

Trends in Infection Prevention and Control:

**Healthcare Textiles:
Laundry Science and
Infection Prevention**

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The Imperative for Cleanliness

There is a renewed commitment to the elimination of healthcare-acquired infections (HAIs), triggered by the mandates established by healthcare policymakers, federal and state regulators, and consumer groups. A greater emphasis on hygiene and asepsis, coupled with implementation of evidence-based practices by healthcare professionals, is driving protocols relating to healthcare attire, healthcare textiles, and healthcare laundry.

Healthcare textiles are becoming an important issue in infection prevention and control. As Tinker (2010) notes, "Laundry plays a vital role in every healthcare facility's integrated infection prevention and control program. During a hospital stay, patients are literally surrounded and exposed to yards of healthcare textiles, including hospital staff work attire, sheets, blankets, towels, gowns, privacy curtains and more."

As the Healthcare Laundry Accreditation Council (HLAC) emphasizes, "Today's healthcare laundry plays a key role in supporting not only day-to-day textile needs, but the infection prevention strategies of its healthcare customers. Laundry professionals recognize that raising their own standards and improving performance measurements helps meet the increasing demands of healthcare customers. Healthcare laundry professionals play an active role in supporting these demands by practicing infection prevention strategies that result in the consistent delivery of hygienically clean textiles."

In this report, we examine healthcare textiles and laundry from many aspects, including infection prevention, microbiology, industrial hygiene, healthcare economics, and much more. For the purposes of this report, we use the Centers for Disease Control and Prevention (CDC)'s definition of laundry in a healthcare facility as including bed sheets, blankets, towels, personal clothing, patient apparel, uniforms, scrub suits, gowns and drapes for surgical procedures. (CDC, 2003)

Healthcare Textiles as Fomites

As Tinker (2010) explains, "Studies have shown that a textile can be considered a fomite, an object capable of carrying an organism and serving as a reservoir that can be involved in transmission. In one study, Neely and Maley showed that bacteria such as VRE and MRSA injected into sterile textiles can survive anywhere from one to 90 days, provided that textile has not been cleaned, laundered or otherwise decontaminated during that time. And while there's no guarantee the mere presence of infectious microorganisms on surfaces and fomites will lead to transmission or infection, proper laundry processing protocols and guidelines reduce the likelihood that such a microbial transfer will occur by reducing the numbers of microorganisms remaining on the surface or fomite. That, in turn, minimizes the possibility of textiles posing as a source of infection or danger to the patient or healthcare worker."

In this report, we will explore the role that healthcare textiles play in infection prevention and control, including reviewing the critical steps in the entire healthcare laundry process. Tinker (2010) reminds us of the basics involved in this process and the ramifications for healthcare worker and patient safety: "Because of this potential infection risk, it is crucial that healthcare textiles be properly processed and delivered to the customer in a hygienically clean state. The most obvious method to achieve hygienically clean textiles (textiles devoid of bio-burden and therefore pose little or no threat of infection transmission) is through the laundering process itself, which consists of the proper combination of water, heat, pH, oxidation, chemical sanitizers, and drying and ironing. Additional critical factors that help ensure a hygienically clean textile are the physical layout of the laundry itself and the design/specifications of the facility infrastructure. The primary concern is that clean textiles are not re-contaminated during processing, handling, finishing, storage or delivery. Maintaining a clean, sanitary environment with work processes that help prevent cross-contamination is critical to meeting the high standards of healthcare customers."

In its "Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings" (2007) the CDC states, "Soiled textiles, including bedding, towels, and patient or resident clothing may be contaminated with pathogenic microorganisms. However, the risk of disease transmission is negligible if they are handled, transported, and laundered in a safe manner. Key principles for handling soiled laundry

are not shaking the items or handling them in any way that may aerosolize infectious agents; avoiding contact of one's body and personal clothing with the soiled items being handled; and containing soiled items in a laundry bag or designated bin ... The methods for handling, transporting, and laundering soiled textiles are determined by organizational policy and any applicable regulations; guidance is provided in the CDC's Guidelines for Environmental Infection Control in Healthcare Facilities. Rather than rigid rules and regulations, hygienic and common sense storage and processing of clean textiles is recommended. When laundering occurs outside of a healthcare facility, the clean items must be packaged or completely covered and placed in an enclosed space during transport to prevent contamination with outside air or construction dust that could contain infectious fungal spores that are a risk for immunocompromised patients."

Pathogen Persistence

Numerous studies indicate that pathogenic microorganisms persist in the inanimate environment. In their literature review, Kramer, et al. (2006) summarized data on the persistence of various pathogens on inanimate surfaces. They report that most Gram-positive bacteria, such as *Enterococcus* spp. (including VRE), *Staphylococcus aureus* (including MRSA), or *Streptococcus pyogenes*, survive for months on dry surfaces. Many Gram-negative species, such as *Acinetobacter* spp., *Escherichia coli*, *Klebsiella* spp., *Pseudomonas aeruginosa*, *Serratia marcescens*, or *Shigella* spp., can also survive for months. A few others, such as *Bordetella pertussis*, *Haemophilus influenzae*, *Proteus vulgaris*, or *Vibrio cholerae*, however, persist only for days. Mycobacteria, including *Mycobacterium tuberculosis*, and spore-forming bacteria, including *Clostridium difficile*, can also survive for months on surfaces. *Candida albicans* as the most important nosocomial fungal pathogen can survive up to four months on surfaces. Persistence of other yeasts, such as *Torulopsis glabrata*, was described to be similar (five months) or shorter (*Candida parapsilosis*, 14 days). Most viruses from the respiratory tract, such as corona, coxsackie, influenza, SARS or rhino virus, can persist on surfaces for a few days. Viruses from the gastrointestinal tract, such as astrovirus, hepatitis A virus (HAV), polio- or rota virus, persist for approximately two months. Bloodborne viruses, such as hepatitis B virus (HBV) or human immunodeficiency virus (HIV), can persist for more than one week. Herpes viruses, such as cytomegalovirus (CMV) or herpes simplex virus (HSV) types 1 and 2, have been shown to persist from only a few hours up to seven days.

Studies also have indicated that pathogenic microorganisms can collect on healthcare worker apparel as part of the environment. For example, a recent study reported that 65 percent of nurses who had performed patient care activities on patients with MRSA in a wound or urine contaminated their nursing uniforms or gowns with MRSA. Boyce, et al. (1997) sought to study the possible role of contaminated environmental surfaces as a reservoir of MRSA in hospitals through a prospective culture survey of inanimate objects in the rooms of patients with MRSA in a 200-bed university-affiliated teaching hospital. Thirty-eight consecutive patients colonized or infected with MRSA. Patients represented endemic MRSA cases. Ninety-six (27 percent) of 350 surfaces sampled in the rooms of affected

patients were contaminated with MRSA. When patients had MRSA in a wound or urine, 36 percent of surfaces were contaminated. In contrast, when MRSA was isolated from other body sites, only 6 percent of surfaces were contaminated (odds ratio, 8.8; 95% confidence interval, 3.7-25.5; $P < .0001$). Environmental contamination occurred in the rooms of 73 percent of infected patients and 69 percent of colonized patients. Frequently contaminated objects included the floor, bed linens, the patient's gown, overbed tables, and blood pressure cuffs. Sixty-five percent of nurses who had performed morning patient-care activities on patients with MRSA in a wound or urine contaminated their nursing uniforms or gowns with MRSA. Forty-two percent of personnel who had no direct contact with such patients, but had touched contaminated surfaces, contaminated their gloves with MRSA.

Researchers are continuing to explore the role that healthcare textiles play in this persistence. Neely and Maley (2000) sought to examine the survival of several clinical and environmental staphylococcal and enterococcal isolates on fabrics and plastic commonly used in hospitals. "The transfer of Gram-positive bacteria, particularly MRSA and VRE, among patients is a growing concern," the researchers write. "One critical aspect of bacterial transfer is the ability of the microorganism to survive on various common hospital surfaces."

Neely and Maley (2000) examined the survival of 22 Gram-positive bacteria (vancomycin-sensitive and -resistant enterococci and methicillin-sensitive and -resistant staphylococci) on five common hospital materials: smooth 100 percent cotton (clothing), 100 percent cotton terry (towels), 60 percent cotton/40 percent polyester blend (scrub suits and lab coats), 100 percent polyester (privacy drapes), and 100 percent polypropylene plastic (splash aprons). The researchers inoculated swatches with 104 to 105 CFU of a microorganism, assayed daily by placing the swatches in nutritive media, and examining for growth after 48 hours. All isolates survived for at least one day, and some survived for more than 90 days on the various materials. Smaller inocula survived for shorter times but still generally for days. Antibiotic sensitivity or resistance had no consistent effect on survival.

The researchers emphasize that, "The long survival of these bacteria, including MRSA and VRE, on commonly used hospital fabrics, such as scrub suits, lab coats, and hospital privacy drapes, underscores the need for meticulous contact control procedures and careful disinfection to limit the spread of these bacteria." All staphylococci tested survived for at least one day on all fabrics and plastic. Staphylococcal viability was longest on polyester (one to 56 days) and on polyethylene plastic (22 to >90 days). There was a tendency for the size of the microbial inoculum to increase the survival time of the coagulase-

negative staphylococci (CNS) tested; however, even a few hundred bacteria survived for days on most fabrics. The shortest survival time for any enterococcus tested was 11 days. As with the staphylococci, the enterococci lived longer on polyester and polyethylene than on other materials. In general, enterococci lived longer than staphylococci on the fabrics and plastic. Of the enterococci, *E. faecium* tended to survive the longest on all of the surfaces tested.

As Neely and Maley (2000) conclude, "Data in this study indicate that staphylococci and enterococci can survive for extended periods of time on materials commonly worn by patients and healthcare workers and on various other fabrics in the hospital environment. While most previous studies have tested survival of principally staphylococci using cotton as a representative fabric, the present study examined the survival of enterococci, including VRE, and staphylococci, on a number of different fabrics. Most of the bacteria tested in this study survived longer on polyester than on cotton. Hence, fabric type may influence survival. The length of survival of these organisms on the various materials may have significant infection control implications. For example, the polyester tested in this study is the material used at our hospital for privacy drapes, which are handled by both patients and staff when they are drawn around the patient's bed. Staphylococci and enterococci survived for days to months on this fabric, thereby suggesting that such drapes could act as reservoirs for these bacteria. Also, all bacteria tested survived for at least a day on the cotton-polyester blend. Since scrub suits, lab coats, and many regular clothes are blends, blends are probably the most common fabric worn by health care workers. One can easily postulate how these fabrics could become vectors for the spread of staphylococcal or enterococcal organisms as a healthcare worker moves from one patient to another, and the sleeve of his lab coat, for example, contacts different patients. Hence, the lengthy survival of these microorganisms on these various materials underscores the importance of both meticulous contact control procedures and thorough disinfection of hospital fabrics and plastic to minimize the spread of gram-positive microorganisms such as MRSA and VRE."

In a study of fungi persistence, Neely and Orloff (2001) report that tests of the survival of *Candida* spp., *Aspergillus* spp., a *Fusarium* sp., a *Mucor* sp., and a *Paecilomyces* sp. on hospital fabrics and plastics indicated that viability was variable, with most fungi surviving at least one day but many living for weeks. The researchers say their findings reinforce the need for appropriate disinfection and conscientious contact control precautions.

But not every researcher is convinced that healthcare textiles can spread infection. Wilson, et al. (2007) conducted a systematic search and quality assessment of the literature to establish current knowledge on the role of healthcare workers' uniforms as vehicles for the transfer of healthcare-associated infections. Their review consisted of a systematic search of national and international guidance, published literature and data on recent advances in laundry technology and processes, and the researchers say they found only a small number of relevant studies that provided limited evidence directly related to the decontamination of uniforms. They add that studies concerning domestic laundry processes are small-scale and largely observational, and that current practice and guidance for laundering uniforms is extrapolated from studies of industrial

hospital linen processing. They add that healthcare workers' uniforms, including white coats, become progressively contaminated in use with bacteria of low pathogenicity from the wearer and of mixed pathogenicity from the clinical environment and patients. The hypothesis that uniforms/clothing could be a vehicle for the transmission of infections is not supported by existing evidence. Wilson, et al. (2007) concludes that, "All components of the laundering process contribute to the removal or killing of microorganisms on fabric. There is no robust evidence of a difference in efficacy of decontamination of uniforms/clothing between industrial and domestic laundry processes, or that the home laundering of uniforms provides inadequate decontamination."

Lynne Sehulster, PhD, M(ASCP), of the Division of Healthcare Quality Promotion at the Centers for Disease Control and Prevention (CDC), is among the experts cautioning practitioners not to jump to conclusions regarding a link between pathogen transmission and healthcare textiles.

"I'm well aware of the fact that various investigators have identified pathogens on a variety of healthcare textiles during the use of these items. After all, these items are not sterile, nor should we expect them to remain free of pathogens during use. But just because pathogenic microorganisms have been found on textiles, that doesn't automatically mean that transmission of infection will occur with each textile contact. The chain of Infection is an important concept to keep in mind. If any of the other four links in the chain is missing (e.g., portal of entry, susceptible person, mode of transmission, sufficient dose), transmission will not occur."

Healthcare Textiles and Outbreaks

There have been some instances where investigators have looked at the connection between healthcare textiles and infectious outbreaks, but the take-home message of some of these investigations is that it's not necessarily the healthcare textiles that represent a reservoir for infectious transmission, but it's the way these textiles are handled after they are processed.

A paper presented at the 2010 International Conference on Healthcare-Associated Infections by Duffy, et al. which examined a Zygomycosis outbreak associated with hospital linens, has become a go-to paper for those pointing to a close relationship between infection and healthcare textiles, but a close reading is required so as not to miss the point of contamination – a critical fine point in this dialogue.

In their paper, Duffy, et al. (2010) report on their investigation of an outbreak of Zygomycosis, an invasive fungal infection, to identify the environmental source and prevent further infections. The researchers explain that fungal

infection caused by mucormycetes (formerly zygomycetes), a ubiquitous group of molds including *Rhizopus* species, are rare, usually occur in people with an underlying medical condition, can affect various body sites, and have a case fatality rate of more than 50 percent.

The researchers defined a case as illness consistent with mucormycete infection confirmed by culture or histopathology. Retrospective case-finding was performed by reviewing hospital databases starting from 1993. Case-patient medical records were reviewed for clinical course and exposure to items and locations within the hospital. Environmental samples were collected from air and surfaces at Hospital A and the laundry facility of its linen supply company. Fungal species that were isolated from patients and the environment were identified and subtyped using DNA sequencing and Inter Simple Sequence Repeat (ISSR) methods, respectively.

The researchers reported that nine cases were diagnosed at Hospital A since 1993, with six cases temporally clustered from August 2008 to July 2009. One of these was a community-associated case of meningoencephalitis, but five were hospital-associated cutaneous infections in patients ranging in age on admission from 0 days to 13 years. Hospital length of stay at first sign of infection was 20 to 51 days. Admitting diagnosis categories were: cardiac, hematologic and preterm birth. All five had established risk factors for Zygomycosis, including acidosis and bone marrow transplantation. Cases occurred on different wards served by different air handling systems. Hospital linens (sheets, pillowcases, gowns) were the only items common to all the cases. Environmental cultures taken at Hospital A demonstrated *Rhizopus* species from 26 (40 percent) of 65 swabs of clean linens and areas in contact with clean linens, and from one (4 percent) of 25 samples from items not in contact with linens. Hospital A changed linen supply companies, replaced all linens, and disinfected linen storage areas. Hospital air and surface cultures (n=29) taken three weeks later were negative. All specimens available for testing (13 environmental and four patient) were identified as *Rhizopus oryzae*. One patient isolate was available for subtyping and was genotypically related to an isolate from a clean linen transport cart. Non-*Rhizopus oryzae* mucormycetes were recovered from seven (88 percent) of eight surface cultures from the linen company laundry facility.



The researchers concluded that hospital linens likely acted as a vector bringing *Rhizopus* in contact with susceptible patients in this outbreak, and that *Rhizopus* may have contaminated linens at the laundry facility or during delivery to the hospital. The researchers emphasize that hospital linens should be laundered, shipped and stored in a manner that minimizes exposure to environmental contaminants.

The CDC's Lynne Sehulster, an author on the *Rhizopus* paper, says that it was an unusual outbreak, in that healthcare textiles was the only thing in common to all the cases. "The five case-patients were all extremely medically compromised during their hospital stays and at increased risk for acquiring an HAI, whereas no infections were identified among other patients with intact immunity and/or less severe medical conditions. Environmental sampling was done on a wide variety of surfaces and materials," Sehulster says. "Evidence pointed to possible departures from best practices during storage and other post-laundering activities. The actual laundering of the textiles apparently was not the problem, but what happens to hygienically clean textiles after washing, drying, ironing and folding may be the issue."

Andrew J. Streifel, a hospital environment specialist at the University of Minnesota, has conducted numerous healthcare-related outbreak investigations in his career, and emphasizes that these analyses indicate that contamination can exist in unexpected places and can be triggered by surprising circumstances. He harkens back to the late 1970s when pointing to a case involving *Aspergillus* at his own institution.

"We did the world's first successful bone marrow transplant here in 1968 and as we did more and more of these procedures, we moved into another location in the same building," Streifel explains. "But as soon as we did that, we started seeing *Aspergillus* right away. We had gone from a laminar air flow environment with HEPA filtration into a more primitive setting with antiquated ventilation, and so we were really vulnerable to *Aspergillus*. As time passed we built a new building; with a great deal of pride we moved in and our *Aspergillus* problem resolved. But then, all of a sudden, *Aspergillus flavus* started showing up. I had conducted the culturing in our new building and I had never seen *Aspergillus flavus* recovered from its air. So we were scratching our heads saying to ourselves, 'There is nothing here and all of a sudden there is something, so what could it be?' *Aspergillus flavus* showed up in the fall and somewhere around the first of November an isolate was recovered from a skin infection — there were several mycetomas on the patient's skin, and I thought, 'That changes everything.'" A mycetoma is a chronic subcutaneous infection caused by actinomycetes or fungi.

Streifel continues, "If it's on the skin, that means patients are somehow laying on something. So I went to the laundry storage area and selected some textiles to test. I have a clean room at my disposal and I wanted to vacuum the laundry to see if anything was there, and *Aspergillus flavus* contamination was confirmed. We were trying to figure out what the contamination point was, and eventually we discovered it — work on the city's sewers was being done in Minneapolis, and the road that the laundry truck took was one of the roads being worked on. We discovered that the laundry truck didn't have an adequate back door and although the laundry

was somewhat covered with plastic, contamination was occurring. And by the time we figured it out, they paved the road and the problem was resolved.”

As the CDC’s Guidelines for Environmental Infection Control in Health-Care Facilities (2003) instructs, “Clean linens provided by an off-site laundry must be packaged prior to transport to prevent inadvertent contamination from dust and dirt during loading, delivery and unloading. Functional packaging of laundry can be achieved in several ways, including a) placing clean linen in a hamper lined with a previously unused liner, which is then closed or covered; b) placing clean linen in a properly cleaned cart and covering the cart with disposable material or a properly cleaned reusable textile material that can be secured to the cart; and c) wrapping individual bundles of clean textiles in plastic or other suitable material and sealing or taping the bundles ...After washing, cleaned and dried textiles, fabrics, and clothing are pressed, folded, and packaged for transport, distribution, and storage by methods that ensure their cleanliness until use. State regulations and/or accrediting standards may dictate the procedures for this activity. Clean/sterile and contaminated textiles should be transported from the laundry to the healthcare facility in vehicles (e.g., trucks, vans, and carts) that allow for separation of clean/sterile and contaminated items. Clean/sterile textiles and contaminated textiles may be transported in the same vehicle, provided that the use of physical barriers and/or space separation can be verified to be effective in protecting the clean/sterile items from contamination. Clean, uncovered/unwrapped textiles stored in a clean location for short periods of time (e.g., uncovered and used within a few hours) have not been demonstrated to contribute to increased levels of healthcare-acquired infection. Such textiles can be stored in convenient places for use during the provision of care, provided that the textiles can be maintained dry and free from soil and body-substance contamination.”

Streifel also points to another investigation he made at a Texas hospital many years ago in which some neonates in an ICU also developed skin problems. “They asked me to take a look because they thought it had to do with construction or water damage, or some kind of similar environmental cause. But again, it was dermatological in nature; the hospital was clean and there was no indication of any problem in that environment. However, when I visited the laundry facility in the hospital, I saw that it was pretty wide open – all of this laundry was stored everywhere without being adequately covered. They were conducting blow-downs with high-pressure air to remove lint from the rafters to eliminate a fire hazard, but didn’t realize that the lint and particulates were being blown onto the unprotected laundry.”

“It’s those dermatological issues that tip us off,” Streifel adds. “The hospital reported that the affected neonates had the mycetomas on their backs, yet they asked me if they should sample the air and I said it’s got to be surface issue – you won’t find it in the air. I think that’s an important consideration when we start to investigate these cases where people are tempted to air-sample right away. I did an investigation recently in a pediatric facility that was facing an *Aspergillus* and other fungi problem; I brought 20 surface contact plates with me and we found the organisms on surfaces in the rooms. So the environmental contamination component

is something that might often be overlooked. If there is water seepage and mold is growing in the corner of the laundry facility where linens are stored, that might pose problems.”

This kind of contamination stemming from the environment is exactly what laundry professionals and infection preventionists should be looking for, Streifel says, adding that healthcare textiles may be fine through the washing and drying process, but a break in the hygiene chain can leave healthcare textiles vulnerable to contamination.

“From what I have seen, it’s the way the laundry is handled after it is washed that accounts for so many of the investigations I have done,” Streifel says. “For example, in drying a load, because it is cooled down with outside air, is that a contributing factor for contamination if there’s a construction project around the laundry facility? Again, depending on whether the wind is blowing in the right direction, or where the dirt is dug up, anything might be possible. In one of my earliest investigations in a Pennsylvania hospital in the late 1980s, I saw that construction workers were jack-hammering and the laundry storage was directly across the hall from this activity and there was no barrier.”

Sometimes, humans might also pose as contamination threats. “I have data, based on studies we have conducted in clean rooms, that our clothing is contaminated,” Streifel says. “We’d all be shocked if we knew what we were carrying on us. It launders off very nicely, but it can become contaminated again very quickly by simply walking outside. So not only should we think about what we supply to the patients in terms of healthcare textiles, but also what comes into the hospital via other channels. Very anecdotally many years ago, a colleague and I looked at a bunch of isolates of *Aspergillus* and we saw a higher incidence of fungal isolate recovery from pediatric patients than from adults – could that be because we cuddle them more? It’s been reported that of the neonates who get *Aspergillosis*, roughly 50 percent of the cases are dermatological, not pulmonary. So it makes you think, where is that exposure coming from?”

The Healthcare Laundry Process

To fully understand how textiles can or cannot be implicated in any infection, it is essential that healthcare professionals know the steps involved in a process as complex and exacting as healthcare laundry. And it is important to understand that there are usually two choices when it comes to healthcare laundry – processing it in-house at the hospital or healthcare facility, or outsourcing to an accredited healthcare laundry facility or laundry service. While some healthcare institutions may choose to do their own laundry onsite, many opt to contract with an offsite laundry facility or laundry service –

especially in light of the movement toward using accredited healthcare laundries. An accredited healthcare laundry is subject to compliance with the standards promulgated by the Healthcare Laundry Accreditation Council (HLAC), an independent accreditation organization. HLAC accredits healthcare laundry facilities based on standards that uphold best practices, as established by the American National Standards Institute (ANSI), the Association for the Advancement of Medical Instrumentation (AAMI), regulations created by the Occupational Safety and Health Administration (OSHA) and evidence-based recommendations from medical literature review.

As we will see, every step in the healthcare laundry process is exacting and regulated within an accredited laundry or laundry service, and this kind of quality may not be achievable in an unaccredited healthcare laundry. In addition, the HLAC says that accredited healthcare laundries provide a level of efficiency that often can't be matched by in-house hospital laundries, and explains that today's healthcare laundries are state-of-the-art, high-tech and efficient. The HLAC points out that an accredited laundry facility's continuous investment of energy-efficient equipment, automated systems and computerized monitoring programs can result in savings to a hospital's bottom line. Additionally, quality is also built into third-party laundries and laundry services; the HLAC says that documented policies related to acceptable textile quality and serviceability are in place, and that process monitoring, checklists, chemical supplier information, water testing, load size verification, equipment maintenance, and detailed quality definitions all contribute to meeting the specific quality needs of the healthcare laundry customer.

Judy Reino, president of Reino Linen Service and co-chair of the HLAC's marketing committee, enumerates the many complexities in healthcare laundry today. "Laundries and laundry services have moved past everything being 100 percent cotton or everything being washed at the same temperature and it comes out hygienically clean," Reino says. "Now we are looking at more complex fabrics, and there are many more different chemicals and other challenges. For example, we ran across a new kind of tape that was leaving residue on otherwise perfectly good linens. We had to find a chemical that would remove that residue; otherwise it would ruin a \$4 sheet. We have a very close relationship with the International Textile Analysis Laboratory; we send them samples and they test them for us. Say we encounter a stain that we or the chemical company can't figure out, they help us understand what it is and what's causing it. If it's something we did, we will address it on our end, but if the stain is medicinal in some way, we may make a recommendation to our healthcare

customer to have staff place a disposable pad underneath when applying the medication and save a \$4 sheet."

The CDC's Lynne Sehulster acknowledges that current thought concerning chemicals and laundry additives is evolving with time and the introduction of new fiber-related challenges. "Part of the historical position in infection control and laundry is that bleach is king," Sehulster says. "When you think about it, while bleach has excellent antimicrobial properties, it's not the laundry additive of choice for all of the current fibers available today. The healthcare textile industry is making advances in the fibers they use and different fibers will perform for different purposes, and clearly bleach is not appropriate for all. It does certainly maintain its whitening and antimicrobial properties, especially for the cottons and other natural fibers that will withstand hot water and bleach. What the infection prevention community would like to see, however, is evidence from the medical literature addressing the efficacy of the new laundry chemicals on the market today."

Sehulster also points to the use of chlorhexidine gluconate (CHG) for the patient's skin preparation prior to surgery and other skin antiseptic procedures and how it impacts the healthcare laundry process. "What the laundry industry is finding is that when you have CHG on the textiles and these go into the laundry where hot water and bleach are used, what comes out are textiles with brownish-orange stains. Then you have hospitals that will take one look at a clean but stained textile and say it is not usable. So healthcare laundry professionals are suggesting to their hospital customers that they consider the use of alternatives to bleach when CHG may be present on the textiles (e.g., oxygenated, non-chlorine products). Check the product label of the oxygenated products. If they require a hot-water temperature, there will be some antimicrobial activity present due to high temperature. However, there are some infection preventionists who are convinced that bleach is the only choice out there, so the industry is probably going to need to do some education of their customers as to the pros and cons of using other laundry additives."

There are numerous other considerations that an accredited offsite laundry facility or

Inside the Healthcare Laundry Process

Photos courtesy of Reino Linen Service



► Incoming soiled linen.



► Cart dumper.

laundry service handle for their customers, Reino says. "A key component is having an onsite engineer and a team of preventive maintenance people to ensure that the equipment is operating properly. Another component is having good relationships with the chemical companies, who help us with our testing of chemical and water levels, etc. We find that something as simple as a change in the seasons can affect the quality of the water and its interaction with the chemicals. And we are on top of what is happening in the linen marketplace. For example, the price of cotton is going up, and so linen vendors are becoming more creative in their use of fabric blends – we are seeing laundry items that are constructed with more polyester and synthetic fibers. With these fabric blends, we must then re-examine the chemicals we are using, and the temperatures used, because you don't want shrinkage or scorching. If you use a chemical on 100 percent cotton and then you use it on a blend, it may set the stain and make it unusable. And the temperature when finishing the linen is key – while you want to achieve pathogen kill, you still want to try to preserve the integrity of the fabrics."

The HLAC concurs with the AAMI standards for surgical textiles and says that, "The processing of reusable surgical textiles is a complex process requiring specialized equipment, adequate space, qualified personnel who are provided with ongoing training, and continuous monitoring for quality assurance. Depending on the healthcare organization, the processing of surgical textiles might be accomplished by an internal operation (on-premise laundry, external hospital-owned facility, or shared laundry service) or outsourced to a commercial laundry or to a facility providing finished sterile surgical textile packs. Regardless of the type of facility, certain work practices and procedures should be followed to ensure that surgical textiles will be safe to use on patients and provide satisfactory performance to surgical staff."

There are no current data on the number of hospitals that are doing their laundry in-house, but this information is something that the HLAC is hoping to determine in the near future.

"It would be very helpful if we had some overview of facility data," Sehulster says. "I think that hospitals are faced with budget issues and it's not unusual to outsource the laundry function, as it tends to be one of the first things that can be passed off to another party. I would say hospitals still have the obligation to provide the final reprocessing procedures (i.e., sterilization) of packaged surgical textiles according to the ANSI/AAMI standard at the very least, regardless of who launders the textiles. And hospitals also have to follow ANSI/AAMI ST79 if there were some packaged items for sterilization that used muslin as the outer wrapping. Therefore, if hospitals

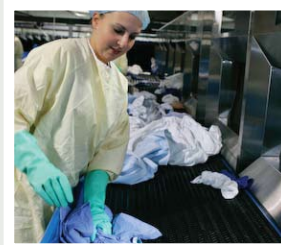
still choose to use that type of wrapping, they would be obligated to keep those textiles clean and in good repair. The one advantage that the hospitals have over an offsite laundry is that they don't have to deal with the transportation issue. So you automatically eliminate a post-processing factor over which you may have no direct control. So by eliminating that one unknown, you could potentially improve the post-process handling of the product to keep it as hygienically clean as possible and also have the shortest time interval in between the laundry processing and the patient's bed."

Sehulster continues, "I think the advantage for the offsite laundry facility or service versus an in-house healthcare laundry would be having staff whose sole job it is to tend to the healthcare textiles, so they are on top of all of the advancements in fiber and chemical technologies. These people spend 100 percent of their time and effort on their laundry business, whereas the laundry in a hospital might be a unit administratively tasked with additional responsibilities not related to laundry functions."

There is a considerable amount of guidance available regarding the proper healthcare laundering process, whether done offsite by a laundry facility or service, or done in-house at a healthcare facility. The document "ANSI/AAMI ST65:2008 – Processing of Reusable Surgical Textiles for Use in Healthcare Facilities" provides guidelines for the proper handling, processing and preparation of reusable surgical textiles either on-site or off-site for use in healthcare facilities. The guideline's most pertinent recommendations that uphold the prevention of cross-contamination are reviewed in Appendix A. The HLAC's most pertinent standards are reviewed in Appendix B.

In order to acquaint infection preventionists with the basics of the healthcare textile laundering process, here is a look at the most salient points from the HLAC standards (see Appendices A and B for more details):

The processing of reusable surgical textiles is a complex process requiring specialized equipment, adequate space, qualified personnel who are provided with ongoing training, and continuous monitoring for quality assurance.



▶ **Sorting soil linen before depositing it into the chutes.**

1. Handling, Collection and Transportation of Soiled Healthcare Textiles

- ▶ All healthcare textiles must be handled and collected in accordance with OSHA regulations and federal guidelines, thereby minimizing potential exposure of patients, hospital personnel, or laundry personnel to bloodborne pathogens or other infectious agents. [OSHA: 29 CFR 1910.1030 § (d) (4) (iv); CDC/HICPAC EIC F.III]
- ▶ All soiled healthcare textiles must be assumed to be contaminated, and standard precautions must apply at all times to all personnel who handle soiled textiles.
- ▶ Soiled textiles shall be collected and handled only as necessary to complete the defined tasks, and in such a way as to minimize microbial contamination of the air and the personnel handling the textiles. Soiled textiles must not be sorted or rinsed in patient-care areas. [OSHA: 29 CFR 1910.1030 (d) (4) (iv) (A) (1)]
- ▶ Standard precautions shall be followed during containment of soiled or contaminated textiles.
- ▶ The collection bags or containers must functionally contain wet or soiled textiles, preventing contamination of the environment during collection, transportation and storage prior to processing. The containers must not tear when loaded to capacity, be leak-proof, and be capable of being closed securely to prevent textiles from falling out.
- ▶ The bags or other containers must be specially color-coded or labeled. If only soiled healthcare textiles are coming into the laundry, and all personnel are following standard) precautions when handling these textiles, the bags do not need to be color-coded or labeled. [OSHA: 29CFR1910.1030 (d)(4)(iv)(A)(2)]
- ▶ The laundry provider must maintain functional separation of clean from soiled textiles in carts and/or vehicles at all times during collection and transportation of soiled textiles.
- ▶ Standard precautions must be observed while moving, loading, and unloading soiled textiles.

2. Washing, Extraction and Drying

- ▶ The wash process shall ensure that healthcare textiles become hygienically clean.
- ▶ Three basic types of washing equipment are used in the processing of healthcare textiles: washers, washer/extractors, and continuous batch washers. Depending on the equipment in use at the facility, modifications in these requirements and other factors affecting the process shall be necessary to

assure that agreed-upon quality standards are consistently met. If modifications are indicated, the laundry facility shall document these modifications, date them, and revise as needed as equipment needs change.

- ▶ The load size (weight) for each classification of soil shall be established by the facility and shall be recorded for each load processed.
- ▶ The wash cycle shall comply with all applicable state and local requirements for healthcare textile processing.
- ▶ Each classification shall have established standards for the following factors: Cycle time: Pre-wash, wash, rinse, and final rinse times; water levels/usage (total water usage and/or water levels); temperature (wash cycle, bleach cycle and rinse cycle temperatures); chemical usage (chemical types and usage levels for each step in the wash process).
- ▶ The provider shall extract or dry the clean healthcare textiles in a manner that preserves the integrity of the textile merchandise, minimizes microbial growth after washing, and prepares the textiles for efficient ironing or folding. Damp textiles shall not be left in machines overnight. [CDC/HICPAC: EIC G.II, III]

3. Finishing

- ▶ The finishing process of ironing or folding textiles shall ensure that the merchandise is maintained in the same clean state that it emerged from washing. The ironing or folding procedures shall meet the needs and expectations of the user. If any textiles become soiled in this process, they shall be rewashed, as outlined above.
- ▶ Ironing equipment shall be maintained in good operating condition so that it adequately irons, dries and folds the textiles without excessive heat, pressure, or mechanical damage. The equipment shall maintain a temperature of at least 300 degrees on the ironer chests.
- ▶ Dry folding equipment shall be in good operating condition, as to properly fold the textiles without damage.



▶ Processing linens.



▶ Soil sort conveyor.



▶ Soiled linen being loaded onto the conveyor.

4. Packaging and Storing

- ▶ Packaging and storage of healthcare merchandise shall preserve the textiles in a clean state for delivery to the customer as outlined in the service agreement.
- ▶ The textiles may be wrapped into fluid-resistant bundles, or placed bundled but unwrapped into fluid-resistant covered carts or hampers. The wrapping material may be plastic or other suitable material, and shall be securely closed during transport to the customer.
- ▶ During packaging, textiles shall be handled as little as possible to prevent soiling or contamination.
- ▶ If unwrapped merchandise is placed into carts or hampers and covered, the container shall remain covered at all times until delivered to the user's textiles storage room or other designated location in the healthcare facility. If the cart does not have a solid bottom, it must be lined with heavy plastic or impervious paper before placing clean textiles inside.
- ▶ Bundled and wrapped textiles may be stored in open racks in the laundry, on the trucks, or at the user's facility, provided the integrity of bundled and wrapped textiles is not compromised.
- ▶ Unwrapped clean textiles may be stored in rooms designed as whose specifications are given in
- ▶ The laundry storage room shall only be accessible to appropriate personnel.
- ▶ Only clean linens shall be stored in this area and signage posted as "Linen storage room."
- ▶ The door shall remain closed at all times.
- ▶ If any textiles become soiled during packaging and storage, they shall be reprocessed in accordance with previously stated processing guidelines.

5. Delivery of Cleaned Healthcare Textiles

- ▶ Functional separation of clean from soiled textiles shall be maintained during transportation by bagging soiled textiles in fluid-resistant containers; anchoring soiled textiles in the vehicle, so that they do not spill from their containers; training personnel regarding proper bagging and placement of textiles in the transporting truck; ensuring that all employees with this responsibility follow standard precautions at all times.
- ▶ Textile containment issues that must be addressed include: Clean and soiled textiles shall not be stored in the same container; containers used for the collection of soiled textiles may be returned

for use for clean textiles, if allowed by state regulations, after cleaning in accordance with the provider's policies and procedures.

- ▶ Vehicle considerations include: Clean and soiled textiles may be transported in the same vehicle, provided proper and effective functional separation of clean from soil is maintained at all times. Separation may be accomplished by the use of physical barriers, and/or space separation sufficient to protect clean textiles from contact with soiled textiles; the interior of the vehicle's cargo trailer used to transport healthcare textiles shall be cleaned on a regular basis as per company policy, or whenever visibly soiled; vehicles used to transport healthcare textiles shall have waterless antibacterial hand cleaner on board for the purpose of hand hygiene. If visible soil is apparent, drivers shall use utility gloves to minimize contact with the soil. Handwashing with soap and water is required at the earliest opportunity upon removal of the utility gloves.
- ▶ Considerations regarding the proper use of carts include: When the cart contains clean textiles, the textiles shall be wrapped inside the cart, or if unwrapped, the cart shall be lined with plastic or heavy paper and securely covered; if a cart used to transport clean textiles appears soiled, it shall be cleaned; any time a cart has transported soiled textiles, it must be cleaned before any next use, whether to transport clean or soiled textiles; reusable textile cover materials, such as liners, must be washed before the next use; carts shall be maintained in good working order, with wheels free from strings or other debris that impairs functioning or collects dirt; containers and covers used to collect or transport soiled textiles shall be properly cleaned; proper cleaning may include steam cleaning or cleaning with an EPA registered detergent/disinfectant; reusable textile covers may be washed and dried.



▶ Top view of soil sort conveyor.



▶ Soil sort system with chutes.



▶ Soil sort system.

Reino says that healthcare laundries must follow these standards in keeping with their commitment to protecting laundry staff as well as healthcare facility employees and patients. “We simply assume that everything we receive is contaminated and treat it that way,” Reino says. “We don’t assume that anything is without potential harm, so we are very cautious, and our healthcare customers are very helpful. For example, one of our healthcare facility customers had a bed bug problem, so we worked out a system with them where they would put the bed bug-infested linen in a dissolvable bag inside of a mesh bag and put the mesh bag inside of another bag to prevent cross-contamination with other laundry; it is marked and washed separately.”

That same level of care should be demonstrated all along the pick-up process. “Our truck drivers must be very mindful of the different kinds of situations they might encounter when picking up the soiled linen from healthcare facility customers. It’s not uncommon for them to go to a soiled room and the bag went down the chute and the dirty linens are on the floor. They have to don PPE when picking it up. Every link in the chain is very important. We’re also mindful of how linen is handled in the healthcare facility. We offer a biodegradable bag in a bag stand we provide to customers. The stand is designed to be placed in patient rooms so there is minimal handling of linen by healthcare workers. When full, the bags are sealed and then taken to the soiled room where they are then picked up.”

Reino continues, “Laundry vehicles should be cleaned after every soil pick-up – swept out and sprayed with a disinfectant. Major soil factors should be addressed. We also have a cart-wash system so after the soiled linen is removed, carts receive a quaternary ammonium disinfectant spray and scrub-down, and are wiped. To further ensure that linens are kept hygienically clean, the laundry personnel touching the linens should be clean. For example, we require our people to wear hair nets and a clean tee shirt every day, and if they are working on the soiled side of the laundry, they must wear personal protective equipment. On the finishing side of the process, we make sure people are not touching the linen with soiled clothing, or that hair does not fall onto the clean linen that comes off the folding machines or ironer. The linens are placed into the cart and plastic-sealed. Periodically we do a random sample culture to ensure there is nothing happening with the linen that we can’t detect visually. And finally, where we are at the offsite laundry lose control of the linen, hopefully the hospital observes similar hygiene standards to further protect the healthcare textiles from contamination.”

The Debate Over the Link Between Healthcare Laundry and Infection

In addition to HLAC standards, the CDC has promulgated recommendations addressing healthcare textiles and laundry in its aforementioned “Guidelines for Environmental Infection Control in Health-Care Facilities.” This is no surprise given the fact that contaminated textiles often contain high numbers of microorganisms from body substances, including blood, skin, stool, urine, vomitus and other body tissues and fluids. According to the CDC, when textiles are heavily contaminated with potentially infective body substances, they can contain bacterial loads of six to eight logs CFU/100 cm² of fabric.”

The CDC also notes that “Disease transmission attributed to healthcare laundry has involved contaminated fabrics that were handled inappropriately (i.e., the shaking of soiled linens). Bacteria (*Salmonella* spp., *Bacillus cereus*), viruses (hepatitis B virus [HBV]), fungi (*Microsporum canis*), and ectoparasites (scabies) presumably have been transmitted from contaminated textiles and fabrics to workers via direct contact or aerosols of contaminated lint generated from sorting and handling contaminated textiles. In these events, however, investigations could not rule out the possibility that some of these reported infections were acquired from community sources. Through a combination of soil removal, pathogen removal, and pathogen inactivation, contaminated laundry can be rendered hygienically clean. Hygienically clean laundry carries negligible risk to healthcare workers and patients, provided that the clean textiles, fabric and clothing are not inadvertently contaminated before use ... When the incidence of such events are evaluated in the context of the volume of items laundered in healthcare settings (estimated to be 5 billion pounds annually in the United States), existing control measures (e.g., standard precautions) are effective in reducing the risk of disease transmission to patients and staff.”

The CDC guidance hastens to add that, “Although contaminated textiles and fabrics in



▶ Soiled linen being dropped into the CBW.



▶ Soiled linen after dropping into the first chamber of the CBW.



▶ The washing process.

healthcare facilities can be a source of substantial numbers of pathogenic microorganisms, reports of healthcare-associated diseases linked to contaminated fabrics are so few in number that the overall risk of disease transmission during the laundry process likely is negligible ... Therefore, use of current control measures should be continued to minimize the contribution of contaminated laundry to the incidence of healthcare-associated infections.

The CDC's Lynne Sehulster emphasizes that the laundry management statements in the CDC's "Guidelines for Environmental Infection Control in Health-Care Facilities" are based on principles of hygiene, common sense and consensus guidance, and that healthcare professionals should think critically about any perceived link between healthcare textiles and healthcare-associated infections. "We really haven't seen a great number of observations or concise communications in the literature about problems with the actual laundering process," Sehulster says. "When you think about the sheer tonnage of laundry produced in hospitals in the U.S., it's still a pretty good track record for a hygienically clean product. What we observed in the Rhizopus agent outbreak investigation was that the laundering process was not deficient, but rather something post-laundering may have inadvertently introduced contamination. Infection preventionists are now asking questions about laundry management, and that's always a good thing."

The laundering process is, of course, designed to produce healthcare textiles that are as free from lingering contamination as possible. According to the CDC (2003), "laundering cycles consist of flush, main wash, bleaching, rinsing and souring. Cleaned wet textiles, fabrics, and clothing are then dried, pressed as needed, and prepared (e.g., folded and packaged) for distribution back to the healthcare facility." The guideline adds, "The antimicrobial action of the laundering process results from a combination of mechanical, thermal, and chemical factors. Dilution and agitation in water remove substantial quantities of microorganisms. Soaps and detergents function to suspend soils and also exhibit some microbiocidal properties. Hot water provides an effective means of destroying microorganisms. A temperature of at least 160°F (71°C) for a minimum of 25 minutes is commonly recommended for hot-water washing. The use of chlorine bleach assures an extra margin of safety. A total available chlorine residual of 50–150 ppm is usually achieved during the bleach cycle. Chlorine bleach becomes activated at water temperatures of 135°F–145°F (57.2°C–62.7°C). The last of the series of rinse cycles is the addition of a mild acid (i.e., sour) to neutralize any alkalinity in the water supply, soap, or detergent. The rapid shift in

pH from approximately 12 to 5 is an effective means to inactivate some microorganisms ... Although hot-water washing is an effective laundry disinfection method, the cost can be substantial. Laundries are typically the largest users of hot water in hospitals. They consume 50 percent to 75 percent of the total hot water, representing an average of 10 percent to 15 percent of the energy used by a hospital. Several studies have demonstrated that lower water temperatures of 71°F–77°F (22°C–25°C) can reduce microbial contamination when the cycling of the washer, the wash detergent, and the amount of laundry additive are carefully monitored and controlled. Low-temperature laundry cycles rely heavily on the presence of chlorine- or oxygen-activated bleach to reduce the levels of microbial contamination. The selection of hot- or cold-water laundry cycles may be dictated by state healthcare facility licensing standards or by other regulation. Regardless of whether hot or cold water is used for washing, the temperatures reached in drying and especially during ironing provide additional significant microbiocidal action. Dryer temperatures and cycle times are dictated by the materials in the fabrics. Man-made fibers (i.e., polyester and polyester blends) require shorter times and lower temperatures."

As the "Guidelines for Environmental Infection Control in Health-Care Facilities" (2003) note, "Fabrics, textiles and clothing used in healthcare settings are disinfected during laundering and generally rendered free of vegetative pathogens (i.e., hygienically clean), but they are not sterile." Sehulster says she is comfortable with the concept that the laundering process is sufficient to render healthcare textiles "hygienically clean." She points to the section of the aforementioned CDC guideline (2003) in which it is emphasized that "Through a combination of soil removal, pathogen removal, and pathogen inactivation, contaminated laundry can be rendered hygienically clean" and says that while there is no official definition of "hygienically clean," microbiology can provide some guidance.

"Infection preventionists are now asking questions about laundry management, and that's always a good thing."

–Lynne Sehulster, PhD, M(ASCP)



▶ Clean linen conveyor delivering linen to pack area.



▶ Small piece folder.



▶ Surgical pack room.

Sehulster explains that a microbial log reduction is achieved in the laundry process, but that a specific number is “a matter for some debate, since we have not really determined what the starting contamination level is on all varieties of soiled textiles,” she says. “It will range anywhere from less than 100 per unit per square area versus being very highly contaminated if there is a blood or body fluid/substance spill. We have never issued any single number to represent what is considered to be contaminated, therefore we have never defined what is the necessary microbial log reduction that would be needed to render a textile ‘hygienically clean.’ There are situations in healthcare where having something that is clean is sufficient and safe, and healthcare textiles, by and large, is one of these situations. We could mandate that every textile be purposefully sanitized, but would that make our experience that much more safe? We really don’t have a study to support the need to raise the standard up to routinely sanitize textiles; frankly it might be a difficult study to do because we have so few events to that suggest that hygienically clean textiles pose problems. You would need a very large study to even determine that sanitizing laundry will make you healthier. The combination of hot water temperatures, laundry additives, high-temperature drying and high-temperature ironing offer a microbial reduction that could easily be two or three or more logs in magnitude. So in and of itself, the laundry process is sanitizing in nature, even if it is not officially designating as such. The weak link in the whole thing is what happens after the process is done and the cleaned textile comes out of the ironers, folded, packaged, stored and transported. After the *Rhizopus* outbreak paper was presented at Decennial, there were some in the disinfectants industry who were calling for sanitization. They were using this outbreak as an example of the need to call for sanitizing, but again, the outbreak was linked to post-processing events – the laundry process was not at fault.”

Sehulster continues, “Researchers from Ecolab demonstrated at Decennial that *C. difficile* spores could survive the laundering process in small numbers. We remind people, at the very least, that during the process to make healthcare textiles hygienically clean, there is a reduction in pathogens, but that we are not rendering a sterile product. So the question then becomes this: there may be some limited residual spore or bacterial or fungal contamination on cleaned textiles – again, are we seeing transmission of infection from said textiles? There may be some transmission but it is probably occurring at some extremely low levels and therefore would be extremely difficult to detect.”

As we have seen, some offsite laundry facilities and services take microbiologic samples of freshly processed linens for quality control purposes. “The Guidelines for Environmental Infection Control in Health-Care Facilities” (2003) notes, “In the absence of microbiologic standards for laundered textiles, no rationale exists for routine microbiologic sampling of cleaned healthcare textiles and fabrics. Sampling may be used as part of an outbreak investigation if epidemiologic evidence suggests that textiles, fabrics or clothing are a suspected vehicle for disease transmission. Sampling techniques include aseptically macerating the fabric into pieces and adding these to broth media or using contact plates (RODAC plates) for direct surface sampling.”

“Some people have suggested that adenosine triphosphate (ATP) bioluminescence assay systems could be used to obtain some bioburden readings on healthcare textiles,” Sehulster says. “After speaking with several manufacturers of ATP products we found some of them are not recommending their use on porous surfaces like fabrics; furthermore, some would say that there are no established benchmarks for results from porous surfaces. Some have said it is difficult to analyze results when using the systems on natural fibers like cotton. We have not established a microbiologic benchmark for textile contamination and we have not established a recommended log reduction to achieve a state of ‘hygienically clean.’ There have been only a few researchers that have looked at this more analytically since the CDC environmental guideline came out, and even from that it’s still difficult to come up with a set statement that is equally applicable for all laundries. The push for evidence-based statements is laudable but in the environmental services side of the world, obtaining those data would be either difficult to do or prohibitively expensive. Laundering healthcare textiles is one of the processes and procedures that have stood the test of time and maybe at some point there will be people who will be in a position to evaluate this.”

Home Laundering of Healthcare Attire

No conversation about healthcare textiles could be complete without discussion of the controversial issue of home laundering of scrubs or other surgical attire. The pervasiveness of scrubs worn as streetwear has touched a nerve with some infection preventionists who are concerned about pathogenic organisms both leaving and coming back into the healthcare institution on healthcare workers’ contaminated apparel. This trend, coupled with the home laundering of healthcare apparel, is focusing new attention on the microbial load present on these textiles.

As the “Guidelines for Environmental Infection Control in Health-Care Facilities” (2003) note, “Experts are divided regarding the practice of transporting clothes worn at the workplace to the healthcare worker’s home for laundering. Although OSHA regulations prohibit home laundering of items that are considered personal protective apparel or equipment (e.g., laboratory coats), experts disagree about whether this regulation extends to uniforms and scrub suits that are not contaminated with blood or other potentially infectious material. Healthcare facility policies on this matter vary and may be inconsistent with recommendations of professional organizations. Uniforms without blood or body substance contamination presumably do not differ appreciably from street clothes in the degree and microbial

nature of soilage. Home laundering would be expected to remove this level of soil adequately. However, if healthcare facilities require the use of uniforms, they should either make provisions to launder them or provide information to the employee regarding infection control and cleaning guidelines for the item based on the tasks being performed at the facility. Healthcare facilities should address the need to provide this service and should determine the frequency for laundering these items. In a recent study examining the microbial contamination of medical students' white coats, the students perceived the coats as 'clean' as long as the garments were not visibly contaminated with body substances, even after wearing the coats for several weeks. The heaviest bacterial load was found on the sleeves and the pockets of these garments; the organisms most frequently isolated were *Staphylococcus aureus*, diphtheroids, and *Acinetobacter* spp. Presumably, the sleeves of the coat may make contact with a patient and potentially serve to transfer environmentally stable microorganisms among patients. In this study, however, surveillance was not conducted among patients to detect new infections or colonization. The students did, however, report that they would likely replace their coats more frequently and regularly if clean coats were provided. Apart from this study, which documents the presence of pathogenic bacteria on healthcare facility clothing, reports of infections attributed to either the contact with such apparel or with home laundering have been rare." We will return to the more current literature a little later in this report.

Recommendation II in the Association of periOperative Registered Nurses (AORN)'s "Recommended Practice for Surgical Attire" clearly states that "Clean surgical attire... should be worn in the semi-restricted and restricted areas of the surgical or invasive procedure setting," with the rationalization that "clean attire minimizes the introduction of microorganisms... from healthcare personnel to clean items and the environment." Recommendation II also addresses proper protocol for the wearing of scrubs: "Facility-approved, clean and freshly laundered or disposable surgical attire should be donned daily in a designated dressing area before entry or re-entry into the semi-restricted and restricted areas. Changing from street apparel into facility-approved, clean and freshly laundered or disposable surgical attire in a designated area decreases the possibility of cross-contamination..." The recommendation adds, "Healthcare personnel should change into street clothes whenever they leave the healthcare facility or when traveling between buildings located on separate campuses. Surgical attire may become contaminated by direct or indirect contact with the external environment."

Contamination of healthcare workers' attire has been substantiated in the literature. For example, Perry, et al. (2001) cultured healthcare workers' home-laundered uniforms at the beginning of a shift and found that 39 percent of the apparel identified as "clean" had one or more organisms such as *Clostridium difficile*, VRE or MRSA. The apparel was cultured again at the end of the shift and researchers found that 54 percent had one or more organisms.

With soil from the workplace as well as additional contamination from streetwear, items of apparel such as scrubs require a thorough and proper washing and drying process – something that may be sorely lacking in a home laundering. While some pathogens may be removed, some studies point to persistence on laundered apparel, and there may be a significant difference in kill rates among bacteria and viruses. As Gerba and Kennedy (2007) explain, "Previous studies have been conducted to identify the common pathogens that can be isolated from household and hospital laundry and to elucidate those laundering procedures that are most effective at reducing pathogen numbers. These studies have been primarily concerned with bacterial survival. Bacterial survival, however, is not an entirely accurate measurement of viral survival. Viruses, in general, are far more resistant to disinfection by chlorination and detergents than are bacteria." They add, "If these viruses remain infectious throughout laundering, they may be transmitted to other individuals in a hospital or household setting through direct contact (laundry, hand, mouth) or through more indirect routes (laundry, hand, food, mouth)."

Gerba and Kennedy (2007) sought to determine whether enteric viruses (such as adenovirus, rotavirus and hepatitis A virus) added to cotton cloth swatches survive the wash cycle, the rinse cycle and a 28-minute permanent press drying cycle as commonly practiced in U.S. households. Detergent with and without sodium hypochlorite (bleach) was added to washing machines containing sterile and virus-inoculated swatches, 3.2 kg of cotton T-shirts and underwear, and a soiled pillowcase designed to simulate the conditions (such as pH level and organic load) encountered in soiled laundry. According to the researchers, the most important factors for the reduction of virus in laundry were passage through the drying cycle and the addition of sodium hypochlorite. Washing with detergent alone was not found to be effective for the removal or inactivation of enteric viruses, as significant concentrations of virus were found on the swatches. It was also demonstrated that viruses are readily transferred from contaminated cloths to uncontaminated clothes. The use of sodium hypochlorite reduced the number of infectious viruses on the swatches after washing and drying by at least 99.99 percent. The researchers conclude that laundering practices in common use in the United States do not eliminate enteric and respiratory viruses from clothes.

One notable aspect of this study is that Gerba and Kennedy observed transfer of virus from contaminated to uncontaminated swatches, in that one item of heavily contaminated clothing can contaminate an entire laundry



load: "Studies we have conducted on the occurrence of fecal coliforms on the undergarments of individuals 1 to 50 years of age suggest that 0.01 to 10 g of fecal material is present per garment. The reported concentration of enteric viruses in feces of infected individuals ranges as high as 10¹⁰ to 10¹¹/g. This suggests that significant concentrations are potentially present on undergarments before and after laundering. As little as one cell culture infective virus has the potential to cause illness. Therefore, sufficient numbers of rotavirus and HAV survived to cause a risk of infection in laundry washed only with detergent and this is potentially a risk for infection, especially during the transfer of wet laundry from the washer to the dryer, when the hands may become contaminated. Infection may result when the hands are brought to the mouth or encounter food or fomites. Bacterial and viral transfer from fomites to the hands and then to the mouth is very efficient."

Another notable aspect is the temperature of the water needed to achieve pathogen-kill; as Gerba and Kennedy note, "Washing in warm or hot water does result in a greater reduction of virus. It is estimated that only 5 percent of all home laundering in the United States currently is done with hot water."

That hot-water washing is a necessity if you consider what is growing on one's healthcare attire. Treakle, et al. (2009) acknowledges that "patient-to-patient transmission of nosocomial pathogens has been linked to transient colonization of healthcare workers, and studies have suggested that contamination of healthcare workers' clothing, including white coats, may be a vector for this transmission." They performed a cross-sectional study involving attendees of medical and surgical grand rounds at a large teaching hospital to investigate the prevalence of contamination of white coats with important nosocomial pathogens, such as methicillin-sensitive *Staphylococcus aureus* (MSSA), and VRE. Each participant completed a brief survey and cultured his or her white coat using a moistened culture swab on lapels, pockets, and cuffs. Among the 149 grand rounds attendees' white coats, 34 (23 percent) were contaminated with *S. aureus*, of which 6 (18 percent) were MRSA. None of the coats was contaminated with VRE. *S. aureus* contamination was more prevalent in residents, those working in inpatient settings, and those who saw an inpatient that day. The researchers conclude that, "This study suggests that a large proportion of healthcare workers' white coats may be contaminated with *S. aureus*, including MRSA. White coats may be an important vector for patient-to-patient transmission of *S. aureus*."

In light of what some studies in the literature demonstrate and the anecdotal evidence that exists suggesting an inconsistent and potentially ineffective home laundering process, AORN is unequivocal in stating in its newly revised "Recommended Practices for Surgical Attire," released in January, that home laundering of surgical attire is not acceptable. In this recommended practice (RP), AORN is underscoring the science-based rationale for quality assurance monitoring of laundering practices, as well as taking a stand on other attire-related issues that compromise patient safety.

AORN recommends that surgical attire should be laundered in a healthcare-accredited laundry facility, according to Recommendation V within the RP, and all recommendations for home laundering of surgical attire

have been removed. This is the most significant change since 2005, when the Recommended Practices for Surgical Attire was first released. Like other recommendations in this updated RP, Recommendation V includes an expanded rationale section that cites literature and guidelines published since the previous version.

Recommendation V states, "Surgical attire should be laundered in a healthcare-accredited laundry facility." The RP states the rationale that "Surgical attire; street clothing; PPE and other hospital textiles (e.g., bed linens, towels, privacy curtains, washcloths) may become contaminated by bacteria and fungi during wear or use." As the RP states further, "Home laundering is not monitored for quality, consistency or safety. Exposure of healthcare personnel and their family members to blood and other potentially infectious materials may result from improper handling and decontamination of surgical attire. Home washers may have a lower temperature (i.e., less than 160 degrees F) or washing parameters and temperatures may not be adjustable. Home washers may have limited capacity for chemical additives and may not have directions for using alkalis and acids. Home laundering may not meet the specified measures necessary to achieve a reduction in antimicrobial levels in soiled surgical attire."

A study comparing the aerobic bacterial bioburden associated with surgical scrub attire shows significantly greater contamination among home-laundered attire than scrubs laundered by the healthcare facility, scrubs sent out by the facility to a third-party company for laundering, or single use/disposable scrubs. In fact, home-laundered scrubs cleaned and ready to wear had as much bacteria present as facility-laundered, third-party laundered and single-use scrubs which had been worn for one day, the study asserts. (Twomey, et al., 2009) Conducted in the spring of 2009, the study was performed by Bioscience Laboratories, Inc., of Bozeman, Mont., and sponsored by Molnlycke Health Care U.S., LLC. A total of 80 surgical scrub garments, tops and bottoms, prior to use and after use in the operating room for a day, were collected from multiple healthcare facilities across the U.S. They comprised 10 sets of scrubs in each category: single-use; home-laundered; facility-laundered; and third-party laundered. The study showed no statistically significant difference in bacterial contamination among facility-laundered, third-party laundered or single-use scrubs prior to use ("clean"), but revealed that the bioburden found on home-laundered scrubs prior to use ("clean") was significantly greater than on any of the other garments (facility-laundered, third-party laundered or single-use, non-woven) that had been worn for a day in the operating room.

"According to these results, a healthcare professional beginning his or her shift in home-

laundered scrubs would essentially be wearing scrubs with the same quantity of bacteria as the scrubs of a healthcare professional finishing a shift in worn scrubs," says Heather Beitz, BA, MEd, director of clinical research for Mölnlycke Health Care. "This study indicates that home-laundering is not as effective as facility- or third-party laundering in decontaminating surgical scrub attire," Beitz explains. "Another option, of course, is single-use surgical attire. In addition to eliminating cross-contamination concerns as indicated in this study, single-use scrubs are durable and designed for daily use in a variety of surgical procedures and acute care needs and can reduce replacement costs," she added.

For more than a year, members of AORN's Recommended Practices Committee have reviewed existing evidence in the literature, and in the spring, opened the proposed RP for input from the perioperative and infection prevention communities. Ramona Conner, RN, MSN, CNOR, manager of standards and recommended practices for AORN, reports that several hundred comments were received. "This recommended practice incites a great deal of interest," Conner says. "For some people it's an emotional issue. We began working on the review of this RP in January 2009, so this has been a long process and one with which we have taken extraordinary care and invested much thought and discussion in order to reach what we feel are good, achievable recommendations, based on the best evidence we have, with as much consensus from the community as we could achieve."

Conner points to a mounting body of evidence implicating healthcare textiles in outbreaks. "The literature has demonstrated reports of outbreaks directly related to healthcare laundry, and the evidence has really been emerging in the last three or four years," Conner explains. "AORN has always recommended that surgical attire be laundered by a facility or industrial laundry. In our previous edition we had to acknowledge that the evidence was not there and not published; we felt compelled to recommend that people not home launder but our previous edition essentially said that if you are working for an employer that requires you to home launder, we will provide guidance on how to do that safely. As we conducted our literature review for this latest edition we found there is no practical way for people in their homes to be able to meet the same criteria for safe laundering as healthcare-accredited facilities do. Because the evidence has become so much stronger in the last few years we felt compelled to say that surgical attire should be laundered by an accredited laundry facility. I suspect that over the next few years we are going to see even more evidence. Much of the research we have on survival of these pathogens on fabrics comes from laboratory studies, and although we are beginning to see in vivo studies, we still need more information."

As we have seen, accredited healthcare laundry facilities provide a monitored laundering process and must adhere to established standards established by the HLAC that certifies laundry facilities based on standards such as the ANSI/AAMI ST65:2000 Guidance for Processing of Reusable Surgical Textiles for Use in Health Care Facilities.

"I think laundering surgical attire is a process similar to achieving sterilization," Conner says. "It is a chain of events that must occur in order to do it properly, and if you have

a break in the chain anywhere along the line of that process, you could have a failure. That is as true with laundering as it is with sterilization. For example, when the contaminated linen is handled, if the worker isn't well protected and wearing personal protective equipment (PPE), the healthcare worker can be exposed to these contaminants. Once the laundry is sorted and placed into the washers, the temperature, the dilution, the detergent, the pH level, all of those parameters need to be monitored to make certain they are all in correct proportion. Then the wet linen, although decontaminated, needs to be dried and so the temperature of the dryers and the length of the drying cycle must be monitored. The way the washers and dryers are loaded is a critical step; if they are not loaded right, are too heavy or too light, it affects the other parameters such as exposure of all surfaces to the detergent. Once the linens are dried properly, it must be protected from contaminants in the environment then transported to the point of use. Anywhere along that chain, any number of things can go wrong. What's important and why we are focused on recommending accredited laundries is that these laundries conduct stringent quality monitoring and you just can't do that home."

The prevalence of people wearing scrubs as street attire and the home-laundering of surgical attire creates exposure to infectious pathogens in the community as well as inside the healthcare institution. "It's very important that we protect our patients, our healthcare workers and our communities from exposure to infectious microorganisms," Conner says. "I go to a grocery store and see someone standing in line wearing surgical attire and there's a significant 'ick' factor in my mind – I wonder where they have been in those scrubs, what patients were they caring for, when was the last time that their attire was laundered, and how was it laundered. We all launder our clothes all the time and it's no big deal, but what people don't understand is that healthcare workers are exposed to some pretty nasty pathogens that are then carried on our clothing and those pathogens can survive anywhere from one to 90 days according to some reports. Healthcare workers take that attire home and include it with their family laundry, often just using a cold or lukewarm water temperature to save energy, and not necessarily using the correct amount of detergent, and perhaps not drying the attire properly. It's a concern."

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The CDC's Lynne Sehulster says she spoke with AORN about the position that they are advancing in the revised recommended practice and thinks that a different approach to the issue would help make a more persuasive argument in the home laundering versus industrial laundering debate. "I think you have a stronger argument if you approach it from the notion that with an industrial process, whether it's in-house in hospital or offsite, you have a process that can be very carefully controlled in terms of the temperature of the water, the amounts of the chemicals and additives used, the type of fibers, the temperature of your dryers, the whole process can be mechanized and controlled very carefully, to the point where you get a consistent product. Whereas in home laundry, and I think Dr. Gerba has data pointing to this – home laundering can be something that is obviously less rigorously controlled. There is a certain amount of consistency but clearly not to the extent you have in the industrial laundry. My argument to them was if your confidence level in the ability of the process to remove and inactivate pathogens is more consistent with industrial process, which should be the basis of your argument. If you want to make the statement, 'If the pathogens are there, this will be a problem,' having the bugs there is only one part of the situation, as there are other factors to consider (remember the chain of infection). And just because the bugs may be there, this doesn't automatically mean that transmission of infection is going to occur. I gave them what I felt was a position that could withstand scrutiny more readily than making the argument that if the textiles have pathogens on them they will cause problems – we haven't seen data to that effect. We still know that the actual occurrence of infection transmission is low to almost negligible in the overwhelming volume of textiles. Having said that, or course, there's still no excuse for not keeping them clean."

Many voices are adding to the chorus against the home laundering of healthcare attire. As the HLAC explains in its standards, "It should be noted that the use of home washers for the processing of reusable surgical textiles is not recommended. Home washers are designed for retail situations, and this design does not take into account industrial environments and hazards addressed in the OSHA bloodborne pathogen standard. Typical design limitations of home washers are lower-temperature washing, set cycle parameters, limited chemical access, and use recommendations that do not include the alkalis and acids commonly found in industrial cycles."

"Just look at the immense variability involved in home laundering," says the University of Minnesota's Andrew Streifel. "From the biofilm that may be in your pipes, to the kind of detergent you are using, to the level of contamination with blood and body fluids; these are all factors that will create different outcomes in home laundering. And as people try to conserve energy by cold-water washing, are the pathogens being killed? Home laundering is simply too hard to control to achieve the requisite standards for pathogen removal."


Streifel cautions that healthcare professionals remain level-headed about the issue of healthcare textile laundering. "It's very much a risk-based issue," he says. "Not everybody is going to be – or should be – this hyper cautious about what's on healthcare textiles. It's critical that you first consider what your healthcare facility's risk factors are related to the laundering process. Healthcare institutions should look at their common practices to determine their particular types of risks and then see if they warrant additional scrutiny of the laundry. Should all healthcare facilities be subject to this level of scrutiny? I don't know, but I think we need to bring this issue to people's attention without stirring the pot too much. If we can avoid the problem, that's even better than having to deal with it in the first place. Prevention often means you won't see problems. However, based on risk levels, sometimes you have to be vigilant about everything."

Collaboration Between Laundry and Infection Prevention Departments

Because the healthcare laundering issue is complicated and requires input from numerous stakeholders, Reino Linen Service's Judy Reino recommends that infection preventionists join their facility's linen committee. "People do tend to work in silos and it can be beneficial to come into a situation with fresh eyes," Reino says. "Challenges often fall away when people work together. We encourage infection control professionals to serve on their linen committees and if they don't have one, we encourage them to create one. The linen committee can have a dynamic combination of people – those who work solely in the linen room can tell you from a practical standpoint how to make the process more efficient. And infection control nurses can bring their unique perspective and expertise. It's so important to have nurses at these meetings. Usually when we first start the meetings, they are a bit frustrated. They walk into a room with a stack of sheets they think are unacceptable and say, 'Look at what we've been getting.' We will figure out these sheets represent a tiny fraction of the sheets they receive, so we try to figure out why they are getting them, and find a solution. They bring wonderful information to the table, as they help from the utilization side and the infection control side; they understand that you shouldn't carry a stack of fresh linen into a patient room and only use a quarter or a third of that stack and leave the rest – it has to be re-laundered before it can be used, for example. They help healthcare facilities determine how they can spend less on washing linen they shouldn't. Commercial laundries and laundry services can show them new products that may make patients more comfortable and help staff make their days more efficient."

The communication should also flow between a healthcare facility and its laundry service. "We're finding that the more educated our customers are about the laundry process, the more they appreciate

what we do," Reino says. "For example, we always strive to build a good relationship with the infection control nurses because they understand that we're just not casually washing linens and delivering them, but we understand each step in the process – from the way they are packaged when they are soiled, to the way we pick them up, to the way we handle them when they come into the plant, to the ways the laundry is washed, dried and ironed, then packaged for delivery, etc. They understand all of that and they become our closest ally because they can see that the way we treat the linen is going to help them prevent infections."

There must also be continued dialogue about the issue of home laundering of healthcare attire. The revisions in the surgical attire RP from AORN will necessitate change in the organizational culture, something that the AORN's Ramona Conner acknowledges will require effort, communication and teamwork. "Culture change is an ongoing challenge but what we do is look at the evidence, help people understand what the best practice is, and then help them achieve it," Conner says. "Implementing any change in a healthcare facility requires a team approach. We all bring a different perspective, so if we work together and draw from each other's expertise we can often come up with some very exciting improvements." 

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Appendix A:

Pertinent Points from “ANSI/AAMI ST65:2008 – Processing of Reusable Surgical Textiles for Use in Healthcare Facilities”

- ▶ The laundry facility should be designed to have a physical barrier or functional separation between areas in which soiled textiles are received and processed and areas in which clean textiles are handled and stored for distribution to the surgical pack assembly area. The work area design should allow adequate space for all functions and should promote efficiency by minimizing the distance between related areas. Work flow should be designed to ensure that contaminants are contained and that employee exposure to bloodborne and other disease-producing microorganisms is minimized. Work flow patterns should also be designed so that items are moved progressively from being contaminated to being safe to handle.

Rationale: Separating soiled and clean areas limits the potential for environmental contamination of the surgical textiles to be sterilized.

- ▶ The soil-sort area should be functionally and physically separated from other areas of the facility. In addition to the preceding recommendations for construction of the floors, walls and ceilings and the ventilation system, there are several specific requirements that should be met in order to ensure a productive, safe environment in the soil-sort area. For example, work surfaces should be constructed of nonporous materials capable of withstanding frequent cleaning. Air from the soil-sort area should be exhausted to the outdoors without recirculation in accordance with AIA requirements for soiled textile sorting/processing areas. If it is necessary to re-circulate air, the air should only be re-circulated back into the soil-sort area and it should be filtered. Sharps containers should be provided and should be readily accessible to all work areas in the soil-sort area, in accordance with OSHA regulations (29 CFR 1910.1030). Separate handwashing and change areas (preferably with shower facilities) should also be provided in the soil-sort area. Sufficient floor drains should be available to prevent pooling of water and to accommodate wet mopping.

Rationale: Contamination of work surfaces, as well as airborne microbial and particulate contamination, is likely to be high in the soil-sort area due to the type of work performed and should be controlled through work practices and engineering controls whenever possible. Contamination can be spread by personnel who touch environmental surfaces or other personnel. Regular cleaning is necessary to control environmental contaminants. Physical separation of the soil-sort area is necessary in order to limit the potential for contamination of personnel or clean, processed textiles. Exhausting air to the outdoors prevents reintroduction of contaminants onto clean items and into clean work areas. Sharps containers are required for personnel safety. The availability of handwashing facilities encourages frequent handwashing, which is essential to personnel safety and to infection prevention and control.

- ▶ The ventilation system in the surgical pack assembly area should be designed so that air flows from the clean work area (positive pressure) to a soiled area (negative pressure). The air circulation system should be of a down-draft type, and the number of air exchanges per hour (typically 10) should be sufficient to minimize lint particles in the air. Portable fans should not be permitted in the area. Other aspects of ventilation should comply with the guidelines set forth in AIA guidelines (2006) and ASHRAE guidelines (2003, 2004). The ventilation system should be designed so that the room is able to maintain the appropriate positive pressure in relation to the rest of the facility (i.e. cleanest to dirtiest). When building design and construction allow, it is preferable to locate return air and/or exhaust ducts at or near floor level. Regardless of the specific location of the return duct, its placement should facilitate the installation and effective maintenance of any filtering systems.

Rationale: Lint and airborne particles can carry microorganisms. The air flow patterns in the textile processing area help reduce these particles in the environment. A filtering system reduces the amount of particles and lint being exhausted and (especially) recirculated. Proper maintenance of any filtering systems will promote good air flow and improve the workplace environment.

- ▶ Effective hand hygiene procedures should be employed. On a regularly scheduled basis, all personnel should be advised of the facility's hand hygiene policies and instructed in proper hand hygiene procedures, especially when policies are more stringent for a particular work area (e.g., the soil-sort area, the pack assembly area). In particular, personnel should be instructed to wash/sanitize their hands and remove PPE when they leave the soil-sort area. Employees should be trained in the proper disposal of sharps and other biohazardous waste that could have been left inadvertently in soiled textiles returned for processing. Linen should not be tossed or thrown. The final disposition of sharps and other biohazardous waste must be in accordance with applicable regulations.

Rationale: Careful attention to personal hygiene and compliance with prescribed policies on attire (including PPE), hand hygiene, and the handling and disposition of sharps and other biohazardous waste will minimize the potential for acquiring or transmitting disease. Hand hygiene, in particular, is the single most important aspect of infection prevention and control. Nail polish can flake off, and the flakes can get into items being prepared; artificial nails can promote the growth of fungus under the nails. Bloodborne pathogens such as the hepatitis virus may be found in blood or other body fluids on soiled textiles and can enter personnel through small cuts or abrasions on the skin. Vaccinations provide backup protection when there has been a failure in work practices or when an unexpected event occurs. Throwing or tossing linen that may contain improperly disposed of sharp objects could increase the risk of sharps-related injuries and exposure to blood and OPIM.

- ▶ All personnel involved in processing reusable surgical textiles should wear clean uniforms that are provided by and donned at the facility. Attire should be changed daily or more often as needed and must be changed when it is visibly contaminated (i.e. when wet, grossly soiled, or visibly contaminated with hazardous materials). Reusable uniforms that are visibly contaminated by blood and body fluids must be laundered in the laundry facility or area designated by the healthcare facility for the decontamination of reusable surgical textiles. Shoes worn in the department should be clean, should have non-skid soles, and should be sturdy enough to prevent injury if an item drops on the foot. All head and facial hair (except for eyebrows and eyelashes) should be completely covered with a surgical-type hair covering. Jewelry and wristwatches should not be worn in textile processing areas. The policy on use of cover apparel when employees leave the department to travel to other areas of the healthcare facility should be determined by each facility and should comply with state and local regulations. Employees should change into street clothes whenever they leave the health care facility or when traveling between buildings located on separate campuses.

Rationale: Appropriate, clean attire minimizes the introduction of microorganisms and lint from personnel to items being processed and to the environment. Controlled laundering of garments contaminated with blood or body fluids reduces the risk of transferring pathogenic microorganisms from the health care facility to home and family. Jewelry should not be worn in textile processing areas because it is not easily or routinely cleaned daily, it can harbor microorganisms, it can become dislodged and fall into processed packs, and it can cause holes in gloves or other barrier protection. Wristwatches and rings, in particular, can catch on equipment or instruments, injuring personnel or damaging the item or packaging. All textiles should be clean and free of debris when being prepared for sterilization. Otherwise, when the pack is sterilized and then opened for use under aseptic conditions, a foreign substance (e.g., hair) could be introduced into the surgical incision. Any foreign substance left in the human body has the potential to cause adverse reactions.

- ▶ Personal protective equipment must comply with OSHA regulations (29 CFR 1910.1030). In addition to the attire recommended in 4.5.1, personnel involved in the separation or handling of soiled reusable surgical textiles should wear appropriate PPE in accordance with the facility's exposure control plan. Such attire might include heavy-duty protective gloves, a protective gown or apron, an appropriate face mask, eye protection, and shoe covers. Personnel also should be instructed on when and how to use the PPE for the area in which they are working and how the PPE is to be removed and cleaned or disposed of. The policy on PPE and the appropriate use of each type of attire or device should be reviewed on a scheduled basis.

Rationale: Soiled textiles are a potential source of pathogenic microorganisms that could invade personnel through nicks or cuts on the hands or through contact with the mucous membranes of the eyes, nose, or mouth. Wearing PPE correctly helps minimize this risk.

- ▶ Soiled textiles must be immediately contained and transported to the laundry soil-sort area, where sorting procedures can be initiated by personnel protected by appropriate attire and trained in handling potentially infectious soiled textiles. Soiled surgical textiles should not be sorted or rinsed in patient care areas. Disposable sharps used in the surgical procedure should be removed and placed into an appropriate sharps container at the point of use. Reusable surgical instruments and single-use items should be placed into appropriate containers. Written procedures must be developed to protect personnel from exposure to bloodborne pathogens during the sorting process, to comply with OSHA regulations (29 CFR 1910.1030) and CDC guidelines (Siegel, et al., 2007).

Rationale: After each use, all surgical textiles (e.g., gowns, drapes, wrappers, towels), including patient-care textiles, should be considered contaminated and sources of infection. It is important to ensure that both single-use and reusable sharps, instruments, and other items are placed in appropriate containers and not left in the soiled reusable surgical textiles.

Appendix B:

Pertinent Points from the HLAC Accreditation Standards for Processing Reusable Textiles for Use in Healthcare Facilities

- ▶ The steps in a washing process should be completely described, controlled, and monitored for each classification being processed. Many types of equipment and chemicals are used in washing processes. Each facility should formalize internal work procedures and laundry formulas to achieve consistent and reliable results. As part of the facility's quality assurance program, appropriate procedures should be in place to control changes to the process and formulas.

Rationale: Proper washing procedures are essential for the effective cleaning/decontamination of surgical textiles and for maintenance of the durability and performance attributes of the items being processed.

- ▶ Loading practices should allow for free circulation of the textiles being processed and exposure to the various types of wash chemicals used during the process. Load size should be specified for each textile classification and for each type of equipment used. Equipment and textile product manufacturers' recommendations should be consulted when establishing the appropriate load size, including maximum and minimum weight limits for each classification.

Rationale: Improper equipment loading can inhibit the mechanical and chemical activities necessary to clean/decontaminate and effectively rinse soiled textiles. Overloading can drastically reduce the effectiveness of the washing process. The rated capacity of processing equipment should be viewed as a maximum limit, because equipment manufacturers rate their equipment for the best possible productivity (pounds per hour), not necessarily the optimization of product life performance, rewash rates, and other product attributes.

- ▶ The washing process consists of a combination of mechanical action, water flow, water temperature, time, and chemicals to clean/decontaminate soiled textiles. These individual processes can be adjusted in commercial washing machines to optimize the productivity of the operation and the performance and durability of the textiles being processed. These processes should be automatically controlled by the equipment by means of a microprocessor or a punch card. Each individual laundry formula should have a separate punch card or, in the case of a microprocessor, a unique formula number. Each step in a laundry formula should clearly define the following process settings: water level, water temperature, duration of the step, type of chemical, and amount of chemical.

Rationale: Laundry processes require a set of interrelated steps (functions) to clean and decontaminate and produce a product meeting its predetermined performance attributes. Control of the process variables in each of the steps of the formula through automation of the laundry process helps ensure consistent and reproducible results. Decades of work have been devoted to identifying laundry processes that destroy or remove microorganisms from textiles. Studies confirm that a number of interrelated factors contribute to the quantity of microorganisms removed from fabric, including detergents; action of oxidizing agents (e.g., chlorine bleach, oxygen bleach); washing temperature and time; action of repeated changes of water (dilution); drying temperature in dryers or of ironers and presses. Attempts have been made to rank the importance of these factors in eliminating microbial contamination, but no definitive studies are known (CDC 2003).

Handling, Collection and Transportation of Soiled Healthcare Textiles

- ▶ All healthcare textiles must be handled and collected in accordance with OSHA regulations and federal guidelines, thereby minimizing potential exposure of patients, hospital personnel, or laundry personnel to bloodborne pathogens or other infectious agents. [OSHA: 29 CFR 1910.1030 § (d) (4) (iv); CDC/ HICPAC EIC F.III]
- ▶ All soiled healthcare textiles must be assumed to be contaminated, and Universal Precautions (per OSHA) must apply at all times to all personnel who handle soiled textiles. Standard Precautions (per CDC) may apply as determined by either the customer or the provider.
- ▶ Soiled textiles shall be collected and handled only as necessary to complete the defined tasks, and in such a way as to minimize microbial contamination of the air and the personnel handling the textiles. Soiled textiles must not be sorted or rinsed in patient-care areas. [OSHA: 29 CFR 1910.1030 (d) (4) (iv) (A) (1)]
- ▶ Universal (or Standard) Precautions shall be followed during containment of soiled or contaminated textiles.
- ▶ The collection bags or containers must functionally contain wet or soiled textiles, preventing contamination of the environment during collection, transportation and storage prior to processing. The containers must not tear when loaded to capacity, be leak-proof, and be capable of being closed securely to prevent textiles from falling out.

- ▶ The bags or other containers must be specially color-coded or labeled. If only soiled healthcare textiles are coming into the laundry, and all personnel are following Universal (or Standard) Precautions when handling these textiles, the bags do not need to be color-coded or labeled. [OSHA: 29CFR1910.1030 (d)(4)(iv)(A)(2)]
- ▶ The laundry provider must maintain functional separation of clean from soiled textiles in carts and/or vehicles at all times during collection and transportation of soiled textiles.
- ▶ Observe Universal (or Standard) Precautions while moving, loading, and unloading soiled textiles.
- ▶ Soiled sorting area: The physical environment must comply with any applicable local, state, or federal regulations as per statements in Part I, Section 2.2 of the HLAC Accreditation Standard.
- ▶ The physical environment in the soiled sorting area shall be cleaned and disinfected as indicated in Part I, Section 2.3, Subsection 2.3.2 of the HLAC Accreditation Standard.
- ▶ All personnel who handle soiled healthcare textiles must follow Universal (or Standard) Precautions to prevent contact with blood or other potentially infectious or hazardous materials. Under Universal (or Standard) Precautions, all soiled healthcare textiles coming into a laundry are treated as contaminated.
- ▶ Soiled textiles shall be sorted into appropriate wash loads by classification such as color, type of fabric, soil type or soil load, and/or type of goods (e.g., diapers, sheets, or patient gowns) for each laundry formula used.
- ▶ Appropriate sharps safety containers (closable, puncture resistant, leakproof on sides and bottom, and labeled or color-coded) in accordance with OSHA standards shall be located near soil handling or sorting stations for collection and proper disposal of sharps. [OSHA: 29 CFR 1910.1030 (g) (1) (i)]
- ▶ Any worker who is injured by a sharp shall follow OSHA's policy on sharps injury documentation, post-exposure evaluation and follow-up. [OSHA: 29 CFR 1910.1030 (f) (3)]
- ▶ The wash process shall ensure that healthcare textiles become hygienically clean. Three basic types of washing equipment are used in the processing of healthcare textiles: Washers, Washer/Extractors, and Continuous Batch Washers. Depending on the equipment in use at the facility, modifications in these requirements and other factors affecting the process shall be necessary to assure that agreed-upon quality standards are consistently met. If modifications are indicated, the laundry facility shall document these modifications, date them, and revise as needed as equipment needs change.
- ▶ The load size (weight) for each classification of soil shall be established by the facility and shall be recorded for each load processed.
- ▶ The wash cycle shall comply with all applicable state and local requirements for healthcare textile processing.
- ▶ Each classification shall have established standards for the following factors:
 - a. Cycle time: Pre-wash, wash, rinse, and final rinse times.
 - b. Water levels/usage: Total water usage and/or water levels.
 - c. Temperature: Wash cycle, bleach cycle, and rinse cycle temperatures.
 - d. Chemical usage: Chemical types and usage levels for each step in the wash process.
- ▶ The provider shall extract or dry the clean healthcare textiles in a manner that preserves the integrity of the textile merchandise, minimizes microbial growth after washing, and prepares the textiles for efficient ironing or folding. Damp textiles shall not be left in machines overnight. [CDC/HICPAC: EIC G.II, III]
- ▶ The finishing process of ironing or folding textiles shall ensure that the merchandise is maintained in the same clean state that it emerged from washing. The ironing or folding procedures shall meet the needs and expectations of the user. If any textiles become soiled in this process, they shall be rewashed, as outlined above.
- ▶ Ironing equipment shall be maintained in good operating condition so that it adequately irons, dries and folds the textiles without excessive heat, pressure, or mechanical damage. The equipment shall maintain a temperature of at least 300 degrees on the ironer chests.
- ▶ Dry folding equipment shall be in good operating condition, as to properly fold the textiles without damage.
- ▶ Packaging and storage of healthcare merchandise shall preserve the textiles in a clean state for delivery to the customer as outlined in the service agreement.
- ▶ The textiles may be wrapped into fluid-resistant bundles, or placed bundled but unwrapped into fluid-resistant covered carts or hampers. The wrapping material may be plastic or other suitable material, and shall be securely closed during transport to the customer.
- ▶ During packaging, textiles shall be handled as little as possible to prevent soiling or contamination.
- ▶ If unwrapped merchandise is placed into carts or hampers and covered, the container shall remain covered at all times until delivered to the user's textiles storage room or other designated location in the healthcare facility. If the cart does not have a solid bottom, it must be lined with heavy plastic or impervious paper before placing clean textiles inside.

- ▶ Bundled and wrapped textiles may be stored in open racks in the laundry, on the trucks, or at the user's facility, provided the integrity of bundled and wrapped textiles is not compromised.
- ▶ Unwrapped clean textiles may be stored in rooms designed as whose specifications are given in
- ▶ A schedule of cleaning, including floor and shelves, shall be in writing.
- ▶ Storage room shall only be accessible to appropriate personnel.
- ▶ Only clean linens shall be stored in this area and signage posted as "Linen storage room."
- ▶ Door shall remain closed at all times.
- ▶ If any textiles become soiled during packaging and storage, they shall be reprocessed in accordance with previously stated processing guidelines.
- ▶ Functional separation of clean from soiled textiles shall be maintained during transportation by:
 - a. Bagging soiled textiles in fluid-resistant containers
 - b. Anchoring soiled textiles in the vehicle, so that they do not spill from their containers.
 - c. Training personnel regarding proper bagging and placement of textiles in the transporting truck.
 - d. Ensuring that all employees with this responsibility follow Universal (or Standard) Precautions at all times.
- ▶ Clean and soiled textiles shall not be stored in the same container.
- ▶ Containers used for the collection of soiled textiles may be returned for use for clean textiles, if allowed by state regulations, after cleaning in accordance with the provider's policies and procedures.
- ▶ Clean and soiled textiles may be transported in the same vehicle, provided proper and effective functional separation of clean from soil is maintained at all times. Separation may be accomplished by the use of physical barriers, and/or space separation sufficient to protect clean textiles from contact with soiled textiles.
- ▶ The interior of the vehicle's cargo trailer used to transport healthcare textiles shall be cleaned on a regular basis as per company policy, or whenever visibly soiled.
- ▶ Vehicles used to transport healthcare textiles shall have waterless antibacterial hand cleaner on board for the purpose of hand hygiene. If visible soil is apparent, drivers shall use utility gloves to minimize contact with the soil. Handwashing with soap and water is required at the earliest opportunity upon removal of the utility gloves.
- ▶ When the cart contains clean textiles, the textiles shall be wrapped inside the cart, or if unwrapped, the cart shall be lined with plastic or heavy paper and securely covered.
- ▶ If a cart used to transport clean textiles appears soiled, it shall be cleaned as outlined in Part II Section 6 Subsection 6.4.5 of the HLAC Accreditation Standard.
- ▶ Any time a cart has transported soiled textiles, it must be cleaned before any next use, whether to transport clean or soiled textiles. Reusable textile cover materials, such as liners, must be washed before the next use.
- ▶ Carts shall be maintained in good working order, with wheels free from strings or other debris that impairs functioning or collects dirt.
- ▶ Containers and covers used to collect or transport soiled textiles shall be properly cleaned. Proper cleaning may include steam cleaning. Or cleaning with an EPA-registered detergent/disinfectant.
- ▶ Reusable textile covers may be washed and dried.

The HLAC standards address the facility design of onsite hospital laundries to ensure that they have "a functional separation of areas that receive, store or process soiled textiles from areas that process, handle or store clean textiles." Specifically:

- ▶ The soiled textiles area must be functionally separated from the clean textiles processing area by any one or more of the following methods: a physical barrier; negative air pressure in the soiled textiles area; and/or positive air flow from the clean textiles area through the soiled textiles area with venting directly to the outside.
- ▶ The storage area for clean, unwrapped textiles must be free of vermin, be devoid of lint, have a temperature ranging from 68 degrees to 78 degrees F, be properly ventilated to prevent accumulation of dust and lint, have a positive air pressure relative to adjacent spaces, and be free of drains or hot water pipes.
- ▶ Per ANSI/AAMI ST65:2000 9.6.2, shelves for storing clean textiles must be approximately 1 to 2 inches from the wall for accessible cleaning; the bottom shelf must be 6 to 8 inches from the floor; and the top shelf must be 12 to 18 inches below the ceiling.

- ▶ Warning signs about the presence of contaminated textiles and the need to follow Standard Precautions must be posted in work areas where potentially contaminated textiles are stored or sorted prior to processing.
- ▶ Traffic patterns must be planned and posted to minimize the potential for contaminating clean textiles. Laundry areas must be limited to authorized personnel.
- ▶ Handwashing facilities must be located in all areas where soiled or contaminated textiles are handled, and hygiene resources such as handwashing facilities or antiseptic handcleaner/cleaner dispensers) must be available in or around all work areas and in personnel support areas, per OSHA 29 CFR 1910.1030 §d.2.iii, iv and HICPAC Hand Hygiene guideline: 1 A-N.

The HLAC standards also address the issue of quality control and process monitoring to ensure the cleanliness and serviceability of the textiles. Regarding quality assurance, the HLAC requires that its accredited laundries periodically review the entire service program, as well as monitor processes to verify that the on-going laundry operation is producing clean textiles that will meet customer expectations and needs. Processes that must be checked regularly include:

- ▶ Supplies: Verify that laundry chemicals are appropriate for the equipment in accordance with the equipment manufacturer, textile classifications, and water temperatures being used. Every chemical used must have a MSDS on file, and an appropriate label on every container into which it is placed in accordance with OSHA Hazard Communications Standard. [OSHA: 29 CFR 1910.1200]
- ▶ Water: Incoming water shall be tested on a regular basis for hardness, alkalinity (active and total), iron content, and pH. At a minimum, testing shall take place once per month or more often during periods of abnormal water conditions. The laundry washing formulas may require adjustment based on these factors.
- ▶ Load size shall follow the equipment manufacturer's recommendations. Each load shall be weighed using a calibrated scale. The scale shall be inspected and calibrated by an outside auditor on a scheduled basis, but at a minimum annually, and the results made available to the customer upon request.
- ▶ Equipment. All laundry equipment shall be included in the company's preventive maintenance program, and checked on a regular basis as defined by the manufacturer for proper operation. Typically a chemical titration and service report from the facilities' chemical suppliers' technician will have all this information. Some automatic equipment dispensers can also record the chemical injection amounts and times by classification.
- ▶ Finished products: The quality of finished products shall be maintained as pre-defined by the customer, and shall be sufficient to meet the needs of the customer. A variety of process monitors may be used to indicate how the laundry process has performed. These may include rewash rates, color transfer, pH spot tests, residual chlorine spot tests, and laundry test pieces. At a minimum, monthly titrations shall validate that the chemistry of the wash is correct, according to the formula for each major classification of soil.

Appendix C:

Precautions to Prevent Transmission of Infectious Agents

According to the Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. (2007), there are two tiers of HICPAC/CDC precautions to prevent transmission of infectious agents, Standard Precautions and Transmission-Based Precautions. Standard Precautions are intended to be applied to the care of all patients in all healthcare settings, regardless of the suspected or confirmed presence of an infectious agent. Implementation of Standard Precautions constitutes the primary strategy for the prevention of healthcare-associated transmission of infectious agents among patients and healthcare personnel. Transmission-Based Precautions are for patients who are known or suspected to be infected or colonized with infectious agents, including certain epidemiologically important pathogens, which require additional control measures to effectively prevent transmission. Since the infecting agent often is not known at the time of admission to a healthcare facility, Transmission-Based Precautions are used empirically, according to the clinical syndrome and the likely etiologic agents at the time, and then modified when the pathogen is identified or a transmissible infectious etiology is ruled out.

Standard Precautions combine the major features of Universal Precautions (UP) and Body Substance Isolation (BSI) and are based on the principle that all blood, body fluids, secretions, excretions except sweat, non-intact skin, and mucous membranes may contain transmissible infectious agents. Standard Precautions include a group of infection prevention practices that apply to all patients, regardless of suspected or confirmed infection status, in any setting in which healthcare is delivered. These include: hand hygiene; use of gloves, gown, mask, eye protection, or face shield, depending on the anticipated exposure; and safe injection practices. Also, equipment or items in the patient environment likely to have been contaminated with infectious body fluids must be handled in a manner to prevent transmission of infectious agents (e.g. wear gloves for direct contact, contain heavily soiled equipment, properly clean and disinfect or sterilize reusable equipment before use on another patient). The application of Standard Precautions during patient care is determined by the nature of the healthcare worker/patient interaction and the extent of anticipated blood, body fluid, or pathogen exposure. For some interactions (e.g., performing venipuncture), only gloves may be needed; during other interactions (e.g., intubation), use of gloves, gown, and face shield or mask and goggles is necessary. Education and training on the principles and rationale for recommended practices are critical elements of Standard Precautions because they facilitate appropriate decision-making and promote adherence when HCWs are faced with new circumstances. An example of the importance of the use of Standard Precautions is intubation, especially under emergency circumstances when infectious agents may not be suspected, but later are identified (e.g., SARS-CoV, N. meningitidis). Standard Precautions are also intended to protect patients by ensuring that healthcare personnel do not carry infectious agents to patients on their hands or via equipment used during patient care.

For more specifics on Transmission-Based Precautions, see the CDC's Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. (2007).

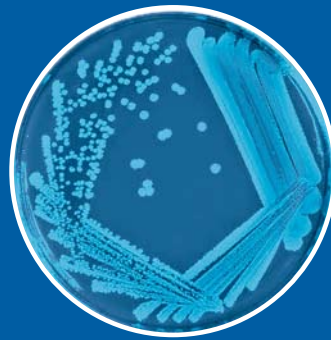
The prevention of HAIs is about to take a giant leap forward.



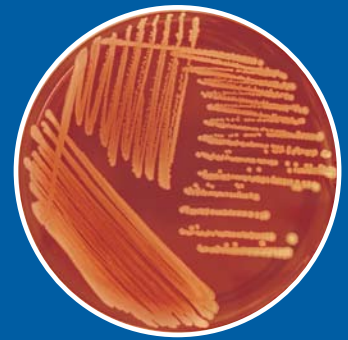
Pseudomonas aeruginosa



Klebsiella pneumoniae



Staphylococcus aureus



Methicillin-resistant
Staphylococcus aureus
(MRSA)

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