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# Barrier precautions, isolation protocols, and personal hygiene in veterinary hospitals

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Decreasing exposure of equine patients and veterinary personnel to pathogens is an important aspect of the infection control program. The ideal situation would be to prevent entrance of pathogens into a veterinary hospital; however, the nature of medicine is such that pathogen carriage by clinically affected animals as well as by subclinical carriers is always present. Therefore, containment of pathogens is essential. Protocols to contain pathogens and limit the risk of spread within a facility are variable and depend on a variety of factors involving the facility and the animal caseload. Among the factors that must be considered when attempting to limit the risk of transmission of pathogens in a veterinary hospital are barrier precautions, isolation protocols, and hygiene practices of veterinary personnel.

# **Barrier precautions**

Barrier techniques, those used to prevent contamination of hospital personnel with pathogens from animals or their environment, have been an important part of the infection control program for decades. By preventing contamination of hospital personnel's skin, regular clothing, personal items, and medical instruments, pathogen transmission from equine patients to their caregivers can be reduced. Barrier techniques may also be used to reduce the risk of infection of other hospitalized patients from hospital personnel's regular clothing or equipment that might act as fomites and to

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reduce the risk of infection of hospitalized animals with pathogens from the resident microflora of hospital personnel.

In human medicine, prevention of transmission of bloodborne pathogens, such as HIV, hepatitis B virus, and hepatitis C virus, from patients to health care workers (HCWs) is a major concern [1,2]. The epidemic of HIV in the general population and HCWs led to the development of universal precautions. Based on universal precautions, infection control practices are applied to all patients, regardless of known or suspected infectious disease status, and emphasize the prevention of any contact with blood or certain body fluids [2]. In veterinary medicine, there currently are not the same concerns about transmission of bloodborne pathogens to veterinary personnel. Indeed, the attitude toward blood contamination in veterinary medicine is somewhat cavalier. Nevertheless, it is critical to remember that new diseases are emerging at all times and that many of these new diseases are zoonotic. Just because there is minimal concern about bloodborne pathogens of horses at this point in time does not mean that there is no risk posed by exposure to equine blood now or in the future. It is prudent to ensure that adequate precautions be taken now rather than waiting for the infection of large numbers of veterinary personnel to stimulate change, as occurred in human medicine.

Although the initial focus of barrier precautions in human hospitals was prevention of disease in HCWs, increasing attention has been paid to the role of HCWs in dissemination of pathogens in human hospitals. The dissemination of multidrug-resistant (MDR) pathogens and the severe impact of MDR infections in human hospitals have led to changes in protocols to limit the spread of these organisms within hospitals. The use of barrier precautions has been an important part of these protocols; however, the efficacy and necessity of these protocols are unclear.

In the United States, the Occupational Safety and Health Administration (OSHA) has mandated that HCWs have access to appropriate personal protective equipment. The type of personal protective equipment required for each situation has been left to the discretion of the employee and employer; however, potentially contaminated body fluids are not to reach the employee's work clothes or street clothes, undergarments, skin, eyes, mouth, or other mucous membranes [3]. The level of barrier protection required would thus depend on the risk of contact with body fluids of concern, the potential for splashing or aerosol exposure, the volume of fluid that might be produced, and the duration of exposure [1]. These same points are relevant in the veterinary context. Veterinary hospitals need to be aware of OSHA or equivalent rules to provide a safe workplace and avoid potential liability. Thus, the development of appropriate infection control protocols, including barrier precautions, is required. In general, consideration must be given to the route of pathogen transmission: contact (direct or indirect), droplet, airborne, common vehicle (eg, equipment, medical devices), and vector borne.

#### Standard protective outerwear

Standard protective outerwear includes clean coveralls, laboratory coats, scrubs, or other dedicated clothing (eg, hospital uniforms). Protective outerwear should be changed whenever it is visibly soiled or otherwise contaminated with body fluids perceived or known to pose a risk (eg, feces, blood, nasal exudates, urine or uterine fluid). Additionally, outerwear should be changed frequently (at least daily), because gross contamination does not need to be present for pathogen contamination to have occurred. Hospital personnel should change their hospital outerwear before leaving the building; coveralls, laboratory coats, surgical scrubs, and related items should not be worn out of the hospital setting. Wearing protective outerwear home increases the risk of transmission of pathogens from the hospital to the household and from animals at home to hospitalized animals. All veterinary hospitals should provide laundry services so that outerwear does not leave the building.

# Gloves

Gloves are an important component of most, if not all, barrier protocols. The Centers for Disease Control and Prevention (CDC) recommend glove use by HCWs to reduce the risk of transmission of infections from patients to personnel, to prevent HCW skin flora from being transmitted to patients, and to reduce transient contamination of the skin on hands of personnel by microorganisms that can be transmitted from one patient to another [2].

Glove use has been shown to be an effective means of reducing pathogen transmission in human medicine. The use of gloves during peripheral venous catheter placement has been demonstrated to reduce the frequency of complications in human patients compared with regular handwashing [4]. Glove use has been an important part of successful infection control programs in human hospitals [5–7], although the relative effect of glove use versus concurrently applied measures is sometimes difficult to interpret. It has been suggested that universal glove use in human hospitals might be preferable for prevention of transmission of MDR bacteria, because as many as 5 to 10 patients may be colonized for every patient known to be infected [8].

To the author's knowledge, there are no published standards for glove use in veterinary hospitals apart from the use of sterile gloves during surgery. Examination gloves that are clean but not sterile are often used when handling wounds, infected body sites, and animals known or likely to be shedding pathogens in body fluids from orifices or on their skin; however, widespread use of examination gloves and protocols regarding glove use are not common. At the Ontario Veterinary College Veterinary Teaching Hospital (OVC-VTH), a policy requiring glove use for any contact with equine patients was instituted in response to nosocomial and zoonotic transmission of methicillin-resistant *Staphylococcus aureus* (MRSA). Whether this has reduced the transmission of MRSA or other MDR bacteria at the OVC-VTH is under investigation. Objective data are not available to help develop glove use protocols for veterinary hospitals; however, it is reasonable to recommend that gloves be worn whenever there might be contact with nasal secretions; feces; or discharge from surgical incisions, draining abscesses, or wounds.

Education of hospital personnel is important so that glove use does not result in less emphasis on hand hygiene. Gloves may have small inapparent defects or be torn during use, and hands may be contaminated while removing gloves. Hand hygiene measures should be performed immediately after glove removal. If gloves are used to handle potentially contaminated items and not immediately discarded, they are not acting as an effective barrier in preventing the spread of nosocomial pathogens to surfaces or other patients, although they may still be protecting the wearer. Care should be taken to remove gloves before handling items like pens, stethoscopes, thermometers, stall surfaces, medical records, pagers, telephones, and cabinet or door handles. Gloves should be changed between all patient contacts.

#### Gowns

For more than a century, gowns have been used to prevent transmission of disease to HCWs and patients [1]. Gowns have most commonly been used in surgery; however, their use in hospital wards is increasing. The CDC has produced guidelines stating that "gowns are worn by personnel during the care of patients infected with epidemiologically important microorganisms to reduce the opportunity for transmission of pathogens from patients or items in their environment to other patients or environments" [2]. Gowns should be worn whenever direct contact with the patient or indirect contact with the environment or patient care items may result in transmission of pathogens.

A variety of types of gowns are available in terms of the degree of body coverage and the material the gown is made of. The ideal barrier gown would cover all areas of the body that might become contaminated, prevent penetration of liquids, be of adequate strength to resist tearing and puncture under normal activities, be comfortable to wear for long periods, be available in appropriate sizes for all personnel, be nonabrasive to skin, and be of acceptable cost [1].

Neither the overall effectiveness of gowning nor the effectiveness of different gowns in veterinary situations has been adequately evaluated. All these factors must be considered when choosing a gown for use in a hospital (nonsurgical) situation. In particular, the ability to resist contamination during anticipated animal contacts, ease of use, and cost are important. The most likely problem in veterinary practice is poor resistance to liquids, especially under direct contact or pressure. In equine medicine, there is a greater likelihood of high-volume contact with fluids (ie, diarrheic horse) or direct contact with patient surfaces that would have moist secretions or excretions (ie, horse with nasal discharge rubbing against personnel). These types of high-risk situations must be considered when choosing an appropriate gown. Additionally, prolonged contact with potentially infectious patients, such as with 24-hour nursing care of neonatal intensive care unit foals, creates additional problems. If gowns do not cover the entire body (eg, gowns that do not cover the lower extremities) and hospital personnel are in prolonged contact situations with foals, the likelihood of contamination is high. Full body gowns may be more appropriate in these situations.

There is more evidence supporting the effectiveness of gowns in preventing disease transmission to HCWs compared with the prevention of spread of nosocomial disease [1]. Some studies have failed to show any benefit of gowning in specific situations, such as newborn units and neonatal intensive care units [9–11], whereas others have reported significant beneficial effects on nosocomial disease [12–14]. In particular, the use of gowns that offer little resistance to liquid penetration and those that leave the lower extremities exposed have been questioned. Perhaps the main advantage of gowns in these situations is raising awareness of the potential infectious nature of the patient and encouraging the concurrent use of other appropriate infection control protocols.

# Eye protection

Protective eyewear, including goggles and face shields, is used in human medicine during procedures in which sprays of blood, body fluids, and secretions may occur [2], and the use of these items is mandated in some instances by the OSHA bloodborne pathogens final rule [3]. The use of eye protection in equine hospitals is extremely uncommon, perhaps justifiably so, considering the low prevalence of bloodborne zoonotic pathogens in horses. Nevertheless, it would be prudent to consider the use of these items when spraying of potentially infected secretions may occur.

# Masks

Normal surgical masks may be effective against the spread of large particle droplets that are transmitted by close contact and travel only short distances (up to 3 ft) from infected patients [2]. Transmission of severe acute respiratory syndrome to HCWs prompted re-evaluation of the effectiveness of normal surgical masks in the prevention of disease transmission. One study reported that wearing of surgical or N95 masks (but not paper masks) by staff was associated with protection [15]. Other authors have questioned the overall effectiveness of surgical masks in hospital situations [16].

Airborne transmission of zoonotic pathogens from horse to veterinary personnel is thought to be of minimal concern in most hospital settings, and mask use is uncommon in veterinary hospitals apart from surgical procedures. Surgical masks might be useful for reducing transmission of MRSA. Although MRSA is not considered to be spread via the airborne route, the main location of colonization of MRSA in hospital personnel is in the nasal passages, and hand-to-nose contact is frequent. Thus, mask use prevents direct contact between the hand and nose, thereby decreasing hand contamination or decreasing the risk of inoculation of the nose after contamination of the hands during contact with a horse. The actual benefit of masks during short-term patient contact situations is unclear.

### Use of barrier precautions in equine hospitals

Basic barrier techniques must be used in all veterinary hospitals. Clean protective outerwear must be worn by all hospital personnel. The use of other barrier techniques is much more variable and should be directed at control of specific diseases or syndromes. It is important that written protocols outlining the required level of barrier protection be available. Gowns and overboots are the most commonly used items for additional barrier protection, but masks, caps, and eye protection may be required at times. In some facilities, overboots are not used but personnel are required to wear rubber boots that are easy to disinfect, and disinfection of boots is required after exiting potentially contaminated areas.

Determination of the required level of barrier precautions may be based on clinical findings (ie, diarrhea, fever of unknown origin, nasal discharge), farm history (eg, endemic disease, recent infectious diseases on farms), or the nature of the disease. At some hospitals, mainly those in regions where salmonellosis is of particular concern, all horses with colic are treated as if they may be shedding *Salmonella*. Common protocols for these equine patients include the use of gloves, gowns, and overboots; restriction of movement in the hospital; and provision of dedicated medical equipment (eg, thermometers, nasogastric tubes, buckets). An understanding of the incidence of pathogen shedding by certain groups within the equine population is required to define appropriate protocols. Thus, ongoing active and passive surveillance of nosocomial infection rates plays a key role in determination of the appropriate barrier protocols.

#### Limitations to barrier precautions

Barrier precautions, as a whole, have been successful in controlling some outbreaks of nosocomial disease [17,18] but not others [19]. The reasons why barrier precautions are variably effective is difficult to determine; however, nosocomial infection is a complex multifactorial process, and the individual effects of certain factors are difficult to discern. Like most other infection control methods, barrier precautions are only effective if used appropriately, and poor compliance is an ever-present concern that can have a negative impact on the entire infection control program. Failure of barrier techniques may involve inherent weaknesses in the items used, inappropriate selection of items, inappropriate use of items, inadequate training of personnel, or the inherent inability of barrier precautions to prevent pathogen transmission completely in all cases. It is important that barrier items do not create a false sense of security. Barrier items are useful but by no means 100% effective at preventing transmission of pathogens. It is critical that veterinary personnel use all adjunctive infection control techniques (ie, hand hygiene) and not rely solely on barriers. The reported variability in the benefits of barrier precautions should not dissuade hospitals from implementing these protocols.

### Isolation units and isolation protocols

# Isolation units

The use of quarantine to prevent transmission of human or animal disease dates back to biblical times and was widespread in the Middle Ages [20], predating understanding and acceptance of the "germ theory." Published recommendations for isolation protocols appeared as early as 1877 [21]. The early emphasis was on segregating certain patients in "infectious disease hospitals," which continued to have high levels of nosocomial disease because of a lack of barrier precautions, asepsis, and separation of patients according to their disease [2]. These hospitals were closed over time as better infection control practices and hospital designs were developed [2].

Isolation protocols are designed with two basic goals in mind: prevention of transmission of pathogens from infected animals to other animals, people, or the hospital environment and prevention of nosocomial infection to high-risk individuals.

Guidelines published by the CDC in 1970 and 1975 recommended that hospitals divide isolation precautions into a variety of categories: strict isolation, respiratory isolation, protective isolation, enteric precautions, wound and skin precautions, discharge precautions, and blood precautions [22,23]. The protocols for each category were based on epidemiologic features of diseases in the given category. In 1983, guidelines were revised to allow for more decision making on the part of the users [24]. Hospital infection control committees were given broader powers to develop their own protocols considering the circumstances and environment specific to the hospital. Category-specific guidelines were modified and consisted of strict isolation, contact isolation, respiratory isolation, tuberculosis isolation, enteric precautions, drainage/secretion procedures, and blood and body fluid precautions [24]. Further changes occurred later, largely in response to the HIV epidemic, and these earlier categories may be most relevant to veterinary hospitals at this point. In veterinary hospitals, there has been less attention paid to the development of standardized protocols for different diseases or categories. It is logical, however, that veterinary hospitals design appropriate guidelines to deal with diseases of concern in their area and hospital. Most isolation protocols have been developed to limit transmission of *Salmonella*. Whether all these protocols are necessary for other pathogens, such as viral respiratory pathogens and MDR bacteria, needs consideration, as does whether extra precautions are required in some instances. At a minimum, strict isolation, respiratory isolation protocols based on CDC recommendations should be considered, and veterinary-specific guidelines for working with those classes should be developed.

Identification of the isolation status of patients is critical. This is particularly important when horses may be housed under isolation protocols implemented in the main hospital. Appropriate signage should be used to make it clear to all personnel that the animal may be infectious and that additional protocols must be used. At the Colorado State University Veterinary Teaching Hospital, a color-coding system is used to indicate the infectious disease status of each patient (P. Morley, DVM, PhD, personal communication, 2003). Under this system, adhesive dots are placed on the stall cards of all animals. Red dots indicate animals with a known highly contagious disease. Yellow dots indicate that the animal is suspected of having an infectious disease or is at increased risk of acquiring an infectious disease. Green dots indicate that the animal is not suspected of carrying a relevant infectious agent and that it is not at an increased risk of acquiring an infectious agent compared with the general hospital population. This type of system is easy to apply and easy to understand and should be considered in all hospitals. Additionally, more prominent signs can be used to indicate certain concerns (ie, Salmonella, MRSA, rabies suspect) more clearly to all personnel.

Isolation units should be designed so that, apart from surgical procedures, horses rarely, if ever, have to leave the unit. Stocks, examination areas, and weight scales should be available if possible. The isolation unit should be designed so that there is minimal movement of personnel and items between it and the main hospital. Changing rooms with showers are ideally present in the unit. Preferably, the isolation unit should be physically separated from the main hospital. In cold snowy climates, this may be problematic because of the difficulty in moving personnel, animals, and supplies. If the isolation unit is properly designed and largely self-sufficient in terms of supplies and staffing, these difficulties may be largely overcome, although there may be resistance from clinicians because of the additional effort required to evaluate animals in the isolation unit.

Much consideration should be given to the design of stalls in isolation units. In particular, the area of entry and means of manure disposal should be considered. Anterooms containing routine supplies and medical records are commonly used. These rooms allow for containment of routine items used on the animal but can be a highly contaminated environment depending on the barrier methods used when in the stall, the method of removal of barrier items, and cleaning protocols for the stall and anteroom. If anterooms are stocked with routine items (ie, syringes, bottles of soap and disinfectant, medical records), consideration should be given to preventing contamination of these items and what to do with all items in the stall after an infectious animal is discharged. Ideally, anterooms should be minimally stocked and all items disposed of when the animal leaves the hospital. Any items returned to the hospital from an isolation stall should be cleaned and disinfected in the stall if possible, placed in a leak-proof bag, labeled as potentially infectious, and returned to the hospital to a designated area for further disinfection. Contamination of the anteroom with manure should be avoided.

Ideally, there should be minimal contact of personnel with infectious animals and their stall environment. Minimization of contact should not interfere with the delivery of appropriate veterinary care, however. Sealed windows used as viewing sites allow for general inspection of patients without having to enter the stall or anteroom. Closed-circuit televisions or Web-cameras can be placed in stalls and projected to a central area for frequent remote monitoring. An added advantage of Web-cameras is that remote password-controlled access from any computer can be established so that clinicians can evaluate the general appearance of the patient without even entering the isolation unit, let alone the stall.

# Isolation of animals in the main hospital

In some situations, a degree of increased barrier precautions or some physical distance from other patients when transferring a horse to the isolation unit is not indicated, practical, or desirable. Examples of this would be when animals cannot be safely or effectively treated in isolation (eg, neonatal intensive care unit foals, horses with severe neurologic disease) or when the isolation unit is full. In these situations, some clinics use inhospital isolation or "semi-isolation." In-hospital isolation protocols allow for an increased level of protection but are not a replacement for a proper isolation unit and should not be used solely for clinician convenience.

It is critical that animals isolated within the main hospital be prominently identified, as discussed previously. Protocols should be developed regarding the handling of animals, the stall, and the area around the stall. Animals that are isolated in the hospital should not be walked outside their stall unless they are being moved for a required procedure. If they are moved, their feet should be picked out and scrubbed with an appropriate disinfectant (ie, 0.5% chlorhexidine) at the time they leave the stall. One person should follow behind the horse to collect and appropriately dispose of any feces, and any areas potentially contaminated by the horse or its body

fluids should be sprayed with disinfectant. People handling these horses should wear protective barrier clothing, such as full waterproof coveralls or a full-length waterproof gown, gloves, and dedicated footwear or boot covers. Care should be taken to avoid clutter of potentially contaminated items (ie, barrier items, buckets, nasogastric tubes) outside the stall. The area around the stall entrance should be considered potentially infectious and disinfected routinely (at least three to four times per day). Attention should be paid to the pattern of water drainage from the stall and in the area. If water runs from the stall to the breezeway or runs down the breezeway past the stall, housing of potentially or known infectious animals in the stall may be inappropriate. Horses should not be able to come into direct contact with neighboring animals. Barriers may be required if solid walls are not present on all sides. Horses potentially carrying respiratory pathogens that can be spread via the aerosol route should not be housed in general ward areas. Specific protocols should be developed for cleaning inhospital isolation stalls. These stalls should be cleaned last, personnel cleaning stalls must wear protective gear, and items used to clean the stall must be disinfected immediately after use.

#### Compliance with barrier and isolation protocols

One of the major problems with barrier precautions is obtaining compliance by hospital personnel. "Time factors" and "too cumbersome" were the most commonly reported reasons for noncompliance with barrier precaution protocols by trauma professionals in a human hospital [25]. A similar study evaluated the use of barrier precautions during trauma resuscitations and reported that none of 104 HCWs in the study were in complete compliance with protocols for the use of barrier precautions; however, 98% wore gloves [26]. The authors concluded that HCWs are cavalier with respect to bloodborne diseases and that measures to encourage or force compliance are required.

Compliance is also of concern in isolation units in terms of admission of potentially infectious horses and the correct use of appropriate protocols. Depending on the facility, there may be reluctance to admit certain moderate-risk patients to the isolation unit because of difficulties in case management, such as distance to the unit from the main hospital, time required to comply with all the isolation protocols, and the associated increased cost to the client.

Cost is another factor that may limit the use of barrier precautions. Barrier precautions almost always involve the use of disposable items, and the cost of these items is not insignificant. At the OVC-VTH, approximately US \$42,000 is spent annually on disposable isolation gowns (\$14,000), gloves (\$18,000), and overboots (\$10,000). Although these figures are for the entire teaching hospital, most barrier items are used in caring for hospitalized equine patients. It is also important to note that glove use is required for any contact with horses in this institution, thereby explaining the use of more than 4200 boxes of examination gloves. In times of fiscal constraint, especially at veterinary teaching institutions, there may be reluctance to spend this amount of money without clearly demonstrated benefits. Concerns about cost should be tempered with the consideration of the costs of nosocomial and zoonotic infections and costs of hospital closure and decontamination should major outbreaks occur.

Cost is also a concern with isolation facilities because they are expensive to build, maintain, and staff. Isolation units should be designed so that enough stalls are present to allow contaminated stalls to be cleaned and disinfected, followed by a specific period when the stall remains empty between patients. Ideally, isolation facilities should have dedicated personnel so that there is no cross-contact with the main hospital. This is not feasible in all situations, particularly in small hospitals, where the caseload does not justify full-time technical staffing.

### Effect of barrier protocols and isolation on patient care

Another area of concern that is difficult to quantify is the potential adverse effect of barrier precautions on patient care. If cumbersome protocols are required, particularly in busy hospitals, there may be a tendency to spend less time in direct contact with animals. In human medicine, it has been reported that certain infection control protocols may be a disincentive to enter patient rooms [27]. In some aspects, this might be desirable, because infection control protocols should reduce personnel traffic and limit the potential for spread of pathogens. Although limiting unnecessary contact is desirable, the concern is that medically required contacts may be limited and that patient care may be compromised. A recent study in a human hospital confirmed this suspicion, reporting significantly lower contact times with isolated patients, despite the isolated patients being more severely ill [28]. Results of this study clearly demonstrate that proper consideration be given to which patients to isolate and how to manage these patients to ensure proper care.

# Personal hygiene and its impact on the infection control program

# Hand hygiene

Of all the possible measures that can be taken to reduce nosocomial and zoonotic infection, hand hygiene is perhaps the most important, easiest to use, most cost-effective, and most underused measure [29–31]. An understanding of the beneficial effects of hand hygiene dates back to the middle 1800s and the astute observations of Ignaz Semmelweis [32]. His institution of a mandatory hand disinfection program for clinicians and students resulted in a tremendous decrease in puerperal fever, which was a common

cause of postpartum disease in women during that period. Independently, Oliver Wendell Holmes concluded that the hands of HCWs spread puerperal fever, and he described methods for limiting the spread of disease [33]. Formal implementation of hand hygiene policies lagged tremendously, however, and it was well into the twentieth century before an emphasis began to be placed on hand hygiene. Hands of HCWs are thought to be the most common source of nosocomial infection; despite convincing data regarding the benefits of hand hygiene, particularly when compared with the overall dearth of other objective data regarding infection control measures, hand hygiene is still underused in the medical field.

Traditionally, handwashing with water and soap has been the standard for hand hygiene. The cleaning activity of soaps is from their detergent properties, which results in removal of debris from the hands [33]. Plain soaps have little if any effect on pathogens residing on the hands, however. It has been demonstrated that handwashing with plain soap fails to remove pathogens from the hands of hospital personnel [34]. Paradoxically, some studies have shown that handwashing with plain soap may increase bacterial counts on the skin [35,36]. Handwashing with plain soap before intravenous catheter placement was reported to be no more effective than no hand hygiene at reducing the incidence of catheter complications in human patients [4].

Antimicrobial soaps are widely available in hospitals and have been demonstrated to be effective at reducing bacterial hand contamination. These may contain a variety of antimicrobial substances, including triclosan, hexachlorophene, povidone-iodine, and chlorhexidine [33]. Unfortunately, compliance with handwashing is typically poor. Studies evaluating handwashing frequency in HCWs have yielded disappointing results, with handwashing only occurring after 12.9% to 75% of situations in which it was indicated [30,37]. In particular, physicians tend to have poor compliance with hand hygiene protocols [27]. Compliance with hand hygiene protocols is a major challenge for infection control programs. Reasons given for poor compliance with hand hygiene include lack of time, poor access to proper handwashing facilities, and skin damage from repeated washing [33,38]. Skin damage from repeated handwashing is a definite concern in hospital situations. The frequency of dermatitis can be high in personnel who wash their hands frequently. One study reported that 25% of nurses evaluated had clinical signs of dermatitis and 85% had a history of skin problems [38]. Damaged skin is of particular concern from an infectious control standpoint because it can harbor greater numbers of bacteria than normal skin.

More recently, alcohol-based hand sanitizers have become popular. These products have many advantages over antimicrobial soaps, including their spectrum of antimicrobial activity, speed of activity, dermal tolerance, and ease of use. They also eliminate the chance for cross-contamination from water taps and paper towel dispensers [39]. Increasingly, hand hygiene guidelines are recommending the use of these products when gross contamination of hands is not present [33]. Most alcohol-based hand sanitizers contain 60% to 70% alcohol and may be in a gel or liquid form. Recently, it has been suggested that an alcohol concentration of 80% or higher is desirable, and a product containing 85% alcohol is now available [40]. Although there are potential advantages of alcohol-based products in terms of effectiveness against microorganisms, the main advantage is ease of use. Additionally, alcohol-based hand sanitizers can easily be placed throughout the hospital at minimal cost. As well, individual use bottles can be dispensed to health care providers to keep on their person for ease of use even when wall dispensers are not in the immediate area. Sinks, on the other hand, are difficult and costly to add in an established facility.

The use and effectiveness of hand hygiene in veterinary situations have not been adequately explored. Although much of the information obtained in human medicine can be applied to veterinary hospitals, care must be taken with direct extrapolation of human studies. It is logical to assume that horses would have a higher endogenous bacterial load on their skin because of their haired coat and typical housing methods. This would translate into the potential for greater contamination of the skin on hands of veterinary personnel who handle horses compared with human health care providers. Veterinarians typically wear gloves less commonly than their counterparts in the medical field, and there is a somewhat cavalier attitude taken toward hand contamination in veterinary medicine as compared with human medicine. Gross contamination of hands with feces, discharge, and pus is likely more common, and access to handwashing facilities may be limited.

Effectiveness of hand hygiene in veterinary situations has not been thoroughly evaluated. A recent study reported that use of an alcohol-based hand sanitizer was more effective at reducing hand contamination after physical examination of horses than a 15-second handwash with antibacterial soap (J.L. Traub-Dargatz, DVM, MS, personal communication, 2004). This finding is important because it countered concerns that debris on the hands from animal contact might inhibit the efficacy of alcohol-based products.

Many facilities are now placing alcohol-based hand disinfectant dispensers widely throughout the hospital. At the OVC-VTH, approximately 80 dispensers have been placed. At some hospitals, individuals have been given small personal containers of hand disinfectant to carry around while on clinical duty. All hospitals should consider widespread placement of alcohol-based hand dispensers as part of the infection control program.

# Fingernails

The area under the fingernails tends to harbor large numbers of bacteria. Hospital personnel with false fingernails have been shown to harbor more gram-negative bacterial pathogens under their fingernails before and after handwashing [41,42]. Naturally long (>0.25 in) fingernails may also affect the effectiveness of hand hygiene and harbor excessive bacteria [43]. Additionally, chipped nail polish may support the growth of larger numbers of bacteria on the fingernails [33]. At the OVC-VTH, people in animal contact positions are not allowed to wear false fingernails or nail polish and must keep their nails cut short.

# Personal items

Studies have indicated, not surprisingly, that skin underneath rings is more heavily colonized with bacteria compared with other areas on the fingers [44,45]. This may relate to a more hospitable environment for bacterial growth (eg, warm, moist, protected) and decreased exposure during handwashing. Whether the wearing of rings is linked to transmission of disease is unknown and requires further study [33]. In the interim, some facilities, including our institution, have restricted jewelry to wedding rings and wedding bands, although there has been little effort to evaluate and enforce compliance at this point. Long neck chains and bracelets that could come into contact with animals are also of concern for safety (entanglement) and infection control reasons. Although the risk of these items is unclear, it is reasonable to prohibit wearing of any jewelry items that could come into contact with animals.

Hospital personnel commonly carry cellular and wireless telephones, and these items have a high likelihood of becoming contaminated. Frequently, personnel handle telephones if they are ringing regardless of the cleanliness of their hands or examination gloves. Further, disinfection of telephones and pagers is rarely performed because of the possibility for damage to the telephone or pager. MRSA has been isolated from a wireless telephone in a veterinary clinic [46]. Pagers have a similar potential to become contaminated [47]. The role of contaminated surfaces of telephones and pagers in pathogen transmission is unclear at this point but should be considered. Unlike barrier materials, an additional concern about these items is that they frequently accompany personnel home and, if contaminated, could expose other individuals or animals at home. Personnel training should emphasize that telephones and pagers should only be handled with clean hands. Telephone covers that protect the telephone from contamination and can be routinely disinfected should be considered.

Personal medical items, particularly stethoscopes, have come under scrutiny as reservoirs of potential pathogens. Stethoscopes have close and frequent contact with patient skin surfaces and can easily become contaminated. One study reported that 69% of doctors' stethoscopes had microorganisms on them, with most organisms being potential nosocomial pathogens [48]. Regular cleaning of the stethoscope bell and diaphragm with alcohol has been shown to reduce bacterial contamination significantly [49]. Stethoscopes should be cleaned at least once daily and after every contact with a potentially infectious horse. Consideration should be given to

providing dedicated stethoscopes for infectious cases and animals at greater risk of acquiring a nosocomial infection (ie, compromised neonatal foals).

#### Summary

Because nosocomial and zoonotic diseases are inherent and ever-present risks in veterinary hospitals, proactive policies should be in place to reduce the risk of sporadic cases and outbreaks. Policies should ideally be put in place before disease issues arise, and policies should be effectively conveyed to all relevant personnel. Written policies are required for practical and liability reasons and should be reviewed regularly.

Although no infection control program can eliminate disease concerns, proper implementation of barrier precautions and isolation can reduce the exposure of hospitalized animals and hospital personnel to infectious agents. Appropriate personal hygiene, particularly hand hygiene, can assist in the prevention of disease transmission when pathogens bypass barriers and are able to contact personnel.

Veterinary hospitals have moral, professional, and legal requirements to provide a safe workplace and to reduce the risks to hospitalized patients. Based on experience in the human medical field and on the continual emergence of new infectious diseases, infection control challenges can only be expected to increase in the future. Regular reassessment of protocols based on ongoing research and clinical experiences is required.

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