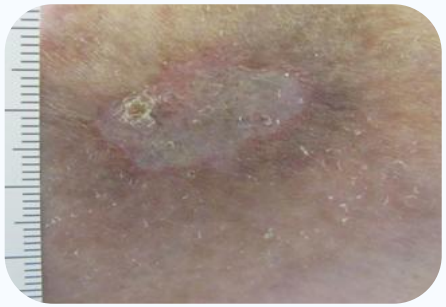
INTERNATIONAL WOUND INFECTION INSTITUTE

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

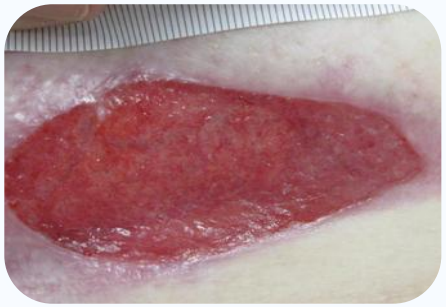
Terry Swanson
Jenny Hurlow
Greg Schultz
Jacqui Fletcher

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

Slide courtesy of J Fletcher

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

Slide courtesy of J Fletcher

How about these?

- All pressure ulcers
- All black

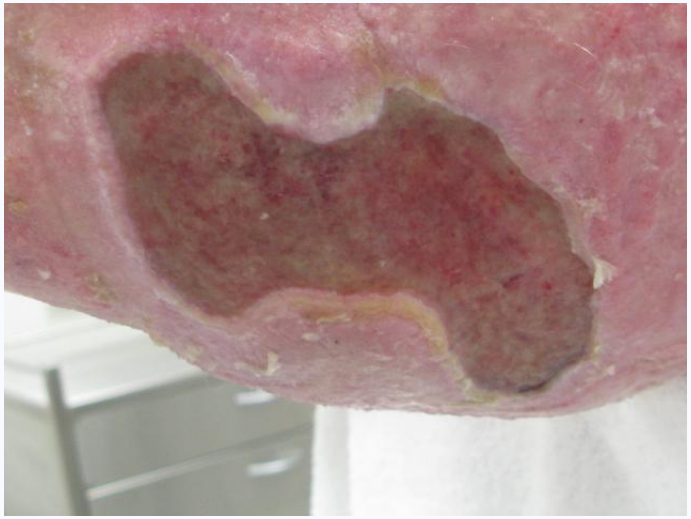
But are they the same?

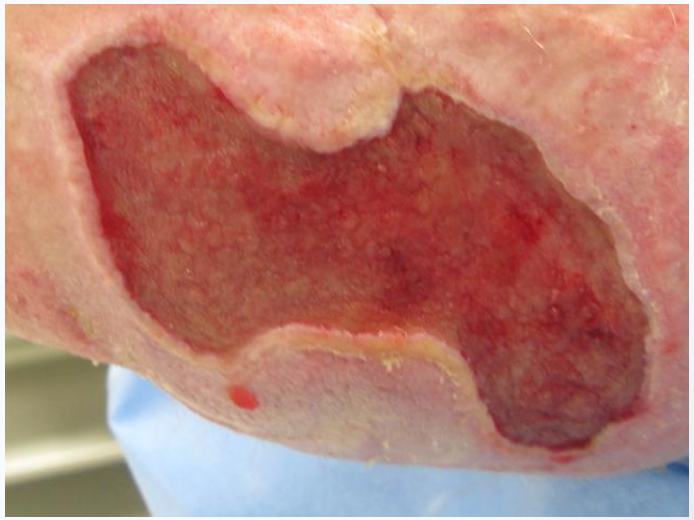
1. Necrosis due to pressure damage
2. Deep tissue injury probably due to shear
3. Blood filled blister
4. Faeces covering the wound bed

Slide courtesy of J Fletcher

Slough

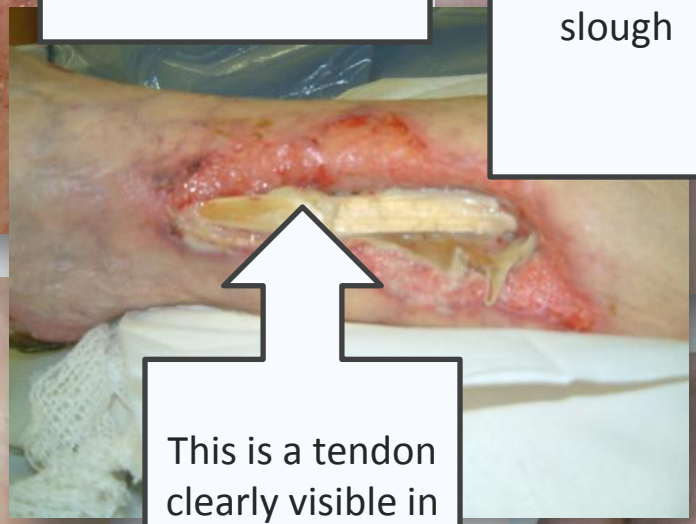
- Moist devitalized host tissue
- The colour will vary from cream, yellow and tan depending on hydration
- It can firmly attached or loose
- May be slimy, gelatinous, stringy, clumpy or fibrinous consistency
- Maybe liquefying necrosis
- Recent suggestion of biofilm related slough
- Contains:
  - Proteinaceous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



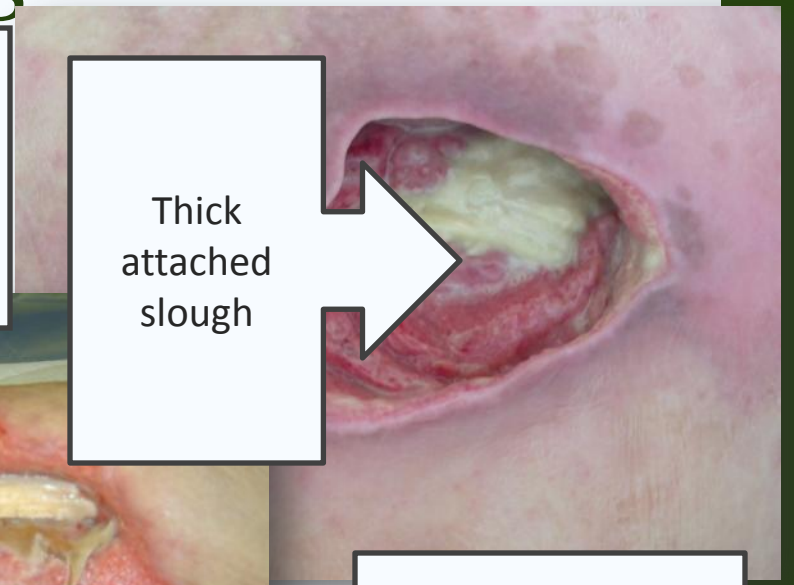


Creamy / yellow
But are these all slough?

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



This is a tendon clearly visible in the wound bed



Thick attached slough

This is liquefying material

slough, adherent material

Slide courtesy of J Fletcher

Types of and colour of nonviable tissue

Colour	Moisture content (range)	Consistency	Adherence to wound bed
Cream/yellow	Moist or wet	'Mucinous'/slimy soft	Non-adherent
		'Gelatinous' soft	Loosely adhered
Tan/brown			Firmly adhered
Grey/blue **May be seen with topical application of some silver antimicrobial dressings**		Stringy/clumpy firm	Separating edges
Green **May be seen in the presence of Pseudomonas aeruginosa – local infection**		Fibrinous firm to hard	
Black (in addition to full-thickness NVT) **May also be seen in the presence of specific bacterial local infection**		'Leathery' hard	
	Dry and dehydrated		

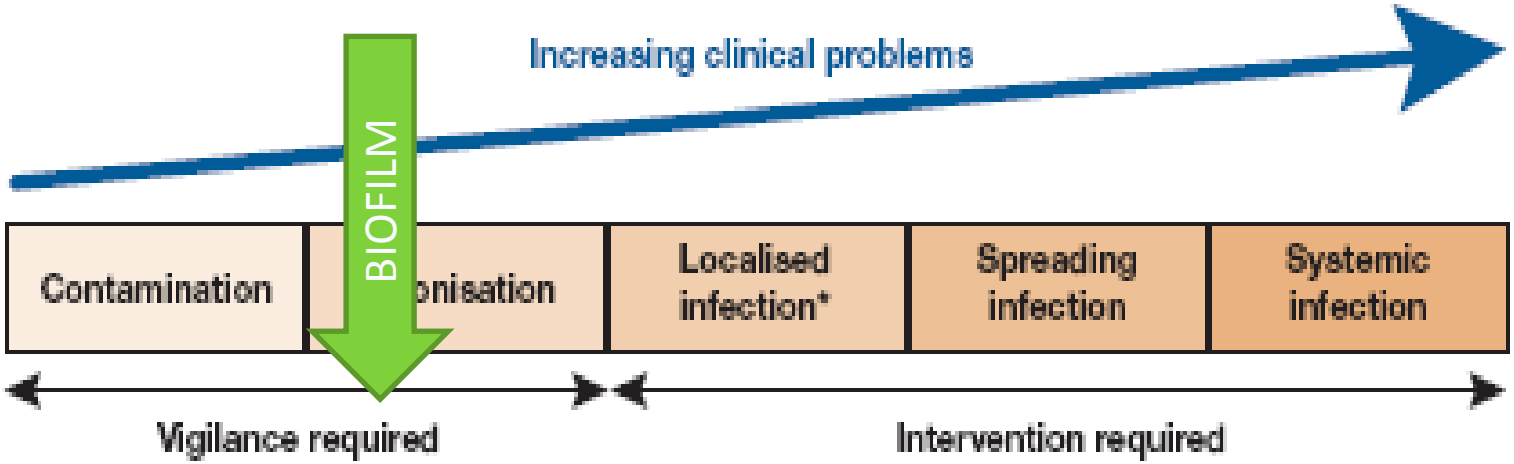
White W & Asimus M, (in print) Assessment and management of non-viable tissue. Chapter 8 in Swanson T, Asimus M, McGuiness W. Wound Management for the Advanced Practitioner. PI Communications . Used with permission

Biofilm? Slough? What is it?

Photo by R Wolcott and G Schultz

International Wound Infection I Consensus Document 2008
AWMA 2009

Bacteria continuum



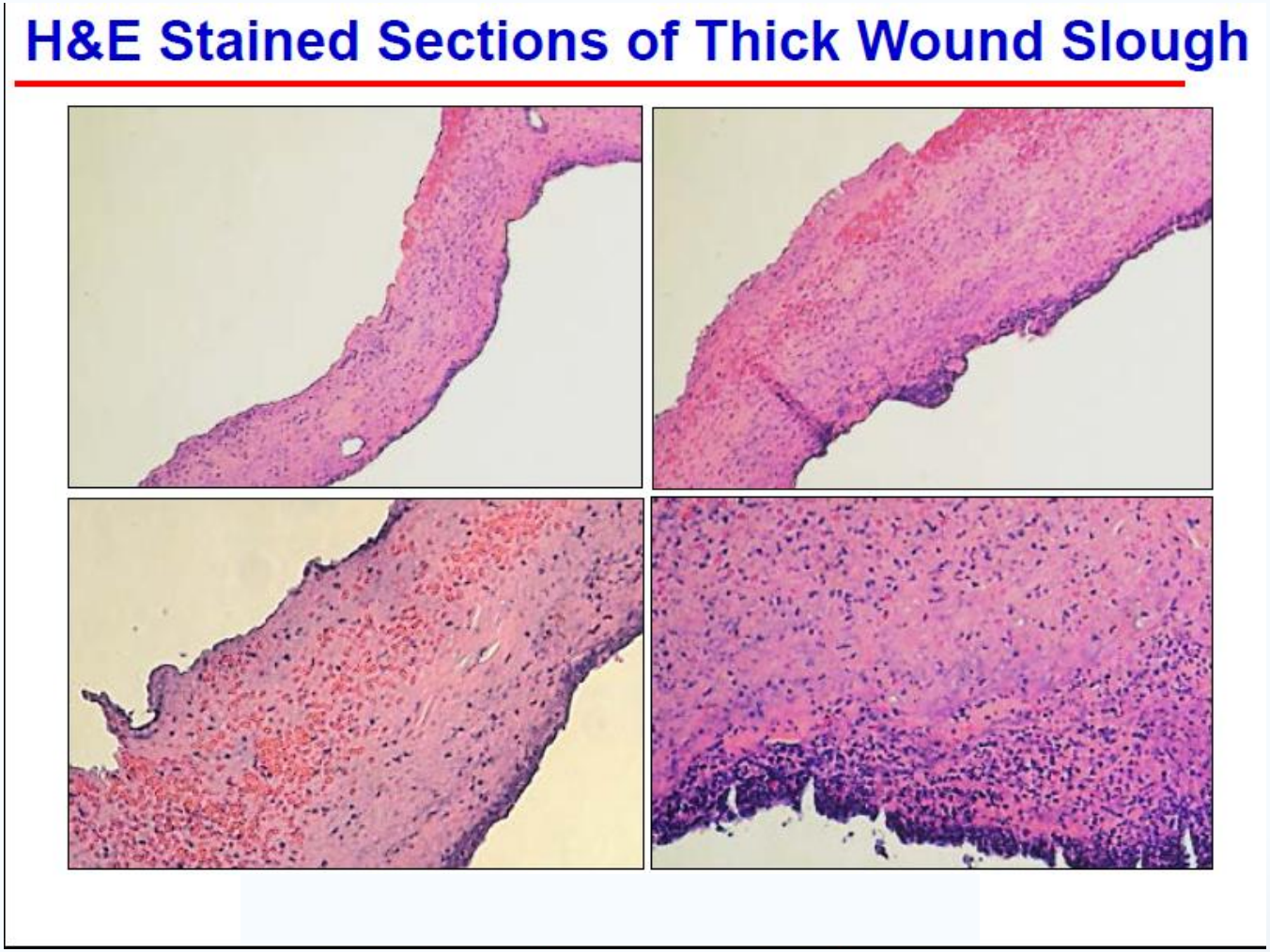
*Localised infection may or may not be accompanied by the classical signs and symptoms of inflammation. When it is not, various terms have been used, eg critical colonisation (see main text)

What Are These Shiny Substances on Wound Beds?

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.

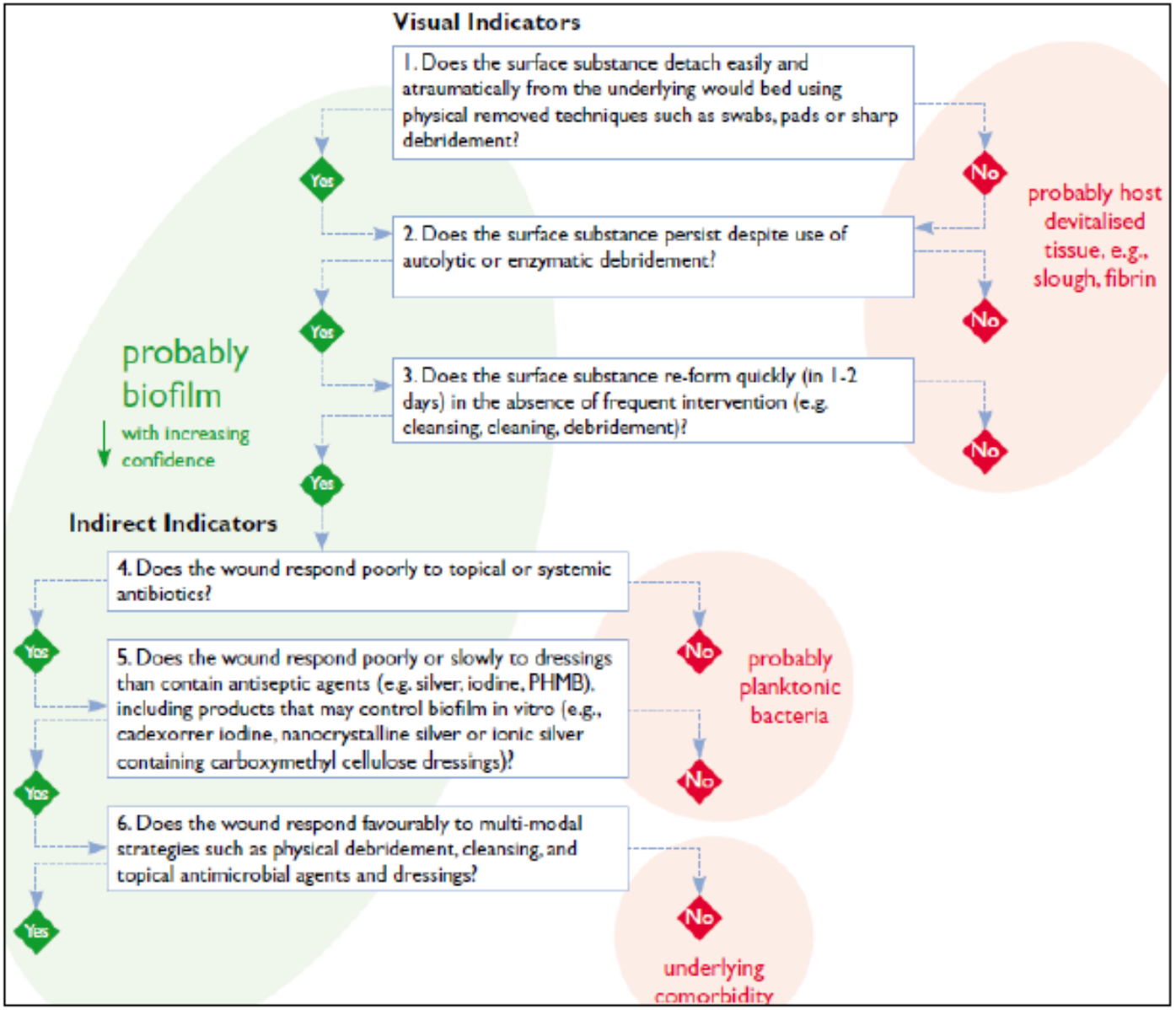
D.G. Metcalf, P.G. Bowler, J. Hurlow. A clinical Algorithm for Wound Biofilm Identification. J Wound Care 2014.

Microscopic evaluation



Slide courtesy of G Schultz

Clinical Algorithm For Wound Biofilm Identification

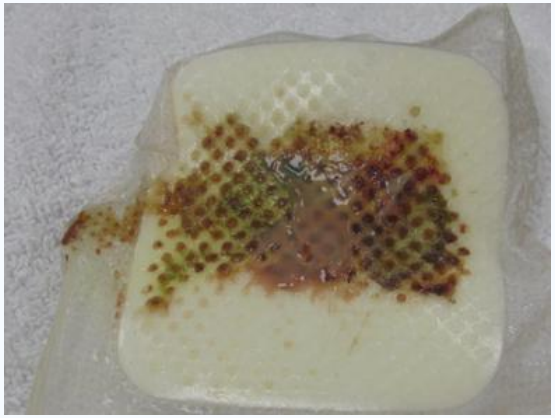


D.G. Metcalf, P.G. Bowler, J. Hurlow. A clinical Algorithm for Wound Biofilm Identification. J Wound Care 2014.

Table 1. Clinical indicators of biofilm in chronic wounds and supporting evidence.

Excessive moisture / exudate	Evidence that excessive moisture encourages biofilm development[12]
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]

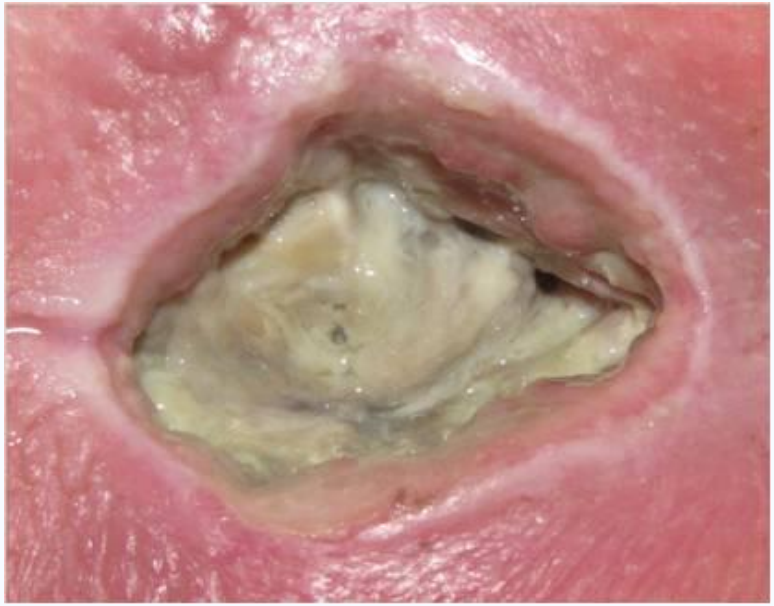
Is Biofilm only on the wound?

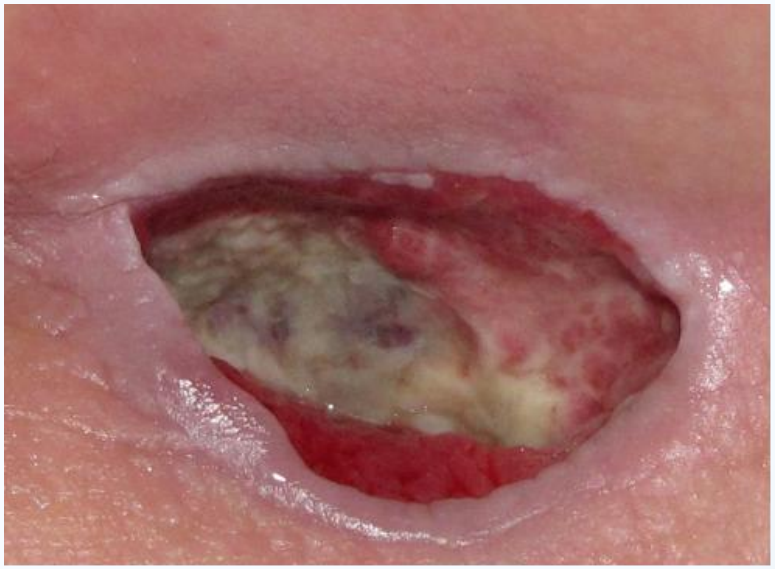


25/2/14

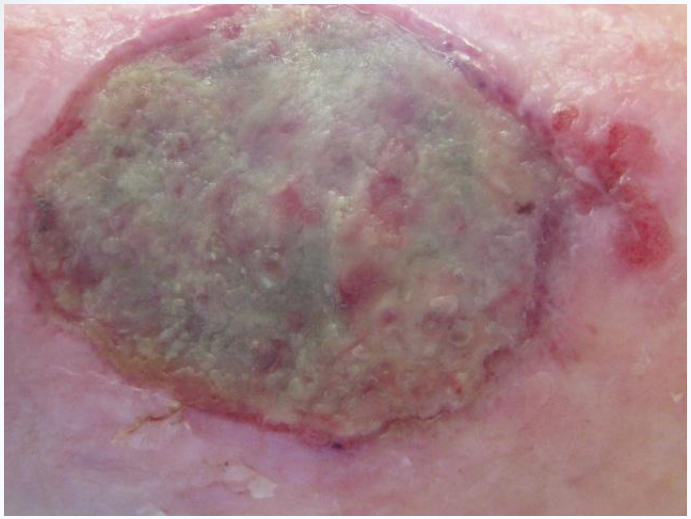
It lifts off easily and comes back by next week?

Curetting surface biofilm/slough





Photos courtesy of Lisa Hewitt CNC Bendigo Health



Photos T Swanson

EWMA

POSITION DOCUMENT

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

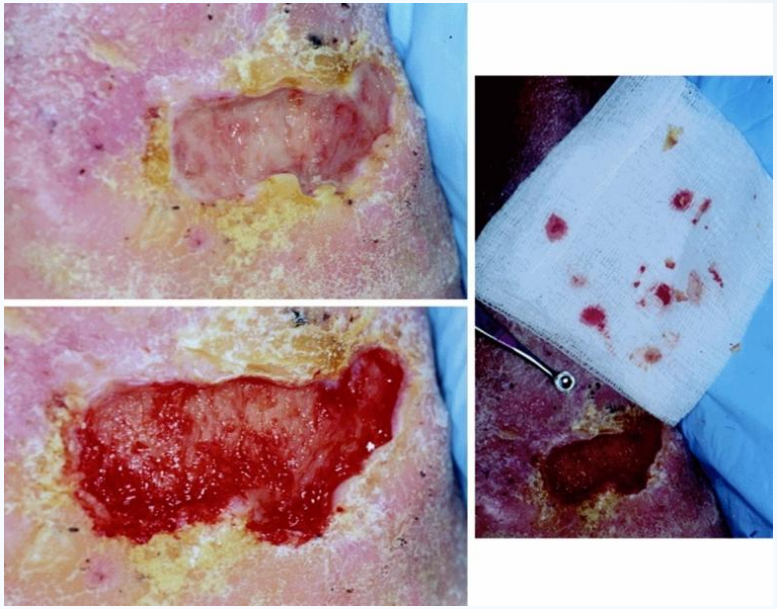
How do we manage it?

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

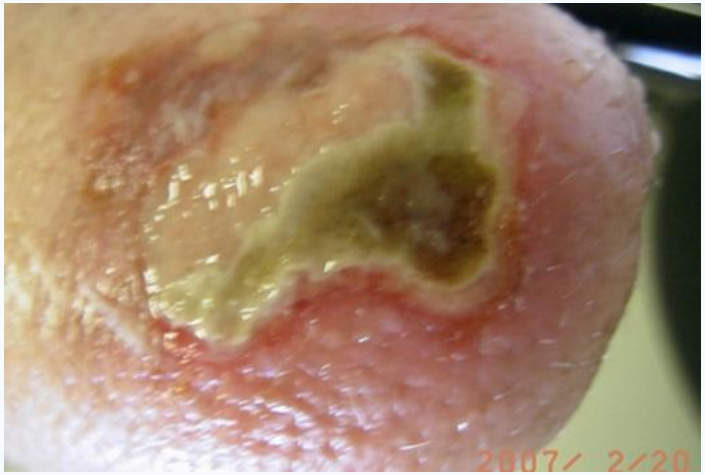
"removal of surface contaminants, bacteria and remnants of previous dressings from the wound surface and its surrounding skin"

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

Rodeheaver GT, Ratliff CR (2007) Wound Cleansing, Wound Irrigation, Wound Disinfection. In: Rodeheaver GT, Krasner DI, Sibbald RG eds. *Chronic Wound Care: A Clinical Source Book for Healthcare Professionals*. HMP Communications, Malvern, P.A.

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

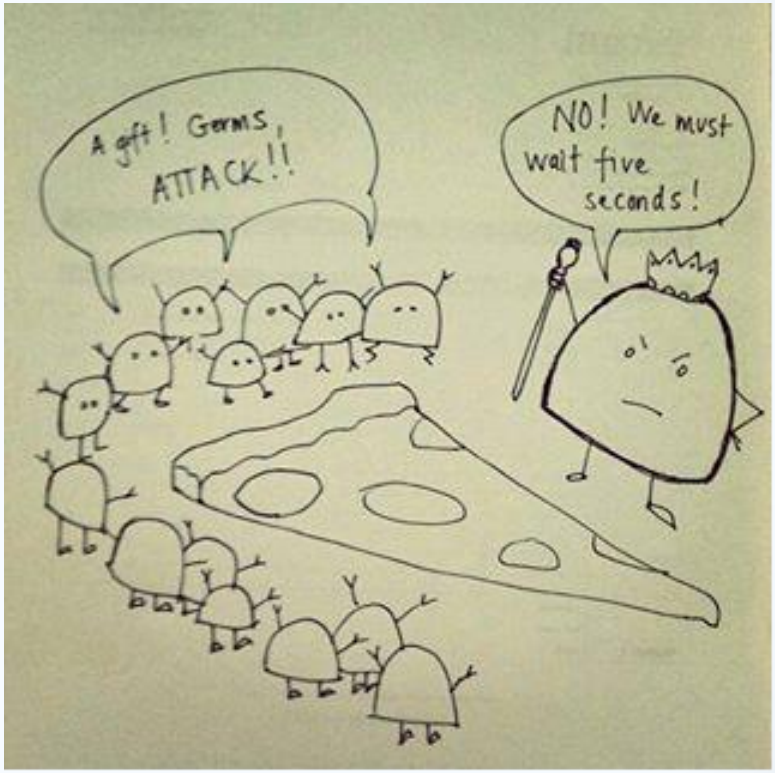
Clean and cover

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



Jenny Hurlow NP, 2014

“ 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

- Hurlow, J., Bowler, P.G. Potential implications of biofilm in chronic wounds: a case series. .Wound Care 2012; 21: 3,109–115.
- Cutting, K.F., Harding, K.G. Criteria for identifying wound infection. J Wound Care. 1994; 3:4, 198–201.
- Wolcott R, Rhoads D, Dowd S. Biofilms and chronic wound inflammation. J Wound Care. 2008 17(8):33r3-341.
- Wolcott R, Rhoads D, Bennett M, Wolcott B, Gogokhia L, Costerton J, Dowd S. Chronic wounds and the medical biofilm paradigm. Journal of Wound Care 2010;19(2): 45-53.
- Fonseca A. Biofilms in wounds; An unsolved problem? EWMA Journal. 2011; 11(2);10-12.
- Wolcott R, Ehrlich G. Biofilms and chronic infections. JAMA. 2008;299(22):2682-4.
- Dalton T, Dowd SE, Wolcott RD, Sun Y, Watters C, et al. (2011) An In Vivo Polymicrobial Biofilm Wound Infection Model to Study Interspecies Interactions. PLoS ONE 6(11): e27317. oi:10.1371/journal.pone.0027317
- Cutting k, Wolcott R, Dowd S Percival S Biofilms and Significance to Wound Healing 233-247 in Percival S .Cutting K(2010) Microbiology of Wounds. CRC Press Boca Raton.
- Hurlow J, Bowler PG. Clinical experience with wound biofilm and management: a case series. *Ostomy Wound Manage* 2009; 55(4): 38-49.
- Wolcott RD, Rumbaugh KP, James G, Schultz G, Phillips P, Yang Q, Watters C, Stewart PS, Dowd SE. Biofilm maturity studies indicate sharp debridement opens a time-dependent therapeutic window. JWound Care 2010:19(8):320-8.
- Abida, M., Zubair, M., & Jamal, A. (n.d). Original article: The diabetic foot infections: Biofilms and antimicrobial resistance. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, *7*101-107
- Zhao g, Usui M, Soyeon L et al. Biofilms and Inflammation in Chronic Wounds . Advances in Wound Care 2013 1- 11.
- Leaper DJ, Schultz G, Carville K, Fletcher J, Swanson T, Drake R. (2012) Extending the TIME concept: what have we learned in the past 10 years? Int Wound J, 9(Suppl.2): 1-19.
- Percival SL, Bowler PG, Woods EJ. Assessing the effect of an antimicrobial wound dressing on biofilms. Wound Repair Regen 2008; 16: 52-57
- Phillips PL, Yang Q, Davis S, Sampson EM, Azeke JI, Hamad A, Schultz GS. Antimicrobial dressing efficacy against mature *Pseudomonas aeruginosa* biofilm on porcine skin explants. Int Wound
- Kostenko V, Lyczak J, Turner K, Martinuzzi RJ . Impact of Silver-Containing Wound Dressings on Bacterial Biofilm Viability and Susceptibility to Antibiotics during Prolonged Treatment. Antimicrob Agents Chemother 54:5120–5131, 2010. J 2013
- Bjarnsholt T, Kirketerp-Moller K, Jensen PO, Madsen KG, Phipps R, Krogfelt K, Holby N, Givskov M. Why chronic wounds will not heal: a novel hypothesis. Wound Repair Regen 2008; 16: 2-10