Biofilm and Advanced Wound Management Strategies
A Comprehensive Review

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Objectives

▪ What are Biofilms
▪ How Biofilms are formed
▪ Effects of Biofilm in wounds
▪ Stages of biofilm formation
▪ Biofilm timelines
▪ Biofilm and wound infection
▪ Diagnosis & management of biofilms
▪ Recommended debridement options
Bacterial colonization is one of the most common cause of delayed healing in chronic wounds. If neglected it can progress from colonization to local infection and to systemic infection, sepsis and multiple organ dysfunction syndrome, and it can be life-threatening.
A biofilm can be described as bacteria embedded in a thick, slimy barrier of sugars and proteins. The biofilm barrier protects the microorganisms from external threats.
Bacterial or fungal species are commonly present in the wounds free floating (planktonic) and solitary. These microorganisms tend to attach to surfaces and eventually form biofilms.
Planktonic Bacteria
How Biofilms Formed?

As the bacteria multiply, they become more firmly attached (sessile) and differentiate, changing gene expression patterns in ways that promote survival. This is usually the result of a type of bacterial communication known as “quorum sensing”. (Surface Adhesion Phase)
Staphylococcus biofilm
Once firmly attached, the bacteria begin to secrete a surrounding matrix known as extracellular polymeric substance. This is a protective matrix or ‘slime’. Small bacterial colonies then form an initial biofilm.
Formation of Biofilm

Bacterial Biofilm
Effects of Biofilm

- **Excessive inflammation** – through excessive and prolonged stimulation of nitric oxide

- **Delay in Wound Healing** - Activation of immune complexes leading to a delay in wound healing.
Biofilm Timeline

- **Stage- I** - Form micro-colonies within 2 to 4 hours.

- **Stage- II** - Form initial slime and become increasingly tolerant to antibiotics, antiseptics and disinfectants, within 6–12 hours

- **Stage- III** - Form mature biofilm within 24 hours and shed planktonic bacteria within 2 to 4 days.
The life cycle of a biofilm consists of several events occurring in the following timeframes:

**EVENT:**
1. Bacteria adhere to a surface
2. Attached bacteria divide and begin to excrete extracellular matrix
3. The matrix-cell mixture expands, forms architectural features of biofilms
4. Further expansion and microbial growth
5. Dispersion of planktonic bacteria

**TIMEFRAME:**
- Reversible, continuous
- Within seconds to minutes
- Minutes to hours
- Days
- Days to weeks
Biofilms are made up of a complex protective glycocalyx, produced by bacterial communities, which protects them from host defenses and antimicrobial therapy, whether it is administered topically (antiseptics) or systemically (antibiotics).
**Systemic inflammatory response syndrome (SIRS)**

Manifestation of any two of the clinical components constitutes SIRS:

- **Pyrexia**: > 38 °C or < 36 °C
- **Tachycardia**: > 90 beats/minute
- **Tachypnea**: 20 breaths per minute or PaCO₂ < 4.2 kPa
- **WBC**: 12 x 10⁹ cells

**Sepsis** is systemic inflammatory response syndrome with documented infection.
Wound Infection

- Abnormal granulation tissue
- Bleeding from friable granulation tissue
- Wound breakdown and enlargement
- Changes in color of the wound bed
- Increasing inflammatory signs and abscess formation
- Increasing pain
- Increasing odor
- Increased exudate and maceration of surrounding skin
Biofilms cannot be seen with the naked eye. A diagnostic guideline to recognize biofilm presence in chronic wounds has been established:

(i) Microbiological evidence of a localized infection
(ii) Examination of tissue sample via electron microscopic presence of microbial aggregation and glycocalyx. (confocal laser scanning microscopy).
(iii) Recurrent infection in a chronic wound with organisms that are clonally identical
(iv) Persistent wound infection despite the correct dose and duration of an appropriate antimicrobial therapy
(v) A chronic wound bed that is heavily exuding or covered with ‘fibrinous’ or necrotic material that needs repeated debridement
As a practical guide the following recommendations are prudent for the management of Biofilm involving chronic wounds:

i. Serial Sharp or ultrasonic debridement are the best methods for reducing biofilm burden.

ii. Appropriate wound microbiology and sensitivities must be done prior to antimicrobial therapy.

iii. Topical antimicrobial agents should be used only to reduce the wound bioburden and critical colonization, and not to treat infection.

iv. Antibiotics,

v. Literature review shows that Antibiotics: **Linezolid**, **Daptomycin**, **Rifampicin** and **Ceftaroline** can penetrate biofilms.
Following sharp debridement methods are recommended for the management of Biofilms:

i. **Sharp Debridement**
   1. Dermal Curette
   2. Scalpel
   3. Ultrasonic


