Investigations and Diagnosing How accurate are they in different populations?

Australian Wound & Skin Alliance Summer School 2025

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Case study

41 woman

Chronic non-healing right 4th toe ulcer

Past Med History

- T1DM diagnosed 9 years old on Humalog Mix 8 units mane and lunch, 10 units nocte. HbA1c 10
- Hypertension on Atacand plus 32/25mg tablet daily

NKDA

Social History

Home with family, non-smoker, non-drinker

Case study

On examination well looking

- RR 16 SpO2 98% RA BP 143/92 HR 105 bpm T 36.4°C
- Right 4th toe 2cm ulcer red, swollen and discharge, extended to right 5th toe
- Dorsalis pedis +++ tibialis posterior + on right foot
- Capillary refill > 5s

Investigations

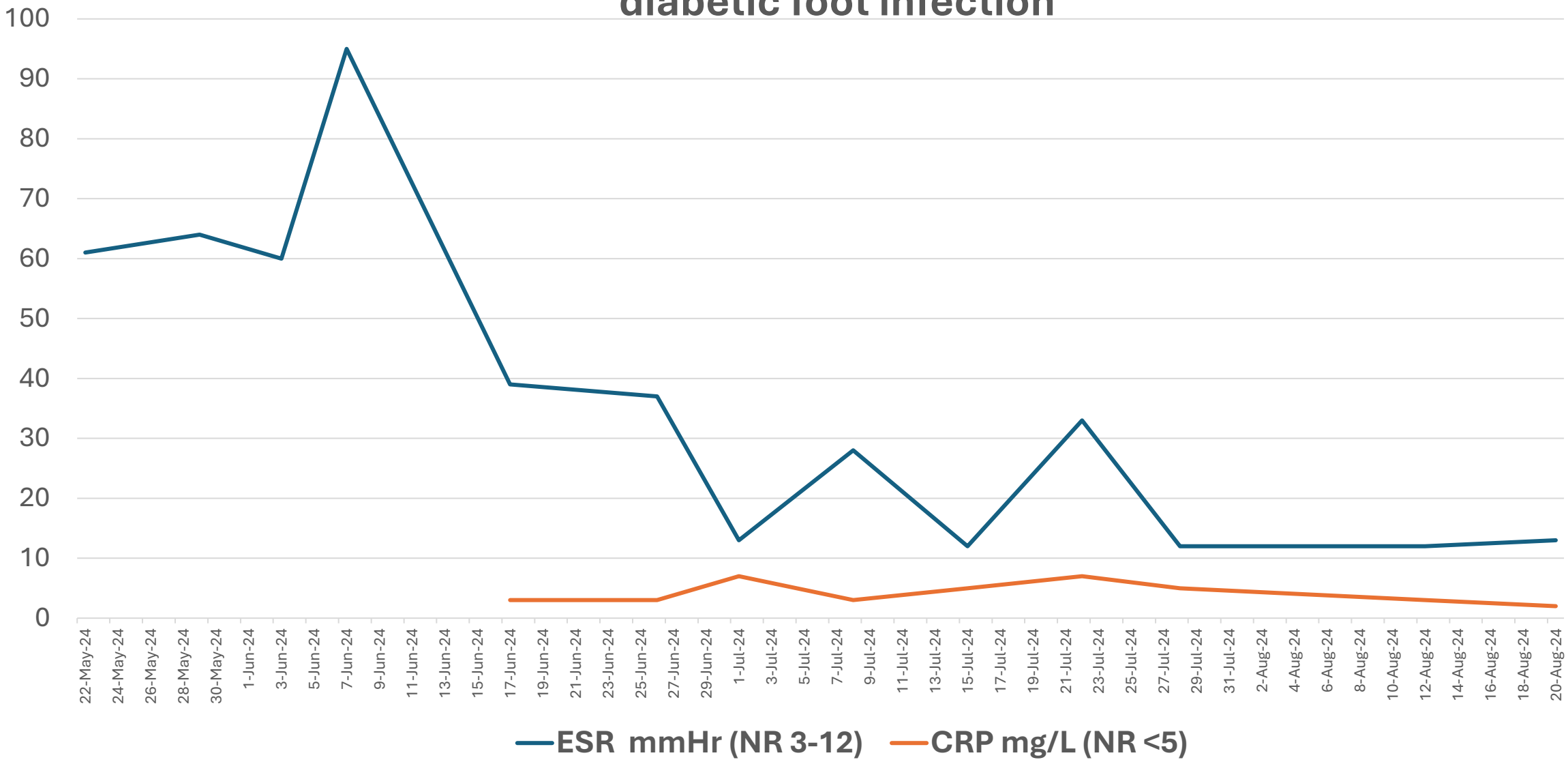
- 19/5/2024 CRP 3 mg/L (< NR 5) white blood cell 7.8 x 10^0/L
- Renal function and liver function test – normal

Case study

Date	Specimen type	Gram stain	Culture
15/4/2019	Wound swab	2+ leucocytes Few gram-positive cocci No epithelial cell	Moderate growth MSSA
20/3/2024	Ulcer swab foot	No leucocytes Few epithelial cells No organism seen	Moderate growth PSSA
16/5/2024	Tissue right fourth toe	No leucocytes No epithelial cell No organism seen	No growth after 10 days of incubation

Case study

- Debrided by vascular surgeon on the 16/5/2024
- MRI right foot on the 24/5/2024
  - There was some minor edematous soft tissue overlying the 4th toe in keeping with a history of recent debridement. No bone or bone marrow changes to suggest the presence of osteomyelitis
- Started on intravenous antibiotic followed by oral antibiotic (total duration 3 months) under hospital in the home
- Diabetic foot infection resolved, monitoring for relapse


Monitoring ESR and CRP in diabetic foot infection
100
90
80
70
60
50
40
30
20
10
0
22-May-24
24-May-24
26-May-24
28-May-24
30-May-24
1-Jun-24
3-Jun-24
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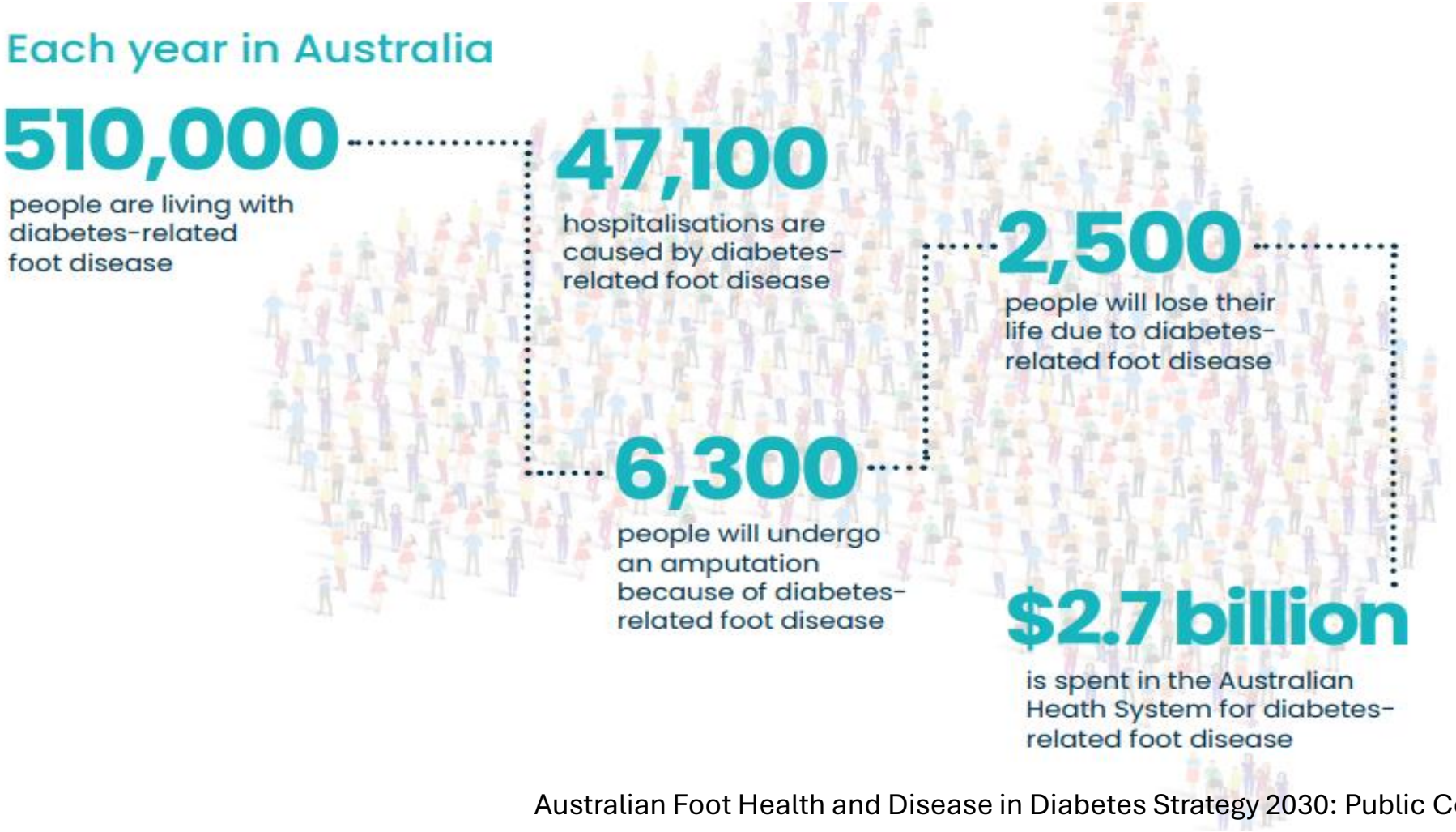
16-Aug-24
18-Aug-24
20-Aug-24
ESR mmHr (NR 3-12)
CRP mg/L (NR <5)

Interpretation of diagnostic results on various health etiologies

- Depends on the specific health condition
- Test used
- Clinical context

Burden of Diabetes Feet in Australia



Australian Foot Health and Disease in Diabetes Strategy 2030: Public Consultation Draft

Diabetes Foot Infections (DFIs)

537 million adults aged between 20 and 79 years – DIABETES in 2021 worldwide[1]

DFIs is experienced by up to 34%[2]

DFIs most frequent diabetes-related complications

- hospitalisation
- lower extremity amputation.[3,4]
- one large prospective study, at the end of 1 year
  - the ulcer had healed in only 46% (and it later recurred in 10% of these)
  - 15% had died
  - 17% required a lower extremity amputation.[5]

1. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Belgium; 2021. https://www.diabetesatlas.org
2. Armstrong DG, et al. Diabetic foot ulcers and their recurrence. N Eng J Med 2017; 376:2367-75
3. Chen L, et al. Global mortality of diabetic foot ulcer: a systemic review and meta-analysis of observational studies. Diabetes Obes Metab 2023; 25:36-45.
4. Jia L, et al. Incidence and risk factors for developing infection in patients presenting with uninfected diabetic foot ulcers. PLoS One 2017; 12:e0177916.
5. Richard JL, et al. Management of patients hospitalized for diabetic foot infection: results of the French IPIDIA study. Diabetes Metab 2011; 37:208-15.

Clinical Infectious Diseases

IDSA GUIDELINES

IWGDF/IDSA Guidelines on the Diagnosis and Treatment of Diabetes-related Foot Infections (IWGDF/IDSA 2023)

Éric Senneville,[1,2] Zaina Albalawi,[3] Suzanne A. van Asten,[4] Zulfiqarali G. Abbas,[5] Geneve Allison,[6] Javier Aragón-Sánchez,[7] John M. Embil,[8] Lawrence A. Lavery,[9] Majdi Alhasan,[10] Orhan Oz,[11] Ilker Uçkay,[12] Vilma Urbančič-Rovan,[13] Zhang-Rong Xu,[14] and Edgar J. G. Peters[15,16,17]

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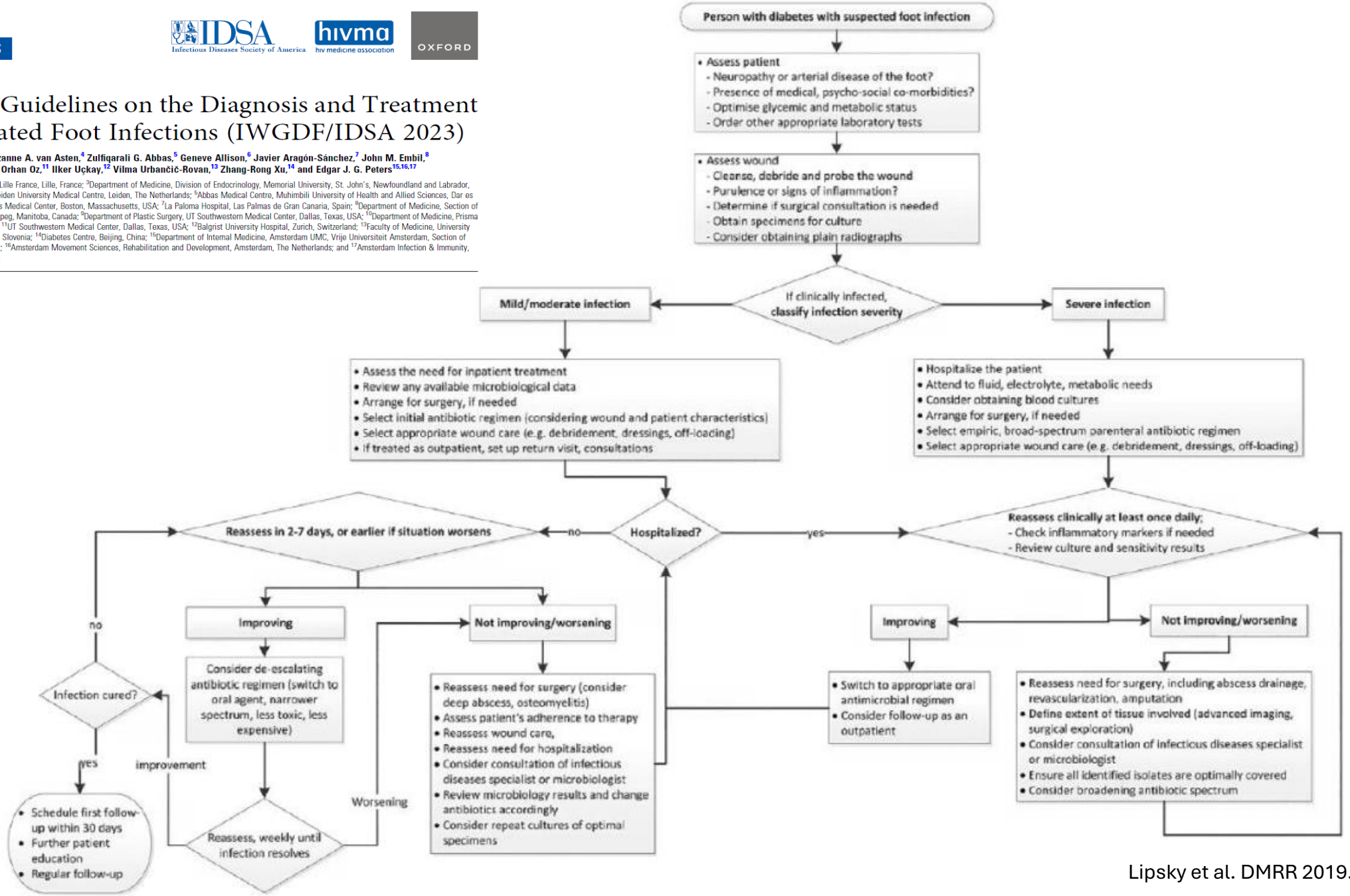


Lipsky et al. DMRR 2019.

Samples collection for culture

- Swab
  - Discouraged
  - Flocked swab and transport medium if must be used [1-4]
  - Meta –analysis: lower extremities swab vs deeper culture [5]
    Sensitivity 49%; Specificity 62% ; + likelihood ratio 1.1; – likelihood ratio 0.67

- Aspirates[6]

- Tissue[6]

1. Nys S, et al. 2010. Comparison of Copan eSwab with the Copan Venturi Tran-system for the quantitative survival of *Escherichia coli*, *Streptococcus agalactiae* and *Candida albicans*. Eur J Clin Micobiol Infect Dis 29:453-456
2. Tyrell KL, et al. 2016. Comparison of the Copan eSwab system with an agar swab transport system for maintenance of fastidious anaerobic bacterium viability. J Clin Microbiol 54:1364-1367.
3. Jones G, et al. 2011. Comparison of automated processing of flocked swabs with manual processing fiber swabs for detection of nasal carriage of Staphylococcus aureus. J. Clin Microbiol 49: 2717-2718.
4. Saegeman V, et al. 2011. Clinical evaluation of the Copan ESwab for methicillin-resistant Staphylococcus aureus detection and culture of wounds. Eur J Clin Microbiol Infect Dis 30: 943-949.
5. Chakraborti C, et al. 2010. Sensitivity of superficial cultures in lower extremity wounds. J Hosp Med 5: 415-420.
6. Lipsky BA, et al. 2012. 2012 Infectious Diseases Society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections. Clin Infect Dis 54:e132-e173.

Comparison among wound culture techniques

	Descriptions	*Advantages*	*Disadvantages*
Deep-tissue biopsy	Obtain tissue sample by punch/needle biopsy or a scalpel; quantitative results acquired by microscopic examinations.	Conclusive and accurate result for detecting invading microorganisms; gold standard for wound infection diagnosis.	Time-consuming, costly, invasive, painful, require special equipment and special training; high risk for postsurgical trauma, wound disruption, and bacteremia.
Needle aspiration	Obtain microbes below the surface of the wound by inserting a fine-gauge needle into tissue to aspirate fluid.	Feasible for small open wound and detecting subcutaneous microorganisms; less invasive.	Time-consuming, painful; may underestimate bacterial isolates.
Swab culture	Press sterile culture swab against the wound base to extract wound fluid; using eluent for incubation and quantification.	Practical, noninvasive, reproducible, and inexpensive; has sufficient correlation with tissue biopsy outcome.	Time-consuming; cannot detect pathogenic strain invading deeper tissues; weak in detection of biofilm infection.

Li S, et al. Diagnostics for Wound Infections. Adv Wound Care (New Rochelle). 2021 Jun;10(6):317-327. doi: 10.1089/wound.2019.1103. Epub 2020 Jul 7. PMID: 32496977; PMCID: PMC8082727.

CULTURE

- **SPECIMEN TRANSPORT AND STORAGE**
  - Specimens should be transported to the laboratory promptly and
  - Appropriately labelled as to
    - Time of collection and
    - Date
    - Patient demographic data and physician.
- **PROCESSING REQUIREMENTS FOR WOUNDS**

Wound category	HBA (CO_2)	Choc (CO_2)	NC/ Mac. (Air)	TC BS (Air)	HB-Neo (AnO_2)	Gram stain
Exit sites	x		x			x
Superficial wounds	x		x			x
Operative wounds, abscess, sinus / fistula	x		x		x	x
Burns	x		x			x
Bites / Facial cellulitis	x	x	x		x	x
Aquatic wounds	x		x	x		X
Ulcers	x		x			x

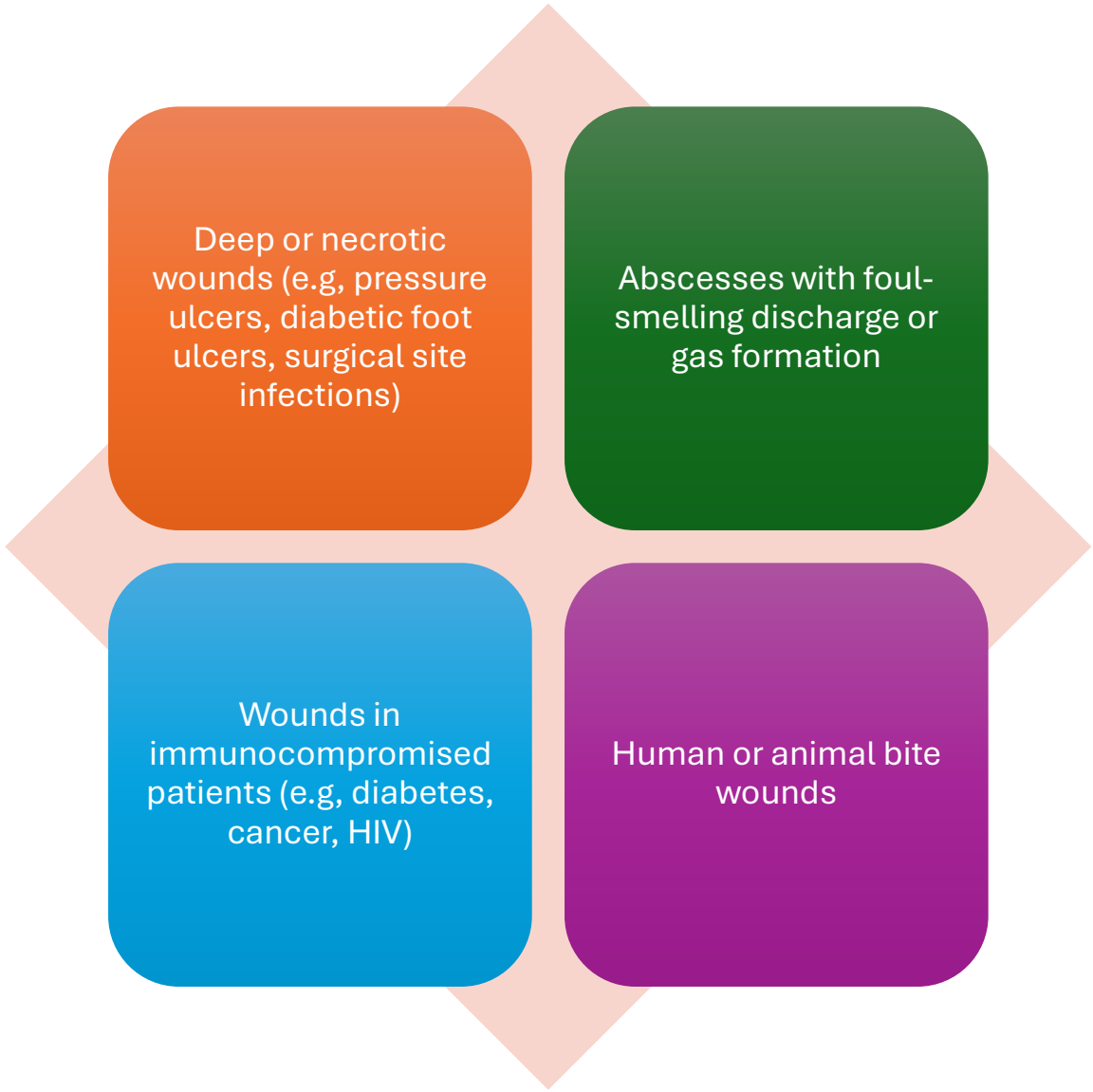
Anerobic and Fungal culture

Anaerobic and fungal culture should be considered when clinical suspicion exists

Whether routinely recommended depends on the

Wound type	Clinical presentation	Risk factors

Anaerobic Culture



Fungal Culture

Chronic, non-healing wounds

- (especially in immunocompromised patients)

Wounds with atypical appearance

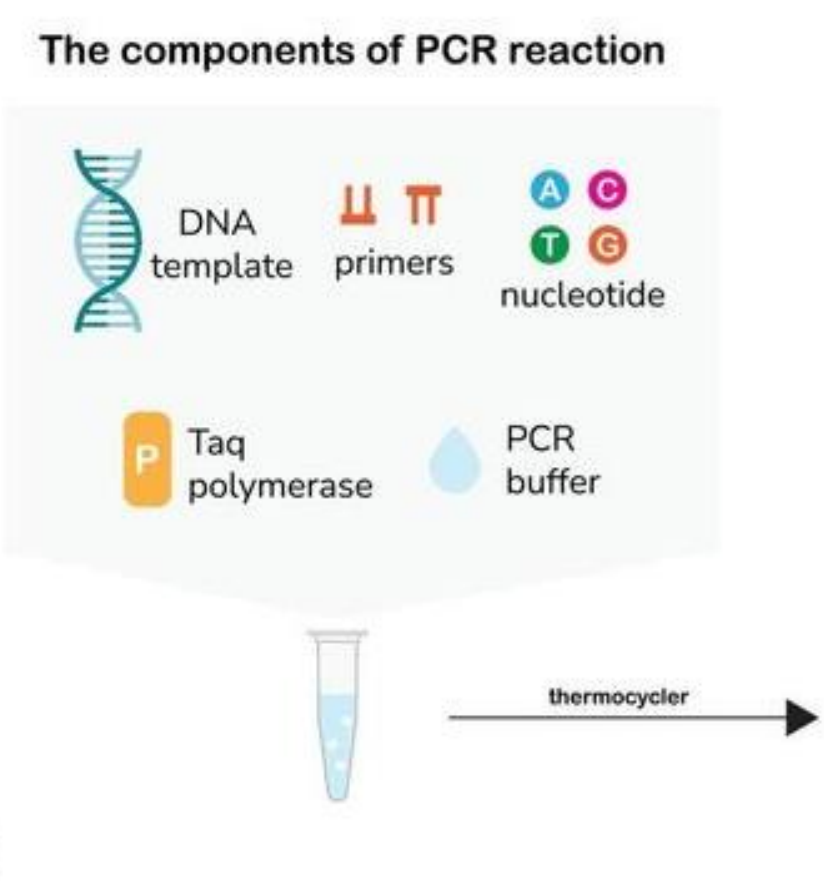
- (e.g., colored discharge, unusual granulation tissue)

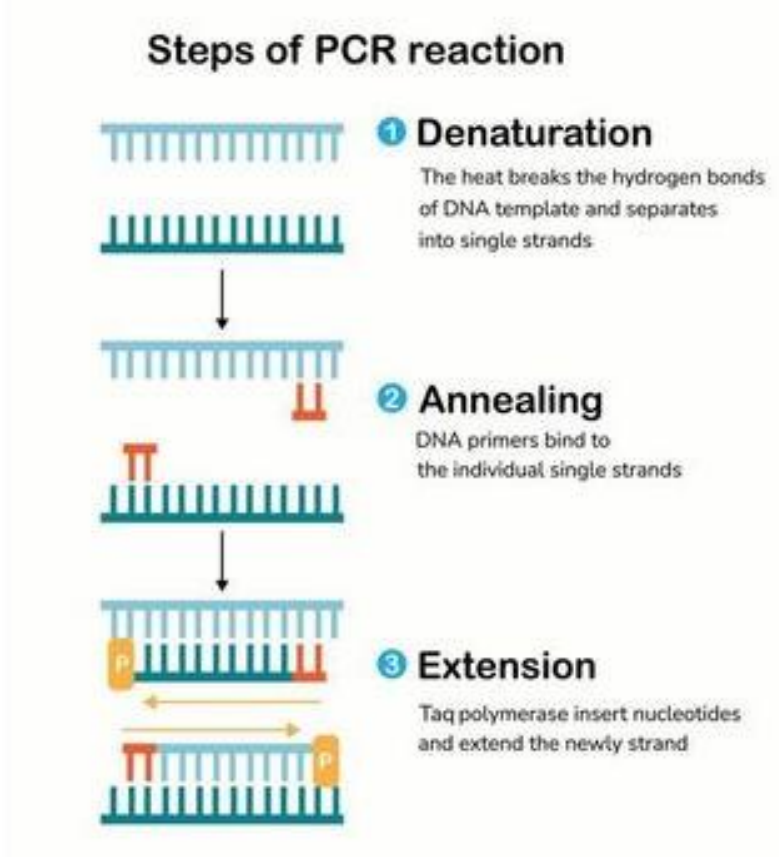
Wounds in warm, moist environments

- (e.g., intertriginous areas, prolonged occlusion)

Post-surgical infections after implant placement

Polymerase Chain Reaction (PCR)





Wound PCR

GENETWORx Wound Pathogen Panel: This test detects 30 pathogens and identifies patient-specific antibiotic resistance, delivering results within 48 hours. GENETWORX.COM

Thermo Fisher Scientific's TrueMark Real-Time PCR Solutions: Designed for research purposes, these customizable qPCR panels target a wide range of bacterial, fungal, and antibiotic resistance genes, accommodating various laboratory throughput needs.

Ability Diagnostics' PCR Wound Test: This test identifies 50 wound pathogens, both bacterial and fungal, and detects 10-20 resistance genes to aid in targeted antibiotic prescription. WOUNDSOURCE.COM

Eurofins Viracor's Skin and Soft Tissue Infection Panel: Utilizing Target Enriched Multiplex PCR (TEM-PCR) technology, this panel detects 19 bacterial targets commonly found in skin and soft tissue infections. EUROFINS-VIRACOR.COM

Methods	Pros	Cons
PCR-based	- Fast - Consistent & reliable identification	- Costly - Limited - Not easily translatable into clinical practice, no impact on antibiotic prescription - False positive
Cultured-based	- Established - Susceptibility result	- Slow - Lack sensitivity in polymicrobials environment

IWGDF/IDSA Guidelines on diagnosing Diabetic Foot Infections

- In a person with suspected soft tissue DFI, consider a sample for culture to determine the causative microorganisms, preferably by aseptically collecting a tissue specimen (by curettage or biopsy) from the wound. (Recommendation, Conditional; Certainty of evidence: Moderate).

- Use conventional, rather than molecular, microbiology techniques for the first-line identification of pathogens from soft tissue or bone samples in a patient with a DFI. (Recommendation, Strong; Certainty of evidence: Moderate).

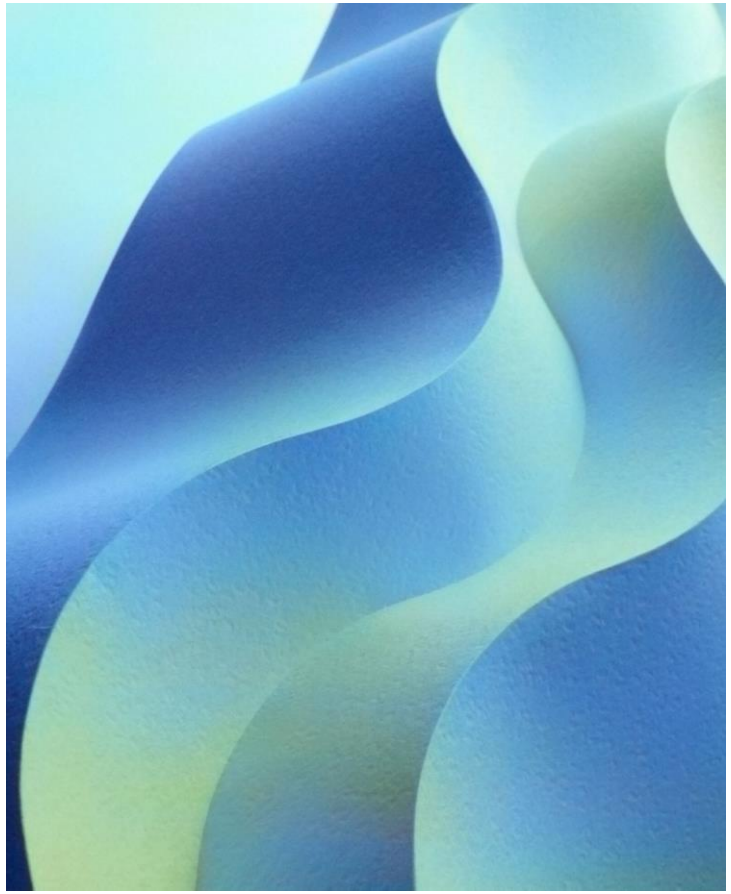
Éric Senneville, et al., IWGDF/IDSA Guidelines on the Diagnosis and Treatment of Diabetes-related Foot Infections (IWGDF/IDSA 2023), Clinical Infectious Diseases, 2023;, ciad527, https://doi.org/10.1093/cid/ciad527

pH as a prognostic indicator

Higher pH values correlate with poor healing outcomes[1]

A drop in pH over time is generally a good prognostic sign, indicating healing progression[2]

Infected diabetic foot ulcers tend to be more alkaline due to bacterial activity (ammonia and other alkaline byproducts)[2]

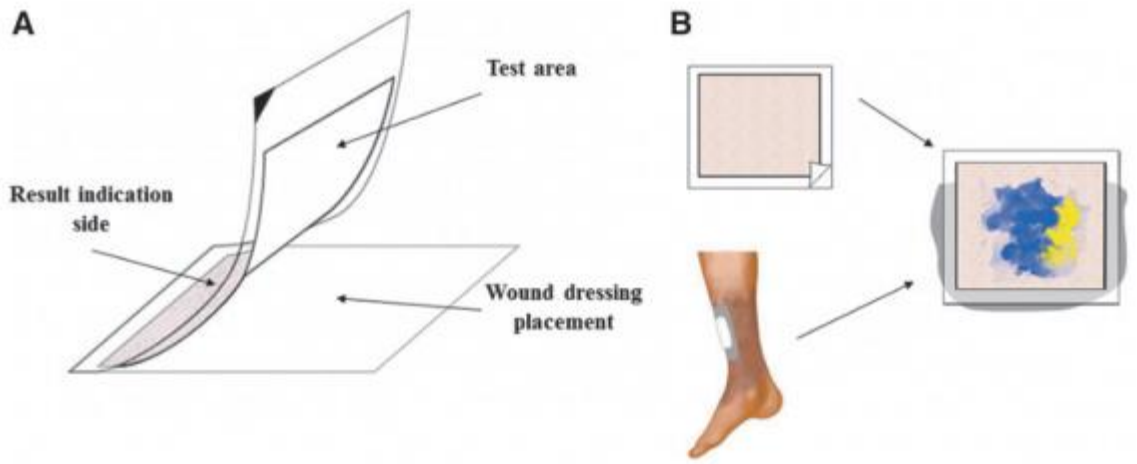


1. Wang Y, et al. An observational study of the pH value during the healing process of diabetic foot ulcer. J Tissue Viability. 2024 May;33(2):208-214.

2. Léo-Paul Tricou, et al. Wound pH-Modulating Strategies for Diabetic Wound Healing. Advances in Wound Care 2024 13:9, 446-462

pH as a prognostic indicator

- Several publications have voiced support for detecting pH as valuable wound biomarkers



Vu H, et al. A Device to Predict Short-Term Healing Outcome of Chronic Wounds. Adv Wound Care (New Rochelle). 2020 Jun;9(6):312-324.

Conclusion

- Diabetic foot infection, high health care burden
- Tissue would be preferred than swab
- Culture-based is still the current practice
- pH as prognostic indicator is valuable wound biomarkers, either as a standalone or supplementary tool.

Questions