Faculty of Veterinary Medicine

Cairo University

Biosecurity & Infection Control Unit

2022

Mission Statement

The Biosecurity & Infection Control Unit (BICU) is responsible for development, maintenance and monitoring of infection control activities in the Faculty of Veterinary Medicine, Cairo University, Teaching Hospital, and to reduce the incidence and impact of sporadic infectious diseases and outbreaks amongst animals and humans.

VisionStatement

Establishment and optimizing of Biosecurity & Infection Control program in the Faculty of Veterinary Medicine, Cairo University, Teaching Hospital, as a leader unit among the local and regional Faculties of Veterinary Medicine, hospital, and clinics and thereby improve the patient care and protect accompanying persons.

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Infection control is an essential component in the operation of all veterinary hospitals. Biosecurity risks include outbreaks of nosocomial infections in hospitalized patients and zoonotic infections in hospital personnel. Veterinary clinicians and hospital administrators have become increasingly aware of the importance of biosecurity in providing optimal care. Optimally, to allow for the best use of available resources, management decisions related to infection control practices should be based on objective data rather than on personal perception.

The Biosecurity & Infection Control Unit (BICU)

The Biosecurity & Infection Control Unit (BICU) at the Faculty of Veterinary Medicine, Cairo University, Teaching Hospital follows The National Guide to Infection Control, which was developed by the Infection Control Department, Ministry of Health and Population, Egypt in collaboration with the US Naval Medical Research Unit No. 3, and the World Health Organization (WHO) (2001), and also follows the American Animal Hospital Association Infection Control, Prevention, and Biosecurity (AAHA ICPB) Guidelines (2018), the composition of which is described below. Daily infection control activities are performed by Infection Control Practitioner (ICP), under the supervision of the Chief of the Biosecurity & Infection Control unit. The BICU is an advisory committee to the Dean, Vices Dean, heads of clinical departments, and Teaching Hospital manger and board of directors.

Terms of Reference/Composition

Purpose

The overall purpose is to advise and assist in all matters relating to infection control. This extends to the identification and reduction of risk of infection for patients, staff, and visitors to the Faculty of Veterinary Medicine, Cairo University, Teaching Hospital. Major components include:

- advising on the content and monitoring of the organization-wide infection control program
- providing advice and support to the Faculty of Veterinary Medicine, Cairo University, Teaching Hospital to meet its legislative, accreditation, governmental and ethical obligations relating to infection control practice
- identifying and interpreting current best practice standards regarding infection control in the context of the strategies and goals of the Faculty of Veterinary Medicine, Cairo University, Teaching Hospital
- monitoring compliance with legislative requirements, organizational policies and procedures relating to infection control practices
- providing a forum for regular consultation between the infection control team and other hospital staff

Guiding Principles

1. Infection prevention and control strategies are designed to protect patients, owners, veterinary personnel, and the community.
2. While poorly quantified, healthcare (hospital)-associated infections (HAIs) occur in veterinary clinics and can have a significant impact on animal health. Although not all HAIs are preventable, a significant percentage of these infections can be prevented with proper adherence to basic, practical infection control practices. While the proportion of preventable HAIs in veterinary clinics is unknown, it has been estimated that 30-70% of HAIs in human hospitals are preventable.
3. A systematic approach to infection prevention and control requires all veterinary personnel to play an active role in protecting every person and animal associated with activities at the
Faculty of Veterinary Medicine, Cairo University, Teaching Hospital.
4. Veterinary personnel need to always follow infection prevention and control protocols and use critical thinking and problem solving in managing clinical situations.

Composition and Function

The BICU reports to the Dean, and is comprised of the following individuals:

- Chief of Infection Control (Chair)
- Infection Control Practitioner (ICP)
- Animal Health Laboratory Representative
- Assistants and workers Representative
- Clinical Faculty Representative: Companion Animal Hospital
- Clinical Faculty Representative: Large Animal Hospital
- Ruminant Field Services Representative

- Primary Healthcare Centre Representative

Additional members may be added at the discretion of the dean and BICU Chair.

Responsibilities

The BICU Chair's responsibilities include:

- Calling meetings (semesterly)
- Interaction with the ICP
- Coordinating protocol development
- Outbreak Investigation
- Interacting with housing managers and pharmacy personnel as needed
- Communicating with ICC Members and other relevant individuals regarding infection control issues
- Evaluation of protocol breaches
- Coordinating periodic review of protocols

The ICP's responsibilities include:

- Daily infection control activities such as ward census
- Co-ordination of cage/stall quarantine
- Communication with animal housing and other relevant individuals
- Monitoring and collating surveillance results and collating results
- Identifying and reporting infection control breaches
- Recording infection control orientation of personnel
- Communicating with the Animal Health Laboratory on reporting of Internally Reportable Diseases
- Maintaining a record of Internally Reportable Diseases
- Performing infection control orientation of new personnel

The Dean is ultimately responsible for the implementation of infection control protocols and disciplinary action regarding serious or recurrent protocol breaches.

The BICU Chair and ICP will work closely in implementing, maintaining, and monitoring the program. The ICP will act as the 'front-line' infection control professional and will be the main liaison between the BICU and clinical personnel for routine issues. The BICU Chair will assume primary responsibility for protocol development and outbreak investigation, and will work with the ICP and Dean in dealing with problems with protocol compliance.

Function

The BICU will meet on a formal basis at least once a semester. Efforts will be made to facilitate attendance by all committee members; however, 4 individuals will constitute a quorum.

Email communication will be encouraged to discuss routine and emergency issues. Voting by email will be allowed and coordinated by the dean. The decision on whether to submit a measure to email vote will be made by the BICU Chair, however a formal meeting can be required if a request is made by 2 or more BICU members. All votes will be decided by simple majority. The Chair of the meeting will not vote except to break a tie.

Infection Control Manual

This Infection Control Manual will act as a resource and contain all approved infection control protocols. This manual will be updated as necessary. This may be in the form of minor additions or changes, or a complete review and revision. This will be determined by the BICU. The Infection Control Manual will be available to the public on the faculty website.

All infection control protocols are not contained within this Manual. Standard operating procedures (SOPs) are developed. The Infection Control Committee, through the Chief of BICU and/or ICP will participate in development and review of SOPs relating to infection control activities (e.g., cleaning and disinfection, movement of animals).

Introduction and Objectives

Without effective infection control, prevention, and biosecurity (ICPB) implemented in the veterinary primary care and referral settings, the clinician's efforts at disease prevention and treatment are compromised and, in some cases, nullified. Thus, ICPB is at the heart of the veterinarian's pledge to protect animal health and welfare and public health, as well as the universal mandate among the healing professions to "first, do no harm." Hospital-acquired infections (HAI), sometimes referred to as nosocomial infections, are an inherent risk in human and veterinary medicine, and breaches in ICPB can have direct and indirect financial, social, and environmental impacts on patients, clients, and staff. In a practical sense, any practitioner who doubts the value of ICPB need only experience a client's displeasure, an animal's health complications, or the consequences of an unflattering online review when a pet contracts infectious enteritis or respiratory disease during boarding or hospitalization or requires postsurgical treatment due to an HAI.[1] The fact is, our best work can be undone by an infection control breach in the practice or homecare setting. The AAHA Infection Control, Prevention, and Biosecurity Guidelines are the first clinician-focused and practice-oriented guidelines on this topic developed specifically for use in companion animal medicine. As such, these guidelines complement the growing emphasis in human medicine on infection control to prevent HAIs and exposure of patients and workers to infectious pathogens in the practice or laboratory and build off existing veterinary best practice and topic-focused documents.[2–7] The increasing involvement of drug-resistant pathogens such as methicillin-resistant staphylococci in HAIs has created additional urgency for effective ICPB. Adding to the risk associated with ICPB lapses is the potential for in-hospital exposure to zoonotic diseases such as leptospirosis, rabies, salmonellosis, campylobacteriosis, and infections with ecto- and endoparasites (e.g., fleas, ticks, and helminths). Taken together, these factors created a strong motivation to assemble a task force of experts to produce these ICPB guidelines.

As many HAI likely occur unnoticed, solely relying upon the awareness of outbreaks as a measure of effective ICPB practices results in a false sense of security and unnecessary patient and staff health risks. As such, effective ICPB is dependent on the development of and adherence to standardized processes and protocols followed by self-audit and protocol adjustment. These guidelines provide a conceptual roadmap and specific, practical guidance on how to institute and evaluate ICPB standard operating procedures (SOPs) that will safeguard patients, staff, and clients from avoidable exposure to infectious pathogens. It is important to acknowledge that not all HAI will be prevented by following ICPB SOPs; however, studies indicate 10–70% of all HAIs in human medicine are preventable by using practical infection control measures, an estimate that is likely applicable to veterinary medicine.[8] Even a 10% reduction in HAI would have large impacts on patient health, owner cost, and owner and staff satisfaction.

Implementing the various protocols specified in these guidelines or provided as online resources may seem daunting at first. However, most practices already effectively apply many infection control procedures as an aspect of sound clinical practice. These guidelines will nevertheless help any primary care or referral practices to systematize and strengthen their existing ICPB protocols and enlist the entire healthcare team in this essential aspect of high-quality veterinary care. To that end, the guidelines present a progression of interventions from most to least critical. Therefore, veterinary practices can implement the recommendations of the ICPB task force incrementally without being overwhelmed by attempting an immediate, complete overhaul of ICPB protocols.

As ICPB principles become part of a practice's culture, the healthcare team can more confidently admit and treat all patients, including those with emerging or endemic infectious diseases, while minimizing the risk of exposing other patients, staff, and clients. An effective approach, strongly recommended by the ICPB task force, is to appoint a practice "champion" who takes primary responsibility for implementing ICPB protocols and ensuring staff compliance. This individual should focus on the two principal components of ICPB, which are to (1) limit pathogen introduction, exposure, transmission, and infection within the hospital population; and (2) evaluate the effectiveness of infection control practices at controlling disease.[9,10]

There are limited data and evidence-based studies that clearly measure the added benefits of infection control practices in veterinary practices.[9,10] Nonetheless, the prevailing opinion within the profession, supported by evidence from other healthcare fields, is that veterinarians can more widely implement effective ICPB protocols and conduct staff training on ICPB to protect patient, staff, and client health.[6,9,11] To help fill this void, the guidelines represent the consensus recommendations of experts with extensive ICPB experience in veterinary medicine and public health. Their recommendations reflect the latest scientific data, clinical expertise, and best practices for infection control. Thus, these guidelines

address the growing public awareness of HAI, the emergence of drug-resistant microbes and infections, and the expectation that veterinary medicine will match or exceed ICPB initiatives in human medicine. More specifically, the objectives of the guidelines are to

- Help veterinary practice teams understand the importance of ICPB and why it should be prioritized.
- Help practice teams implement appropriate ICPB protocols that enhance patient care and safety.
- Provide general concepts that guide effective ICPB (versus exhaustive information on all potential pathogens).
- Provide specific surveillance strategies and protocols that will allow practices to self-audit, assess, and adjust their SOPs for infection control.
- Provide resources for motivating and training staff to understand, implement, and comply with ICPB strategies.
- Provide practical information that can be adapted as client education materials.

Conversely, the purpose of the guidelines is not to focus on hospital design or the judicious use of antimicrobial agents, two ancillary topics that are more appropriately reviewed in other forums and publications. When the ICPB objectives listed above are met, it will inherently advance the quality of care provided by your practice. When clients see visible evidence that ICPB protocols are consistently implemented by your healthcare team (e.g., barrier precautions, take-home postsurgical instructions, posted ICPB protocols), it will invariably strengthen the mutual loyalties of the veterinarian-client-patient relationship that is the basis of successful veterinary practice.

Principles of Infection Control, Prevention, and Biosecurity

Routes of Transmission

Infection control and prevention depends on disrupting the transmission of pathogens from their source (the infected animal or human) to new hosts (animal or human) or locations.[7,12] Understanding routes of disease transmission and how it contributes to the spread of organisms allows for the identification of effective prevention and control measures not only for specific diseases, but also other pathogens transmitted by a similar route, including unanticipated infectious diseases.[12] The transmission of microorganisms can be divided into the following five main routes: direct contact, fomites, aerosol (airborne), oral (ingestion), and vector borne. Some microorganisms can be transmitted by more than one route.

Direct Contact Transmission

Direct contact transmission occurs through direct body contact with the tissues or fluids of an infected individual. Physical transfer and entry of microorganisms occurs through mucous membranes (e.g., eyes, mouth), open wounds, or abraded skin. Direct inoculation can occur from bites or scratches. Examples include organisms such as rabies, Microsporum, Leptospira spp., and staphylococci, including multidrug-resistant (MDR) species methicillin-resistant Staphylococcus aureus and Staphylococcus pseudintermedius (MRSP). This is probably the most common and highest-risk route of pathogen transmission to patients and personnel.

Fomite Transmission

Fomite transmission involves inanimate objects contaminated by an infected individual that then come in contact with a susceptible animal or human. Fomites can include a wide variety of objects such as exam tables, cages, kennels, medical equipment, environmental surfaces, and clothing. Disease examples include canine parvovirus and feline calicivirus infections.

Aerosol (Airborne) Transmission

Aerosol transmission encompasses the transfer of pathogens via very small particles or droplet nuclei. Aerosol particles may be inhaled by a susceptible host or deposited onto mucous membranes or environmental surfaces. This can occur from breathing, coughing, sneezing, or vocalization of an infected individual, but also during certain medical procedures (e.g., suctioning, bronchoscopy, dentistry, inhalation anesthesia). Very small particles may remain suspended in the air for extended periods and be disseminated by air currents in a room or through a facility. However, most pathogens pertinent to companion animal veterinary medicine do not survive in the environment for extended periods or do not travel great distances due to size and as a result require close proximity or contact for disease transmission. Examples of common aerosolized pathogens include Bordetella bronchiseptica, canine influenza, and canine distemper virus.

Oral (Ingestion) Transmission

The ingestion of pathogenic organisms can occur from contaminated food or water as well as by licking or chewing on contaminated objects or surfaces. Environmental contamination is most commonly due to exudates, feces, urine, or saliva. Examples

of diseases acquired via oral transmission include feline panleukopenia and infections caused by Campylobacter, Salmonella, Escherichia coli, and Leptospira.

Vector-Borne Transmission

Vectors are living organisms that can transfer pathogenic microorganisms to other animals or locations and include arthropod vectors (e.g., mosquitoes, fleas, ticks) and rodents or other vermin. Vector-borne transmission can be an important route of transmission in climates where these pests exist year-round and may be brought into the practice by an infested patient. Examples of vector-borne diseases include heartworm disease, Bartonella infection, Lyme disease (borreliosis), and plague.

Zoonotic Transmission

It is important to remember many animal diseases are zoonotic and therefore pose a risk for the healthcare team as well as clients. The transfer of these agents can occur by the same five routes of transmission described above. Examples of zoonotic pathogens include Microsporum, Leptospira, Campylobacter, and Bartonella.

Hierarchy of Controls

The hierarchy of controls concept, often used to address measures taken to reduce workplace hazards, is useful when considering infection control strategies in veterinary settings.[7,13–17] Figure 1 shows a four-tier hierarchy pyramid that can be used to determine effective ICPB procedures such as changes in facility design, policies or procedures, and wearing protective clothing. The top tiers are generally considered more effective at minimizing hazards (e.g., pathogen exposure) than the lower tiers.[15,16] Often, a combination of control measures are needed to effectively reduce exposures.[16]

Elimination of sources of pathogen exposure involves physically removing (or preventing) the hazard (i.e., pathogen) from entering the facility.[15,16] Although completely eliminating infected animals from a facility is unlikely to occur, measures can be taken to prevent patients from infecting the general population. While elimination controls are the most effective at reducing hazards, they are often the most difficult to implement.[15]

Engineering controls include measures designed into the facility to remove a hazard at its source or to improve compliance with infection control procedures.[4,7,15,16] These measures can be highly effective but generally have higher initial costs.[4,13–17]

Administrative controls include protocols or changes to work practices, policies, or procedures to keep patients or staff separated from a known hazard as well as providing staff with information, training, and supervision for these measures. Administrative controls address the way people work and how animals move through the hospital (traffic flow) when an onsite infectious disease is known or suspected.[4,13–17]

Personal protective equipment (PPE) includes the use of special clothing and equipment to protect staff and patients who

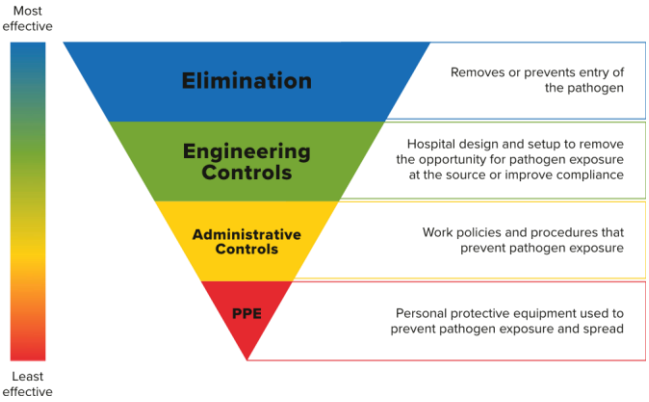

FIGURE 1 An inverted pyramid depicting tiers of the hierarchy of control methods used in determining effective infection control procedures to disrupt pathogen spread. The top tiers (e.g., physical barriers) are generally more effective at reducing pathogen exposure (elimination) than the lower tiers (procedural barriers, e.g., PPE). Not all tiers will be applicable to a given situation. Although less effective, lower tiers (e.g., PPE) remain critical for effective infection control. PPE, personal protective equipment. Adapted from CDC NIOSH Hierarchy of Controls, available at: https://www.cdc.gov/niosh/topics/hierarchy/default. html.[15]

may be exposed to known or suspected pathogens.[13,15,16] PPE places a barrier between staff and an exposure risk (e.g., infected animal, diagnostic specimens) and with appropriate use, helps prevent the spread of pathogens between animals and within the practice. The use of PPE is considered a relatively less effective means of controlling exposures because it relies on human factors such as staff compliance and appropriate education and training.[4,15] Although less effective, lower tiers (e.g., PPE) remain critical for effective infection control and should be used when indicated.

Table 1 provides examples of hierarchy of control measures that can be applied to disrupt pathogen transmission and provide infection control for a variety of microorganisms.

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TABLE 1

Hierarchy of Control Measures Applied to Infection Control, Prevention, and Biosecurity Measures for the Disruption of Pathogen Transmission[4,7, 13–17]

Hierarchy of Control Tier	Measures for All Transmission Routes	Additional Measures for Aerosol Transmission	Additional Measures for Vector-Borne Transmission
Elimination	Early identification of infectious cases (e.g., phone triage) to prevent exposures within the main hospital areas		Implement pest management (extermination) for the practice
Engineering	• Establish a dedicated isolation room (preferably with a direct to outside or alternate entrance in a lower-traffic area) • Place dedicated equipment within the isolation room • Place hand hygiene and cleaning and disinfection resources near exam rooms to improve compliance • Install (or use) nonporous materials for work surfaces and floors for more effective disinfection	Isolation room with separate ventilation (negative-pressure ventilation possibly an additional benefit)	
Administrative	• Develop and implement infection control policies and procedures (written infection control plan) • Provide staff training on infection control protocols: isolation, infectious disease outbreaks, use of PPE, disinfection procedures, proper animal handling and restraint • Limit staff access to patients with suspected or known infectious diseases • Place signs to deter unauthorized persons from entering isolation areas • Limit and control infectious patient transport throughout the hospital to essential purposes only • Require hand hygiene between patients • Provide rabies pre-exposure vaccination for staff • Establish effective waste management and soiled laundry protocols • Implement proper disinfection protocols for equipment, work areas, and traffic areas		Remove vectors from infested patients
PPE	• Use gloves and gowns when in contact with infected animals, their bodily fluids, or contaminated surfaces/equipment or bedding • Use higher levels of protection (e.g., masks, eye protection) when performing necropsies, dental procedures, obstetrics, or other procedures for which there is a splash or aerosol hazard depending on the target pathogen	Use gloves, gowns, masks, and eye protection as appropriate for the pathogen	Use gloves when performing vector removal or extermination tasks

PPE, personal protective equipment.

Implementing an Infection Control, Prevention, and Biosecurity Program

Every veterinary practice should have a documented ICPB program. At a minimum, this should be a collection of agreed-upon basic infection control practices and accompanying SOPs, growing into a formal manual incorporating specific staff education and training, client education, surveillance, and compliance programs. The pros-pect of developing or refining an existing infection control program may seem daunting to veterinary staff. Most staff have not received formal training in this area, and the value of providing the required resources (e.g., time, finances) may be questioned. However, the process of instituting a program need not be an "all or none" approach. Importantly, a significant percentage of HAIs in veterinary practices can likely be prevented with proper compliance to basic, practical infection control practices that a hospital can build over time.[18] An incremental approach to program development and refinement can be done in a step-by-step process that is practical, economical, and effective. Ordered steps to develop an ICPB program are as follows:

1. Assign a staff member to oversee and champion the development of and implementation of the ICPB program. Commonly referred to as the infection control practitioner (ICP) or infection preventionist, this individual serves a critical role in infection control (1) program development, maintenance, compliance, and evaluation; (2) staff training development and documentation; (3) protocol compliance evaluation; and (4) receipt of actionable infection control concerns, including suspected HAIs. Time commitments will vary with attributes of the practice (e.g., size, caseload, existing SOPs) but in most cases can be accomplished by an existing practice technician or veterinarian who has an interest, but not necessarily specific training, in infection control. The factors most critical to success are an interest in the topic, motivation to make improvements, and support (e.g., enthusiasm, financial resources and incentives, time) of practice leaders. Existing resources are available in the human and veterinary fields that provide an engaged practice member with the guidance, skills, and tools to be successful.[4,5,7,8,18–21] Because staff acceptance, support, and respect for established protocols are critical to a program's success, the ICP should keep staff engaged (e.g., regular program updates, surveillance findings, evaluations; seek and respond to infection control-related feedback; involve staff in SOP development and review). Additional resources can be found at aaha.org/ biosecurity.
2. Identify and develop protocols and checklists. Protocols serve as the main resource for guidance of many components of an ICPB program and should be compiled within an infection control manual. To be effective, protocols must consist of agreed-upon steps that will be taken by all practice members. Existing protocols developed as general guidance or for a specific practice are an excellent starting point for ICPs.[4,7] Protocols should be customized for the given needs and resources of the practice. Sample protocols for key areas of a practice's ICPB program include

   - Hand hygiene (Table 2).
   - Cleaning and disinfection (Table 3).
   - Sequence for putting on and removing PPE (Table 4).
   - Identifying high-risk patients; questions to ask when making appointments (Table 5).
   - Placing and maintaining IV and urinary catheters (Tables 6, 7).
   - Entering and exiting isolation or dedicated areas for high-risk patients (Table 8).
   - Necropsy procedures (Table 9).
   - Checklists of key tasks are known to improve compliance throughout the practice workplace, including infection control and the reduction of HAIs.[22] Checklists are encouraged for cleaning and disinfection, surgery (pre- and postoperative), and any commonly performed duty that benefits from a reminder and communication system.
3. Perform an initial assessment of the facility to identify strengths and areas for improvement. To best prioritize resources, ICPs should identify ICPB strengths and weakness of the practice. Tools have been developed to assist with this process (Table 10). Regardless of the tool used, it is most important that all key areas of a program are examined (e.g., hand hygiene, cleaning and disinfection,

identification of procedures used to treat and house high-risk patients, PPE) and the continuum of effective risk mitigation is included (e.g., presence of written protocols, staff knowledge of and compliance with protocols). A properly performed assessment will indicate areas of the facility on which to focus most immediate attention. The ICP should then begin to develop and refine an infection control manual containing protocols for identified areas.

4. Develop a staff education and training plan. All personnel, including temporary lay personnel, kennel staff, veterinarians, technicians, receptionists, students, and volunteers, should receive education and training about infection control. Training should occur during orientation and at least annually. Training should be tailored to individual job duties, but in all cases emphasize health risks and existing protocols to reduce patient, staff, and client infection-related hazards. A checklist of required readings, meetings with key staff, and electronic resources to review should be provided and completion documented. An assessment (examination) to document staff knowledge and comprehension should be performed after trainings.

TABLE 2

Protocol for Hand Hygiene Using Soap and Water or Alcohol-Based Hand Sanitizer[21]

Hand Wash (Soap and Water)	Hand Rub (AHS)
Turn on water	—
Wet hands	—
Dispense appropriate amount of product directly onto hands (e.g., 1–2 pumps from dispenser)	Dispense appropriate amount of product directly onto hands (e.g., 1–2 pumps from dispenser)
Apply product to all surfaces of hands; min. 15 s contact time	Apply product to all surfaces of hands; min. 15 s contact time
Palms	Palms
Back of hands	Back of hands
Between fingers	Between fingers
Finger tips	Finger tips
Thumb and thumb web	Thumb and thumb web
± Wrists	± Wrists
Rinse all surfaces of hands with water	—
Dry hands thoroughly with single-use towel	Rub hands until dry
Turn water off, using drying towel to avoid direct contact with faucet handles (unless automatic faucet present)	—
Discard towel	—
TOTAL TIME: ~30–60 s	TOTAL TIME: ~20–30 s

AHS, alcohol-based hand sanitizer

5. Identify a staff member to collect client education materials specific for use in your practice. Efforts should be made to identify, catalog, and make readily available appropriate materials that assist clients in understanding infectious and zoonotic disease risks and the basic steps they can take to protect themselves, household members, and their animals. Several sources provide client-appropriate materials on these topics, such as Worms and Germs blog's pet resources (wormsandgermsblog.com), the CDC's Healthy Pets Healthy People (http://www.cdc.gov/healthypets/index.html), the Center for Food Security and Public Health (http://www.cfsph.iastate.edu), and aaha.org/biosecurity.

TABLE 3

Example of an Environmental Cleaning and Disinfection Protocol (Adapted)[20]

- Have all material safety data sheets or product safety data sheets for cleaning and disinfection materials available. Follow instructions for proper mixing, disposal, and PPE (e.g., gloves, eye protection). As able, ensure the area is well ventilated.
- Exam rooms and cages should be cleaned and disinfected immediately following use. Place signage at the room entry that it should not be used until cleaning and disinfection is completed.
- As applicable, remove all bedding and organic material (e.g., feces, feed, hair, linens, bandage, or other materials) and dispose in designated waste bin. Gloves should be worn during this procedure.
- "Dry"-clean surfaces (e.g., sweeping, wiping with disposable microfiber cloth) to remove loose organic material.
- "Wet"-clean surfaces with warm water and detergent. Scrubbing surfaces is often necessary to remove feces or bodily fluids, biofilms, and stubborn organic debris, especially in animal housing areas.
- Rinse with clean water. For all rinsing and product application procedures, care must be exercised to avoid overspray. High-pressure washing should be avoided. Higher pressures can help remove stubborn organic debris but may also force debris and organisms into crevices or porous materials, from which they can later emerge. Additionally, high-pressure washing causes aerosolization and overspray, which may spread organisms widely, even into previously uncontaminated areas.
- Allow the area to dry or manually do so. If excess water remains, subsequently applied disinfectants may be diluted to the point of inefficacy.
- Apply disinfectant solution at the indicated concentration and ensure the appropriate contact time (allotted time required for disinfectant to remain wet on the surface to kill the pathogens of interest; time is based on the product, concentration, and targeted pathogens but generally 5–10 min). Rinse thoroughly with clean water; this is especially important for disinfectants that leave a residue or for surfaces vulnerable to damage from the disinfectant. Always follow the disinfectant label (**Figure 2**) for appropriate use, concentration, and contact time (see **Figures 3, 4; Table 11** for choosing a disinfectant).
- Allow the treated area to dry as much as possible before reintroducing animals or reusing the area.
- In known contaminated or high-risk areas, a second application of a disinfectant with wide spectrum (e.g., accelerated hydrogen peroxide product) should be considered as a final decontamination step. Ensure appropriate contact time, rinse with clean water, and allow the treated area to dry, as stated above.

PPE, personal protective equipment.

TABLE 4

Sequence for Donning and Doffing of Personal Protective Equipment[21]

Donning PPE (Putting on)	Doffing PPE (Taking off)
1. Perform hand hygiene	1. Remove shoe covers (if applicable)
2. Put on shoe covers (if applicable)	2. Remove gown and gloves together*
3. Put on gown	3. Perform hand hygiene
4. Put on mask/respirator (if applicable)	4. Remove eye protection (if applicable)
5. Put on eye protection (if applicable)	5. Remove mask/respirator (if applicable)
6. Put on gloves	6. Perform hand hygiene

*If gloves are removed first, hands must only touch uncontaminated surfaces of the gown, typically behind the neck (ties) and at the back of the shoulders. The gown is then peeled down off the body and arms, balling or rolling in the contaminated surfaces (front and sleeves). This is difficult to do, however, without contaminating the hands. The preferred method for doffing a disposable gown and gloves is, therefore, to break the ties at the neck by pulling on the upper front portion of the gown with the hands still gloved, balling or rolling in the contaminated surfaces, and pulling the gloves off inside-out as the hands are withdrawn from the gown's sleeves. The gown and gloves can then be placed in a disposal receptacle together.
PPE, personal protective equipment.

6. Develop and implement a surveillance program. Surveillance, the routine collection of information with defined responses, is critical for effective infection control. It provides feedback to determine if a practice's infection control practices are effective at controlling disease, helps to identify areas ofweakness, and provides a warning to allow for an early response to a concern, reducing patient and staff illness, expenses, and time. Many forms of surveillance are easy, inexpensive, and can be readily incorporated into day-today veterinary practice. Some form of surveillance (either passive or active) should be used by all veterinary facilities. Passive surveillance involves using data that are already available (e.g., client-paid bacterial culture and susceptibility results, identified surgical site infections [SSIs]) to determine clinically relevant elements such as disease rates, antimicrobial susceptibility patterns, and trends and identify changes that may indicate an important infection control problem (e.g., increase in SSI rate). Routine recording of animals with specific diagnoses (e.g., SSIs, MDR organisms) or syndromes (e.g., vomiting, diarrhea, coughing) is another simple method of collecting information that can help in the prevention and early detection of outbreaks. The key to passive surveillance is to centralize available data, with the ICP compiling and evaluating data and reporting results on a regular basis. Many electronic medical record systems can be set to track and report on certain diagnostic codes that the ICP has designated for surveillance. Active surveillance involves gathering data specifically for infection control purposes. An inexpensive, highly effective example of active surveillance for that may indicate an important infection control problem (e.g., increase in SSI rate). Routine recording of animals with specific diagnoses (e.g., SSIs, MDR organisms) or syndromes (e.g., vomiting, diarrhea, coughing) is another simple method of collecting information that can help in the prevention and early detection of outbreaks. The key to passive surveillance is to centralize available data, with the ICP compiling and evaluating data and reporting results on a regular basis. Many electronic medical record systems can be set to track and report on certain diagnostic codes that the ICP has designated for surveillance. Active surveillance involves gathering data specifically for infection control purposes. An inexpensive, highly effective example of active surveillance for environmental cleaning is fluorescent tagging. This process involves applying marks only visible under ultraviolet light (so staff are not aware marks have been placed) that are easily removed with routine cleaning and monitoring surfaces for presence of marks after cleaning was to occur (e.g., 24 hr after mark placement).23 Regularly marking and collecting this information provides insight into cleaning deficiencies (e.g., locations or objects often missed), allowing for targeted adjustment to cleaning and disinfection protocols or staff training. Culturing environmental surfaces or diagnostic samples from animals is another example of active surveillance, but due to expense would generally be reserved for an outbreak investigation.environmental cleaning is fluorescent tagging. This process involves applying marks only visible under ultraviolet light (so staff are not aware marks have been placed) that are easily removed with routine cleaning and monitoring surfaces for presence of marks after cleaning was to occur (e.g., 24 hr after mark placement).23 Regularly marking and collecting this information provides insight into cleaning deficiencies (e.g., locations or objects often missed), allowing for targeted adjustment to cleaning and disinfection protocols or staff training. Culturing environmental surfaces or diagnostic samples from animals is another example of active surveillance, but due to expense would generally be reserved for an outbreak investigation.

TABLE 5

Identifying High-Risk Patients: Questions to Ask When Making Appointments[5]*

- Age of the patient.
- Vaccination history.
- Recent history:
  - Has the pet been to a boarding kennel, dog park, day care facility, animal shelter, or other similar venue in the past month?
  - Traveled to another area or country?
  - Are other pets in the household ill?
- Acute vomiting?
- Acute diarrhea (defined as three or more loose stools during the past 24 hr) or episodes of bloody diarrhea?
- Acute coughing?
- Acute sneezing?
- Fever (if known)?

If the patient is acutely coughing, sneezing, vomiting, or having diarrhea, ± a fever, the pet should not enter the reception area. Evaluate such animals before entry into the building or immediately transport them to a dedicated examination or isolation room depending on practice policy.
If the hospital records indicate that the pet has a multidrug-resistant infection, the pet should not enter the reception area.
*Patients fitting these criteria should not enter the reception area. Meet owners outside and escort them in via a separate entrance or use a carrier or gurney to transport the pet through the reception area if necessary. Use alternative waiting/examination locations or use of barrier precautions based on the initial risk assessment. Clean and disinfect any waiting or examination locations occupied before using those areas again for other animals.

TABLE 6

Placement and Maintenance of Peripheral Intravenous Catheters to Prevent Infection[5]

1. Clip hair from the proposed site of catheter insertion.
2. Perform hand hygiene and put on clean examination gloves.
3. Use gauze sponges, sterile saline, and chlorhexidine scrub diluted with sterile saline to between 0.5 and 2% chlorhexidine.
4. Perform hand hygiene and put on sterile or clean gloves to insert the catheter. Do not reuse a catheter after a failed attempt.
5. Attach a catheter cap, T set, or suitable extension set to the catheter, and flush the catheter with sterile saline solution. Carefully secure the catheter with tape and cover it with sterile bandage materials. Povidone iodine ointment may be applied at the site of entry into the skin.
6. Examine the catheter site at least two times daily. Observe for pain and evaluate for evidence of swelling or thrombophlebitis. If the bandage is not clean and dry, replace the bandage. If there is any evidence of thrombophlebitis and the catheter is still necessary, replace the catheter in a different site.
7. When IV lines are disconnected (e.g., to take a dog for a walk), the sites of connection should be cleaned with isopropyl alcohol single-use wipes and capped with injection caps. Do not reuse injection caps.
8. IV tubing used for fluid administration should be changed every 72 hr. The IV tubing used for TPN administration should be changed every time a new bag of TPN is placed, or every 24 hr, whichever is more frequent.

TPN, total parenteral nutrition.

TABLE 7

Placement and Maintenance of Indwelling Urethral Catheters[5]

For all site cleansing, wear examination gloves and use sterile gauze sponges to cleanse, alternating between an appropriate dilute skin antiseptic (e.g., chlorhexidine scrub diluted with sterile saline to 0.5–2% chlorhexidine, 1:200 povidone iodine/sterile saline) and sterile saline.

Dogs

- Clip hair on prepuce and surrounding ventral abdomen. Shorten nearby long hair.
- Cleanse the area, using at least three scrubs with each solution.

Males

- Flush the prepuce three to five times with 2–12 mL of dilute skin antiseptic (volume depends on size of dog) using a sterile syringe.
- Assistant wearing clean examination gloves should exteriorize the penis. Cleanse of any gross exudates, then cleanse the entire area, using at least three wipes with each solution. Flush with 2–5 mL dilute skin antiseptic.

Females

- Cleanse vulva and perivulvar area, using at least three scrubs with each solution.
- Flush the vaginal vault three to five times with 0.5–12 mL dilute skin antiseptic (volume depends on size of animal) using a sterile syringe.

All

- Place a sterile fenestrated drape over the work area.
- Perform hand hygiene and put on sterile gloves.
- Test the bulbs of Foley catheters before placement.
- Coat the distal catheter with sterile lubricating jelly from a single-use packet and place the catheter using sterile technique.
- Immediately connect a sterile closed collection system.
- Anchor the catheter to prevent displacement and place an Elizabethan collar on the animal.

Daily maintenance of indwelling catheters

Perform hand hygiene and put on sterile gloves. Clean at the junction of the patient and the external portion of the catheter every 24 hr with sterile gauze sponges, alternating between dilute skin antiseptic solution and sterile saline (greater than or equal to three scrubs with each solution).

Managing the closed collection system

- Do not administer prophylactic antimicrobials; these increase the risk of hospital-acquired resistant infections and have not been shown to prevent infection. Give antimicrobials only for documented infection.
- Position collection bags lower than the animal to allow urine to flow by gravity. Prevent retrograde flow of urine from the collection bag back into the patient because this may cause iatrogenic urinary tract infection with resistant organisms. The collection system clamp should be closed when the patient is moved or walked and immediately reopened once the collection bag is again lower than the patient. Check patency of the tubing hourly.
- Culturing the urine (via cystocentesis) at the time of catheter removal is only indicated if there is evidence of cystitis. Urine culture results drawn from indwelling catheters (not recommended) should be interpreted with caution. Do not culture the tip of a removed catheter.

TABLE 8

Sample Protocol for Entering and Exiting an Isolation (or Similarly Dedicated) Area[5]

Entering and exiting isolation rooms

1. Before entering the isolation area, remove practice outerwear (e.g., laboratory coat) and any equipment (e.g., stethoscope, scissors, thermometer, watch, cell phone) and leave outside the isolation unit/anteroom.
2. Gather any necessary supplies and medications before putting on PPE.
3. Wash hands or use alcohol hand rub, and then put on booties, gown, and gloves before entering the isolation room (see Table 4 for proper procedures).
4. Attend to the patient in isolation as needed. DO NOT bring treatment sheets, pens, or electronic devices such as laptops, cell phones, or tablets into the isolation room.
5. Clean and disinfect any equipment used while caring for the patient.
6. Before leaving the isolation room, remove PPE (see Table 4; remove booties last as stepping out of the isolation room and avoid touching the outer surface of the boots). Clean and disinfect nondisposable PPE (e.g., eye protection). Place used disposable PPE in the trash container lined with a biohazard bag in the isolation room. DO NOT SAVE DISPOSABLE PPE FOR REUSE. Avoid contact with external portions of the door when exiting the isolation room.
7. Wash hands with soap and water, and then disinfect any surfaces (e.g., doorknobs) that may have accidentally been contaminated when the room was exited. Make any needed chart entries. Wash hands again before leaving the anteroom (as applicable).

PPE, personal protective equipment.

TABLE 9

Procedures for Performing a Necropsy Appointments[5]*

Necropsies are high-risk procedures because of potential contact with infectious body fluids, aerosols, and contaminated sharps. Nonessential persons should not be present.

- Personnel involved in or present at necropsies should wear:
  - Protective outerwear (e.g., designated lab coat, designated scrubs)
  - Disposable gloves
  - Protective eye glasses/goggles or a full-face shield
  - Cut-proof gloves (machine washable) when opening the body cavities of larger animals, for heavy cutting, and when working on cases of high occupational risk (e.g., rabies suspect)
  - Additional precautions for respiratory protection (including environmental controls and face masks) should be employed if power equipment is used
- In-hospital necropsies should not be conducted on any animal suspected of being infected with a pathogen requiring biosafety precautions above level 2 (e.g. *Chlamydophila psittaci*, *Coxiella burnetii*, *Francisella tularensis*, rabies virus). Instead, the entire body (or head for rabies testing as required by the testing facility) should be submitted to an approved diagnostic laboratory.
- Ensure all requirements for shipment of biological samples are met (available from the laboratory in question).

TABLE 10

Sample Infection Control Audit Tool[4]

Audit Areas and Items	Fully Implemented	Partly Implemented	Not Implemented	Not Applicable	Comments
Designated practice areas available					
Isolation area					
Diagnostic specimen handling area					
Staff "break" area					
Protective equipment available					
Gloves					
Household rubber, reusable					
Latex, nitrile or other, disposable					
Masks					
Surgical					
N95 masks, including fit testing					
Gowns					
Lab coats					
Foot covers/booties					
Eye protection (e.g., goggles)					
Written policies for dress code					
No/limited jewelry (rings or bracelets) for staff with animal contact					
No artificial nails or nail enhancements (e.g., nail polish) for staff with direct patient care					
Hand hygiene					
AHS stations available					
Signage for AHS with instructions					
Hand washing stations available					
Signage for hand washing with instructions					
Staff trained on how and when to use hand hygiene					
Before and after patient contact					
Before aseptic procedures					
Before putting on and after taking off gloves					
After contact with body fluids or mucous membranes					
After contact with contaminated equipment or surfaces					

TABLE 10 (Continued)

Audit Areas and Items	Fully Implemented	Partly Implemented	Not Implemented	Not Applicable	Comments
After personal body functions (i.e., sneezing, coughing, going to the bathroom)					
Before eating					
Cleaning and disinfecting procedures					
Written protocols and procedures for cleaning and disinfection developed and followed					
Safety Data Sheets for disinfectant products available					
Appropriate detergents available					
Appropriate disinfectant products available for patient-contact surfaces					
Approved and appropriate disinfectant products available for equipment and instruments					
Disinfection and sterilization of medical devices					
Proper technique used (i.e., product concentration, contact time, equipment properly cleaned before sterilized)					
Manufacturer's instructions followed					
Laundry					
Laundry performed on site or by a commercial service					
Laundry dried at high temperatures (65–70°C)					
Infectious laundry presoaked in bleach solution (9 parts water:1 part household bleach)					
Soiled laundry transported in a clean manner					
Clean laundry segregated from soiled laundry					
Hand hygiene available in laundry area					
Education provided regarding protective practices					
Sharps handling					
Approved puncture-resistant, labeled containers used					
Containers not more than 3/4 filled					
Containers accessible in all required areas					
Sharps disposed immediately after use					
Waste segregation					
Clear guidelines regarding waste that is:					
Biohazardous					
Nonbiohazardous					
Vector control					
Rodent control apparent					
Food debris and clutter eliminated					

TABLE 10 (Continued)

Audit Areas and Items	Fully Implemented	Partly Implemented	Not Implemented	Not Applicable	Comments
Points of entry for rodents sealed					
No standing water outside practice					
Windows screened					
Documentation of staff immunization (may not be provided by employer, but useful to document)					
Rabies					
Tetanus					
Examination rooms					
Hand washing sinks with soap available in all rooms					
Only essential supplies present					
Policies enforced for cleaning exam rooms between patients and at the end of the day					
Protocol ensuring rooms immediately cleaned/disinfected as needed (e.g., used for an infectious case)					
Enhanced cleaning/disinfection protocol in place for cleaning rooms where an infectious case may have been					
Written procedures for handling potential exposure of staff to zoonotic pathogens					
Separate refrigerators used for food, vaccines and medications, and diagnostic specimens					
Protocol development and staff training					
Documented annual staff training and updating on infection prevention and control measures					
Documented annual staff training on use of PPE					
Infection control program					
ICP designated in the practice to oversee the infection control program					
Surveillance in place					
Infection control and prevention issues (e.g., SSIs, MDR organisms) reported to ICP					
All new staff trained and provided with a copy of the infection control protocols					
Periodic assessment of all staff's knowledge of related SOPs					
Periodic assessment of staff's compliance with related SOPs					
A list of reportable diseases readily available in the practice					
Contact numbers for the appropriate veterinary and public health groups (e.g., for disease reporting) readily available in the practice					
Autoclave					
Quality control sterility indicators included in each autoclaved pack					

TABLE 10 (Continued)

Audit Areas and Items	Fully Implemented	Partly Implemented	Not Implemented	Not Applicable	Comments
Biological indicators periodically used to ensure adequate sterilization, and results are recorded in a log					
Isolation areas					
Dedicated isolation area for animals with infectious diseases available and clearly marked					
Dedicated equipment and PPE available and remain in the isolation area					
Signage available and appropriate					
Footbaths or footmats available					
Miscellaneous					
Policy not to feed patients raw meat					
Printed materials for clients on zoonotic diseases available					
Written policy on admitting animals from shelters					
List of syndromes of potentially infectious diseases (i.e., acute diarrhea, acute upper respiratory tract infection) provided to receptionists					
Policy with list of potential HAIs (e.g., SSIs) requiring reporting to hospital ICP					
Animal bite policy					
Training requirements for volunteers					
Staff (including receptionists) trained to triage and identify potentially infectious patients when making appointments, and contact a veterinarian to determine whether additional infection control practices are required prior to the animal entering the practice					

AHS, alcohol-based hand sanitizer; HAI, hospital-acquired infection; ICP, infection control practitioner; MDR, multidrug resistant; PPE, personal protective equipment; SOP, standard operating procedure; SSI, surgical site infection.

7. Establish and maintain a compliance evaluation program. Although the development of an effective ICPB program is a primary goal, only with regular compliance selfauditing can a practice ensure that their practices align with their protocols, goals are being met, and continued improvement occurs, resulting in lowering HAIs and worker safety risks. A comprehensive audit can build from the previously mentioned initial assessment using the same audit tool. The audit should include inspection of the physical environment, review of workplace ICPB practices, and assessment of workers′ knowledge and application of infection control principles. Regular audits (at least annually) by the ICP will allow for the establishment of benchmarks, identify and prioritize needs, and identify resources and timelines to meet benchmarks. Incorporating other team members in the audit process is encouraged to provide additional perspectives and further buy-in by practice staff.

General Procedures for a Veterinary Infection Control, Prevention, and Biosecurity Program

As the foundation for infection control practices, patient and staff flow, hand hygiene, cleaning and disinfection, and PPE should be addressed in all practice ICPB programs.

Patient and Staff Flow

Attention to the movement of patients and staff into and through a practice can affect HAI risks.[8] The ability to identify and manage infectious patients as early as possible (ideally before they enter the facility) will have the greatest success for reducing environmental

TABLE 11

Properties of Disinfectants Recommended for Routine Disinfection of Environmental Surfaces and Equipment[34]

Active Agent	Product Examples	Contact Time, min	Advantages	Disadvantages	Comments
Hypochlorite	Bleach; 1:10–1:50 dilution of household bleach	1–5	- Broad spectrum effective against most resistant organisms (nonenveloped viruses, bacterial spores, dermatophytes). - Readily available. - Cost-effective.	- Corrosive for some surfaces. - Poor stability when exposed to light. - Poorly active in the presence of organic debris (e.g., dirt, feces). - Can discolor fabrics.	- Good for various environmental surfaces. - Efficacy decreases with increasing pH, decreasing temperature, presence of ammonia and nitrogen. - Reserve high concentration (1:10) for specific circumstances with resistant microorganisms. −1:32–1:50 more commonly used. - Never mix with other chemicals. - Change diluted solutions daily. - Do not store in clear containers.
Potassium peroxymonosulfate (oxidizing agent)	Virkon, Trifectant	10	- Broad spectrum, with activity against nonenveloped viruses and bacterial spores. - Active in the presence of moderate organic debris.	- Corrosive, especially with metal surfaces. Masks should be worn when mixing powdered solutions	- Commonly used routine disinfectant. - Care must be taken when handling concentrated product. - Consider rinsing metal and concrete surfaces after required contact time.
Accelerated hydrogen peroxide (oxidizing agent)	Rescue, Prevail	1–10	- Broad spectrum, with activity against nonenveloped viruses, bacterial spores, and dermatophytes. - Good activity in moderate organic debris. - Low toxicity. - Biodegradable. - Does not appear to be corrosive, unlike other oxidizing agents.	- More expensive than other options.	- Excellent choice for environmental disinfection.
Quaternary ammonium compounds	Various	10–30	- Low cost. - Low toxicity. - Stable under storage. - Good against Gram-negative, many Gram-positive bacteria, and enveloped viruses.	- Limited impact on nonenveloped viruses, bacterial spores, dermatophytes. - Inhibited by organic debris.	- Common environmental disinfectant, but spectrum may be inadequate for some situations.

Isolating an Infectious Patient

As an example, before a dog suspected of parvovirus arrives at a practice, staff should consider

- Mode of transmission for the suspected pathogen (in this case most likely to be spread by fecal, direct, or fomite transmission).
- Individuals with anticipated patient contact should wear appropriate PPE (i.e., gowns, gloves).
- Carrying the patient or use a gurney with a disposable cover through a separate entrance directly into the exam or isolation room.
- Use of a similar transport procedure for patient's admission to isolation or during practice discharge.
- Use of a disinfectant that is effective against parvovirus.

contamination, direct and indirect patient contact, and within hospital pathogen transmission.

Taking an appropriate history prior to patient arrival can prevent pathogen introduction. SOPs and staff training should address identifying high-risk patients when possible, during appointment scheduling (Table 5). When an infectious disease is suspected prior to the appointment, the client should be instructed to call upon arrival and use a designated path to an appropriate, dedicated area for examination. Practices should determine the best path based on their facility, with the intention of minimizing contact with the general patient population and staff. Animals suspected or confirmed to pose a high risk (Table 12) should be examined and housed in a dedicated isolation area. Because an isolation room may not always be available, facilities should develop an SOP for where and how such animals will be housed. Facilities' procedures should be consistent with those used for isolation (i.e., housed physically and procedurally separate from other patients; Table 8). Complete discussion of facility design is beyond the scope of these guidelines.[4,19]

Some patients will be identified as potentially infectious during the appointment or while hospitalized. In such cases, staff should minimize owner and patient contact with other patients, staff, and surfaces (e.g., provide outpatient treatments and complete checkout process in the same exam room or designated infection control area). Staff should identify places where contact between infectious patients and other patients or where exposure to common areas may have occurred. These areas should be promptly cleaned and disinfected.

Hand Hygiene

Hand hygiene, using soap and water or an alcohol-based hand sanitizer (AHS), is the responsibility of all individuals involved in healthcare.

TABLE 12

Pathogens of Greatest Infection Control Concern for a Small Animal Hospital[6]

- Adenovirus (canine)
- *Bordetella bronchiseptica*
- Calicivirus (feline)
- *Chlamydophila* (feline)
- Distemper virus (canine)
- Herpesvirus (feline)
- Influenza viruses (canine, novel)
- *Leptospira interrogans*
- *Microsporum canis*
- Parainfluenza virus (canine)
- Parvoviruses (canine, feline)
- Respiratory coronavirus (canine)
- *Salmonella* spp.
- Multidrug-resistant organisms
  - *Acinetobacter* spp.
  - *Escherichia coli*
  - *Enterococcus* spp.
  - *Staphylococcus* spp.
  - *Pseudomonas* spp.

Generally considered the single most important way to prevent infections in healthcare, hand hygiene should be the subject of considerable attention to availability, encouragement, and compliance auditing.[21,24] Effective hand hygiene kills or removes microorganisms on the skin while maintaining skin integrity (i.e., prevents skin chapping and cracking). The objective is to reduce the number of microorganisms, particularly those that are part of the transient microflora of the skin, because these are easily shed and include the majority of opportunistic pathogens. In most circumstances, either method of hand hygiene (soap and water or AHS) is effective if performed appropriately and when indicated (Table 2). In the practice, hand hygiene should occur

- Immediately before and after patient contact, especially invasive procedures.
- Before and after contact with items in the patient's environment.
- After exposure to patient bodily fluids (e.g., discharge, specimen handling).
- Before putting on gloves and especially after glove removal.
- After using the restroom.
- Before eating.

AHS is the preferred method when hands are not visibly soiled because these products have a superior ability to kill microorganisms

TABLE 13

Recommended Cleaning and Disinfection Frequency for Common Environmental Surfaces in Veterinary Practices[4]

Surface or Object	Procedures	Special Considerations
Horizontal surfaces with low patient contact (e.g., front desk, records area)	1. Clean regularly with detergent (e.g., biweekly) 2. Clean and disinfect promptly if visibly soiled with feces, urine, or body fluids	Electrostatic wipes (can be used to remove loose fur and dust)
Horizontal surfaces with high patient contact (e.g., exam tables, scale, kennels)	1. Clean and disinfect between all patients. Surface should be cleaned of visible debris, and then a disinfectant should be applied. Adequate contact time should be ensured, as per label directions. 2. Provide enhanced disinfection after contact with high-risk patients (e.g., diarrheic). Higher-level disinfection (i.e., oxidizing agent) should be used if lower-level disinfectants are used routinely	
Vertical surfaces (e.g., walls, doors, windows including blinds/curtains)	1. Clean regularly with a detergent (e.g., monthly) 2. Clean and disinfect if visibly soiled with feces, urine, or body fluids	
Hard floors (e.g., tile, sealed cement)	1. Clean and disinfect daily 2. Clean and disinfect after potentially infectious patients 3. Clean and disinfect if visibly soiled with feces, urine, or body fluids	
Carpets and upholstery	1. Vacuum regularly (e.g., weekly)* 2. Shampoo or steam clean if necessary to remove visible dirt and debris	Cleaning is especially important for these surfaces as they are difficult or impossible to disinfect

*Do not vacuum if there may have been contact with an animal shedding an infectious pathogen (i.e., ringworm), unless the vacuum is equipped with a high-efficiency particulate air (HEPA) filter.

TABLE 14

Personal Protective Equipment and Clinical Indications[21]

Contact Precaution	Description	Applicable Conditions and Scenarios	Comments
Sterile gloves	Impermeable, sterile, single-use latex, nitrile, or vinyl gloves of appropriate size for individuals	Sterile gloves should be used when the primary risk is transmission of microbes to (rather than from) a particular body site or item (e.g., surgery, examination of "clean" wounds [surgical incisions, handling sterile equipment]).	Not a substitute for hand hygiene. Due to the risk of pre-existing defects, puncture, or tears during use and potential contamination of the hands when removing (and of sterile gloves when putting on), hand hygiene before and after glove use remains as important as before and after patient contact when gloves are not used
Single-use gowns or dedicated laboratory coats	Single-use disposable gowns, reusable cloth gowns, or laboratory coats that are laundered after each applicable patient contact or procedure. Clothing worn underneath must be completely covered from the wrists and waist to the collar at a minimum, depending on the size and type of patient. Use of coveralls is also an option for animals requiring extensive handling, especially on the floor.	Any scenario in which there is increased risk of hand or clothing contamination with a larger number of microbes or any number of highly virulent, resistant, or transmissible microbes, for example: • Any animal with potential respiratory tract infection, diarrhea, skin infection, fever of unknown origin • Oral manipulation or procedures (e.g., dentistry) • Exposure to potentially infectious fluids or discharge (e.g., obstetric procedures, necropsy, handling of clinical samples or soiled linens and other items)	Disposable gowns and laboratory coats are typically permeable to liquids, especially with prolonged or heavy contact; therefore, additional precautions may be required to prevent microbial strike-through
Face mask	Single-use disposable surgical mask along with eye protection or reusable full-face shield consisting of a stiff clear plastic sheet that covers the face from forehead to chin. Each face shield should be dedicated to a single person but should be discarded or fully reprocessed (i.e., cleaned and disinfected) if it becomes visibly contaminated or comes in contact with a contaminated surface (including used glove), and between patients.	Any scenario in which there is a significant splash risk or risk of droplet transmission, for instance: • Dental procedures • Wound lavage • Potentially zoonotic respiratory disease with productive coughing or sneezing • Necropsy (especially if any potential risk of rabies)	• A face shield may be more appropriate for individuals with heavy facial hair that is not adequately covered by a mask. • Does not protect against airborne pathogens—this requires a properly fitted respirator (N95 or higher)
Eye protection	Typically, reusable plastic goggles that wrap around the sides of the face or include side-protectors or a full-face shield		Poorly fitted eye protection can cause visibility issues from fogging or slipping. Regular eyeglasses are not a substitute because they do not fully protect the eyes, particularly from the lateral aspect
Shoe covers or dedicated footwear	Single-use disposable cloth or plastic boots that fit over regular footwear or reusable slip-on footwear that is easily cleaned and disinfected (e.g., rubber boots)	Any scenario in which there is suspected to be significant contamination of the floor with a high-risk substance, for example: • Dog with leptospirosis housed on the floor • Infectious vomiting or diarrhea, particularly in large dogs housed on the floor • Management of large open wounds if floor could become contaminated with discharge or lavage fluid	Disposable plastic shoe covers can create a slipping hazard if they do not have treads. Not commonly needed in small animal practices; however, contamination of the floor must always be carefully considered because of the high degree of contact of patients and staff with the floor.

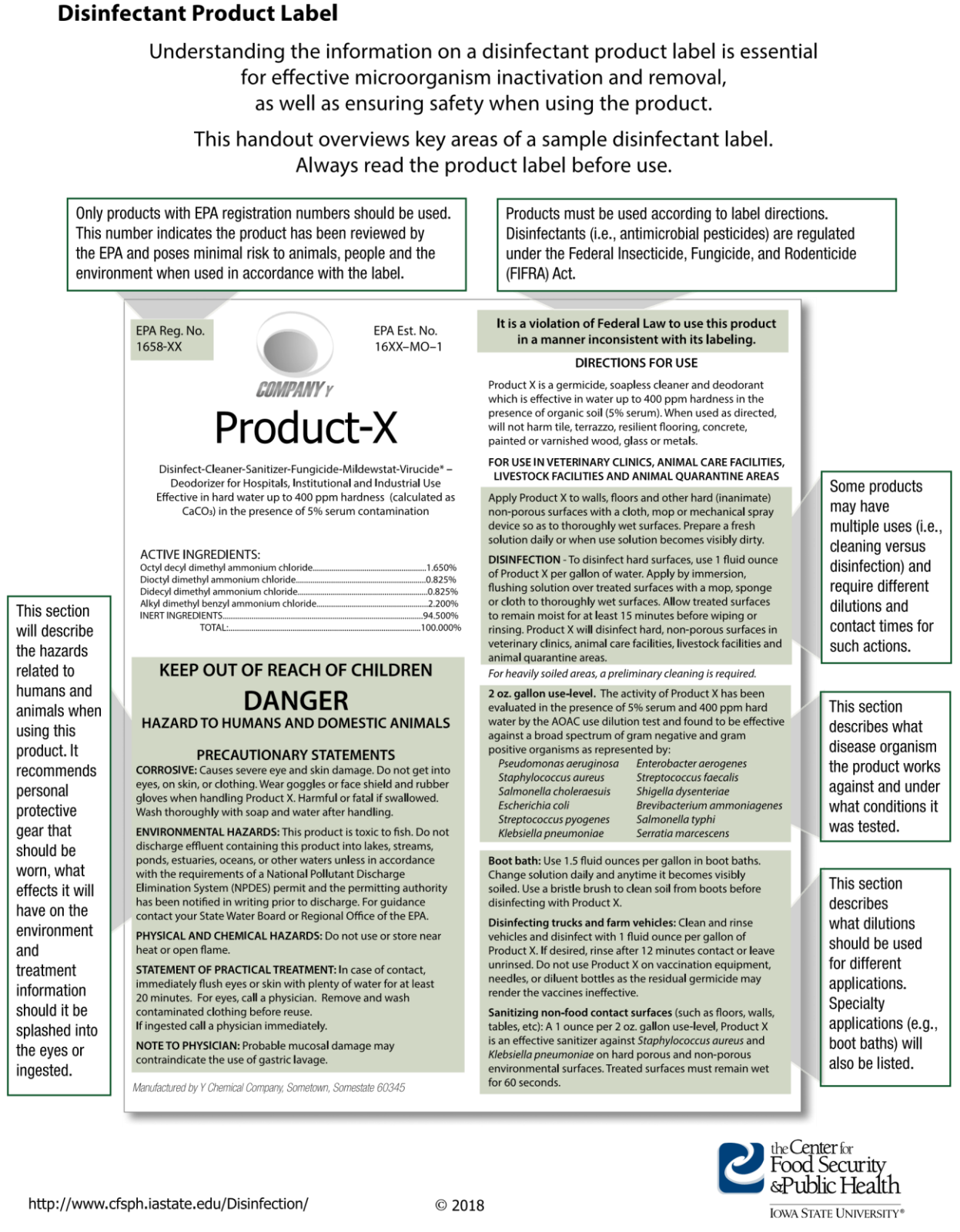

FIGURE 2 Understanding the information on a disinfectant product label is essential for effective disease organism removal and the safety of those handling the product. Always read the product label before use. It is a violation of federal law to use a product in a manner

inconsistent with its labeling. From the Center for Food Security and Public Health, available at: http://www.cfsph.iastate.edu/Disinfection/Assets/disinfectant_product_label.pdf.

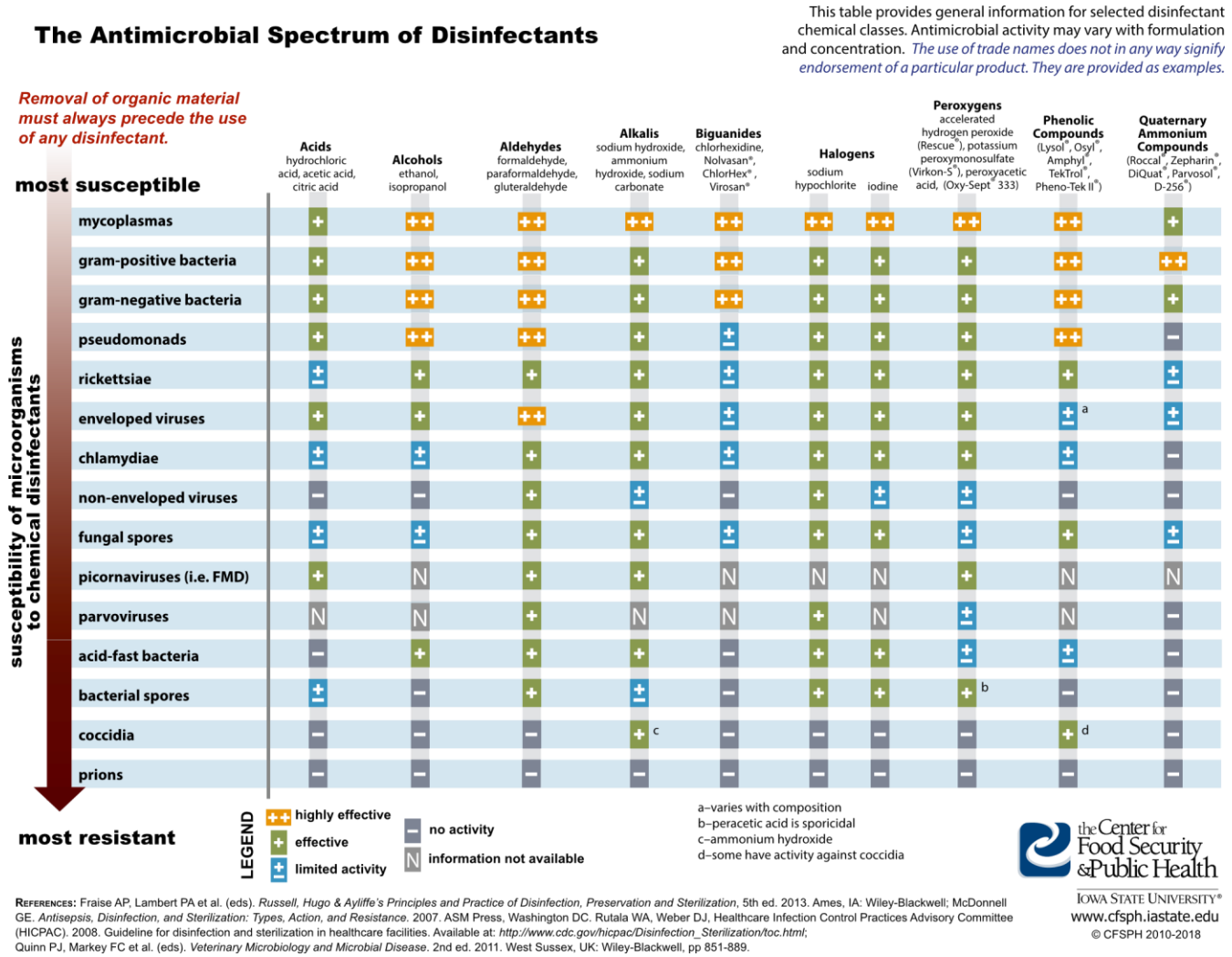

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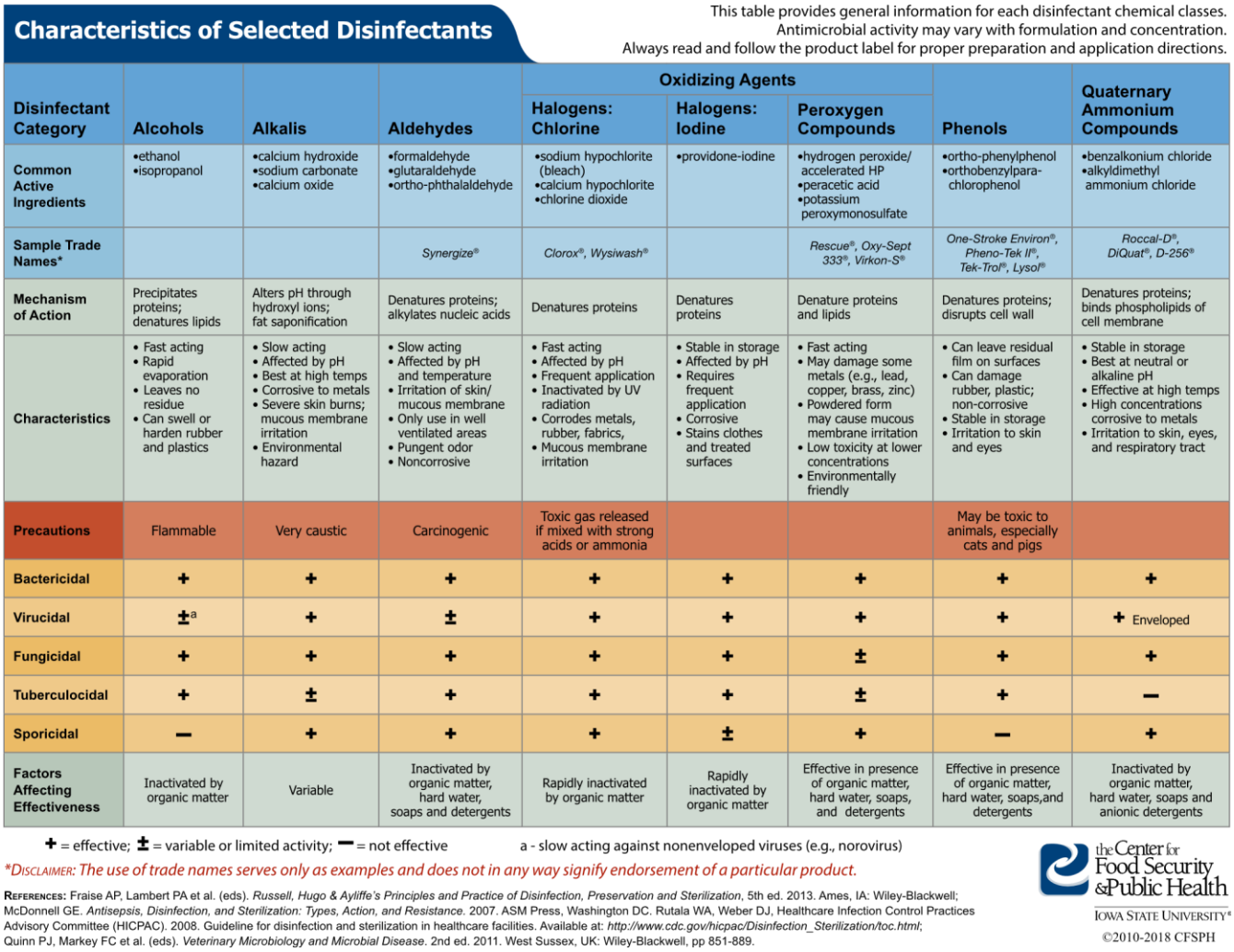
FIGURE 3 Spectrum of selected disinfectants. on the skin, can quickly be applied, minimize skin damage, and are easily and inexpensively made available at any point of care.[24,25] AHS is not effective against bacterial spores (e.g., Clostridium spp.), Cryptosporidium spp., and nonenveloped viruses (e.g., parvovirus). When these pathogens are suspected, washing hands with soap and water is encouraged. Bar soaps should never be used in practices due to risks for microbial contamination and transfer to other personnel. Dispenser-provided liquid or foam soap should be used; if containers will be refilled, they must first be disinfected.

Cleaning and Disinfection

The environment and equipment in veterinary hospitals can serve as important routes of pathogen transmission to patients, owners, and staff.[26,27] Cleaning, and disinfection aim to reduce key pathogens. However, when cleaning and disinfection are improperly performed, pathogens are likely to remain and can result in HAIs.[28–30] Cleaning and disinfection are two separate tasks. Cleaning involves the removal of visible organic matter (e.g., feces, urine, food, dirt) with soap or detergent, whereas disinfection involves the application of a chemical to kill the remaining microbes. Cleaning is essential because organic matter increases the environmental survival of many pathogens and decreases the effectiveness of many disinfectants. Surfaces that are porous (e.g., unsealed wood, concrete, grout) or with poor integrity (e.g., cracks) are difficult to effectively clean and disinfect and should be repaired or replaced.

Disinfection can only be maximally effective if it is preceded by cleaning. Some pathogens (e.g., clostridial spores) are highly resistant to disinfection; therefore, cleaning in these cases is particularly important to mechanically remove the organisms. Disinfectants should be selected based on pathogens of concern, compatibility with materials, and level of risk (Figures 3, 4; Table 11). For instance, a quaternary ammonium compound may be reasonable for routine



Characteristics of Selected Disinfectants

This table provides general information for each disinfectant chemical classes.
Antimicrobial activity may vary with formulation and concentration.
Always read and follow the product label for proper preparation and application directions.

Disinfectant Category	Alcohols	Alkalis	Aldehydes	Oxidizing Agents: Halogens: Chlorine	Oxidizing Agents: Halogens: Iodine	Oxidizing Agents: Peroxygen Compounds	Phenols	Quaternary Ammonium Compounds
Common Active Ingredients	•ethanol •isopropanol	•calcium hydroxide •sodium carbonate •calcium oxide	•formaldehyde •glutaraldehyde •ortho-phthalaldehyde	•sodium hypochlorite (bleach) •calcium hypochlorite •chlorine dioxide	•providone-iodine	•hydrogen peroxide/ accelerated HP •peracetic acid •potassium peroxymonosulfate	•ortho-phenylphenol •orthobenzylpara-chlorophenol	•benzalkonium chloride •alkyldimethyl ammonium chloride
Sample Trade Names*			*Synergize®*	*Clorox®, Wysiwash®*		*Rescue®, Oxy-Sept 333®, Virkon-S®*	*One-Stroke Environ®, Pheno-Tek II®, Tek-Trol®, Lysol®*	*Roccal-D®, DiQuat®, D-256®*
Mechanism of Action	Precipitates proteins; denatures lipids	Alters pH through hydroxyl ions; fat saponification	Denatures proteins; alkylates nucleic acids	Denatures proteins	Denatures proteins	Denature proteins and lipids	Denatures proteins; disrupts cell wall	Denatures proteins; binds phospholipids of cell membrane
Characteristics	• Fast acting • Rapid evaporation • Leaves no residue • Can swell or harden rubber and plastics	• Slow acting • Affected by pH • Best at high temps • Corrosive to metals • Severe skin burns; mucous membrane irritation • Environmental hazard	• Slow acting • Affected by pH and temperature • Irritation of skin/ mucous membrane • Only use in well ventilated areas • Pungent odor • Noncorrosive	• Fast acting • Affected by pH • Frequent application • Inactivated by UV radiation • Corrodes metals, rubber, fabrics, • Mucous membrane irritation	• Stable in storage • Affected by pH • Requires frequent application • Corrosive • Stains clothes and treated surfaces	• Fast acting • May damage some metals (e.g., lead, copper, brass, zinc) • Powdered form may cause mucous membrane irritation • Low toxicity at lower concentrations • Environmentally friendly	• Can leave residual film on surfaces • Can damage rubber, plastic; non-corrosive • Stable in storage • Irritation to skin and eyes	• Stable in storage • Best at neutral or alkaline pH • Effective at high temps • High concentrations corrosive to metals • Irritation to skin, eyes, and respiratory tract
Precautions	Flammable	Very caustic	Carcinogenic	Toxic gas released if mixed with strong acids or ammonia			May be toxic to animals, especially cats and pigs	
Bactericidal	+	+	+	+	+	+	+	+
Virucidal	±[a]	+	±	+	+	+	+	+ Enveloped
Fungicidal	+	+	+	+	+	±	+	+
Tuberculocidal	+	±	+	+	+	±	+	–
Sporicidal	–	+	+	+	±	+	–	+
Factors Affecting Effectiveness	Inactivated by organic matter	Variable	Inactivated by organic matter, hard water, soaps and detergents	Rapidly inactivated by organic matter	Rapidly inactivated by organic matter	Effective in presence of organic matter, hard water, soaps, and detergents	Effective in presence of organic matter, hard water, soaps,and detergents	Inactivated by organic matter, hard water, soaps and anionic detergents

+ = effective; ± = variable or limited activity; – = not effective a - slow acting against nonenveloped viruses (e.g., norovirus)

Disclaimer: The use of trade names serves only as examples and does not in any way signify endorsement of a particular product.

References: Fraise AP, Lambert PA et al. (eds). *Russell, Hugo & Ayliffe's Principles and Practice of Disinfection, Preservation and Sterilization*, 5th ed. 2013. Ames, IA: Wiley-Blackwell; McDonnell GE. *Antisepsis, Disinfection, and Sterilization: Types, Action, and Resistance*. 2007. ASM Press, Washington DC. Rutala WA, Weber DJ, Healthcare Infection Control Practices Advisory Committee (HICPAC). 2008. Guideline for disinfection and sterilization in healthcare facilities. Available at: *http://www.cdc.gov/hicpac/Disinfection_Sterilization/toc.html*; Quinn PJ, Markey FC et al. (eds). *Veterinary Microbiology and Microbial Disease*. 2nd ed. 2011. West Sussex, UK: Wiley-Blackwell, pp 851-889.

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FIGURE 4 Characteristics of selected disinfectants.

disinfection in general animal areas, but a disinfectant with an extended spectrum (e.g., oxidizing agent that also kills nonenveloped viruses) would be indicated in an isolation or critical care area. To be effective and meet expected spectrum of activity, disinfectants must be applied at the correct dilution and for the designated contact time (allotted time required for disinfectant to remain wet on the surface to kill the pathogens of interest; this time is based on the product, concentration, and targeted pathogens, but is generally 5–10 min). If the disinfectant dries before the allotted time, it must be reapplied so that the surface remains wet throughout the contact time. Use of the proper disinfectant concentration is critical from a cost, effect, and safety standpoint. Because disinfectant products can have a range of efficacious concentrations depending on the specific pathogen, the concentration used for disinfecting is pathogen- and situation-dependent.

ICPs should identify surfaces for cleaning and disinfection and establish a desired frequency that can be incorporated into a checklist (Table 13). In general, animal-contact surfaces should be cleaned and disinfected between patients. This includes exam rooms; floors where patients (e.g., large dogs) are examined/treated; and equipment such as thermometers, stethoscopes, bandage scissors, clippers handle and blades, otoscope handle and tips (if reused), monitoring equipment (e.g., Doppler cuffs, electrocardiogram leads), and endotracheal tubes. Surfaces such as lobby floors should be cleaned and disinfected on a regular basis, at least daily; when knowninfectious animals have been in contact with the surface; or

when surfaces are visibly soiled with feces, urine, or body fluids (Table 11). Nonanimal-contact surfaces should not be forgotten (e.g., light switches, door handles, computer keyboards/mice). Enhanced disinfection is important after contact with a suspected or confirmed infectious patient. Efforts will vary with the pathogen(s) suspected, including route of transmission, pathogenicity, persistence, and risk for the practice's patient population. For an examination room, this would include careful attention to cleaning all patient-contact surfaces (including floors as indicated), followed by broad-spectrum disinfection (e.g., oxidizing agent) if more narrow-spectrum disinfectants are used routinely. Because many of the pathogens involved in veterinary HAIs can survive in the environment for an extended period, leaving an area closed for several days is unlikely to prove beneficial.[31] Instead, as indicated by the level of risk, a second round of disinfection may be advisable. There is no evidence that appropriately chosen disinfectants should be routinely rotated to reduce the development of pathogen resistance.[32] In all circumstances, protect involved staff by requiring the use of gloves and eye protection when splashes are likely (e.g., pouring or mixing disinfectants) and ensuring areas are well ventilated.

PPE

PPE should be considered a last line of defense for hazards that cannot be overcome with other preventive measures. Nevertheless, given the inherent risk of exposure to pathogens in veterinary practices, the proper use of PPE is a critical component of an ICPB program. The purpose is to reduce the risk of contamination of clothing, reduce pathogen exposure to skin and mucous membranes of personnel, and reduce transmission of pathogens between patients by personnel. Common examples of PPE include lab coats, scrubs, gloves, gowns, eye protection, facemasks, and shoe covers. The type of PPE used will vary with procedure and suspicion for an infectious disease and its route of transmission (Table 14). Some form of PPE should be worn in all clinical situations, including any contact with animals and their environment, and should not be worn outside of the work environment. Lab coats and scrubs should be laundered at least daily or when contaminated (e.g., contact with an infectious patient). Gloves, gowns, and shoe covers should not be reused, even when attending to the same patient. Correct removal of PPE is critical to limit contamination of clothing and skin and mucous membranes (Table 4). Gloved hands should not be used to contact surfaces that will be touched by nongloved hands, with care taken to avoid contamination of personal items (e.g., telephones, pens). There is limited data on the effectiveness of footbaths and foot mats in infection control.[32,33] Careful use of other approaches (e.g., shoe covers) is reasonable and may have fewer concerns (e.g., maintenance of disinfectant, spills).

Areas for Special Consideration

Disinfection of Physical Rehabilitation Equipment (Underwater Treadmill, Mats, Balls)

Physical rehabilitation equipment poses a unique challenge for infection control, as items for this use are frequently difficult to disinfect (e.g., foam construction, underwater treadmill with chemical-sensitive materials). Patients receiving physical rehabilitation are often at increased risk for shedding or acquiring HAI pathogens (e.g., older with concurrent disease or skin infections, patients with fecal or urinary incontinence, surgical complications including SSIs). Further, some pathogens may be frequently encountered in rehabilitation environments (e.g., MDR Pseudomonas spp.), yet such environments are often overlooked as a source of HAIs.[35,36] Infection control, prevention, and biosecurity for a physical rehabilitation unit should focus on screening of patients, restricting or adjusting use based on risk (e.g., confirmed/suspected infectious disease, recent history of diarrhea), regular cleaning and disinfection of all equipment surfaces, monitoring and adjusting water chemistry for water devices (e.g., appropriate chlorine levels will provide adequate disinfection for healthy patients), and educating the entire practice team for proper technique and the use of PPE. SOPs unique to this environment (e.g., fecal accidents in water devices) should be developed.[37]

Animals Fed a Raw Meat Diet

Raw meat diets have grown in popularity.[38] Pets fed raw foods are a unique source of HAI-associated pathogens in the hospital environment because they may shed organisms (often asymptomatically) that can cause illness in humans or other pets.[39–41] Education of the client is of utmost importance with this population of patients because risk avoidance starts in the home environment with adequate cooking of raw ingredients before the patient reaches the hospital. Patients fed raw meat products within the past 30 days likely pose the greatest risk and may warrant enhanced precautions such as use of PPE with or without isolation. Proper handling of feces and surfaces contaminated by patients fed raw animal diets (e.g., PPE, prompt cleaning and disinfection) is critical.

Multidrug-Resistant Organisms

MDR organisms (e.g., MRSP, methicillin-resistant S aureus, extended spectrum b-lactamase-producing Enterobacteriaceae such

as E coli, enterococci, Salmonella spp., Acinetobacter spp., Pseudomonas spp.) have become increasingly problematic in veterinary medicine. These organisms can be passed directly or indirectly between patients, the environment, and staff, resulting in infections that are challenging to treat.[6] Close attention to hand hygiene, early identification of patients infected or colonized with these organisms, prompt removal of feces, environmental cleaning and disinfection, proper PPE, surveillance, antimicrobial stewardship, and education of clients and the practice team are the keys to minimizing HAIs by these bacteria.[6,42]

Surgery

Surgical site infections are an inherent risk in veterinary medicine and are complicated by the emergence of MDR organisms and the evolution of more invasive procedures and increasing frequency of immunocompromised patients.[43] Examples of risk factors for SSIs are the length and invasiveness of the procedure, perioperative hypotension, the presence of MDR organisms on the patient or environment, a "clean" versus "dirty" procedure, and the presence of an implant.[43] In a recent study of veterinary SSIs, the majority of infections were caused by MRSP, an organism that is not controlled solely by most patient pre- or postsurgical protocols or perioperative prophylaxis with beta-lactam antimicrobials (e.g., cephalosporins).[43] HAIs in surgery can be controlled or prevented through attention to environmental cleaning and disinfection, patient preparation, proper surgical technique, simplified surgical suite design, PPE of surgeons and staff, the use of proper hand preparation techniques, appropriate (drug, dose, frequency) perioperative antimicrobial prophylaxis, and meticulous postoperative wound managment.[6,44] Because of enhanced antibacterial efficacy, rapid action, fewer side effects (e.g., do not cause skin abrasion), lower potential for resistance development, and time savings (generally 3 min rub time), presurgical hand rubbing using alcohol-based formulations is now encouraged over traditional scrubs.[45]

Dentistry

The primary HAI considerations for a veterinary dentistry unit are the heightened risk of aerosolization of infectious particles; contamination of equipment such as wet tables, endotracheal tubes, and drills; and staff education on environmental cleaning and disinfection and PPE.[46] Aerosols (defined as particles ,50 m that have the potential to remain airborne and penetrate the airways and lower lung passages of humans) can transmit pathogens, saliva, blood, and bacteria-laden debris.[46] As pathogens frequently reside in the oral cavity of companion animals and aerosolization of pathogens is possible, zoonotic transmission during veterinary dentistry is a concern.[7,47] Pathogens of recent interest and relevance to veterinary dentistry, such as Pasteurella multocida and Staphylococcus spp., emphasize the importance of proper ICPB practices. Irrigating the oral cavity with a 0.12% chlorhexidine solution before dental scaling has been recommended by some to decrease bacterial aerosolization.[48,49] Dental procedures should be performed in a designated location distant from other procedures, patient housing, and staff so as not to potentiate HAIs via aerosolization. Proper face protection (e.g., goggles/face shield and face mask), gowns, and gloves should be used, and surfaces cleaned and disinfected between patients.[7]

Resuscitation

Considerations for ICPB for cardiopulmonary resuscitation procedures are similar to what are proposed for dentistry. Aerosolization and exposure to direct contact with pathogens are similar risk factors for HAIs and zoonotic transmission to the practice team. Environmental cleaning, separate areas for resuscitation (if possible) to avoid cross-contamination, and the use of PPE during resuscitation are critical, and can be easily overlooked during an emergency.[7] The acute nature of resuscitation emphasizes the need for regular (e.g., quarterly) "practice runs" in order to prepare the veterinary practice team to properly incorporate hand hygiene, PPE, and cleaning and disinfection into resuscitation procedures.

Immunocompromised Patients

Immunocompromised patients include those receiving chemotherapy or other immunosuppressive agents and those with immune-altering comorbidities (e.g., cancer, asplenia), as well as very young and geriatric patients. Proper identification of these individuals is important so that individualized procedures can be developed for each patient. When possible, the use of higher-risk procedures should be avoided (e.g., in-dwelling urinary catheters); when used, additional attention should be placed on protocols that reduce HAI (e.g., Tables 6, 7). In addition, hand hygiene and proper PPE should be strictly enforced.[7]

Obstetrics

Zoonotic risks of exposure to Brucella canis, C burnetii, and other infectious pathogens result from contact with birthing fluids of parturient animals, stillborn fetuses, and infected neonates.[7] Proper PPE includes gloves, waterproof gowns, and facial protection. In some circumstances, respiratory tract protection is necessary (e.g.,

when handling aborted fetuses likely to be infected with C burnetii).[7] It is helpful to know in advance what pathogens are common in a geographic area in order to take appropriate infection control precautions.

Burn Care

Although burn victims are relatively uncommon in veterinary medicine, they present special challenges because the patients in these cases are immunocompromised and have wounds that require invasive techniques. Burns trigger a cascade of necrotic changes in tissue that are directly related to the cause of the injury and temperature of exposure.[50] Precautions for HAIs depend on the depth and severity of burnresulting thermal injury.[50] Infection control, prevention, and biosecurity related to burns focus on wound control and exposure of patient and veterinary practice team members to potential MDR pathogens as well as other HAIs. As appropriate, isolation and wound management including cleaning of the burn site, use of only sterile equipment, and careful attention to hand hygiene with proper PPE are critical for protecting these patients.

Necropsy

Necropsy presents several infection risks for veterinary personnel including personal injury while performing the procedure, exposure to zoonotic pathogens originating from the animal, and environmental contamination with pathogens.[7] Eye protection, respiratory protection, and cut-proof gloves are necessary PPE for necropsy procedures (Table 9).[7] Necropsies should be performed in a location distant from the general hospitalized population and staff. However, if this is not possible, adherence to PPE, removing organic debris, and postprocedural cleaning and disinfection will help minimize HAI risks.

Environmental Procedures

Heating, Ventilation, and Air Conditioning

Consideration of proper heating, ventilation, and air conditioning is critical for practice infection control. Appropriate ventilation is particularly important for reducing airborne diseases, excessive moisture and dust, and chemical fumes from disinfection products that make patients and staff susceptible to infection as a result of damaging their airways. Ventilation should not cause movement of air from areas with known infected patients to other areas of the practice. Spaces where infected patients are held should be vented to the outside. The number of air exchanges per hour (the rate at which the complete volume of air inside a building or room is replaced with fresh outside air) is critical for good ventilation. Recommendations vary between 5 and 8 air exchanges per hour. Whenever possible, three levels of air filtration are recommended in a practice: (1) a wire mesh to remove hair and large matter from the air; (2) a finer (less porous) filter placed within the air ducts to remove dust and other particulate matter; and (3) a high-efficiency particulate air filter to remove viral particles and very fine particulate matter. Highefficiency particulate air filters are expensive, and appropriate replacement of these filters may not be affordable for all practices. Regardless of type, filters must be cleaned or changed frequently to prevent infectious buildup and hair-clogged vents. Ventilation systems need to be inspected regularly and updated as needed.

Rodent and Insect Vectors

Some important veterinary pathogens can be transmitted by wild rodents or insect vectors (e.g., fleas, ticks, mosquitoes, flies). Pest management practices include examination of patients upon arrival for ectoparasites; immediate treatment of patients with fleas, ticks, or mites; and appropriate housing (e.g., isolation) until resolution. Dry pet food and garbage should be stored in metal or thick plastic containers with pest-proof lids. Prompt disposal of food waste and other materials (e.g., feces) that may attract rodents or insects is critical. Sealing potential pest points-of-entry, including maintenance of intact window screens, is important. Elimination of potential rodent nesting and mosquito breeding sites around the practice (e.g., brush, debris, empty food bowls, clogged gutters) prevents onsite pest reproduction. Consultation with a pest control expert is recommended if a particular infestation is present, or for additional guidance and information.

Spills and Waste

Veterinary biomedical waste is a potential source of zoonotic and nonzoonotic pathogens. In the United States, biomedical waste is defined and regulated at both state and municipal levels.[51] Veterinary medical waste includes sharps, tissues (anatomic waste), highly contaminated materials, and deceased animals.

It is beyond the scope of these guidelines to describe spill cleanup and veterinary biomedical waste management in detail. However, basic guidelines are summarized here. Used sharps are considered biomedical waste and should be disposed of in accordance with regulations from municipal and state authorities. Use approved, puncture-resistant sharps disposal containers to remove, store, and dispose of needles and other items capable of causing punctures. Ensure such containers are readily available and used everywhere sharps are handled to prevent sharps injuries to staff and clients. Nonanatomical waste saturated with blood, such as blood-soaked lap sponges and gauze, or materials used to clean up a spill of blood or infectious secretions, are also disposed of as

biomedical waste. Liquid waste such as drained thoracic fluid, abdominal fluid, irrigated solutions, excretions, and secretions may usually be poured carefully down a toilet or drain connected to a sanitary sewer or septic tank. Local, state, and federal regulations may dictate maximum volume of blood or body fluids permitted to be poured into the sanitary sewer. If the fluid is likely to splash or spray during disposal, appropriate PPE should be worn. Waste should be contained in a leak-proof container or bag discarded with the waste (plastic garbage bag). Urine and feces are not biomedical waste, nor is disposable equipment that has come in contact with an infectious animal (e.g., examination gloves, gowns, bandage materials not saturated with blood).

Potentially infectious, contaminated materials may pose a risk to practice personnel, patients, and waste disposal personnel. Precautions should be taken to minimize contamination of the practice environment and the risk to people and animals from potentially infectious waste. These include double-bagging of materials from isolation areas. If the inside of a waste container becomes contaminated, the container should be thoroughly cleaned and disinfected after emptying. All waste from an isolation room should be treated as potentially infectious; trash from these areas should be removed by appropriately gloved and gowned personnel. Contaminated articles should be either discarded or taken for additional cleaning and disinfection. Rural practices, where biomedical waste disposal services may not be available, may be able to make arrangements with a local human hospital or other medical facility to have waste disposed of with human hospital waste.

Laundry

Single-use, disposable items are ideal for infection control, but their disposal produces tremendous waste and an environmental burden. Laundering reusable bedding, gowns, scrubs, towels, and other items is therefore an important component of infectious disease control. Linens and professional garb can serve as fomites, transporting pathogens within the practice and outside the practice into the community. Microbe populations on soiled laundry are significantly reduced by dilution and further by the mechanical action of washing. Hot air drying further eliminates microorganisms. As transport to individuals' homes or other facilities increases ICPB risks, professional garb (e.g., scrubs, lab coats) should be washed onsite or by a specialized commercial laundry facility equipped to clean medical laundry. Practices should have appropriate laundry facilities or laundry services to accommodate cleaning of these items daily or more frequently if necessary. To reduce contamination with infectious organisms and health risks to staff, appropriate PPE (i.e., gloves and dedicated laboratory coat) should be worn by those performing laundry duties. Linens with gross contamination should be assessed to determine if they can be effectively cleaned. If not, they should be properly discarded. Otherwise, gross organic material should be removed prior to washing.

Additional precautions should be taken for laundry from isolation rooms and infected animals. These items should be washed and processed separately from other practice laundry while wearing appropriate PPE to prevent spread of microbes. Items from infected animals should be presoaked in diluted bleach (9 parts water:1 part household bleach) for 10 min to disinfect prior to machine washing. Isolation-room laundry should be washed in hot water with bleach, per manufacturer's instructions. After bleaching and washing, laundry should be completely dried in a separate load from any other laundry and returned to isolation.

Appropriate Antimicrobial Stewardship

The concept of antimicrobial stewardship, or the judicious use of antimicrobials, including when not to use these agents, has emerged in the last decade as a necessary approach across health professions to prevent adverse events and selection for drug-resistant infectious pathogens. The misuse of antimicrobials in human and veterinary healthcare is one of the key factors leading to the current epidemic of antimicrobial resistance. More information on the overall concept of antimicrobial stewardship and how it is applied in veterinary practice as advised by the American Veterinary Medical Association can be found at avma.org/KB/Resources/Reports/Pages/AntimicrobialStewardship-in-Companion-Animal-Practice.aspx. Previously created American Association of Feline Practitioners-AAHA guidelines discuss the judicial therapeutic use of antimicrobials (aaha.org/public_documents/professional/guidelines/aafp_aaha_antimicrobial guidelines.pdf). Information on more longstanding antimicrobial stewardship practices in human hospitals and long-term care facilities in the United States, referenced in the American Veterinary Medical Association document, can be found at cdc.gov/getsmart/healthcare/implementation/core-elements.html.

Personnel Vaccination

Although not always financially viable for all hospitals or staff within a hospital, personnel vaccination is an important component of occupational health and safety. Decisions regarding vaccination of staff should consider the risk of exposure, the severity of disease, whether the disease is treatable, the transmissibility of disease, and the quality and safety of the vaccine. It is recommended that all veterinary personnel who might have contact with animals should be

vaccinated against rabies, except in areas that have been formally declared rabies-free (e.g., Hawaii).[7] This includes lay staff that might have periodic animal contact, such as receptionists. Rabies vaccines for humans are generally considered safe and highly effective. For additional information on human rabies vaccination, see the CDC rabies website (cdc.gov/rabies/exposure/ preexposure.html).

Other vaccinations including tetanus and annual influenza may be appropriate depending on the practice setting and other exposure risks. Additional information is available.[7]

Education, Training, and Compliance

Education and training of the practice team is an integral part to any successful ICPB program. Numerous studies have demonstrated decreases in HAIs after some form of educational or training program was completed.[52–55] A comprehensive training program should include education on basic principles of ICPB, departmental specific protocols, strategies to develop critical and independent thinking to help team members in unexpected patient care situations, and an evaluation of staff compliance through surveillance, testing, and auditing.[56]

The effectiveness of an ICPB program is dependent on not only appropriate training of the practice team, but on the extent to which infection control protocols are accepted by the practice team as necessary and useful.[57,58] Therefore, it is critical that prior to starting the formal education program, the practice team is committed to and passionate about infection control. One strategy to accomplish this is a hospital-wide meeting (or a small-group meeting if training new employees) in which the ICP discusses recent hospital or local disease outbreaks, documented increases in HAIs, or presents current ICPB deficiencies at the practice (e.g., observations of hand hygiene compliance, environmental cleaning deficiencies identified with fluorescent tagging; see the "Implementing an Infection Control Program" section). The ICP should use data uncovered during an assessment/audit of the practice facility to guide this discussion (Table 10).

The formal education program should begin with training all practice team members on the basic principles of ICPB. Topics to cover include modes of transmission of pathogens (discussed earlier in these guidelines), common pathogens that may be encountered in the practice setting, and a demonstration of appropriate hand hygiene and PPE use. Cleaning and disinfection protocols should be covered at this time as well. This training can take the form of an inperson meeting, required reading/online training, or both, depending on the practice setting.

After teaching basic ICPB principles, focused education on departmental-specific protocols and situations should be covered. This is best accomplished by integrating infection control education into routine training on daily duties for the position, supplemented with handouts and checklists covering specific protocols. For example, during phone training for receptionists, there should be discussion of recognizing cases that may present an infection control concern, phone scripts to identify high-risk patients, demonstrating appointment scheduling for a suspected infectious patient, and learning arrival instructions for patients with infectious disease. The team member being trained should be given written material to reference and shown where to easily access any scripts or checklists within the practice.

However, even the most extensive training cannot prepare practice team members for all the possible infection control scenarios they might encounter. Although having protocols for the most common situations is helpful, practice team members must also develop a level of critical and independent thinking about infection control so that they can make sound clinical decisions when encountering a more complex or unexpected situation. Simulations of these situations has been theorized to improve outcomes in the human medical field.[58,59] Although the resources of a typical veterinary practice do not allow for the often-extensive simulated training that occurs in human hospitals, simulating infection control scenarios in the practice setting can be an invaluable tool. The ICP's creativity is a key factor in the infection control component of the training program, and this type of training can be accomplished without excessive time or expense. The use of fluorescent tagging or simulated patients (stuffed animals or staff pets) can be helpful in staging a mock infection outbreak. Infection control drills can be staged during downtime in the practice. Receptionists can receive a call from a mock client that challenges their history-taking and decision-making process.

A method for evaluating compliance with the practice's training program is needed to ensure the training has been successful, and a formal performance feedback program can also further improve outcomes.[53] Written testing of basic ICPB knowledge and departmental-specific protocols should be performed at the end of each training period and periodically thereafter to assess retention of knowledge. Routine surveillance data should be used to monitor for any breaches or noncompliance with the ICPB program. Regular reporting of this data can provide feedback to staff members. Simulated, real-world scenarios can also be useful in assessing the practice team's knowledge of infection control and can be used to monitor compliance with the program. These tools for evaluating and assessing compliance should be applied in a positive,

nonpunitive way to help motivate staff to consistently and effectively implement the practice's program and appreciate the importance of each person's actions in HAI prevention and overall ICPB success.

Client Education

Although veterinary staff work to prevent the spread of pathogens and disease within their facilities, it is imperative that clients are also sufficiently educated regarding the key role they have in ICPB in the community and their home environment. Educating clients on the importance of regular visits to their veterinarian and appropriate preventive measures, such as vaccination, endo- and ectoparasite control, and good overall health of their pets, is the best way to prevent the spread of disease.

In addition to general infectious disease education, clients should be informed on zoonotic risks relevant to their pets, themselves, and family members. Key pathogens to highlight for clients include but are not limited to common endoparasites (e.g., hookworms, roundworms, tapeworms), dermatophytosis, toxoplasmosis, geographically relevant ectoparasite-transmitted diseases, rabies, Salmonella, and Campylobacter spp.[60] Some diseases, although not transmitted directly from the pet to humans, still demand appropriate control methods such as avoiding exposure to vector-borne diseases via shared contact with the pet or its environment. For example, fleas are easily transferred between animals and humans. Environmental or on-animal infestations, particularly in homes with young children, carry a risk of zoonosis for flea-borne diseases, such as Bartonella infection. Although there is not a direct zoonotic risk from ticks attached to a pet, they should be disposed of carefully when removed, and owners of these pets should take caution of similar risks to themselves and others in the household due to encountering ticks in the same environments as their pet.[61]

It is possible to reduce the spread of zoonotic diseases with appropriate preventive care including routine veterinary visits for annual exams, vaccinations, overall health assessment, as well as flea and tick control as indicated by their area. Fecal exams for detection of intestinal parasites should be performed as indicated by the patient age, geographical location, and parasite exposure risk.

Further owner considerations in preventing zoonotic diseases include the practice of good personal hygiene, particularly hand hygiene after handling pets; handling pet food and treats, especially when it includes an uncooked meat product; and always before eating. Litter boxes, pet dishes, pet beds, and toys should be kept clean. Cat litter boxes should be cleaned regularly (daily if higherrisk persons are in the household). In the case of households with dogs, cleaning up pet feces should be done regularly (e.g., at least weekly) to reduce environmental contamination with pathogens. Feces should be disposed of in a waste receptacle, not in recyclable waste or compost. Additional pet "messes" (vomitus, stool, and urine) should be cleaned up, disposed of accordingly, and surfaces disinfected. Hands should be thoroughly washed afterward; gloves can be used to provide an extra level of protection. Pets should be fed a high-quality diet, avoiding raw or undercooked diets. Hunting for food sources, including garbage or table scraps, should also be discouraged. Additional pet behaviors that can pose increased zoonotic disease risks and should be discouraged are drinking from the toilet, eating feces (own or of other animals), and drinking standing water.

Pets should not be permitted to have contact with wild animals. Owners of pets likely to have contact with wild animals (e.g., predominately outdoor, hunting) should be informed of these increased risks and, when possible, preventive measures taken to reduce pet and owner health risks (e.g., endo- or ectoparasite prevention, rabies vaccination, preventing consumption of wildlife). Potentially contaminated environments or situations in which exposure risks are unknown, including interactions with animals with unknown vaccination or parasite status, should be avoided. Additional suggestions for prevention of infection include regular pet grooming and bathing, maintaining short nails to prevent scratches, and spaying and neutering to prevent roaming, which can increase risk of disease exposure and transmission.[60]

Immunocompromised people have an increased risk of acquiring zoonotic diseases, including those transmitted by pets. Those individuals who are ,5 or .65 yr of age; pregnant; diabetic; have HIV-infection; are undergoing immunosuppressive chemotherapy, organ transplantation, or treatment for autoimmune diseases; or have other conditions for which their physician has indicated that they are at an increased risk for infections should take greater caution.[62] Immunocompromised clients should be advised of modifiable behaviors that reduce their risk for pet-associated infections, with particular emphasis on always performing hand hygiene after pet contact, discouraging pets from face-licking, and not having contact with pet feces (i.e., ideally have an immunocompetent household member perform this duty). Regular cleaning and disinfection of cages, food areas, bedding, and toys should be performed by an immunocompetent individual who observes strict hand hygiene. Immunocompromised people should avoid contact with amphibians, reptiles, rodents, exotic animals, strays, young animals, and any animal suspected to be infectious (e.g., with acute vomiting, diarrhea, skin disease), as well as items that have been in contact with these animals.

A key to infection control success in the household and community is client compliance with risk reduction strategies. This requires active involvement and cooperation of the clinical team and the client. Clients should be provided with handouts in addition to face-to-face counseling on prevalent local infectious diseases of importance. Pet owners can also be directed to online resources such as the Companion Animal Parasite Council (capcvet.org/capcrecommendations), the CDC′s Healthy Pets Healthy People (cdc. gov/healthypets), Worms and Germs Blog′s resources for pets (wormsandgermsblog.com), the DVM360′s handout on parasites (veterinarybusiness.dvm360.com/forms-parasitology-handouts), and aaha.org/biosecurity.

Summary

Without effective ICPB practices implemented in the primary care and referral settings, the clinician′s efforts at disease prevention and treatment are compromised and, in some cases, nullified. Because many pathogens in the hospital environment have zoonotic potential, barriers to human exposure to animal pathogens in a clinical setting also serve to safeguard public health. Taken together, the consequences of ICPB have profound implications for clinical practice and should be of high priority. Stated another way, the veterinarian′s best efforts can be negated if faulty ICPB results in exposure of the staff or patient to infectious pathogens.

The methodology of ICPB is largely procedural, meaning that it is based on protocols and SOPs that apply to the entire healthcare team. To adapt to changing circumstances at the local level, including staff turnover, these processes should be regularly revisited, followed by revision as needed, with refresher trainings for the entire healthcare team. Patient and staff flow, hand hygiene, cleaning and disinfection, and PPE serve as the foundation for ICPB practices and should be addressed in all practice programs.

Effective ICPB is based on control methods that form a hierarchy of effectiveness. Prevention (elimination) of microbial contamination by removal or denying access to general patient areas of the premises by high-risk patients (i.e., those considered likely to be infectious) is the most effective method of ICPB control, followed in declining order of efficacy by hospital design to mitigate exposure, administrative controls, and use of PPE.

Various situations in clinical practice require different approaches to ICPB to avoid contaminating the premises or exposing the patient or staff to opportunistic infectious agents. These specialized circumstances include surgery, dentistry, resuscitation, management of immunocompromised patients, admission of patients with infectious disease, obstetrics, burn care, rehabilitation areas, and handling of postmortem tissues and patients, including necropsy. In such cases, exposure to pathogens may be increased because of the nature of the procedure, through the generation of aerosols, direct contact with infected tissues, and contact with fomites. Additionally, surgical or trauma sites may place patients at increased risk of exposure to microbes.

In many veterinary practices, the clinical staff may not be formally trained in ICPB, and the various ICPB protocols may seem daunting to implement. However, these factors should not deter veterinarians from implementing a comprehensive ICPB program. Rather, the process of developing and systematically employing ICPB protocols can be done incrementally, building on and strengthening ICPB methods already in use. Improvements in a practice′s compliance with ICPB practices and reductions in related risks, ideally catalogued by the ICP dedicated to monitoring program success, will reinforce the tangible value of ICPB observed by the healthcare team. Managing ICPB requires focus and dedication of the entire staff, including education, training, and monitoring of the entire healthcare team to ensure comprehension, proficiency, and compliance with best practices. These efforts are enabled by the use of situation-specific protocols and procedures for ICPB, and by client education to inform pet owners of the importance of home care to avoid exposure of the patient and owner to infectious pathogens.

With the increasing complexity of care including the use of oncolytic agents, surgical implants, and the increase of MDR organisms, it is now paramount that the modern veterinary practice develop infection prevention and control protocols. For those practices with few or no infection control protocols, they should be heartened and encouraged to take small steps. As ICPB steps become prioritized, veterinary practice owners and employees will realize additional direct health benefits to patients, staff, and clients as well as indirect financial, social, and environmental positive impacts.

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