Slough: What is it? How do we manage it?

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Tissue Identification

Universally recognized colour system:

Pink
Red
Yellow
Black
Green
The discussion and concern

“For years it’s been worrying me how best to teach about slough in the wound bed”

“Many nurses and other clinicians refer to all the yellow / creamy / greyish tissue as ‘slough’, yet some slough can be cleared by autolytic debridement alone, whereas others require other forms of debridement”
Black: eschar

Black (dark) tissue may represent:

- Necrosis due to pressure damage / hypoxia
- ‘Deep tissue injury’ which has yet to evolve usually related to pressure and shear forces
- Haematoma
- Ischaemia or avascular
- A purple edge such as in Pyoderma Gangrenosum
- Devitalised – detached from its blood supply or traumatised such as a full thickness burn
- Colour will vary depending on hydration
How would you describe these?

They are all black, but there is a different reason for each being black

1. Necrosis, tissue death due to pressure damage
2. Haematoma
3. Ischaemia in a diabetic patient
How about these?

• All pressure ulcers
• All black

But are they the same?

1. Necrosis due to pressure damage
2. Deep tissue injury probably due to shear
3. Blood filled blister
4. Faeces covering the wound bed

Slide courtesy of J Fletcher
Slough

- Moist devitalized host tissue
- The colour will vary from cream, yellow and tan depending on hydration
- It can firmly attached or loose
- May be slimy, gelatinous, stringy, clumpy or fibrinous consistency
- Maybe liquefying necrosis
- Recent suggestion of biofilm related slough
- Contains:
  - Proteinaceous tissue
  - Fibrin
  - Neutrophils
  - Bacteria
Creamy / yellow
But are these all slough?

This patient has gout, this crystalline material is due to uric acid crystals.

Thick attached slough.

This is a tendon clearly visible in the wound bed.

This is liquefying material.

Slough, adherent material.

Slide courtesy of J Fletcher
# Types of and colour of nonviable tissue

<table>
<thead>
<tr>
<th>Colour</th>
<th>Moisture content (range)</th>
<th>Consistency</th>
<th>Adherence to wound bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cream/yellow</td>
<td>Moist or wet</td>
<td>‘Mucinous’/slimy soft</td>
<td>Non-adherent</td>
</tr>
<tr>
<td>Tan/brown</td>
<td></td>
<td>‘Gelatinous’ soft</td>
<td>Loosely adhered</td>
</tr>
<tr>
<td>Grey/blue</td>
<td></td>
<td>Stringy/clumpy firm</td>
<td>Firmly adhered</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td></td>
<td>Fibrinous firm to hard</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black (in addition to full-thickness NVT)</td>
<td>Dry and dehydrated</td>
<td>‘Leathery’ hard</td>
<td></td>
</tr>
</tbody>
</table>

May be seen with topical application of some silver antimicrobial dressings

May be seen in the presence of Pseudomonas aeruginosa – local infection

May also be seen in the presence of specific bacterial local infection

Biofilm? Slough? What is it?

Photo by R Wolcott and G Schultz
Bacteria continuum

Increasing clinical problems

Contamination → Colonisation → Localised infection* → Spreading infection → Systemic infection

Vigilance required → Intervention required

*Localised infection may or may not be accompanied by the classical signs and symptoms of inflammation. When it is not, various terms have been used, eg critical colonisation (see main text)
Fig 2. Visual indicators of wound biofilm; (A) a static, non-progressing wound on a stable diabetic patient that had amputation of four toes. The shiny appearance of parts of the wound bed may be biofilm (as indicated by arrows); (B) a stage IV pressure ulcer with a heavily colonised wound bed. There may be a layer of suspected biofilm over some of the wound bed, particularly on the right side of the wound where this substance appears to be slightly thicker and opaque (as indicated by arrow); (C) an ischaemic and infected wound with suspected biofilm forming through and over a previously-applied gauze dressing; (D) green-pigmented suspected biofilm formed within 24 hours in a chronic wound beneath, and on, a silver alginate dressing; (E) forefoot amputation with bone exposure. Viscous, pale, green-blue, slimy suspected biofilm covered most of the wound bed; (F) surgical wound, post-necrotising fasciitis. The subsequent skin graft failed to take, and the wound had been static with minimal progress. The wound surface exhibited yellow suspected biofilm, possibly mixed with slough, with granulation tissue attempting to form beneath; (G) an ischaemic wound exhibiting signs of infection. This suspected biofilm re-formed quickly over granulation tissue despite antibiotic usage; (H) the suspected biofilm could be removed atraumatically using forceps to reveal the granulation tissue beneath.

Microscopic evaluation

H&E Stained Sections of Thick Wound Slough

Slide courtesy of G Schultz
Clinical Algorithm For Wound Biofilm Identification

Visual Indicators

1. Does the surface substance detach easily and atraumatically from the underlying wound bed using physical removal techniques such as swabs, pads or sharp debridement?

   Yes
   ©
   2. Does the surface substance persist despite use of autolytic or enzymatic debridement?

   Yes
   ©
   probably host devitalised tissue, e.g., slough, fibrin
   No
   probably biofilm with increasing confidence
   No

Indirect Indicators

4. Does the wound respond poorly to topical or systemic antibiotics?

   Yes
   ©
   5. Does the wound respond poorly or slowly to dressings than contain antiseptic agents (e.g., silver, iodine, PHMB), including products that may control biofilm in vitro (e.g., cadexomer iodine, nanocrystalline silver or ionic silver containing carboxymethyl cellulose dressings)?

   Yes
   ©
   No
   No
   6. Does the wound respond favourably to multi-modal strategies such as physical debridement, cleansing, and topical antimicrobial agents and dressings?

   Yes
   No

<table>
<thead>
<tr>
<th><strong>Table 1. Clinical indicators of biofilm in chronic wounds and supporting evidence.</strong></th>
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<tbody>
<tr>
<td><strong>Excessive moisture / exudate</strong></td>
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</table>
| **Poor-quality granulation tissue**  
(e.g. friable, hypergranulation) | High bioburden may present as friable granulation tissue[^13] |
| **Signs and symptoms of local infection** | Secondary signs of infection are more typical of biofilm infection[^14] |
| **Antibiotic failure or recurring infection following antibiotic cessation** | Antibiotic failure is the hallmark of biofilm infection. The use of antibiotics is still controversial regarding biofilm management; it has been suggested that – without the use of concurrent strategies for biofilm management – efficacy may be as low as 25%–30%[^15,16] |
| **Negative wound culture** | Routine cultures will only pick up the free-floating (i.e. planktonic) bacteria, not those within a biofilm[^17,18] |
| **Non-healing in spite of optimal wound management and host support** | Biofilm defences include resistance to: ultraviolet light, biocides, antibiotics and host defences. Biofilm can quickly reconstitute but strategically does not kill its host[^19] |
| **Infection lasting >30 days** | Infections of ≤30 days’ duration may also contain biofilm, planktonic infection would not persist >30 days[^15] |
| **Responds to corticosteroids and TNF- alpha inhibitors** | Inflammation is a by-product of biofilm, thus a good response to these treatments suggests presence of biofilm. Decreasing inflammation removes the primary source of nutrition[^15] |
| **Gelatinous material easily removed from the wound surface** | Clinicians and researchers are trying to determine if the by-product of biofilm formation can be clinically seen. Case studies demonstrate differences in wound material that can be easily removed but quickly reform, either on the wound or under a dressing. Some authors believe that slough equals biofilm, but this has not been conclusively proven. A build-up of self-secreting polymers and host components is suggestive of biofilm[^20,21] |
| **Surface substance reform quickly** | Research suggests that biofilm can reform within 24–72 hours[^22] |
Is Biofilm only on the wound?
It lifts off easily and comes back by next week?
Curetting surface biofilm/slough

Photos courtesy of Lisa Hewitt CNC Bendigo Health
Wound bed preparation in practice

Wound bed preparation: science applied to practice

Wound bed preparation for diabetic foot ulcers

Wound bed preparation for venous leg ulcers

Photos T Swanson
How do we manage it?

BBWC / WBP / TIME

• Debridement (serial)
• Topical antimicrobials
• Systemic antimicrobials
• Antibiofilm agents that prevent attachment of planktonic bacteria
• Interruption or prevention of quorum sensing

Moisture Management

Patient Centered Concerns
Wound Cleansing

“removal of surface contaminants, bacteria and remnants of previous dressings from the wound surface and its surrounding skin”

- Therapeutic irrigation 4-15psi
- PHMB with Betaine (a surfactant)
- Providone- iodine
- Octenidine with Ethylhexyl glycerine (a surfactant)

Debridement

- Autolytic
- Mechanical
  - Therapeutic irrigation
  - Hydrotherapy
  - Hydrosurgical
  - LFUD
  - Monofilament pads
- Surgical/CSWD
- Chemical and enzymatic
- Biosurgical

**Benefit:**
- Decrease potential for infection
- Reduce odour
- Reduce exudate production
- Increased efficacy of topical antimicrobials
Moisture Management

- Oedema control
- Moisture balance of wound bed

**Wound Fluid Management options**
- Super absorbers
- Negative pressure wound therapy
- Fiber dressings: Alginates/ hydrofibers
- Combination dressings
- Therapeutic compression

**Benefits:**
- Improved periwound condition
- Decreased nutrients for biofilm
- Decreased pro-inflammatory soup
Topical Antimicrobials

- Cadexomer Iodine
- Silver dressings
- Honey
- PHMB

Clean and cover
2 week rule
2 week challenge
Future

- Beside diagnostic for biofilm
- Clearer understanding of strategies regarding debridement to disrupt biofilm
- Dressings that are effective in disrupting biofilm
- Prevention of biofilm formation
- Better definitions and consensus of nonviable tissue
- Better understanding of VIABLE tissue = bacteria-derived tissue = biofilm
“I do not believe that ‘sloughs' all contain the same components nor should they be treated with the same strategies. I consider biofilm to be alive”

'This nonhealing tissue found on a wound bed can provide us with many clues about the state of the wound and the patient’
References

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• Zhao g, Usui M, Soyeon L et al. Biofilms and Inflammation in Chronic Wounds . Advances in Wound Care 2013 1- 11.
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