# Preventing and treating infection in wounds: translating evidence and recommendations into practice

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Infected wounds are slower to heal than non-infected wounds and are a growing problem for both patients and healthcare systems (Guest et al, 2015; Wounds UK, 2017). A group of researchers undertook a modified Delphi process to build a consensus among 85 international wound care specialists on how to prevent, identify and managed chronic wound infections. Consensus was reached on when and how to assess chronic wounds, the warning signs of infection, prevention strategies, management of infection and biofilms, and when to refer a patient to a wound care specialist.

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*This research did not require ethical approval. It did not include patients, or patient data. Only the opinions of health care providers were gathered, and that information was gathered directly from the providers, who consented to the process and the information collected.*

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Eighty-five wound care specialists from 19 countries took part in a consensus process that spanned 4 months, ending in November 2019. The process included traditional Delphi surveys, as well as virtual and face-to-face facilitated dialogues (Keast et al, 2020). The result was a consensus on best practices in chronic wound care and how to translate those best practices into effective bedside care for patients. This, the third article in a four-part series, focuses on how to prevent and treat wound infections with the ultimate goal of reducing healing time.

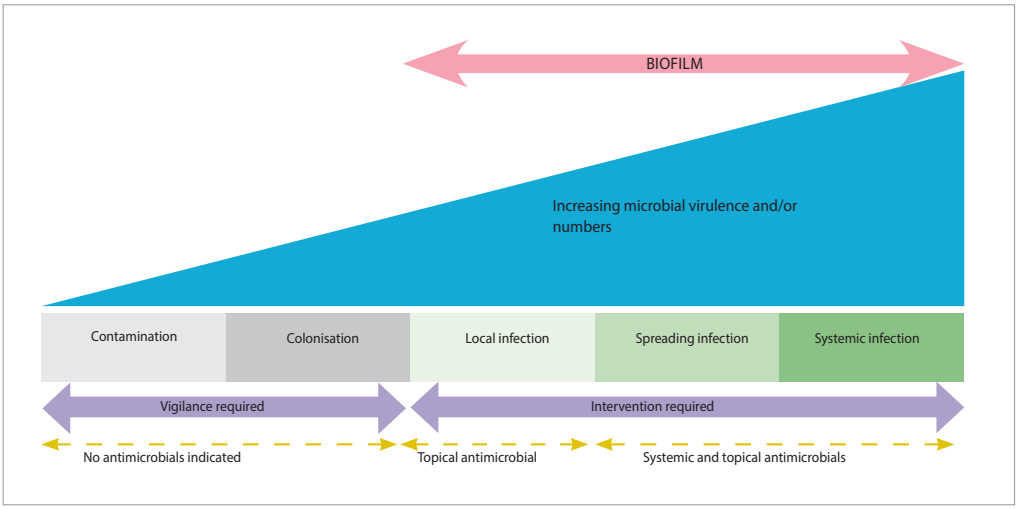
Microbial burden in wounds has been a topic of research and investigation for many years. Chronic and acute wounds are different. Acute wounds follow an orderly repair process (Swanson et al, 2015). In contrast, chronic wounds are slower to heal, usually remaining in an inflammatory state with high microbial loads (Scali and Kunimoto, 2013). Chronic wounds in this consensus process were defined as nonhealing wounds, that have healing potential, and have not healed within 4 weeks.

It is generally agreed that a holistic wound assessment is needed to determine the risk of infection (Keast et al, 2014; Swanson et al, 2014; Wounds UK, 2018; Dowsett et al, 2019) and that proactive wound management is needed to prevent infection (Keast et al, 2014; Swanson et al, 2015; International Wound Infection Institute [IWII], 2016; World Union of Wound Healing Societies [WUWHS], 2016). Where the risk of infection is high, but the signs and symptoms of spreading infection are absent, the goal of treatment should be to prevent escalation of infection through therapeutic cleansing, debridement, moisture balance and exudate management (Swanson et al, 2014; Dowsett and Muenter, 2020).

The presence of microorganisms in a wound does not necessarily mean that the wound is infected (European Wound Management Association, 2005; Moore and Strapp, 2015). The bacterial status of wounds continuously changes depending on local, environmental and systemic factors (WUWHS, 2008). Wound infection was defined by international consensus in 2016 as "the invasion of a wound by proliferating microorganisms to a level that invokes a local and/or systemic response in the host. The presence of microorganisms within the wound causes local tissue damage and impedes wound healing" (IWII, 2016). In wounds exhibiting signs and symptoms of local infection, the immediate treatment goal should be to reduce the bioburden within the wound (Swanson et al, 2014).

The transition from non-infected to infected wounds is often gradual. Identifying infection in chronic wounds can be challenging for clinicians who may be required to rely on a range of signs and symptoms depending on the wound aetiology, comorbidities, wound

**Figure 1. IWII Wound Infection Continuum (reproduced with permission).**




location and the patient's overall health and wellbeing (EWMA, 2005). A wound's microbial balance has been conceptually described by IWII (2016) as a continuum or a gradual increase in the number and virulence of microorganisms and the response those organisms invoke in the host. As the microbial virulence, numbers and pathogenic action increases, the wound infection moves from contamination through colonisation, local infection, spreading infection to systemic infection *[Figure 1]*. While progress in laboratory testing has been made, most clinicians do not have access to modern microscopy tests that identify the causative organism of infections, such as biofilm. Therefore, a wound infection must be diagnosed using clinical signs and symptoms, followed by a wound culture that may assist in identifying the causative organisms and resistant species to antibiotics that were commenced.

The classic signs and symptoms of wound infection include inflammation, new or increasing pain, increased malodour, local heat, swelling, advancing redness and purulence (WUWHS, 2008; Swanson et al, 2014; IWII, 2016). Increased exudate or exudate that has become purulent can be signs that the microbial burden in the wound may be stalling the wound's healing progression in the inflammatory phase (WUWHS, 2008; Swanson et al, 2015). In wounds where infection is suspected, the healthcare provider's immediate treatment goal must be to reduce the bioburden in the wound by therapeutic cleansing of the wound at each dressing change and through aggressive debridement of surface substance and underlying non-viable or unhealthy tissue to disrupt microbial burden and suppress biofilm regrowth (WUWHS, 2008; Swanson et al, 2014; WUWHS, 2019).

A holistic wound management approach and patient education about aseptic wound management is also critical for effectively treating wound infections (IWII, 2016; Moura et al, 2020). Monitoring progress and continual reassessment are important to evaluate the progression of the wound against the treatment goals, and a multidisciplinary approach, coupled with a treatment pathway that enables timely referral to specialists, is important for optimal outcomes (Ousey and Atkin, 2013; Swanson et al, 2014).

The role that biofilm plays in the development of infection, inflammation and in the delay of wound healing is generally accepted (Dowsett et al, 2019). Biofilms are described as microorganisms embedded in a thick, slimy barrier of sugars and proteins that acts as a barrier that shields microorganisms from the patient's natural immune system and from many antimicrobial agents (Keast et al, 2014). The seminal IWII 2016 International Consensus: Principles of Best Practice, defines biofilms as "a structured community of microbes with genetic diversity and variable gene expression (phenotype) that creates behaviours and defences used to produce unique infections (chronic infection)".

Biofilms are characterised by significant tolerance to antibiotics and biocides, while remaining protected from host immunity. Biofilm can develop within 2–4 days of initial colonisation, and become very tightly attached to extracellular matrix components or the wound bed, making them difficult to remove by surface irrigation or superficial debridement (Phillips et al, 2010; Swanson et al, 2014; Schultz et al, 2017). There is evidence that suggests biofilm is present in the majority of chronic wounds (Keast et al, 2014; WUWHS, 2016; Johani et al, 2017; Malone et al, 2017).

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Therapeutic wound cleansing at every dressing change and ongoing aseptic management, as well as conservative sharp and mechanical debridement are critical to effective biofilm management (Rodeheaver and Ratliff, 2007; WUWHS, 2008; Wolcott et al, 2010; Keast et al, 2014; IWII, 2016; WUWHS, 2019). Biofilms appear to 'recur' despite repeated attempts at antibiotic therapy (Keast et al, 2014). Biofilm eradication is difficult and almost impossible with a single structure approach. Multiple modalities are required to disrupt, decrease, and prevent reformation of biofilms.

The IWII 2016 consensus document recommends at least four steps are required: therapeutic cleansing, debridement, after debridement cleansing/care, antimicrobial dressings, and if spreading, systemic antimicrobials. An international consensus document in 2020, recommends an early antibiofilm intervention strategy through therapeutic cleansing, debridement, cleansing the edges and topical antimicrobials (Murphy et al, 2020). Evidence suggests that after appropriate wound bed preparation, applying topical antimicrobials to the wound helps reduce biofilm reformation and protects the wound from contamination by other microbes (Wolcott et al, 2010; IWII, 2016; Percival, 2017; Schultz et al, 2017; Wounds UK, 2017; WUWHS, 2019).

The best strategy for biofilm management is, therefore, the 'clean and cover' approach, which relies on the use of antimicrobial dressings between debridements to reduce the ability of planktonic bacteria to re-establish a biofilm (Keast et al, 2014). Both silver and iodine releasing dressings have been shown to kill biofilm bacteria (Akiyama et al, 2004; Percival et al, 2008; Phillips et al, 2015). The efficacy is influenced by time of exposure, number of applications, moisture level and agent formulation (Phillips et al, 2013).

## Methodology

Consensus building is based on the belief that when people think together, they can make better decisions (Bain and Hansen, 2020). This project utilised a Modified Delphi Process that combines the rigour and validation of the traditional scientific Delphi method with professionally facilitated virtual and face-to-face collaborative processes (Keast et al, 2020). Eighty-seven wound care specialists across 19 countries were sent a series of surveys on chronic wound care, including specific questions on best practices in the prevention and treatment of infection and biofilms, based on literature review evidence. Eighty-four of the survey participants then met face-to-face for 2 days to review the survey results and finalise their consensus.

## Participants

Participants were qualified wound-care specialists:

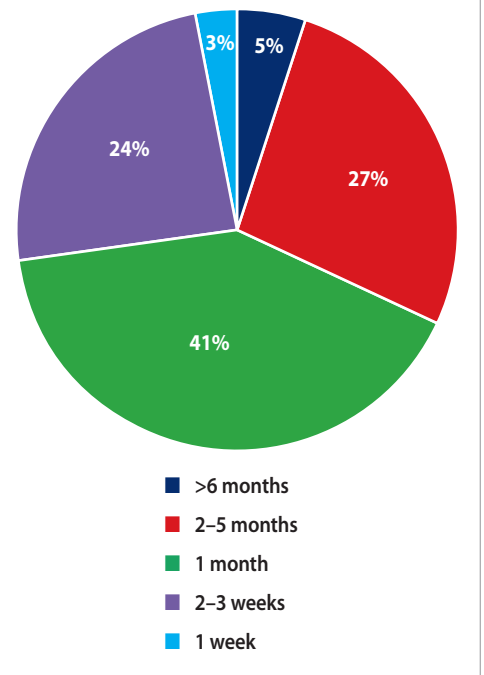
- 86% had more than 10 years of wound care experience
- 18% of participants reported that their practice is 100% wound care, with the average across all respondents being 65% of their total clinical practice being wound care
- Participants included: doctors (29%), nurse specialists (61%) and other healthcare professionals (10%)
- Participants reported that 65% of the wounds they treat are chronic wounds
- Participants reported that on average 44% of the wounds they treat are infected.

## Survey results

Eighty-seven wound care specialists were surveyed in September and October 2019. The first survey had an 82% response rate and the second survey had a 71% response rate.

When asked how much longer, in their experience, wounds took to heal because of the existence of infection or biofilm, 73% of

**Figure 1: Added wound healing time due to infection.**



respondents reported that healing time was extended by 4 weeks or more *[Figure 1]*. A total of 82% of respondents agreed that the presence of bacteria in wounds is one of the biggest factors that delays healing. Regarding biofilm, 95% of respondents agreed that biofilm in a chronic wound can cause infection and delay healing.

When conducting a wound assessment, 91% of respondents indicated that they always examine the wound bed for signs of infection. Ninety-eight percent of respondents indicated that assessing the wound at each dressing change provides an opportunity to diagnose and treat a wound infection in the early stages and decreases the potential of limb- or life-threatening infections. When asked what they look for when assessing the level of bioburden in a wound, respondents indicated amount, odour and colour of exudate (88%), inflammation of the wound edge and periwound skin (85%), and increased pain levels (75%).

Ninety-eight percent of respondents agreed that one of best ways to decrease the risk of infection and the development of biofilm in chronic wounds is to manage the gap or dead-space between the wound bed and the dressing. Management of wound bioburden was identified as one of the top three most important critical success factors in managing chronic wounds. Eighty-seven percent of respondents agreed or strongly agreed that managing biofilm is an important step in preventing spread and systemic infection. When asked to rank in order of importance, factors considered when choosing the best dressing choice for patients, respondents identified wound bed assessment, prevalence of bacteria in the wound, amount of exudate and presence of biofilm as the top-four risk factors *[Table 1]*.

When treating an infected wound, respondents indicated the two most effective ways to prepare the wound bed are debridement and therapeutic irrigation. Forty percent of respondents indicated they always or usually debride the wound before applying a dressing and the most popular debridement methods reported were surgical sharp (79%), autolytic (63%) and mechanical (54%). Eighty-three percent of survey respondents indicated that once the wound bed is prepared the best way to fill the gap for wounds that are up to 2 cm deep is to use a dressing that conforms to the wound bed.

## Consensus results

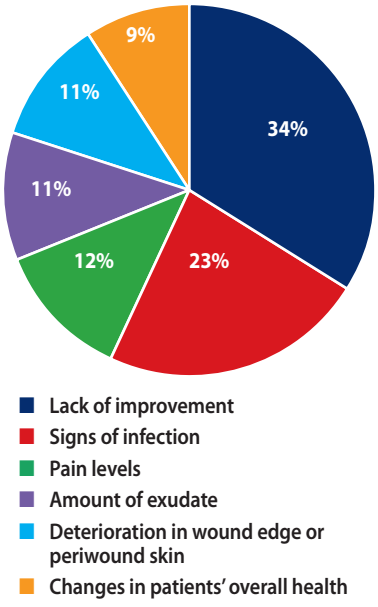
Eighty-four of the wound specialists surveyed met in Denmark in November 2019 for a 2-day facilitated face-to-face dialogue. Consensus was reached on a number of recommendations on how to prevent and management infection and biofilm. Consensus was achieved when more than 80% of participants agreed AND no participants disagreed with a recommendation (i.e. 100% of participants either agreed with or agreed to support a recommendation).

Eighty-two percent of participants agreed that chronic wounds should be assessed at least once per week, with 23% of those indicating

**Table 1. Importance of factors in determining best dressing choice for patients.**

| Rank | |
|---|---|
| 1st | Wound bed assessment |
| 2nd | Prevalence of bacteria in the wound |
| 3rd | Amount of exudate |
| 4th | Occurrence of biofilm in the wound |
| 5th | Amount of dead-space in the wound |
| 6th | Assessment of periwound skin |
| 7th | Frequency of dressing changes |
| 8th | Availability of resources |
| 9th | Patient's body profile and activity level |
| 10th | Patient's capacity to engage in effective self-care |
| 11th | Patient preferences |

**Figure 2. What warning signs should healthcare providers watch for when assessing a chronic wound?**



assessment should happen at every dressing change. Participants also agreed that the warning signs that healthcare providers should be looking for when assessing a chronic wound are: lack of improvement; signs of infection; pain levels; amount of exudate; deterioration of wound edge or periwound skin; and changes to the patient's overall health and wellbeing *[Figure 2]*.

Consensus was reached on how to prevent infections in chronic wounds. It was agreed that the best prevention strategies are:

- Effective debridement and wound cleansing
- Managing exudate by managing the gap between the wound bed and the dressing
- Assessing wound bioburden at each dressing change using the IWII Wound Infection Continuum (IWII, 2016)
- Promoting a sterile environment through hand washing, antiseptic use, and ongoing patient education; and
- Continuous antimicrobial stewardship.

Participants also agreed that the best ways to prepare the wound bed to prevent or treat infection were debridement and therapeutic cleansing, followed by using a dressing with antimicrobial properties for local infections and the use of systemic antibiotics, appropriate for the type and level, for spreading and systemic infections. When asked what active components in dressings are best used to treat local infections, participants recommended, in rank order:

1. Silver
2. PHMB (Polyhexamethylene Biguanide)
3. Honey
4. Iodine

Consensus was also reached on what factors should prompt health care providers to refer a patient to a wound-care specialist. When one or more of the following factors is present, it was recommended that the patient be referred to a wound care specialist:

- Worsening of wound condition observed by increase in wound size, odour, pain or exudate (i.e. a treatment plan was established and followed but the wound is not healing or is deteriorating)
- There is a lack of wound healing progression within 14 days
- There is suspicion of, or signs of, systemic infection or biofilm
- Comorbidities and other complications (i.e. diabetes, elevated C-Reactive Proteins, underlying structures like exposed bone or tendons, aetiology of wound is not known).

Regarding biofilm, consensus was reached on best practices to prevent biofilms, what to look for when assessing the presence of biofilm and what healthcare providers should do if biofilm is suspected in a chronic wound. Best practices in preventing biofilm development were identified as:

- Debridement
- Therapeutic Cleansing
- Antimicrobial choices and stewardship, and
- Managing the gap between the wound bed and the wound dressing.

When assessing a wound for presence of biofilm, it was recommended that healthcare providers look for the following:

- Delay in healing progression
- Complications, such as bleeding, discolouration, granulation and fragile tissue
- Excessive amounts of exudate or grey film in the wound
- Odour; and
- Changes in the patient's overall wellbeing or quality of life.

When biofilm is suspected it is recommended that healthcare providers do the following:

1. Debride and clean the wound;
2. Employ antimicrobials and/or NPWT (negative pressure wound therapy);
3. Change the dressing type or dressing frequency;
4. Perform diagnostic tests or refer to a wound care specialist;
5. Manage the gap or dead-space between the wound bed and the dressing.

Participants also agreed that the best dressing choice for wounds down to 2 cm deep is a dressing that conforms to the wound bed.

## Conclusions

The prevalence of non-healing wounds continues to be a global problem. Evidence is mounting about the importance of prevention and treatment of infection in wound care and there is growing evidence that biofilm is detrimental to wound healing. This project brought together wound care specialist from across 19 countries to develop a consensus on how healthcare providers should prevent, identify, and treat infection and biofilm in chronic wounds. The consensus reached was that managing the gap or the dead-space between the wound bed and the dressing is one of the best ways to prevent infection and detrimental biofilm development in chronic wounds.

The consensus process concluded that the prevention of infection and biofilm development should always be a goal of

wound care. If the wound bioburden reaches a point where it begins to delay wound healing, then immediate action should be taken to reinvigorate the wound healing progression, hence reducing costs and morbidity. The choices that healthcare professionals make regarding the prevention and treatment of wound infection and biofilm will significantly impact the patient experience, will influence the patients' quality of life, will impact the healing time and will have significant impact of costs to the healthcare system. The healthcare providers' outcome goal should always be fewer days with wounds and prevention of infection and the treatment of wound bioburden is one of the best ways to achieve that outcome. WINT

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