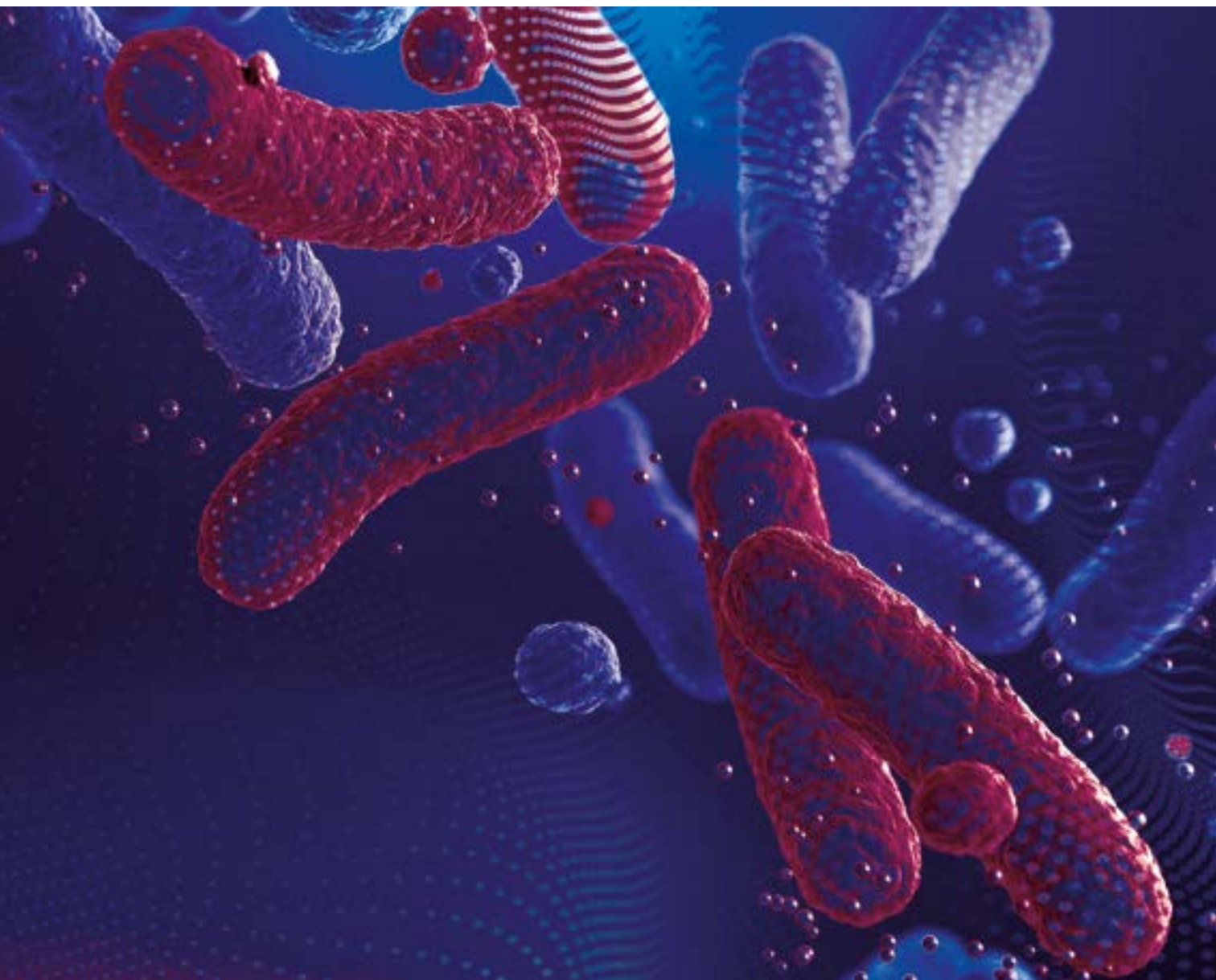


# International guideline on antimicrobial stewardship and the role of microbial-binding dressings in wound care 2026: infection prevention, control, early intervention and treatment



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# MA Healthcare

## Contents

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- S3** Foreword
- S4** Panel
- S5** International guideline on antimicrobial stewardship and the role of microbial-binding dressings in wound care 2026: infection prevention, control, early intervention and treatment
  - S5** Aims
  - S5** Methods
  - S7** Results
  - S10** Discussion
  - S20** Clinical pathways
  - S22** Limitations
  - S23** Conclusions
- S24** Pathways
  - S24** Closed surgical incisions
  - S26** Hard-to-heal wounds
  - S28** Diabetes-related foot ulcers
  - S30** Venous leg ulcers
- S32** Appendices
- S35** References

# Foreword

Antimicrobial stewardship (AMS) is a challenge for all healthcare professionals (HCPs) involved in infection control, prevention of progression and treatment of wound infection. The rising evidence of antimicrobial resistance (AMR) in both surgical and hard-to-heal wounds makes infections harder to treat and jeopardises the healing process, negatively impacting patients' lives and making this a global responsibility.

HCPs managing wounds should be asking 'Is the wound infected?' and, if so, 'How can the infection be responsibly treated?'. However, HCPs often lack the knowledge and confidence to identify infection by its signs and symptoms, differentiate it from inflammation and make a confident assessment and diagnosis. Likewise, wound care in clinical practice is variable and not always in alignment with AMS, with widespread use of antimicrobials in uninfected wounds.

Strengthening AMS and reducing AMR in wound care can preserve the effectiveness of antimicrobials, prevent complications and improve patient outcomes. However, this will require a shift in practice towards safe and early first-line interventions that minimise the microbial

burden in a wound, manage local infection and prevent progression, with minimal antimicrobial requirements.

This guideline aims to meet the need for clear, credible and practical guidance on AMS in wound care. Its applications are intended to support clinical decision making and complement clinical judgement in a way that is relevant, accessible and implementable for HCPs across all settings, whether working with surgical incisions or hard-to-heal wounds. The guideline has been carefully developed through a rigorous, evidenced-based interdisciplinary process and is complemented with four standalone clinical pathways. Moreover, it is a living document, intended to evolve alongside the evidence with key updates on this fast-moving area of research.

The guideline builds the evidence for a shift towards early AMS-aligned intervention to control microbial burden before antimicrobials become necessary. All HCPs in wound care are encouraged to collaborate in advancing this evidence-based paradigm shift in infection prevention and control for the benefit of patients and colleagues now and in the future.

## Abstract

**Background:** Wound microbial burden and infection can delay wound healing, increase complications and rapidly progress to spreading or systemic infection, particularly in high-risk patients. Early diagnosis and appropriate treatment are essential for improved outcomes and reduced antimicrobial resistance (AMR). AMR is a growing concern in wound care due to reported inappropriate use of topical antiseptics, as well as systemic antibiotics. A recent survey found 41.8% of healthcare professionals used antimicrobial prophylactically, against recommendations, while 37.2% did not follow antimicrobial stewardship (AMS) guidance, indicating a potential gap in best-practice treatment.

**Aims:** The primary aim of this document was to provide evidence-based guidance on the role of microbial-binding dressings (MBDs) in managing microbial burden, preventing infection and reducing the need for antimicrobial intervention in both surgical incisions and hard-to-heal wounds. The secondary aim was to summarise key findings in four clinical pathways.

**Methods:** This guideline was developed according to AGREE II with a pragmatic literature review with GRADE assessments and a modified Delphi process for developing evidence-based statements. The literature search asked: 'In adults with a wound or surgical incision, do MBDs, compared with standard care, reduce surgical site infections, microbial burden, signs of infection, antibiotic use, antiseptic dressing use, time to healing or complication rates?'. For the statements, a 10-member expert panel scored agreement from 1 to 5, over three rounds (two remote and one in person), with acceptance at a mean score of  $\geq 4.00$  ( $SD \leq 1.00$ ).

**Results:** The literature review returned 12 studies on surgical incisions and 17 on hard-to-heal wounds, varying in evidence level and certainty. From 13 original statements, strong agreement was reached for 14; nine in round one, two in round two and three in round three (in-person meeting), with one statement split into two prior to agreement. The statements fit three themes: challenges of wound infection and AMR; benefits of MBDs for infection prevention and control (IPC); and early IPC in future AMS strategies. The guideline presents each statement with supporting evidence and detailed guidance for implementation in practice. This is followed by four easy-to-use AMS clinical pathways to support practical implementation, decision-making and consistency in care, currently under evaluation, with further validation studies expected.

**Conclusion:** This guideline identifies and aims to meet a clear need for evidence-based best practice to enhance AMS in wound care. A paradigm shift towards infection prevention, early intervention and first-line treatment using MBDs should be considered an opportunity in everyday practice to minimise progression of infection, limit antimicrobial requirements and thus tackle the global threat of AMR.

**Keywords:** Antimicrobial stewardship, wound care, infection prevention and control, wound infection prevention and management, surgical and hard-to-heal wounds, early intervention, microbial-binding dressings

# Panel

## Author panel

**Chair:** **Patricia Idensohn**, Independent Consultant, Comp Consulting, Stratford-Upon-Avon, UK

**Co-chair:** **Emma Woodmansey**, Owner and Principal Consultant, Clinical & Scientific Solutions, York, and Honorary Senior Lecturer, Cardiff University, Cardiff, UK

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**Zhavandre van der Merwe**, PhD Candidate, Murdoch University, and Advanced Wound Care Specialist, 4 Wounds Wound Care Practice, Pretoria, South Africa

**Kevin Woo**, Professor, Queen's University, Kingston, Canada, and Adjunct Professor, Curtin University, Perth, Australia

## Review panel

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## Consent and approvals

No informed consent or institutional review board approvals were required for this research.

## Contributions

**Chair:** Evidence review, statements, validation, writing of original draft preparation, review and editing

**Co-chair:** Conceptualisation, searches, evidence review, statement drafting, formal analysis, visualisation, writing original draft preparation, review and editing

**Other authors:** Validation, writing and review

## Conflicts of interest

All panel members declared any direct and indirect conflicts of interest, which were not a barrier to participation. All panel members received a fee for their contribution to this guideline from the *Journal of Wound Care*. Febe Bruwer, Patricia Idensohn, Astrid Probst, George Smith, Zhavandre van der Merwe, Kevin Woo and Emma Woodmansey had received speaker and/or consultancy fees from Essity prior to this publication. Windy Cole, Bodo Günther, Klarida Hoxha, Vivek Lakshmanan and Paulo Ramos had no conflict of interest to declare.

## Abbreviations

<b>AGREE</b>	Appraisal of Guidelines Research and Evaluation
<b>AMR</b>	Antimicrobial resistance
<b>AMS</b>	Antimicrobial stewardship
<b>CDC</b>	Centers for Disease Control and Prevention
<b>CEAP</b>	Clinical, Etiological, Anatomical Pathophysiological classification of venous disease
<b>DRFU</b>	Diabetes-related foot ulcer
<b>GRADE</b>	Grading of Recommendations Assessment, Development and Evaluation
<b>HCP</b>	Healthcare professional
<b>IPC</b>	Infection prevention and control
<b>IWII</b>	International Wound Infection Institute
<b>MBD</b>	Microbial-binding dressing
<b>MDRO</b>	Multi-drug-resistant organism
<b>PI/PU</b>	Pressure injury/pressure ulcer
<b>PICO</b>	Problem, Intervention, Comparison, Outcome
<b>SINBAD</b>	Site, Ischaemia, Neuropathy, Bacterial infection and Depth
<b>SSI</b>	Surgical site infection
<b>VLU</b>	Venous leg ulcer
<b>WHO</b>	World Health Organization
<b>WIC</b>	Wound Infection Continuum
<b>WIFI</b>	Wound Ischaemia Foot Infection

# International guideline on antimicrobial stewardship and the role of microbial-binding dressings in wound care 2026: infection prevention, control, early intervention and treatment

Wound infection is a major burden for patients, delaying healing and impacting quality of life,<sup>1-5</sup> making it a major concern for the majority of healthcare professionals (HCPs).<sup>6</sup> Progression can lead to serious complications, including spreading infection, systemic involvement and even amputation or death,<sup>1,7-9</sup> requiring significant resources to treat.<sup>10-12</sup>

These challenges are amplified in infections caused by microbes that are resistant to antimicrobial treatment.<sup>13,14</sup> Infections with antimicrobial resistance (AMR) are more difficult to treat and increase risk of death, being associated with over 4.7 million deaths from 1990 to 2021, including an 80% increase in deaths in patients older than 70 years.<sup>14</sup> AMR, the process by which microbes (bacteria, fungi, parasites, viruses) evolve mechanisms to reduce the effectiveness of antimicrobials, develops in response to selective pressure from antimicrobial challenge and natural selection, particularly if antimicrobials are used inappropriately, increasing antimicrobial treatment failure and making infections more difficult to treat.<sup>15</sup> The global burden of AMR-related infection is predicted to rise by 2050,<sup>14</sup> placing it among the World Health Organization's top 10 threats to global health.<sup>16</sup>

These trends are mirrored in wound care, where both hard-to-heal<sup>17-20</sup> and surgical wounds<sup>21-23</sup> increasingly demonstrate complications driven by antimicrobial-resistant organisms. This burden is further exacerbated in clinical practice by the inappropriate use of antimicrobials, including topical antiseptics and systemic antibiotics, particularly when they are applied in the absence of infection.<sup>24-28</sup> Collectively, these challenges underscore the need for greater awareness of AMR-related issues in wound management.

Wound care has a widely identified need for greater antimicrobial stewardship (AMS).<sup>29-33</sup> AMS can be defined as a systematic, healthcare-wide approach to promoting the judicious, responsible use of antimicrobials as part of infection prevention and control (IPC) strategies,<sup>34</sup> to preserve their future effectiveness.<sup>29,35,36</sup> However, in a recent observational study only 33% of surgeons complied with AMS guidelines,<sup>37</sup> and a recent survey found 37.2% of HCPs did not follow AMS guidance in everyday practice.<sup>28</sup> These findings pave the way for new guidance on AMS in wound care.

This guideline is intended to overcome identified challenges posed by wound infection and AMR, including limitations of current practice and inappropriate use of antimicrobials, particularly where no local infection is observed.<sup>28</sup> Surveyed HCPs identified the need for support for making evidence-based decisions on antiseptic dressings, including clinical evidence demonstrating efficacy of new technologies (77.9%), guidance documents (71.6%) and pathways to support appropriate treatment (71.6%).<sup>28</sup> This document is intended to provide that evidence-led support for preventing and treating infection in closed surgical incisions and hard-to-heal wounds by presenting clinical evidence, guidance and pathways (*Figure 1*), thus supporting AMS.

## Aims

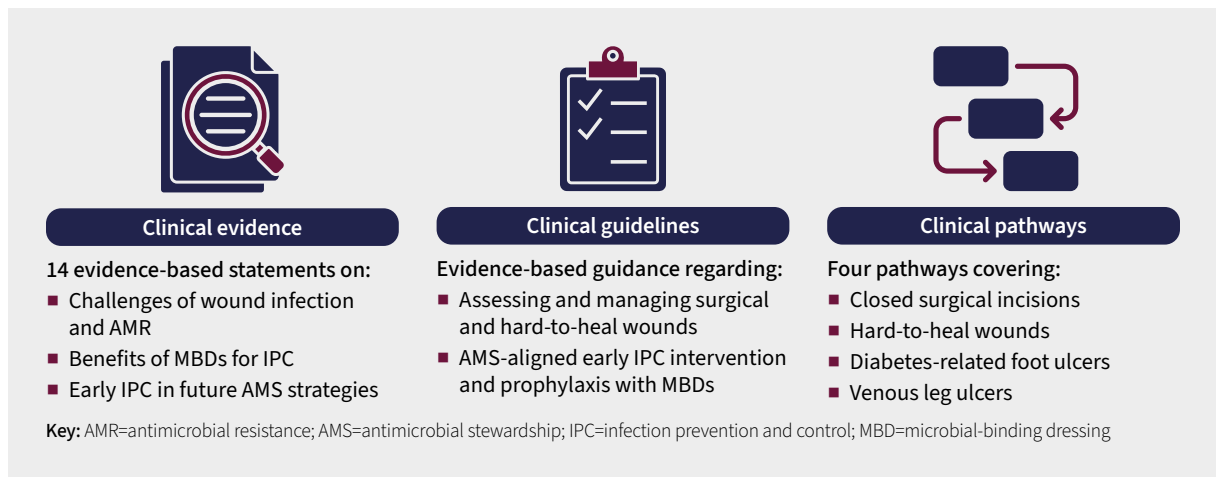
The primary aim of this document was to provide evidence-based guidance on the role of microbial-binding dressings (MBDs) in managing microbial burden, preventing infection and reducing the need for antimicrobial intervention in both surgical incisions and hard-to-heal wounds. The secondary aim was to summarise key findings in easy-to-use AMS clinical pathways to aid decision making and implementation in practice.

As a target population, this guideline is intended for all HCPs involved in wound care, including specialist and general nurses, general practitioners, surgeons, pharmacists, podiatrists, dermatologists, endocrinologists, geriatricians, infectious disease specialists, managers of wound care facilities and healthcare institutions, healthcare funders and those involved in IPC with a vested interest in reducing AMR and promoting AMS at regional, national and international levels.

## Methods

The guideline was developed according to the Appraisal of Guidelines Research and Evaluation (AGREE II) instrument, which provided a rigorous, transparent and globally relevant methodological structure for reporting of objectives, panel membership, pragmatic literature searches and development of evidence-based statements and recommendations.<sup>38,39</sup> The development of this guideline was prompted by a global survey to identify the gaps and needs in AMR in clinical practice.<sup>28</sup>

**Figure 1. Document components**



**Panel selection**

To complete the 12-member panel, the chair and co-chair selected 10 voting members through a structured mapping process with the following criteria:

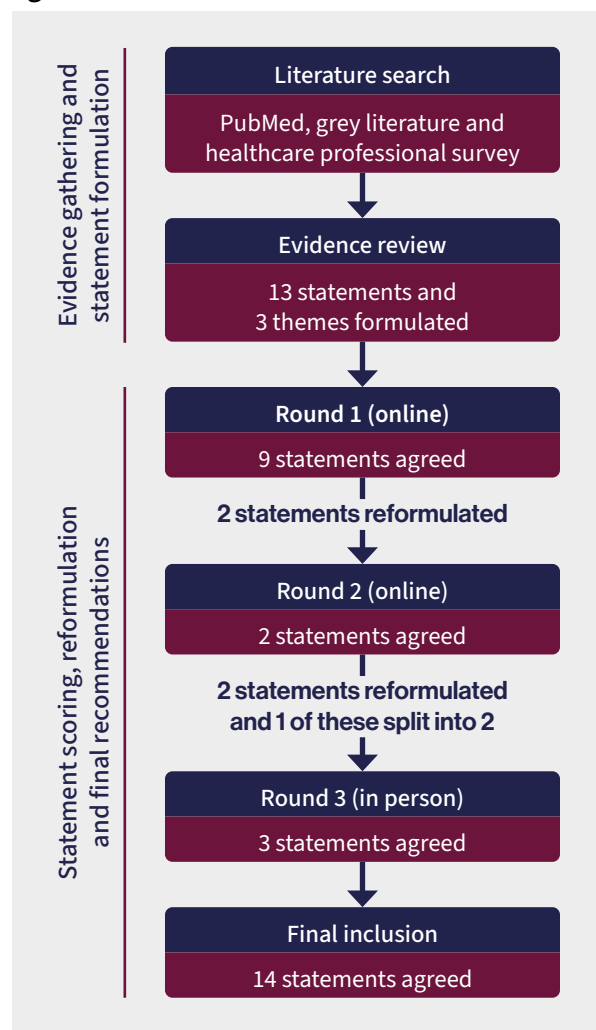
- Clinical expertise:** demonstrated by publications, presentations and best-practice involvement covering hard-to-heal or surgical wounds
- Deep knowledge:** including experience in guideline development, initiatives and professional education relevant to AMS in wound care
- International representation:** covering five continents to ensure recommendations are applicable across diverse healthcare systems and cultural contexts
- Multidisciplinary representation:** including specialist nurses, orthopaedic surgeons, a vascular surgeon, a podiatrist, a microbiologist, researchers and policy makers
- Scientific weight:** recognised by academic contributions, research leadership and advocacy of IPC and AMS principles.

**Literature review**

The guideline development process (Figure 2) began with a pragmatic scoping literature review to inform statement development. The literature search was conducted via PubMed on 1 August 2025, and more recent literature was prioritised in the review (Table 1). A single reviewer was sufficient for a pragmatic review. It excluded paediatric patients, preclinical data, wound types other than those in the pathway, non-English language text and publications before 1990. The following PICO (Problem, Intervention, Comparison, Outcome) selection criteria were used to identify studies directly or indirectly aligned to the topic of AMS:

- Population:** Adults with a wound or surgical incision
- Intervention:** Dialkylcarbamoil chloride (DACC) dressings (i.e. MBDs)
- Comparator:** Standard care (various)
- Outcomes:** Surgical site infection (SSI) prevention, microbial burden, signs and symptoms of infection,

**Figure 2. Process for development and agreement of evidence-based statements**



antibiotic use, antiseptic dressing use, wound healing, complications.

This resulted in the clinical question: 'In adults with a wound or surgical incision, do DACC dressings, compared with standard care, reduce SSIs, microbial burden, signs of infection, antibiotic use, antiseptic dressing use, time to healing or complication rates?'

Studies were reported by evidence level (Oxford Centre for Evidence-Based Medicine),<sup>40</sup> and the certainty of evidence was assessed using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) tool.<sup>41</sup>

### Statement formulation

The initial statements were drafted by the chair and co-chair, based on published evidence. The statement themes encompassed core issues related to wound infection and AMR, particularly the inappropriate use of antimicrobials in wound care, and they explored how earlier intervention with MBDs could help align clinical practice with AMS principles.

A modified Delphi process<sup>42</sup> was used to develop and gain agreement on statements. The minimally acceptable response rate was 70% and all statements were scored using the Likert scale of 1–5 (1 strongly disagree to 5 strongly agree).<sup>43</sup> Consensus agreement for statements was defined as mean score of  $\geq 4.00$  and standard deviation of  $\leq 1.00$ . Responses from round 1 were calculated by the co-chair and methodologist (EW). Quantifiable scoring was supported by capturing anonymous qualitative comments, including additional research. The chair (PI) and co-chair/methodologist (EW) did not participate in the scoring due to their involvement in statement development; all other panellists anonymously scored statements in each round. Agreed statements were removed from subsequent rounds. For rounds 1 and 2, statements were distributed to panel members and responses received using an electronic survey tool (Microsoft Forms). In round 2, statements for which consensus was not achieved were reformulated and circulated as described for round 1. The statements not agreed in round 2 were brought to the in-person meeting

(round 3) for voting. At round 3, remaining areas lacking consensus were discussed and re-formulated statements finalised in a face-to-face meeting, with anonymous paper responses collated by the co-chair. The evidence base used to inform and support agreed statements was then linked and summarised, reflecting each of the subsections of the guideline. Traceability of modifications between rounds for each statement is shown in *Appendix 1*.

### Guideline and pathway development and review

Following statement formulation, the full guideline document was drafted by the chair and co-chair, describing the guideline development process and exploring the evidence and recommendations in detail.

Building on the current guidance for infection prevention and management and to aid implementation in everyday clinical practice, the evidence-based recommendations were summarised in four clinical pathways for treating IPC and AMS in closed surgical incisions and hard-to-heal wounds, including specific pathways for diabetes-related foot ulcers (DRFUs) and venous leg ulcers (VLUs). The pathways are intended as easy-to-use quick reference guides and practical clinical decision-making algorithms to be used in combination with clinical judgement and best-practice guidelines.

The manuscript and pathways underwent several rounds of feedback from both the author panel and a panel of five external blinded reviewers until a final draft was approved by all stakeholders. Reviewers were selected by the journal based on suggestions from the sponsor and using the same criteria as the author panel. Review took the form of open-ended comments and questions, seeking to improve quality, gather feedback on draft recommendations, assess applicability and feasibility and disseminate evidence, which the panel considered in forming final recommendations and structuring the published document. The manuscript was approved by all stakeholders.

### Results

#### Literature review

The literature review returned 12 studies on surgical incisions (*Table 2*) and 17 studies on hard-to-heal wounds, with levels of evidence ranging from 5 to 1a (*Table 3*). The study outcomes underwent GRADE assessment of certainty, with certainty levels ranging from very low to high (*Table 4* and *Appendix 2*).

#### Evidence-based statements

Of the 13 statements initially assessed by the panel, strong agreement was reached for nine in round 1, two in round 2 and three in round 3, with one statement split into two separate statements prior to agreement (for a total of 14). Overall, strong agreement was reached for 14 statements (*Table 5*). Statement iterations and modifications are shown in *Appendix 1*. The key points of each theme can be summarised as follows:

**Table 1. Search terms**

#	Search terms	Results
#1	((DACC)) OR (dialkylcarbamoyl chloride)	1433
#2	(((((("Complex wound") OR ("Chronic wound") OR ("Hard-to-heal wound") OR ("Non-healing wounds") OR ("Closed incision") OR ("Incision*")) OR ("Surgical site*")) OR ("Diabetic foot*")) OR ("Venous ulcer") OR ("Venous leg ulcer") OR ("Pressure ulcer") OR ("Pressure injury")) OR ("Dehisced surgical wound")) OR ("Surgical wound"))	179558
#3	Combining searches #1 and #2 plus grey literature and company data/literature on any terms above	29

**Note:** The term 'microbial-binding dressing' was not included in the search as it had not yet been established

**Table 2. Key evidence for use of microbial-binding dressings to control infection in surgical incisions**

Author (date)	Title	Wound	Study type	Level of evidence	Controlled microbial burden	Cost saving	Improved healing	Infection prevention	Reduced antibiotic use	Reduced readmission
Magro and Ashfield (2025) <sup>44</sup>	Reducing surgical site infections and antibiotic prescribing after Caesarean section with the use of dialkylcarbamoyl chloride coated (DACC) dressings	Surgical (C-section)	Ambispective	2b		✓		✓	✓	✓
Rippon et al (2025) <sup>45</sup>	Use of DACC-coated wound dressings in the reduction of surgical site infection: a systematic review and meta-analysis	Surgical	SLR-MA	1a				✓		
Mulpur et al (2024) <sup>46</sup>	Dialkyl carbamoyl chloride (DACC)-impregnated dressings for the prevention of surgical site infection: experience from a multi-disciplinary study in India	Surgical	Non-comparative observational	3b				✓		
Magro (2023) <sup>47</sup>	Reducing surgical site infections post-caesarean section	Surgical (C-section)	Ambispective	2b		✓		✓	✓	✓
Wijetunge et al (2021) <sup>48</sup>	Advanced dressings for the prevention of surgical site infection in women post-caesarean section: a systematic review and meta-analysis	Surgical (C-section)	SLR-MA	1a				✓		✓
Jiang et al (2020) <sup>49</sup>	Evaluation of different surgical dressings in reducing postoperative surgical site infection of a closed wound: a network meta-analysis	Surgical (SSI)	SLR-MA	1a				✓		
Taylor et al (2020) <sup>50</sup>	Reducing SSI rates for women birthing by caesarean section	Surgical (C-section)	Ambispective	3b		✓		✓		
Totty et al (2019) <sup>51</sup>	A pilot feasibility randomised clinical trial comparing dialkylcarbamoyl chloride-coated dressings versus standard care for the primary prevention of surgical site infection	Surgical (vascular)	Pilot RCT	2b			✓	✓		
Bua et al (2018) <sup>52</sup>	Dialkylcarbamoyl chloride dressings in the prevention of surgical site infections after nonimplant vascular surgery	Surgical (vascular)	Non-concurrent comparative cohort	2b				✓		
Stanirowski et al (2016a) <sup>53</sup>	Dialkylcarbamoyl chloride-impregnated dressing for the prevention of surgical site infection in women undergoing cesarean section: a pilot study	Surgical (C-section)	Pilot RCT	2b				✓	✓	
Stanirowski et al (2016b) <sup>54</sup>	Randomised controlled trial evaluating dialkylcarbamoyl chloride impregnated dressings for the prevention of surgical site infections in adult women undergoing cesarean section	Surgical (C-section)	RCT	1b		✓		✓	✓	✓
Bullough (2012) <sup>55</sup>	The use of DACC-coated dressings for the treatment of infected, complex abdominal wounds	Surgical (open)	Case series	4	✓		✓		✓	

Key: RCT=randomised controlled trial; SLR-MA=systematic literature review and metaanalysis; level of evidence: 1=highest, 2=high, 3=medium, 4=low, 5=lowest

■ **Challenges of wound infection and AMR:** SSI and infected hard-to-heal wounds remain a challenge for HCPs. Current guidance supports appropriate use of antiseptics and systemic antibiotics. However, fear of infection consequences leads many HCPs to use these antimicrobials when not indicated. Inappropriate use of antimicrobials can increase the risk of AMR.

■ **Benefits of MBDs for IPC:** MBDs can support both infection prevention and management strategies by reducing microbial contamination and consequently risk of infection. Effective management of microbial burden with MBDs can reduce the requirement for antimicrobial use. These clinical impacts align with AMS principles and should support cost-savings.

**Table 3. Key evidence for use of microbial-binding dressings to control infection in hard-to-heal wounds**

Author (date)	Title	Wound	Study type	Level of evidence	Controlled microbial burden	Improved healing	Infection prevention	Reduced antibiotic use	Reduced signs and symptoms of infection
Nakamura et al (2025) <sup>56</sup>	Effect on bacterial load of a DACC-coated dressing as a wound contact layer in negative pressure wound therapy	HtHW, STSG	Prospective inpatient comparative	3b	✓				
Manas et al (2025) <sup>57</sup>	Treating diabetic foot ulcers with antimicrobial wound dressing impregnated with dialkylcarbamoyl chloride	DRFU	Prospective observational	3b	✓	✓		✓	
Lev-Tov (2024) <sup>58</sup>	Dialkylcarbomoyl chloride compared to silver dressing in treatment venous leg ulcers	VLU	Pilot RCT	2b		✓			
Sebayang (2024) <sup>59</sup>	Comparison of effectiveness of hydrophobic Cutimed Sorbact versus cadexomer iodine 0.9% on healing of diabetic foot ulcer: a randomized control trial	DRFU	RCT	2b		✓			✓
Dissemmond et al (2023) <sup>60</sup>	Aquacel Ag Advantage/ Ag+ Extra and Cutimed Sorbact in the management of hard-to-heal wounds: a cohort study	VLU, DRFU, PI	Retrospective audit/chart review	3b		✓		✓	✓
Malone et al (2023) <sup>61</sup>	In vivo observations of biofilm adhering to a dialkylcarbamoyl chloride-coated mesh dressing when applied to diabetes-related foot ulcers: a proof of concept study	DRFU	Prospective case series	3b	✓				
Williams (2022) <sup>62</sup>	The Leeds Wound Infection Framework: development and implementation of a new pathway to improve care	HtHW	Quality improvement	4				✓	
Seckam (2021) <sup>63</sup>	Clinical performance and quality of life impact of an absorbent bacteria-binding foam dressing	VLU/DRFU	Multicentre observational	3b					✓
Mosti et al (2015) <sup>64</sup>	Comparative study of two antiseptic dressings in infected leg ulcers: a pilot study	Leg ulcers	RCT (pilot)	2b	✓			✓	
Gentili et al (2012) <sup>65</sup>	Panbacterial real-time PCR to evaluate bacterial burden in chronic wounds treated with Cutimed™ Sorbact™	AU/VLU	NCCS	3b	✓	✓			
Bruce (2012) <sup>66</sup>	Using Cutimed® Sorbact® Hydroactive on chronic infected wounds	HtHW	Multicentre case series	4		✓			✓
Skinner et al (2010) <sup>67</sup>	The diabetic foot: managing infection using Cutimed® Sorbact® dressings	DRFU	Case series	5			✓		
Johansson et al (2009) <sup>68</sup>	Open study on the topical treatment of interdigital fungal infections in diabetic patients	DRFU	NCCS	3b	✓				
Kammerlander et al. (2008) <sup>69</sup>	An investigation of Cutimed Sorbact as an antimicrobial alternative in wound management	HtHW	Observational	3b		✓			✓
Pirie (2009) <sup>70</sup>	Cutimed® Sorbact® gel: a new infection management dressing	Various LLU	Case series	5		✓			✓
Hampton (2007) <sup>71</sup>	An evaluation of the efficacy of Cutimed® Sorbact® in different types of non-healing wounds	HtHW	Case series	4		✓			✓
Mussi (2004) <sup>72</sup>	Clinical evaluation of Sorbact (bacteria adsorbing dressing) in the treatment of infected pressure sores	PI	Case-controlled comparative	3b		✓			✓

**Key:** AU=arterial ulcer; DRFU=diabetes-related foot ulcer; HtHW=hard-to-heal wound; LLU=lower leg ulcer; NCCS=non-comparative cohort study; PI=pressure injury; RCT=randomised controlled trial; VLU=venous leg ulcer; level of evidence: 1=highest, 2=high, 3= medium, 4=low, 5=lowest

■ **Early IPC in future AMS strategies:** Inappropriate use of antimicrobials exists in some non-infected wounds, despite clear guidance on appropriate use. Using MBDs as the first choice of dressing in management

of microbial contamination and local infection helps to minimise antiseptic and antibiotic use when not needed, thus reducing the risk of AMR and reserving antimicrobial use for when appropriate.

## Discussion

The following discussion summarises the relevant published evidence supporting the guideline statements by theme.

**Table 4. GRADE assessments of the certainty of literature review outcomes**

Wound type	Studies	Certainty
<b>Surgical incisions</b>		
Controlled microbial burden	1	Low
Cost saving	3	Low/high
Improved healing	2	Low/high
Infection prevention	6	Moderate/high
Reduced antibiotic use	4	Low/high
Reduced readmission	2	Moderate/high
<b>Hard-to-heal wounds</b>		
Controlled microbial burden	6	Low/high
Improved healing	9	Low/high
Infection prevention	1	Very low
Reduced antibiotic use	4	Low/high
Reduced signs and symptoms of infection	8	Low/moderate

Key: GRADE=Grading of Recommendations Assessment, Development and Evaluation

## Challenges of wound infection and antimicrobial resistance

### Statements 1-6

1. Wound infection continues to be one of the biggest challenges facing HCPs in wound care<sup>6,9,31,73-76</sup>
2. The number of wound infections attributable to antimicrobial-resistant organisms could be underestimated<sup>74,77</sup>
3. AMR in wound care is a growing challenge<sup>17-20,22,29,78-89</sup>
4. Prevention of infection is one of the key focus areas for global AMR strategy<sup>13,14,36,90-96</sup>
5. Inappropriate use of antimicrobials has been reported in non-infected wounds not requiring intervention<sup>24-28,97</sup>
6. Inappropriate use of antimicrobials may increase the risk of AMR development<sup>98-109</sup>

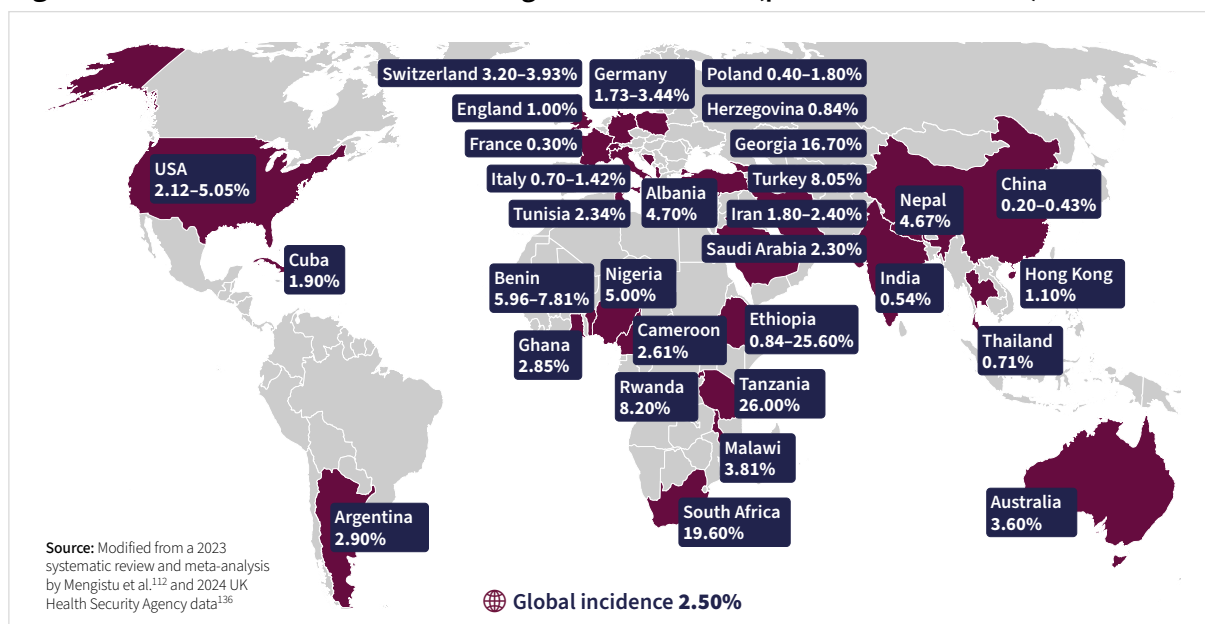
Wound infection is a challenge to healthcare globally, contributing substantially to delayed wound healing, increased wound care costs, negative impact on patient quality of life, morbidity and mortality.<sup>1-5,7-12,110</sup> Limited evidence on host-microbe interactions and infection progression challenges HCPs in identifying, diagnosing and managing wound infections.<sup>24,111</sup> There is a need for careful balancing of infection progression risk and appropriate management, with due consideration of the global impact of AMR.<sup>24,111</sup> The focus for this current guideline is surgical and hard-to-heal wounds given the increasing burden of both globally.

**Table 5. Evidence-based statements by theme, Delphi round and agreement scores (mean±SD)**

#	Statement	Round	Mean	SD
<b>Theme: Challenges of wound infection and AMR</b>				
1	Wound infection continues to be one of the biggest challenges facing HCPs in wound care	1	4.30	0.90
2	The number of wound infections attributable to antimicrobial-resistant organisms could be underestimated	2	4.10	0.94
3	AMR in wound care is a growing challenge	1	4.40	0.80
4	Prevention of infection is one of the key focus areas for global AMR strategy	1	4.50	0.67
5	Inappropriate use of antimicrobials has been reported in non-infected wounds not requiring intervention	1	4.60	0.49
6	Inappropriate use of antimicrobials may increase the risk of AMR development	2	4.60	0.49
<b>Theme: Benefits of MBDs for IPC</b>				
7	Microbial burden of a wound may be reduced using MBDs	1	4.60	0.49
8	Early intervention with MBDs decreases microbial burden, minimising risk of progression on the wound infection continuum	1	4.40	0.49
9	Incorporating MBDs into postoperative care bundles can significantly reduce the risk of (superficial) SSIs	1	4.40	0.49
10	Prevention of SSI using MBDs can result in reduced re-admission, treatment and hospital-stay costs	1	4.30	0.66
<b>Theme: Early IPC in future AMS strategies</b>				
11	Considering comprehensive wound care, reserving use of antiseptic dressings for covert and overt infection, combined with antibiotics for spreading and systemic infection, supports AMS	3	4.70	0.46
12a	Prophylactic prevention and control of microbial burden with MBDs may reduce the need for antibiotic therapy, supporting AMS	3	4.50	0.50
12b	Management of local infection with MBDs may reduce the need for antibiotic therapy, supporting AMS	3	4.50	0.50
13	MBDs should be considered a key part of IPC and AMS in wound care	1	4.70	0.46

Key: AMS=antimicrobial stewardship; AMR=antimicrobial resistance; HCPs=healthcare professionals; IPC=infection prevention and control; MBD=microbial-binding dressing; SD=standard deviation; SSI=surgical site infection

**Figure 3. Global and national rates of surgical site infection (published 1996–2021)**



### Burden of surgical site infection

SSI has a global incidence of 2.5% (95% CI 1.6–3.7), varying by country (Figure 3).<sup>112</sup> Rates are highest in Sub-Saharan Africa, due to overcrowding of hospitals, inadequate IPC, understaffing and inappropriate use of restricted resources.<sup>112–114</sup>

SSI incidence can be much higher depending on patient risk factors, surgical location and procedure type (Figure 4).<sup>112,115–126</sup> Surveillance for SSI can also be variable, which may lead to an underestimate of actual rates.<sup>128</sup> They are the leading cause of postoperative readmissions<sup>129,130</sup> prolonged hospitalisation,<sup>129–131</sup> delayed wound healing<sup>132</sup> and increased wound dehiscence and scarring.<sup>133,134</sup> The number of deaths among people with an SSI directly attributable to the infection has been reported at around 30%.<sup>129,130</sup>

SSI is the most expensive hospital-acquired infection, with costs ranging from over \$20000 to \$68101 per person<sup>129,135</sup> and from \$3.3 billion to \$10 billion for the whole US healthcare system annually.<sup>131</sup> The long-term post-discharge impacts of SSIs on clinical outcomes and system costs are inadequately recognised,<sup>129,130</sup> and there are known environmental impacts that correlate with SSI severity.<sup>12</sup> Many SSIs are caused by AMR organisms.<sup>21–23,113,122</sup>

### Prevention of surgical site infection

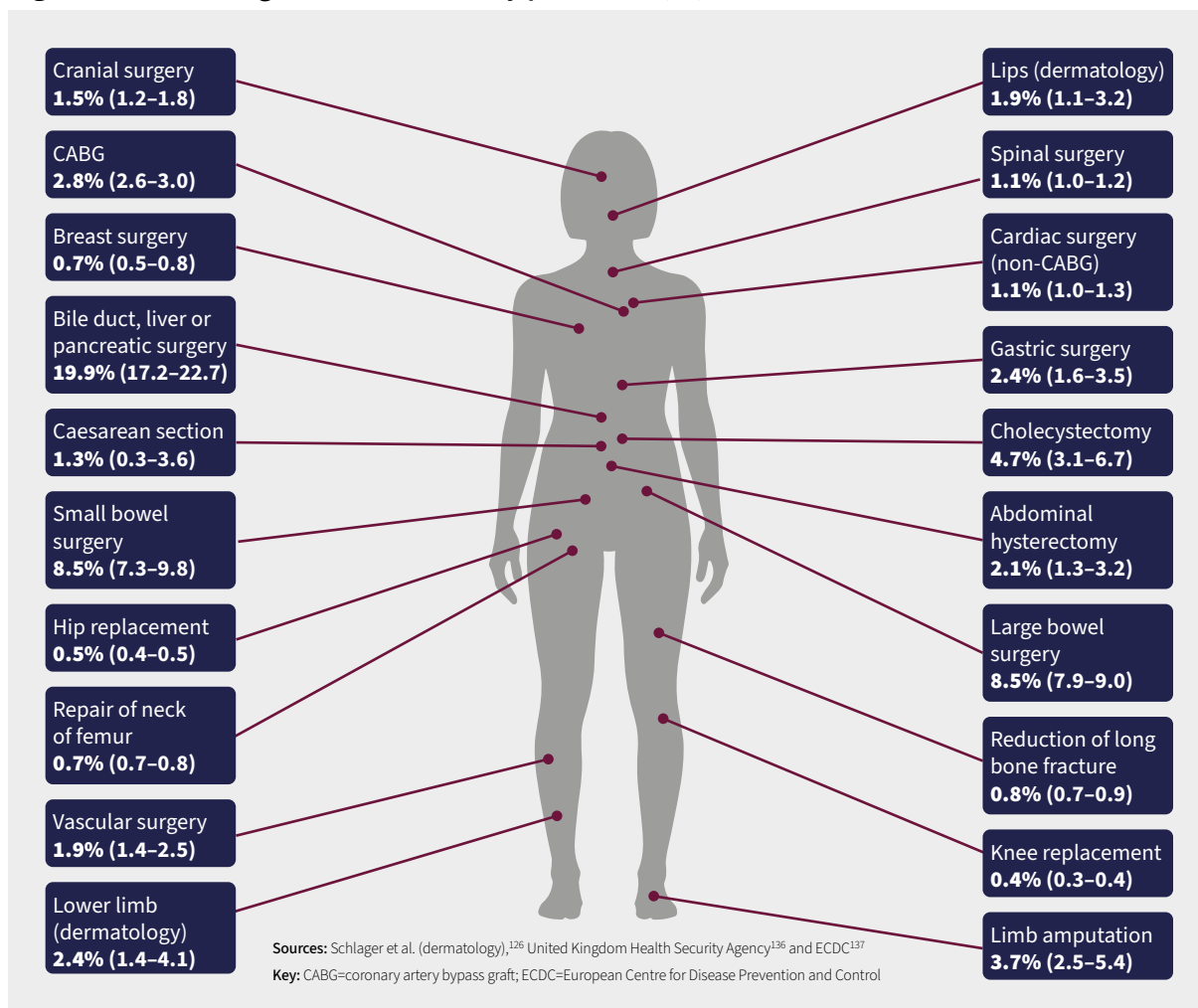
SSIs are mostly preventable,<sup>138</sup> and evidence-based interventions may prevent up to 50% of SSIs.<sup>121</sup> This makes infection prevention the priority of AMS.<sup>31,34,95,122,139</sup> To optimise patient safety and reduce unnecessary costs, clinicians should implement standardised evidence-based SSI prevention interventions, pre-, intra- and postoperatively, according to international guidelines.<sup>121,122,138</sup>

Reducing SSI risk begins pre-operatively by identifying risk factors using a structured risk assessment tool,<sup>112,115–125</sup> such as the American College of Surgeons online risk calculator.<sup>140</sup> However, existing risk-assessment tools tend to focus on cardiac procedures and morbidity and mortality outcomes, and there is a need for validated tools for assessing risk of SSI and dehiscence in most surgical populations.<sup>141</sup> Documenting details of the patient and procedure, including the wound contamination class (Box 1), provides prognostic indicators of complications and informs targeted risk-modification strategies.<sup>119,122,142</sup> Stratification into low, medium and high-risk groups may support treatment pathways.<sup>123,124</sup>

Risk stratification supports AMR by allowing prophylactic antibiotics to be restricted to appropriate high-risk patients or procedures,<sup>121–123,143</sup> avoiding unjustified use, including in the presence of surgical drains.<sup>122,138</sup> SSI risk can be lowered by optimising nutrition, maintaining wound and hand hygiene and applying sterile dressings,<sup>31</sup> with operative and postoperative aseptic technique being key to minimising the risk of SSI.<sup>121,122,138</sup>

Postoperatively, wound dressings can be applied to manage microbial colonisation locally before it progresses to local infection.<sup>144</sup> The limited guidelines on local wound management recommend a sterile interactive dressing (i.e. designed to protect against contamination and absorb exudate to maintain a moist healing environment),<sup>138</sup> which should be selected according to the wound characteristics, applied aseptically and left in place for a period determined by continuous assessment.<sup>121,122,138</sup> Most scenarios do not require advanced dressings, such as hydrocolloids and hydrogels. Limited evidence suggests that high-risk patients may benefit from gentle cleansing

**Figure 4. Risk of surgical site infection by procedure (%)**<sup>126,136,137</sup>



with antiseptic solutions and use of antiseptic dressings, but this must be balanced against the potential risk of AMR.<sup>74,145</sup> Postoperative dressings should be worn for 2–14 days, balancing the benefits of undisturbed healing with the need to remove sutures or manage presenting patient and wound factors (such as signs and symptoms of infection), including replacing exudate-saturated dressings.<sup>146,147</sup> In closed surgical incisions, systemic antibiotics should be reserved for where the patient or surgery presents a high risk of contamination.<sup>121–123,143</sup>

### Assessment of surgical site infection

Effectively assessing and managing infected surgical incisions requires a structured approach to facilitate early recognition, appropriate treatment and prompt escalation of SSIs, which is imperative to avoid progression, readmission and sepsis.<sup>8,122,138,148–150</sup> For epidemiology, surveillance and diagnosis, SSIs are defined as an infection at a surgical site occurring within 30 days postoperatively (or 90 days if an implant is present).<sup>119,147,148</sup> Accurate definition, diagnosis and documentation of SSI

are challenging and require expertise, time and resources.<sup>122,138,148</sup> Visual indicators of SSI may be less reliable with dark skin tones, which may delay diagnosis.<sup>147,151</sup> Differentiating between inflammation and SSI is also a challenge and may lead to unnecessary antimicrobial use and delayed healing.<sup>31,147</sup>

A comprehensive assessment of the incision, the patient and their preferences is necessary to align plans for IPC.<sup>74</sup> SSIs are classified by the US Centers for Disease Control and Prevention (CDC) criteria based on location and depth as superficial incisional, deep incisional or organ/space SSIs (Box 2).<sup>119,148</sup>

SSIs should be differentiated from other surgical wound complications, including surgical wound dehiscence (SWD), seroma, haematoma, incisional hernia, periwound maceration, medical adhesive-related skin injury and poor-quality scarring, as these vary in cause and management.<sup>152,153</sup> SWD is the separation of the margins of a closed surgical incision.<sup>152</sup> SWD increases SSI risk, and

SSI can cause SWD. However, SWD is not always caused by infection<sup>152</sup> and it may result from closure issues or mechanical stress in uninfected wounds. Inaccurately differentiating the cause of SWD can result in unnecessary antimicrobial use and AMR,<sup>31,152</sup> highlighting the need for AMS-aligned IPC in these open wounds.<sup>152</sup>

SSIs require swabs or tissue sampling for microbiological culture to guide the selection of targeted antibiotics or antifungals.<sup>74,148</sup> Semi-quantitative wound swabs following wound cleansing and debridement remain the mainstay of sampling due to their simplicity and routine availability<sup>154</sup> and should be performed with the Levine technique and as described by the International Wound Infection Institute (IWII).<sup>74</sup> Microbiological samples should be submitted with full clinical information to enable accurate analysis and ensure that laboratory results support clinically relevant decision making.<sup>155</sup>

If not managed appropriately, SSIs can progress rapidly to sepsis, a life-threatening condition in which the body's response to infection causes organ dysfunction, multiple organ failure and death.<sup>8,149</sup> Signs and symptoms of sepsis require urgent escalation, as sepsis is a medical emergency requiring immediate specialist assessment and management, including optimal antibiotics.<sup>110,149,150,156</sup> So care can be escalated, sepsis may be recognised early by looking for the subtle signs of fever (or hypothermia), tachycardia, tachypnoea, malaise/fatigue or local infection signs worsening. The following red-flag features indicate severe illness and require emergency intervention including urgent escalation:

- S. Slurred speech/confusion
- E. Extreme shivering or pain
- P. Passing of low or no urine in 24 hours
- S. Severe breathlessness
- I. It feels like you are going to die
- S. Skin that is mottled or discoloured.<sup>149</sup>

### Management of surgical site infection

With limited guidance specific to surgical wounds,<sup>157</sup> management can follow the Tissue, Infection, Moisture balance and Edge TIME framework to support consistency and guide best practice.<sup>158-160</sup> SSI management should aim to readjust the interaction between the host and infecting pathogen and treat the cause of infection, while controlling pain and inflammation and remaining cognisant of AMS.<sup>74,147</sup> Deep or organ/space SSIs require systemic antibiotics, targeted to the causative organism according to resistance patterns and microbiology results, supporting the clinical judgment of the multidisciplinary team (MDT).<sup>138</sup>

With increased risk of infection in SWD, prevention and management aligned with AMS is necessary.<sup>152</sup>

The surgical-wound MDT may comprise surgeons and wound care specialists, supported by community nurses, GPs, podiatrists, microbiologists and dietitians.

### Box 1. Wound contamination classes<sup>119</sup>

**Clean (Class I):** An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tract is not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage. Operative incisional wounds that follow nonpenetrating (blunt) trauma should be included in this category if they meet the criteria.

**Clean-contaminated (Class II):** An operative wound in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, operations involving the biliary tract, appendix, vagina, and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered.

**Contaminated (Class III):** Open, fresh, accidental wounds. In addition, operations with major breaks in sterile technique (e.g. open cardiac massage) or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered are included in this category.

**Dirty/infected (Class IV):** Old traumatic wounds with retained devitalised tissue and those that involve existing clinical infection or perforated viscera. This definition suggests that the organisms causing postoperative infection were present in the operative field before the operation.

### Box 2. Centres for Disease Control and Prevention (CDC) classification of surgical site infections (SSIs)<sup>119,14</sup>

**Superficial incisional SSI:** Involves only skin and subcutaneous tissue of the incision

**Deep incisional SSI:** Involves deep soft tissues of the incision (for example, fascial and muscle layers)

**Organ/space SSI:** Involves the organ/space tissues (deeper than the fascia/muscle)

Coordinating the MDT requires clear documentation and communication between centres, including verbal and written clinician referral and patient education at discharge.<sup>125,157</sup>

### Burden of infected hard-to-heal wounds

Hard-to-heal wounds are wounds that fail to heal within an expected timeframe, and wounds that do

not reduce in size by at least 40%–50% in 4 weeks are less likely to heal by 12 weeks.<sup>161–163</sup> Hard-to-heal wounds, largely comprising VLU, arterial leg ulcers, DRFUs and pressure ulcers/injuries, are an increasing global healthcare burden, affecting approximately 2% of the developed global population.<sup>164</sup> Hard-to-heal wounds are associated with increased mortality and reduced patient satisfaction among other negative impacts.<sup>4,76,165–168</sup> Patients may require hospital stays and ongoing management with specialist resources and interventions, such as wound dressings, antibiotics and surgeries.<sup>162,169</sup> This has significant implications for patient outcomes and healthcare resource use.<sup>4,7,11,162,165,170</sup> This cost is increased by complications such as infection and amputation, with an uninfected VLU costing at least 69% less than an infected wound, and amputations costing up to £16900.<sup>171</sup> In the US, hard-to-heal wounds cost around \$22.5 billion annually.<sup>11</sup>

Wound infection is a key cause of delayed healing in over 40% of hard-to-heal wounds.<sup>172</sup> A large cohort study showed healing in 59% of uninfected wounds compared with 45% of infected wounds.<sup>170</sup> More than half of DRFUs develop infection, which can progress rapidly without timely intervention; approximately 17% of infected DRFUs may require amputation;<sup>76,171</sup> and 80% of DRFU-related hospital admissions are due to infection.<sup>171</sup> Between 30% and 65% of VLUs may be infected on initial presentation,<sup>173</sup> and up to 38.1% develop a systemic infection.<sup>174</sup> Furthermore, hard-to-heal wounds are associated with increased bacterial counts, C-reactive protein levels, inflammatory cytokines and wound diameter.<sup>73</sup>

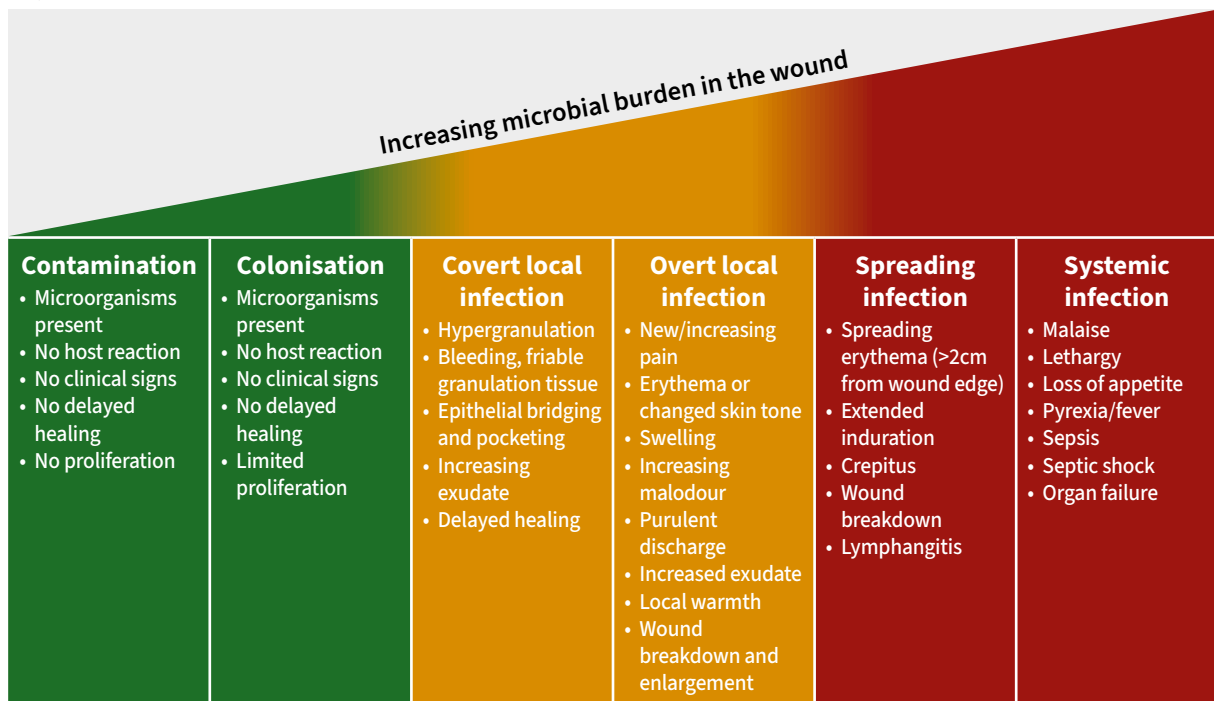
## Assessment and diagnosis of infected hard-to-heal wounds

Hard-to-heal wounds, with or without infection, require regular assessment. This is imperative to accurately identify and manage the wound's underlying aetiology and increase the probability of wound healing.<sup>74,158,175–177</sup> Assessment should be holistic and multifactorial, taking an interdisciplinary approach and covering not just the wound but the whole patient, their vascular status and any contributing local, systemic, social and environmental factors.<sup>74</sup>

The IWII Wound Infection Continuum (WIC) is an educational tool that aims to standardise approaches to diagnosing infection in hard-to-heal wounds (Figure 5). This structured model divides the microbiological progression of wound infection into different stages according to severity and increasing microbial burden, from contamination to colonisation and local (covert and overt) infection to spreading and systemic infection. Observable clinical signs and symptoms are provided to help differentiate between these stages.<sup>74</sup>

Infection in hard-to-heal wounds can be a challenge to identify.<sup>24,31,74</sup> As there are limited routine diagnostic tests that accurately indicate infection,<sup>178</sup> diagnosis relies on the identification of multiple clinical signs and symptoms.<sup>74,179,180</sup> However, signs of infection such as redness (erythema) may be less visible in patients with darkly pigmented skin tones and therefore requires touch assessment for skin temperature, tissue consistency changes and swelling.<sup>74,181,182</sup> Differentiation between

**Figure 5. International Wound Infection Institute Wound Infection Continuum<sup>74</sup>**



uninfected and infected wounds is a challenge in patients with comorbidities, compromised immune systems, peripheral neuropathy or poor vascular perfusion, where covert local signs and symptoms of infection may be masked or muted.<sup>74,183</sup>

Diagnostic accuracy can be inconsistent in practice. In a retrospective multicentre audit, HCPs were unsure of the wound infection diagnosis, and they used antimicrobials in 35% of non-infected wounds and did not use them in 41% of infected wounds where indicated, despite gaining confidence in identification as the number of signs of infection increased.<sup>24</sup> Uncertainty in identification and diagnosis of infection led to the inappropriate use of antiseptic dressings.<sup>24</sup>

Infection in DRFUs is diagnosed by more than two clinical signs of infection and staged as low, mild, moderate and severe, according to the International Working Group for the Diabetic Foot (IWGDF) and the Infectious Disease Society of America (IDSA).<sup>184</sup> Infection is a key criterion in many DRFU scoring systems, including Wound Ischaemia foot Infection (WIFI)<sup>185</sup> and Site, Ischaemia, Neuropathy, Bacterial infection and Depth (SINBAD).<sup>185-187</sup> Severely infected DRFUs require additional tests, such as magnetic resonance imaging or x-ray, for progression of infection into deeper tissues and bone (osteomyelitis).<sup>184</sup> Equivocal clinical diagnosis may require measurement of serum inflammatory markers, such as C-reactive protein and erythrocyte sedimentation rate.<sup>73,184</sup> Osteomyelitis should be considered in any hard-to-heal wound with palpable or exposed bone.<sup>188</sup> If osteomyelitis is suspected, bone samples should be taken for culture and sensitivities and for histology.<sup>184</sup>

Spreading or systemic infections in hard-to-heal wounds require swabs or tissue sampling for a microbiological culture to target antibiotic or antifungal treatment.<sup>184,189</sup> Samples are ideally taken with a biopsy, although a swab may be more accessible.<sup>154</sup> Samples should be submitted with full clinical information.<sup>155</sup>

Sepsis requires urgent recognition, escalation and treatment, as described for SSIs.<sup>110,149,150,156</sup>

### Managing infection in hard-to-heal wounds

Optimal management of microbial burden in wounds should be multifactorial, including therapeutic cleansing, debridement and dressings, alongside appropriate antimicrobial use.<sup>74</sup>

Hard-to-heal wounds anywhere on the WIC require wound bed preparation using the TIMERS framework.<sup>74,158,160,183,190-193</sup> Vigorous therapeutic cleansing of the wound zones should be performed before and repeated after debridement.<sup>191,193</sup> International guidelines recommend therapeutic cleansing with antiseptic solutions in patients with hard-to-heal wounds with signs and symptoms of local or spreading or systemic infection, as well as those at high risk infection in whom signs and symptoms

of infection might be muted.<sup>74,191</sup> Wounds should be cleansed at every dressing change, as well as debrided and re-cleansed as indicated by an individual holistic assessment.<sup>191,193</sup> Debridement of devitalised (dead) tissue, which helps reduce the microbial burden and disrupt biofilm, should follow consensus recommendations on integral debridement.<sup>190,193</sup>

Interventions should be aligned with the WIC.<sup>74</sup> This means avoiding all antimicrobials on contaminated or colonised wounds, using antiseptics in local spreading and systemic infections, and reserving systemic antibiotics and antifungals for spreading and systemic infections.<sup>194</sup> Antibiotic use should follow strict evidence-based guidance, and antibiotics should be targeted to specific pathogen susceptibilities identified by wound culture once available.<sup>74,184,194</sup> Presence of osteomyelitis may require longer antibiotic treatment duration of 6 weeks or more,<sup>184,188</sup> although some studies report similar outcomes with 3 weeks' treatment.<sup>195</sup> Infected wounds may even require surgical intervention.<sup>184</sup>

Treatment effectiveness should be reviewed every 2 weeks, with a comprehensive reassessment of wound size, infection status and other indicators of healing progress to guide continuation, change or escalation of care.<sup>196,197</sup>

### Burden of antimicrobial resistance in wound care

AMR due to misuse of antibiotics is reaching a crisis point across healthcare-related infections, with more infections caused by AMR-associated pathogens reported globally.<sup>13,14,80</sup> AMR infections are a major driver of morbidity, poor quality of life and mortality.<sup>13</sup> AMR-related deaths increased by up to 80% in people over 70 years old from 1990 to 2021 and are forecast to rise to 8.2 million by 2050.<sup>14</sup> AMR makes infections much more difficult and resource-intensive to treat,<sup>198</sup> costing up to \$74 306<sup>199</sup> and adding 9.2 days of hospital care.<sup>80</sup>

These trends are also reflected in wounds with AMR-related skin infections leading to around 200 000 deaths in 2019.<sup>13</sup> Reported rates of AMR-related SSIs after gastrointestinal surgery include 16.6% in high-income and 35.9% in low-income countries.<sup>85</sup> SSIs caused by multi-drug-resistant organisms (MDROs) are associated with major post-operative complications, re-admissions and re-operations,<sup>22</sup> requiring additional resources that dramatically exacerbate management costs.<sup>86</sup> Despite the increasingly obvious implications of AMR in the surgical arena, AMS principles are inconsistently applied.<sup>23,82</sup> Antibiotics are given during or after 55% of surgical procedures, compared with 45% in medical practice.<sup>200</sup> This frequency increases further if a patient develops an SSI.<sup>201</sup> In a major UK hospital, antibiotics were prescribed more frequently, for longer and with less compliance to local policy in surgery than general medicine.<sup>200</sup>

In hard-to-heal wounds, up to 88% of isolates show resistance to an antibiotic and nearly 30% show resistance

to more than six antibiotics.<sup>17</sup> Hard-to-heal wounds are an independent risk factor for developing MDROs.<sup>84</sup> MDROs, such as methicillin-resistant *Staphylococcus aureus*, carbapenem-resistant *Pseudomonas aeruginosa* and extended-spectrum beta-lactamase-producing *Enterobacteriales*, have been shown to be common in pressure ulcers/injuries.<sup>87</sup> AMR is common in DRFUs,<sup>18,19,89</sup> where MDROs prevalence is as high as 63%<sup>88</sup> and polymicrobial infections are common.<sup>18,19</sup> A recent meta-analysis in DRFUs found the highest frequency of AMR to a single antibiotic in *S. aureus*, closely followed by the Gram-negative *Pseudomonas* species, and to multiple antibiotics in *Acinetobacter* isolates.<sup>89</sup> VLU infections are common, and they are often caused by *P. aeruginosa*, which can be resistant to many antibiotics,<sup>20</sup> including carbapenems, the last-line treatment for many *P. aeruginosa* infections.<sup>79</sup> An Indian study of chronic leg ulcers observed *S. aureus* was the most common organism isolated (27%), followed by *P. aeruginosa* (17%). Among *S. aureus* isolates, 53% were methicillin-resistant. Among the Gram-negative isolates, extended spectrum beta lactamase (36%) and metallo-beta-lactamase (46%) production was highest among *Escherichia coli*.<sup>83</sup> AMR was detected against ciprofloxacin, gentamicin, ceftazidime and meropenem.<sup>83</sup> The true burden of AMR in wounds is likely to be underestimated, as wound sampling is not recommended for local infection, and is only indicated if a spreading or systemic infection is suspected.

### Causes of antimicrobial resistance in wound care (limitations of current practice)

AMR results from widespread use of antibiotics, and the risk of AMR is greater in settings with high antibiotic use, such as intensive care, burn units and long-term care.<sup>84,202,203</sup> In wound care, high frequencies of antibiotic use have been reported across traumatic and postoperative wounds (78.3%), VLU (66%) and pressure ulcers/injuries (36.4%).<sup>25</sup> Antibiotics are also often used, in many cases empirically, in DRFUs, where infection can progress rapidly.<sup>88,184</sup> A registry study found over 70% of hard-to-heal wounds were treated with antibiotics, although this was dramatically reduced to around 20–30% following initiation of a wound registry.<sup>26</sup> Moreover, hard-to-heal wounds often require repeated rounds of antibiotics due to recurrent infections.<sup>25</sup> The efficacy of antibiotics in hard-to-heal wounds is limited by the high prevalence of biofilms, which are inherently tolerant to antimicrobials.<sup>204–208</sup>

One factor that can increase the risk of AMR is prescribing the incorrect antibiotic for the infection, which has been reported in 41.8% of skin and soft-tissue infections.<sup>27</sup> Another factor is insufficient bioavailability of the antibiotic in the wound and surrounding tissue, giving microbes the opportunity to survive sub-therapeutic levels and develop resistance mechanisms. Bioavailability may be limited by comorbidities that limit perfusion, particularly in the peripheries, such as diabetes, vascular disease and oedema.<sup>209</sup> Bioavailability is also affected by patient weight, and dosage should be adjusted accordingly to maintain therapeutic levels.

The risk of AMR is also increased by inappropriate use of antiseptics. Using antiseptic dressings with insufficient concentrations of active agents can lead to selection for resistance.<sup>109</sup> Antiseptic dressings are often used where they are not indicated, with studies showing use rates of 35% in non-infected wounds<sup>24</sup> and 41.8% of all wounds on a just-in-case basis.<sup>28</sup> Microbes have been shown to develop resistance to antiseptics commonly used in wound care, including chlorhexidine gluconate and silver nitrate, mainly following laboratory exposure at below-therapeutic levels.<sup>106,107,210</sup> Triclosan may have a dual impact on AMR, with resistance to the antiseptic and augmentation of acquisition of resistance to antibiotics, based on limited in vitro data.<sup>102</sup> In addition, a recent review of resistance to some silver dressings in clinical scenarios reinforces the need for appropriate antiseptic use.<sup>104</sup> These studies highlight that antiseptics are not exempt from AMS principles, and their use should be guided by clear clinical indications, appropriate concentrations and defined treatment durations.

## Benefits of microbial-binding dressings for infection prevention and control

### Statements 7–10

7. Microbial burden of a wound may be reduced using MBDs<sup>55–57,61,64,65,68</sup>
8. Early intervention with MBDs decreases microbial burden, minimising the risk of progression on the wound infection continuum<sup>44–54,56,57,59,60,63–72</sup>
9. Incorporating MBDs into postoperative care bundles can significantly reduce the risk of (superficial) SSIs<sup>44–54</sup>
10. Prevention of SSI using MBDs can result in reduced re-admission, treatment and hospital-stay costs<sup>44,47,48,50,54,211,212</sup>

MBDs are wound dressings that support IPC and align with AMS principles, with a microbial-binding mode of action distinct from the microbicidal action of antiseptic dressings, by definition placing MBDs in its own unique category of dressings with an antimicrobial effect (Box 3 and Figure 6).<sup>213</sup> MBDs irreversibly bind microbes to the dressing through interactions with a coating of the hydrophobic agent dialkylcarbamoyl chloride (DACC). The microbes are then removed from the wound.<sup>214</sup> This controls microbial burden, shifting the balance in favour of the host's immune response, minimising risk of progression and allowing healing to progress.<sup>58,59,65,69,215,216</sup> This is in contrast to absorbent dressings that are not indicated and have no clinical evidence for the management of wound infection.

### Efficacy of microbial-binding dressings

The effectiveness of MBDs in IPC has been demonstrated in clinical evidence on both surgical incisions (Table 2) and hard-to-heal wounds (Table 3). Several studies on the use of MBDs show reduced microbial counts:

- Significantly reduced microbial count compared with silicone gauze (1.2 log<sub>10</sub> CFU reduction, p=0.0175) in hard-to-heal wounds requiring a split-thickness skin

graft over 7 days (MBD used under negative pressure wound therapy)<sup>56</sup>

- Significantly reduced microbial count of 73.1%, compared with 41.6% with a silver hydrofiber dressing ( $p < 0.00001$ ), in highly colonised leg ulcers (i.e. covert local infection) over 4 days, in a pilot randomised controlled trial (RCT)<sup>64</sup>
- Reduced bacterial load of  $2.4 \log_{10}$  CFU/mg from biopsy samples of arterial and venous ulcers over 4 weeks (non-comparative)<sup>65</sup>
- Reduced fungal levels and no fungal growth in 45% of interdigital toe lesions (areas of damaged or abnormal tissue between the toes) in patients with diabetes by day 10.<sup>68</sup>

Another study showed bacterial load remaining stable where it might be expected to increase in infected DRFUs over 2 weeks.<sup>61</sup>

Observational studies have linked MBDs to improvements in clinical signs and symptoms of infection, including exudate,<sup>55,63,66,71</sup> odour,<sup>55,66,71</sup> slough,<sup>66,67,70,71</sup> necrotic tissue,<sup>71</sup> erythema/heat,<sup>67,72,219</sup> pain,<sup>55,66,67,69,216</sup> wound tissue<sup>66,70,71</sup> and peri-wound skin.<sup>63,66</sup> Such improvements can be useful indirect measures of efficacy, even if individual responses are influenced by comorbidities, immune response and medications.<sup>220</sup>

### Early interventions for infection control

Studies also show that MBDs can help prevent infection from occurring by controlling microbial burden before it becomes an issue. RCTs have shown significant reductions in SSI rates when MBDs are used instead of standard care following C-sections<sup>54</sup> and vascular surgery.<sup>51</sup> Real-world

evidence on incorporating MBDs into IPC care bundles has demonstrated similar SSI reductions in C-sections<sup>44,47,50</sup> and vascular,<sup>52</sup> orthopaedic and gastrointestinal surgeries.<sup>46</sup>

### Box 3. Definitions of antimicrobial agents used in wound care

**Antibiotics:** Agents (traditionally organic, obtained from fungi or bacteria) used to inhibit or kill specific bacteria (based on target sites within bacterial cells). Examples include beta-lactams (penicillin, cephalosporin, carbapenem), aminoglycosides (gentamicin) and macrolides (erythromycin).

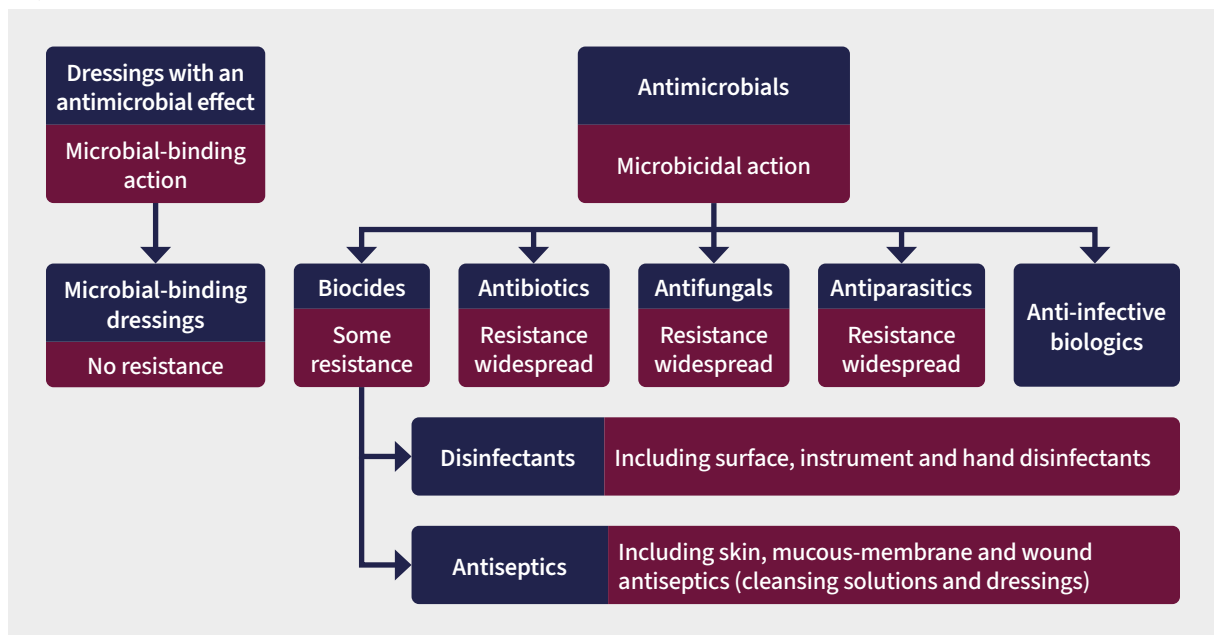
**Antifungals:** Agents (chemical) used to inhibit or kill fungal infections. Examples include azole compounds for superficial mycoses, amphotericin B for aspergillosis and flucytosine for systemic fungal infection.

**Antiseptics:** Biocides used topically on living tissue, such as skin. Examples include silver, iodine, polyhexamethylene biguanide, chlorhexidine gluconate, sodium hypochlorite and honey.

**Biocides:** Agents (chemical or organic) used to inhibit or kill a broad spectrum of microbes. Biocides include antiseptics and disinfectants, both of which typically have an effect on most microbes (including some spores).

**Disinfectants:** Biocides used on inert surfaces. Disinfectants are usually toxic to living tissue, such as skin.

**Figure 6. Antimicrobial classification**<sup>217,218</sup>



These data on SSI prevention have been systematically reviewed in three meta-analyses:

- One found that using MBDs instead of standard dressings almost halved SSI rates after C-section or vascular surgery (58.5%, OR 0.585, 95% CI 0.462–0.741)<sup>45</sup>
- Another found that using MBDs significantly reduced SSI rates following C-section in a sub-analysis comparing six advanced wound dressings (RR 1.20, 95% CI 0.77–1.88,  $p=0.41$ )<sup>48</sup>
- A wider network meta-analysis of nine dressings across 22 studies incorporating different surgery types further substantiated the impact of MBDs on reducing SSI risk compared with conventional dressings (OR=1.047, 95% CI 1.012–1.083,  $p=0.008$ )<sup>49</sup>

Prevention studies are more difficult in hard-to-heal wounds, which are often already colonised with microbes.<sup>221,222</sup> However, MBDs have been shown to prevent infection in DRFUs.<sup>67</sup>

### Antimicrobial stewardship

As MBDs do not release any antimicrobial chemicals into the wound, genetic resistance development is not expected. This makes MBDs an AMS-appropriate option for routine early prophylactic use without contributing to AMR.

Moreover, the ability of MBDs to prevent the occurrence or progression of infection has been shown to reduce the subsequent need for antibiotics and the resulting selective pressure for AMR development, a key goal of AMS.<sup>29,95</sup> Use of MBDs after C-section has been shown to reduce antibiotic use compared with standard care,<sup>44,47,53,54</sup> including a 30% reduction in an ambispective study,<sup>47</sup> a significant decrease (0 vs 7%,  $p=0.03$ ) in a pilot RCT<sup>53</sup> and a non-significant decrease (0% vs 1.5%) in a larger RCT by the same group.<sup>54</sup> Likewise, a pilot RCT found use of MBDs after vascular surgery reduced SSI rates and corresponding antibiotic use, compared with standard dressings.<sup>51</sup>

Similar reductions in antibiotic use have been reported in hard-to-heal wounds. A prospective observational trial in DRFU antibiotic use was reduced by 54% post MBDs compared to baseline.<sup>57</sup> These data reinforce the findings of a retrospective audit in DRFUs, VLUs and PUs who highlighted a marked reduction in antibiotic use for wounds managed with MBDs compared to silver hydrofiber dressings in both Germany and the USA (20% and 16% respectively).<sup>60</sup> Reductions in antibiotic prescribing following the introduction of MBDs as part of a framework for infected wounds within a NHS trust in the UK further substantiates this trend, with a concurrent reduction in spend across antiseptic dressings also, both supporting AMS initiatives.<sup>62</sup>

### Cost benefits

Infection prevention reduces healthcare resource costs, such as re-admission to manage infectious complications. A hospital using MBDs after C-section reduced readmissions by 31% and saved £234 784 over the same 12 months.<sup>47</sup>

Other reports show annual savings of £21 548<sup>212</sup> and £163 816.<sup>50</sup> An economic analysis of an RCT found using MBDs after C-section reduced costs by 46.6%, driven by reductions in SSI cases, outpatient attendances and inpatient length of stay.<sup>211</sup> Adopting MBDs could generate annual NHS savings of £5.3 million in C-section and £1.2 million in vascular surgery, according to guidance from the National Institute for Health and Care Excellence (NICE).<sup>223</sup> MBD use can also save on antimicrobial product spend, with an infection wound pathway incorporating MBDs at a UK healthcare trust reducing spend on silver dressings alone by 47.7% (£124,894.54) within 1 year.<sup>62</sup>

## Early infection prevention and control in future antimicrobial stewardship strategies

### Statements 11–13

- 11.** Considering comprehensive wound care, reserving use of antiseptic dressings for covert and overt infection, combined with antibiotics for spreading and systemic infection, supports AMS<sup>31,74,183,194,197,224,225</sup>
- 12A.** Prophylactic prevention and control of microbial burden with MBDs may reduce the need for antibiotic therapy, supporting AMS<sup>44,47,48,54</sup>
- 12B.** Management of local infection with MBDs may reduce the need for antibiotic therapy, supporting AMS<sup>57,60,62,64</sup>
- 13.** MBDs should be considered a key part of IPC and AMS in wound care<sup>31,218,224</sup>

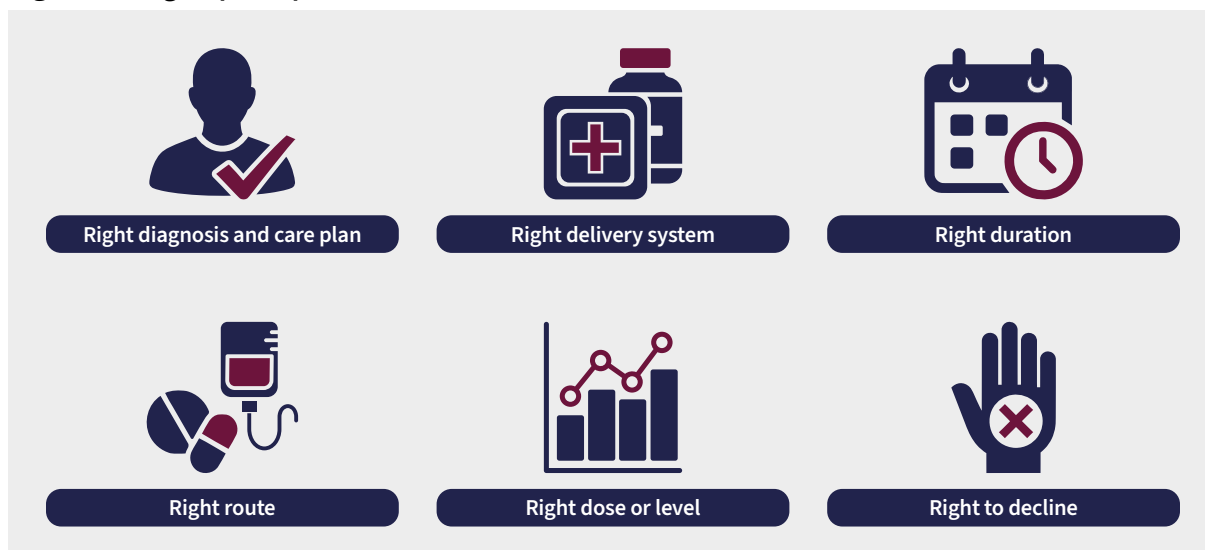
AMS is a systematic, healthcare-wide approach to promoting the judicious, responsible use of antimicrobials as part of IPC strategies, to preserve their future effectiveness.<sup>29,35,36</sup> AMS aims to minimise unnecessary antimicrobial use as the main driver of AMR.<sup>30,74,224</sup> To support AMS, HCPs must be able to distinguish between antimicrobial classifications, including antiseptics and antibiotics, and precise terminology in communication and documentation is essential to avoid errors in prescribing, use or reporting.<sup>74,217</sup> Moreover, all antimicrobials, including antiseptics and antibiotics, should be prescribed according to the 'Right Principles': the right diagnosis and care plan, right delivery system, right dose or level, right route, right duration and right to decline (Figure 7).<sup>139,226–228</sup>

### Infection prevention

The most effective way to minimise the spread and impact of AMR in wound care is to negate the need for antimicrobials by preventing infections from occurring in the first place.<sup>29</sup> Infection prevention is supported by a recent European Wound Management Association (EWMA) AMS toolkit.<sup>139</sup> Minimising the risk of wound infection requires the implementation of globally recommended IPC principles,<sup>34,95,122</sup> including standard and transmission based precautions.<sup>34</sup> Infection risk is also minimised by optimal management of wounds to minimise microbial burden, disrupt biofilm and facilitate healing.<sup>74,158,183,190,191</sup>

Infection can be prevented by intervening prophylactically to reduce microbial burden in the early stages of the WIC.

**Figure 7.** ‘Right’ principles of antimicrobial use<sup>139,226–228</sup>



Early first-line prophylactic interventions should ideally comprise therapeutic cleansing, debridement and dressings that manage exudate and microbial burden, aligned with AMS. These interventions help manage moisture levels (avoiding desiccation or maceration), as well as control and remove microbes before they can overcome the body's defences, reducing microbial burden and tipping the balance in favour of the host.<sup>222</sup> This should prevent progression from contamination and colonisation to local, spreading and systemic infection, consequently minimising the need for antiseptics and antibiotics, both of which can contribute to AMR.<sup>44,47,51,53,54,57,60,62,229</sup> Prophylactic cleansing should be performed with inert solutions to avoid contributing to AMR.<sup>191</sup> The importance of early prophylactic intervention with MBDs is becoming increasingly recognised across surgery and wound care.<sup>74,218</sup>

### Infection management

Managing infection in hard-to-heal wounds requires early multifactorial intervention to prevent progression, reduce microbial burden and facilitate healing. This includes standard wound care, such as the application of aseptic technique; therapeutic cleansing of the wound, periwound and surrounding skin; debriding devitalised tissue; managing inflammation and controlling infection; and maintaining a moist healing environment conducive to wound-edge advancement. Healing may be supported by patient optimisation, such as improving blood supply, offloading pressure or reducing oedema, as well as addressing local, systemic and social factors.<sup>74,147,191,230</sup> There is insufficient evidence to support the use of topical antibiotics in the management of hard-to-heal wounds.<sup>183,184,231</sup>

If local infection does occur, effective early intervention can prevent progression to a spreading or systemic infection that would require antibiotic therapy.<sup>74,194</sup> This includes the use of MBDs, which have been shown to markedly reduce signs and

symptoms of local infection while avoiding AMR.<sup>55,63,66,67,69–72,219</sup> However, in infected wounds, selective use of effective antiseptic cleansing solutions and (second-line) antiseptic dressings may be necessary to reduce the microbial burden, thus supporting AMS by preventing progression and limiting unnecessary systemic antibiotics.<sup>197,217,225,231</sup> Conversely, inappropriate or prolonged use of these antiseptics may contribute to AMR and adverse effects.<sup>104,197,225</sup> Recent guidance for infected DRFUs recommends against using antiseptics to improve infection outcomes.<sup>184</sup>

When selecting dressings for IPC in wounds with local infection, MBDs should generally be used as the first-line option and exchanged for a second-line antiseptic dressing if first-line treatment fails (*Box 4* and *Table 6*). This would align with the routine practice of dividing some medications, especially antibiotics, into access and watch groups, based on an empirical balance between safety and effectiveness. The access group is prioritised for first-line use based on a balance between safety and effectiveness, and the watch group is reserved as a second-line alternatives if the first line fails. This approach, based on expert recommendations, would minimise antimicrobial overuse and integrate wound care into wider AMS practices across infectious disease and pharmacy specialists.<sup>232</sup>

### Changing mindsets

Wound care needs a shift in mindset away from both inappropriate just-in-case antimicrobial use<sup>28</sup> and intervening only once infection has occurred. There is scope for further expansion of HCPs guidance on managing microbial burden in contaminated wounds before an infection fully develops. HCPs can be reassured that evidence shows early AMS-aligned prophylactic interventions, including MBDs, have a key and increasing role in IPC and AMS in surgical and hard-to-heal wounds.<sup>31,144,224</sup>

**Table 6. Intervention recommendations based on the Wound Infection Continuum**

Intervention	Contamination or colonisation	Covert or overt local infection	Spreading or systemic infection
Therapeutic cleansing <sup>191</sup>	Inert cleansing solutions <sup>4</sup>	Inert cleansing solutions or antiseptic cleansing solutions	Inert cleansing solutions or antiseptic cleansing solutions
Dressings	Microbial-binding dressings	Microbial-binding dressings (first line) or antiseptic dressings (second line)	Microbial-binding dressings (first line) or antiseptic dressings (second line)
Antibiotics <sup>74</sup>	No antibiotics	No antibiotics	Targeted antibiotics

Note: <sup>4</sup>Antiseptic cleansing solutions may be used in wounds at high risk of infection

**Box 4. First- and second-line interventions for treating wound infection**

**Established use in antibiotics**

- **First-line therapy:** Access-group antibiotics
- **Second-line therapy:** Watch-group antibiotics

**Expanded use across wound care**

- **First-line therapy:** Microbial-binding dressings
- **Second-line therapy:** Skin and wound antiseptics, with antibiotics or antifungals as appropriate in spreading or systemic infection

This indication-based approach requires regular review to optimise outcomes while conserving antimicrobial efficacy.<sup>74,197</sup> In practice, this approach needs to achieve a fine balance between the risk of AMR, the risk of infection development/progression and limitations on resources.

**Clinical pathways**

This guideline led to the development of four clinical pathways for AMS.

**Rationale**

Clinical pathways are interdisciplinary care frameworks aimed to translate evidence into practical guidance to improve clinical outcomes<sup>234</sup> by improving quality of care, reducing risks and improving how resources are allocated.<sup>235</sup> AMS pathways provide a structured approach to IPC for appropriate antimicrobial initiation optimisation and de-escalation, which supports targeted antimicrobial use and minimises the risk of AMR.<sup>236</sup> Evidence suggests that standalone, evidence-based, clinical pathway interventions support reduction of length of stay in hospitals and in-hospital complications and can increase clinical compliance with guidelines.<sup>234</sup>

The pathways presented are intended as simple, easy-to-apply, evidence-based tools to support and guide clinical decisions in the prevention and management of infection in surgical and hard-to-heal wounds. They emphasise application of AMS principles and strategies in daily IPC practice, including a shift to early intervention with MBDs to manage microbial burden and prevent development or progression of infection.

**Box 5. Rationale for implementing clinical pathways for antimicrobial stewardship**

**Prevents development of infection:** Early risk-factor identification and prophylactic intervention may prevent progression from colonisation to local infection and consequent complications

**Reduces antimicrobial use:** Preventive intervention to control microbial burden can reduce the use of antimicrobials

**Reduces antimicrobial resistance:** Minimising unnecessary antimicrobial exposure reduces selective pressure and emergence of resistant organisms

**Improves patient outcomes:** Early intervention and prevention can accelerate healing and reduce complications

**Supports proactive care:** Embedding early intervention shifts practice from reactive treatment to prevention

**Reduces healthcare burden:** Preventing infection decreases hospital admissions, resource use, complications and antimicrobial resistance

Adoption of these pathways should support clinicians to make decisions, provide consistent care and improve patient outcomes, among other key benefits (Box 5).<sup>35</sup> These pathways should serve as a guide to be used in combination with clinical judgement and best-practice guidelines. The pathways are intended to undergo clinical evaluation and validation.

The four clinical pathways cover the following areas:

- Closed surgical incisions
- Hard-to-heal wounds
- DRFUs
- VLUs.

**Implementation**

Successful implementation of these clinical pathways for AMS-aligned IPC requires consistent adoption, adaptation and integration into local organisational contexts for routine clinical practice.<sup>35,237,238</sup>

**Table 7. Facilitators and barriers to implementation of clinical guidelines and pathways for antimicrobial stewardship in wound care**

Domain	Facilitators	Barriers
Antimicrobial stewardship (AMS) education	<b>AMS alignment:</b> microbial-binding dressings (MBDs) can reduce microbial burden, avoiding unnecessary antimicrobial use, without contributing to AMR	<b>Knowledge gaps:</b> limited clinician awareness of AMS principles and MBD mechanisms can hinder appropriate use
Infection prevention and control (IPC) pathways	<b>Integration into existing pathways:</b> easy integration of MBDs into structured wound IPC pathways can ensure convenient, consistent and timely care	<b>Established prescribing habits:</b> reliance on antiseptics and systemic antibiotics can limit adoption of AMS-aligned interventions
Diagnosis	<b>Diagnostic education:</b> training can develop clinician competency and confidence to identify, assess and diagnose infection early	<b>Diagnostic uncertainty:</b> difficulty in identifying high risk or presence of wound infection can delay intervention
Patient factors	<b>Patient engagement:</b> Involving patients in their care and educating them to recognise infection signs can enhance adherence to effective preventive measures	<b>Variability adherence and engagement:</b> social, economic or health-related barriers can limit patient participation in preventive and curative care
Resources	<b>Resource availability:</b> local access to adequate staffing, equipment, microbiological support and MBDs facilitates consistent implementation	<b>Resource constraints:</b> limited access to MBDs, specialist services, staffing or microbiological support may hinder timely implementation
Monitoring and feedback	<b>Audit mechanisms:</b> tracking and feedback of antimicrobial use and AMR outcomes can encourage implementation and adherence, as well as support continuous quality improvement	<b>Workload pressures:</b> Adherence to sufficient accurate assessment, documentation and monitoring can be difficult under high clinical workloads
Multidisciplinary team	<b>Collaboration:</b> engagement of the team members and other stakeholders can ensure alignment, shared goals and coordinated care	<b>Communication gaps:</b> poor coordination, documentation and communication across teams can compromise continuity and effective pathway use
Institutional culture	<b>Institutional support:</b> a culture that values early intervention, infection prevention treatment and AMS as continuous improvement can encourage consistent adoption	<b>Resistance to change:</b> clinicians accustomed to reactive management may be slow to adopt early intervention and AMS-driven preventive approaches
Organisational leadership	<b>Organisational support:</b> inclusion of MBDs in local guidelines, formularies and AMS governance frameworks can promote sustained uptake	<b>Organisational variability:</b> system-level differences in policies, infrastructure and staffing may limit consistent implementation

This requires coordination across an MDT of surgeons, clinicians, nurses, clinical nurse specialists,<sup>239</sup> IPC practitioners, pharmacists, microbiologists, podiatrists and dermatologists, often alongside collaboration with other stakeholders, such as quality improvement teams, organisational leaders, policymakers, payers, healthcare funders and patients.<sup>240,241</sup> With so many stakeholders, clear communication is essential to ensure alignment, shared understanding and knowledge.<sup>238,242</sup> Wound care specialists are best placed to lead this collaboration, education and active engagement.<sup>239</sup> Decision-makers should be guided by the various facilitators and barriers that can influence the successful implementation of AMS pathways (*Table 7*).<sup>35,144,236</sup> Antimicrobial stewardship initiatives within wound infection should be addressed at government, organisational and clinical level to facilitate successful implementation (*Figure 8*).<sup>197,218,225,243,255</sup>

Applying these recommendations may initially increase resource use in the short term, particularly in staff time, training, dressing costs and local policy making. However, these investments are likely to be offset by longer-term cost-savings from reduced rates of infection, complications and antimicrobial use, leading to improved wound healing and other patient outcomes, as well as reduction in AMR.<sup>47</sup>

### Box 6. Areas for monitoring and audit criteria

- Adherence to early intervention and prevention protocols
- Timely and appropriate use of microbial-binding dressings
- Adherence to infection control, such as septic technique and swabs only taken for targeted prescribing in spreading and systemic infection
- Documentation accuracy
- Patient and wound outcomes, including infection rates, extent of infection, dehiscence and time to infection resolution or wound healing
- Use of antiseptics, antibiotics and antifungals
- Surveillance for AMR organisms from wound isolates (if needed)
- Additional resource use, such as hospitalisations, readmissions, length of stay, visits, additional procedures, re-operations and nursing time

**Figure 8. Antimicrobial stewardship initiatives**



## Monitoring

Regular feedback and review of the application of these pathways in individualised wound care can identify gaps in the criteria, reinforce consistent adoption and support continuous improvement (Box 6).

## Limitations

A systematic review process would have greater authority than the rigorous pragmatic literature review conducted. The generalisability of the recommendations is limited

by the variable strength of evidence and heterogeneity of wound types covered, as well as the focus on English-language literature. The scope is limited to adults and is specific to MBDs only, with little detail on other dressing types. The pathways would be strengthened by prospective validation and inclusion of specific pathways for additional wound aetiologies, to be addressed in future updates. This guideline and its recommendations could influence future research, such as further comparative, implementation and validation studies.

## Conclusions

Early intervention against wound microbial burden, including prophylactic use of MBDs, has been shown to minimise development and progression of infection, along with consequent requirements for antibiotic and antiseptic use. This supports a paradigm shift towards an IPC approach to reinforce AMS in wound care.

This guideline, based on a pragmatic literature review and evidence-based statements, advocates best-practice AMS principles and detailed guidance. The practical application of these principles is supported by four clinical pathways,

intended as simple tools to guide clinical decisions, in combination with clinician judgement and best-practice guidelines (*Appendix 3*), in everyday IPC across closed surgical incisions and hard-to-heal wounds.

IPC in accordance with AMS principles is a professional responsibility for everyone working in wound care, fulfilled through diligent, evidence-based practice. HCPs should work with wound care teams and the wider MDT, including IPC, pharmacy and infectious disease specialists, to demonstrate how implementing this guideline and the pathways can support AMS and ultimately improve patient outcomes.

## Glossary

**Advanced wound dressing:** Dressings that actively modify the local wound environment to support healing through, for example, moisture management, facilitating gas exchange and/or antimicrobial effects

**Antimicrobial:** Agent that kills (microbicidal) or stops the growth of (microbiostatic) microorganisms

**Antimicrobial effect:** Reduction in the microbial burden and/or reduction in the clinical signs and symptoms of infection by removal of microorganisms

**Antimicrobial resistance:** Evolution by microorganisms of mechanisms to reduce antimicrobial effectiveness, in response to selective pressure from antimicrobial challenge and natural selection, particularly in inappropriate antimicrobial use, increasing antimicrobial treatment failure and making infections harder to treat

**Antimicrobial stewardship:** Systematic, healthcare-wide approach to promoting the judicious, responsible use of antimicrobials as part of infection prevention and control strategies, to preserve their future effectiveness

**Clinical, Etiological, Anatomical, Pathophysiological classification of venous disease (CEAP):** International assessment tool for chronic venous disorders, with 12 categories from C0 to C6r

**Hard-to-heal wound:** Wound that fails to progress through normal stages of healing within an expected timeframe as a result of multiple local and systemic factors

**Infection prevention and control:** Evidence-based, practical approach to prevent the development and spread of harmful, often healthcare-associated, infections among patients, staff and visitors

**Infection:** The presence of multiplying organisms which overwhelm the body's immune system resulting in a host response evident in clinical signs and symptoms

**Infectious Disease Society of America:** Organisation that provides globally relevant evidence-based guidelines, resources and insights on the prevention and treatment of infectious diseases ([www.idsociety.org](http://www.idsociety.org))

**Integral debridement:** Approach to debridement recognising that some methods are sufficient alone and others require an adjunct to be effective, as well as that methods should be matched to need and availability

**Interactive wound dressing:** Wound dressings designed to interact with the wound by maintaining a local moist environment at the wound surface, with selection and duration of use guided by ongoing clinical assessment

**International Working Group for the Diabetic Foot:** Global, multidisciplinary expert group that has developed guidelines for preventing, managing and reducing the burden of diabetes-related foot diseases through structured, evidence-based care (<https://iwgdfguidelines.org>)

**International Wound Infection Institute:** A group for healthcare professionals with an interest in wound infection supporting education and tools to support appropriate infection management in wound care (<https://woundinfection-institute.com>)

**Microbial-binding dressing:** Non-medicated, hydrophobic wound dressings that physically bind and remove bacteria and fungi, reducing wound microbial burden without releasing active agents

**Sepsis:** Life-threatening condition in which the body's response to infection causes organ dysfunction, multiple organ failure and death

**Site, Ischaemia, Neuropathy, Bacterial infection and Depth (SINBAD):** Validated international assessment tool for diabetes-related foot ulcers, with scores  $\geq 3/6$  indicating a more severe/complicated ulcer

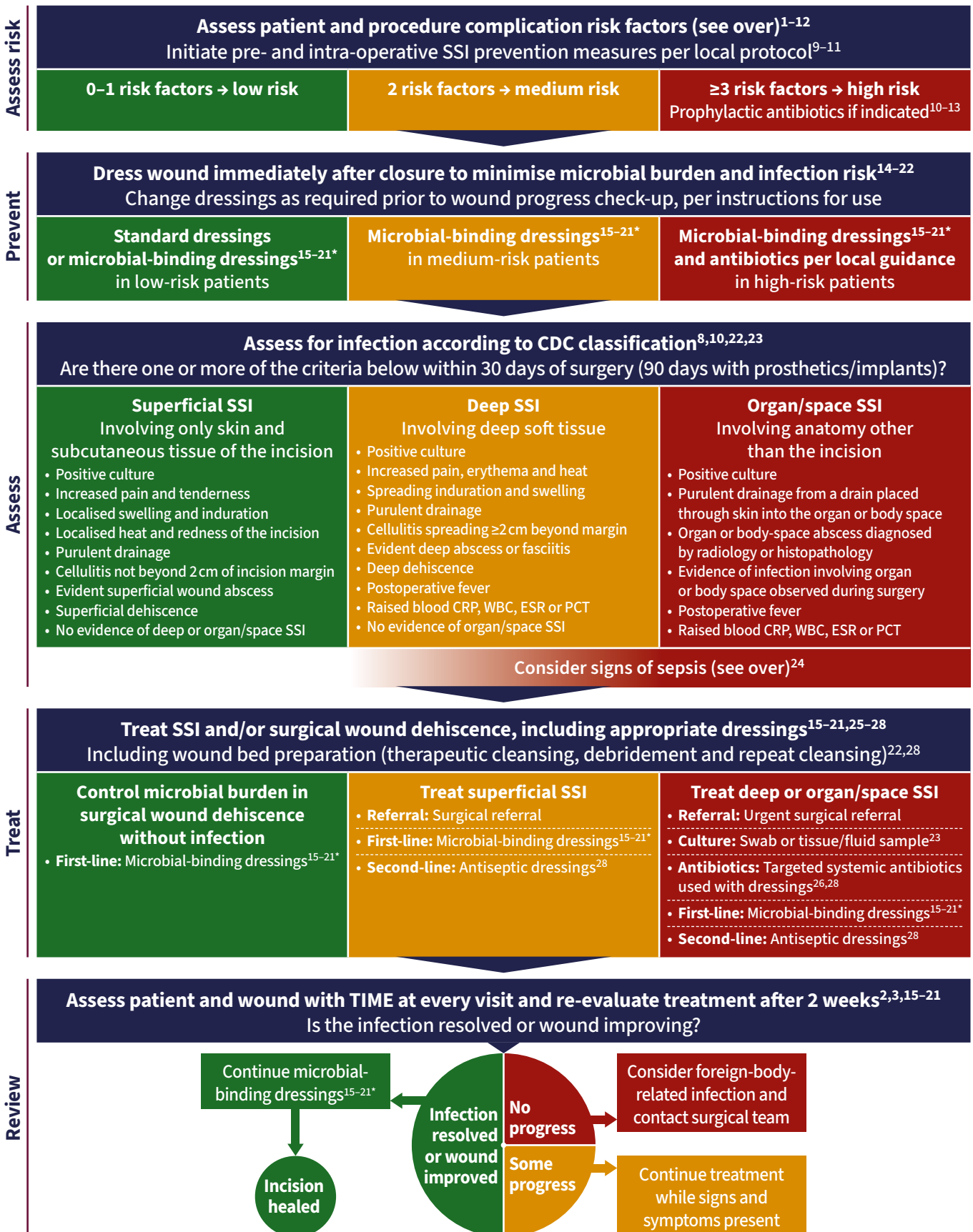
**Surgical site infection:** Infection occurring at or near a surgical incision within 30 days of the procedure (or within 90 days if prosthetic material was implanted)

**Surgical wound dehiscence:** Separation of the margins of a closed surgical incision, with or without exposure or protrusion of underlying tissue, organs or implants

**Therapeutic wound cleansing:** Cleansing of the wound bed, wound edge, periwound and surrounding skin, before and after debridement, performed diligently, at times vigorously and considering individual holistic needs, using appropriate techniques, solutions and sequencing

**Wound Ischaemia foot Infection (WIFI):** Risk-assessment tool for diabetes-related foot ulcers, comprising three factors (wound severity, perfusion and infection) and four stages (0–3), predicting 1-year major amputation risk and potential revascularisation benefit

# ANTIMICROBIAL STEWARDSHIP PATHWAY: CLOSED SURGICAL INCISIONS



**Notes:** \* Microbial-binding dressings have a DACC coating that can control microbial burden to prevent or manage infection in a way that is not expected to contribute to antimicrobial resistance. All treatments should be used per local policy and where clinically appropriate. This pathway applies to closed surgical incisions healing by primary intention. See over for supplementary tables, abbreviations and references.

## Risk factors for SSIs<sup>5-13</sup>

### Patient risk factors

- Advanced age
- Chronic liver or kidney disease
- Diabetes
- Immunosuppression (drug induced or genetic)
- Malnutrition
- Obesity
- Pre-operative nasal colonisation with *Staphylococcus aureus*
- Respiratory conditions
- Smoker/nicotine use
- Steroid use
- Drug/alcohol abuse/addiction

### Surgical procedure risk factors

- Anatomical location of surgery (consult guidance for specifics)
- Classification of surgery as clean, clean/contaminated, contaminated or dirty
- Complexity of surgical procedure
- Emergency procedure
- Interruption of asepsis during surgery
- Introduction of a prosthetic implant
- Prolonged duration of surgery

## Signs of sepsis<sup>24</sup>

Sepsis is a life-threatening condition in which the body's response to infection causes injury to its tissues and organs. Organ dysfunction is a key component in any diagnosis of sepsis.

### Act on any of the following red flags:

- S.** Slurred speech or confusion
- E.** Extreme shivering or muscle pain
- P.** Passing no urine (in a day)
- S.** Severe breathlessness
- I.** It feels like you are going to die
- S.** Skin mottled or discoloured



**Abbreviations:** CDC=Centers for Disease Control and Prevention; CRP=C-reactive protein; DACC=dialkylcarbamoyl chloride ESR=erythrocyte sedimentation rates; PCT=pro-calcitonin; SSI=surgical site infection; TIME=Tissue, Infection/inflammation, Moisture balance, Edge/epithelialisation; WBC=white blood cell.

1. Erritty M et al. Arch Gynecol Obstet. 2018;308:1775-1783. 2. Schultz et al. Int Wound J. 2004;1:19-32. 3. Harries et al. Int Wound J. 2016;13:8-14. 4. American Society of Anesthesiologists. Statement on ASA physical status classification system. 2025. 5. Bucataru A et al. Clin Pract. 2023;14:52-68. 6. Florschütz AV et al. J Am Acad Orthopaed Surg. 2015;23:S8-S11. 7. Korol E et al. PLoS One. 2013;8:e83743. 8. Mangram AJ et al. Am J Infect Control. 1999;27:97-134. 9. Nepogodiev D et al. Br J Surg. 2020;107:970-977. 10. World Health Organization. Global guidelines for the prevention of surgical site infection. 2018. 11. Berríos-Torres SI et al. JAMA Surg. 2017;152:784. 12. Amri R et al. JAMA Surg. 2017;152:686. 13. Souroullas P et al. Br J Surg. 2022;109:426-432. 14. National Institute for Health and Care Excellence. Surgical site infections: prevention and treatment. 2020. 15. Rippon M et al. Glob Wound Care J. 2025;1:24-30. 16. Bua N et al. Ann Vasc Surg. 2017;44:387-392. 17. Totty JP et al. Int Wound J. 2019;16:883-890. 18. Stanirowski PJ et al. Surg Infect. 2016;17:427-435. 19. Stanirowski PJ et al. Arch Med Sci. 2016;12:1036-1042. 20. National Institute for Health and Care Excellence. Leukomed Sorbact for preventing surgical site infection. 2021. 21. Wijetunge S et al. Eur J Obstet Gynecol Reprod Biol. 2021;267:226-233. 22. Sandy-Hodgetts K et al. J Wound Care. 2025;34:S1-S20. 23. National Healthcare Safety Network. Surgical site infection. 2025. 24. UK Sepsis Trust. Spotting the signs of sepsis. 2025. 25. Bullough et al. Wounds UK. 2012;8:102-109. 26. Pinchera B et al. Antibiotics. 2022;11:1608. 27. Ousey K et al. Wounds Int. 2018;1-48. 28. International Wound Infection Institute. Wound infection in clinical practice: principles of best practice - Wounds International. 2022.

## Guidance



**Centers for Disease Control and Prevention (2025)**  
[Surgical site infection](#)



**International Surgical Wound Complications Advisory Panel (2025)**  
[Guideline for post-operative incision care](#)



**International Wound Infection Institute (2022)**  
[Wound infection in clinical practice](#)



**World Health Organization (2018)**  
[Global guidelines for the prevention of surgical site infection](#)

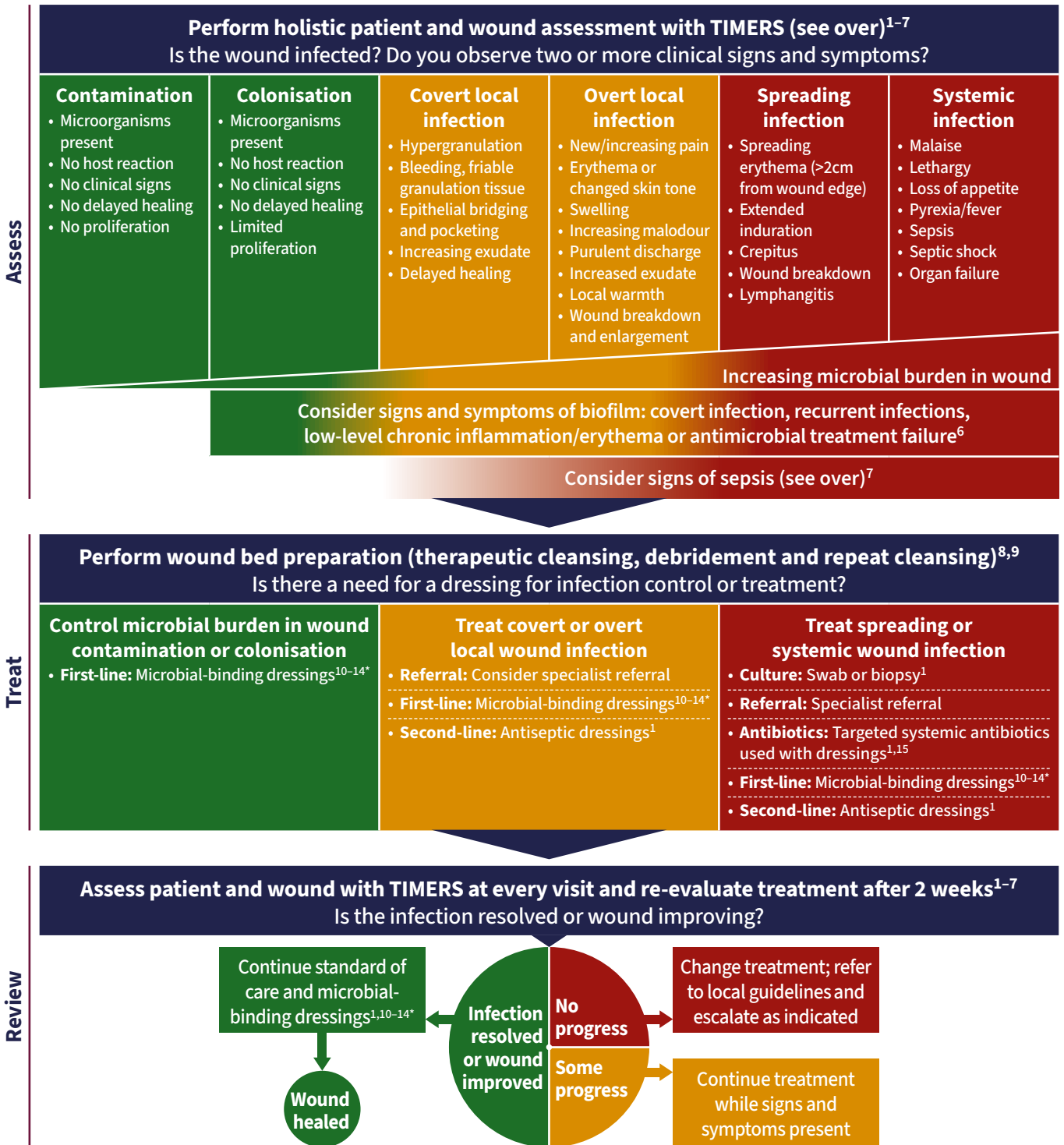


**World Union of Wound Healing Societies (2018)**  
[Surgical wound dehiscence: improving prevention and outcomes](#)



**DACC™-coated dressings**  
[instructions for use](#)

# ANTIMICROBIAL STEWARDSHIP PATHWAY: HARD-TO-HEAL WOUNDS



**Notes:** \*Microbial-binding dressings have a DACC coating that can control microbial burden to prevent or manage infection in a way that is not expected to contribute to antimicrobial resistance. All treatments should be used per local policy and where clinically appropriate. See over for supplementary tables and references. Aetiology-specific variants of this pathway are available for diabetes-related foot ulcers and venous leg ulcers.

**Abbreviations:** DACC=dialkylcarbamoyl chloride; TIMERS=Tissue, Infection/Inflammation, Moisture balance, Edge/epithelialisation, Regeneration and repair, Social factors



## Aspects of a holistic patient assessment in hard-to-heal wounds – adapted from TIMERS<sup>1-6</sup>

### Patient assessment

- Comorbidities
- Current medication
- Functionality and mobility
- Nutritional assessment
- Skin assessment (including skin tone)
- Social factors
- Surgical and medical history

### Local assessment

- Ankle brachial index, toe brachial index and toe systolic pressure (lower leg)
- Oedema
- Skin perfusion
- Skin temperature
- Surrounding skin condition
- Transcutaneous oxygen pressure
- Vitals

### Wound assessment

- Aetiology and classification
- Imaging as appropriate
- Location, duration, size and depth
- Odour
- Pain (see guidance)
- Periwound condition
- Previous investigations and treatments
- Tissue biopsy (if appropriate in ≥3 months duration or atypical presentation)
- Tissue types on wound bed (necrotic, sloughy, granulation or epithelial)

## Risk factors for wound infection – adapted from the International Wound Infection Institute<sup>1,15,16</sup>

### Patient risk factors

- Alcohol, smoking or illicit drug use
- Conditions associated with hypoxia or poor perfusion (e.g. anaemia, cardiac disease, respiratory disease, peripheral arterial disease, renal impairment or rheumatoid arthritis)
- Connective tissue disorders (e.g. Ehlers-Danlos syndrome)
- Corticosteroid use
- Immune disorders (e.g. acquired immune deficiency syndrome)
- Lymphoedema
- Malnutrition or obesity
- Neuroarthropathy
- Peripheral arterial disease (including ischaemia)
- Peripheral neuropathy (sensory, motor and autonomic)
- Poor adherence to treatment plan
- Poorly controlled diabetes
- Radiation therapy or chemotherapy

### Wound risk factors

- Atypical aetiology<sup>18</sup>
- Duration of wound
- Foreign body presence (e.g. drains, sutures or wound dressing fragments)
- Haematoma
- Impaired tissue perfusion
- Increased exudate and oedema that is not adequately managed
- Involvement of tissue deeper than skin and subcutaneous tissues (e.g. tendon, muscle, joint or bone)
- Necrotic or sloughy wound tissue
- Probing to bone
- Wounds over bony prominences

### Environmental risk factors

- Hospitalisation (due to increased risk of exposure to antimicrobial-resistant microorganisms)
- Inadequate hand hygiene and aseptic technique
- Inadequate management of moisture (e.g. due to exudate, incontinence or perspiration)
- Unhygienic environment (e.g. dust, unclean surfaces, or presence of mould/mildew)

## Signs of sepsis<sup>7</sup>

Sepsis is a life-threatening condition in which the body's response to infection causes injury to its tissues and organs. Organ dysfunction is a key component in any diagnosis of sepsis.

### Act on any of the following red flags:

- S.** Slurred speech or confusion
- E.** Extreme shivering or muscle pain
- P.** Passing no urine (in a day)
- S.** Severe breathlessness
- I.** It feels like you are going to die
- S.** Skin mottled or discoloured



## Guidance



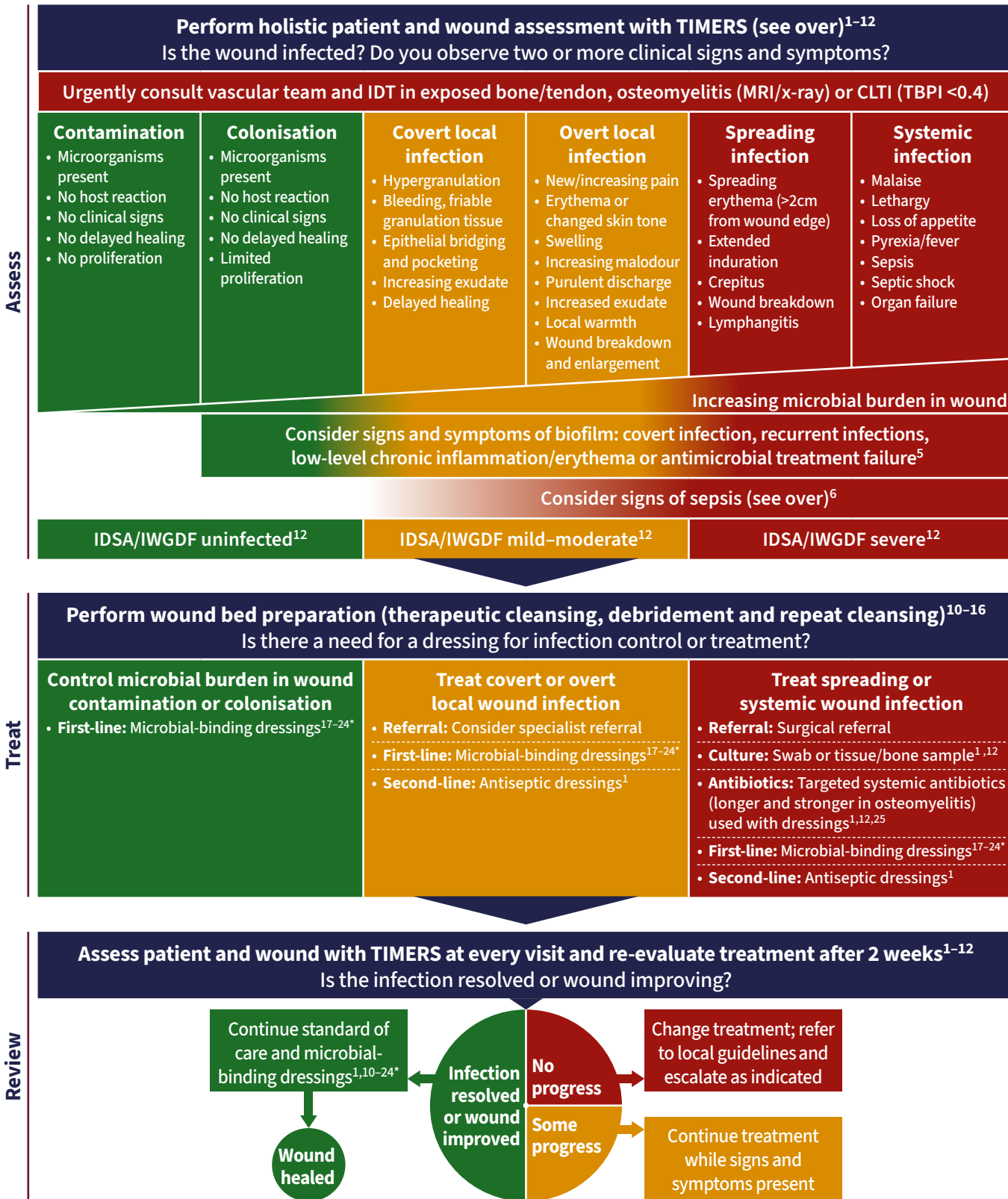
**European Wound Management Association (2024)**  
[Holistic management of wound-related pain](#)



**International Wound Infection Institute (2022)**  
[Wound infection in clinical practice](#)

1. International Wound Infection Institute. Wound infection in clinical practice: principles of best practice – Wounds International. 2022. 2. Atkin L et al. J Wound Care. 2019;28:S1–50. 3. Fletcher J et al. Wounds UK. 2018;1–24. 4. Conte MS et al. Eur J Vasc Endovasc Surg. 2019;58:S1–S109. 5. Isoherranen K et al. J Wound Care. 2019;28:S1–92. 6. Schultz GS et al. Wound Rep Regen. 2017;25:744–757. 7. UK Sepsis Trust. Spotting the signs of sepsis. 2025. 8. Haesler E et al. Wounds Int. 2025;1–52. 9. Schultz GS et al. Wound Rep Regen. 2003;11:S1–28. 10. Bjarnsholt T et al. Wounds Int. 2020;1–32. 11. Blackburn J et al. Int Wound J. 2025;22:e70684. 12. Cole W et al. Wounds. 2025;37:S1–S24. 13. Mosti G et al. J Wound Care. 2015;24:121–127. 14. Rippon MG et al. J Wound Care. 2021;30:284–296. 15. Assadian O et al. J Wound Care. 2023;32:3–4. 16. García Nores GD et al. J Invest Dermatol. 2018;138:325–335

# ANTIMICROBIAL STEWARDSHIP PATHWAY: DIABETES-RELATED FOOT ULCERS



**Notes:** Microbial-binding dressings have a DACC coating that can control microbial burden to prevent or manage infection in a way that is not expected to contribute to antimicrobial resistance. All treatments should be used per local policy and where clinically appropriate. See over for supplementary tables and references.

**Abbreviations:** CLTI=critical limb-threatening Ischaemia; CRP=C-reactive protein; DACC=dialkylcarbamoyl chloride; ESR=erythrocyte sedimentation rates; IDSA=Infectious Diseases Society of America; IDT=interdisciplinary team; IWGDF=International Working Group on the Diabetic Foot; TBPI=toe brachial pressure index; TIMERS=Tissue, Infection/Inflammation, Moisture balance, Edge/epithelialisation, Regeneration and repair, Social factors



## Aspects of a holistic patient assessment in diabetes-related foot ulceration – adapted from TIMERS<sup>1-5,7-12</sup>

### Patient assessment

- Comorbidities
- Current medication
- Functionality and mobility
- Nutritional assessment
- Skin assessment (including skin tone)
- Social factors
- Surgical and medical history

### Foot assessment

- Neuropathic assessment
- Oedema
- Pallor
- Pulses
- Skin perfusion
- Skin temperature
- TBPI/toe systolic pressure
- Transcutaneous oxygen pressure
- Vitals

### Wound assessment

- Charcot foot
- DFU stage (Wagner, Texas, SINBAD or Wifi)
- Imaging as appropriate (CT, MRA, duplex)
- Location, duration, size and depth
- Odour
- Pain (nociceptive or neuropathic)
- Periwound condition
- Previous investigations and treatments
- Tissue types on wound bed (necrotic, sloughy, granulation or epithelial)

## Risk factors for wound infection – adapted from the International Wound Infection Institute<sup>1,25-47</sup>

### Patient risk factors

- Acute kidney injury/disease
- Alcohol, smoking or illicit drug use
- Conditions associated with hypoxia or poor perfusion
- Connective tissue disorders (e.g. Ehlers-Danlos syndrome)
- Corticosteroid use
- Immune disorders (e.g. acquired immune deficiency syndrome)
- Lymphoedema
- Malnutrition or obesity
- Neuroarthropathy
- New/worsening azotaemia and electrolyte abnormalities
- Peripheral arterial disease (inc. ischaemia)
- Peripheral neuropathy (sensory, motor and autonomic)
- Poor adherence to treatment plan
- Poorly controlled diabetes
- Radiation therapy or chemotherapy
- Severe/worsening hyperglycemia or acidosis

### Wound risk factors

- Duration of wound
- Foreign body presence (e.g. drains, sutures or wound dressing fragments)
- Haematoma
- Impaired tissue perfusion
- Increased exudate and oedema that is not adequately managed
- Large or deep wounds
- Necrotic or sloughy wound tissue
- Penetration to subcutaneous tissues (fascia, tendon, muscle, joint or bone)
- Previous ulceration or amputation
- Probing to bone
- Traumatic aetiology
- Wounds over bony prominences

### Environmental risk factors

- Hospitalisation (due to increased risk of exposure to antimicrobial-resistant microorganisms)
- Inadequate hand hygiene and aseptic technique
- Inadequate management of moisture (e.g. due to exudate, incontinence or perspiration)
- Interface pressure that is inadequately offloaded
- Unhygienic environment (e.g. dust, unclean surfaces, or presence of mould/mildew)

## Signs of sepsis<sup>6</sup>

Sepsis is a life-threatening condition in which the body's response to infection causes injury to its tissues and organs. Organ dysfunction is a key component in any diagnosis of sepsis.

### Act on any of the following red flags:

- S.** Slurred speech or confusion
- E.** Extreme shivering or muscle pain
- P.** Passing no urine (in a day)
- S.** Severe breathlessness
- I.** It feels like you are going to die
- S.** Skin mottled or discoloured



1. International Wound Infection Institute. Wound infection in clinical practice: principles of best practice – Wounds International. 2022. 2. Atkin L et al. J Wound Care. 2019;28:S1-50. 3. Fletcher J et al. Wounds UK. 2018;1-24. 4. Conte MS et al. Eur J Vasc Endovasc Surg. 2019;58:S1-S109. 5. Schultz GS et al. Wound Rep Regen. 2017;25:744-757. 6. UK Sepsis Trust. Spotting the signs of sepsis. 2025. 7. Wagner FW. Foot Ankle. 1981;2:64-122. 8. Mills JL et al. J Vasc Surg. 2014;59:220-234. 9. Treece KA. Diabet Med. 2004;21:987-991. 10. ElSayed NA et al. Diabetes Care. 2025;48:S252-S265. 11. Fitridge R et al. Diabetes Metab Res Rev. 2024;40:e3686. 12. Senneville É et al. Diabetes Metab Res Rev. 2024;40:e3687. 13. Bus SA et al. Diabetes Metab Res Rev. 2024;40:e3647. 14. Chen P et al. Diabetes Metab Res Rev. 2024;40:e3644. 15. Haesler E et al. Wounds Int. 2025;1-52. 16. Schultz GS et al. Wound Rep Regen. 2003;11:S1-28. 17. Johansson A et al. J Wound Care. 2009;18:470-473. 18. Mañas CR et al. J Wound Care. 2025;34:278-284. 19. Sebayang et al. J Wound Res Technol. 2024;1:28-37. 20. Bjarnsholt T et al. Wounds Int. 2020;1-32. 21. Blackburn J et al. Int Wound J. 2025;22:e70684. 22. Cole W et al. Wounds. 2025;37:S1-S24. 23. Rippon MG et al. J Wound Care. 2021;30:284-296. 24. Assadian O et al. J Wound Care. 2023;32:3-4. 25. García Noreas GD et al. J Invest Dermatol. 2018;138:325-335. 26. Brocklehurst JD et al. Adv Skin Wound Care. 2023;36:1-5

## Classification and guidance



**Treece et al (2023)**  
[SINBAD classification](#)



**Bus et al (2024)**  
[IWGDF guidelines on offloading foot ulcers in persons with diabetes](#)



**Chen (2024)**  
[IWGDF guidelines on interventions to enhance healing of foot ulcers in people with diabetes](#)



**El-Sayed et al (2025)**  
[American Diabetes Association standards of care in diabetes](#)



**Fitridge et al (2024)**  
[Intersocietal guidelines on peripheral artery disease in people with diabetes and a foot ulcer](#)



**International Wound Infection Institute (2022)**  
[Wound infection in clinical practice](#)

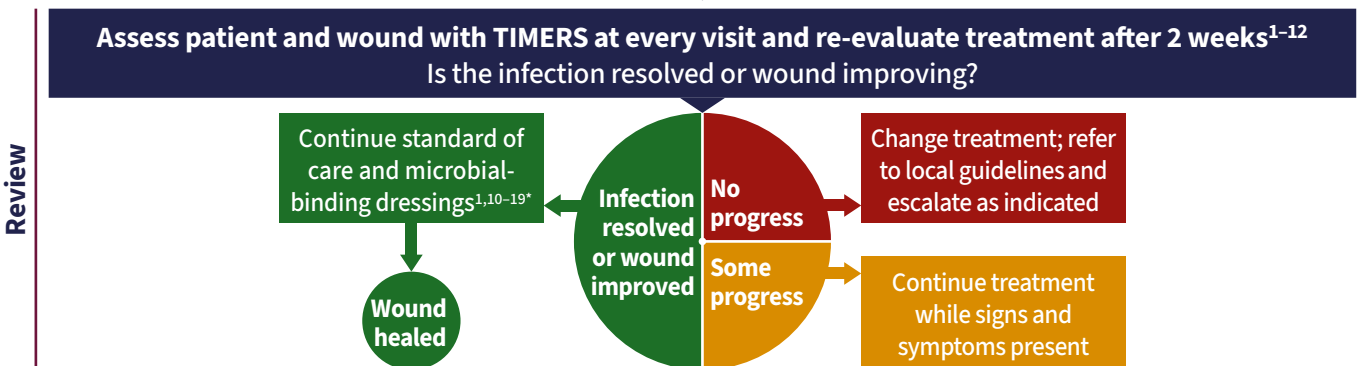
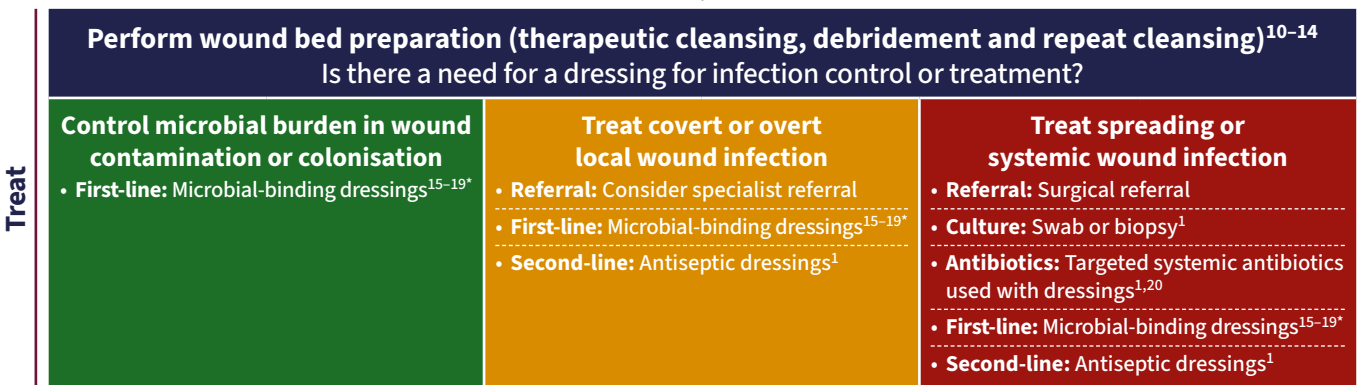
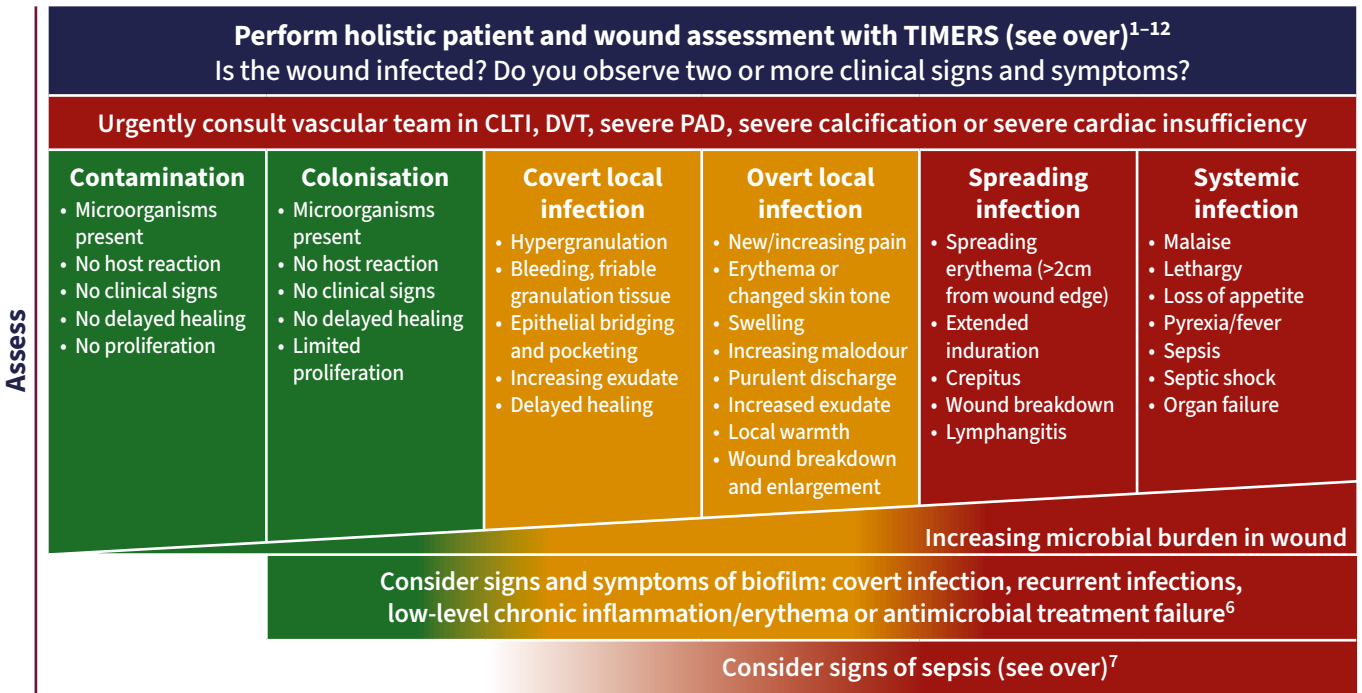


**Mills et al (2014)**  
[Wifi classification](#)



**Monterro-Soares et al (2024)**  
[IWGDF guidelines on the classification of foot ulcers in people with diabetes](#)

# ANTIMICROBIAL STEWARDSHIP PATHWAY: VENOUS LEG ULCERS



**Notes:** Microbial-binding dressings have a DACC coating that can control microbial burden to prevent or manage infection in a way that is not expected to contribute to antimicrobial resistance. All treatments should be used per local policy and where clinically appropriate. See over for supplementary tables and references.

**Abbreviations:** CEAP=Clinical, Etiological, Anatomical Pathophysiological Classification of Venous Disease; CLTI=critical limb-threatening ischaemia; DACC=dialkylcarbamoyl chloride; DVT=deep vein thrombosis; PAD=peripheral arterial disease; TIMERS=Tissue, Infection/Inflammation, Moisture balance, Edge/epithelialisation, Regeneration and repair, Social factors



## Aspects of a holistic patient assessment in venous leg ulceration – adapted from TIMERS<sup>1-6,8-12</sup>

### Patient assessment

- Comorbidities
- Current medication
- Functionality and mobility
- Nutritional assessment
- Skin assessment (including skin tone)
- Social factors
- Surgical and medical history

### Lower-leg assessment

- Ankle or toe brachial pressure index
- CEAP classification
- Doppler/vascular ultrasound
- Leg and foot pulses
- Oedema
- Skin perfusion
- Skin temperature
- Surrounding skin condition
- Transcutaneous oxygen pressure
- Vitals

### Wound assessment

- Classification
- Imaging as appropriate
- Location, duration, size and depth
- Odour
- Pain
- Periwound condition
- Previous investigations and treatments
- Tissue biopsy (if appropriate in ≥3 months duration or atypical wound presentation)
- Tissue types on wound bed (necrotic, sloughy, granulation or epithelial)

## Risk factors for wound infection – adapted from the International Wound Infection Institute<sup>1,20,21</sup>

### Patient risk factors

- Alcohol, smoking or illicit drug use
- Conditions associated with hypoxia or poor perfusion (e.g. anaemia, cardiac disease, respiratory disease, peripheral arterial disease, renal impairment or rheumatoid arthritis)
- Connective tissue disorders (e.g. Ehlers-Danlos syndrome)
- Corticosteroid use
- Immune disorders (e.g. acquired immune deficiency syndrome)
- Lymphoedema
- Malnutrition or obesity
- Neuroarthropathy
- Peripheral arterial disease (inc. ischaemia)
- Peripheral neuropathy (sensory, motor and autonomic)
- Poor adherence to treatment plan
- Poorly controlled diabetes
- Radiation therapy or chemotherapy

### Wound risk factors

- Atypical wounds
- Duration of wound
- Foreign body presence (e.g. drains, sutures or wound dressing fragments)
- Haematoma
- Impaired tissue perfusion
- Increased exudate and oedema that is not adequately managed
- Involvement of tissue deeper than skin and subcutaneous tissues (e.g. tendon, muscle, joint or bone)
- Necrotic or sloughy wound tissue

### Environmental risk factors

- Hospitalisation (due to increased risk of exposure to antimicrobial-resistant microorganisms)
- Inadequate hand hygiene and aseptic technique
- Inadequate management of moisture (e.g. due to exudate, incontinence or perspiration)
- Unhygienic environment (e.g. dust, unclean surfaces, or presence of mould/mildew)

## Signs of sepsis<sup>7</sup>

Sepsis is a life-threatening condition in which the body's response to infection causes injury to its tissues and organs. Organ dysfunction is a key component in any diagnosis of sepsis.

### Act on any of the following red flags:

- S.** Slurred speech or confusion
- E.** Extreme shivering or muscle pain
- P.** Passing no urine (in a day)
- S.** Severe breathlessness
- I.** It feels like you are going to die
- S.** Skin mottled or discoloured



1. International Wound Infection Institute. Wound infection in clinical practice: principles of best practice – Wounds International. 2022. 2. Atkin L et al. J Wound Care. 2019;28:S1–50. 3. Fletcher J et al. Wounds UK. 2018;1–24. 4. Conte MS et al. Eur J Vasc Endovasc Surg. 2019;58:S1–S109. 5. Isoherranen K et al. J Wound Care. 2019;28:S1–92. 6. Schultz GS et al. Wound Rep Regen. 2017;25:744–757. 7. UK Sepsis Trust. Spotting the signs of sepsis. 2025. 8. Fletcher J et al. Best practice statements: effectively assessing ABPI in leg ulcer patients. 2024. 9. Lurie F et al. J Vasc Surg Venous Lymphat Disord. 2020;8:342–352. 10. Atkin L & Tickle J. Wounds UK. 2016;12:32–36. 11. Isoherranen K et al. J Wound Manag. 2023;24:S1–S76. 12. Nair HK et al. J Wound Care. 2024;33:S1–S31. 13. Haesler E et al. Wounds Int. 2025;1–52. 14. Schultz GS et al. Wound Rep Regen. 2003;11:S1–28. 15. Bjarsholt T et al. Wounds Int. 2020;1–32. 16. Blackburn J et al. Int Wound J. 2025;22:e70684. 17. Cole W et al. Wounds. 2025;37:S1–S24. 18. Mosti G et al. J Wound Care. 2015;24:121–127. 19. Rippon MG et al. J Wound Care. 2021;30:284–296. 20. Assadian O et al. J Wound Care. 2023;32:3–4. 21. García Nores GD et al. J Invest Dermatol. 2018;138:325–335

## Classification and guidance



**Conte et al (2019)**  
[Global vascular guidelines on the management of chronic limb-threatening ischemia](#)



**European Wound Management Association (2023)**  
[Lower leg ulcer diagnosis & treatment](#)



**European Wound Management Association (2024)**  
[Holistic management of wound-related pain](#)



**International Wound Infection Institute (2022)**  
[Wound infection in clinical practice](#)



**Lurie et al (2020)**  
[Update of the CEAP classification](#)



**Nair et al (2024)**  
[Leg ulceration in venous and arteriovenous insufficiency: assessment and management](#)

# Appendices

## Appendix 1. Evidence-based statements and revisions by Delphi round and score

S	R	Statement	M	SD
1	1	Wound infection continues to be one of the biggest challenges facing HCPs in wound care	4.3	0.90
2	1	The number of wound infections attributable to antimicrobial-resistant organisms is underestimated	3.8	0.75
	2	The number of wound infections attributable to antimicrobial-resistant organisms could be underestimated	4.1	0.94
3	1	AMR in wound care is a growing challenge	4.4	0.80
4	1	Prevention of infection is one of the key focus areas for global AMR strategy	4.5	0.67
5	1	Inappropriate use of antimicrobials has been reported in non-infected wounds not requiring intervention	4.6	0.49
6	1	Inappropriate overuse of antimicrobials with active agents may increase the risk of AMR development	4.2	0.87
	2	Inappropriate use of antimicrobials may increase the risk of AMR development	4.6	0.49
7	1	Microbial burden of a wound may be reduced using BBDs	4.6	0.49
	2	Microbial burden of a wound may be reduced using MBDs	4.8	0.40
8	1	Early intervention with BBDs decreases microbial burden, minimising risk of progression on the wound infection continuum	4.4	0.49
	2	Early intervention with MBDs decreases microbial burden, minimising risk of progression on the wound infection continuum	4.8	0.40
9	1	Incorporating BBDs into post-operative care bundles can significantly reduce the risk of (superficial) SSIs	4.4	0.49
	2	Incorporating MBDs into postoperative care bundles can significantly reduce the risk of (superficial) SSIs	4.8	0.40
10	1	Prevention of SSI using BBDs can result in reduced re-admission, treatment and hospital-stay costs	4.3	0.66
	2	Prevention of SSI using MBDs can result in reduced re-admission, treatment and hospital-stay costs	4.8	0.40
11	1	Reserving antimicrobial dressings for covert and overt local infection, combined with antibiotics for spreading and systemic infections, supports the appropriate use of antimicrobials	4.1	0.54
	2	Following comprehensive wound bed preparation, reserving the use of antimicrobial dressings for covert and overt local infection, combined with antibiotics for spreading and systemic infection, supports the appropriate use of antimicrobials	4.2	0.40
	3	Considering comprehensive wound care, reserving use of antiseptic dressings for covert and overt infection, combined with antibiotics for spreading and systemic infection, supports AMS	4.76	0.46
12	1	Management of local bioburden/wound infection with BBDs reduces the need for antibiotic therapy, supporting AMS	4.0	0.77
	2	Early, proactive management of local bioburden/wound infection with BBDs may reduce the need for antibiotic therapy, supporting AMS	4.0	0.77
	3	12A. Prophylactic prevention and control of microbial burden with MBDs may reduce the need for antibiotic therapy, supporting AMS	4.5	0.50
		12B. Management of local infection with MBDs may reduce the need for antibiotic therapy, supporting AMS	4.5	0.50
13	1	BBDs should be considered a key part of IPC and AMS in wound care	4.7	0.46
	2	MBDs should be considered a key part of IPC and AMS in wound care	4.8	0.40

Key: **1** Statement number; **1** Round (not accepted or requiring redraft); **1** Round (accepted)

Notes: Some accepted statements were revised and rescored to enhance clarity; 'bacteria-binding dressings' was replaced with 'microbial-binding dressings' at round 3 (M 4.80, SD 0.40); AMR=antimicrobial resistance; AMS=antimicrobial stewardship; BBD=bacteria-binding dressing; HCP=healthcare professional; IPC=infection prevention and control; MBD=microbial-binding dressing; M=mean (approval score); R=round; S=statement; SD=standard deviation (approval score); SSI=surgical site infection

## Appendix 2. Detailed GRADE assessments of the certainty of literature review outcomes

Outcome (study type)	Studies	Design	Certainty	Importance	Details
<b>Surgical incisions</b>					
Controlled microbial burden	1	Non-randomised	2. Low		
Cost saving	1	Randomised	4. High		
Cost saving (non-RCT)	2	Non-randomised	2. Low		SA, SRB
Improved healing	1	Randomised	4. High		
Improved healing (case series)	1	Non-randomised	2. Low		APRC, CS, SRB
Infection prevention	3	Randomised	4. High	Critical	
Infection prevention (non-RCT)	3	Non-randomised	3. Moderate	Critical	SA
Reduced antibiotic use	2	Randomised	4. High	Important	
Reduced antibiotic use (case series)	1	Non-randomised	2. Low		APRC, CS, SRB
Reduced antibiotic use (non-RCT)	1	Non-randomised	4. High	Important	APRC, SA
Reduced readmission	1	Randomised	4. High	Important	
Reduced readmission (non-RCT)	1	Non-randomised	3. Moderate		SA
<b>Hard-to-heal wounds</b>					
Controlled microbial burden	1	Randomised	4. High	Critical	
Controlled microbial burden (3b observational studies)	5	Non-randomised	2. Low	Critical	
Improved healing	2	Randomised	4. High		
Improved healing (L3b)	5	Non-randomised	2. Low		
Improved healing (L4/5 case series/studies)	3	Non-randomised	2. Low		
Infection prevention	1	Non-randomised	1. Very low	Important	CS, PBSS
Reduced antibiotic use	1	Randomised	4. High		
Reduced antibiotic use (L3b observational studies)	3	Non-randomised	2. Low		
Reduced signs and symptoms of infection	1	Randomised	3. Moderate		IRI, PBSS
Reduced signs and symptoms of infection (L3b observational studies)	4	Non-randomised	2. Low		
Reduced signs and symptoms (L4 case series)	2	Non-randomised	2. Low		
Reduced signs and symptoms (L5 case report)	1	Non-randomised	2. Low		
<b>Abbreviations:</b> CS=company sponsorship; PBSS=publication bias strongly suspected; APRC=all plausible residual confounding would reduce the demonstrated effect; IRI=infection resolution inferred by wound progress and healing but not reported specifically; SA=strong association; SRB=serious risk of bias					

### Appendix 3. Guidelines

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**American College of Surgeons (2025)**  
[Online risk calculator](#)

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**Centres for Disease Control and Prevention (2025)**  
[National Healthcare Safety Network: surgical site infection](#)

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**International Surgical Wound Complications Advisory Panel (2025)**  
[Guideline for post-operative incision care](#)

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**International Wound Infection Institute (2022)**  
[Wound infection in clinical practice](#)

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**International Wound Infection Institute (2025)**  
[Therapeutic wound and skin cleansing: clinical evidence and recommendations](#)

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**Mayer et al. (2024)**  
[Best practice for wound debridement](#)

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**UK Sepsis Trust (2025)**  
[Spotting the signs of sepsis](#)

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**World Health Organization (2018)**  
[Global guidelines for the prevention of surgical site infection](#)

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**World Union of Wound Healing Societies (2018)**  
[Surgical wound dehiscence: improving prevention and outcomes](#)

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# References

- Whitehouse JD, Friedman ND, Kirkland KB et al. The impact of surgical-site infections following orthopedic surgery at a community hospital and a university hospital adverse quality of life, excess length of stay, and extra cost. *Infect Control Hosp Epidemiol.* 2002;23(4):183–9. <https://doi.org/10.1086/502033>
- Probst Sebastian, Menon T, Stefanelli A et al. Empathy in wound care: a scoping review of its role, impact, and barriers to person-centred healing. *Int Wound J.* 2025;22(6):e70687. <https://doi.org/10.1111/iwj.70687>
- Woo K, González CVS, Amdie FZ, De Gouveia Santos VLC. Exploring the effect of wound related pain on psychological stress, inflammatory response, and wound healing. *Int Wound J.* 2024;21(7):e14942. <https://doi.org/10.1111/iwj.14942>
- Smith J, Carville K, Maguire C et al. The impact of venous leg ulcers on quality of life. *Wound Pract Res.* 2023;31(4). <https://doi.org/10.33235/wpr.31.4.164-173>
- Sidapra M, Ramakrishnan P, Siracusa F et al. Patient-reported quality of life factors in vascular surgical wounds healing by secondary intention (SWHSI): a qualitative patient and public involvement (PPI) exploration. *J Vasc Soc GB Irel.* 2023;2. <https://doi.org/10.54522/jvsgbi.2023.070>
- Dowsett C, Bellingeri A, Carville K et al. A route to more effective infection management: the infection management pathway – Wounds International. 2020. <https://woundsinternational.com/journal-articles/route-more-effective-infection-management-infection-management-pathway/> (accessed 7 April 2026)
- Sen CK. Human wound and its burden: updated 2020 compendium of estimates. *Adv Wound Care.* 2021;10(5):281–92. <https://doi.org/10.1089/wound.2021.0026>
- Rudd KE, Johnson SC, Agesa KM et al. Global, regional, and national sepsis incidence and mortality, 1990–2017: analysis for the Global Burden of Disease Study. *Lancet.* 2020;395(10219):200–11. [https://doi.org/10.1016/S0140-6736\(19\)32989-7](https://doi.org/10.1016/S0140-6736(19)32989-7)
- Prompers L, Huijberts M, Apelqvist J et al. High prevalence of ischaemia, infection and serious comorbidity in patients with diabetic foot disease in Europe. Baseline results from the Eurodiab study. *Diabetologia.* 2007;50(1):18–25. <https://doi.org/10.1007/s00125-006-0491-1>
- Nussbaum SR, Carter MJ, Fife CE et al. An economic evaluation of the impact, cost, and medicare policy implications of chronic nonhealing wounds. *Value in Health.* 2018;21(1):27–32. <https://doi.org/10.1016/j.jval.2017.07.007>
- Carter MJ, DaVanzo J, Haught R et al. Chronic wound prevalence and the associated cost of treatment in Medicare beneficiaries: changes between 2014 and 2019. *J Med Econ.* 2023;26(11):894–901. <https://doi.org/10.1080/13696998.2023.2232256>
- Lathan R, Daysley H, Ravindran B et al. Environmental and financial cost of surgical-site infection by severity after lower limb vascular surgery. *BJS Open.* 2025;9(3). <https://doi.org/10.1093/bjsopen/zraf015>
- Murray CJL, Ikuta KS, Sharara F et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet.* 2022;399(10325):629–55. [https://doi.org/10.1016/S0140-6736\(21\)02724-0](https://doi.org/10.1016/S0140-6736(21)02724-0)
- Naghavi M, Vollset SE, Ikuta KS et al. Global burden of bacterial antimicrobial resistance 1990–2021: a systematic analysis with forecasts to 2050. *Lancet.* 2024;404(10459):1199–226. [https://doi.org/10.1016/S0140-6736\(24\)01867-1](https://doi.org/10.1016/S0140-6736(24)01867-1)
- World Health Organization. Antimicrobial resistance. 2026. <https://www.who.int/health-topics/antimicrobial-resistance> (accessed 24 February 2026)
- World Health Organization. Global antibiotic resistance surveillance report 2025: WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS). 2025. <https://www.who.int/publications/i/item/9789240116337> (accessed 24 February 2026)
- Puca V, Marulli RZ, Grande R et al. Microbial species isolated from infected wounds and antimicrobial resistance analysis: data emerging from a three-years retrospective study. *Antibiotics.* 2021;10(10):1162. <https://doi.org/10.3390/antibiotics10101162>
- Balakrishnan T, Amarasena DK, Bilal A et al. A geographical paradox: microbiological profile and antibiotic resistance of diabetic foot infection in North West England. *Pract Diabetes.* 2024;41(3):35–40. <https://doi.org/10.1002/pdi.2514>
- Coşkun B, Ayhan M, Ulusoy S, Guner R. Bacterial profile and antimicrobial resistance patterns of diabetic foot infections in a major research hospital of turkey. *Antibiotics.* 2024;13(7):599. <https://doi.org/10.3390/antibiotics13070599>
- Matei S-C, Dumitru CS, Fakhry AM et al. Bacterial species involved in venous leg ulcer infections and their sensitivity to antibiotherapy—an alarm signal regarding the seriousness of chronic venous insufficiency C6 stage and its need for prompt treatment. *Microorganisms.* 2024;12(3):472. <https://doi.org/10.3390/microorganisms12030472>
- Teillant A, Gandra S, Barter D et al. Potential burden of antibiotic resistance on surgery and cancer chemotherapy antibiotic prophylaxis in the USA: a literature review and modelling study. *Lancet Infect Dis.* 2015;15(12):1429–37. [https://doi.org/10.1016/S1473-3099\(15\)00270-4](https://doi.org/10.1016/S1473-3099(15)00270-4)
- Foschi D, Yakushkina A, Cammarata F et al. Surgical site infections caused by multi-drug resistant organisms: a case-control study in general surgery. *Updates Surg.* 2022;74(5):1763–71. <https://doi.org/10.1007/s13304-022-01243-3>
- Lakhani A, Jindal K, Khatri K. Antimicrobial resistance (AMR) in Orthopaedic surgeries: A Complex issue and global threat. *J Orthopaed Rep.* 2025;4(4):100466. <https://doi.org/10.1016/j.jorep.2024.100466>
- Hampton J, Sharpe A, McCluskey P et al. Diagnosis and treatment of infected wounds: A multi-centre audit of current clinical practice across the UK, Ireland and Scandinavia. *J Clin Nurs.* 2023;32(15):4730–40. <https://doi.org/10.1111/jocn.16527>
- Gürgen M. Excess use of antibiotics in patients with non-healing ulcers. *EWMA Journal.* 2014;14(1):17–22
- Öien RF, Forssell HW. Ulcer healing time and antibiotic treatment before and after the introduction of the Registry of Ulcer Treatment: an improvement project in a national quality registry in Sweden. *BMJ Open.* 2013;3(8):e003091. <https://doi.org/10.1136/bmjopen-2013-003091>
- White AT, Clark CM, Sellick JA, Mergenman KA. Antibiotic stewardship targets in the outpatient setting. *Am J Infect Control.* 2019;47(8):858–63. <https://doi.org/10.1016/j.ajic.2019.01.027>
- Probst Astrid, Günther B, Woodmansey E et al. Healthcare practitioners' perspectives on infection management, antimicrobial resistance and stewardship in wound care practice. *J Wound Care.* 2025;34(11):910–20. <https://doi.org/10.12968/jowc.2025.0518>
- Lipsky BA, Dryden M, Gottrup F et al. Antimicrobial stewardship in wound care: a Position Paper from the British Society for Antimicrobial Chemotherapy and European Wound Management Association. *J Antimicrob Chemother.* 2016;71(11):3026–35. <https://doi.org/10.1093/jac/dkw287>
- Edwards-Jones V. Antimicrobial stewardship in wound care. *Br J Nurs.* 2020;29(15):S10–6. <https://doi.org/10.12968/bjon.2020.29.15.S10>
- Blackburn J, Ousey K, Rippon M et al. Applying antimicrobial strategies in wound care practice: a review of the evidence. *Int Wound J.* 2025;22(6):e70684. <https://doi.org/10.1111/iwj.70684>
- Fletcher J, Edwards-Jones V, Fumarola S et al. Best practice statement: antimicrobial stewardship strategies for wound management – Wounds UK. 2020. <https://wounds-uk.com/best-practice-statements/antimicrobial-stewardship-strategies-for-wound-management-recommendations-for-the-uk/> (accessed 7 April 2026)
- Kourbeti I, Kamiliou A, Samarkos M. Antibiotic Stewardship in Surgical Departments. *Antibiotics.* 2024;13(4):329. <https://doi.org/10.3390/antibiotics13040329>
- World Health Organization. Global strategy on infection prevention and control. 2023. <https://www.who.int/publications/i/item/9789240080515> (accessed 24 February 2026)
- World Health Organization. Antimicrobial stewardship interventions: a practical guide. 2021. <https://www.who.int/europe/publications/i/item/9789289056267> (accessed 24 February 2026)
- National Institute for Health and Care Excellence. Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use. 2015. <https://www.nice.org.uk/guidance/ng15> (accessed 24 February 2026)
- Goncalves S, Mohammedi N, Antonini F et al. Compliance with antimicrobial stewardship guidelines in surgery: an observational, multidisciplinary, cohort study. *World J Emerg Surg.* 2025;20(1):63. <https://doi.org/10.1186/s13017-025-00636-0>
- Brouwers MC, Kerkvliet K, Spithoff K, AGREE Next Steps Consortium. The AGREE reporting checklist: a tool to improve reporting of clinical practice guidelines. *Br Med J.* March 8 2016;1152. <https://doi.org/10.1136/bmj.i1152>
- AGREE Next Steps Consortium. The AGREE II Instrument. 2017. <https://www.agreetrust.org/wp-content/uploads/2017/12/AGREE-II-Users-Manual-and-23-item-Instrument-2009-Update-2017.pdf> (accessed 7 April 2026)
- OCEBM Levels of Evidence Working Group. The Oxford Levels of Evidence 2. 2011. <https://www.cebm.ox.ac.uk/resources/levels-of-evidence/ocebml-levels-of-evidence> (accessed 7 April 2026)
- Prasad M. Introduction to the GRADE tool for rating certainty in evidence and recommendations. *Clinical Epidemiology and Global Health.* 2024;25:101484. <https://doi.org/10.1016/j.cegh.2023.101484>
- Kerlinger FN. Foundations of behavioral research. 2nd edn. New York: Holt, Rinehart, and Winston; 1973
- Likert R. A technique for the measurement of attitudes. In: *Archives of Psychology.* New York: The Science Press; 1932:55
- Magro M, Ashfield T. P15 Reducing surgical site infections and antibiotic prescribing after Caesarean section with the use of dialkylcarbomoyl chloride coated (DACC) dressings. *JAC Antimicrob Res.* 2025;7(S1):dlae217.019. <https://doi.org/10.1093/jacamr/dlae217.019>
- Rippon M, Rogers A, Ousey K, Stephenson J. Use of DACC-coated wound dressings in the reduction of surgical site infection: a systematic review and meta-analysis – Global Wound Care Journal. *Global Wound Care Journal.* 2025;1(1):24–30. <https://doi.org/10.63896/gwcj.1.1.24>
- Mulpur P, Jayakumar T, Sancheti PK et al. Dialkyl carbamoyl chloride (DACC)-impregnated dressings for the prevention of surgical site infections: experience from a multi-disciplinary study in india. *Cureus.* October 29 2024. <https://doi.org/10.7759/cureus.72654>
- Magro M. Reducing surgical site infections post-caesarean section. *IJWH.*

2023;15:1811–9. <https://doi.org/10.2147/IJWH.S431868>

48. Wijetunge S, Hill R, Katie Morris R, Hodgetts Morton V. Advanced dressings for the prevention of surgical site infection in women post-caesarean section: A systematic review and meta-analysis. *Eur J Obstet Gynecol Reprod Biol.* 2021;267:226–33. <https://doi.org/10.1016/j.ejogrb.2021.11.014>
49. Jiang N, Rao F, Xiao J et al. Evaluation of different surgical dressings in reducing postoperative surgical site infection of a closed wound: A network meta-analysis. *Int J Surg.* 2020;82:24–9. <https://doi.org/10.1016/j.ijssu.2020.07.066>
50. Taylor L, Mills E, George S, Seckam A. Reducing SSI rates for women birthing by caesarean section – Journal of Community Nursing. 2020. [https://www.researchgate.net/publication/354564176\\_Reducing\\_SSI\\_rates\\_for\\_women\\_birthing\\_by\\_caesarean\\_section](https://www.researchgate.net/publication/354564176_Reducing_SSI_rates_for_women_birthing_by_caesarean_section) (accessed 24 February 2026)
51. Totty JP, Hitchman LH, Cai PL et al. A pilot feasibility randomised clinical trial comparing dialkylcarbamoylchloride-coated dressings versus standard care for the primary prevention of surgical site infection. *Int Wound J.* 2019;16(4):883–90. <https://doi.org/10.1111/iwj.13113>
52. Bua N, Smith GE, Totty JP et al. Dialkylcarbamoyl chloride dressings in the prevention of surgical site infections after nonimplant vascular surgery. *Ann Vasc Surg.* 2017;44:387–92. <https://doi.org/10.1016/j.avsg.2017.03.198>
53. Stanirowski PJ, Davies H, McMaster J et al. Cost-effectiveness of a bacterial-binding dressing to prevent surgical site infection following caesarean section. *J Wound Care.* 2019;28(4):222–8. <https://doi.org/10.12968/jowc.2019.28.4.222>
54. Stanirowski Paweł J., Kociszewska A, Cendrowski K, Sawicki W. Dialkylcarbamoyl chloride-impregnated dressing for the prevention of surgical site infection in women undergoing cesarean section: a pilot study. *Arch Med Sci.* 2016;5:1036–42. <https://doi.org/10.5114/aoms.2015.47654>
55. Bullough L, Little G, Hodson J, Morris A. The use of DACC-coated dressings for the treatment of infected, complex abdominal wounds – Wounds UK. 2012. [https://wounds-uk.com/wp-content/uploads/2023/02/content\\_10626.pdf](https://wounds-uk.com/wp-content/uploads/2023/02/content_10626.pdf) (accessed 7 April 2026)
56. Nakamura H, Makiguchi T, Hino A et al. Effect on bacterial load of a DACC-coated dressing as a wound contact layer in negative pressure wound therapy. *J Wound Care.* 2025;34(11):952–6. <https://doi.org/10.12968/jowc.2023.0058>
57. Mañas CR, Rodríguez RA, Sánchez JP et al. Treating diabetic foot ulcers with antimicrobial wound dressing impregnated with dialkylcarbamoyl chloride. *J Wound Care.* 2025;34(4):278–84. <https://doi.org/10.12968/jowc.2024.0170>
58. Lev-Tov H, Hermak S, Yaghi M, Pastar I. Dialkylcarbamoyl chloride compared to silver dressing in treatment of venous leg ulcers. *European Wound Management Association. London; 2024. Conference abstract*
59. Mixrova Sebayang S, Burhan A. Comparison of effectiveness of hydrophobic cutimed sorbact versus cadexomer iodine 0.9% on healing of diabetic foot ulcer: a randomized control trial. *J Wound R-Tech.* 2024;1(1):28–37. <https://doi.org/10.70196/jwrt.v1i1.5>
60. Dissemmond J, Aare K, Ozer K et al. Aquacel Ag Advantage/Ag+ Extra and Cutimed Sorbact in the management of hard-to-heal wounds: a cohort study. *J Wound Care.* 2023;32(10):624–33. <https://doi.org/10.12968/jowc.2023.32.10.624>
61. Malone M, Radzieta M, Schwarzer S et al. In vivo observations of biofilm adhering to a dialkylcarbamoyl chloride-coated mesh dressing when applied to diabetes-related foot ulcers: A proof of concept study. *Int Wound J.* 2023;20(6):1943–53. <https://doi.org/10.1111/iwj.14054>
62. Williams K. The Leeds Wound Infection Framework: development and implementation of a new pathway to improve care – Wounds UK. 2022. <https://wounds-uk.com/journal-articles/leeds-wound-infection-framework-development-and-implementation-new-pathway-improve-care/> (accessed 24 February 2026)
63. Seckam AM, Twardowska-Sauchka K, Heggemann J et al. Clinical performance and quality of life impact of an absorbent bacteria-binding foam dressing. *Br J Nurs.* 2021;30(5):S21–30. <https://doi.org/10.12968/bjon.2021.30.5.S21>
64. Mosti G, Magliaro A, Mattaliano V et al. Comparative study of two antimicrobial dressings in infected leg ulcers: a pilot study. *J Wound Care.* 2015;24(3):121–7. <https://doi.org/10.12968/jowc.2015.24.3.121>
65. Gentili V, Giancesini S, Balboni PG et al. Panbacterial real-time PCR to evaluate bacterial burden in chronic wounds treated with Cutimed™ Sorbact™. *Eur J Clin Microbiol Infect Dis.* 2012;31(7):1523–9. <https://doi.org/10.1007/s10096-011-1473-x>
66. Bruce Z. Using Cutimed® Sorbact® Hydroactive on chronic infected wounds – Wounds UK. 2012. [https://wounds-uk.com/wp-content/uploads/2023/02/content\\_10334.pdf](https://wounds-uk.com/wp-content/uploads/2023/02/content_10334.pdf) (accessed 7 April 2026)
67. Skinner R, Hampton S. The diabetic foot: managing infection using Cutimed Sorbact dressings. *Br J Nurs.* 2010;19(11):S30, S32–36
68. Johansson A, Ljungh Å, Apelqvist J. Open study on the topical treatment of interdigital fungal infections in diabetic patients. *J Wound Care.* 2009;18(11):470–3. <https://doi.org/10.12968/jowc.2009.18.11.44988>
69. Kammerlander G, Locher E, Suess-Burghart A et al. An investigation of Cutimed Sorbact as an antimicrobial alternative in wound management – Wounds UK. 2008. <https://wounds-uk.com/journal-articles/an-investigation-of-cutimed-sorbact-as-an-antimicrobial-alternative-in-wound-management/> (accessed 7 April 2026)
70. Pirie G, Duguid K, Timmons J. Cutimed Sorbact Gel: a new infection management dressing – Wounds UK. 2009. [https://wounds-uk.com/wp-content/uploads/2023/02/content\\_9282.pdf](https://wounds-uk.com/wp-content/uploads/2023/02/content_9282.pdf) (accessed 7 April 2026)
71. Hampton S. An evaluation of the efficacy of Cutimed Sorbact in the

- different types of non-healing wounds – Wounds UK. 2007. <https://wounds-uk.com/journal-articles/an-evaluation-of-the-efficacy-of-cutimed-sorbact-in-the-different-types-of-non-healing-wounds/> (accessed 24 February 2026)
72. Mussi C, Salvioli G. Clinical evaluation of Sorbact (bacteria adsorbing dressing) in the treatment of infected pressure sores – *Acta Vulnol.* 2004. <https://www.minervamedica.it/en/journals/acta-vulnologica/article.php?cod=R45Y2004N01A0009> (accessed 24 February 2026)
73. Kim J, Stechmiller J, Weaver M et al. The Association of Systemic Inflammation, Wound Bioburden and Total Bacterial Counts With Healing Outcomes in Older Adults With Chronic Venous Leg Ulcers. *Int Wound J.* 2025;22(7):e70717. <https://doi.org/10.1111/iwj.70717>
74. Swanson T, Ousey K, Haesler E et al. Wound infection in clinical practice: principles of best practice – Wounds International. 2022. <https://woundsinternational.com/consensus-documents/wound-infection-in-clinical-practice-principles-of-best-practice/> (accessed 7 April 2026)
75. Ousey K, Rippon M, Rogers A, Stephenson J. Antimicrobial stewardship in wound care implementation and measuring outcomes: results of an e-survey. *J Wound Care.* 2022;31(1):32–9. <https://doi.org/10.12968/jowc.2022.31.1.32>
76. Armstrong DG, Swerdlow MA, Armstrong AA et al. Five year mortality and direct costs of care for people with diabetic foot complications are comparable to cancer. *J Foot Ankle Res.* 2020;13(1):16. <https://doi.org/10.1186/s13047-020-00383-2>
77. Serena TE, Gould L, Ousey K, Kirsner RS. Reliance on clinical signs and symptoms assessment leads to misuse of antimicrobials: post hoc analysis of 350 chronic wounds. *Adv Wound Care.* 2022;11(12):639–49. <https://doi.org/10.1089/wound.2021.0146>
78. Kainat S, Sohail M, Rafique S et al. Prevalence of multidrug-resistant biofilm-forming pathogens in diabetic foot ulcers and antimicrobial activity of nanoparticles. *J Infect Dev Ctries.* 2025;19(07):1055–65. <https://doi.org/10.3855/jidc.21000>
79. Sengeruan LP, Omar OS, Kanje LE et al. Distribution of carbenemase genes associated with global high-risk sequence types in *Pseudomonas aeruginosa* isolates from chronic leg ulcer patients in northern Tanzania. *Int Wound J.* 2025;22(8):e70735. <https://doi.org/10.1111/iwj.70735>
80. Taie A, Gheorghe M, Amos J et al. Antimicrobial resistance trends, predictors, and burden in England: a retrospective study using the Clinical Practice Research Datalink from 2015 to 2021. *Int J Antimicrob Agent.* 2025;66(3):107535. <https://doi.org/10.1016/j.ijantimicag.2025.107535>
81. Monk EJM, Jones TPW, Bongomin F et al. Antimicrobial resistance in bacterial wound, skin, soft tissue and surgical site infections in Central, Eastern, Southern and Western Africa: A systematic review and meta-analysis. *Musaya J, ed. PLOS Glob Public Health.* 2024;4(4). <https://doi.org/10.1371/journal.pgph.0003077>
82. Birgand G, Dhar P, Holmes A. The threat of antimicrobial resistance in surgical care: the surgeon's role and ownership of antimicrobial stewardship. *Br J Surg.* 2023;110(12):1567–9. <https://doi.org/10.1093/bjs/znad302>
83. Lekshmi R, Gandham NR, Vyawahare CR et al. Bacteriological profiles and antimicrobial resistance in chronic leg ulcers: a culture-based study. *J Merine Med Soc.* September 17 2025. [https://doi.org/10.4103/jmms.jmms\\_213\\_24](https://doi.org/10.4103/jmms.jmms_213_24)
84. Rodríguez-Villodres Á, Martín-Gandul C, Peñalva G et al. Prevalence and risk factors for multidrug-resistant organisms colonization in long-term care facilities around the world: a review. *Antibiotics.* 2021;10(6):680. <https://doi.org/10.3390/antibiotics10060680>
85. Bhanu A, Ademuyiwa AO, Aguilera ML et al. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. *Lancet Infect Dis.* 2018;18(5):516–25. [https://doi.org/10.1016/S1473-3099\(18\)30101-4](https://doi.org/10.1016/S1473-3099(18)30101-4)
86. Anderson DJ, Kaye KS, Chen LF et al. Clinical and financial outcomes due to methicillin resistant *Staphylococcus aureus* surgical site infection: a multi-center matched outcomes study. *Otto M, ed. PLoS ONE.* 2009;4(12):e8305. <https://doi.org/10.1371/journal.pone.0008305>
87. Binsuaidan R, Khan MA, Alzahrani RH et al. Prevalence of multidrug-resistant and ESBL-producing bacterial pathogens in patients with chronic wound infections and spinal cord injury admitted to a tertiary care rehabilitation hospital. *Antibiotics.* 2023;12(11):1587. <https://doi.org/10.3390/antibiotics12111587>
88. Caruso P, Maiorino MI, Macera M et al. Antibiotic resistance in diabetic foot infection: how it changed with COVID-19 pandemic in a tertiary care center. *Diabetes Research and Clinical Practice.* 2021;175:108797. <https://doi.org/10.1016/j.diabres.2021.108797>
89. Li W, Sadeh O, Chakraborty J et al. Multifaceted antibiotic resistance in diabetic foot infections: a systematic review. *Microorganisms.* 2025;13(10):2311. <https://doi.org/10.3390/microorganisms13102311>
90. Meštrović T, Haller S, Robles Aguilar G et al. Antimicrobial resistance burden landscape in Germany in 2019: a comparative country-level estimation. *JAC Antimicrobi Resist.* 2025;7(4). <https://doi.org/10.1093/jacmr/dlaf142>
91. Ho CS, Wong CTH, Aung TT et al. Antimicrobial resistance: a concise update. *Lancet Microb.* 2025;6(1):100947. <https://doi.org/10.1016/j.lanmic.2024.07.010>
92. UK Government. Confronting antimicrobial resistance 2024 to 2029. UKHSA; 2024. <https://www.gov.uk/government/publications/confronting-antimicrobial-resistance-2024-to-2029> (accessed 7 April 2026)
93. Swedish Ministry of Health and Social Affairs. Swedish strategy to combat antibiotic resistance 2024–2025. 2023. [https://www.government.se/content/assets/1fedc516373d421f919814f1963e2fe1/amr\\_strategi\\_eng\\_web\\_ny2.pdf](https://www.government.se/content/assets/1fedc516373d421f919814f1963e2fe1/amr_strategi_eng_web_ny2.pdf)

(accessed 7 April 2026)

94. O'Neill J. Tackling drug-resistant infections globally: final report and recommendations. Review on Antimicrobial Resistance. London; 2016. [https://amr-review.org/sites/default/files/160525\\_Final%20paper\\_with%20cover.pdf](https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf) (accessed 7 April 2026)
95. World Health Organization. Global action plan on antimicrobial resistance. 2015. <https://www.who.int/publications/i/item/9789241509763> (accessed 24 February 2026)
96. Centers for Disease Control and Prevention. Antibiotic resistance in the United States 2019. CDC; 2019. <https://www.cdc.gov/antimicrobial-resistance/media/pdfs/2019-ar-threats-report-508.pdf> (accessed 7 April 2026)
97. Dolk FCK, Pouwels KB, Smith DRM et al. Antibiotics in primary care in England: which antibiotics are prescribed and for which conditions? *J Antimicrob Chemother.* 2018;73(S2):ii2–10. <https://doi.org/10.1093/jac/dkx504>
98. McDonnell G, Russell AD. Antiseptics and disinfectants: activity, action, and resistance. *Clin Microbiol Rev.* 1999;12(1):147–79. <https://doi.org/10.1128/CMR.12.1.147>
99. Sultan AM, Ahmed MA. Distribution of chlorhexidine resistance genes among *Staphylococcus aureus* clinical isolates: the challenge of antiseptic resistance. *Germes.* 2022;12(4):461–71. <https://doi.org/10.18683/germes.2022.1352>
100. Kampf G. Acquired resistance to chlorhexidine – is it time to establish an 'antiseptic stewardship' initiative? *J Hosp Infect.* 2016;94(3):213–27. <https://doi.org/10.1016/j.jhin.2016.08.018>
101. Kõljalg S, Naaber P, Mikelsaar M. Antibiotic resistance as an indicator of bacterial chlorhexidine susceptibility. *J Hosp Infect.* 2002;51(2):106–13. <https://doi.org/10.1053/jhin.2002.1204>
102. Yang QE, Ma X, Li M et al. Evolution of triclosan resistance modulates bacterial permissiveness to multidrug resistance plasmids and phages. *Nat Commun.* 2024;15(1):3654. <https://doi.org/10.1038/s41467-024-48006-9>
103. Chuanchuen R, Beinlich K, Hoang TT et al. Cross-resistance between triclosan and antibiotics in *Pseudomonas aeruginosa* is mediated by multidrug efflux pumps: exposure of a susceptible mutant strain to triclosan selects NFXB mutants overexpressing MexCD-OprJ. *Antimicrob Agents Chemother.* 2001;45(2):428–32. <https://doi.org/10.1128/AAC.45.2.428-432.2001>
104. Rippon M, Rogers A. Development of silver resistance: a focus on wound care – Wounds International. 2025. <https://woundsinternational.com/journal-articles/development-of-silver-resistance-a-focus-on-wound-care/> (accessed 7 April 2026)
105. Lev-Tov H, Head CR, Pastar I. Protocol for a longitudinal cohort study: identification and characterisation of silver tolerant bacteria in venous leg ulcers. Symposium for Advanced Wound Care. Virtual; 2020. Conference abstract
106. Randall CP, Gupta A, Jackson N et al. Silver resistance in Gram-negative bacteria: a dissection of endogenous and exogenous mechanisms. *J Antimicrob Chemother.* 2015;70(4):1037–46. <https://doi.org/10.1093/jac/dku523>
107. Randall CP, Oyama LB, Bostock JM et al. The silver cation (Ag<sup>+</sup>): antistaphylococcal activity, mode of action and resistance studies. *J Antimicrob Chemother.* 2013;68(1):131–8. <https://doi.org/10.1093/jac/dks372>
108. Elkrewi E, Randall CP, Ooi N et al. Cryptic silver resistance is prevalent and readily activated in certain Gram-negative pathogens. *J Antimicrob Chemother.* 2017;72(11):3043–6. <https://doi.org/10.1093/jac/dkx258>
109. Chopra I. The increasing use of silver-based products as antimicrobial agents: a useful development or a cause for concern? *J Antimicrob Chemother.* 2007;59(4):587–90. <https://doi.org/10.1093/jac/dkm006>
110. White R, Witts S. Sepsis and chronic wounds: what do you need to know? What should you know? – Wounds UK. 2016. [https://wounds-uk.com/wp-content/uploads/2023/02/content\\_11868.pdf](https://wounds-uk.com/wp-content/uploads/2023/02/content_11868.pdf) (accessed 7 April 2026)
111. Malone M, Schultz G. Challenges in the diagnosis and management of wound infection. *Br J Dermatol.* 2022;187(2):159–66. <https://doi.org/10.1111/bjd.21612>
112. Mengistu DA, Alemu A, Abdulkadir AA et al. Global Incidence of Surgical Site Infection Among Patients: Systematic Review and Meta-Analysis. *Inquiry.* 2023;60:00469580231162549. <https://doi.org/10.1177/00469580231162549>
113. Irek EO, Amupitan AA, Obadare TO, Aboderin AO. A systematic review of healthcare-associated infections in Africa: An antimicrobial resistance perspective. *African Journal of Laboratory Medicine.* 2018;7(2). <https://doi.org/10.4102/ajlm.v7i2.796>
114. Ogunsofa FT, Mehtar S. Challenges regarding the control of environmental sources of contamination in healthcare settings in low and middle-income countries - a narrative review. *Antimicrob Resist Infect Control.* 2020;9(1):81. <https://doi.org/10.1186/s13756-020-00747-0>
115. American Society of Anesthesiologists. Statement on ASA Physical Status Classification System. *Anesthesiology Open.* 2025;1(1):e0002. <https://doi.org/10.1097/ao9.000000000000002>
116. Bucataru A, Balasoiu M, Ghenea AE et al. Factors contributing to surgical site infections: a comprehensive systematic review of etiology and risk factors. *Clin Pract.* 2023;14(1):52–68. <https://doi.org/10.3390/clinpract14010006>
117. Florschütz AV, Fagan RP, Matar WY et al. Surgical Site Infection Risk Factors and Risk Stratification: *J Am Acad Orthopaed Surg.* 2015;23:S8–11. <https://doi.org/10.5435/JAAOS-D-14-00447>
118. Korol E, Johnston K, Waser N et al. A systematic review of risk factors associated with surgical site infections among surgical patients. *Khan AU, ed. PLoS ONE.* 2013;8(12):e83743. <https://doi.org/10.1371/journal.pone.0083743>
119. Mangram AJ, Horan TC, Pearson ML et al. Guideline for prevention of surgical site infection, 1999. *Am J Infect Control.* 1999;27(2):97–134. [https://doi.org/10.1016/S0196-6553\(99\)70088-X](https://doi.org/10.1016/S0196-6553(99)70088-X)
120. Nepogodiev D, Adisa A, Abantanga FA, Ademuyiwa A, Chakrabortee S, Ghosh D, et al. Delphi prioritization and development of global surgery guidelines for the prevention of surgical-site infection. *British Journal of Surgery.* 2020 Jun 15;107(8):970–7. [doi:10.1002/bjs.11530](https://doi.org/10.1002/bjs.11530)
121. Berríos-Torres SI, Umscheid CA, Bratzler DW et al. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection. *JAMA Surg.* 2017;152(8):784. <https://doi.org/10.1001/jamasurg.2017.0904>
122. World Health Organization. Global guidelines for the prevention of surgical site infection. 2018. <https://www.who.int/publications/i/item/9789241550475> (accessed 23 March 2026)
123. Amri R, Dinaux AM, Kunitake H et al. Risk stratification for surgical site infections in colon cancer. *JAMA Surg.* 2017;152(7):686. <https://doi.org/10.1001/jamasurg.2017.0505>
124. Erritty M, Hale J, Thomas J et al. Evaluation of independent risk factors associated with surgical site infections from caesarean section. *Arch Gynecol Obstet.* 2022;308(6):1775–83. <https://doi.org/10.1007/s00404-022-06885-7>
125. Stryja J. Surgical site infection and local management of the wound meta-analysis. *Rozhl Chir.* 2021;100(7):313–24. <https://doi.org/10.33699/PIS.2021.100.7.313-324>
126. Schlager JG, Ruiz San Jose V, Patzer K et al. Are specific body sites prone for wound infection after skin surgery? A systematic review and meta-analysis. *Dermatol Surg.* 2022;48(4):406–10. <https://doi.org/10.1097/DSS.0000000000003387>
127. Tanner J, Padley W, Kiernan M et al. A benchmark too far: findings from a national survey of surgical site infection surveillance. *J Hosp Infect.* 2013;83(2):87–91. <https://doi.org/10.1016/j.jhin.2012.11.010>
128. Magill SS, O'Leary E, Janelle SJ et al. Changes in prevalence of health care-associated infections in U.S. hospitals. *N Engl J Med.* 2018;379(18):1732–44. <https://doi.org/10.1056/NEJMoa1801550>
129. Shambhu S, Gordon AS, Liu Y et al. The burden of health care utilization, cost, and mortality associated with select surgical site infections. *Joint Commission Journal on Quality and Patient Safety.* 2024;50(12):857–66. <https://doi.org/10.1016/j.jcjq.2024.08.005>
130. Badia JM, Casey AL, Petrosillo N et al. Impact of surgical site infection on healthcare costs and patient outcomes: a systematic review in six European countries. *J Hosp Infect.* 2017;96(1):1–15. <https://doi.org/10.1016/j.jhin.2017.03.004>
131. Zimlichman E, Henderson D, Tamir O et al. Health care-associated infections: a meta-analysis of costs and financial impact on the US health care system. *JAMA Intern Med.* 2013;173(22):2039. <https://doi.org/10.1001/jamainternmed.2013.9763>
132. Guest JF, Fuller GW, Griffiths B. Cohort study to characterise surgical site infections after open surgery in the UK's National Health Service. *BMJ Open.* 2023;13(12):e076735. <https://doi.org/10.1136/bmjopen-2023-076735>
133. Shanmugam VK, Fernandez SJ, Evans KK et al. Postoperative wound dehiscence: Predictors and associations. *Wound Rep Regen.* 2015;23(2):184–90. <https://doi.org/10.1111/wrr.12268>
134. Gaultz GG, Korting HC, Pavicic T et al. Hypertrophic Scarring and Keloids: Pathomechanisms and Current and Emerging Treatment Strategies. *Mol Med.* 2011;17(1):113–25. <https://doi.org/10.2119/molmed.2009.00153>
135. Byshe T, Gao Y, Heaney-Huls K et al. Estimating the additional hospital inpatient cost and mortality associated with selected hospital-acquired conditions. 2017. <https://www.ahrq.gov/hai/pfp/haccost2017.html> (accessed 7 April 2026)
136. UK Health Security Agency. Surveillance of surgical site infections in NHS hospitals in England, April 2023 to March 2024. 2024. <https://assets.publishing.service.gov.uk/media/67879dc22cca34bdf58a23e/SSISS-annual-report-2023-to-2024.pdf> (accessed 24 February 2026)
137. European Centre for Disease Prevention and Control. Healthcare-associated infections: surgical site infections. Annual epidemiological report 2021–2022. ECDC; 2025. <https://www.ecdc.europa.eu/en/publications-data/healthcare-associated-infections-surgical-site-infections-annual-1> (accessed 7 April 2026)
138. National Institute for Health and Care Excellence. Surgical site infections: prevention and treatment. 2019. <https://www.nice.org.uk/guidance/ng125> (accessed 24 February 2026)
139. European Wound Management Association. Antimicrobial stewardship in wound care. 2024a. <https://ewma.org/wp-content/uploads/2024/02/Antimicrobial-Stewardship-in-Wound-Care-UK.pdf> (accessed 24 February 2026)
140. American College of Surgeons. National Surgical Quality Improvement Program: Surgical Risk Calculator. 2025. <https://riskcalculator.facs.org/RiskCalculator/> (accessed 24 February 2026)
141. Sandy-Hodgetts K, Assadian O, Wainwright TW et al. Clinical prediction models and risk tools for early detection of patients at risk of surgical site infection and surgical wound dehiscence: a scoping review. *J Wound Care.* 2023;32(Sup8a):S4–12. <https://doi.org/10.12968/jowc.2023.32.Sup8a.S4>
142. Mioton LM, Jordan SW, Hanwright PJ et al. The relationship between preoperative wound classification and postoperative infection: a multi-institutional analysis of 15,289 patients. *Arch Plast Surg.* 2013;40(5):522–9. <https://doi.org/10.5999/aps.2013.40.5.522>
143. Souroulas P, Barnes R, Carradice D et al. Extended-course antibiotic prophylaxis in lower limb amputation: randomized clinical trial. *Br J Surg.* 2022;109(5):426–32. <https://doi.org/10.1093/bjs/znac053>

144. Rippon MG, Rogers AA, Ousey K. Antimicrobial stewardship strategies in wound care: evidence to support the use of dialkylcarbamoyl chloride (DACC)-coated wound dressings. *J Wound Care*. 2021;30(4):284–96. <https://doi.org/10.12968/jowc.2021.30.4.284>
145. Dumville JC, Gray TA, Walter CJ et al. Dressings for the prevention of surgical site infection. Cochrane Wounds Group, ed. *Cochrane Database Syst Rev*. 2016;2016(12). <https://doi.org/10.1002/14651858.CD003091.pub4>
146. Morgan-Jones R, Bishay M, Hernandez-Hermoso J et al. Incision care and dressing selection in surgical wounds: findings from an international meeting of surgeons – Wounds International. 2019. <https://woundsinternational.com/consensus-documents/incision-care-and-dressing-selection-surgical-wounds-findings-international-meeting-surgeons/> (accessed 7 April 2026)
147. Sandy-Hodgetts K, Carvalho S, Rochon M et al. International Surgical Wound Complications Advisory Panel: guideline for post-operative incision care. *J Wound Care*. 2025;34(S1a):S1–19. <https://doi.org/10.12968/jowc.2025.34.Sup1a.S1>
148. National Healthcare Safety Network. Surgical site infection. 2025. <https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscscsscurrent.pdf> (accessed 24 February 2026)
149. UK Sepsis Trust. Spotting the signs of sepsis. The UK Sepsis Trust. 2025. <https://sepsistrust.org/about-sepsis/spotting-the-signs-of-sepsis/> (accessed 24 February 2026)
150. National Institute for Health and Care Excellence. Suspected sepsis in people aged 16 or over: recognition, assessment and early management. 2025. <https://www.nice.org.uk/guidance/ng253> (accessed 24 February 2026)
151. Eze AN, Yu J, Cui CL, Kim Y. When infections hurt more: black patients experience more severe surgical site infections following lower extremity bypass. *Ann Vasc Surg*. 2026;125:259–64. <https://doi.org/10.1016/j.avsg.2025.12.042>
152. Ousey K, Djohan R, Dowsett C et al. Surgical wound dehiscence: improving prevention and outcomes – Wounds International. 2018. <https://woundsinternational.com/wp-content/uploads/2023/02/b059a6fa619551481b42c9f2f8c8bd28.pdf> (accessed 7 April 2026)
153. Sandy-Hodgetts K, Alves P, Conway B et al. Optimising prevention of surgical wound complications: detection, diagnosis and prediction – Wounds International. 2022. <https://woundsinternational.com/wp-content/uploads/2023/02/933dfca2e2e9ea57418b7fe1e165d9e0.pdf> (accessed 7 April 2026)
154. Ward D, Holloway S. Validity and reliability of semi-quantitative wound swabs. *Br J Community Nurs*. 2019;24(S12):S6–11. <https://doi.org/10.12968/bjcn.2019.24.Sup12.S6>
155. Patten H. Identifying wound infection: taking a swab – Wounds UK. 2010. <https://wounds-uk.com/wound-essentials/wound-essentials-5-identifying-wound-infection-taking-a-swab/> (accessed 24 February 2026)
156. World Health Organization. Improving the prevention, diagnosis and clinical management of sepsis: report by the Secretariat. 2017. <https://www.who.int/publications/i/item/A70-13> (accessed 24 February 2026)
157. Sinha S. Management of post-surgical wounds in general practice. *Aust J Gen Pract*. 2019;48(9):596–9. <https://doi.org/10.31128/AJGP-04-19-4921>
158. Schultz GS, Sibbald RG, Falanga V et al. Wound bed preparation: a systematic approach to wound management. *Wound Rep Regen*. 2003;11(s1). <https://doi.org/10.1046/j.1524-475X.11.s2.1.x>
159. Schultz GS, Barillo DJ, Mazingo DW, Chin GA. Wound bed preparation and a brief history of TIME. *International Wound Journal*. 2004;1(1):19–32. <https://doi.org/10.1111/j.1742-481x.2004.00008.x>
160. Harries RL, Bosanquet DC, Harding KG. Wound bed preparation: TIME for an update. *Int Wound J*. 2016;13(S3):8–14. <https://doi.org/10.1111/iwj.12662>
161. Snyder RJ, Cardinal M, Dauphinée DM, Stavosky J. A post-hoc analysis of reduction in diabetic foot ulcer size at 4 weeks as a predictor of healing by 12 weeks. *Ostomy Wound Manage*. 2010;56(3):44–50
162. Sen CK. Human wound and its burden: updated 2025 compendium of estimates. *Adv Wound Care*. 2025;14(9):429–38. <https://doi.org/10.1177/21621918251359554>
163. Lammert A, Kiehlmeier S, Dissemmond J et al. Percentage area reduction as surrogate for complete healing of hard-to-heal wounds: a review of clinical trials. *J Wound Care*. 2024;33(10):737–55. <https://doi.org/10.12968/jowc.2023.0117>
164. Martinengo L, Olsson M, Bajpai R et al. Prevalence of chronic wounds in the general population: systematic review and meta-analysis of observational studies. *Ann Epidemiol*. 2019;29:8–15. <https://doi.org/10.1016/j.annepidem.2018.10.005>
165. Zhu X, Olsson MM, Bajpai R et al. Health-related quality of life and chronic wound characteristics among patients with chronic wounds treated in primary care: A cross-sectional study in Singapore. *Int Wound J*. 2022;19(5):1121–32. <https://doi.org/10.1111/iwj.13708>
166. Vogt TN, Koller FJ, Dias Santos PN et al. Quality of life assessment in chronic wound patients using the Wound-QoL and FLQA-Wk instruments. *Invest Educ Enferm*. 2020;38(3). <https://doi.org/10.17533/udea.iee.v38n3e11>
167. Soares Dantas J, Silva CCM, Nogueira WP et al. Health-related quality of life predictors in people with chronic wounds. *J Tissue Viability*. 2022;31(4):741–5. <https://doi.org/10.1016/j.jtv.2022.07.017>
168. Simonsen NV, Möller S, Rae C et al. Patient and wound factors associated with WOUND-Q scales measuring health-related quality of life: An international cross-sectional study. *Wound Rep Regen*. 2025;33(1):e13245. <https://doi.org/10.1111/wrr.13245>
169. Melikian R, O'Donnell TF, Iafrafi M. The economic impact of infection requiring hospitalization on venous leg ulcers. *J Vasc Surg Venous Lymphatic Disord*. 2022;10(1):96–101. <https://doi.org/10.1016/j.jvsv.2021.06.012>
170. Guest JF, Fuller GW, Vowden P. Cohort study evaluating the burden of wounds to the UK's National Health Service in 2017/2018: update from 2012/2013. *BMJ Open*. 2020;10(12):e045253. <https://doi.org/10.1136/bmjopen-2020-045253>
171. Guest Julian F, Fuller GW, Vowden P. Diabetic foot ulcer management in clinical practice in the UK: costs and outcomes. *Int Wound J*. 2018;15(1):43–52. <https://doi.org/10.1111/iwj.12816>
172. Yao Z, Niu J, Cheng B. Prevalence of chronic skin wounds and their risk factors in an inpatient hospital setting in northern China. *Adv Skin Wound Care*. 2020;33(9):1–10. <https://doi.org/10.1097/01.ASW.0000694164.34068.82>
173. Guest Julian F, Fuller GW, Vowden P. Venous leg ulcer management in clinical practice in the UK: costs and outcomes. *Int Wound J*. 2018;15(1):29–37. <https://doi.org/10.1111/iwj.12814>
174. Cacia Sanchez MT, Buenahora G. Socio-demographic characteristics and associated factors of morbidity in patients with venous ulcers treated in two institutions of contributive and subsidized regime in Colombia: retrospective, multicenter, observational study. *Vasc Health Risk Manage*. 2022;18:89–104. <https://doi.org/10.2147/VHRM.S345542>
175. Fletcher J, Fumarola S, Haycocks S et al. Best practice statement: improving holistic assessment of chronic wounds – Wounds UK. 2018. <https://wounds-uk.com/wp-content/uploads/2023/02/e7e7d76d9ef876a3ab2c5044b36e6da5.pdf> (accessed 7 April 2026)
176. Conte MS, Bradbury AW, Kolh P et al. Global vascular guidelines on the management of chronic limb-threatening ischemia. *Eur J Vasc Endovasc Surg*. 2019;58(S1):S1-S109.e33. <https://doi.org/10.1016/j.ejvs.2019.05.006>
177. Isoherranen K, Conde E, Atkin L et al. Lower leg ulcer diagnosis and principles of treatment. *Journal of Wound Management*. 2023;24(2). <https://doi.org/10.35279/jowm2023.24.02.sup01>
178. Berenguer-Pérez M, Manzanaro-García N, González-de La Torre H et al. Systematic review and meta-analysis of diagnostic test accuracy in chronic wound's microbiology. *Int Wound J*. 2024;21(9):e70063. <https://doi.org/10.1111/iwj.70063>
179. Lima DCJ, Paes GO. Infection assessment tools for acute and chronic wounds: a scoping review. *Rev Esc Enferm USP*. 2025;59:e20240392. <https://doi.org/10.1590/1980-220x-reeusp-2024-0392en>
180. Woo KY, Sibbald RG. A cross-sectional validation study of using NERDS and STONEES to assess bacterial burden. *Ostomy Wound Manage*. 2009;55(8):40–8; no DOI available]
181. Probst S. What are venous leg ulcers? 2025. [https://ewma.org/wp-content/uploads/2025/11/Wound\\_Infection\\_FactSheet4\\_VLU.pdf](https://ewma.org/wp-content/uploads/2025/11/Wound_Infection_FactSheet4_VLU.pdf) (accessed 24 February 2026)
182. National Pressure Injury Advisory Panel, European Pressure Ulcer Advisory Panel, Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers/injuries: clinical practice guideline. 2025. <https://internationalguideline.com> (accessed 23 July 2025)
183. Falcone M, De Angelis B, Pea F et al. Challenges in the management of chronic wound infections. *J Glob Antimicrob Resist*. 2021;26:140–7. <https://doi.org/10.1016/j.jgar.2021.05.010>
184. Senneville E, Albalawi Z, van Asten SA et al. IWGDF/IDSA guidelines on the diagnosis and treatment of diabetes-related foot infections (IWGDF/IDSA 2023). *Diabetes Metab Res Rev*. 2024;40(3):e3687. <https://doi.org/10.1002/dmrr.3687>
185. Mills JL. Update and validation of the Society for Vascular Surgery wound, ischemia, and foot infection threatened limb classification system. *Sem Vasc Surg*. 2014;27(1):16–22. <https://doi.org/10.1053/j.semvascsurg.2014.12.002>
186. Brocklehurst JD. The validity and reliability of the SINBAD classification system for diabetic foot ulcers. *Adv Skin Wound Care*. 2023;36(11):1–5. <https://doi.org/10.1097/ASW.0000000000000050>
187. Treece KA, Macfarlane RM, Pound N et al. Validation of a system of foot ulcer classification in diabetes mellitus. *Diabet Med*. 2004;21(9):987–91. <https://doi.org/10.1111/j.1464-5491.2004.01275.x>
188. Pugliese DJ. Infection in venous leg ulcers: considerations for optimal management in the elderly. *Drugs Aging*. 2016;33(2):87–96. <https://doi.org/10.1007/s40266-016-0343-8>
189. Gotttrup F, Apelqvist J, Bjarnsholt T et al. EWMA document: antimicrobials and non-healing wounds: evidence, controversies and suggestions. *J Wound Care*. 2013;22(S5):S1–89. <https://doi.org/10.12968/jowc.2013.22.Sup5.S1>
190. Schultz G, Bjarnsholt T, James GA et al. Consensus guidelines for the identification and treatment of biofilms in chronic nonhealing wounds. *Wound Repair Regeneration*. 2017;25(5):744–57. <https://doi.org/10.1111/wrr.12590>
191. Haessler E, Swanson T, Ousey K, Larsen D. Therapeutic wound and skin cleansing: clinical evidence and recommendations – Wounds International. 2025. <https://woundsinternational.com/consensus-documents/therapeutic-wound-and-skin-cleansing-clinical-evidence-and-recommendations/> (accessed 18 February 2026)
192. Atkin L, Bučko Z, Montero EC et al. Implementing TIMERS: the race against hard-to-heal wounds. *J Wound Care*. 2019;28(S3a):S1–50. <https://doi.org/10.12968/jowc.2019.28.Sup3a.S1>
193. Mayer DO, Tettelbach WH, Ciprandi G et al. Best practice for wound debridement. *J Wound Care*. 2024;33(S6b):S1–32. <https://doi.org/10.12968/jowc.2024.33.Sup6b.S1>
194. Assadian O, Ousey K, Fleming L et al. When is antibiotic therapy necessary for patients with infections in hard-to-heal wounds? *J Wound Care*.

2023;32(1):3–4. <https://doi.org/10.12968/jowc.2023.32.1.3>

195. Gariani K, Pham T-T, Kressmann B et al. Three weeks versus six weeks of antibiotic therapy for diabetic foot osteomyelitis: a prospective, randomized, noninferiority pilot trial. *Clin Infect Dis*. 2021;73(7):e1539–45. <https://doi.org/10.1093/cid/ciaa1758>

196. Eriksson E, Liu PY, Schultz GS et al. Chronic wounds: Treatment consensus. *Wound Rep Regen*. 2022;30(2):156–71. <https://doi.org/10.1111/wrr.12994>

197. Roberts CD, Leaper DJ, Assadian O. The role of topical antiseptic agents within antimicrobial stewardship strategies for prevention and treatment of surgical site and chronic open wound infection. *Adv Wound Care*. 2017;6(2):63–71. <https://doi.org/10.1089/wound.2016.0701>

198. Dadgostar P. Antimicrobial resistance: implications and costs. *Infect Drug Res*. 2019;12:3903–10. <https://doi.org/10.2147/IDR.S234610>

199. Nelson RE, Hatfield KM, Wolford H et al. National estimates of healthcare costs associated with multidrug-resistant bacterial infections among hospitalized patients in the United States. *Clin Infect Dis*. 2021;72(S1):S17–26. <https://doi.org/10.1093/cid/ciaa1581>

200. Charani E, De Barra E, Rawson TM et al. Antibiotic prescribing in general medical and surgical specialties: a prospective cohort study. *Antimicrob Resist Infect Control*. 2019;8(1):151. <https://doi.org/10.1186/s13756-019-0603-6>

201. Aiken AM, Wanyoro AK, Mwangi J et al. Changing use of surgical antibiotic prophylaxis in thika hospital, Kenya: a quality improvement intervention with an interrupted time series design. *Schiltdgen O, ed. PLoS ONE*. 2013;8(11):e78942. <https://doi.org/10.1371/journal.pone.0078942>

202. Teng J, Imani S, Zhou A et al. Combatting resistance: understanding multi-drug resistant pathogens in intensive care units. *Biomed Pharmacother*. 2023;167:115564. <https://doi.org/10.1016/j.biopha.2023.115564>

203. Obenhuber T, Scheier TC, Stutz T et al. An outbreak of multi-drug-resistant *Acinetobacter baumannii* on a burns ICU and its control with multifaceted containment measures. *J Hosp Infect*. 2024;146:102–8. <https://doi.org/10.1016/j.jhin.2024.01.002>

204. Stewart PS, Rayner J, Roe F, Rees WM. Biofilm penetration and disinfection efficacy of alkaline hypochlorite and chlorosulfamates. *J Appl Microbiol*. 2001;91(3):525–32. <https://doi.org/10.1046/j.1365-2672.2001.01413.x>

205. Stewart PS, William Costerton J. Antibiotic resistance of bacteria in biofilms. *Lancet*. 2001;358(9276):135–8. [https://doi.org/10.1016/S0140-6736\(01\)05321-1](https://doi.org/10.1016/S0140-6736(01)05321-1)

206. Costerton JW, Stewart PS, Greenberg EP. Bacterial biofilms: a common cause of persistent infections. *Science*. 1999;284(5418):1318–22. <https://doi.org/10.1126/science.284.5418.1318>

207. Salisbury A-M, Woo K, Sarkar S et al. Tolerance of biofilms to antimicrobials and significance to antibiotic resistance in wounds. *Surg Technol Int*. 2018;33:59–66

208. Malone M, Bjarnsholt T, McBain AJ et al. The prevalence of biofilms in chronic wounds: a systematic review and meta-analysis of published data. *J Wound Care*. 2017;26(1):20–5. <https://doi.org/10.12968/jowc.2017.26.1.20>

209. Levison ME, Levison JH. Dis. Pharmacokinetics and pharmacodynamics of antibacterial agents. *Infect Dis Clin N Am*. 2009;23(4):791–815. <https://doi.org/10.1016/j.idc.2009.06.008>

210. Whelan L, Leal J, Barkema HW et al. Baseline prevalence of antimicrobial resistance in patients who develop a surgical site infection in hip and knee replacements: A brief report. *Am J Infect Control*. 2023;51(12):1449–51. <https://doi.org/10.1016/j.ajic.2023.06.012>

211. Stanrowski Pawel Jan, Bizoń M, Cendrowski K, Sawicki W. Randomized controlled trial evaluating dialkylcarbamoyl chloride impregnated dressings for the prevention of surgical site infections in adult women undergoing cesarean section. *Surg Infect*. 2016;17(4):427–35. <https://doi.org/10.1089/sur.2015.223>

212. Clarke L, Livesey A. Dressing evaluation and audit for women with raised BMI undergoing caesarean section. *J Clin Nurs*. 2021;35(2):49–53

213. Ljungh Å, Yanagisawa N, Wadström T. Using the principle of hydrophobic interaction to bind and remove wound bacteria. *J Wound Care*. 2006;15(4):175–80. <https://doi.org/10.12968/jowc.2006.15.4.26901>

214. Husmark J, Morgner B, Susilo YB, Wiegand C. Antimicrobial effects of bacterial binding to a dialkylcarbamoyl chloride-coated wound dressing: an in vitro study. *J Wound Care*. 2022;31(7):560–70. <https://doi.org/10.12968/jowc.2022.31.7.560>

215. Lee JW, Park SH, Suh IS, Jeong HS. A comparison between DACC with chlorhexidine acetate-soaked paraffin gauze and foam dressing for skin graft donor sites. *J Wound Care*. 2018;27(1):28–35. <https://doi.org/10.12968/jowc.2018.27.1.28>

216. Sibbald G, Woo K. The effectiveness of a new antimicrobial dressing with microbinding action for the management of chronic wounds – Wounds Canada. 2012. <https://www.woundscanada.ca/docman/public/wound-care-canada-magazine/2012-vol-10-no-3/471-wcc-summer-2012-v10n3-antimicrobial-dressing/file> (accessed 24 February 2026)

217. Roberts C. Antimicrobial agents used in wound care. In: Edwards-Jones V, ed. *Essential Microbiology for Wound Care*. Oxford: Oxford University Press; 2016:103–21

218. Bjarnsholt T, Edwards-Jones V, Malone M et al. The role of non-medical dressings for the management of wound infection. 2020. <https://tinyurl.com/43v8vuyv> (accessed 24 February 2026)

com/43v8vuyv (accessed 24 February 2026)

219. Haycocks S, Chadwick P, Guttormsen K. Use of a DACC-coated antimicrobial dressing in people with diabetes and a history of foot ulceration – Wounds UK. 2011. <https://wounds-uk.com/journal-articles/use-of-a-dacc-coated-antimicrobial-dressing-in-people-with-diabetes-and-a-history-of-foot-ulceration/> (accessed 7 April 2026)

220. Haesler E, Swanson T, Ousey K, Carville K. Clinical indicators of wound infection and biofilm: reaching international consensus. *J Wound Care*. 2019;28(S3b):s4–12. <https://doi.org/10.12968/jowc.2019.28.Sup3b.S4>

221. Bowler PG, Duerden BI, Armstrong DG. Wound microbiology and associated approaches to wound management. *Clin Microbiol Rev*. 2001;14(2):244–69. <https://doi.org/10.1128/CMR.14.2.244-269.2001>

222. Edwards R, Harding KG. Bacteria and wound healing. *Cur Opin Infect Dis*. 2004;17(2):91–6. <https://doi.org/10.1097/00001432-200404000-00004>

223. National Institute for Health and Care Excellence. Leukomed Sorbact for preventing surgical site infection. 2021. <https://www.nice.org.uk/guidance/mtg55> (accessed 24 February 2026)

224. Cole W, Greenstein E, Herman IM et al. Antimicrobial resistance in wound care: expert panel consensus statements. *Wounds*. 2025;37(S5):S1–24

225. Woodmansey EJ, Roberts CD. Appropriate use of dressings containing nanocrystalline silver to support antimicrobial stewardship in wounds. *Int Wound J*. 2018;15(6):1025–32. <https://doi.org/10.1111/iwj.12969>

226. Hanson A, Haddad LM. Nursing rights of medication administration. 2025. (accessed 24 February 2026)

227. National Institute for Health and Care Excellence. Managing medicines in care homes. 2014. <https://www.nice.org.uk/guidance/sc1> (accessed 24 February 2026)

228. Dryden M, Johnson AP, Ashiru-Oredope D, Sharland M. Using antibiotics responsibly: right drug, right time, right dose, right duration. *J Antimicrob Chemother*. 2011;66(11):2441–3. <https://doi.org/10.1093/jac/dkr370>

229. Totty JP, Bua N, Smith GE et al. Dialkylcarbamoyl chloride (DACC)-coated dressings in the management and prevention of wound infection: a systematic review. *J Wound Care*. 2017;26(3):107–14. <https://doi.org/10.12968/jowc.2017.26.3.107>

230. Holloway S, Ahmajärvi K, Frescos N, Jenkins S. Holistic management of wound-related pain an overview of the evidence and recommendations for clinical practice. *J Wound Manage*. April 12024. <https://doi.org/10.35279/jowm2024.25.01.sup01>

231. O'Meara S, Al-Kurdi D, Ologun Y et al. Antibiotics and antiseptics for venous leg ulcers. *Cochrane Wounds Group, ed. Cochrane Database Syst Rev*. 2014;2014(1). <https://doi.org/10.1002/14651858.CD003557.pub5>

232. Moja L, Zanichelli V, Mertz D et al. WHO's essential medicines and AwaRe: recommendations on first- and second-choice antibiotics for empiric treatment of clinical infections. *Clinical Microbiology and Infection*. 2024;30:S1–51. <https://doi.org/10.1016/j.cmi.2024.02.003>

233. Rotter T, Kinsman LD, Alsius A et al. Clinical pathways for secondary care and the effects on professional practice, patient outcomes, length of stay and hospital costs. *Cochrane Central Editorial Service, ed. Cochrane Database Syst Rev*. 2025;2025(6). <https://doi.org/10.1002/14651858.CD006632.pub3>

234. De Bleser L, Depreitere R, Waele KD et al. Defining pathways. *J Nurs Manag*. 2006;14(7):553–63. <https://doi.org/10.1111/j.1365-2934.2006.00702.x>

235. Hulscher MEJL, Prins JM. Antibiotic stewardship: does it work in hospital practice? A review of the evidence base. *Clin Microbiol Rev*. 2017;23(11):799–805. <https://doi.org/10.1016/j.cmi.2017.07.017>

236. Zhou P, Chen L, Wu Z et al. The barriers and facilitators for the implementation of clinical practice guidelines in healthcare: an umbrella review of qualitative and quantitative literature. *J Clin Epidemiol*. 2023;162:169–81. <https://doi.org/10.1016/j.jclinepi.2023.08.017>

237. Thoonsen AC, Van Schoten SM, Merten H et al. Stimulating implementation of clinical practice guidelines in hospital care from a central guideline organization perspective: A systematic review. *Health Policy*. 2024;148:105135. <https://doi.org/10.1016/j.healthpol.2024.105135>

238. Gurzick M, Kesten KS. The impact of clinical nurse specialists on clinical pathways in the application of evidence-based practice. *J Prof Nurs*. 2010;26(1):42–8. <https://doi.org/10.1016/j.profnurs.2009.04.003>

239. Ballengee LA, King HA, Simon C et al. Partner engagement for planning and development of non-pharmacological care pathways in the AIM-Back trial. *Clin Trial*. 2023;20(5):463–72. <https://doi.org/10.1177/17407745231178789>

240. Cené CW, Johnson BH, Wells N et al. A narrative review of patient and family engagement: the “foundation” of the medical “home.” *Med Care*. 2016;54(7):697–705. <https://doi.org/10.1097/MLR.0000000000000548>

241. Zhang J, Xue X, Liang S et al. Implementation science promotes clinical practice of guidelines: a scoping review. *BMC Health Serv Res*. 2025;25(1):1431. <https://doi.org/10.1186/s12913-025-13317-0>

242. Williams K. Barriers and enablers of strategies to reduce antibiotic prescribing in wound care: a narrative review - *Global Wound Care Journal*. 2025. <https://doi.org/10.63896/gwcj.1.2.41>. <https://globalwoundcarejournal.com/articles/barriers-and-enablers-of-strategies-to-reduce-antibiotic-prescribing-in-wound-care-a-narrative-review> (accessed 4 March 2026)

243. Pulcini C, Morel CM, Tacconelli E et al. Human resources estimates and funding for antibiotic stewardship teams are urgently needed. *Clin Microbiol Infect*. 2017;23(11):785–7. <https://doi.org/10.1016/j.cmi.2017.07.013>



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