UNDERSTANDING WOUND INFECTION AND COLONISATION

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In order to manage wounds more effectively healthcare professionals need to be able to distinguish between wound colonisation and infection. This article describes both states in detail and explains how to detect the development of infection. The importance of infection control precautions, good hand hygiene and the assessment of wounds at each dressing change is also discussed.

The type of wounds patients present with vary from one setting to another, ranging from acute surgical wounds, traumatic wounds such as those that occur following an accident, burn wounds or chronic wounds such as leg and pressure ulcers. Healthcare professionals should have a good understanding of wound management issues, including wound colonisation and infection, as failure to distinguish between the two may result in inappropriate patient care and potentially serious complications. For example, a patient who acquires an infection while undergoing major bowel surgery may develop septicaemia (infection within the bloodstream), multi-organ failure and death if the infection is not detected and treated early. Having a good understanding of wound colonisation and infection is therefore crucial.

What is wound colonisation and infection?

The first step to understanding wound colonisation and infection is recognising that all wounds are contaminated with micro-organisms; contamination is the presence of organisms on the surface of a wound (Stotts, 2004). The type and quantity of organisms vary from one wound to another (Cooper and Lawrence, 1996) and contamination can occur in a variety of ways. Often it arises through the transfer of normal body bacteria. All individuals are covered by a range of bacteria, known as normal body flora, which generally live quite harmlessly in various body sites without causing any active disease or ill health and often offer protection from more harmful or pathogenic organisms (Wilson, 2001). Examples of normal body flora include *Staphylococcus aureus* and *Staphylococcus epidermidis*, both of which commonly live on the skin of many individuals without causing any harm (Wilson, 2001). Intact skin normally provides a natural physical barrier to contamination from micro-organisms (White et al, 2001), but once the skin becomes broken and a wound is created, the natural protection of the skin is lost and normal body bacteria may gain entry. During surgical procedures such as bowel surgery, wounds may readily become contaminated with the bacteria that naturally live in that area of the body, such as *Escherichia coli* which naturally lives in the gut of many people. In addition, wounds may become contaminated by other outside sources, for instance, other patients. This generally occurs through contamination of the healthcare workers' hands. Environmental contamination of wounds may also occur and it is particularly likely with traumatic wounds that arise following an accident; an injured motorcyclist may have a wound contaminated with dirt and micro-organisms from the road. All wounds will be contaminated to a lesser or greater extent depending on their type (*Table 1*).

Wound colonisation is defined as the presence of multiplying micro-organisms on the surface of a wound, but with no immune response from the host (Ayton, 1985) and with no associated clinical signs and symptoms. This indicates that wound colonisation, similar to wound contamination, is a normal state and is not associated with active disease, ill health or delayed wound healing (*Figure 1*). However, within the wound infection continuum, wound

Figure 1. A colonised wound.

colonisation may lead to heavier colonisation, known as critical colonisation (White, 2003). This is the point at which the multiplying micro-organisms can no longer be controlled by the body's immune system and may lead to wound infection (Kingsley, 2001).

In contrast, wound infection is defined as the presence of multiplying organisms which overwhelm the body's immune system resulting in spreading cellulitis (inflammation of the tissues) (Kingsley, 2001) (*Figure 2*). This definition indicates that wound infection results in active disease that is likely to delay the wound healing process and is determined by clinical diagnosis. It involves not only identifying which type of micro-organism(s) are present within a wound through microbiological testing, but also assessing the patient for clinical signs and symptoms suggestive of infection, rather than the mere presence of micro-organisms within the wound. There are several classic signs and symptoms of infection, such as pus and cellulitis (Scanlon, 2005), however, in some types of wounds, for instance chronic wounds with heavy exudate (discharge), identifying signs and symptoms can be difficult. In addition, in older or immuno-suppressed patients, such as those receiving chemotherapy or long-term steroid therapy, the immune response is less efficient and therefore clinical signs and symptoms of infection are less apparent. To aid this process, other criteria have been suggested. These are oultined in detail on p.126.

Two of the most accurate signs and symptoms of wound infection are increasing pain and wound breakdown (Gardner et al, 2001). Healthcare professionals should therefore regularly assess the patient, including regular visualisation of the patient's wound for signs and symptoms of infection. It has been recommended that wounds should be assessed at all dressing changes (Kingsley, 2001).

Pain assessment and management

To accurately assess the patient's level of pain, a pain assessment tool should be used. The Numerical Rating Scale (Downie et al, 1978) is one such took, where a scale of one to 10 (with one representing no pain and 10 representing severe pain), may be utilised. Accurate documentation is an important part of this assessment. If the patient does complain of unexpected or increasing pain, the practitioner should provide analgesia as prescribed and report to the relevant medical staff for review.

Repositioning the patient or providing distractions such as

Table 1

Summary of definitions of terminology used

Term	Definition
Contamination	The presence of bacteria on the surface of a wound, before multiplication takes place
Colonisation	The presence of multiplying bacteria in a wound, but with no patient immune response (Ayton, 1985). There is no active disease or ill-health, therefore no signs or symptoms
Critical colonisation	The point when the patient's immune system is no longer able to control the colonising bacteria in a wound
Infection	The presence of multiplying bacteria that overwhelms the patient's immune system and results in spreading cellulitis (Kingsley, 2001). Active signs and symptoms of disease present

Figure 2. An infected wound.

books, magazines or television may help to detract the patient's attention from the pain (Burton, 2006).

Factors that determine wound colonisation or infection

A number of factors determine whether a wound remains harmlessly colonised or becomes infected. Emmerson (1998) indicates that there needs to be a balance between the patient's immune response and type of wound *versus* the type, quantity and disease-causing ability (known as virulence) of the micro-organisms present within a wound. Wound infection will occur when this balance is lost.

Individual resistance to infection

Individual vulnerability

The patient's individual vulnerability and immune response will significantly influence what effect bacteria have within a wound. Factors include:

- Stress: including the stress caused by ill health and surgery (Scanlon, 2005).
- Nutritional status: poor nutrition increases the risk of wound infection. Protein is required for a robust immune response, along with vitamins such as vitamin B complex and vitamin C (Dealy, 2005). Therefore, patients who consume insufficient amounts of protein and vitamins are more likely to develop wound infection than those patients who have a healthy well-balanced diet.
- Circulatory system: disorders of the circulatory system, such as cardiovascular disease, result in a reduced blood and oxygen supply within wounds. This slows the healing process and increases the risk of wound infection (Dealy, 2005).
- Metabolic disorders: such as diabetes mellitus. Patients with diabetes mellitus are at increased risk of developing wound infection (Wilson, 2001), because high blood sugar levels (hyperglycaemia) reduce neutrophil (white blood cells) activity, in particular the ingestion and destruction of foreign matter, such as micro-organisms. This process is known as phagocytosis and is important for a robust immune response (Slaughter et al, 1993).
- Increasing age: the elderly often have other underlying medical conditions, some of which may directly affect the healing process, for instance cardiovascular disease. Aging itself is associated with a decreased immune response.
- Concurrent infections: in situations where the immune system is busy dealing with wound colonisation and the patient then develops another concurrent infection, e.g. of the chest, the immune system may find it hard to cope with both of these at the same time and be overwhelmed.
- Drugs that lower the immune system: drugs such as chemotherapy and long-term steroid therapy depress the immune response and allow bacteria to multiply in wounds (Wilson, 2001) increasing the risk of wound infection rather than harmless colonisation.
- Body size: obesity has been shown to be an important risk factor for developing surgical wound infection (Cruse and Foord, 1973). This is because deep layers of adipose tissue (fat) can complicate surgery, reducing the blood flow to the wound during healing and increasing the risk of wound infection (Mangram et al, 1999).

These factors indicate that the healthier the patient, the more likely it is that a wound will remain harmlessly colonised with micro-organisms and there will be a lower risk of wound infection. In contrast, patients who have a compromised immune system due to some or all of these factors

Table 2

Standard infection control precautions

Standard infection control precaution	Application of precaution
Hand decontamination	Thorough hand decontamination using liquid soap and running water or alcohol hand rub (on visibly clean hands) before and after all contact with patients likely to result in hand contamination
Personal protective equipment	Appropriate use of disposable gloves and plastic apron, for instance when performing wound dressings and handling blood/body fluids. Change between procedures and between patients. Decontaminate hands on removal
Waste management	Correct segregation and disposal of waste. Ensure that items contaminated with micro-organisms are correctly disposed of as clinical/hazardous waste according to local policies, for instance, contaminated wound dressings
Equipment	Use single use/single patient-use disposable equipment whenever possible. Ensure adequate decontamination of reusable multi-patient use equipment after each use to reduce the risk of cross-contamination
Laundry management	Correct segregation and laundering of used and contaminated/infected laundry. Bag laundry according to local policies, for example, red stitched alginate soluble bag inside an outer red plastic bag for contaminated /infected laundry
Blood and body fluid spillage/contamination	Clean all blood and body fluid spillages correctly. Wear personal protective clothing. For blood spillages use a suitable disinfectant, e.g. chlorine releasing agent, such as Milton, ensuring a minimum contact time of two minutes. Clean the area with water and detergent afterwards, dry/allow to dry thoroughly. For body fluid contamination (with no visible blood) use hot water and detergent

will have a greater risk of wound infection. Scanlon (2005) concurs that the transition of a wound from being harmlessly colonised to becoming infected is very much determined by the individual's susceptibility to infection. It is important for healthcare professionals to understand this point in order to accurately assess individual vulnerability and to plan and deliver care to overcome or counteract these factors where possible, and provide the patient with accurate information.

Reducing the risk of infection

Nutrition

Healthcare professionals have a key role in assessing whether the patient has a healthy, well-balanced diet with enough calories, protein, vitamins and minerals to aid the wound healing process and reduce the risk of wound infection (Burton, 2006). All of these dietary components are crucial for uncomplicated wound healing. A recognised nutritional screening tool, such as the Malnutritional Screening Tool (MUST) (British Association for Parenteral and Enteral Nutrition [BAPEN], 2005) should be used to accurately assess the patient's nutritional status. The assessment should include discussion about food preferences and dislikes. Where specialist advice is required the patient should be referred to a dietitian.

Wound characteristics

Wound characteristics such as size, position, duration and presence of dead tissue or blood clots are all important factors that also impact on wound colonisation and infection (White et al, 2001). In terms of wound size, the larger the wound the greater the surface space for bacteria to contaminate, multiply and potentially lead to either wound colonisation or infection. There is an increased risk for patients undergoing major abdominal surgery as they will have a significantly large abdominal wound compared with patients undergoing minor surgery, such as removal of a bunion on the toe, where the resulting wound will be much smaller with less surface space for bacterial entry.

The position of a wound on the patient's body may also influence the amount of wound contamination that occurs, thus increasing the risk of wound colonisation and infection. Surgical wounds created following bowel surgery are likely to become heavily contaminated because the bowel itself is heavily colonised by large numbers of bacteria which can readily enter the wound site when surgery is performed. Similarly chronic wounds, such as sacral pressure sores, can become heavily contaminated with bacteria if the patient is faecally incontinent because faeces naturally contain large numbers of normal gut bacteria.

The duration of the wound also impacts on wound colonisation and infection. Older wounds, for

example, chronic wounds such as leg ulcers, are more likely to be heavily contaminated and colonised with a variety of micro-organisms, increasing the risk of wound infection, particularly if the patient has a poor immune response.

The presence of necrotic (dead) tissue, blood clots or other foreign material, such as dirt and mud, also increases infection risk, as all of these provide a focus for microbial multiplication.

Microbial characteristics

The type and/or number of bacteria present within a wound may influence whether it remains harmlessly colonised or becomes infected (Scanlon, 2005). Both of these factors are important as all organisms have differing levels of virulence, or ability to cause disease. Some organisms have low virulence and are unlikely to cause wound infection unless the bacteria are present in very large numbers and overwhelm the immune system by sheer quantity.

The bacterial loading — or bioburden — within the wound is particularly significant for patients with a reduced immune response (White et al, 2001), for instance those receiving chemotherapy. In contrast, other organisms have high virulence and will produce infection readily even if present in very low numbers. *S. aureus*, including methicillin-resistant *S. aureus* (MRSA), is often found in chronic wounds such as leg ulcers in large quantities but does not cause wound infection (Emmerson et al, 1996), while in contrast other organisms, such as beta-haemolytic streptococci, can cause wound infection even in low concentrations as these bacteria have much higher virulence (Robson, 1997).

Managing wound colonisation and infection

Healthcare professionals play a pivotal role in correctly identifying and managing wound colonisation and infection.

For colonised wounds it is important to monitor the wound regularly for any signs of change that may indicate the development of infection. Accurate documentation is vital for this process to inform other healthcare professionals involved in the patient's care about the status of the wound. Once assessed as being colonised, the wound should be dressed with an appropriate dressing product most suited to the wound type, following moist wound healing principles.

For infected wounds careful monitoring of the patient and the wound is required for signs of improvement or for early identification of further complications that may arise. Patients with particularly large, deep wound infections are potentially at risk of systemic infection, such as septicaemia (infection in the blood-stream) and consequently are at risk of multi-organ failure and possibly death. It is vital to monitor the patient carefully for signs of deterioration. This includes regular visualisation of the wound and monitoring the patient's body temperature to detect for pyrexia (raised body temperature), which may be indicative of spreading infection throughout the body. All observations must be carefully recorded and medical staff alerted at an early stage if abnormal observations are detected. Where wound infection is suspected a wound swab or aspirate of pus should be taken to identify the causative organisms.

Patients diagnosed with a wound infection will require systemic antibiotics; these will be prescribed according to available antibiotic sensitivities. Topical antibiotics should be avoided as they increase the risk of developing antibiotic-resistant organisms (Ovington and Eisenbud, 2004). Topical antiseptics may be useful.

Antiseptics are available in a variety of preparations, including solutions and dressings. Care needs to be taken when using antiseptic solutions as they can be toxic to wounds when used at high concentrations and may cause delayed healing (Scanlon, 2005). Dressings impregnated with antiseptics have much lower concentrations and often have slow-release mechanisms to minimise damage to the wound (Scanlon, 2005). Examples of antiseptic-impregnated dressings which may be useful include iodine and silver dressings, both of which have good action against most bacteria and fungi (see p.182–5).

Local wound dressing guidelines should be consulted and followed. If unsure about which type of dressing is most suitable, specialist advice should be sought from the tissue viability nurse specialist.

Reducing the risk of cross-infection

Patients with wounds represent a cross-infection risk, regardless of whether they have a wound that is colonised or infected. It is important to remember that one patient's wound colonisation may be another patient's wound infection if they are more susceptible to infection. For example, MRSA may colonise some patients' wounds, but equally has the ability to cause wound infection even if present in the same numbers in those patients who are vulnerable. Therefore, it is vital for healthcare professionals to adopt a set of standard infection control precautions (*Table 2*) with all patients at all times, regardless of any known cross-infection risk or not.

A number of factors may increase the risk of spreading micro-organisms from one patient to another. A primary means of cross-infection is via healthcare workers' hands (Wilson, 2001) which become readily contaminated during wound cleansing and dressing, even if disposable gloves are worn. This is because hands often become contaminated during glove removal. Furthermore, gloves can leak through micro-tears that are not visible to the naked eye but are large enough to allow micro-organisms through the gloves (Clark et al, 2002). If hands are not thoroughly washed following glove removal these bacteria may be spread to other patients. To minimise this risk healthcare professionals should undertake meticulous hand hygiene. Hands should be thoroughly cleaned before and after all clinical contact with patients where they are likely to become contaminated with micro-organisms, including following glove removal (Pratt et al, 2007).

Contaminated equipment and instruments may also spread micro-organisms from one wound to another (Kingsley, 2000). For example, a footstool used by a patient with a heavily discharging wound may act as an indirect source of cross-infection if the stool is not thoroughly cleaned before use by another patient. It is crucial that equipment that is used by many different patients is cleaned well between each patient use.

Poor wound dressing technique may be another important means of spreading infection. If aseptic or clean technique principles are not strictly adhered to while undertaking wound dressings, micro-organisms may be transferred from one wound to another (Wilson, 2001). Aseptic principles should be practised for all wounds healing by primary intention, such as those that are surgically created and a clean technique may be adopted for wounds healing by secondary intention, for example chronic wounds such as leg ulcers (Wilson, 2001).

When adopting aseptic principles it is important that only sterile items have contact with the vulnerable wound site to reduce the risk of wound infection; surgical wounds healing by primary intention will have few contaminating organisms present and it is important to keep microbial numbers low to facitate healing. In contrast, when using a clean technique for wounds healing by secondary intention, clean rather than sterile items may be used, for example, clean rather than sterile gloves, as these types of wounds are already likely to be heavily contaminated with micro-organisms.

Glossary

Antibiotic: a substance that is poisonous to bacteria.

Antiseptic: a chemical used to kill microbes on body surfaces.

Bioburden: the number of micro-organisms present on surfaces.

Cellulitis: inflammation of the tissues.

Exogenous: from outside to the body.

Exudate: discharge.

Hyperglycaemia: high blood sugar levels.

Micro-organisms: organisms too small to be seen with the naked eye, includes bacteria, viruses and fungi.

Necrotic: dead tissue.

Normal flora: the micro-organisms that colonise a body surface.

Pathogenic: a microbe capable of causing disease.

Pyrexia: raised body temperature.

Septicaemia: infection within the bloodstream.

Virulence: the ability or power of an organism to cause disease.

Conclusion

Bacteria are present in all wounds, however, their mere presence does not indicate wound infection. The role bacteria play within a wound will depend on a variety of factors, including the type of

bacteria present, numbers and their disease-causing ability, all balanced against individual patient vulnerability to infection and the nature of the wound itself. It is crucial for healthcare professionals to have an understanding of these contributing factors to comprehend the difference between wound colonisation and infection so that patients with wounds receive the most appropriate care. **WE**

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Key Points

- All wounds are contaminated with a variety of micro-organisms.
- Colonisation is the harmless presence of multiplying micro-organisms within a wound, but with no immune response. This is a normal state.
- Infection is the presence of multiplying micro-organisms that have overwhelmed the immune system, resulting in spreading cellulitis and producing an immune response. Infection is associated with active disease.
- Unexpected or increasing pain and wound breakdown are most likely to indicate wound infection.
- The balance between the patient's immune response, the wound and the micro-organisms determine whether a wound remains harmlessly colonised or becomes infected.
- Healthcare professionals play a key role in assessing and managing wound colonisation and infection.
- Wounds should be reassessed at all dressing changes for any sign of change.
- Standard infection control precautions should be employed with all patients and at all times to reduce the risk of cross-infection from one patient's wound to another.
- Thorough hand hygiene is crucial for reducing cross-infection risk.

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