Glovesick

Hospital gloves are vulnerable to permeation, punctures, and other risks; here's how to keep health care workers safe

Personal protective equipment (PPE) is the last line of defense between the body and the myriad hazards lurking in the health care setting—including infectious diseases, noxious drugs, and harmful chemicals. Perhaps the most frequently used PPE of all is gloves, which function as a crucial barrier between these threats and the hands—the body part that most often and easily comes into contact with and spread these dangers to others.

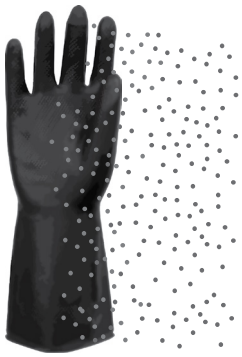
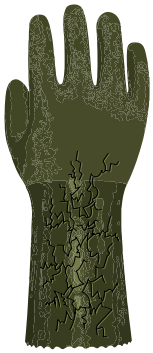
Gloves, however, are not impervious shields of safety. They are susceptible to leaks, permeation, tears, punctures, and deterioration that can result in infection and injury to health care workers (HCWs). In fact, one study revealed that bacterial flora from patients was found on the hands of up to 30% of HCWs who had worn gloves during patient contact.[1]

Surgeons and their assistants continually face glove penetration risks, with perforation rates varying from 22% to 61% during various types of procedures.[2] Yet other staff who work within the environment of care, including engineering, maintenance, housekeeping, and security personnel, often are required to wear gloves that are vulnerable to failure due to improper use or accidents.

Hospital leaders need to be aware of these risks and ensure that staff are properly prepared by supplying the right gloves, providing necessary training and education, and complying with government regulations, industry standards, and best practices.

Three-Way Glove Failure

At some stage, protective gloves will cease to safeguard the wearer from exposure to hazards because of one (or more) of the following three failures, says Michael A. Pannell, PhD, CIH, senior industrial hygienist, Office of Health Enforcement, Occupational Safety and Health Administration (OSHA), Washington, DC:

1. Permeation	2. Penetration	3. Degradation
		
The glove becomes permeable, allowing a chemical or an agent—including chemotherapy drugs, cytostatic agents, disinfectants, and composite resin materials—to migrate through the glove at a molecular level.	The glove has physical spaces in the material caused by rips, tears, penetrable seams, pinholes, or manufacturing defects that allow the bulk flow-through of a chemical agent or pathogen.	The glove sustains a damaging change in one or more physical properties of the glove material after exposure to a chemical agent, as evidenced by hardening, embrittlement, stiffness, cracking, softening, or swelling of the glove.

Pondering the perils

Michael A. Pannell, PhD, CIH, senior industrial hygienist, Office of Health Enforcement, Occupational Safety and Health Administration (OSHA), Washington DC, says there are three ways in which any protective glove will, at some stage, fail to safeguard the wearer from exposure to hazards. *See* "Three-Way Glove Failure," above.

Environment of care staff who don gloves are at risk for any of these three possibilities in the course of their jobs. For example, a housekeeping employee may use a chlorine-based disinfectant

(continued on page 6)

that can eventually permeate or degrade the gloves he's wearing, causing his skin to be exposed to corrosive chemicals. A facilities engineer who is changing a HEPA filter in an isolation room could easily tear an overused glove on a sharp corner within the ventilation system. And a security officer called in to restrain an unruly patient could suffer a scratch or bite through one of his protective gloves.

Many factors can compromise a glove's ability to protect, including the following:

- Employing improper donning methods that can result in tears and rips
- Wearing a glove for too long
- Wearing a glove of inadequate thickness for a given activity
- Using lotions and donning gloves before hand sanitizers have a chance to dry, both of which can degrade gloves
- Keeping fingernails long and wearing hand jewelry that may tear, snag, and puncture gloves
- Improperly storing gloves (which can be weakened by moisture, heat, and light)
- Selecting the wrong glove size or material for the task

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"Keeping glove stock rotated is a potential problem. The shelf life of gloves varies by glove type and manufacturer," says Pannell. "Using gloves for their intended purpose is another concern. I have frequently seen housekeeping staff use surgical gloves, when it is clear that the work they do has a much higher likelihood of physically damaging the glove [than the glove material warrants]." (*See* "Glove Materials—What's Best?" above.)

Glove Materials—What's Best?

Hospital gloves are commonly made from the following materials, each of which has advantages and disadvantages.[3,4]

Material	Pros	Cons
Latex (natural rubber)	Good for water-based and biological materials; tensile strength; tactile sensitivity; puncture/tear resistant; elasticity	Poor for organic solvents; oxygen, ultraviolet (UV) light, ozone can deteriorate; oils can degrade; can provoke allergies
Vinyl (PVC)	Good for bases, acids, fats, oils, amines, and peroxides; good abrasion resistance	Poor for most organic solvents, glutaraldehyde, and chemotherapy agents; less durable; vulnerable to breakdown from alcohol
Nitrile	Good for oils, solvents, greases, and some acids and bases; resistant to punctures, several chemicals, glutaraldehyde, and abrasion	High modulus and stiffness; oxygen, UV light, and ozone can deteriorate
Neoprene	Good for alcohols, acids, bases, peroxides, fuels, hydrocarbons, phenols; resistant to many chemicals and oil	High modulus and stiffness; oxygen, UV light, and ozone can deteriorate
Polyurethane	Resistant to oil and abrasion; tensile strength	Vulnerable to alcohol breakdown; slippery; embrittles and hardens at low temperatures
Norfoil	Suitable for most hazardous chemicals; resists permeation by a wide range of solvents, acids, and bases	Poor fit

The hospital's responsibility

OSHA standards for PPE (29 CFR 1910.132[5]) and bloodborne pathogens (29 CFR 1910.1030[6]) require that employers provide appropriate gloves that should be used and maintained in a sanitary and reliable condition whenever necessary due to hazards encountered in a manner capable of causing injury or impairment and when there is risk of exposure to blood or other potentially infectious materials. Alternatives should also be readily accessible to employees who are allergic to the gloves normally provided.

Accredited facilities must also abide by Joint Commission standards related to PPE, such as the following:

- IC.02.02.01: "The hospital reduces the risk of infections associated with medical equipment, devices, and supplies."

Glove Dos and Don'ts

OSHA and the CDC recommend several best practices[6,7] when it comes to using gloves in a health care setting, including the following:

- When donning personal protective equipment (PPE), put gloves on last and, if wearing a gown, extend the gloves over the cuffs.
- Remove gloves immediately after the activity for which they were used and, if disposable, discard them.
- Discard gloves if they are cracked, peeling, torn, punctured, show signs of deterioration, or become heavily soiled or when their ability to function as a barrier is compromised.
- Avoid prolonged wearing of gloves, which increases the risk of irritant contact dermatitis from sweat and moisture within the glove, breakdown of the glove material itself, and tears.
- Remove gloves properly:
  1. Grasp the outside edge near the wrist.
  2. Peel away from the hand, turning the glove inside-out.
  3. Hold the first glove in your opposite gloved hand.
  4. Slide an ungloved finger under the wrist of the remaining glove and peel off from the inside, creating a bag for both gloves.
  5. Discard.

- EC.02.02.01: "The hospital manages risks related to hazardous materials and waste."
- EC.02.02.01, Element of Performance 3: "The hospital has written procedures, including the use of precautions and (PPE), to follow in response to hazardous material and waste spills or exposures."
- EC.04.01.01: "The hospital collects information to monitor conditions in the environment," which includes asking staff when they are having problems with PPE.

In addition, it's important for administrators to follow PPE glove manufacturer recommendations carefully and check that their products conform to appropriate standards—among them ASTM International Standards F739-99A and D6978-05 (permeation testing), D515 (hole detection testing), D3767 (thickness testing), and D412 (stretch testing); and European Standards EN 374-3 (permeation testing) and EN 374-2 (liquid penetration and microorganism testing).

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Tools of the trade

It is important to assess and select the most appropriate glove to be worn for the activity to be performed. Staff who provide clinical care directly to patients typically wear sterile or nonsterile examination gloves often made from nitrile, latex, or neoprene, while many nonclinical environment of care workers usually don thicker nonsterile gloves consisting of vinyl, polyurethane, and other materials. Selection of gloves should be based on a risk analysis of the type of setting, the task that is to be performed, likelihood of exposure to body substances, length of use, amount of stress on the glove, and glove material.

Case in point: Nitrile gloves are ideal for wet work of long duration when durability is required, such as discharge/transfer cleaning, and contact with certain chemical powders and solutions. Heavy-duty gloves are recommended if the task has a high risk for percutaneous injury (sorting linen, handling waste). Environmental services personnel often wear reusable heavy-duty gloves made of latex to work with caustic disinfectants when cleaning environmental surfaces. However, they sometimes use patient care gloves, too.

Disposable vinyl gloves may be used for routine daily cleaning and disinfecting procedures in patient care areas and public washrooms where there is limited patient contact. Disposable utility gloves, however, are acceptable only for cleaning in non-care areas, with the exception of public washrooms.

Choosing the right glove material sometimes isn't enough to guarantee adequate protection. Hence, the practice of double-gloving is often recommended, depending on the work required. One study conducted a prospective, randomized trial of 143 procedures involving 284 people and found that the glove failure rate (blood contamination of the fingers) was 51% when one glove was worn but only 7% with double-gloving.[8]

Labor of glove

While protecting HCWs from glove-related infections, accidents, and injuries remains a challenge, the good news is that glove quality and integrity have improved a lot over the years. "This [improvement] is due to increased research, more stringent testing standards, and the development of improved materials made specifically for particular uses," says Pannell. "For instance, the development of the nitrile glove has helped many health care workers who have latex allergies."

Despite this progress, health care

(continued on page 11)

facilities will continually need to be aware of new chemicals, medications, and equipment introduced into their environments that could compromise glove effectiveness. "Complacency creates a false sense of security and increases your risk of exposure," says Pannell. "Hospitals need to continually evaluate hazards, inform and train employees on these potential hazards, and select the best protective measures" (*see* "Glove Dos and Don'ts," page 7). EC

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This article was developed through the cooperative efforts of the OSHA/Joint Commission Resources Alliance.

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An OSHA Cooperative Program