



Increasing Patient Safety in the Operating Room:

A New Perspective on the
Role of Surgical Attire

(A Continuing Education Self-Study Activity)

A Continuing Education Activity

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**INCREASING PATIENT SAFETY IN THE OPERATING ROOM:
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CONTACT INFORMATION:



2101 S. Blackhawk Street, Suite 220

Aurora, CO 80014-1475

Phone: 720-748-6144

Fax: 720-748-6196

Website: www.pfiedlerenterprises.com

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INCREASING PATIENT SAFETY IN THE OPERATING ROOM: A New Perspective on the Role of Surgical Attire

(A Continuing Education Self-Study Activity)

OVERVIEW

One of the expected outcomes for the patient undergoing an operative or invasive procedure is that he/she will be free from infection. Therefore, it is the responsibility of all members of the surgical team to provide the best possible environment for surgical intervention. While there are numerous infection prevention practices in every surgical setting, the significance of surgical attire, as it relates to patient safety, is often overlooked. The purpose of this continuing education activity is to provide an overview of the impact of surgical attire, specifically scrub apparel and head covers, on patient safety in the operating room (OR). A brief history of surgical attire will be provided, as well as a discussion of the materials used to fabricate scrubs and surgical head covers. Current applicable regulations, guidelines, and professional recommended practices for the use of surgical attire and also ancillary considerations such as wearing of jewelry in the OR will be outlined. In addition, this independent learning activity will provide a review of the pertinent scientific literature related to pertinent clinical issues, such as the appropriate use, care, and handling of surgical scrubs and head covers, including home laundering. Approaches to improving OR personnel compliance with accepted guidelines related to the proper use of surgical attire will also be discussed. Case studies will provide the opportunity to synthesize the information and evaluate selected clinical scenarios.

LEARNER OBJECTIVES

Upon completion of this continuing education activity, the participant should be able to:

1. Discuss the impact of surgical attire on patient safety.
2. Outline the historical development of surgical attire.
3. List the major types of materials used in the fabrication of surgical attire.
4. Explain pertinent guidelines related to surgical attire.
5. Identify the rationale for surgical attire.
6. Describe the PRECEDE model of behavior modification.
7. Critique clinical scenarios related to appropriate surgical attire.

INTENDED AUDIENCE

This independent learning activity is intended for use by perioperative nurses, surgical technologists, and other healthcare professionals who are responsible for safe patient practices knowing that surgical attire plays a role in preventing surgical site infections.

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PLANNING COMMITTEE

Judith A. Veale, PhD

Neurophysiologist
Colorado Springs, Colorado

Rose Moss, RN, MN, CNOR

Nurse Consultant
Del Norte, Colorado

Judith I. Pfister, RN, BSN, MBA

Program Coordinator
Pfiedler Enterprises
Aurora, Colorado

Anthony Adams, CST

Surgical Technologist
University of Colorado Hospital
Aurora, CO

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Judith A. Veale, PhD

1. No
2. Not Applicable
3. No

Rose Moss, RN, N, CNOR

1. No
2. Not Applicable
3. No

Judith I. Pfister, RN BSN, MBA

1. No
2. Not Applicable
3. No

Anthony Adams, CST

1. No
2. Not Applicable
3. No

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Phone: 720-748-6144
Email: tonia@pfiedlerenterprises.com
Postal Address: 2101 S. Blackhawk Street, Suite 220
Aurora, Colorado 80014
Website URL: <http://www.pfiedlerenterprises.com>

MINI-VIGNETTE

An outbreak of sternal wound infections post-coronary artery bypass graft (CABG) surgical procedures led the hospital's infection control practitioner to conduct "environmental rounds" within the operating room (OR) during the CABG procedures to investigate the marked increase in the infection rate.¹ These increased infection rates were resulting in increased readmissions as well as prolonged lengths of stay. She found that the team was very "sloppy" - members of the surgical team wore loose hair and jewelry (earrings, necklaces); several also wore regular sandals into the OR. The infection control practitioner noted also that several team members did not re-scrub when moving from working on the saphenous vein graft in the patient's leg back to the patient's open chest. In the commentary on this case, the conclusions included that:

- While definitive studies have not been performed for many aspects of surgical infection control, data suggest that the currently available recommendations [regarding removal of jewelry, covering of head and facial hair, use of surgical masks, avoidance of long or artificial nails, and covering feet] will limit surgical site infections.
- Changing health care worker behavior is a challenging endeavor that requires a comprehensive approach for success.

SURGICAL ATTIRE

The Big Picture – Surgical Site Infections

Safety in the OR environment is paramount for every patient undergoing a surgical procedure. One key aspect of patient safety is the prevention of a surgical site infection (SSI). SSIs account for 14-16% of all hospital-acquired infections and are a common complication of care; through the implementation of measures to reduce SSIs, hospitals could realize saving of \$3,152 and also decrease extended lengths of stay by seven days for each patient who develops an infection.² In American Hospitals Healthcare Associated Infections (HAI) account for an estimated 1.7 million infections. Approximately 22% of these HAI's are surgical site infections. The cost of these SSI's are approximately \$10,443 per infection and increase hospital stays by an average of 7.5 days.

For purposes of standardized reporting, SSIs have been defined and classified by the CDC's National Nosocomial Infections Surveillance (NNIS) System as superficial incisional SSIs, deep incisional SSIs, and organ/space SSIs (see Table 1).³

Table 1. Definitions of Surgical Site Infections

Superficial Incisional SSI

- Infection occurs within 30 days of the operation.
- Infection involves only skin or subcutaneous tissue.
- At least 1 of the following:
 - Purulent drainage,
 - Positive culture from the incision,
 - At least 1 symptom of infection (pain or tenderness, localized swelling, redness, heat) and incision is opened by surgeon, unless incision is culture-negative, or
 - Diagnosis of SSI by surgeon or attending physician.

Deep Incisional SSI

- Infection within 30 days of the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation.
- Infection involves deep soft tissues.
- At least 1 of the following:
 - Purulent drainage from the deep incision but not from organs/spaces associated with the surgical site,
 - Spontaneous dehiscence of deep incision or deliberate opening by a surgeon when the patient has at least 1 symptom of infection (fever, localized pain, or tenderness), unless site is culture-negative,
 - Abscess or other evidence of infection involving the deep incision found on direct examination, during reoperation, or by histopathology or radiography, or
 - Diagnosis of SSI by surgeon or attending physician.

Organ/Space SSI

- Infection within 30 days of the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation.
- Infection involves any part of the anatomy (e.g., organs or spaces), other than the incision, which was opened or manipulated during an operation.
- At least 1 of the following:
 - Purulent drainage from drain placed into the organ/space,
 - Positive culture of fluid or tissue from the organ/space,
 - Abscess or other evidence of infection involving the deep incision found on direct examination, during reoperation, or by histopathology or radiography, or
 - Diagnosis of SSI by surgeon or attending physician.

Surgical site infections are caused by the contamination of the surgical site by either endogenous microorganisms, for example, bacteria from the patient's own skin or mucous membranes, or microorganisms from exogenous sources, such as healthcare personnel, surgical instrumentation and other materials, as well as the environment. The most common causative agents in SSIs are *Staphylococcus aureus*, coagulase-negative staphylococci, *Enterococcus* species, and *Escherichia coli*. Alarming, SSIs are more often being caused by antibiotic-resistant microorganisms, such as methicillin-resistant *S. aureus* (MRSA).⁴

The skin, hair and nares of surgical personnel are reservoirs of bacteria, which may be discharged in particle form into the air and therefore pose a risk of SSI to the patient. Because the human body is a major source of microbial contamination within this environment, scrub clothing is worn in order to promote a high level of cleanliness and hygiene within the surgical practice environment.⁵ Sebaceous and sweat glands in and around hair follicles over the entire surface of the body contain microorganisms that are constantly shed into the environment. The purpose of surgical attire is to provide an effective barrier that prevents the dissemination of these microorganisms to the patient. Surgical attire consists of body covers, including a two-piece pantsuit, head cover, mask, and shoe covers, as appropriate. Each of these items is a specific means for containment of or protection against the potential sources of environmental contamination; in addition, each is intended to combat sources of exogenous contamination to the patient.⁶

In order to reduce bacterial and skin shedding (scurf), all persons who enter the semirestricted and restricted areas of the surgical suite should wear clean, facility-laundered, surgical attire that is composed of multiuse fabric or limited-use nonwoven material.⁷ Dressing rooms, accessed through an outer corridor, are located in the unrestricted area adjacent to the semirestricted area of the OR suite for personnel to change into surgical attire; street clothes are not worn beyond the unrestricted area.

As noted, infection prevention is a key aspect of care for all patients, but is certainly significant for the surgical patient. One of the National Patient Safety Goals promulgated by The Joint Commission is to reduce the risk of health-care associated infections.⁸ More specifically, Outcome O10 in the Perioperative Nursing Data Set (PNDS) is that the patient is free from signs and symptoms of infection.⁹ The nursing interventions and activities noted to achieve this outcome include:¹⁰

- Protects from cross-contamination (I98)
 - Wears clean, dry, freshly laundered surgical attire intended for use in the surgical suite.
 - Wears long-sleeved jacket that is snapped or buttoned closed when not scrubbed.
 - Covers head and facial hair, including sideburns and neckline, when in semirestricted areas (including most of the peripheral support areas of the surgical suite that have storage areas for clean and sterile supplies)

and restricted areas (where surgical procedures are performed and unwrapped supplies are sterilized) of the surgical suite by wearing a hat or hood that minimizes microbial dispersal.

- Confines or removes all jewelry and watches.

Proper surgical attire is a key component of aseptic environmental control; it is an important factor in controlling the potential spread of infection to the surgical patient. By restricting the apparel worn within the surgical suite, the first barrier to infection is established. Every surgical suite should have specific, written policies and procedures regarding the proper attire that is to be worn within the semirestricted and restricted areas of the suite.

A LITTLE HISTORY

Surgical attire – including surgical gowns, scrubs, masks, hair coverings, and gloves – did not come into routine use until well into the 20th century. The German surgeon Gustav Neuber is credited as the first to advocate absolute cleanliness in the OR and to require surgeons and assistants to wear sterile gowns and caps.¹¹ Scrubs were first advocated in the literature by Dr. Hunter Robb in his 1894 book, *Aseptic Surgical Technique*: “It is safer and better that all should put on a complete change of costume rather than simply don a sterilized coat and pair of trousers over the ordinary clothing as has been recommended by the German school.”¹² Scrubs were not used in the operating room until around 1900.¹³ Previously, a surgeon usually wore street clothes covered by a butcher’s apron to protect his clothes from stains.

Among the earliest references to scrub attire for OR nurses appeared in two textbooks published in the 1920s.^{14,15} Previously, and indeed through much of the 1930s, nurses wore regular nurse uniforms in the OR, supplemented by a surgical gown in the case of the sterile or instrument nurse.

By the 1940s, scrubs, surgical gowns, and surgical drapes were in common use in the OR, as a result of advances in aseptic technique and infection control. Scrub hats also became standard wear to help protect patients from contaminants in hair. In the late 1950s and early 1960s, much attention became focused on airborne contamination as a source of SSIs. Studies showed that the skin bacteria of health care personnel could be disseminated into the environment, especially from the lower extremities.^{16,17} Subsequent studies demonstrated that a reduction in airborne bacteria arising from the perineum, thighs, and feet could be achieved by wearing specially designed trouser-like clothing that was occluded at the feet and waist and made of tightly woven material that restricted the dissemination of skin squames; and so it was that pants were first introduced for women in the health care setting.¹⁸

In the 1950s and 1960s, changes in color, design, and materials of fabrication took place. Scrubs were originally white, but OR personnel were experiencing eyestrain from bright operating lights and an all-white environment, so scrubs intended for use in surgery were manufactured in light green or light blue colors. New materials were used to provide wrinkle resistance, durability, breathability, and ease of maintenance.

By the 1970s, scrub attire had reached its modern state: a short sleeved, V-necked shirt and drawstring pants or a short-sleeved, calf-length dress, made of green cotton or a cotton/polyester blend. (Originally known as “surgical greens,” this attire came to be known as “scrubs” because it was worn in a “scrubbed” environment.) In addition, a tie-back or bouffant-style cloth or disposable cap was worn, as well as a mask made of gauze or synthetic textile, a reusable or disposable surgical gown, latex surgical gloves, and supportive closed-toe shoes. Surgical hoods also came into wide use in the 1970s. As late as 1976, the scrub dress was the preferred style for women; since then, however, “unisex” scrubs have become the norm, both in the OR and elsewhere in the health care facility.

In recent years, the types and styles of head coverings have proliferated, mainly to accommodate fashion tastes. The traditional, utilitarian bouffant-style is still commonly used, but now such styles as the “Pony hat” (which holds up long hair more effectively) are available as well.

MATERIALS OF FABRICATION

Surgical apparel was initially manufactured from readily available fabrics, such as cotton muslin. In the early 1970s, tightly woven fabrics with water-repellent chemical finishes were adopted for surgical use, including polyester/cotton blended sheeting of various thread counts. In the 1980s, tightly woven, chemically finished polyester fabrics came into wide use, as well as various composite materials that were laminated or coated to improve their performance characteristics. All of these materials are woven or knitted and reusable.

Single-use surgical apparel was introduced in the late 1960s. Such apparel is commonly manufactured from nonwoven materials, alone or in combination with plastic films. Fiber-bonding technologies are used to fabricate nonwoven materials from various types of natural fibers, such as wood pulp and cotton, and various types of synthetic fibers, such as polyester and polyolefin. Nonwoven materials include “spunlace” fabric (a blend of wood pulp and polyester fibers), “spunbond/meltblown/spunbond” fabric (which consists of three layers of polypropylene), and “wetlaid” fabric (which consists of wood pulp fibers or a blend of polyester and wood pulp fibers). These specific terms relate to the specific fiber-bonding technology used to create the fabric. Composites (combinations of nonwoven fabrics and films intended to enhance performance) are also used to manufacture single-use surgical apparel.

GUIDELINES, REGULATIONS, AND RECOMMENDED PRACTICES

Practice guidelines, standards, recommended practices, and other resources have been developed by various regulatory agencies and professional associations, including the Centers for Disease Control and Prevention (CDC), the Occupational Safety and Health Administration (OSHA), and the Association for periOperative Registered Nurses (AORN) to assist in the development of policies and procedures regarding surgical attire and infection prevention. A brief summary of these various guidelines, regulations, and recommended practices follows.

CDC GUIDELINE

The CDC's Guideline for Prevention of Surgical Site Infection addresses surgical attire as one of a spectrum of considerations that may affect the incidence of SSIs.¹⁹ Acknowledging that few controlled clinical studies have evaluated the relationship between the use of surgical attire and SSI risk, experimental data demonstrate that live microorganisms are shed from the hair, exposed skin, and mucous membranes of OR personnel. However, the use of barriers appears to be prudent, in order to minimize the patient's exposure to the skin, hair, and/or mucous membranes of the surgical team members. All of CDC's intraoperative recommendations regarding surgical attire are characterized as Category IB (strongly recommended for implementation and supported by some experimental, clinical, or epidemiological studies and strong theoretical rationale):

- A cap or hood that fully covers the hair on the head and face should be worn when entering the operating room.
- Scrubs that are visibly soiled, contaminated, and/or penetrated by blood or other potentially infectious materials should be changed.
- No recommendations are made regarding how or where scrubs should be laundered, on restricting the use of scrubs to the operating suite, or whether to cover scrub suits when outside of the operating suite.

In its preoperative recommendations on hand and forearm antisepsis for surgical team members, the CDC's recommendations include that hand or arm jewelry should not be worn.

OSHA REGULATIONS

Scrubs are not personal protective equipment (PPE) because, unlike surgical gowns, they are not made of barrier-type materials, that is, materials that are resistant or impermeable to penetration by liquids or microorganisms. However, if scrubs are worn in situations in which personnel could be exposed to blood or other potentially infectious materials, the Occupational Safety and Health Administration's (OSHA's) regulations limiting occupational exposure to bloodborne pathogens apply.²⁰ These regulations require employers to provide appropriate PPE to protect health care personnel from the anticipated degree of exposure to blood or other potentially infectious materials (OPIM). OSHA's Instruction and Enforcement Procedures for Examiners states that scrubs are usually worn in a manner similar to street clothing, and normally should be covered by appropriate gowns, aprons or laboratory coats when splashes to skin or clothing are anticipated.²¹ In addition, the OSHA instruction manual states that if a pull-over scrub (as opposed to scrubs with snap closures) becomes minimally contaminated, the employee should be trained "...to remove the pull-over scrub in such a way as to avoid contact with the outer surface, for example, rolling up the garment as it is pulled toward the head for removal. However, if the amount of blood exposure is such that the blood penetrates the scrub and contaminates the inner surface..." it may be prudent to train employees to cut such a contaminated scrub to aid removal and prevent exposure to the face.

OSHA's regulations are also relevant to the issue of home laundering of scrubs, insofar as OSHA requires that surgical attire that is visibly contaminated by blood or OPIM must be laundered by the health care facility or a facility-contracted commercial laundry.²²

AORN RECOMMENDED PRACTICES

AORN's Recommended Practices for Surgical Attire provide guidelines for the attire that is worn within both the semirestricted and restricted areas of the perioperative practice environment. A brief synopsis of the recommended practices related to surgical apparel, head coverings, and jewelry is presented below.²³

Recommended Practice I: All individuals who enter the semirestricted and restricted areas of the surgical suite should wear freshly laundered surgical attire intended for use only within the surgical suite. The interpretive statements go on to outline:

- Personnel should don facility-approved, clean, freshly laundered surgical attire in a designated dressing area upon entry or reentry to the facility; scrubs worn into the facility from outside should be changed before entering semirestricted or restricted areas to minimize the potential for contamination.
- Surgical attire aids in containing bacterial shedding and promotes environmental control.
- Whether reusable or single-use, surgical attire should be low-linting that minimizes bacterial shedding. If a two-piece pantsuit is worn, the top of the scrub suit should be secured at the waist, tucked into the pants, or fitted closely to the body.
- Surgical attire should be changed daily or whenever it become visibly soiled, contaminated, or wet.
- Surgical attire should be placed in designated containers after use.
- Visibly soiled, contaminated, or wet surgical attire should be removed as soon as possible and replaced with fresh, clean attire. Changing contaminated, soiled, or wet attire decreases the potential for cross-infection and also protects personnel from prolonged exposure to potentially harmful bacteria. Worn surgical attire should be placed in an appropriately designated container for washing or disposal after use; it should not be placed in a locker for wearing at another time.
- Surgical attire that is contaminated with visible blood or body fluids must remain at the facility and be laundered by the health care facility or a facility-contracted commercial laundry. The controlled laundering of attire that is contaminated by blood or body fluids decreases the risk of transferring pathogenic microorganisms from the facility to the home environment or the general public.
- Home laundering of surgical attire is not recommended.
- During transport and storage, laundered surgical attire should be protected from contamination.
- The use of cover apparel should be determined by the individual practice

setting. The use of cover apparel has been found to have minimal or no effect on reducing contamination, but it is often used for practical enforcement and cost considerations. If used, however, cover apparel should be removed before personnel enter a semirestricted or restricted area since they can be a source of contamination. The decision on the use of cover apparel depends on individual state regulations, the culture within each perioperative suite, and the manager's assessment of the priorities.

- Nonscrubbed personnel should wear long-sleeved jackets that are buttoned or snapped closed during use. Complete closure of the jacket avoids accidental contamination of the sterile field. Long-sleeve attire is also advocated in order to prevent bacterial shedding from bare arms and is included in the OSHA regulation for the use of PPE.
- Other garments should be contained completely within or covered by the surgical attire; clothing that cannot be completely covered by the surgical attire should not be worn.

Recommended Practice II: Personnel should cover head and facial hair, including sideburns and necklines, when in the semirestricted and restricted areas of the surgical suite. Specific interpretive statements include:

- A clean, low-lint surgical head cover or hood that confines all hair should be worn. Hair covers eliminate the potential of hair or dandruff being shed onto surgical attire. Personnel with a bald or shaved head should wear a head cover in order to prevent the shedding of squamous cells, i.e., scurf.
- The head cover or hood should be designed to minimize microbial dispersal. Hair serves as a filter when left uncovered and collects bacteria in relation to its length, curliness, and oiliness. Shedding from hair has been demonstrated to affect surgical wound infection, therefore complete coverage is necessary. Disposable bouffant and hood-style coverings are preferred. Net caps should not be used because they do not provide a barrier to dandruff and hair fallout. Skullcaps that do not cover the side hair above the ears and the hair at the nape of the neck should not be worn in the surgical suite.
- Single-use head coverings should be removed and discarded in a designated container as soon as possible after daily use. Reusable hats or hoods should be laundered in a commercial laundry after each use.
- Contaminated head coverings must be removed and laundered by the facility.

Recommended Practice IV: All personnel entering the semirestricted and restricted areas of the surgical suite should confine or remove all jewelry and watches. The interpretive statements include:

- Rings should be removed from hands. Rings may harbor organisms that cannot be removed during hand washing. Increased bacterial counts have been noted when jewelry is worn.

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- Other jewelry, such as watches, earrings, bracelets, necklaces, and piercings, should be removed or totally confined within the scrub attire. While no evidence exists that demonstrates that other jewelry increases bacterial shedding, there is the concern that jewelry could potentially fall onto the sterile field or into the wound if not contained. Necklaces could contaminate the front of the sterile gown if not confined.

Recommended Practice V: Fingernails should be kept short, clean, natural, and healthy.

- The subungual region harbors the majority of microorganisms found on the hand. Recent studies found no increase in microbial growth related to wearing freshly applied nail polish, however, nail polish that is obviously chipped or worn longer than 4 days is associated with the presence of increased numbers of bacteria and has been associated with infections.
- Artificial nails should not be worn.

Recommended Practice VII: Policies and procedures for surgical attire should be developed, reviewed periodically, and readily available in the practice setting. These policies and procedures should include, but not be limited to, definition of areas where surgical attire must be worn, appropriate attire within those defined areas, and the choice for the use of cover apparel outside the surgical suite.

CONTEMPORARY ISSUES

Scrubs in the OR

A report on the use of scrubs published by the Association for Professionals in Infection control and Epidemiology (APIC) asserted that despite the AORN recommendations and the long-standing tradition of wearing scrubs in the operating room setting, no scientific data support the practices as a means for preventing transmission of infection.²⁴ AORN continues to recommend frequent changing of surgical attire to promote cleanliness and hygiene within the practice setting, citing several studies demonstrating higher bacterial colony counts when scrubs are removed, stored, and used again.²⁵ The CDC does not take a position on the wearing of scrub attire outside the OR and simply cites AORN recommendations and OSHA regulations regarding attire that is visibly soiled or contaminated by blood or other potentially infectious materials (OPIM).²⁶ Some authors have argued that since no scientific studies have conclusively linked the use of scrub attire to the prevention of SSIs, many of today's conservative rituals are unnecessary and cannot be justified in terms of cost–benefit.²⁷ A more recent review concluded that “there is little or no research to show that wearing theatre attire outside the theatre and returning without changing into clean theatre attire increases wound infection rates.”²⁸

Cover Gowns

Today, the term “cover gown” refers to long-sleeved laboratory coats or jackets worn over scrubs to prevent contamination of the scrubs. Studies reported in the 1980s indicated that the level of contamination on scrubs was reduced if cover gowns were worn outside the OR.^{29,30} However, the methodology used in these studies has been questioned³¹ because

personnel wore cover gowns that opened in the rear and were tied at the neck and back, which is not current practice. In addition, later studies have not demonstrated a relationship between the use of cover gowns and bacterial contamination rates^{32,33} or between the use of cover gowns and infection rates;³⁴ in the case of the last-cited study, abandoning the policy requiring the use of cover gowns resulted in considerable cost savings (\$120,000 in one year). The failure of studies to show an impact of cover gowns on bacterial contamination rate has led some health care facilities to change their policies regarding the use of cover gowns³⁵ and AORN to change its recommendations. Currently, AORN states that the use of cover gowns “depends on the culture of each perioperative setting, the perioperative manager’s assessment of priorities and state regulatory laws,” noting also that “the use of cover apparel has been found to have little or no effect on reducing contamination, but it is used for practical enforcement and cost considerations.”³⁶ The CDC regards the wearing of cover gowns over scrubs as an unresolved issue.³⁷

Laundering

The home laundering of scrubs continues to be controversial. Despite AORN recommendations to the contrary, an increasing number of health care facilities have programs in which OR personnel launder scrubs at home, largely for cost-containment reasons and apparently without an increase in the incidence of SSIs.³⁸ AORN expresses concern about the efficacy of home laundering in relation to commercial laundering and about the potential for the spread of contamination to the home environment; acknowledging, however, that some health care facilities do require home laundering of surgical attire, AORN suggests minimum criteria for home laundering.³⁹

Few studies provide evidence that would definitively resolve the issue. A series of studies published in 2000 and 2001 reported that various species of gram-negative bacteria, gram-positive bacteria, and fungi can survive for extremely long periods of time on fabric materials commonly used in scrubs and other attire; of particular note were the findings that methicillin-resistant *Staphylococcus aureus* (MRSA) survived on polyester for 7 weeks and on polyethylene for 12 weeks; vancomycin-resistant enterococcus (VRE) survived even longer.⁴⁰⁻⁴² However, a small pilot study reported in 2004 found that there was no difference in pathogenic contamination between scrubs laundered at home and scrubs laundered in the hospital; also, there was no impact of home washing procedures, water temperature, pets in the home, or donning procedures.⁴³ And, a more recent study on the effectiveness of home laundering found that home-type washing machines reduced viable counts of *Staphylococcus aureus* on staff uniforms to below detectable levels, even at a comparatively low wash temperature (40°C); it was also found that the washing machine itself can introduce Gram-negative bacteria, but that the organisms were destroyed by subsequent tumble drying or ironing. These authors concluded that “domestic laundering of uniforms is an acceptable alternative to hospital laundering if combined with tumble drying or ironing.”⁴⁴ On the other hand, a 2007 study using microbial indicators to assess the disinfection effect of laundering procedures found that *Enterococcus faecium*, *Staphylococcus aureus*, *Enterobacter aerogenes*, and *Pseudomonas aeruginosa* survived on cotton textiles after laundering at 60°C but not at 75°C.⁴⁵ Most home wash cycles average 10 to 12 minutes at 125 °F to 130 °F. To kill staphylococci, it takes 20

minutes washing at 140 °F, the beginning temperature where most bacteria begin to be destroyed.⁴⁶ The problem that persists with home laundering is that you can't monitor that staff wash their scrubs as they should.

A study comparing how/where surgical scrubs are laundered compared reusable scrubs laundered at facility, third-party laundered, home laundered and single use disposable scrubs. There was no statistically significant difference in mean microbial populations among the facility laundered, third part laundered or disposable scrubs. The bioburden associated with home laundered scrubs was significantly greater. The most important finding was a clinician beginning his/her shift in home laundered scrubs would be wearing the same quantity of organisms as the scrubs of a healthcare professional finishing a shift. This study did not determine if there is a correlation between the bioburden on scrubs and SSI's.⁴⁷

Head Coverings

Human hair is a significant source of bacteria. Outbreaks of SSIs have been associated with bacteria isolated from the hair or scalp of OR personnel, even when caps were worn in the OR.^{48,49} As noted earlier, CDC recommends that surgical caps or hoods be worn to reduce the risk of hair falling into the operative field,⁵⁰ and AORN recommends that bouffant- or hood-style head covers be worn to ensure that all hair is covered.⁵¹ Shedding from facial areas can also be problematic. In one report, unacceptably high bacterial counts were found in two slit-air samples taken during arthroplasty surgery in a laminar-flow OR.⁵² Isolates matched organisms cultured from swab samples taken from the skin of one of the surgeon's foreheads. Further investigation involving microbiological swabbing of the foreheads, eyebrows, and ears of OR personnel revealed significantly more colonies from the ears, leading the authors to conclude that exhaust helmets should be used in arthroplasty surgery or that scrub staff should be required to wear surgical hats that cover the ears.

Recently, there has been something of a trend towards the use of personalized, reusable cloth hats in the OR, despite policies at many health care facilities mandating disposable head covers. AORN recommends that reusable hats or hoods be laundered in a commercial laundry after each use (i.e., not laundered at home), but has noted the difficulties associated with the care, cleaning, and tracking of reusable hats.⁵³

Jewelry/Fingernails

As noted earlier, both AORN⁵⁴ and CDC⁵⁵ recommend that hand or arm jewelry not be worn in the OR, and AORN recommends that earrings, piercings, and other jewelry should be removed as well or else confined within scrub attire. AORN acknowledges that there is no evidence that jewelry other than rings increases bacterial shedding, but notes that there is concern that jewelry could fall onto the sterile field or into the wound if not contained. Necklaces could contaminate the front of the sterile gown if not confined.^{56,57} The CDC states that the effect of the wearing of nail polish or jewelry on the incidence of SSIs has not been adequately studied.⁵⁸

The scientific literature regarding finger rings, nail polish, and bacterial contamination or SSI risk is distinctly mixed. A 1997 review concluded that “keeping rings on [when scrubbing and during surgery] may put the patient at risk of hospital-acquired infection.”⁵⁹ On the other hand, a 2001 Cochrane review concluded that “there is no evidence of the effect of removing nail polish or finger rings on the rate of surgical wound infection” and that “there is insufficient evidence of the effect of wearing nail polish on the number of bacteria on the skin.”⁶⁰ (An update of this review published in 2006 reached the same conclusion.⁶¹) Bartlett, et al (2002), found that finger rings and nose and ear piercings increased local surface bacterial counts when in place and especially after removal. These authors suggested that while UK guidelines recommend the removal of all jewelry before scrubbing, it is preferable that jewelry worn on the nose or ear be left in place and covered by masks and hats.⁶² A 2003 study found that ring wearing was associated with a 10-fold increase in median skin organism counts as well as contamination with *Staphylococcus aureus*, gram-negative bacilli, or *Candida* organisms; moreover, the risk of contamination increased with the number of rings worn.⁶³ More recent studies have been no more consistent. One 2006 study found no evidence that surgeons wearing rings during surgery had higher bacterial counts under their gloves than surgeons not wearing rings.⁶⁴ Other authors have found that there are more bacteria under rings than on adjacent skin or the opposite hand.⁶⁵

There does seem to be a consensus among national guidelines⁶⁶⁻⁶⁸ and the scientific literature that artificial nails should not be worn. Numerous studies have demonstrated that artificial nails are associated with increased bacterial and fungal colonization of the hands and with an increased risk of SSIs.⁶⁹⁻⁷⁶ One commonly cited study of an outbreak of *Serratia marcescens* wound infections in cardiovascular surgery patients found that the infections originated with a surgical nurse who wore artificial nails.⁷⁷ A later outbreak of *Candida* osteomyelitis and diskitis after spinal surgery was also associated with the use of artificial nails.⁷⁸

ADDITIONAL CLINICAL ISSUES

In every practice setting, additional issues related to surgical attire may arise. Some of these types of issues are discussed below.

In one facility, an orthopedic surgeon new to the facility requested that the personnel assigned to his room wear hoods and also tape their sleeves and pant legs.⁷⁹ The facility’s policy required members of the surgical team to wear bouffant-style disposable head covers and two-piece scrub suits. Many of the staff members felt that the surgeon’s request was extreme and needless. In consulting the AORN Recommended Practices for Surgical Attire, it was noted that the same surgical attire is recommended for everyone entering the semirestricted and restricted areas of the surgical suite for all types of surgical procedures. In addition, these Recommended Practices specify that a cap or hood that completely covers all hair on the head and face be worn; the determining factor is covering all the hair, not the type of procedure being performed. Surgical attire should be secured at the waist, tucked in, or fit close to the body. Although taping sleeves and pant legs may provide some sense of greater confidence

in reducing the potential risk for infection, AORN is not aware of any published research, recommendations, or guideline that supports the practice of taping sleeves and/or pant legs. The CDC also does not differentiate surgical attire for specific procedures; the CDC recommends that surgical caps or hoods be worn in order to reduce contamination of the surgical field by organisms shed from the scalp and hair. As noted, wearing proper surgical attire decreases shedding and promotes environmental control.

In another case, a facility had begun home laundering of scrubs, after which time, persons entering the restricted areas for short periods of time were not required to don scrub attire or a jumpsuit; they were only required to wear head covers, including maintenance staff members and parents accompanying their children into the OR for induction of anesthesia.⁸⁰ This change in practice caused many infection control concerns. The practice of allowing people to enter the semirestricted or restricted areas of the OR suite in street clothes that are of questionable cleanliness is not advocated, as it presents an unnecessary risk of exposure to microorganisms to the patients. There is no way to assess if the visitor's clothing is clean or to what it has been exposed, prior to entering the OR. In addition, the person wearing street clothes in the OR is at risk of inadvertently contaminating the clothing with blood or body fluids and therefore being exposed to potentially infectious material. This is both a health risk to the person, but also a potential liability to the facility. This author concluded that the practice of allowing other staff members and visitors to wear street clothes into the OR is risky.

In another facility, it was noted that a staff member arrived in the surgical suite with a fleece turtleneck under her scrub clothes.⁸¹ The AORN Recommended Practices for Surgical Attire specify that all exposed clothing worn in the OR should be composed of a low-linting fabric. Fleece fabric is not low linting, therefore it is inappropriate to wear a fleece garment if any portion of it is exposed. It may be reasonable to wear a fleece shirt as an undergarment if it is completely covered and/or contained at all times by a scrub shirt or warm-up jacket, including the neckline and sleeves. The practice of staff members wearing clothing from home also presents the additional risk regarding the requirement that the facility launder the garment if it becomes contaminated with blood or body fluids; this could result destruction to the garment.

STRATEGIES TO ADDRESS COMPLIANCE WITH SURGICAL ATTIRE POLICIES

While the scientific literature does not unequivocally support some of the recommendations contained in guidelines and recommended practices regarding OR attire and while some health care facilities have chosen to establish policies and procedures that do not completely conform to these guidelines (for cost-containment or other reasons), certain commonly accepted principles of infection control are recognized and mandated in virtually all health care settings, for example, the need for OR personnel to completely cover their hair in the surgical suite. Yet, as exemplified in the mini-vignette, enforcing such principles remains difficult in practice. Poor levels of compliance with infection control principles as elementary and as universally recognized as good hand hygiene continue to be reported.

Changing human behavior can be a daunting endeavor. Behavior theory has been applied to practices in the health care environment.⁸² The PRECEDE (“Predisposing, Reinforcing, Enabling, Causes, Educational Diagnosis and Evaluation”) model, for example, postulates predisposing, enabling, and reinforcing factors in changing behavior. In the case described in the mini-vignette, for example, a predisposing factor would be convincing members of the surgical team that completely covering all hair and removing jewelry will reduce the incidence of SSIs. (In the case of some desired attire practices, this may be more difficult in the absence of definitive scientific studies.) Enabling factors in this situation might include the lack of access to appropriate hair coverings or the lack of education about the potential problems posed by jewelry or even just forgetfulness. Reinforcing factors for changing behaviors, that is, complying with policies on head coverings and jewelry, could be information on reduced rates of SSIs.

In the situation described in the mini-vignette, one author’s recommendation for improving compliance is as follows:⁸³

A reasonable approach for this case may include an initial session with the operating room teams and the surgery leadership to provide information about their current infection rate and data supporting the importance of adequate infection control practices. This could be followed by unscheduled audits to check adherence to good infection control practices, and by feedback on both the improvement in performance as well as any change in the sternal wound infection rate. Emphasis should be placed on practices likely to protect both patients and staff: in this case, adequate hair covering, foot protection, and jewelry removal. This model may not only be useful for improving infection control, but, if adapted thoughtfully, might serve as a useful model for the implementation of other patient safety interventions.

SUMMARY

In today’s dynamic healthcare environment, reducing the patient’s risk for the development of a surgical site infection is a key clinical consideration for all members of the surgical team. The appropriate use of surgical attire within the OR environment is an effective infection prevention strategy. Scrub attire and head coverings are needed in order to provide the safest possible surgical environment. In addition, practices such as removing or containing jewelry and other garments also contribute to decreasing the risk for development of a surgical site infection. All members of the surgical team must understand the role of proper surgical attire in promoting the highest level of cleanliness and hygiene for the patient undergoing surgical intervention. Through this understanding and the implementation of effective practices related to surgical attire, positive patient outcomes can be achieved.

CASE STUDIES

Case Study 1: Fashion Statements in the OR

Dan Williams, RN, MBA, CNOR is the interim Director of Perioperative Services at St. Ann's Regional Medical Center, which is a rural, 50-bed acute care facility in the southwest. An external perioperative nurse consultant had conducted a surgical services operational review and found many areas for improvement, one of which was surgical attire. The husband of one of the circulating nurses had opened a Native American art/jewelry shop in town and many of the female staff members had purchased natural stone necklaces and earrings, which were worn in the OR, outside of the head covering. In addition, many of the staff wore long-sleeved t-shirts or turtlenecks underneath their scrubs and therefore did not need to wear a warm-up jacket. It was reported that one of the nurses wore seasonal or holiday-related shirts or turtlenecks underneath her scrubs and wanted them to be visible to the other staff members as well as the patients. In addition, the majority of the female staff members had purchased reusable colorful head coverings, which on some of the staff members, did not fully contain all of their hair and jewelry. It was also noted that these head coverings were laundered infrequently, at home.

Points to Consider:

- What are the significant issues?
- What regulations/recommended practices are applicable to this situation?
- How should Dan address these issues?

Discussion of Points to Consider:

- What are the significant issues?
 - Jewelry and clothing that is not totally confined within the scrub attire.
 - Reusable head coverings that are not laundered in a commercial laundry after each use.
- What regulations/recommended practices are applicable to this situation?
 - OSHA Final Rule: Occupational Exposure to Bloodborne Pathogens.
 - AORN Recommended Practices for Surgical Attire.
- How should Dan address these issues?
 - Dan should first review the facility's existing policy and procedure regarding surgical attire.
 - He should then research state and local regulations, consult with the appropriate persons at the facility (i.e., Infection Control Practitioner, Risk Manager) as well as the resources noted above and revise the policy accordingly.
 - Then, Dan must educate the staff on the new policy and procedure, including the rationale and enforcement.

Case Study 2: The Hand Surgery “Extras” Set

Susie Smith, RN, CNOR and Beth Jones, CST are setting up for their first case of the day, a carpal tunnel release for Dr. Odom. Dr. Odom has requested a tray with special, small instruments for these types of cases, which the staff labeled the Hand Surgery Extras. As Beth is preparing to set up the instruments on the back table and mayo stand, she notices a melted clump of what appears to have been a metal dangle earring in the Hand Surgery Extras tray. She immediately points it out to Susie and hands off the tray to her. After Susie and Beth correct the breaks in technique on the sterile field, Susie immediately takes the tray out to the OR Manager.

Points to Consider:

- Were the actions taken by Susie and Beth correct?
- What resources are available to assist in addressing this situation?

Discussion of Points to Consider:

- Were the actions taken by Susie and Beth correct?
 - Yes – since they were not certain if the melted clump of metal found in the set was adequately sterilized, it was prudent to correct the breaks in technique on the sterile field and remove the questionable set.
- What actions should be taken to address this situation?
 - The OR Manager should review the existing policy on surgical attire for the staff in all areas, including Central Processing.
 - The OR Manager should also discuss the incidence with the staff in all areas and explain its impact on patient safety.
 - The policy should be revised, if necessary, and a plan for monitoring compliance should also be developed to minimize the likelihood of a subsequent occurrence.

Case Study 3: Skullcaps: To Ban or Not to Ban

Dr. Steven Taylor, an esteemed general surgeon, has been practicing for over 20 years. He has always worn a skull cap during surgery, as the elastic in the bouffant style caps irritates his forehead. While his hair is short, the hair on the nape of his neck is always exposed. At the last Surgical Services Operations Meeting, the Infection Control Practitioner noted the increasing infection rate for Dr. Taylor's patients. The committee members reviewed and discussed various related factors, including wound classification, surgical and aseptic technique, and the administration of preoperative antibiotics. After the meeting, Sherry Warner, RN, BSN, CNOR, the Clinical Director, pointed out to the Infection Control Practitioner that Dr. Taylor always wears a skullcap as part of his surgical attire and that this is not in compliance with the policy on surgical attire. She wondered if this practice could be a contributing factor to the increased infection rate.

Points to Consider:

- How should this issue be addressed with Dr. Taylor?
- What resources are available to present the rationale for a change in practice to Dr. Taylor?

Discussion of Points to Consider:

- How should this issue be addressed with Dr. Taylor?
 - The Infection Control Practitioner and Sherry should meet with the Director of Surgical Services to discuss the issue and review the current policy and procedure on surgical attire as well as the specific data on his infection rate.
 - The Chief of Surgery and Risk Manager should also be consulted as needed.
 - Once all of the data is compiled, a meeting should be conducted with Dr. Taylor to review the issue.
- What resources are available to present the rationale for a change in practice to Dr. Taylor?
 - Facility policy and procedure on surgical attire
 - AORN Recommended Practices on Surgical Attire
 - The CDC Guideline for Prevention of Surgical Site Infection

GLOSSARY OF TERMS

Artificial Nails	Substances or devices applied or added to the natural nails to augment or enhance the wearer's own nails. Examples are bonding, tips, wrappings, tapes, and decorative items.
Barrier	A physical or mechanical obstacle between a person and a hazardous substance or microorganism.
Bloodborne Pathogens	Pathogenic microorganisms that are present in human blood and can cause disease in humans; these pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).
Cleaning	The physical removal of soil or organic material using water or mechanical action with or without detergent; the cleaning process removes rather than destroys microorganisms.
Contaminated	The presence or reasonably anticipated presence of blood or other pathogenic organisms on an item or surface.
Cover Gown	A garment, for example, a laboratory coat, gown, or jacket that is worn over surgical attire in order to prevent contamination.
Endogenous	Produced within or caused by factors within the organism.
Exogenous	Originating outside or caused by factors outside the organism.
Health-care Associated Infection	Infection acquired by patients during hospitalization; the infective agent may originate from endogenous sources (from one tissue to another within the patient, i.e., self-infection) or from exogenous sources (acquired from objects or other patients within the hospital, i.e., cross-infection). This type of infection may not become apparent until after the patient has been discharged.

Infection	The invasion and multiplication of microorganisms in body tissues causing cellular injury.
Microorganism	An organism that is too small to be seen with the naked eye and may be viewed using a microscope. Bacteria, viruses, fungi, and protozoa are generally identified as microorganisms.
Pathogen	A microorganism that causes disease.
Personal Protective Equipment (PPE)	Personal protective equipment (for standard precautions) includes intact gloves, gowns, masks, and eye protection, e.g., face shields, glasses with side shields, goggles.
Potentially Infectious Material	Blood; all body fluids, secretions, and excretions (except sweat), regardless of whether they contain visible blood; nonintact skin; mucous membranes; and airborne, droplet, and contact-transmitted epidemiologically significant pathogens.
Restricted Area	The area that includes the OR and procedure room, the clean core, and scrub sink areas. Personnel in this area are required to wear full surgical attire and cover all head and facial hair, including sideburns, beards, and necklines.
Scurf	The scales or small shreds of epidermis that are continuously exfoliated from the skin.
Semirestricted Area	This area includes the peripheral support areas of the surgical suite that contain storage areas for sterile and clean supplies, work areas for storage and processing of instruments, and corridors leading to the restricted areas of the suite.
Squame	A scale or flake of skin.
Soiled	Worn or dirty, particularly on the surface; stained by body oils, body perspiration, or other substances.

Subungual

Under the nail.

Surgical Attire

Nonsterile apparel designated for the OR practice setting; includes two-piece pantsuits, cover jackets, head coverings, shoes, masks, protective eyewear, and other protective barriers.

Surgical Site Infection (SSI)

Infection involving body-wall layers that have been incised.

SSI Risk Index

The measure of the likelihood that a patient will develop a surgical site infection.

Unrestricted Area

This area includes a central point that has been established to monitor the entrance of patients, personnel, and materials; street clothes are permitted in this area and traffic is not limited.

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