

Ten top tips: identification of wound infection in a chronic wound

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Wound healing is a complex process that can be interrupted or impaired by a variety of factors. This article will focus on the microbial bioburden in chronic wounds. The classic signs of infection may not be obvious in patients who are immunocompromised, such as people with diabetes mellitus, those with peripheral vascular disease, or those taking medications that dampen inflammation, such as steroids. That is why clinicians and patients should be aware of the secondary signs and symptoms of wound infection. The International Wound Infection Institute (IWII) presents ten top tips focusing on the identification of wound infection in a chronic wound.

1 Chronic and acute wounds are different

There are a variety of ways to describe wounds. One of the most common is to broadly differentiate between 'acute' and 'chronic'. An acute wound is one that goes through an orderly and timely healing process with sustained restoration of anatomical integrity, while healing is impaired in a chronic wound due to intrinsic and extrinsic factors that impact on the person, their wound or their healing environment^[1,2].

Although chronic wounds include a variety of aetiologies they appear to share certain characteristics in regards to the imbalance or impairment of growth factors, cytokines, and/or matrix metalloproteinases (MMPs) within the wound that keeps the wound from progressing through the phases of healing^[3]. A majority of chronic wounds — up to 60% — may have biofilm that contributes to maintaining a wound in the inflammatory phase of healing and requires additional measures to disrupt them^[4].

2 Understand the wound infection continuum and related definitions

The wound/host/bacteria relationship can be described as a continuum [Figure 1] as the bacterial status of the wound is continuously changing depending on local, environmental and systemic factors^[5]. There are many definitions for a wound infection, but a simple definition is: impairment of wound healing by bacteria^[5]. Since the mid-2000s, the quantitative definition of infection has been held at 10⁵

colony forming units (cfu) per square centimetre or gram of tissue, but this does not take into effect virulent factors of certain microbes^[6].

Wounds provide an opportunity for microbial species to gain access to exposed human tissue and, as a result, initiates a complex series of interactions between potential pathogens and the host^[7]. The outcome is not predictable, but some definitions commonly used are:

- Contamination results when microbes fail to find suitable conditions to support their growth and division, hence their persistence in the wound is transient^[8]
- Colonisation is achieved when microbial cells grow and divide in the wound environment, without evoking a systemic immune response in the host or overt clinical symptoms of infection. A stable balance is established. Hence, microbes persist in a wound without impeding the healing process^[9]
- Local infection occurs when the microbes and their products have invaded local tissues and some subtle impairment to healing may be noted^[10]
- Spreading infection is noted when microbes have invaded the wound and surrounding tissues and signs of classic or secondary signs and symptoms of infection may be noted.
- Systemic infection is noted when there are signs and symptoms systemically that the patient is unwell. Indicators may be fever, feeling unwell and elevated white cell count. Signs and symptoms arise systemically, as well as within the wound environment.

The transition from non-infected to infected wound is gradual and has not been well characterised. Furthermore, the multiple ways in which microbes and their by-products impact on healing are not yet fully understood. Over the past 15 years, the term critical colonisation has been utilised to describe an intermediate state, but there is not one consistent definition^[8]. However, an association between the presence of biofilm (or bacterial aggregates) and wound chronicity was demonstrated in 2008^[11-14], and this has provided a plausible explanation of why some wounds fail to heal.

3 Know how to recognise a local infection

In localised infection, bacteria are more deeply invasive and the wound bed is involved. Host

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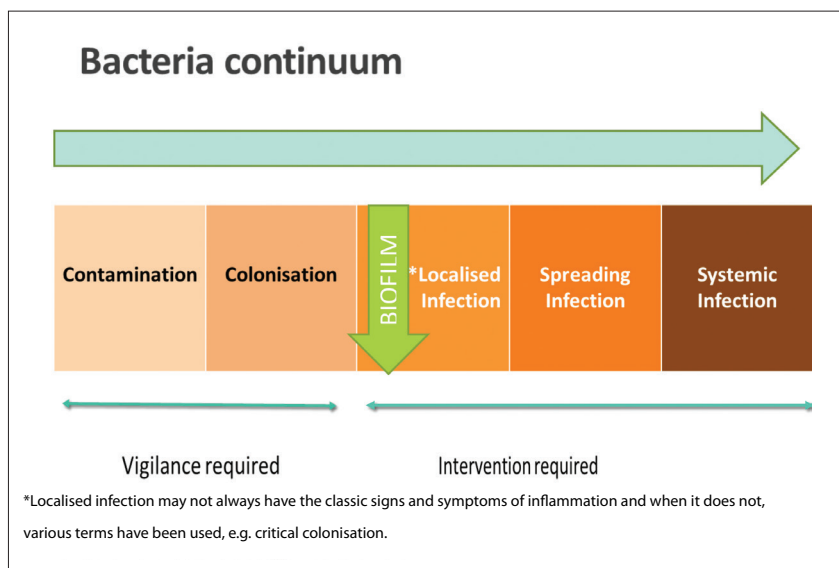


Figure 1. Wound Infection Continuum adapted from *Principles of Best Practice: Wound Infection in Clinical Practice: An International Consensus*. London: MEP Ltd, 2008^[15].

response is localised and the classic signs and symptoms of infection may be absent^[15]. Cutting and Harding first identified the subtle signs of localised infection^[16]. Gardner et al later validated these subtle signs^[17]. Healing is compromised in healable wounds. Subtle signs of infection may include:

- Increased or altered exudate
- Friable, bright red granulation tissue
- Increased odour
- Increased pain
- Localised oedema.

Any combination of two or more of the above subtle signs and symptoms is diagnostic of localised infection. Intervention is, therefore, required. Localised infection can often be managed with local measures, such as topical antimicrobials or antimicrobial dressings, in addition to effective debridement.

4 Know how to recognise a spreading infection

In spreading infection, bacteria now involve the surrounding tissues. In addition to the subtle signs described above, classic signs of infection, such as pain, redness, heat and swelling, may be present. Other signs and symptoms include:

- Wound breakdown with satellite lesions
- Induration and redness greater than 2 cm from wound or incision line
- Lymphangitis
- General malaise.

Any one of these signs or symptoms in combination with any of the subtle signs of infection is diagnostic of spreading infection. Intervention is required involving both

local and systemic measures, including systemic antibiotics^[18].

5 Biofilm is difficult to detect

At the present time, a routine laboratory test for the detection of biofilms in wounds has not been established. Problems arise because biofilms in tissues are normally small (4–200 µm) and can easily be missed^[19]. Biofilms may be located beneath the wound surface^[20] and their detection depends on specialist techniques, such as scanning electron microscopy and confocal laser scanning microscopy^[21–23] that are not routinely available in clinical diagnostic laboratories. Biofilms do not normally grow when processed routinely in microbiology clinical laboratories or pathology laboratories.

The European Society of Clinical Microbiology and Infectious Disease (ESCMID) recently published guidelines for the diagnosis and treatment of biofilm infections^[23]. It recommends a biopsy as the most reliable sample for detecting biofilm. Wound swabs were considered to be unsuitable due to surface contamination from skin flora, the strong adherence of biofilm to host tissue and the growth of anaerobes in deep tissue

There are initiatives to develop clinical indicators of a wound with biofilm and differentiation of slough to assist the everyday clinician in their decision making and application of therapies^[24–25].

6 Wound culture does not diagnose infection, but know how to get the best information

Diagnosing infections in wounds largely relies on presenting clinical signs and symptoms of the infection, and requires empirical antimicrobial intervention when spreading infection occurs. For more than 150 years, planktonic pathogens have been isolated and identified from clinical specimens by traditional culturing methods. This provides qualitative information to the practitioner on any potential pathogens that are present, and their antibiotic susceptibilities.

It does not yield information on all species detected. In addition, not every wound requires microbial investigation. However, failure of an antimicrobial intervention, the need to identify patients with wounds colonised with particular pathogens (such as methicillin-resistant *Staphylococcus aureus* [MRSA] or beta haemolytic streptococci) or failure to heal are suitable reasons to request laboratory assistance.

Although there is still controversy regarding the best way to 'culture a wound', there is consensus that the wound needs to be prepared to have

the culture taken. This requires that the wound is cleansed with sterile water or normal saline. If there are no contraindications, the wound is debrided and cleansed again with normal saline. If the wound is dry, the culture tip is placed in an area of viable or clean tissue in the wound without touching the wound edge or periwound and with downward pressure rotating the swab over 1 cm² on the wound. The amount of pressure is subjective, but sufficient pressure to express fluid from within the wound tissue is required^[26]. This is called the Levine technique.

Another technique is the zig-zag method where, after preparation, the culture swab is moved across the wound surface in a zig-zag motion, at the same time as being rotated between the fingers, again with enough downward pressure to release fluid from the wound surface is required^[27]. Negative cultures do not necessarily rule out wound infection. The laboratory will provide optimum information when given accurate details about:

- The patient, (relevant medical history, i.e., peripheral vascular disease or diabetes mellitus)
- The aetiology, duration and location of the wound
- The reason for sampling (ie, suspected *Pseudomonas* or screening)
- What previous antimicrobial treatments have been utilised (especially systemic antibiotics).

One way to obtain the best information is to develop a good rapport and good communication with the microbiologists in the laboratory. Clinicians should not be afraid to call or visit.

7 Diagnostics not including a wound culture

The developments of molecular-based diagnostics are improving the detection and identification of microorganisms and helping to improve individualised therapies. One of the most important recent advances has been the use of advanced DNA sequencing techniques that can identify essentially all bacterial species and many fungal species that are present in debridement tissue samples of chronic wounds^[28-29].

Important general conclusions that emerged from these studies are that: (1) standard clinical microbiology laboratory results only detect growth of a small percentage of the total bacterial species that are actually present in chronic wounds; (2) fungi are present in a substantial percentage (23%) of chronic wounds; (3) strict anaerobic bacteria were typically present in all three major classes of chronic skin wounds (pressure ulcers, diabetic foot ulcers and venous leg ulcers) and accounted for 60% of all the bacterial species identified by

DNA sequencing technology in chronic pressure ulcers; and (4) patients who received personalised topical therapeutics (including antibiotics) based on the results of the DNA identification of bacteria and fungi had statistically and clinically significant improvements in outcome compared to patients who were prescribed systemic antibiotics on the basis of empiric and traditional culture-based methodologies^[30].

A normal culture will not reveal biofilm. There are new point of care diagnostics that indicate if the wound is high in proteases, which can indicate chronic inflammation commonly associated with biofilm. There is no rapid point of care for indication of bacteria in a wound^[31].

8 Topical management

Irrigate debris from the wound bed with each dressing change. No particular wound irrigant is advantageous over another; saline and potable water are commonly used in clean, low risk wounds. The irrigant must be applied with enough force to lift the debris from the wound without harming the wound bed. Guidelines recommend 4–15 pounds per square inch (psi); and a 35 ml syringe with a 19-gauge needle provides 8 psi^[32]. Contaminated and at-risk wounds should be irrigated with surfactants^[33].

Topical antibiotics should not be routinely applied to superficial wounds that have no clinical signs or symptoms of infection^[34]. Application of topical triple antibiotic, double antibiotic and mupirocin ointments to wounds and incisions is sometimes routine practice. The ointment provides an environmental barrier, antibiotic coverage and moisture to reduce scarring.

However, evidence for this practice is lacking. Several studies demonstrated that post-excisional skin wounds had better healing rates with paraffin compared to mupirocin^[35], while another compared healing rates of wounds from removal of actinic keratosis. Wounds being treated with Aquaphor (Beiersdorf) had better healing rates compared to Neosporin® (Pliva Pharma)^[36].

Local infection

Any abscess in the wound should be drained. If the abscess is superficial and the patient is not immunocompromised, antiseptics may not be needed. Antiseptic-impregnated dressings should be applied to infected or critically colonised wounds.

Antiseptics are primarily used for wounds in the inflammatory phase of wound healing, especially those wounds that are heavily contaminated or clinically infected. Wounds in the proliferative phase of wound healing do

not generally benefit from antiseptics; the cells mediating this phase of healing are often retarded by these agents. The following topical agents have been shown to have efficacy in reducing bacterial burden:

- Acetic acid: *Pseudomonas*^[37]
- Cadexomer Iodine^[38]
- Medical grade honey: MRSA^[39]
- Polyhexamethylene biguanide: MRSA, *Pseudomonas*^[40]
- Sodium hypochlorite (Dakin's solution): *S aureus*, *Pseudomonas*, *E coli*, *Enterococcus*, *Bacteroides*^[41]
- Silver: varied kill rates depending on formulation on *E coli*, *Enterococcus*, MRSA, *Pseudomonas*, *K pneumoniae*^[42]

Spreading infection

Empiric antibiotics should be prescribed for patients with clinically infected wounds after wound tissue cultures are obtained and the patient is receiving local wound care.

Patients with mild to moderate infections in diabetic foot ulcers should be started on antibiotics targeted at aerobic Gram-positive cocci. For more serious infections, a broad-spectrum antibiotic should be used empirically pending culture and antibiotic sensitivity results. Therapy for MRSA should be considered in patients with a prior history of MRSA or if the infection is severe^[34].

9 Aseptic technique for a chronic wound

Aseptic technique is utilised to protect patients during clinical procedures by employing infection control measures to minimise the presence of pathogenic microorganisms^[43]. There are two types of aseptic fields — standard and surgical — that require different management strategies depending on whether the purpose is to ensure or promote asepsis.

Standard asepsis is used for procedures that are usually less technical in nature for a dressing procedure, involves less time (usually less than 20 minutes wound exposure) and involves few or small wounds or equipment. Non-sterile gloves may be used while still maintaining a no-touch technique and protection of key parts of equipment and wound sites.

Meanwhile, surgical asepsis is required when procedures are technically complex, involve extended periods of time (greater than 20 minutes of wound exposure), have large open wounds or key sites, or involve numerous

key parts of equipment. A main critical aseptic field and sterile gloves are required and often full barrier precautions. Non-touch technique, while also maintaining micro aseptic field, is also encouraged, such as not touching the inside of a disc when placing NPWT^[43].

Aseptic non-touch technique (ANTT)[®] is a framework for aseptic practice and provides guiding principles for a variety of settings. In regards to chronic wound management, a risk assessment is conducted by the clinician to determine which aseptic technique is justified for this particular wound. The risk assessment should include the technical difficulty and how confident the clinician is in completing a dressing procedure.

Simple measures in the home setting, such as hand hygiene using alcohol hand cleansers, gloves, a clean surface to place supplies and conduct the procedure can achieve aseptic technique in the home. The type of glove chosen depends on the complexity of the procedure and risk. Regardless of the gloves used, a non-touch technique is recommended when dealing with key parts of the equipment. Potable tap water can be used for cleansing the chronic wound if that has been determined as appropriate.

10 Prevention, identification and education

Patient education should be focused on preventing the spread of infection and cleaning the wound bed. In addition to local infection, wound healing is also affected by other factors, such as comorbidities, wound pain, oxygen supply to the wound area, and patient adherence to treatment. Patients should be instructed how to keep draining wounds covered and how and when to change dressings. The patient should be encouraged to maintain good personal hygiene with regular showers and hand washing with soap and water or alcohol-based hand gels, particularly after touching infected skin or items that have directly contacted a draining wound^[44]. Environmental cleaning should be focused on surfaces that come into frequent contact with bare skin.

Teach the patient how to shower

Showering with potable water is an acceptable means to keep the wound bed clean. The patient or family should be asked to describe the bathroom and help them to determine how to facilitate the shower without increasing the risk of falls. Plastic lawn chairs are usually stable on the shower floor and allow the water to drain. If it has been recommended that the wound remain covered during showering, the patient

will have to ensure the dressing is waterproof, if it is not already protected. Bathing is not recommended.

Conclusion

Signs and symptoms of chronic wounds may be subtle until the wound infection becomes severe. Assessment of the wound and its progression should be documented and triggers such as deterioration, static

wound and new ulcerations should alert the clinician to act in some proactive manner to determine the 'why' and alter management of the wound and or patient as required. There is enough information available to know that chronic wounds are different and account for most of the wounds encountered in the community. Effective assessment and proactive management will provide optimal care.

WINT

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