Infection Prevention and Control Best Practices

For Small Animal Veterinary Clinics

Dear veterinary staff member,

We are conducting a brief online survey to understand your current infection control practices and your motivation for seeking out these guidelines. Participation in the survey is strictly voluntary. You may exit the survey at any time, and you may skip any questions you wish. All responses are anonymous

This survey should only take approximately 2-3 minutes to complete. We would greatly appreciate your feedback.

Click this link to start the survey:

https://uoguelph.eu.qualtrics.com/jfe/form/SV_6DbIPOk3dZnLbQ9

Special Procedures

Surgery

All surgical procedures cause breaks in the normal defensive barriers of the skin or mucous membranes. These breaks are accompanied by an inherent risk of surgical site infection (SSI). Surgical site infections can occur sporadically or as part of an outbreak, and can have devastating outcomes in some situations. A variety of pre-, intra- and post-operative factors can influence SSI risk, and prevention of SSIs involves use of a range of measures. Good general infection control practices (e.g. hand hygiene, cleaning and disinfection) are important for prevention of SSIs. Specific measures pertaining to surgery include maintenance of the surgical environment, use of appropriate personal protective equipment and hand hygiene, disinfection and sterilization of anesthetic equipment and surgical instruments, appropriate use of perioperative antimicrobials, and surgical site care before, during and after the procedure. Many of the recommendations below are already considered minimum practice standards in various jurisdictions, but actual requirements may vary. Veterinarians should contact their veterinary regulatory authority for details about the specific regulations in their area.

Risk factors for the development of SSIs in veterinary surgery include surgery classification (clean vs. dirty), duration of surgery and aesthesia, patient characteristics, and other pre-, intra-, and post-operative factors (Verwilghen & Singh 2015). Not all of these factors are modifiable but it is nonetheless important to take all reasonable precautions to reduce the risk of SSI development in veterinary patients.

Surgical environment and suite design

Having a well-designed and maintained surgical area or suite is very important. In order to keep the surgical environment as clean as possible, this area should be separated from personnel and animal traffic, and all surfaces should be easy to thoroughly clean and disinfect. **A surgical suite should only be used for one surgical procedure at a time** and should not be used for non-surgical procedures between surgeries. The surgical suite should be designed so that the procedure can be efficiently performed and personnel can effectively work and move around in the room without compromising the sterile field. Entrance to the area should be restricted at all times to minimize traffic in the room. The number of people in the surgical area has been identified as a risk factor for SSI in small animals, so only essential personnel should be allowed in the area during any surgical procedure. All personnel participating in the procedure, including those performing surgical nursing duties, must be trained in operating room procedures.

Surgical suites should be dedicated rooms that are fully enclosed with walls running to the ceilings and no outer windows. Sinks should not be present in the surgical suite. In contrast to human hospitals, some veterinary hospitals have multiple surgical tables in operating rooms. This arrangement raises concern about cross contamination, as well as potential risks posed by the greater number of people in the room and more frequent movement in and out of the room. Performing more than one surgical procedure at a time in the same operating room should be discouraged, especially procedures that might be associated with aerosolization of bacteria (e.g. dental procedures).

Air handling

Air movement within an operating room should be organized, predictable and consistent, to maintain the principle of clean-to-dirty air movement. Standards recommended for human hospitals are not commonly achieved in veterinary hospitals but they should be considered a standard to strive for in any newly designed facility. These include:

- positive pressure ventilation (positive pressure in the operating room with respect to adjacent rooms and corridors).
- minimum of 15 air exchanges per hour (at least 3 of which should be fresh air).
- use of appropriate air filters.
- introduction of air at ceiling level with exhaust near the floor.
- operating room doors must never be propped open.
- ventilation of operating room at all times.

Basic aspects such as the level of air introduction and exhaust should be provided for all operating rooms. Window air conditioners, windows with drafts, incompletely enclosed rooms and similar issues that disrupt organized airflow are inadvisable.

The clinical efficacy of ultraclean air rooms, air filtration or treatment, laminar airflow technology, ultraviolet light treatment of air, and other methods such as disinfectant misting or fogging are not currently recommended for routine use as there is insufficient clinical evidence of their effectiveness.

Stocking the surgical suite

Commonly used surgical supplies should be stored within the operating room or in an adjacent room in a manner that prevents contamination by direct contact or aerosols (e.g. in a closed cabinet). If they are not stored in the operating room, items required for a particular procedure should be transported to the operating room immediately before the procedure. These items should be transported on a covered cart or in a case with the cover that can be removed once the items are delivered. Non-surgical items should not be stored in the operating room in order to minimize traffic in the room.

Surgeon preparation areas

Surgical personnel must be able to perform hand antisepsis in close proximity to, but not within, the operating room, to prevent droplet and aerosol contamination of the environment generated during scrubbing with soap and water or other preparation activities. The use of an alcohol-based surgical hand rub (ASHR) significantly reduces this contamination risk (see preoperative hand antisepsis section below for more information on ASHRs). ASHRs are also highly beneficial in clinics without the necessary infrastructure (e.g. physical layout and sinks) to perform soap and water scrub effectively in proximity to the surgical suite. If veterinarians prefer a soap and water hand scrub, sinks should be located away from areas of heavy traffic, areas where patients are housed or prepared for surgery, and open shelving where sterile supplies are stored. Scrub sinks should be designed so that all required supplies are readily accessible and the operating room can be entered without risk of hand contamination.

Surgical waste

Be sure to follow all local regulations pertaining to biomedical waste (see Chapter: Laundry and Waste Management). While the risk of zoonotic infection from blood or tissues from companion animals is relatively low, nonetheless all blood or tissue contaminated items must be managed as potentially biohazardous.

Personnel considerations

Preoperative hand antisepsis

Alcohol-based surgical hand rubs (ASHRs): ASHRs are now the recommended method for surgical hand antisepsis in human medicine (Pittet 2009), but are less common in veterinary clinics. These products have a rapid-kill effect due to their high alcohol content. ASHRs take less time to apply, are less irritating to the skin (particularly with repeated use), and have been shown to be as effective as soap-and-water scrubs for reducing bacterial flora on the hands, when correctly applied (Widmer 2010). It is not necessary for ASHR to contain additional active ingredients, such as chlorhexidine gluconate (CHG) or ortho-phenylphenol, as these products do not enhance the efficacy or residual activity of the product (Kampf 2017). Hand washing with a neutral soap is recommended prior to the first use of an ASHR on a given day, and anytime hands are visibly or likely soiled (e.g. after handling a patient between procedures). Hands must be completely dry before application of the ASHR. Always follow the manufacturer's directions regarding the amount of ASHR product to use and application technique. General guidelines for use of an ASHR are as follows (WHO 2009):

- Remove all hand and arm jewelry, including rings, bracelets and watches.
- Use a pick or file to clean all dirt out from underneath the fingernails.
- If hands or arms are visibly dirty, initially wash with soap and water as per regular hand hygiene protocols.
  - Ensure hands and arms are dry before applying ASHR.
- Use approximately 15ml of product to ensure that hands remain wet throughout the procedure.

- Dispense product into one palm using the elbow of the opposite arm, or a foot pump if available.
- Rub fingertips into solution for at least 5 seconds to clean under the nails.
- Rub product onto the forearm up to the elbow until skin is dry.
- Repeat for opposite arm.
- Dispense additional product into one hand and then rub both hands together until dry, ensuring all surfaces of the hand are covered, including palms, backs of hands, between fingers, back of fingers, and base of thumbs.
- Entire procedure should take approximately 1.5-2 minutes.

Soap-and-water surgical hand scrub: A surgical hand scrub should be performed before donning a sterile gown and sterile gloves. Various surgical scrub techniques have been described (WHO 2016). Most commonly, a structured five-minute surgical scrub with antibacterial soap is used. There is no indication that there is any benefit to a scrub lasting longer than five minutes, and scrubbing for longer than necessary can cause damage to the skin and increase discomfort and the risk of skin infection. Always use warm water, as hot water is irritating to the skin (WHO 2009).

An example of a standard soap-and-water surgical scrub is as follows; further details can be found in currently available veterinary surgery textbooks (Fossum 2013 Johnston & Tobias 2018):

- Remove all hand and arm jewelry, including rings, bracelets and watches.
- Use a pick or file to clean all dirt out from underneath the fingernails.
- If hands or arms are visibly dirty, initially wash with soap and water as per regular hand hygiene protocols.
- Lather both hands and forearms with antibacterial soap.
- Using a soft bristled brush, scrub fingers, palms, back of hands, wrists and forearms to just below the elbows from distal to proximal (i.e. cleanest to dirtiest), alternating from left to right for each part. Pay special attention to fingertips, nail beds, and finger/thumb webs.
- Thoroughly rinse off all soap with clean running water, while keeping the hands above the elbows to ensure all water runs off at the elbows and not the fingers.
- Use a sterile towel to dry the hands and arms completely, proceeding from distal to proximal (i.e. fingers to elbows), before donning a gown and gloves.

The most commonly used soaps for surgical hand scrubs contain either CHG or povidone-iodine (PI). CHG soap has been shown to be more effective for reducing bacterial counts on the hands than PI soap in some studies (Tanner 2008), although there are more concerns about skin irritation from use of CHG versus PI.

Scrubs worn in surgery should not be worn when handling or treating other patients, and at a minimum should be covered with a lab coat when outside the surgery area.

Personal protective equipment

All personnel in the surgical area should wear designated surgical scrubs, a surgery cap or hair bonnet, and a nose-and-mouth mask when surgery is underway, regardless of whether or not they are directly involved in the procedure itself. Scrubs worn in surgery should not be worn when handling or treating other patients, and at a minimum should be covered with a lab coat when outside the surgery area (see Chapter: Personal Protective Equipment). Personnel directly involved in the procedure should also wear a sterile gown and sterile gloves. It is important to follow appropriate surgical gowning and gloving techniques that prevent contamination of any part of the gown or gloves that may come in direct contact with patient's tissues or any part of the sterile surgical field or instruments. Common methods are briefly described here; further details can be found in currently available veterinary surgery textbooks (Fossum 2013, Johnston & Tobias 2018).

Gowning technique:

- Have the folded gown set out on a sterile surface within the surgical suite
- Hands should only come in contact with interior surfaces of the gown; be familiar with how the gown is folded in order to avoid accidental contamination of the outer surfaces
- Grasp the gown and lift it away from the table to provide adequate room for gowning
- Allow the gown to unfold without shaking it, in order to decreases the risk of contamination of the gown or disturbing dust particles in the room
- Slide arms through arm holes, keeping hands inside the cuffs of the gown
- Have the neck ties secured by an assistant. Only secure front ties (if necessary) after donning sterile gloves, with or without assistance depending on the style of gown.

Glove donning techniques:

- Closed gloving (can only be performed after donning a sterile surgical gown)(for a demonstration video see PennVet 2013)
  - With hands still within the cuff of the surgical gown, pick up one glove and place it with thumbs and fingers pointing toward the elbow, palm side down, on the corresponding palm
  - Grasp the cuff on the underside of the glove with the thumb and index finger of the hand to be gloved (through the cuff of the gown), while using the free hand to grasp the cuff on the other side of the glove
  - Use the free hand to pull the cuff of the glove over the opposite hand and the cuff of the gown, while pushing the hand up into the glove. Ensure that the glove covers the entire cuff of the gown when complete.
  - Repeat with other hand. Ensure that the already gloved hand does not come in direct contact with the cuff of the gown of the opposite hand.
- Open gloving (can be used for non-surgical procedures that require sterile gloves but not a sterile gown, or for replacing a contaminated glove during surgery) (for illustrated instructions see Alberta Health Services 2016)
  - Pick up one glove by the inside surface of the folded cuff and pull over the opposite hand until fingers are in the fingers of the glove
  - Hook the folded cuff of the glove over the thumb by anchoring thumb inside near the thumb of the glove
  - Repeat with other hand.
  - Place the gloved fingers of one hand under the edge of the cuff of the glove and pull it down around the wrist, while pushing the fingers the rest of the way into the glove. If necessary, then grasp the thumb of the glove from the outside to allow the thumb on the inside to be repositioned in the thumb opening. The outside surface of one glove should only ever touch the outside surface of the opposite glove.
  - Repeat with other hand.
  - Ensure that the entire cuff of the surgical gown if covered by the cuff of the glove, if applicable
- Assisted Gloving
  - Have a sterile assistant pick up the glove under the cuffs
  - As they hold it open with the thumb of the glove facing the surgeon, push hand into glove
  - Have the assistant gently release the glove cuff such that the cuff of the gown is completely covered
  - Repeat with other hand

Foot covers (booties) are not required if footwear is clean. However, dedicated clean surgical footwear is ideal to minimize contamination of the surgical environment. All footwear must be closed-toed.

Glove perforation: Glove punctures during surgery are common, especially during procedures lasting an hour or more, and often go unnoticed (Verwilghen & Singh 2015). Although the resulting risk of SSI in veterinary patients is unclear, glove perforation has been associated with increased risk of SSI in human patients (Verwilghen & Singh 2015). **Glove use, therefore, does not negate the need for proper preoperative hand antisepsis.** Double gloving can be used to provide an additional layer of protection.

While double gloving does not decrease the overall incidence of glove perforation, punctures of both the inner and outer layers are less common. Double gloving can also be used to reduce contamination of the surgical field due to accidental

contamination of gloves during patient draping and the initial incision, by removing the outer gloves after these steps. This method is often advocated for procedures that have a higher risk of SSI, such as orthopedic surgery involving implants (Verwilghen & Singh 2015).

If glove perforation is identified, gloves should be changed immediately unless the short delay required would result in surgical complications. When double gloves are used, the inner glove must be carefully inspected following removal of the outer glove to ensure that there was not perforation of both gloves. The outer glove can then be replaced if warranted.

Equipment considerations

Sterilization of instruments

Complete sterilization of surgical instruments and any other items that might come in contact with the surgical field is critical to preventing SSIs. Poor sterilization or inappropriate handling of instruments after sterilization can result in contamination of sterile tissues during surgery. Outer indicator tape and inner indicator strips should be checked as soon as a surgical pack is opened, prior to use. If there is any indication of failed sterilization, use a new pack and investigate autoclave function. Biological indicators are also important quality control measures. Inner indicator strips and biological indicators should be routinely used to keep record of autoclave function.

Immediate-use steam sterilization (i.e. "flash" sterilization) is a rapid sterilization method performed on unwrapped items. It is designed for rare situations where there is an immediate need for sterilization, such as when a critical instrument is dropped during surgery and there is no replacement. This method should **never** be used for surgical implants. It should also not be used in lieu of proper surgical planning or purchase of adequate numbers of instruments (PHO 2013).

(see Chapter: Cleaning, Disinfection, Sterilization for more information regarding sterilization techniques)

Disinfection of anesthetic equipment

Endotracheal tubes: In human medicine, endotracheal (ET) tubes are typically considered single-use devices, but reuse of ET tubes has become more common with the rising costs of healthcare. These tubes are considered semi-critical equipment, and as such should be subjected to high-level disinfection or sterilization between patients. They can be effectively sterilized using glutaraldehyde or ethylene oxide gas, although the physical integrity of the cuffs in particular can be compromised by repeated sterilization with these methods. In veterinary medicine, it is impractical to discard ET tubes after a single use, but chemical sterilization may not be readily available. Evidence-based guidelines for reuse of ET tubes in veterinary medicine are not available. Nonetheless, **at an absolute minimum,** ET tubes must be thoroughly cleaned (inside and outside) with hot water and detergent immediately after use to prevent any discharge or debris from drying and forming a biofilm on the device. Tubes should then be soaked in a solution of accelerated hydrogen peroxide (AHP) or CHG for at least 5 minutes, rinsed thoroughly and dried prior to being reused (Crawford & Weese 2015). It is important to test the integrity of the cuff before every use to ensure the device has not been compromised by repeated cleaning and disinfection.

Anesthetic gas tubing and rebreathing bags: Although the tubing connecting the anesthetic machine to the patient's endotracheal tube should not come in direct contact with the patient, moisture and condensation often accumulate in the tubes and may contain microorganisms from the animal's airway. In human medicine, this equipment is also typically single-use. As for ET tubes, evidence-based guidelines for reuse of this equipment in veterinary medicine are not available. **At a minimum,** gas tubing should routinely be thoroughly washed with hot water and detergent and hung to dry at the end of the day's procedures, or more often if they are heavily used. If there is visible discharge in the tubing, or if the animal has a known or suspected respiratory tract infection, the tubing should be thoroughly cleaned with hot water and detergent, soaked in a solution of AHP or CHG, rinsed with water and dried prior to being reused. The corrugations should be routinely checked for accumulation of debris or mold. Rebreathing bags should be cleaned and disinfected as for the associated gas tubing, as they also come in contact with the expired air from the patient.

If an animal has a known or suspected transmissible respiratory tract infection, filters are available which can be placed between the ET tube and the rest of the anesthetic circuit in order to help protect the equipment from contamination.

Perioperative antimicrobials

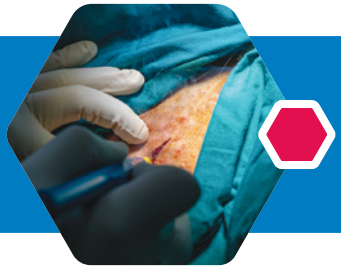
Administration of perioperative (i.e. before, during and after surgery) antimicrobials is an important and complex issue. The goal of perioperative antimicrobial therapy is to reduce the risk of postoperative infection, while minimizing the negative impact on the patient's natural microbiota and the risk of antimicrobial-associated complications such as diarrhea, and the emergence of antimicrobial resistant bacteria. Surgical site management and infection prevention protocols are important tools to help reduce the need for perioperative antimicrobial use (see Chapter: Antimicrobial Stewardship for more information and resources).

There is currently little objective information about the need for antimicrobials for specific veterinary procedures, as well as the optimal choice of drug(s), timing and dosages. **Antimicrobials are indicated in many clean-contaminated, contaminated and dirty procedures.** Descriptions and examples of surgical wound classifications can be found in Table 1 below. Antimicrobial prophylaxis for clean procedures is generally considered unnecessary, but is still relatively common in veterinary medicine. In human medicine, antimicrobials are not typically recommended for clean procedures (e.g. arthroscopy). Regardless, it is unclear whether recommendations from human medicine should be directly extrapolated to veterinary procedures, because there are obvious differences in post-operative incision care and patient environment for animals, which may increase the risk of infection. It has become common practice in veterinary medicine to use antimicrobials for elective orthopedic surgeries such as tibial plateau leveling osteotomy (TPLO) or hip replacement, despite their designation as clean procedures. This is due to the high rates of SSIs associated with these procedures, the potentially catastrophic consequences of such infections, along with data indicating a protective effect of antimicrobials for TPLO (Verwilghen & Singh 2015). Concerns with this practice include inappropriate timing of administration (e.g. too far in advance of surgery or starting after surgery), excessive duration of therapy, inadequate dosing and inappropriate drug choice.

TABLE 1. Surgical wound classifications (adapted from Fossum 2013, Johnston & Tobias 2018, WHO 2018)

Classification	Description	Examples
Clean	Non-traumatic, non-inflamed operative wounds in which the respiratory, gastrointestinal, genitourinary, and oropharyngeal tracts are not entered	Exploratory laparotomy Elective neuter Total hip replacement
Clean-contaminated	Operative wounds in which the respiratory, gastrointestinal, or genitourinary tract is entered under controlled conditions without contamination; an otherwise clean wound in which a drain is placed	Cholecystectomy Small intestinal resection Soft palate resection
Contaminated	Open, fresh, accidental wounds; procedures in which gastrointestinal contents or urine is spilled or a major break in aseptic technique occurs	Open cardiac massage Cystotomy with spillage of infected urine Lacerations
Dirty	Old traumatic wounds with purulent discharge, devitalized tissue or foreign bodies; procedures in which a viscus is perforated or fecal contamination occurs	Excision or drainage of an abscess Peritonitis Perforated intestinal tract

When antimicrobials are used, therapeutic drug levels should be present throughout the *period of risk*. This starts at the time of initial incision and continues until the end the procedure, or a short time thereafter.



If perioperative antimicrobials are used every effort should be made to ensure that such use is as effective and evidence-based as possible. A key concept of peri-operative antimicrobial prophylaxis is that, when antimicrobials are used, therapeutic drug levels should be present throughout the *period of risk.* This starts at the time of initial incision and continues until the end the procedure, or a short time thereafter, since a fully functional barrier is not necessarily immediately achieved with incision closure. This typically requires parenteral administration of an antimicrobial within one hour of the first incision. If the surgical time is longer than two half-lives of the drug(s), then intraoperative redosing is indicated. In human medicine, it has been shown that starting antimicrobial therapy after surgery is no more effective than not using antimicrobials at all (Bratzler & Houck 2005).

The antimicrobial(s) selected for perioperative use should be appropriate for the patient, procedure, and expected opportunistic pathogens. Table 2 lists some of the most commonly used perioperative antimicrobials. It should be noted that for the vast majority of procedures cefazolin, cefoxitin, clindamycin, and ampicillin are likely appropriate. When administering perioperative antimicrobials parenteral routes are preferred, and oral administration is not recommended.

TABLE 2. Commonly used perioperative antimicrobials for small animal surgical procedures

Drug Name	Dosage	Half Life	Comments
Most Commonly Used			
Cefazolin	22mg/kg; q8-12hr IV, IM, SC	1hr	1st generation cephalosporin Gram-positive bacteria (e.g. *Staphylococcus, Streptococcus)* Some gram-negative (e.g. *Pasteurella, E. coli),* although resistance is common
Cefoxitin	Dogs: 30mg/kg; q12hr; IV Cats: 22-33mg/kg; q8hr; IV, IM	45-60min	2nd Generation Cephalosporin Anaerobes and gram-negative bacilli
Clindamycin	Dogs: 11mg/kg; q8-12hr; SC, IV Cats: 5-33mg/kg; q12-24hr; oral, SC	4-4.5hr (5.5mg/kg) 7-10hr (11mg/kg)	Gram-positive and anaerobic bacteria Often used for dental procedures in patients with periodontal disease
Ampicillin	10-20mg/kg; q6-8hr; IV, IM or SC	1-1.5hr	Gram-positive cocci and bacilli (e.g. streptococci, non-beta lactamase producing staphylococci) Many gram-negative bacteria are resistant
Less Common			
Metronidazole	10-12mg/kg; q8hr; IV	4-5hr	Anaerobic bacteria Dilute and give slowly over 20min if using IV
Gentamicin	Dogs: 4.4-6.6mg/kg; q24hr; IV, SC, or IM Cats: 5-8mg/kg; q24hr; IV, SC or IM	1-2hr	Gram-negative bacteria Doses for dogs up to 9-14mg/kg may be given to septicemia patients, if renal function is closely monitored
Amikacin	Dogs: 15-30mg/kg; q24hr; IV, IM or SC Cats: 10-14mg/kg; q24hr; IV, IM, or SC	1-2hr	Gram-negative bacteria, often used for serious infections Activity against some resistant bacterial strains

Typically, antimicrobials are not needed after surgery because the highest-risk time for contamination of the surgical site (i.e. during the surgery itself) is already passed. Recommendations in human medicine typically suggest cessation of antimicrobials within 24 hours postoperatively (Bratzler 2013). There is some evidence for use of antimicrobials post operatively for TPLO patients however, the optimal duration is not known. It is likely that there is little additional benefit after 48 hours of post-operative antimicrobials. More research is required to identify the ideal length of time for antimicrobial therapy after this and other similar procedures (Verwilghen & Singh 2015).

Surgical site management

Preoperative care

Preoperative management of the surgical site is very important, but there has been very little research in this area in veterinary medicine. The goal of preoperative surgical site management is to eliminate potential pathogens without creating a physical environment that may increase bacterial colonization or infection post-operatively. Maintaining a healthy skin barrier is critical. Preparation methods that damage the skin, such as excessive clipping, shaving or excessive scrubbing, must be avoided. Techniques for preoperative surgical site preparation and hand antisepsis tend to vary between clinics, and inappropriate practices, including short contact times and choice of preparation agents, are common (Anderson 2013). As such, veterinary personnel involved with patient preparation should be properly trained and educated to avoid unnecessary surgical site contamination.

Management of the patient's systemic condition (e.g. normothermia, glucose control, oxygenation, total anesthesia time) also play a role in prevention of SSIs, although these factors have not yet been closely examined in veterinary medicine.

If the patient's hair coat is visibly dirty, bathing the animal before surgery is reasonable as long as there is adequate time for the hair coat to dry before the procedure. In humans, it has been suggested that any method of hair removal can be associated with higher SSI rates, but obviously this cannot be avoided for the vast majority of procedures in veterinary medicine. Shaving the surgical site the night before has been associated with higher SSI rates in humans, therefore clipping (not shaving) of the surgical site should only be performed right before surgery. Care must be taken to avoid damaging the skin during this procedure, as abrasions provide sites for invasion and proliferation of opportunistic bacteria. The goal of clipping is not to remove all remnants of hair from the site, but rather to facilitate subsequent skin antisepsis by reducing the amount of hair. Excessive clipping can result in skin trauma, which is a risk factor for infection. Use of good quality, well-maintained clippers and blades helps to reduce the risk of skin abrasions (see Chapter: Cleaning, Disinfection, Sterilization for specifics on maintenance of clippers). If skin lesions around the surgical site are noted before or after surgery, the finding should be recorded and investigated, to determine whether equipment maintenance and/or personnel training need to be improved. **Do not clip animals in the surgery area/suite itself.** Use a "prep" area outside of the surgery area for this and any other preoperative procedures, including the first step of the skin preparation.

Skin preparation after clipping is also important. Typical practices include thorough cleaning and scrubbing of the site with antibacterial soap, followed by application of alcohol, and finally application of an antiseptic that is usually left on the skin. The final antiseptic application step should be performed after the animal has been positioned on the surgery table. As with all disinfectant and antiseptic products, manufacturer's recommendations regarding proper use, including contact time, must be followed in order to maximize efficacy. The two most effective and commonly used antiseptic agents for surgical site preparation are PI or CHG in either alcohol or aqueous solutions. However, CHG is irritating to mucous membranes and should be avoided when there may be exposed to mucous membranes (e.g. preparation of the head, near the eyes, nose or mouth). The application pattern should work from the cleanest area (i.e. incision site) outward to the dirtier areas (i.e. periphery of preparation area). The skin must be allowed to dry before the surgical procedure begins, particularly with use of products containing alcohol as these are flammable. Additional information on preoperative patient skin preparation is available in standard surgical reference texts (Fossum 2013, Johnston & Tobias 2018).

Preparation methods that damage the skin, such as excessive clipping, shaving or excessive scrubbing, must be avoided. Clipping (not shaving) of the surgical site should only be performed right before surgery.

In human medicine, there is evidence that the application of povidone-iodine solutions as a one-step paint or spray may be as effective as the traditional scrub-and-paint with the same solution (Elenhorn 2005), with the added benefit of shorter preparation time and reduced skin trauma. Extrapolation of this finding to veterinary patients must be done with caution, as scrubbing may be more necessary for animals if the haircoat and underlying skin are more heavily contaminated with dirt and debris than bare human skin.

Potential issues that need to be considered when developing clinic standard operating procedures for preoperative skin preparation include:

- preparing a large enough area of skin, in case extension of the intended incision is required.
- adequate initial cleaning with soap and water.
- potential for contamination of preparation solutions.
- ensuring adequate contact time with antiseptics.
- avoiding contamination of the surgical site during and after preparation.

Bandage changes should be performed using aseptic technique.

If skin preparation solutions (e.g. antibacterial soap and water, alcohol, chlorhexidine, iodine) are kept in refillable containers, these containers must themselves be cleaned and then disinfected when empty before being refilled. Contamination of these solutions with bacteria that are resistant to their respective antimicrobial actions can occur. Refilling the containers without disinfecting them can allow these resistant contaminants to accumulate. An outbreak of catheter site infections was reported in a small animal clinic that was associated with contaminated skin preparation solutions (Mathews 1996).

Surgical safety checklists

An emerging trend in human medicine is the use of **surgical safety checklists,** which have been demonstrated to reduce adverse events and errors, ultimately lowering surgery-associated morbidity and mortality. They help engage the entire surgical team in good communication and are an excellent tool to aid in the prevention of SSIs and other complications. See References for the World Health Organization (WHO) Surgical Safety Checklist. See the Appendix for a template veterinary surgical safety checklist that can be tailored to specific surgical environments and procedures.

Postoperative care

Postoperatively, a surgical incision site is highly susceptible to opportunistic infection from the bacteria of the patient's own microflora, from the environment or from hospital personnel. Avoid contact with the surgical incision, particularly with bare hands, as much as possible. Covering or bandaging incisions for 24 to 48 hours after surgery has been recommended in humans (Nicks 2010); this is also a reasonable recommendation in small animals in most situations, but can be considerably more challenging depending on the location of the incision, body shape and demeanor of the patient. Bandage changes should be performed using aseptic technique. Pet owners and handlers should be instructed on how to manage an animal with an incision, and the signs which may indicate the development of a SSI. There is no objective information about the need to cover surgical incisions for more than 48 hours in veterinary or human medicine, but preventing the animal from licking, scratching or otherwise traumatizing the surgical site is critical. Damage to the healing incision or the skin around it can result in the deposition of opportunistic pathogens, and make it easier for bacteria to grow in the area.

SSI surveillance

Every facility should have some form of a SSI surveillance program, as such programs have been shown to help reduce rates of hospital acquired infections. Even with relatively limited effort, sufficient data can be collected to provide a general understanding of endemic SSIs rates and any changes that may occur, allowing the veterinary team to review protocols and procedures related to SSI prevention (also see Chapter: Surveillance).

Accurate SSI rate surveillance is dependent on a number of factors, including accurate identification of SSIs (and differentiation from other infections), use of standard SSI definitions (see Table 3 below), the ability to determine procedure-specific surgical caseload numbers as denominators, and the ability to collect the data centrally and analyze them on a regular basis (ideally in real time). The most common active and passive SSI surveillance methods used (see Table 4) each have limitations that need to be considered. There is no standard approach for veterinary facilities, and factors such as caseload (number and types of procedures), number of clinicians and personnel availability must be considered when determining the optimal program. In general, active methods will provide the most accurate data but are also the most time consuming. No method is ideal, and facilities are encouraged to develop novel approaches to suit their needs (Burgess 2015). Methods such as automatic email questionnaires querying the health of the patient and describing SSIs sent to the owner at a pre-determined post-operative day (e.g. day 30) might be useful, albeit still with some limitations (e.g. response rate, reliance on owners to identify and characterize abnormalities).

Active surveillance programs tend to be most effective as SSIs are often diagnosed post-discharge, though they are more challenging to implement. Through actively identifying cases those patients with SSIs that may be superficial and not serious enough to warrant a recheck appointment are captured and a more accurate picture of SSIs can be generated. This can then be used to identify the areas of the infection control program that are effective or need improvements

TABLE 3. Definitions of different categories of surgical site infections (SSIs) (adapted from Johnston & Tobias 2018, NHSN 2019)

Category	Definition
Superficial SSI	Occurs within 30 days postoperative Affects skin and/or subcutaneous tissues of the incision Includes at least one: - Purulent discharge - Aseptically cultured bacteria - Diagnosis by the surgeon - Reopening of the incision accompanied by pain, heat, redness, swelling
Deep SSI	Occurs within 30-90* days postoperatively Affects deep soft tissues of the incision Includes at least one: - Purulent discharge - Reopening of incision spontaneously, or by surgeon if patient has pain, heat, redness, or tenderness - Abscess or other evidence of infection
Organ/Space SSI	Occurs within 30-90* days postoperatively Affects any area other than the incision that was encountered during the surgery Includes at least one: - Purulent discharge - Bacteria - Abscess or other evidence of infection

*depending on procedure, including those involving implants

TABLE 4. Examples of surgical site infection (SSI) surveillance methods

Method	Description	Comments
Medical record review	Periodic review of SSI reports in medical records	• Dependent on medical record quality. • Can underestimate SSI rates if patients with SSIs are seen by other clinics (e.g. referring veterinary, emergency clinic) and information is not conveyed to the surgical facility. • May be difficult to apply standard definitions to determine SSI with accuracy. • Retrospective, so early changes may be missed. • May require significant time and effort periodically depending on type of records and ability to search (e.g. paper vs electronic records).
Centralized collection of SSI reports	Real time reporting of SSIs detected during routine rechecks or communications to central clinic person	• Dependent on quality of reported data and accurate reporting by clinicians. • Can underestimate SSI rates if patients with SSIs are seen by other clinics (e.g. referring veterinary, emergency clinic) and information is not conveyed to the surgical facility. • Provides timely identification of infections and potential changes in SSI rates. • Fosters infection control communication. • Requires limited time and effort on a daily basis.
Active owner follow-up	Contacting owners at predetermined times specifically to identify SSIs (outside of routine follow-up calls)	• Most accurate data but labour intensive. • Can be made more practical using tools such as email surveys sent at a predetermined time post-operatively.

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