# INVESTIGATING: WOUND INFECTION

Diagnosing infection in surgical and other wounds involves nurses being able to observe the clinical signs in a wound rather than simply obtaining positive microbiology results from the laboratory. This article aims to help nurses gain a good understanding of the clinical signs and symptoms of wound infection in order to help them make an accurate assessment and develop a plan of care.

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All wounds contain a variety of microorganisms, however it is only when wound infection is suspected from clinical signs that further investigation is required. Inappropriate wound investigation, such as routine wound swabbing, can provide confusing and misleading microbiology results.

Therefore, nurses need to have a good understanding of when wound investigation is indicated, the most appropriate method to use and how to interpret the results obtained. This is critical for establishing appropriate wound management strategies.

## Differentiating between colonisation and infection

Microbial bioburden within wounds can range from contamination, colonisation, critical colonisation and infection (Kelly, 2003) (*Table 1*).

These definitions suggest that while contamination and colonisation are normal states with no associated ill-health, in contrast critical colonisation and infection are both abnormal states that can result in a spectrum of disease with clinical signs and symptoms. This suggests that wound investigation should only be undertaken when there are clinical signs that a wound is indeed infected.

**Table 1.**

**Differentiating between contamination, colonisation, critical colonisation and infection**

| Wound state | Definition |
|---|---|
| Contamination | The presence of bacteria on the surface of a wound, without microbial multiplication (Stotts, 2004) |
| Colonisation | The presence of multiplying bacteria in a wound without a host immune response (Ayton, 1985) and without clinical signs and symptoms |
| Critical colonisation | The point at which the host immune response is no longer able to control the microorganisms colonising a wound (Kingsley, 2001) |
| Infection | The presence of multiplying microorganisms within a wound that overwhelm the host's immune response, with associated clinical signs and symptoms (Kingsley, 2001) |

## Assessing patients for wound infection

Diagnosing wound infection is a clinical skill, as progression along the wound infection continuum, from colonisation to infection, cannot be predicted by the mere presence of a specific type of microorganism or by a certain quantity of bacteria (Sibbald, 2003). This is because the host immune response plays a critical role in determining whether wound infection will arise. In a healthy host who is able to mount a robust immune response, the likelihood of infection will be reduced, as the host will be able to tolerate exposure to a larger microbial load and a greater variety of microorganisms.

Conversely, in the compromised host, exposure to the same quantity and variety of microorganisms carries an increased risk of wound infection due to the host's inability to mount a robust immune response. Where wound infection is suspected, wound investigation, such as swabbing, can help to confirm whether any microorganisms are present and direct antibiotic treatment.

There are several classic signs and symptoms of wound infection (*Table 2*), which may alert nurses that wound investigation is required. The inflammatory response that occurs in acute wounds gives rise to the following classic signs:

- Increased blood flow to the wound site, producing pyrexia (fever)
- Fluid leaking from intravascular spaces — causes visible tissue swelling
- Vasoactive mediators (agents affecting the diameter of blood vessels), e.g. histamines produce erythema (redness of the skin)
- Pain — caused when plasma mediators are activated near nerve endings (Sibbald, 2003).

However, while many patients will present with these frank signs and symptoms, making an accurate assessment can be harder when wounds display persistent inflammation or covert signs of wound infection.

Sibbald (2003) indicates that this may occur when the patient is traumatised enough to delay normal wound healing but not harmed enough to cause the typical inflammatory symptoms. Similarly, the patient may be unable to mount a robust immune response due to other comorbidities or risk factors, such as older patients with chronic disease, patients with neutropenia and patients receiving long-term steroid therapy or non-steroidal anti-inflammatory drugs (*Table 3)* (Beldon, 2001).

Patients with diabetes mellitus may also fail to present with the classic signs and symptoms due to a reduced white blood cell response (Mulder et al,1998). Increased vigilance is needed to detect for additional signs and symptoms that the patient may present with (*Table 2*). In patients with diabetes, the most obvious or accurate sign of wound infection may be delayed wound healing. However, it should be noted that other local and systemic factors can also delay the normal wound healing process, for example a poor blood and oxygen supply

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at the site of the wound due to the patient's general health and comorbidities, advancing age, obesity, smoking and poor nutrition.

Therefore, in the case of delayed wound healing the patient should be fully assessed and investigated for wound infection, as delayed healing may arise due to a variety of factors rather than infection alone (although these factors may also increase host susceptibility to wound infection).

## Wound investigations

Wound investigation should generally only be undertaken in wounds that are not healing and display signs and symptoms of infection (Gilchrist, 2000), or for the presence of multi-resistant bacteria, such as meticillin resistant *Staphylococcus aureus* (MRSA) or Vancomycin-resistant *enterococci* (VRE), in accordance with local infection control guidelines.

Routine investigation of a wound that is healing within the expected time frame and which does not display clinical signs and symptoms of infection, is unnecessary (Sibbald, 2003). Wound investigation can be quantitative or qualitative or both; however there is a lack of consensus in the literature about the best method to use.

### Wound tissue sampling

Deep tissue biopsy provides a reliable method of wound sampling, after debridement of slough or necrotic tissue from the surface of a wound (Neil and Munro, 1997). It involves culturing biopsy tissue (a biopsy involves medical removal of tissue from a living subject to determine the

**Table 2.**

Signs and symptoms of wound infection

| Classic signs | Additional signs |
|---|---|
| • Pyrexia | • Delayed healing |
| • Inflammation | • Bridging of skin across a wound |
| • Oedema | • Dark/discoloured granulation tissue |
| • Pain | • Increased friability (tissue which bleeds easily) |
| • Increase in exudate or pus | • Painful/altered sensation to the wound site/surrounding skin |
| | • Altered odour |
| | • Wound breakdown |
| | • Pocketing at the base of the wound |
| | • Increased watery/serous exudate rather than pus |

presence of disease) to obtain quantitative and qualitative microbiology results.

It is thought that once a bacterial load of 106 colony forming units per gram of tissue (CFU/g) is reached, wound healing is usually impaired (Dow, 2001). However, a high bacterial load does not always equate to wound infection as host susceptibility plays a key role. On the other hand, with some microorganisms, such as beta-haemolytic streptococci, even small quantities of bacteria can result in wound infection due to high microbial virulence factors (mechanisms for causing disease). Another limitation of quantitative sampling is that the results may not accurately reflect the true microbial load due to uneven distribution of microorganisms in wounds. This method of wound sampling has restricted use in day-to-day healthcare practice, particularly as it may be traumatic for the patient (Bowler et al, 2001).

## Wound fluid sampling

In wounds where there is a large amount of exudate present, the exudate from the deeper pockets of the wound may be sampled by needle aspiration using an aseptic technique (Bowler et al, 2001). This method of sampling may not be as accurate as tissue sampling, however it is easier to undertake, and provides reliable results.

## Wound swabbing

**The most frequently used method of wound sampling is collection of a wound swab from the surface of a wound.**

The most simple and frequently used method of wound sampling is the collection of a wound swab from the surface of a wound using a cotton-tipped swab.

However, it may be questioned whether a surface wound swab provides accurate results about the microorganisms causing infection at the bed of a wound, or just provides information about colonising bacteria. In addition, routine wound swabbing, for instance at weekly intervals or at the time of frequent dressing changes, is not clinically helpful or cost-effective (Cooper and Lawrence, 1996). Therefore, wound swabs should only be collected when clinically indicated or if advised as part of screening for multiresistant organisms.

The area of the wound that appears clinically infected should be swabbed as there is little value to swabbing dry, healthy areas of a wound (Wilson, 2006).

Furthermore, Kelly (2003) indicates that swabbing of sloughy areas of a wound, including pockets of exudate, should be avoided as these areas are most likely to identify surface contaminants rather than pathogens responsible for causing wound infection. As a result of this, gross exudate should be cleansed before swabbing to help achieve accurate microbiology results.

Where areas of a wound with the most obvious signs of infection appear dry, pre-moistening the swab with saline can increase the pick-up rate (Sibbald, 2003). The tip of the swab should be applied in one full rotation over the affected area. A zigzag pattern can be used for wounds larger than 5cm$^2$ (Sibbald, 2003), although covering the whole wound would not be practical if the wound is large.

**Table 3.**

Risk factors for wound infection (Collier, 2004)

| Local risk factors | Systemic risk factors |
|---|---|
| • Large/deep open wound | • Vascular disease |
| • Chronic wound present for a long period of time | • Oedema |
| • Anatomical location on body, e.g. close proximity to anus/urethra increases risk to additional contamination | • Malnutrition |
| • Foreign bodies present | • Diabetes mellitus |
| • Necrotic tissue present | • Alcoholism |
| • Wound type and mechanism of contamination, i.e. dirty wound contaminated environmentally during a road traffic accident | • Radiotherapy |
| • Heavily contaminated | • Corticosteroids/other immunosuppressants |
| • Reduced blood and oxygen perfusion | |

## Completing the microbiology request form

Bowler et al (2001) stress the importance of providing accurate and relevant information to the microbiology laboratory in order to facilitate appropriate wound investigation. Patient details, including name

and hospital number, should be provided using legible writing or electronically, depending on the system available. If this basic information is illegible or missing, the microbiology laboratory will find it difficult to process the specimen.

Other relevant information includes the type and site of the wound, whether the wound appears infected and whether the patient is receiving antibiotics or other antimicrobials (Kelly, 2003). These details can help the laboratory to identify the most likely causative pathogen (disease-causing organism) (Kelly, 2003), and is particularly important in polymicrobial wounds where more than one organism may be present.

## Interpreting microbiology results

Diagnosing wound infection is essentially a clinical skill and microbiological investigations should only be used to aid diagnosis, rather than the other way round (Sibbald, 2003). Microbiology results can identify specific bacteria present in a wound but cannot predict whether it will remain colonised or go on to become infected; the determining factor is the susceptibility of the individual patient and their ability to mount a robust immune response.

Furthermore, in polymicrobial wounds where several microorganisms are identified, wound infection may occur as a consequence of synergy between the organisms, which increases their overall virulence, even though individually the organisms are of low virulence.

Conversely, where a microbiology result of 'no growth' or 'no significant growth' is returned, the result should be interpreted with care and should not be automatically interpreted as meaning that no infection is present, particularly if the patient has clinical signs and symptoms that suggest otherwise. In this situation such a result should be regarded as a false negative (Kingsley, 2003).

Furthermore, microbiology results can vary depending on the quality of the swab taken and the information provided on the specimen request form (Parker, 2000).

It may be argued that swab results are a reflection of the swabbing technique employed and if a poor swabbing technique is used, it is likely that false negative results will be returned. Therefore, it is vital to manage and treat the patient and not the microbiology result.

**Table 4.**

Examples of bacteria that can infect wounds

| Type of microorganism | Examples |
|---|---|
| Gram-positive cocci | Beta-heamolytic *Streptococcus* (*Streptococcus pyogenes*)*<br>*Enterococcus* (*Enterococcus faecalis*)<br>*Staphylococcus* (sensitive *Staphylococcus aureus* and resistant *Staphylococcus aureus* (MRSA)* |
| Gram-negative aerobic rods | *Pseudomonas aeruginosa** |
| Gram-negative facultative rods | *Enterobacter* species<br>*Escherichia coli*<br>*Klebsiella* species<br>*Proteus* species |
| Anaerobes | *Bacteroides*<br>*Clostridium* |
| Fungi | Yeasts (*Candida*)<br>*Aspergillus* |

*Microorganisms most commonly associated with causing wound infection (Collier, 2004)

## Infected wounds: potential causative species

A number of bacteria may

potentially cause wound infection (*Table 4*).

However, while fungi can be isolated from wounds and can cause superficial infections of the skin, nails and hair, they are rarely responsible for causing wound infection. Similarly, viruses do not usually cause wound infection.

## CONCLUSION

Diagnosing wound infection is a clinical skill that involves more than merely obtaining positive microbiology results. Therefore, healthcare professionals need to have a good understanding of the clinical signs and symptoms in order to be able to make an accurate assessment. Wound investigation, such as wound swabbing, can aid the diagnosis and help direct appropriate antibiotic treatment and wound management strategies. WE

**Key points**

- **Diagnosing wound infection is a clinical skill.**
- **Progression along the wound infection continuum, from colonisation to infection, cannot be predicted by the mere presence of a specific type of microorganism or by a certain quantity of bacteria.**
- **Nurses need to have a good understanding of the clinical signs and symptoms in order to be able to make an accurate assessment.**
- **Wound investigation, such as wound swabbing, can aid the diagnosis and help direct appropriate antibiotic treatment and wound management strategies.**


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