moreover, with windows closed, a typical vehicle is relatively airtight, limiting air exchange.

Cloth masks may be used with the understanding by all passengers that cloth masks trap primarily large and medium-sized particles but still allow small particles and aerosols to move in and out through the cloth, and these may contain infectious virus particles. Ventilation can help reduce viral contamination of the passenger compartment; appropriate filtration of compartment air will also reduce viral particle load. However, despite reductions in particle load, infection can still occur between passengers in the vehicle.

When possible, carpooling should be limited to people who are living in the same household where masks may not be necessary. However, carpooling with people not living in the same household is not recommended. Where travel is necessary with non-household members, N95 respirators are recommended.

Key takeaways

Strategies that improve compliance with infection prevention measures discussed here include increasing availability of handwashing stations and hand sanitizing products.[53] Nurses must learn and follow the procedure for proper donning of PPE; in particular, doffing protective clothing and PPE at the end of each shift and as otherwise indicated must be performed correctly.[50] Not all PPE is worn for an entire shift and as such PPE must be donned and doffed properly each time PPE is changed. Staff should take care to avoid touching the mask or eye protection without washing hands before and after changing PPE.

These guidelines are intended to protect not only nursing staff but also providers and allied healthcare personnel. If nursing staff follow these minimally necessary safety measures, the chance of SARS-CoV-2 infection should be significantly reduced. Systematic use and compliance with these guidelines as well as those we described elsewhere are expected to improve healthcare staff safety by reducing SARS-CoV-2 infection rates. Nurses working under challenging conditions must remain diligent and comply with these guidelines to protect themselves and others from COVID-19. ■

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