Wound Infection in Clinical Practice

Introduction
Wound infection can lead to protracted wound healing, multiple health service visits and increased hospital admission duration. This comes at significant economic cost and negatively impacts quality of life outcomes for the patient with a wound and their family. Accurate and timely identification of the signs and symptoms of wound infection is critical to achieving effective management of wound infection. This Made Easy will introduce the new edition of Wound Infection in Clinical Practice (International Wound Infection Institute [IWII], 2022) and provide an overall view of prevention and management of wound infection from identification and assessment to antimicrobial resistance (AMR) and antimicrobial stewardship (AMS).

International consensus update 2022
The 2022 edition of Wound Infection in Clinical Practice, authored by the IWII Committee, is an update from the previous consensus document published in 2016 (IWII, 2016). Advances in research and clinical practice relating to the wound environment, risk factors for infection, biofilm, AMR, and new technologies for identification and management of wound infection have been incorporated into the update (IWII, 2022). The intention is to provide practical information based on the latest understanding of the science and clinical applications regarding wound infection, which continues to be challenging for people with a wound, their families and health professionals.

In updating the document, rigorous methodology was implemented, including a systematic literature review, a Delphi process (to refine definitions), critical appraisal of the evidence on clinical efficacy of topical antimicrobials, and peer review from global key interdisciplinary opinion leaders.

Identification and assessment
Wound infection is when the quantity of microorganisms in a wound becomes imbalanced, the host response is overwhelmed and wound healing becomes impaired (Swanson et al, 2015). The transition from non-infected to infected is a gradual process determined by the quantity and virulence of microbial burden and the individual’s immune response (IWII, 2016; IWII, 2022).

The IWII Wound Infection Continuum (IWII-WIC)
The IWII-WIC has evolved over time as the understanding of wound infection advances (Figure 1). Conceptually, the concept of covert (subtle) local wound infection is now used to describe the clinical indicators primarily observed in the chronic wound before the wound exhibits overt (classic) signs and symptoms of local wound infection.
The IWII-WIC includes five conceptual stages [Box 1] that
detail the signs and symptoms commonly exhibited
by the individual and the wound as infection develops.
Definitions for these five stages were recently agreed on in
an international consensus process (Haesler et al, 2022).

**Box 1. IWII five conceptual stages (IWII, 2022)**

- **Contamination** — presence within the wound of
  microorganisms that are presumed not to be proliferating.
  No significant host reaction is evoked and no delay in wound
  healing is clinically observed (Haesler et al, 2022)

- **Colonisation** — presence of microorganisms within
  the wound that are presumed to be undergoing limited
  proliferation. In a colonised wound, no significant host
  reaction is evoked, and no delay in wound healing is clinically
  observed (Haesler et al, 2022)

- **Local infection (covert and overt stages)** — presence and
  proliferation of microorganisms within the wound that evoke
  a response from the host, often including a delay in wound
  healing. Local infection is contained within the wound and
  the immediate periwound region (less than 2cm)

- **Spreading infection** — invasion of the surrounding tissue by
  infective microorganisms that have spread greater than 2cm
  from a wound. Microorganisms proliferate and spread to a
  degree that signs and symptoms extend beyond the wound
  border (World Union of Wound Healing Societies [WUWHS],
  2008; Leaper et al, 2012)

- **Systemic infection** — microorganisms spread throughout
  the body via the vascular or lymphatic systems, evoking a
  host response that affects the body as a whole. In the context
  of wound infection, microorganisms spread from a locally
  infected wound. Signs of systemic infection include sepsis —
  referral and immediate treatment in such instances is vital.

**Collaboration, prevention and management**

A holistic and collaborative approach is vital to the delivery
of best practice in the prevention, diagnosis, assessment and
management of wound infection. Ultimately, collaborating
with the patient and their family caregiver in care decisions
can help to reduce the physical and psychosocial impact of
wound infection.

**Enhancing patient engagement**

A fundamental principle of holistic assessment and management is
engagement of the patient and their family caregiver in the process
to understand their priorities, care goals and ability to be involved
in managing the wound (Wounds International, 2012; Fletcher and
Barrett, 2018). Multidisciplinary teams are optimal, and a key player
in the team is the patient themselves (WUWHS, 2020).

Empowering patients using clear communication and
providing education tailored to the patient can offset
anxiety about wound infection, enhance self-care skills and
improve clinical outcomes (Wounds UK, 2018).

**Holistic prevention and management of wound infection**

Knowing the risk factors identified through assessment and
then addressing them or encouraging modification of lifestyle
choices through education and negotiation with the patient
are essential.

It is important to inform the patient and team members
that standard of care for the diagnosis is essential, as well as
adequate wound bed preparation/hygiene. Table 1 outlines
individual, wound and environmental risk factors associated
with wound infection.

A comprehensive wound infection prevention and management
plan should develop from assessment outcomes and aim to
achieve the patient’s goals of care. Holistic management addresses:
- Optimising the individual host response (WUWHS, 2008)
- Reducing local microbial burden (WUWHS, 2008)
- Promoting a positive environment for wound healing (WUWHS,
  2008; Burden and Thornton, 2018).

Strategies to address these domains are summarised in Figure 2.
Table 1. Factors associated with increased risk of wound infection (IWII, 2022)

<table>
<thead>
<tr>
<th>Individual (host) risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ Poorly controlled diabetes (i.e. hyperglycaemia)</td>
</tr>
<tr>
<td>■ Peripheral neuropathy (sensory, motor, and autonomic)</td>
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<tr>
<td>■ Neuroarthropathy</td>
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<tr>
<td>■ Radiation therapy or chemotherapy</td>
</tr>
<tr>
<td>■ Conditions associated with hypoxia and/or poor tissue perfusion (e.g. anaemia, cardiac disease, respiratory disease, peripheral arterial disease, renal impairment or rheumatoid arthritis)</td>
</tr>
<tr>
<td>■ Immune system disorders (e.g. acquired immune deficiency syndrome)</td>
</tr>
<tr>
<td>■ Connective tissue disorders (e.g. Ehlers-Danlos syndrome)</td>
</tr>
<tr>
<td>■ Corticosteroid use</td>
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<tr>
<td>■ Malnutrition or obesity</td>
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<tr>
<td>■ Alcohol, smoking or illicit drug use</td>
</tr>
<tr>
<td>■ Poor compliance with treatment plan</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Wound risk factors</th>
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<tbody>
<tr>
<td>■ Contaminated or dirty wounds</td>
</tr>
<tr>
<td>■ Traumatic injuries</td>
</tr>
<tr>
<td>■ Operation is classified as contaminated or dirty</td>
</tr>
<tr>
<td>■ Inappropriate hair removal</td>
</tr>
<tr>
<td>■ Operative factors (e.g. prolonged surgery, blood transfusion or hypothermia)</td>
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<table>
<thead>
<tr>
<th>Chronic wounds</th>
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<tbody>
<tr>
<td>■ Duration of wound</td>
</tr>
<tr>
<td>■ Large wounds</td>
</tr>
<tr>
<td>■ Anatomically located near a site of potential contamination (e.g. perineum or sacrum)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acute and chronic wounds</th>
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</thead>
<tbody>
<tr>
<td>■ Foreign body presence (e.g. drains, sutures or wound dressing fragments)</td>
</tr>
<tr>
<td>■ Haematoma</td>
</tr>
<tr>
<td>■ Necrotic or sloughy wound tissue</td>
</tr>
<tr>
<td>■ Impaired tissue perfusion</td>
</tr>
<tr>
<td>■ Increased exudate and oedema that is not adequately managed</td>
</tr>
<tr>
<td>■ Wounds over bony prominences or probing to bone</td>
</tr>
<tr>
<td>■ Involvement of tissue deeper than skin and subcutaneous tissues (e.g. tendon, muscle, joint or bone)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental risk factors</th>
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</thead>
<tbody>
<tr>
<td>■ Unhygienic environment (e.g. dust, unclean surfaces, or presence of mould/mildew)</td>
</tr>
<tr>
<td>■ Hospitalisation (due to increased risk of exposure to antibiotic resistant microorganisms)</td>
</tr>
<tr>
<td>■ Inadequate hand hygiene and aseptic technique</td>
</tr>
<tr>
<td>■ Inadequate management of moisture (e.g. due to exudate, incontinence or perspiration)</td>
</tr>
<tr>
<td>■ Interface pressure that is inadequately off-loaded</td>
</tr>
</tbody>
</table>

**Antimicrobial resistance and antimicrobial stewardship**

Implementing an organisational-level antimicrobial stewardship (AMS) committee to provide guidance, monitoring and education on appropriate antimicrobial use is key. It is also recommended that the principles of AMS are embedded into undergraduate healthcare curricula — these are discussed in detail below.

**What is antimicrobial resistance?**

Antimicrobial resistance (AMR) occurs when microorganisms naturally evolve in ways that cause medications used to cure infections to be ineffective. When the microorganisms become resistant to most antimicrobials they are often referred to as ‘superbugs’ (Edwards-Jones, 2018; World Health Organization, 2020).

Studies suggest there is excessive use of antibiotics in individuals with non-healing wounds (IWII, 2022). More judicious antimicrobial use in wound practice will contribute significantly to a reduction in AMR and help to reduce both poor health outcomes and the economic burden associated with side effects of antimicrobials. Reviewing wound care practice and aligning wound infection prevention and management with the goals and principles of AMS is imperative to addressing the global problem of AMR.
What is AMS?
AMS refers to the supervised and organised use of antimicrobial agents. In healthcare, this refers to a coordinated programme designed to decrease the spread of infections caused by multidrug-resistant organisms and improve clinical outcomes by encouraging appropriate and optimised use of all antimicrobials (The Association for Professionals in Infection Control and Epidemiology, 2021).

Initiatives that should form a component of AMS in the context of wound infection
Given the identified issues of AMR associated with wound care, the imperative to implement AMS strategies in ensuring judicious use of antimicrobials is clear. Table 2 provides an overview of initiatives that should form a component of AMS in the context of wound infection at governmental, organisational and clinical levels. The introduction of such initiatives will optimise antibiotic prescribing, reduce inappropriate antimicrobial use, reduce adverse consequences of antimicrobials (e.g. toxicity resistance) and reduce unnecessary economic burden (Rippon et al, 2021).

Clinicians play a significant role in ensuring their practice in prevention and management of wound infection is consistent with AMS. Clinicians should conduct an in-depth wound assessment to identify if the wound is clinically infected (Roberts et al, 2017).
There is no requirement for using topical antimicrobial agents based on individual assessment recognising comorbidities if there are no clinical signs and symptoms of wound infection. Antimicrobials should only be used in identified infected wounds, based on identification of the infecting organisms; antimicrobial use for chronic prophylaxis should be avoided other than in exceptional circumstances.

Figure 2: Holistic wound infection prevention and management

Scan the QR code to see Antimicrobial Resistance and Stewardship (IWII, 2022).
Table 2. Antimicrobial stewardship initiatives (IWII, 2022)

<table>
<thead>
<tr>
<th>Government level antimicrobial stewardship initiatives</th>
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</thead>
<tbody>
<tr>
<td>■ Promote global regulation of prescription and supply of antimicrobials</td>
</tr>
<tr>
<td>■ Support global initiatives focused on reducing AMR</td>
</tr>
<tr>
<td>■ Promote awareness of AMR in the health and animal sectors and the general public</td>
</tr>
<tr>
<td>■ Support and stimulate ongoing research on AMR and development of new antimicrobial agents</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organisational level antimicrobial stewardship initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ Provide adequate funding and resources to support AMS</td>
</tr>
<tr>
<td>■ Convene an AMS committee responsible for guiding and monitoring the use of antimicrobial agents in the facility</td>
</tr>
<tr>
<td>■ Develop institutional policies and procedures on the use of antimicrobial agents based on global guidance</td>
</tr>
<tr>
<td>■ Implement best clinical practice in wound infection prevention and treatment</td>
</tr>
<tr>
<td>■ Facilitate accurate diagnosis of wound infection with appropriate policies, resources and care pathways</td>
</tr>
<tr>
<td>■ Monitor trends in microbial sensitivities in the facility</td>
</tr>
<tr>
<td>■ Audit antimicrobial prescribing and patterns of use</td>
</tr>
<tr>
<td>■ Monitor and publish incidence of wound infection, types of wounds being managed with antimicrobial agents and their effectiveness</td>
</tr>
<tr>
<td>■ Provide regular education to all stakeholders on AMR and AMS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clinical level antimicrobial stewardship initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ Educate patients, their families and healthcare professionals regarding AMR and responsible use of antimicrobial agents</td>
</tr>
<tr>
<td>■ Avoid use of antimicrobials as a prophylactic therapy, except for wounds identified at high risk of infection</td>
</tr>
<tr>
<td>■ Use non-medicated options (e.g. non-medicated wound dressings) to manage infection when possible</td>
</tr>
<tr>
<td>■ Only use antimicrobials when a wound has been clinically identified as infected</td>
</tr>
<tr>
<td>■ Base antimicrobial selection on identification of the infecting organisms</td>
</tr>
<tr>
<td>■ Select antimicrobial agents with narrow-spectrum activity where possible</td>
</tr>
<tr>
<td>■ Reserve broad-spectrum agents for more resistant bacterial infections where possible</td>
</tr>
<tr>
<td>■ Continue the use of antimicrobial therapy for an appropriate duration to prevent development of resistance</td>
</tr>
<tr>
<td>■ Monitor therapeutic response to guide ongoing selection and use of antimicrobials</td>
</tr>
</tbody>
</table>

Conclusion

The IWII is a volunteer organisation that has been promoting prevention, identification and management of wound infection since 2006. The IWII (2022) consensus document, available in multiple languages, is free to download via Wounds International (www.woundsinternational.com), and from www.woundinfectioninstitute.com.

References

Oropallo AR, Andersen C, Abd R et al (2021)

Guidelines for Point-of-Care Fluorescence Imaging for Detection of Wound Bacterial Burden Based on Delphi Consensus. Diagnostics 10(11): 1219
The Association for Professionals in Infection Control and Epidemiology (2021) Antimicrobial stewardship. Available at: https://apic.org/Professional-Practice/PracticeResources/Antimicrobial-Stewardship/

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### International Wound Infection Institute

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### IWII WOUND INFECTION CONTINUUM AND MANAGEMENT GUIDE

**Increasing microbial burden in the wound**

<table>
<thead>
<tr>
<th>CONTAMINATION</th>
<th>COLONISATION</th>
<th>LOCAL WOUND INFECTION</th>
<th>SPREADING INFECTION</th>
<th>SYSTEMIC INFECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COVERT</strong> (subtle)</td>
<td><strong>COLONISATION</strong></td>
<td><strong>LOCAL WOUND INFECTION</strong></td>
<td><strong>SPREADING INFECTION</strong></td>
<td><strong>SYSTEMIC INFECTION</strong></td>
</tr>
<tr>
<td><strong>Microorganisms are present without the wound but are not proliferating</strong></td>
<td><strong>Microorganisms are present and undergo limited proliferation</strong></td>
<td><strong>Hypergranulation</strong></td>
<td><strong>Erythema</strong></td>
<td><strong>Increased exudate/moisture</strong></td>
</tr>
<tr>
<td><strong>No significant host reaction is evoked</strong></td>
<td><strong>No significant host reaction is evoked</strong></td>
<td><strong>Bleeding, tisue granulation</strong></td>
<td><strong>Local warmth</strong></td>
<td><strong>Low-level chronic inflammation</strong></td>
</tr>
<tr>
<td><strong>No delay in wound healing is clinically observed</strong></td>
<td><strong>No delay in wound healing is clinically observed</strong></td>
<td><strong>Epithelial bridging and pocketing in granulation tissue</strong></td>
<td><strong>Swelling</strong></td>
<td><strong>Low-level erythema</strong></td>
</tr>
<tr>
<td><strong>Increasing exudate</strong></td>
<td><strong>Delayed wound healing beyond expectations</strong></td>
<td><strong>Increasing edema</strong></td>
<td><strong>Pusulans discharge</strong></td>
<td><strong>Poor granulation, stable hypergranulation</strong></td>
</tr>
<tr>
<td><strong>Infected wound</strong></td>
<td><strong>Infected wound</strong></td>
<td><strong>Wound breakdown and enlargement</strong></td>
<td><strong>Alopecia or increasing pain</strong></td>
<td><strong>Secondary signs of infection</strong></td>
</tr>
</tbody>
</table>

**As the continuum green shading darkens, microbial burden increases.**

**Be alert for clinical indicators of potential biofilm:**

- Failure of appropriate antibiotic treatment
- Recurrence of delayed healing on cessation of antibiotic treatment
- Delayed healing despite optimal wound management and health support

**Initiate biofilm-based wound care when appropriate using step-down/step-up approach (see below):**

**Perform therapeutic cleansing:**

- Select and use a wound cleansing solution based on resources and local policy
- Use an inert cleansing solution prior to taking a wound sample
- Cleanse the wound and periwound region

**Confirm microorganisms and sensivities:**

- Antibiotics as per culture sensivities
- Determine review dates

**Debridement and post debridement care:**

- Use a topical antibiotic cleanser or surfactant soak
- Initiation and method selected based on clinical need, goal, resources and local policy

**Apply a wound dressing:**

- Select a wound dressing based on clinical assessment, goals of care, tissue type, exudate level, resources and local policy
- Consider either a medicated/active wound dressing or a non-medicated wound dressing with antimicrobial action, consistent with local antimicrobial stewardship policy

Following each review, document assessment and treatment, monitor progress and evaluate management.

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**Step-down/step-up biofilm based wound care**

1. **INITIATE MULTIPLE THERAPIES IN COMBINATION**
   - Aggressive debridement (e.g. mechanical, topical antibiotics and systemic antibiotics)
   - Manage healing factors (e.g. pressure off-loading, compression therapy, dressings management, optimize nutritional status)
   - ILA identification of microorganisms and potential care pathways where available

2. **OPTIMISE THERAPY ACCORDING TO HEALING STATUS**
   - Assess inflammation and healing status
   - Maintenance debridement
   - Optimize topical antimicrobials and systemic antibiotics
   - Consider management of host factors

3. **DE-ESCALATE TREATMENT AS WOUND IMPROVES**
   - Assess inflammation and healing status
   - Maintenance debridement
   - Re-evaluate need for topical antimicrobials and systemic antibiotics
   - Continue management of host factors

4. **EVALUATE WOUND HEALING TO DECIDE**
   - Standard care

**STEP UP TO ADVANCED THERAPIES**

- Standard care
- Advanced therapy options (e.g. Growth factors)
- Skin grafts
- Combination products
- Negative pressure wounds
- Cellular and tissue based products
- Bioengineered grafts

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* indicates a step or option that may be different for chronic wounds. For more information, see Scott, M., et al., *Journal of Wound Care* (2017) 26(2): p. 74-75. Reproduced with permission.

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**Contamination**

- Bacteria
- Fungi
- Viruses
- Paracells

**Colony**

- Pseudomonas
- Staphylococcus
- Escherichia
- Klebsiella

**Local Wound Infection**

- Covert (subtle)
- Overt (classic)

**Spreading Infection**

- Local (superficial)
- Systemic (deep)

**Systemic Infection**

- Septic shock
- Organ failure
- Death

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**Increasing microbial burden in the wound**

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