ASA Guidelines for Surgical Attire

Committee of Origin: Occupational Health

(Approved by the ASA House of Delegates on October 23, 2019)

The ASA Committee on Occupational Health and the Advisory Group on Infection Control are charged with periodically reviewing scientific evidence and expert opinion on matters related to infection control and prevention in the operating room. Based upon evidence available as of April 2019, the Committee and the Advisory Group put forth the following ASA Guidelines for Surgical Attire.

Process Recommendations
1. The facility’s surgical attire policy should be based upon scientific evidence and expert opinion. Evidence should be relevant, free from bias, and drawn from all available information.
2. Local infection control policy should be set by the health care professionals who provide patient care within the setting to which the policies apply (e.g., for policies affecting practices within the operating room, nurses, surgical technicians, surgeons, and anesthesiologists should share representation in the group setting the policy). Outside professional consultation should be sought as necessary (e.g., infectious disease professionals).

Clinical Guidelines
1. In restricted or semi-restricted procedural areas, wear clean scrub attire that fits well.
2. When choosing scrub material, consider both containment of shed skin particles and comfort.
3. Establish and implement a process for laundering scrubs regularly and whenever they become visibly soiled. Change out of visibly soiled scrub attire as soon as possible without delaying exigent patient care.
4. When in a restricted or semi-restricted procedural area, cover the hair and scalp with head gear made of a disposable or launderable re-useable material.
5. When choosing head gear material, consider containment of shed particles, comfort and fit.
6. Establish and implement a process for laundering reusable head coverings regularly and whenever they become visibly soiled.
7. During a procedure in which normally sterile surfaces or mucous membranes are exposed or entered through a needle or cannula, wear a surgical mask that fully covers the mouth and nose. Wear the mask when sterile instruments intended for the procedure are exposed. This does not apply to the insertion of cannulas into superficial peripheral veins for short-term (less than 3 days) intravenous access.
8. When in a restricted or semi-restricted procedural area, cover facial hair not contained within a mask, especially when working over or near the surgical field.
9. When choosing a facial hair covering material, consider containment of shed particles, comfort and fit.
Evidence

All humans shed dead skin cells and hair. During low level activity such as walking, each person sheds about 10,000 enucleated keratinocytes per minute (600,000 per hour) from the outermost layer of the epidermis and between 50-100 hairs per day.

About ten percent of shed skin cells carry bacteria.1 Bacteria firmly attach to human skin and hair. Bacteria attached to hair cannot be removed, destroyed, or attenuated by extensive treatment with neutral detergents, so normal shampooing does not render hair free from bacteria.2

Skin and hair both have long been recognized as potential reservoirs for airborne infectious particles in the operating room setting.1,3,4 Staphylococcus aureus is generally accepted as the most common pathogen potentially transmitted by these airborne particles.1 Less commonly, coagulase-negative Staphylococcal spp. (e.g., Staph. epidermidis) and Group A beta-hemolytic Streptococcus have been implicated.5,6 Other airborne microbial contaminants have been identified, including gram-positive rods, anaerobic bacteria, and fungi.1

Hair may entrap and sequester shed skin particles. When hair is contacted by an article of clothing such as a mask or cap, these skin particles may be released into the ambient air.

Shed skin particles that measure approximately 10 to 25 microns in the greatest diameter have the greatest potential to carry bacteria as compared to smaller particles.3 Gravitational settling accounts for over eighty percent of surface settling for particles over 10 micrometers. For larger particles, factors such as turbulence and particle velocity have far less affect upon settling as compared to gravitational factors. Therefore, measures to contain shed squames are of greatest importance to individuals who are over or near the surgical field.

Surgical procedures involving implants (e.g., total joint replacement, vascular graft insertion, cardiac valve replacement, and spine surgery with instrumentation) have the greatest potential for wound infection, and the most significant consequences, from intraoperative airborne particle settling.7

The recommendation to wear scrub attire made from “fabrics … that are tightly woven and low linting”8 stems from a theoretical concept that material impermeable to shed skin scales would thereby “contain” or “hold them in.” If dispersion into the surrounding air is prevented, then these potentially infectious particles may be prevented from settling on surfaces such as the open wound, a sterile instrument, or a gloved hand.

This premise also underlies the recommendation to “Cover scalp, hair, and beards when entering the semi-restricted and restricted areas”.9 Such coverage may contain potentially bacteria-laden hair and skin particles.

No studies demonstrate an association between the material from which scrubs, head gear, and beard covers are constructed and surgical infectious outcomes (e.g., the incidence of surgical site infection). Similarly, no studies show that the extent to which these articles cover the hair, scalp,
beard, or arms (e.g., long sleeves) affects infectious outcomes in surgical patients. However, a recent study by Markel et al., discussed below, finds differences in permeability of different types of head covers.

Airborne bacteria-laden particles may settle directly into the surgical wound or contact the wound indirectly by settling onto gloves, sterile sponges, and instruments. These potentially infectious airborne particles may be measured using nutrient agar plates that are exposed passively (e.g. settle plates) or actively to ambient air over a specified period. Active sampling uses suction to collect air and drive it into contact with the collection medium. Each colony that arises from one or more viable microorganisms is counted as a “colony forming unit” (CFU’s). The number of CFU’s on the agar plate is divided by the volume of air sampled, yielding a quotient “CFU’s per cubic meter.” The measured CFU’s/m^3 is an indication of air quality.

Some studies found an association between the microbiologic air quality close to the surgical wound and the incidence of surgical site infection following joint replacement procedures. In a study of over 8000 joint replacement procedures, Lidwell and colleagues found that the incidence of joint space infection was significantly lower when done in a setting with less than 50 CFU’s/m^3 as compared greater than 50 CFU’s/m^3. Interestingly, prophylactic antibiotics reduced the incidence of postoperative wound infection to the same extent as reducing the ambient CFU’s/m^3. Dariouche et al. found a direct relationship between the intraoperative airborne CFU’s/m^3 detected immediately adjacent to the incision sites during prosthesis implantation and incidence of postoperative implant infection. Every 10 CFU/m^3 increase in median CFU density approximately doubled the probability of implant infection.

Some investigations found that ambient airborne infectious particles in the operating room were significantly reduced when occlusive or semi-occlusive scrubs and/or surgical gowns were worn as compared to conventional weave cotton attire. However, the results of these studies were often conflicting, and the studies were conducted in settings with varying air flow and filtration systems (e.g., conventional turbulent air flow, laminar air flow, ultrafiltration).

Ritter et al. studied the airborne infectious particles sampled during the use of various head covers. These investigators found no significant difference during the use of a cloth cap, a cloth hood tucked into gown, and no head cover. However, the use of hair spray diminished bacterial counts with or without a head cover.

In contrast, Friberg et al. found that the omission of mask and skull cap head covering resulted in 3- to 5-fold increase in bacterial air counts and an almost 60-fold increase in bacterial sedimentation rate. This study took place in a laminar flow operating room environment. Sterile helmet aspirators provided no benefit beyond wearing head coverings and masks.

If containment of shed skin particles is the goal, then hair coverings would be most effective if constructed of a material impermeable to these particles. Markel et al. compared disposable bouffant-style caps and skull caps to newly home-laundered cloth caps to determine permeability, particle transmission, and pore size. All three types of caps were evaluated twice at two different
institutions for a total of four one-hour long mock surgeries for each. In addition, all cap types underwent permeability and porosity testing. The researchers found that the material of the disposable bouffant cap was more permeable to particles potentially containing bacteria compared to the material of the disposable skull cap and the cloth cap. By using settle plates, the investigators observed greater bacterial shed when bouffant caps were worn than when cloth skull caps were worn.

Kothari et al.\textsuperscript{16} conducted a retrospective study to compare SSI rates following procedures performed when the surgeon wore a bouffant cap versus a skullcap. A total of 1,543 patients were included in the trial. Factors pre-disposing to infection (e.g., smoking, diabetes mellitus) were similar between groups. When adjusting for the type of surgery (e.g., clean, contaminated, clean-contaminated), SSI rates were not significantly different for procedures performed wearing skullcaps compared to those performed wearing bouffant caps.

At least three recent retrospective studies\textsuperscript{17-19} found that strict implementation of a policy to substitute bouffant caps or surgical hoods in place of skull caps had no effect on the incidence of postoperative surgical infections.

Total body exhaust gowns are currently used during high-risk orthopedic procedures; they represent the most extreme barrier precaution to reduce surgical site infections. Interestingly, not all studies demonstrate their superiority over other forms of surgical garb. Polyester gowns were found to contain infectious particles at least as well as total body exhaust gowns.\textsuperscript{11}

Ultraclean air filtration and laminar air flow have each been shown to significantly impact microbiologic air quality. However, improved air quality with these systems has not translated into reductions in surgical site infections following joint implantation procedures.\textsuperscript{20} Importantly, several studies indicate that operating room air quality is affected by the number of people in the operating room and their behavior (e.g., activity level and traffic in and out of doorways). According to a recent review article\textsuperscript{21}, published data about the impact of operating-room behaviors on the risk of infection are limited and heterogeneous, and “studies exhibit major methodological flaws.”

Clothing itself may increase skin scale shedding by friction. Researchers have demonstrated that naked men shed approximately a third to a half as many bacteria as the same men wearing street clothes or scrub suits.\textsuperscript{22} Others demonstrated that women wearing stockings shed more bacteria than women with bare legs.\textsuperscript{23}

If surgical attire is too tight, then this promotes friction. Prolonged friction may cause chafing. In addition, less porous fabrics promote sweating, and hyperhydrated skin from sweating promotes bacterial colonization. Moisture promotes skin maceration, which causes further skin damage.

Prolonged chaffing and moisture can lead to skin damage. Damaged skin often harbors more pathogens than normal skin. Washing damaged skin is less effective at reducing the number of bacteria, and the number of organisms shed from damaged skin are often higher than from healthy skin.\textsuperscript{24} When inflammatory and/or desquamating skin conditions such as eczema and atopic
dermatitis are present, the skin affected by these conditions is more likely than normal skin to be colonized by pathogenic bacteria (e.g., *Staph. aureus* and gram negatives). Moreover, skin affected by these conditions sheds more squames than normal skin and the shed squames are more likely to contain pathogenic bacteria. Because of the effects of friction and the potential for less “breathable” materials to evoke skin damage and inflammatory skin conditions, comfort and fit are important considerations for surgical attire beyond the containment of shed skin particles.

There are case reports describing infectious outbreaks associated with airborne particles shed by a health care worker. One published case report describes an outbreak of surgical infections associated with an individual who carried *Staph. aureus* in his hair. Even though he wore a head covering and a mask during procedures, eleven infections were linked to this carrier. After abatement measures were taken, the infections ceased temporarily. However, the carrier again became colonized and he was linked to five more infections. After the carrier left the facility, no further outbreaks were observed.

Another case report described a series of surgical wound infections linked to a skin carrier of Group A beta-hemolytic *Streptococcus*. Settle plates were used to detect airborne infectious particles shed by this carrier. The carrier was identified as a woman with a history of psoriasis and seborrhea, and multiple skin and hair sites were found to be colonized with the specific *Streptococcal* strain. Interestingly, the carrier consistently wore paper head gear when in the operating room.

There are conflicting data comparing the extent of bacterial shed from bearded and non-bearded personnel and the effectiveness of a surgical mask in containing bacterial shed from bearded individuals. Wakeam et al. compared facial bacterial colonization among 408 male health care workers with and without facial hair. Male hospital workers with facial hair did not harbor more potentially concerning bacteria than clean shaven workers. Clean shaven workers were significantly more likely to be colonized with *Staph. aureus* including MRSA. Both groups shed bacteria at high rates.

Parry et al. studied the CFU’s shed by bearded and clean-shaven men during standardized facial motions. The researchers concluded that, while wearing surgical masks, bearded surgeons and non-bearded surgeons had similar rates of bacterial shedding. The addition of surgical hoods did not decrease the amount of shedding in either group.

By placing blood agar plates 15 cm below a seated subject, McLure et al. examined the colony forming units (CFU’s) dispersed by clean-shaven men, men with beards, and women. Bearded men were found to have significantly more bacterial shedding than women or clean-shaven men, even when wearing a mask. Workers with facial hair were more likely to shed bacteria after rubbing their faces; however, both men (whether bearded or clean shaven) and women shed bacteria at high rates with facial manipulation. The investigators concluded that facial manipulation leads to bacterial shedding in both male and female HCWs, and that facial hair can increase bacterial shedding in male HCWs.
Future studies designed to investigate an association between surgical attire and infectious outcomes should consider factors known to affect surgical infectious outcomes, such as the length of procedure, the body mass index of the patient, co-existing diseases such as diabetes, the use of antimicrobial prophylaxis, and preoperative hair removal method.

**CDC Recommendations for Prevention of Surgical Site Infections**

The 2017 CDC recommendations for prevention of Surgical Site Infections (SSI),\(^29\) based upon information available through April 2014, did not address surgical attire. The supplemental material states “that many of the 1999 strong recommendations should be re-emphasized as accepted practice for preventing surgical site infections.”

The 1999 CDC Guideline for the Prevention of Surgical Site Infection\(^30\) reads as follows:

1. Wear a surgical mask that fully covers the mouth and nose when entering the operating room if an operation is about to begin or already under way, or if sterile instruments are exposed. Wear the mask throughout the operation. *Category IB*
2. Wear a cap or hood to fully cover hair on the head and face when entering the operating room. *Category IB*
3. Do not wear shoe covers for the prevention of SSI. *Category IB*
4. Wear sterile gloves if a scrubbed surgical team member. Put on gloves after donning a sterile gown. *Category IB*
5. Use surgical gowns and drapes that are effective barriers when wet (i.e., materials that resist liquid penetration). *Category IB*
6. Change scrub suits that are visibly soiled, contaminated, and/or penetrated by blood or other potentially infectious materials. *Category IB*
7. No recommendations on how or where to launder scrub suits, on restricting use of scrub suits to the operating suite, or for covering scrub suits when out of the operating suite. *Unresolved issue*

*Federal regulation: OSHA.*

**References**


