

Sample chapter from
BSAVA Manual of Canine and Feline
Surgical Principles
A Foundation Manual

Edited by Stephen Baines, Vicky Lipscomb and Tim Hutchinson

© BSAVA 2012

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of the copyright holder.

The publishers, editors and contributors cannot take responsibility for information provided on dosages and methods of application of drugs mentioned or referred to in this publication. Details of this kind must be verified in each case by individual users from up to date literature published by the manufacturers or suppliers of those drugs. Veterinary surgeons are reminded that in each case they must follow all appropriate national legislation and regulations (for example, in the United Kingdom, the prescribing cascade) from time to time in force.

Tim Hutchinson

Introduction

The aim of aseptic technique is to ensure that surgery can be performed with minimal risk of contamination by microorganisms. The patient itself is a major source of contaminating organisms; however, any wound open to the atmosphere will become contaminated and with time those contaminant organisms may colonize the wound and establish an infection. The longer a wound is open, the greater the risk of contamination and, potentially, infection. Prophylactic antimicrobials are recommended for certain surgical procedures (see Chapter 18), but use of antimicrobial agents will not eliminate problems relating to poor aseptic technique.

During surgery a wound will be exposed to:

- The environment of the operating theatre
- The animal's own bacterial flora
- Theatre personnel, equipment and instruments.

Whilst instruments can be sterilized and hard inert surfaces treated with disinfectants, the reduction of the bacterial flora of the patient and the operating personnel must be balanced with the potential damage to their tissues that removing these bacteria may cause.

Most procedures that are performed as part of aseptic technique have arisen through their development in the human field. The veterinary field, whilst similar in its aim, may differ from human hospitals, not least from the difference in patients, but also in scale, ranging from a large veterinary referral hospital with dedicated theatre suites and personnel, to a small clinic with one or two veterinary surgeons, in which surgical procedures may need to be slotted in between consulting sessions and performed in rooms in an adapted building.

It is important for every practice, regardless of its size, to establish strict protocols (local rules) aimed at minimizing the risk of surgical wound contamination and to enforce them. This chapter focuses on the ideal standard, but the principles of aseptic technique are relevant to all practices. Hopefully it will act as a stimulus to any practice to review their current procedures and identify areas that can be improved.

Preparation of the patient and surgical site

The patient is the major source of contamination of the surgical wound: endogenous staphylococci and streptococci from the skin are the most frequently cultured organisms from wound infections.

- **Transient microorganisms** are usually easy to remove from the skin through physical scrubbing and can be almost completely eliminated with effective antiseptics.
- **Resident organisms** are more complex, in that bacteria that are present within an animal's tissues for a significant time form complicated biofilms, rather than existing as single free-moving (planktonic) organisms or groups (Paulson, 2005).

Clinically significant biofilms occur when resident bacteria attach to tissue or implants (e.g. sutures, metallic items or drains), adhere and attract other similar organisms to form a biofilm matrix. Such infections pose a challenge to the surgeon because:

- Normal skin residents do not immediately trigger an immune response, so the infection is not readily identified
- The efficient metabolism of bacteria within a biofilm matrix means that their uptake of antimicrobial agents is reduced and doses greater than the normal minimum inhibitory concentration (MIC) for a longer period of time may be required.

It is of paramount importance, therefore, that the surgical team makes every effort to ensure that exposure of the wound to contaminating microorganisms is kept to an absolute minimum, through careful clipping, thorough skin preparation and appropriate draping.

Urination and defecation

The inappropriate voiding of urine and faeces in the operating theatre is a hazard that should be minimized. Owners should be encouraged to take dogs for a short toilet walk prior to admission and kennel staff should ensure that dogs have adequate opportunity to

defecate and urinate before premedication. Cats pose more of a problem in that they will have been confined to the house for at least 12 hours before admission and may be reluctant to use a litter tray.

Once the animal is anaesthetized, a full bladder may be gently emptied manually, or by catheterization. Whilst urine itself is usually free of significant numbers of microorganisms, if an animal urinates during surgery the urine will soak into the fur and may lead to bacterial breakthrough. In animals with a full rectum, the manual extraction of faeces and/or placement of a purse-string suture may be required.

For surgical procedures carried out in the perineal region, manual evacuation and a purse-string suture are preferable to the administration of an enema, as the latter tends to result in liquid faeces that are more likely to leak.

Hair removal

Hair acts as a filter, trapping bacteria and dirt, and creates a microclimate at the skin level. The volume of hair vastly increases the surface area for the attachment of microorganisms and particulate matter, so it is essential to remove hair from a wide area around the proposed incision site.

For routine procedures clients should be encouraged to present their animals in a clean state: bathing with a mild shampoo at least 24 hours prior to surgery might be appropriate in some cases (though should be discouraged closer to the time of surgery, as a damp coat will increase evaporative heat losses during the anaesthetic). Toileting on the morning of surgery should be away from muddy fields and other areas of gross soiling.

Hair should be removed over a wide enough area to allow draping of the proposed surgical site and extension of the incision, should it be required during the procedure. In general, a 15 cm border of clipped skin should be present around the proposed incision site. The hair should be removed using electric clippers. The use of razor blades causes damage to the skin, resulting in colonization by bacteria and superficial infections. Hair removal creams may also be associated with cutaneous reactions.

Clippers

Clippers are recommended for hair removal, but poor clipping technique and lax maintenance of clippers will lead to skin abrasion ('clipper rash'), small nicks and even lacerations. Bacteria from deeper layers of the skin and hair follicles are then exposed and rapidly colonize these lesions. Additionally, the irritation to the animal results in licking and self-mutilation of the area around the incision and there may be wound infection and dehiscence. Clipper rash is easily avoided provided basic rules are followed.

Clipping technique: Unless already extremely short, hair should always be removed with a two-stroke technique (Figure 16.1).

- The bulk of the hair is removed by clipping in the direction of the lie of the hair.
- A closer clip is achieved by shaving against the direction of the hair.



16.1

Hair should be removed in a two-stage process: **(a)** first clipping with the lie of the hair; **(b)** a second cut against the lie of the hair to achieve the close surgical clip, but with minimal skin trauma.

Different blades may be used for these different clips, reserving very fine blades for the final clip and using coarse blades for the bulk of the hair removal. When long hair is clipped with a single stroke against the lie of the hair, the hair tends to drag the surrounding skin up into the blades of the clippers, leading to abrasions (Figure 16.2).

During clipping, one hand should be used to pull the skin taut to avoid creases of skin catching in the blades. For extremities, an assistant might be required to take the weight of the limb to allow both hands to be used for clipping.



16.2

Clipper rash results from skin trauma, and traumatized skin may be colonized by bacteria. (Courtesy of S Baines)

When clipping large areas the blades will become hot, and proteins and lipoproteins from the skin and hair will coagulate and bind to the cutting edges of the blades. This effectively dulls the cutting surface and reduces the efficiency of the cut, allowing hair to snag on the blades, resulting in clipper rash. Blades should therefore be changed or cooled during clipping if they become hot or a sense of dragging is perceived.

Cleaning: Blades should be cleaned between each patient to avoid the transmission of one animal's microflora to another. Hair should be removed from the blades and the head of the clipper with a fine brush, taking care to ensure that hair is not trapped between the blades (preventing their close contact). The blades must have any tissue debris removed to restore the fine cutting edge. This is not easily removed with water (and may lead to rusting of the blades), and so a proprietary solvent-based solution (e.g. Oster Blade Wash) is recommended.

The most effective cleaning technique is to dip the tips of the oscillating blades in a dish of this solution, brushing as required. The blades should then be dried, before the application of a thin film of lubricating oil. Blades that have not been cleaned or lubricated effectively will perform poorly and lead to clipper rash.

Blade maintenance: Thorough and correct cleaning will extend the working life of clipper blades, but they will require sharpening. The design of the blades is such that there is a fixed guard blade against which a cutting blade oscillates. Each blade has V-shaped cutting edges, which sever the hair shafts with a scissor action. The cutting blade is intentionally shorter than the guard blade, so that the sharp oscillating metal points do not contact the skin.

With repeated sharpening two problems may occur. Firstly, the distance between the tips of the points of the cutting and guard blades reduces (Figure 16.3) and if this distance becomes too small the oscillating blade will begin to contact the skin during the hair-clip, resulting in clipper rash. Secondly, the tips of the guard blade lose their rounded ends and develop sharp points. These then dig into the skin and, with careless clipping technique, can cause lacerations.

PRACTICAL TIP

A clipper blade has a finite life and should be discarded when:

- The points of the guard blade become excessively sharp
- The gap between the tip of the guard and cutting blades is significantly reduced
- There is gross damage, such as broken teeth.

Clipper blades should therefore be inspected regularly. When sharpening is required, it is worth investing in a premium service that will dismantle the blades, sharpen each one separately and try to minimize the problems noted above.

Hair disposal

To minimize the risk of hair particles contaminating the surgical field, hair removal should always be carried



16.3 With repeated sharpening, the distance between the tips of the clipper guard and cutting blades reduces. The blades in **(a)** have been sharpened too many times and the tips of each blade are so close together that trauma to the skin is likely. In **(b)** there is still an appropriate gap between the two rows of tips.

out in a room separate from the sterile preparation and operating theatre. The bulk of the shaved hair can easily be gathered and disposed of, but a vacuum cleaner should be used to remove smaller remnants and loose hair from the animal. The floor of the preparation area should also be kept free from hair, to prevent it drifting into the theatre. A vacuum cleaner with a fine-particulate filter should be used if possible, to reduce aerosols, and the filters should be changed regularly.

Draping out

If access to the limb but not the foot is required during surgery, it is better and less traumatic to drape out the foot from the surgical field rather than clipping it (Figure 16.4). The foot should first be covered by an



16.4

Rather than clipping all the hair from a foot, it can be draped out of the surgical field by the use of a sterile impervious layer and sterile cohesive bandage.

impervious layer, e.g. a latex glove, held in place by tape or a cohesive bandage. During draping this can then be covered by a sterile cover, such as a glove or cohesive bandage, allowing the foot to be held to manipulate the limb during surgery. It has been shown that the incorporation of a sterile impervious layer is essential to prevent bacterial strikethrough (Vince *et al.*, 2008).

Preoperative antiseptic preparation

Before the animal is moved into the operating theatre, initial skin preparation should be performed. The aim of this treatment is to remove gross dirt and loose skin squames, eliminate transient microorganisms and begin the reduction in the level of the animal's resident bacterial flora. The ideal skin scrub should:

- Be lathering (to remove dirt and grease)
- Have broad-spectrum bactericidal, virucidal, fungicidal and sporicidal properties
- Kill microorganisms with minimal contact time
- Be non-irritating to the skin and any other tissues
- Be economical.

Commonly used scrub solutions and their properties are listed in Figure 16.5. In practice, the two most frequently used are based on chlorhexidine or iodophors. Chlorhexidine has superior residual activity due to the fact that it binds to keratin. Irrespective of the compound used, contact time is the most significant factor relating to the reduction of the number of microorganisms.

Cotton wool, sponges or swabs may be used for this initial scrub, beginning at the site of the proposed incision and working away from it in a circular pattern (Figure 16.6). Whilst the removal of dirt and loose skin is important to expose bacteria that may be trapped beneath, excessive scrubbing that damages the skin surface should be avoided as such abrasions will be colonized by bacteria postoperatively.



16.6 Applying skin scrub. Using cotton wool, gauze swabs or sponges, the skin is cleaned gently, working from the site of the incision to the periphery with a circular motion.

For male dogs undergoing abdominal procedures, the prepuce should be flushed with an antiseptic solution; likewise the vulva of bitches undergoing perineal surgery. Dilute chlorhexidine solution (one part chlorhexidine to 50 parts water) is recommended for this purpose (Neihaus *et al.*, 2010).

Patient positioning

The position of the patient on the operating table will depend on the procedure to be performed. Detailed description is beyond the scope of this chapter and the reader is referred to the appropriate chapter of other surgical texts. However, some general points are given here.

- The animal should be moved into theatre in such a way that the initially prepared surgical field is not contaminated.
- All anaesthetic monitoring aids and extension lines are attached, diathermy ground plates placed and warm-air blankets positioned prior to the sterile scrub and draping.

Antiseptic	Mechanism of action	Properties	Examples
Iodophors (e.g. povidone-iodine)	Iodophors are stable solutions of iodine that are able to penetrate the cell wall of bacteria. Bacterial death is the result of oxidation and replacement of intracellular molecules with free iodine	Broad spectrum (broader than chlorhexidine), including fungi, viruses and some spores. Activity reduced by presence of organic material. Greater contact time required than with chlorhexidine. May be more likely to cause skin irritation than chlorhexidine	Medicine; Pevidine; Vetasept povidone-iodine
Bisbiguanides (e.g. chlorhexidine gluconate)	Precipitate intracellular proteins after disruption of cell wall and membrane	Broad spectrum, but less effective against Gram-negative than Gram-positive bacteria. Virucidal. Low activity against fungi. Good residual action through binding to keratin. Less inhibited by organic matter than iodophors	Hibiscrub; Medihex; Vetasept chlorhexidine
Alcohol	Denatures cell wall proteins, DNA, RNA and lipids	Broad spectrum, including fungi and viruses. Rapid onset of action	70% Isopropyl alcohol
Alcohol-based solutions	Synergistic effect through combining 70% isopropyl alcohol with an antiseptic (e.g. chlorhexidine)	Broad spectrum due to combining different agents with different modes of action	Actiprep (ethanol + zinc pyrithione); Exidine (isopropyl alcohol and chlorhexidine)

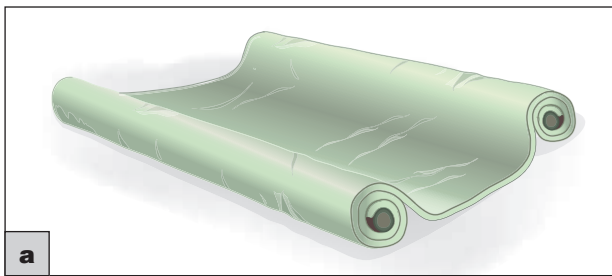
16.5 Comparison of different skin-scrub solutions.

- Knowledge of the procedure will be required in order to anticipate access to parts of the body, positioning of the surgeon and assistant, and location of the instrument trolleys.

Positioning aids

To minimize cross-contamination, positioning aids should be easily cleaned, dedicated to the theatre and not used in other parts of the building. Various aids are available.

- Troughs are a good way of keeping patients in dorsal recumbency and are ideal for positioning for work on the extremities, but limit access to the thorax and may compromise abdominal surgery.
- More versatile are clean sandbags or towels rolled into a trough shape (Figure 16.7).
- Wipe-clean beanbags, which conform to the animal's shape and then maintain that position by removal of air from the bag by suction, can be very useful, but limit repositioning of the animal during a procedure and may be punctured.
- Extension arms for the table to support the patient's limbs are preferred by some surgeons.



16.7 Rolled towels make versatile positioning aids.

Sterile skin preparation

Preoperative skin preparation should have removed all dirt and transient organisms and suppressed the animal's resident flora. The sterile preparation augments this, using the same antiseptic agent as for the initial skin scrub, but applied with sterile gauze/sponges and sterile forceps or a sterile gloved hand. There should be a similar pattern of application, working from the incision site to the periphery.

Finally the skin is coated with a solution of the antiseptic, which may be in an alcohol solution. Alcohol alone is an effective antimicrobial agent, but has no residual activity and may dilute the residual activity of the previously applied chlorhexidine and

especially povidone–iodine. Rinsing with 70% isopropyl alcohol after a 4% chlorhexidine scrub is less effective than rinsing with saline (Osuna *et al.*, 1990), but chlorhexidine has a synergistic effect with alcohol (Hibbard, 2005).

Two techniques have been suggested:

- Scrubbing with povidone–iodine, followed by the application of (non-lathering) 10% povidone–iodine solution, either sprayed or painted on to the area
- Scrubbing with chlorhexidine, followed by the application of a chlorhexidine/alcohol solution.

Povidone–iodine has been reported to have a greater incidence of tissue irritation than chlorhexidine.

Blue dye can be incorporated into the final spray so that it is clear which areas of the skin have been treated, though the entire clipped area should be prepared. Care should be taken to ensure that solutions do not pool in depressions such as the inguinal region.

Draping

Surgical drapes function as a physical barrier to prevent microorganisms from the unprepared parts of the patient and operating table gaining access to the surgical field. All parts of the patient, apart from the surgical field, should be draped out. This barrier must be maintained throughout the procedure, for instance if the drape becomes wet with blood or lavage fluid, or the patient requires repositioning. Draping material must therefore be:

- Strong, but flexible
- Readily conformable to the patient
- Able to be cut (if the surgeon desires a fenestrated single drape rather than a four field pattern), while resisting tearing
- Water-resistant
- Easy to sterilize
- Economical to use.

Draping material

There is no ideal single draping material that will satisfy all the above criteria, so draping techniques will frequently use different materials to achieve different aspects of the overall requirement.

As for whether to use reusable cloth drapes or disposable non-woven types, the same considerations apply as for the choice of materials for surgical gowns (see below). In general, cloth drapes should be avoided in any area subject to wetting, because once wet they offer no barrier to bacterial strike-through. Cloth drapes should always therefore be covered by an impervious layer. Contamination can be in the form of strike-through from those parts of the patient that have not been clipped and prepared, or from the resident microflora deep within the hair follicles of the prepared skin. Scrubbed skin should not be viewed as sterile.

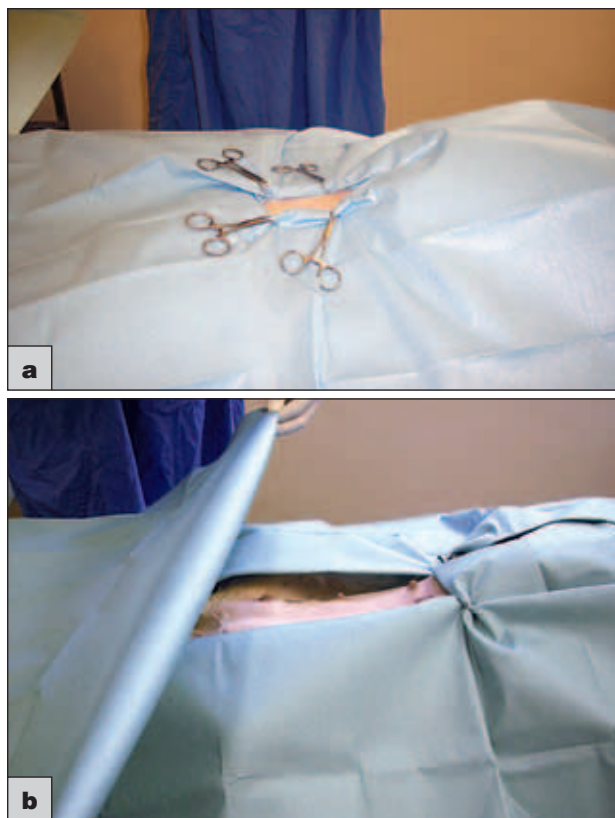
Draping techniques

The technique used for draping will vary according to the procedure to be performed and the location of the surgical site, with the aim being to choose the technique that best prevents contamination.

Initially the clipped and prepared skin should be isolated from the surrounding hair and skin either

by placing a single large drape, fenestrated to the required size (Figure 16.8a), or by draping with four field drapes (Figure 16.8b). With the latter technique:

- Four separate drapes are used, one at each of the four edges of the prepared skin
- The edge of the drape is folded inwards and the drapes are overlapped before securing at each corner of the field with Backhaus towel forceps.



16.8 (a) A single large drape is placed over the entire animal, fenestrated to expose the limit of the proposed skin incision. (b) Four drapes are placed with a folded leading edge and fastened securely with Backhaus towel clips, to define the limit of the scrubbed area.

Cloth drapes may be used for these field drapes, as they conform to the patient better than disposable drapes, which may help to maintain the sterile field especially if the animal's position is adjusted during the procedure. Cloth drapes should always be covered by an impervious layer to prevent strikethrough when wetting occurs.

With the above draping patterns the only skin that is left exposed is the area into which the incision is to be made. However, there is still a risk of contamination of the wound from resident bacteria deep in the hair follicles, if they are disturbed during surgery. There is much debate about how best to exclude this final potential source of contamination.

- One technique is to suture the edges of the drape into the skin incision or clip skin towels to the edge of the skin incision so that, during surgery, the cut skin edge is contiguous with the sterile drape.
- A quicker alternative is to use transparent incise drapes (these may be impregnated with iodine), which adhere to the skin and the incision is made directly through the drape.

Incise drapes: Incise drapes often adhere less well to animal skin than to human skin, and a recent study (Owen *et al.*, 2009) confirmed findings from similar human studies that the use of incise drapes does not affect the rate of bacterial contamination of surgical wounds in clean procedures. However, these drapes are useful in preventing fluids from seeping under the edges of the drapes and may also increase the efficacy of forced-air warmers by preventing the escape of warm air through the edges of the drapes.

Hanging leg preparation: For limb surgery that does not involve the foot, the foot may be draped out of the field using a sterile impervious layer held in place by a sterile cohesive dressing (see Figure 16.4). For such procedures it may be useful to perform a hanging leg preparation, where the limb is suspended from a drip stand during the skin preparation and field-draping before the final sterile layers are placed on the foot. For fracture repairs in which a hanging limb is maintained throughout the procedure, the foot can be covered with a sterile layer whilst still suspended from the stand.

Preparation of the surgical team

The surgical team can potentially contaminate the patient both directly (by contact from the surgeons and the scrub nurse) and indirectly (through increasing the level of airborne bacteria in the theatre environment).

The level of bacteria in the theatre air is directly proportional to the number of personnel and their movement. The number of personnel involved with a procedure should therefore be kept to a minimum and traffic in and out of the theatre should be restricted. Advance planning for a technique is important to ensure that all necessary equipment and theatre disposables are at hand.

Various methods can be employed by the team to minimize contamination and bacterial shedding (detailed below). The degree to which they are utilized will depend on the procedure to be performed. For instance, scrubbed hands and sterile gloves might suffice for the biopsy of a cutaneous mass or feline orchidectomy, but this would obviously be inadequate preparation for more invasive surgery.

General theatre clothing

Scrub suits

Scrub suits should be considered mandatory for all personnel in the surgery suite. Apart from their obvious function to reduce bacterial contamination, they help to differentiate the surgical team from other members of clinical staff (Figure 16.9) and instil an inherent discipline to follow good theatre practice.

Clean suits should be worn at the start of each theatre session and changed if they become soiled. If a member of theatre staff is required to leave the theatre suite, they should change into normal clothing. It may be acceptable on occasion to cover their suit with a white coat to reduce contamination, but this should be avoided.

**16.9**

Dedicated theatre clothing is inexpensive, helps to enforce the discipline of theatre protocols and is a valuable component of the whole aseptic technique. A theatre hat is arguably as important as a sterile gown.

Scrub suits are generally made from a woven polyester/cotton-blend fabric to provide comfort, durability and easy laundering, and their tight weave forms a barrier to microorganisms. This barrier is significantly reduced when the fabric becomes wet and, additionally, bacteria are shed from the open sleeves and trouser legs. The tunic should therefore be worn tucked into the drawstring trousers.

Laundering damages the fibres of the fabric, increasing the size of the holes in the weave and reducing the barrier to microorganisms. Following routine laundering, bacteria may remain on the fabric, so periodic sterilization may be used. Scrubs should be regularly inspected for signs of wear and replaced as required.

Footwear

The level of bacteria on theatre floors is no different whether standard or specially designed theatre shoes are worn (Mangram *et al.*, 1999) and the use of theatre shoes has no effect on the incidence of surgical infection. However, the use of dedicated footwear or shoe covers when out of the theatre suite does reinforce discipline and may help to reduce the transfer of hair and other particulate matter.

Theatre hats and head covers

Hair is a significant carrier of bacteria. The head is often positioned directly over the surgical site and shedding from hair has been shown to increase the surgical infection rate. All hair should therefore be covered by all members of the surgical team. It should be considered essential that if a procedure justifies the use of sterile gloves and gown, hair should also be covered.

Good-quality cheap disposable theatre hats are most commonly used, but cloth caps are available and if used they should be laundered, inspected and treated like scrub suits. Theatre hoods, made from similar fabric, are available for those with facial hair.

Masks

Of all the standard items of theatre wear, the mask is probably the most iconic but arguably the least valuable component. Masks rapidly become saturated,

which reduces their resistance to the passage of microorganisms considerably. Additionally, microorganisms will pass around the sides of the mask during exhalation.

The primary function of the mask is to prevent direct expulsion of larger contaminated droplets from the mouth and nose of theatre personnel during talking, coughing and sneezing. Masks should be close-fitting, using the wired seam to contour the face, and they should be worn by all personnel in theatre.

Surgical scrub

As for the preparation of the patient's skin, the aims of the surgeon's scrub are to:

- Remove dirt and grease
- Eliminate transient microorganisms
- Reduce the resident microflora to as low a level as possible for as long as possible.

The same considerations regarding time, efficiency, tolerance and economy apply as for the patient's skin scrub. Gross soiling should be washed off with soap first.

The traditional approach to scrubbing-up, using an antiseptic solution and bristle brush (either by time or by counted brush-stroke methods – see below), is based on convention rather than stringent research and there is no definitive technique, with each surgical textbook offering a variation. Recently this traditional approach has been questioned. The physical action of the brush aids in the removal of dirt and transient bacteria and is especially useful around and under the nails (Figure 16.10). However, repeated brushing dries and damages the skin through the removal of the surface layers, leading to dermatitis and bacterial colonization, which, as with clipper rash, acts as a source of infection. It is probably acceptable to limit the use of the brush to the tips of the fingers/nails or to use a nail-pick and to apply antiseptic to the hands and arms manually without scrubbing.

**16.10**

The scrubbing brush is still a valuable tool for cleaning the nails, but its role on the skin of the hands and arms is now being questioned.

Alternative approaches have been suggested, including brushless techniques (often employing the use of alcohol-based antiseptic solutions) and a nail-pick to remove debris trapped beneath the nails. They are less damaging and irritating to the skin and several recent studies suggest that they may

be more effective than traditional chlorhexidine or povidone–iodine scrubs. The use of these techniques is gaining popularity in the United States and some UK medical centres.

Irrespective of the technique employed, it is important to ensure that all parts of the hands and forearms are treated, paying particular attention to the nails, backs of hands and the areas between the fingers. The aim is to ensure that the fingers and hands are the cleanest, so the hands should always be held raised above the level of the elbows, allowing liquid to run down the forearms and drop from the point of the elbow. Hands should not be shaken to disperse water or the scrub solution.

Before scrubbing, all jewellery should be removed. It is important to keep nails short and in good condition. Nail varnish should be discouraged, since worn or chipped varnish may harbour bacteria.

Timed technique

This is probably the most common technique employed (and the most varied), using timed scrubbing of anatomical sections of the hands and forearms. The scrub technique recommended by the World Health Organization is shown in Figure 16.11.

This scrub is used for the first procedure of the day. Provided that no gross soiling occurs, subsequent scrubs need only be of 3 minutes in duration.

Steps before starting surgical hand preparation

1. Keep nails short and pay attention to them when washing your hands – most microbes on hands come from beneath the fingernails.
2. Do not wear artificial nails or nail polish.
3. Remove all jewellery (rings, watches, bracelets) before entering the operating theatre.
4. Wash hands and arms with a non-medicated soap before entering the operating theatre area or if hands are visibly soiled.
5. Clean subungual areas with a nail file. Nailbrushes should not be used as they may damage the skin and encourage shedding of cells. If used, nailbrushes must be sterile and single use, although reusable autoclavable nail brushes are on the market.

Protocol for surgical scrub with a medicated soap

6. Start timing.
7. Scrub each side of each finger, between the fingers, and the back and front of the hand for 2 minutes.
8. Proceed to scrub the arm, keeping the hand higher than the arm at all times. This helps to avoid recontamination of the hands by water from the elbows and prevents bacteria-laden soap and water from contaminating the hands.
9. Wash each side of the arm from wrist to the elbow for 1 minute.
10. Repeat the process on the other hand and arm, keeping hands above elbows at all times. If the hand touches anything at any time, the scrub must be lengthened by 1 minute for the area that has been contaminated.
11. Rinse hands and arms by passing them through the water in one direction only, from fingertips to elbow. Do not move the arm back and forth through the water.
12. Proceed to the operating theatre holding hands above elbows.
13. Once in the operating theatre, hands and arms should be dried using a sterile towel and aseptic technique before donning gown and gloves.

At all times during the scrub procedure, care should be taken not to splash water on to surgical attire.

16.11

The scrub technique as recommended by the World Health Organization.

Counted brush-stroke technique

With this technique, the hands and arms are washed and lathered as before but, instead of timing the scrub section, brush strokes are counted. Tips of the fingers are treated as one unit and each finger and arm is considered to have four units: dorsal, palmar, axial and abaxial sides (the dorsal and palmar aspects of the fingers and thumb and the outer sides of the little finger and thumb are scrubbed from tip to wrist). This creates 25 anatomical regions on each hand and arm, all of which should receive an equal number of brush strokes – recommended to be between 20 and 30 strokes, with a stroke consisting of a full back-and-forth motion.

Brushless scrub technique

The recommended protocol will vary according to the manufacturer of the individual scrub solution. The following is an example of the method for Exidine™ (Scrub Care™) 2% chlorhexidine brushless surgical scrub.

1. Rinse hands for 30 seconds with warm running water.
2. Clean finger nails using a nail-pick.
3. Scrub for 90 seconds with the solution, without a brush, paying particular attention to nails, cuticles and the skin between the fingers.
4. Rinse thoroughly for 30 seconds.
5. Scrub for a further 90 seconds and rinse for 30 seconds.

Drying

Once the scrub has been completed the surgeon should move to the gowning area. The sterile pack containing gown and towel should be placed on a dry surface away from the operating table and instrument trolley and opened by a theatre assistant. The hands and forearms should be dried using a 'four-corner' technique: one corner of the towel is used in turn for each hand and forearm, taking care not to touch the parts of the towel once it has been used to dry a part of the body.

Gowns

Types of gown

Two types of gown are available: reusable woven gowns; and disposable gowns made from non-woven material.

Reusable gowns: Reusable gowns are usually woven from cotton or a polyester/cotton-blend. High-quality fabrics of up to 270 fibres per square inch are becoming standard and have better barrier properties than standard 140 muslin when dry.

Reusable cotton gowns are adequate for routine use, but do require care and regular inspection. With age and repeated laundering, areas of gross damage develop, especially around the seams and junctions of the cuffs to the sleeves. Laundering causes thinning of the fabric and, irrespective of the type of cloth used, widening of the pores in the fabric, reducing the barrier to microorganisms. Cotton and polycotton blends, of whatever fabric

density, will lose their barrier effect when wet and it is vital that this is considered when using reusable gowns for procedures where significant wetting is likely. Cloth gowns are available that have been treated with a water-repellent fluorochemical. Gore-Tex reusable gowns may have the best barrier properties.

The common models of bench-top autoclaves are unreliable for sterilizing bulky cloth items in sealed packages and even vacuum models only recommend one gown per load, making routine sterilization laborious unless large porous-load autoclaves or ethylene oxide are available.

Increased duration of the surgical procedure will increase stretching of the gown and contamination with blood and other fluids, thereby increasing the risk of strikethrough. Disposable gowns should be used for all procedures in which there is a significant risk of contamination with fluids.

Disposable gowns: Non-woven disposable gowns are not made directly from yarn, but from cellulose or synthetic fibres closely bonded together to increase the barrier effect compared with woven materials, especially in the presence of moisture. This material can be reinforced to provide additional barrier protection to the lower sleeves and gown-front with impervious material.

Disposable gowns are now available pre-packed and pre-sterilized, including hand-towels. Cost is no longer prohibitive, especially if bought in bulk, when the hidden cost of laundering and sterilizing (electricity, labour and environmental factors) of reusable gowns is considered. The purchase price of disposable gowns is now less than a fifth of the cost of standard reusable gowns and a tenth of the cost of treated fabric gowns.

Gowning technique

Gowning technique is shown in Technique 16.1.

TECHNIQUE 16.1

Gowning

1 Gowns should be folded such that the body of the gown (but not the sleeves) is inside-out. The sterile pack should be opened on a surface away from the operating table.



2 After drying their hands, the scrubbed surgeon should grasp the gown by the inside of the neck and allow the rest of the gown to fall.



3 Touching only the inside surface of the gown, the arms are inserted into the sleeves, keeping the hands covered (see Gloving techniques).



4 An assistant then pulls the gown over the shoulders (touching the inside surface of the gown only) and fastens the rear ties. With hands still within the sleeves, the surgeon passes the waist tie to the side, allowing the tip of the tie to dangle for the unscrubbed assistant to grasp. If wrap-around disposable gowns are used, they are tied by the surgeon after donning gloves.



Gloves

The elastic properties of latex gloves allow them to conform to the shape of the surgeon's hands and stretch comfortably with movement. Gloves should be snug-fitting to reduce the possibility of undetected trauma to baggy pouches around the fingers.

Latex gloves form a very effective barrier, but there may be small holes in up to 1.5% of them before use (quality control standard) and gloves may be punctured in up to 13% of surgical procedures, so they are not a substitute for a thorough skin scrub technique. Double-gloving decreases the risk of complete accidental perforation, but reduces the surgeon's sensitivity which, as well as potentially compromising technique, makes the surgeon less aware that the glove has been punctured. Damaged gloves should be changed during surgery (see below). It may be useful to wear two pairs of gloves for draping the animal, so that the outer pair can be removed prior to starting the surgery, thereby eliminating the risk of accidental contamination.

Latex allergy

Gloves made solely from latex are extremely difficult to put on, so a lubricating agent is required. Traditionally this has taken the form of a powder, usually talcum or cornstarch, but there is concern over the potential for irritation of surgical wounds by the powder from gloves. Additionally, these powders play a significant role in the development of latex glove allergy, as they act as haptens, raising the antigenicity of the tiny latex particles. Type I (acute), type IV (delayed) and non-allergic irritant contact dermatitis are reported reactions to latex gloves (Figure 16.12).



16.12

An example of mild dermatitis resulting from type IV (delayed) latex allergy.

Powder-free gloves coated with an adherent hydrogel should therefore be used for all latex allergy sufferers and, given the rise in latex allergy, should be considered for all staff. Powdered gloves have now been withdrawn from UK hospitals. Further information about latex allergy is available from www.bad.org.uk/site/1029/default.aspx and www.hse.gov.uk/latex/about.htm

Gloving technique

There are three techniques for donning gloves: closed gloving, open gloving and assisted gloving.

Closed gloving: The closed gloving technique is illustrated in Technique 16.2. This technique ensures that the scrubbed hands always remain in the sleeves

of the gown until covered by the sterile gloves. Ungloved hands never touch the outside of the gown or the gloves, so it is the most reliable way of maintaining asepsis and is therefore the technique of choice prior to surgery.

TECHNIQUE 16.2

Closed gloving

1 The inside surface of the cuff of the left glove is grasped by the left hand through the fabric of the gown, so that the fingers remain covered at all times.



2 The right hand (which remains inside the sleeve) is used to draw the cuff over the left hand.



3 The fingers of the left hand are allowed through the sleeve of the gown and into the glove.





4 The process is repeated for the right glove.

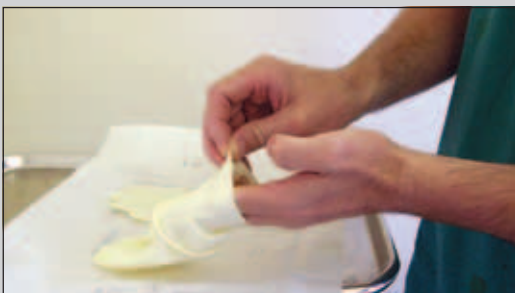


Open gloving: The open gloving technique is illustrated in Technique 16.3. Here, the hands are exposed, but only touch the inside of the glove. Because the hands are exposed the maintenance of a strict aseptic technique is less reliable and this technique is therefore suitable for a minor procedure when a sterile gown is not worn.

TECHNIQUE 16.3

Open gloving for a gownless procedure

1 Touching only the inner surface of the glove, the fingers of one hand are inserted.



2 The thumb remains within the cuff.



3 The opposite glove can then be picked up in such a way that outer surfaces do not contact inner surfaces.



4 The opposite hand is then inserted into the glove.



5 The gloves are pulled over the wrists.



Assisted gloving: Assisted gloving relies on the presence of a previously scrubbed, gowned and gloved assistant to stretch open the cuff of the glove so that the surgeon can plunge the hand into it. The surgeon's hand is exposed prior to insertion in the glove and there is an increased risk of accidental contact

with the outside of the glove and also the potential to push the cuff of the gown too far up the forearm. This is not recommended for veterinary practice.

Glove changing during surgery: If gloves have to be changed during surgery, a non-sterile assistant should be used to assist in removing the glove by pulling on the glove and cuff of the gown so that the surgeon can retract the hand back into the sleeve of the gown. The surgeon should then replace the glove in a closed manner.

Maintenance of aseptic technique during surgery

Provided the above procedures have been followed, the surgical team should be able to approach the draped scrubbed patient with clean dry sterile gowns and gloves. However, attention to detail and discipline are required to maintain the integrity of the sterile surgical field.

The sterile field consists of:

- The properly prepared and draped patient
- The surgeons in sterile gowns
- Instrument trolleys completely covered in sterile impervious drapes.

Instruments

Only personnel in sterile gowns and gloves should lay out instrument trolleys. Instrument trolleys should be laid out completely with all the instruments and implants that may be required before the first incision is made, with the exception of some items that are not required until the end of the procedure (e.g. skin staplers).

PRACTICAL TIPS

- When additional items are brought into the sterile field, the assistant should take care to pass instruments in such a way that they do not contact edges of packaging or bring ungloved hands or unopened packets directly over sterile drapes.
- Scrubbed personnel should remove sterile items from the packaging with gloved hands and items should not be tipped on to the surgical table by unscrubbed theatre personnel.

Personnel

Scrubbed personnel should consider that only the front of the gown is sterile, from the level of the chest to the height of the table. The neckline, axillae and cuffs will collect moisture, which will allow bacterial strikethrough and so are not sterile.

PRACTICAL TIPS

- Hands should remain in front of the surgeon at all times, between waist and shoulder height. Hands should either be clasped, or allowed to rest on the draped area, but arms should not be folded.
- No scrubbed member of the team should touch or approach a non-sterile surface.
- All scrubbed members should face the surgical field at all times.
- Only in exceptional circumstances should a member of the team enter or leave the room.

Contamination

If a glove becomes contaminated, the gloves should be changed (a stock of spare gloves should be maintained in theatre) away from the surgical field. If an incident of gross contamination occurs, it may be necessary for a surgeon or assistant to change gown and gloves completely and in this case it may be prudent to start a short scrub again.

References and further reading

- Arrowsmith VA, Mauder JA, Sargent RJ and Taylor R (2001) Removal of nail polish and finger rings to prevent surgical infection. *Cochrane Database of Systematic Reviews* **4**, CD003325
- Hibbard JS (2005) Analyses comparing the antimicrobial activity and safety of current antiseptic agents: a review. *Journal of Infection Nursing* **28**, 194–207
- Hsieh HF, Chiu HH and Lee FP (2006) Surgical hand scrubs in relation to microbial counts: a systematic literature review. *Journal of Advanced Nursing* **55**, 68–78
- Mangram AJ, Horan TC and Pearson ML (1999) Guidelines for prevention of surgical site infection. *Infection Control and Hospital Epidemiology* **20**, 250–278
- Mulberry G, Snyder AT, Heilman J, Pyrek J and Stahl J (2001) Evaluation of a waterless, scrubless chlorhexidine gluconate/ethanol surgical scrub for antimicrobial efficacy. *American Journal of Infection Control* **29**, 377–382
- Neihaus SA, Hathcock T, Boothe DM and Goring RL (2010) A comparison of the antiseptic efficacy of chlorhexidine diacetate and povidone-iodine for presurgical preparation of the canine preputial cavity. *Veterinary Surgery* **39**, 46
- Osuna DJ, DeYoung DJ and Walker RL (1990a) Comparison of three skin preparation techniques in the dog: experimental trial. *Veterinary Surgery* **19**, 14–19
- Osuna DJ, DeYoung DJ and Walker RL (1990b) Comparison of three skin preparation techniques in the dog: clinical trial in 100 dogs. *Veterinary Surgery* **19**, 20–25
- Owen LJ, Gines JA, Knowles TG and Holt PE (2009) Efficacy of adhesive incise drapes in preventing bacterial contamination of clean canine surgical wounds. *Veterinary Surgery* **38**, 732–737
- Paulson DS (2005) Efficacy of pre-operative antimicrobial skin preparation solutions on biofilm bacteria. *AORN Journal* **81**, 492–501
- Pereira LJ, Lee GM and Wade KJ (1997) An evaluation of five protocols for surgical hand washing in relation to skin condition and microbial counts. *Journal of Hospital Infection* **36**, 49–55
- Tanner J, Swarbrook, S and Stuart J (2008) Surgical hand antisepsis to reduce surgical site infection. *Cochrane Database of Systematic Reviews* **23**, CD004288
- Vince KJ, Lascelles BDX, Mathews KG, Altier C and Roe SC (2008) Evaluation of wraps covering the distal aspect of pelvic limbs for prevention of bacterial strike-through in an *ex vivo* canine model. *Veterinary Surgery* **37**, 406–411