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Surgical Masks and Respirators for Plastic Surgical and Nonsurgical Aesthetic Procedures

Sharon Ann Van Wicklin, PhD, RN, CNOR, CRNFA(E), CPSN-R, PLNC, FAAN, ISPAN-F

***Plastic Surgical Nursing (PSN)*, the official journal of the International Society of Plastic and Aesthetic Nurses (ISPAN), is introducing this new column to provide information about fundamental best practices for plastic surgical nurses.**

Wearing a mask to prevent coronavirus infection has become commonplace across the United States and globally. For plastic surgical nurses and other health care professionals, wearing surgical masks is a fundamental practice for preventing infection and exposure to blood-borne pathogens. N95 respirators and powered air-purifying respirators (PAPRs) provide greater protection against aerosolized pathogens than surgical masks. Plastic surgical nurses should be aware of best practices for wearing surgical masks as well as the applications for and use of N95 respirators and PAPRs. This column defines these medical devices and discusses when and how they should be worn.

WHAT THEY ARE

Surgical Masks

A surgical mask is a loose-fitting covering for the face designed to contain liquid droplets, aerosols, and microorganisms from the wearer's mouth and nose (Thomas Industry, 2020). Surgical masks also protect the wearer's nose, mouth, and lower face from contamination by contact with blood, body fluids, and other potentially infectious materials (Wood, 2020). Surgical masks are designed to be worn by health care professionals during surgery and other medical procedures to reduce the potential for surgical site infection (Thomas Industry, 2020).

Sharon Ann Van Wicklin, PhD, RN, CNOR, CRNFA(E), CPSN-R, PLNC, FAAN, ISPAN-F, is Editor-in-Chief, *Plastic Surgical Nursing*, and is an independent perioperative and legal nurse consultant from Aurora, CO.

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Address correspondence to Sharon Ann Van Wicklin, PhD, RN, CNOR, CRNFA(E), CPSN-R, PLNC, FAAN, ISPAN-F, 8256 South Shawnee St, Aurora, CO 80016 (e-mail: Sharonvwrn@ispan.org).

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Surgical masks are usually designed in three layers (Thomas Industry, 2020). The three layers consist of a single layer of polypropylene, placed between two layers of nonwoven material (Thomas Industry, 2020). Pleats are added to the mask to allow the user to expand the mask so that it covers the wearer's face from the top of the nose to below the chin (Thomas Industry, 2020). Surgical masks are secured to the wearer's head with ear loops, head ties, or elastic straps (Thomas Industry, 2020).

Even when correctly fitted to the wearer's face, a surgical mask does not create a seal between the face and the mask that is sufficient to provide the wearer with a reliable level of protection from inhaling airborne particles smaller than 5 μm (U.S. Department of Labor, 2015). The size of bacterial particles ranges from 0.3 to 60 μm (Engineering ToolBox, 2005). Viral particles are smaller and range from 0.005 to 0.3 μm (Engineering ToolBox, 2005).

The ASTM International (2019) specifies performance requirements for surgical masks in ASTM F2100-19 and is referenced by the U.S. Food and Drug Administration ([FDA], 2018). This standard consists of five testing criteria for medical masks:

1. Bacterial Filtration Efficiency (BFE) is a measure of how well the mask filters bacteria when challenged with a bacteria-containing aerosol. To be designated as a medical surgical mask, a minimum 95% filtration rate is required. Moderate and high protection masks must have bacterial filtration rates greater than 98%.
2. Particulate Filtration Efficiency (PFE) is a measure of how well the mask filters submicron particles when challenged with a 0.1-μm particle size. The higher the percentage, the better the filtration properties of the mask.
3. Fluid Resistance reflects the ability of the mask to minimize the amount of fluid that can be transferred from the outer layer to the inner layer as the result of a splash or spray. The ASTM specifies testing with synthetic blood at pressures of 80 mmHg (representing a splash or spray at venous pressure), 120 mmHg (representing a splash or spray at arterial pressure), or 160 mmHg (representing a high-pressure splash or spray that may occur during surgery).
4. Delta P (Pressure Differential) measures the air flow resistance of the mask in H_2O/cm^2 as an objective

measure of breathability. The lower the pressure, the more breathable the mask. The ASTM standard requires a Delta P of less than 4.0 for low-barrier masks and a Delta P of less than 5.0 for moderate- and high-barrier masks.

5. Flame Spread measures flame resistance. The ASTM standard requires that all hospital masks must withstand exposure to a burning flame (within a specified distance) for at least 3 s.

There are three levels of mask protection (ASTM International, 2019). A Level 3 mask provides the best protection. In addition to the ASTM standard, all medical face masks must be tested to comply with the ISO standards 10993-5:2009 (for cytotoxicity) and 10993-10:2010 (for skin irritation and sensitivity) to help ensure no mask materials are harmful to the user (ISO, 2009, 2010).

A high-filtration surgical face mask is designed to filter particulate matter 0.1 µm in size and larger (Ogg, 2020). Although able to filter smaller particles than surgical masks, a high-filtration mask is also loose-fitting and does not create a sufficient seal between the face and the mask to prevent contaminants from entering the breathing zone of the wearer (Benson, Novak, & Ogg, 2013).

N95 Respirators

An N95 respirator is a protective device designed to achieve a close facial fit and efficient filtration of airborne particles. The edges of the respirator are devised to form a tight seal around the nose and the mouth. Surgical masks and N95 respirators are medical devices regulated under 21 C.F.R. 878.4040 (FDA, 2019). The FDA requires manufacturers of N95 respirators to obtain National Institute of Occupational Safety and Health (NIOSH) certification, conduct flammability testing, and also conduct testing to demonstrate the ability of the N95 respirator to resist penetration by blood and body fluids at a velocity consistent with the intended use of the device (U.S. Department of Labor, 2015). The NIOSH certification process verifies that the N95 filtering facepiece respirator removes at least 95% of airborne particles (U.S. Occupational Safety and Health Administration [OSHA], 1970).

When compared with surgical masks and high-filtration surgical masks, N95 respirators provide greater levels of protection from small airborne particulates (Benson et al., 2013). N95 respirators reduce the aerosol concentration inhaled by the wearer to at least 1/10th of that in the air (Centers for Disease Control and Prevention [CDC], 2020).

Powered Air-Purifying Respirators

A PAPR is an air-purifying respirator that uses a blower to force air through filter cartridges or canisters and into the breathing zone of the wearer (CDC, 2020). This process creates an air flow inside either a tight-fitting facepiece or a loose-fitting hood or helmet (CDC, 2020). A PAPR reduces the aerosol concentration inhaled by the wearer to at least 1/25th of that in the air (CDC, 2020).

WHEN TO WEAR THEM

Surgical Masks

The OSHA requires that surgical masks be worn as personal protective equipment (PPE) whenever contact with splashes, spray, spatter, or droplets of blood or other infectious material can be reasonably anticipated (Siegel, Rhinehart, Jackson, Chiarillo, & the Health Care Infection Control Practices Advisory Committee, 2007). Surgical masks are also worn to protect surgical patients from exposure to pathogens that may be carried in the mouths or noses of surgical team members (Cahn & Wood, 2020).

Surgical team members should wear masks during aerosol-generating procedures (Siegel et al., 2007) and procedures where debridement devices are used (Bowling, Stickings, Edwards-Jones, Armstrong, & Boulton, 2009; Granick, Rubinsky, Parthiban, Shanmugam, & Ramasubbu, 2017; Michailidis et al, 2016). Aerosol-generating procedures are procedures performed on patients that generate higher concentrations of respiratory aerosols than coughing, sneezing, talking, or breathing (e.g., intubation, respiratory tract suctioning, pulse lavage) (Children's Minnesota, 2020). Health care professionals may be exposed to infectious droplets or airborne particles dispersed into the air during aerosol-generating procedures (Siegel et al., 2007).

Certain types of debridement devices (e.g., pulse lavage, low-frequency ultrasonic debridement) may lead to dispersion of droplets containing blood or bacteria when used on open and infected wounds (Bowling et al., 2009; Granick et al., 2017). The resulting mist, spray, or splatter may increase the risk of transmission of potentially infectious material to personnel and to the environment (Bowling et al., 2009; Granick et al., 2017; Michailidis et al., 2016).

N95 Respirators

Health care personnel should wear fit-tested N95 respirators or higher level respirators as respiratory protection:

- When caring for patients with airborne transmissible infections;
- During aerosol-generating procedures for patients under droplet precautions with suspected or proven infections transmitted by respiratory aerosols (e.g., severe acute respiratory syndrome, seasonal influenza, viral hemorrhagic fevers) (Siegel et al., 2007); and
- As secondary protection against surgical smoke that is not evacuated or is incompletely evacuated (Ogg, 2020).

Powered Air-Purifying Respirators

PAPRs may be used for a variety of applications. Because they provide more protection than surgical masks and N95 respirators, PAPRs are suitable for use as PPE during procedures where health care professionals are exposed to aerosolized pathogens that may cause acute respiratory infections (e.g., coronavirus, influenza virus, measles, mumps) (CDC, 2020). PAPRs may be used by hospital first receivers or when the health care professional is not able to wear a tight-fitting respirator (CDC, 2020).

Surgical personnel should assess the limitations and other factors associated with using PAPRs (CDC, 2020) in health care settings. These factors may include the following:

- Potential for the PAPR to interfere with the wearer's visual field;
- Potential for the PAPR noise to reduce the wearer's ability to hear;
- Inability of the wearer to use a stethoscope;
- Need for recharging or replacing PAPR batteries;
- Amount of storage space required for PAPRs; and
- Requirements for cleaning and disinfecting the PAPR (CDC, 2020).

The use of PAPRs in surgical settings may contaminate the sterile field (Wood, 2020). The CDC does not recommend the use of a PAPR with exhalation valves during invasive procedures in the presence of a sterile field (CDC, 2005). The battery-powered blower in the PAPR filters the air intake for the person wearing the device but does not filter the exhaled air of the wearer (Wood, 2020). Unfiltered air from the PAPR may contribute to increased levels of operating room air contamination and potentially increase the patient's risk for surgical site infection (U.S. Department of Labor, 2015).

HOW TO WEAR THEM

Surgical Masks

When wearing a surgical mask, health care personnel should:

- Ensure the mask completely covers the mouth, nose, and chin and fits snugly without gaps at the sides of the mask;
- Select the type of mask attachment (i.e., ties, ear loop, elastic) that provides the best facial fit;
- Don a clean mask before the performing or assisting with each new procedure;
- Replace the mask and discard it when it becomes wet or soiled;
- Remove the mask by touching only the ties and without touching the front of the mask;
- Discard the mask in a waste receptacle and perform hand hygiene; and
- Not wear used masks hanging around the neck (Wood, 2020).

N95 Respirators

When wearing an N95 respirator, health care personnel should:

- Don the respirator in accordance with the manufacturer's instructions for use (IFU) and perform a user seal check (i.e., fit check) for each use (Siegel et al., 2007);
- Not allow facial hair to cross under the seal of a fit-tested N95 respirator (U.S. Department of Labor, 2015);
- Remove the respirator in accordance with the manufacturer's IFU by touching only the ties and without touching the front of the respirator (Wood, 2020); and
- Discard the N95 respirator in a waste receptacle and perform hand hygiene (Wood, 2020).

Powered Air-Purifying Respirators

When wearing a PAPR, health care personnel should:

- Mount the belt unit containing the blower and cartridges on the waist and adjust the belt until it is comfortable;
- Connect the breathing tube to the mask;
- Put on the mask by following the manufacturer's IFU or slipping the hood over the head;
- If using a tight-fitting PAPR, check the facepiece fit by blocking off the breathing tube with the palm of the hand and then breathing in and holding breath for 10 s;
    - if the seal is good, the facepiece will collapse and remain against the face;
    - if there is leakage or the facepiece does not remain collapsed, remove and reposition to obtain a good fit;
    - if a good seal is not obtained by repositioning the fitting straps, check other components for leaks (i.e., breathing tube);
    - do not use the respirator until a good fit is obtained;
- Turn on the blower;
- Attach the breathing tube to the blower (University of Texas at Austin, 2007);
- Remove the PAPR in accordance with the manufacturer's IFU and place components in the designated container or area for cleaning and disinfection; and
- Discard any disposable portions of the PAPR in a waste receptacle and perform hand hygiene (Minnesota Department of Health, 2019).

If you are a plastic surgical nurse and would like to write about an issue of fundamental importance to plastic surgical nurses, or if you would like to see your issue presented in a future *Fundamentals of Plastic Surgical Nursing Practice* column of *PSN*, please contact Sharon Ann Van Wicklin, Editor-in-Chief, *PSN* at sharonvwrn@ispan.org.

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