WOUNDS AND BIOFILM

A STORY ON THREE LEVELS

B BRAUN
SHARING EXPERTISE

LEVEL 1: SHORT OVERVIEW OF SKIN LAYERS WITH A WOUND[1]

- The epidermis is the outer layer of the skin. It holds some nerves and immune cells, but no blood vessels.
- The dermis is made up of connective tissue and contains numerous blood vessels and nerves.
- The subcutis is mainly made up of loose connective tissue and fat cells.

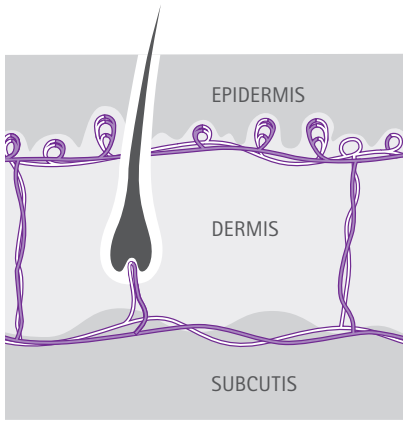

Fig. 1: The skin is made up of three layers: epidermis, dermis and subcutis. As biofilm may be present in all skin layers they will not be indicated in subsequent figures.

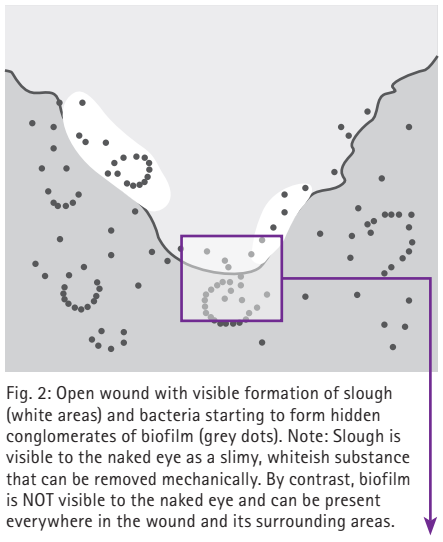

Fig. 2: Open wound with visible formation of slough (white areas) and bacteria starting to form hidden conglomerates of biofilm (grey dots). Note: Slough is visible to the naked eye as a slimy, whiteish substance that can be removed mechanically. By contrast, biofilm is NOT visible to the naked eye and can be present everywhere in the wound and its surrounding areas.

MYTH-BUSTER: IS BIOFILM VISIBLE TO THE NAKED EYE?[2]

The short answer is: no, not really. The longer answer is: it's complicated, and ultimately it does not matter, given the evidence-based assumptions that can be made about biofilm. Some clinicians promote what they believe are 'clinical cues' of biofilm presence, using naked-eye observations including a 'shiny', 'translucent', 'slimy' layer on the non-healing wound surface. However, although it is arguable that these 'signs' may represent manifestations of the presence of biofilm, biofilm itself cannot in fact be seen with the naked eye.

The new "World Union of Wound Healing Societies" position statement notes that 'all non-healing chronic wounds potentially harbor biofilms' and, therefore, relying on anecdotal visual cues is unnecessary. Clinicians should assume that 'all non-healing, chronic wounds that have failed to respond to standard care have biofilm'. Consequently, all treatments should be targeted towards effective disruption of biofilms and prevention of their formation and reformation.

LEVEL 2: CHRONIC WOUND AND THE FORMATION OF BIOFILM[2]

All chronic wounds have biofilm, making chronic wounds much harder to treat than acute wounds. Why?

- The bacteria in a chronic wound are in a "sessile" state (attached to surfaces or other microbes and metabolically inactive), which has been shown to survive concentrations of antibiotics up to 1,000 times higher than bacteria in a "planktonic" state (free-floating and metabolically active).
- Sessile bacteria also have an increased tolerance to the host's immune system.
- In addition, the outer "casing" protects the biofilm by limiting the diffusion of antibiotics, resulting in only sub-therapeutic levels reaching the bacteria.
- Most chronic wounds biofilm harbor several different bacterial species that would require several different antibiotics.

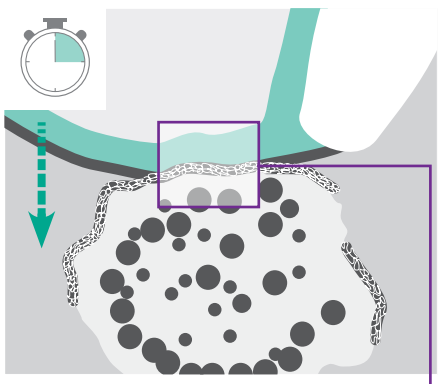

Fig. 3: Prontosan® (green) is applied to the wound. A „soaking time" of several minutes is required to allow the solution to penetrate deeply into the wound and into the herds of biofilm in the wound and skin. By now, these herds are starting to be protected by a wall of EPS matrix (s. text). By contrast, other products may be used up before reaching biofilms in the deep.

LEVEL 3: STRUCTURE OF BIOFILM[2]

What are biofilms made of?

Biofilms are an aggregate of microorganisms (e.g. bacteria or fungi) invisible to the naked eye and tolerant to treatment and the host defense. The aggregate of microorganisms is encased by a thick, glue-like matrix of "extracellular polymeric substance" (EPS), which is composed of water, polysaccharides (sugars), nucleic acid (extracellular DNA) and proteins.

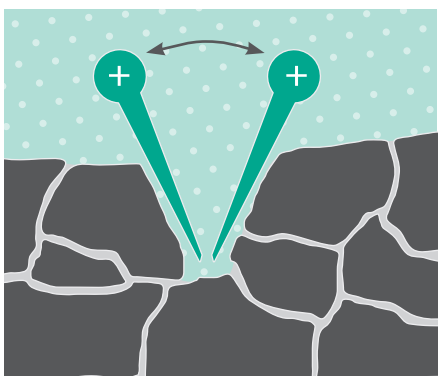

Fig. 4: Prontosan® is composed of two components: Betaine (shown here as green pin-needles) and polyhexanide (not shown in this figure). Betaine is a surfactant. Surfactants consist of a hydrophilic, water-attracting head, and a water-repellent, hydrophobic hydrocarbon body. The polar heads of the surfactant molecules have the same electric load and therefore repel each other. This is how the biofilm is cracked.

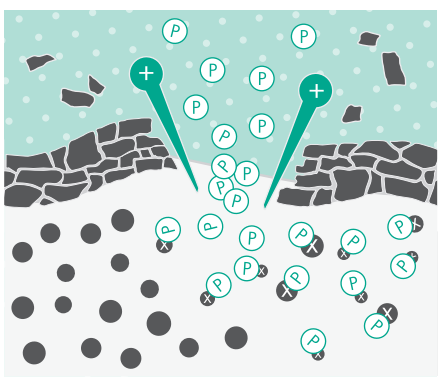

Fig. 5: After the betaine has broken up the wall of the biofilm („blasting open the brick wall"), the polyhexanide (P) can subsequently enter the biofilm and performs an adjuvant antimicrobial effect.

What is the difference between acute and chronic wounds?[3]

Any wound (abrasions, lacerations, incisions, puncture wounds, burns) is initially considered an acute wound, as long as is follows the expected stages of healing. In the absence of significant evidence of healing within about four weeks, the wound has likely entered the chronic stage.

How common are chronic wounds?[4,5]

The most common form of chronic wounds are ulcers of the lower extremities: around 0.6-3% of people aged > 60 years and 5% of the > 80-year-olds are affected. In the course of a lifetime, almost 10% of the population will develop a chronic wound, with a wound-related mortality rate of 2.5%. In the US, the annual costs of chronic wounds is estimated at around 30 billion US$[3,4].

Sources (last access March 2020)
1. Duale Reihe 2003, „Dermatologie", Hrsg: Ernst G. Jung, Ingrid Moll
2. Bjarnsholt T, Eberlein T, Malone M, Schultz G. Management of wound biofilm. Wounds International 2017;8(2):1-6.
3. https://advancedtissue.com/2018/12/what-is-the-difference-between-acute-and-chronic-wounds/
4. Agale SV. Chronic Leg Ulcers: Epidemiology, Aetiopathogenesis, and Management. Ulcers 2013; doi: 10.1155/2013/413604
5. https://www.woundcarestakeholders.org/news/studies-and-publications/chronic-wounds-economic-impact-costs-to-medicare

B. Braun Medical AG | Infection Control | Seesatz 17 | 6204 Sempach | Switzerland
Tel. +49 5661 71-0 | Fax +49 5661 71-2732 | www.bbraun.com/prontosan

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