

Establishing a Consensus on Wound Infection Definitions

Abstract

Aim: The aim of this study was to establish an international, inter-organisational consensus on wound infection terminology.

Methods: This project consisted of definition scoping and a Delphi process to produce a consensus glossary for 18 wound infection terms. Recent guidelines/consensus documents were reviewed to identify 2-4 definitions for each term. An online consensus process was undertaken using the RAND Appropriateness Method, a consensus method for panels to reach agreement. International wound organisations nominated experts to participate, from which 21 participants were selected to represent different organisations, geographic regions and disciplines. In the first consensus round, each term was presented alongside 2-3 definitions and participants nominated their preferred definition, with the majority vote used to select a baseline definition. The consensus process then proceeded, with participants using a 9-point Likert to score their level of dis/agreement with the definition for each term. Participants also provided a justification outlining the reason behind their rating. At the end of each round, a disagreement index was calculated to provide a quantitative evaluation indicating whether dis/agreement had been reached. Reasoning statements were summarised and the definitions were adjusted to incorporate concepts identified by participants. The adjusted definition was presented in the next consensus round, together with the reasoning statements. Terms for which a final definition was not achieved in three consensus rounds were finalized with preferential voting using 2-3 definitions that had reached consensus.

Project progress and significance: The project generated a glossary of wound infection terms, endorsed through participation of 15 international organisations, for dissemination guidelines and clinical decision-making/teaching tools.

Keywords: wounds, wound infection, terminology, guideline, consensus

Reflective questions

- In what ways could a health professional's understanding of terminology influence the management of wound infection?
- Do the definitions for terms associated with wound infection regularly evolve, and if so what influences change?
- Are conceptual frameworks helpful in understanding and teaching the science associated with wound infection?

Establishing a Consensus on Wound Infection Definitions

Introduction

There is an extensive vocabulary associated with chronic wounds in general and wound infection specifically. Consistent use of health-related terminology is important, because the language that is used conveys information between health professionals, patients and family/caregivers about diagnosis, assessment, treatment and evaluation of care.^{1, 2} In addition to influencing the quality of direct patient care, use of consistent terminology is also important in processes that support clinical care, including medical documentation, disease classification, benchmarking and clinical support tools.² Research and education within the field of chronic wounds also depend on using consensus-based terminology. As the use of electronic databases and health records expands, often including features in which the user selects pre-defined terms, a consistent understanding of health vocabulary is becoming increasingly important.^{2, 3}

A broad range of professions and disciplines use wound infection terminology, including nursing, medicine, allied health, biology, immunology and genetics, among many others. However, both within and across these disciplines, there is a lack of consensus regarding the definition of wound infection associated terms.

Previous attempts have been made to attain consensus,⁴⁻⁶ articles have been dedicated to defining terms,^{1, 7, 8} and educational glossaries have been included in wound infection related guidelines.⁹⁻¹¹ The disparity in terminology has previously been demonstrated, with an earlier systematic review identifying 41 different definitions of surgical wound infection, only two of which were formally validated.¹² Likewise, in an exploration of wound infection associated

with joint replacement surgery, Lachiewicz (2018)⁶ identified six common definitions for the term “persistent wound drainage”. This demonstrates that terms are used variably and inconsistently. The lack of consistent use of terms, together with rapidly changing knowledge in this field, can hinder understanding that may lead to inconsistencies in research and academia, education delivery, communication with patients/caregivers and importantly, in clinical care planning. For example, Lachiewicz’s (2018)⁶ observations regarding the disparate use of the term “persistent wound drainage” confounded the post-operative management and implementation of clinical advice on patient monitoring requirements following surgery,⁶ demonstrating the potential for clinical safety issues arising from different understanding of an infection-related term.

Disparity in terminology use is of particular relevance to the concept of infection in chronic wounds. Several international classification systems are commonly used to define and describe medical presentations, including the International Classification of Diseases (ICD),¹³ the International Classification of Primary Care (ICPC)¹⁴ and SNOMED-CT.¹⁵ Although all these systems include internationally standardised terminology, their inclusion of terms associated with wound infection is scant, and none include the clinical presentation of chronic wound infection. However, acute wound infection is represented through inclusion within the terms post-operative wound infection and sepsis in all these terminology systems.

The need to attain international consensus on wound infection terminology has been highlighted by members of the International Wound Infection Institute (IWII). In 2016, the IWII Committee initiated a review of the IWII Wound Infection Continuum (IWII-WIC), using a consensus process to achieve agreement on some of the terms used within the conceptual framework of wound infection^{4,5} that were published in the IWII’s second (2016) edition of *Wound Infection in Clinical Practice*.¹⁰ The IWII-WIC is a popular theoretical framework

commonly used to conceptualise wound infection, particularly as an education tool.^{10, 16} This theoretical model was developed with input from health professionals, microbiologists, wound researchers and educators and designed to convey information about the clinical signs and symptoms that might be observed in the host as microbial activity progresses. Because the theoretical model currently has limited scientific basis, its international users have expressed interest in extending consensus to attain wider agreement on definitions for terms used within the IWII-WIC, as well as consensus on definitions for other infection-related terms. This interest was the impetus for this current study.

Aim

The study aim was to establish international, inter-organisational agreement on terminology associated with wound infection.

Methods

The study sought to explore wound infection related terminology through a rapid review of definitions in common use, and then to achieve agreement on definitions through a consensus process conducted with international wound infection experts. The project was conducted across two study phases: term generation and literature scoping, and an online Delphi process with five voting rounds. All procedures followed institutional guidelines and were consistent with the ethics approval granted by Curtin University Human Research Ethics Committee (HRE2020-0686).

At commencement of the project, the IWII Committee generated a list of terms through group dialogue informed by clinical and academic knowledge (see Appendix A). The terms selected for inclusion in the Delphi process were those considered pertinent to the field of wound

infection (particularly chronic wounds), but for which the definition and/or usage have been subject to debate, confusion, inconsistency and/or regular change, including terms commonly used to describe progression of wound infection along the continuum, broad infection-related terms (e.g., resistance/tolerance and bioburden) and terms commonly used to refer to clinical signs and symptoms (e.g. pocketing, friable tissue and slough) and treatments (e.g., wound cleansing and surfactant). Following selection of the terms, a rapid review of clinical guidelines and pertinent consensus documents was undertaken to identify existing definitions/descriptions for each of the terms.

To achieve international agreement on the definitions, a Delphi process involving wound infection experts was undertaken. Twenty-three scientific, clinical and stakeholder organisations with an interest in wound infection were invited to nominate up to three experts to participate. Fifteen of these international organisations (see Acknowledgements) responded with nominations and were represented in the project. Nominees provided their area of expertise/background and clinical discipline/specialty. From the nominees, the purposive sampling criteria outlined in Table 1 was used to select a participating sample of 21 wound infection experts that would represent a range of perspectives. Selected participants were sent an email invitation outlining study details, the role of participants, the ability to withdraw at any time without consequence, and the anonymous nature of both participation and specific responses provided in the consensus process. All individuals who were invited agreed to participate and confirmed their consent on their first access to the online platform.

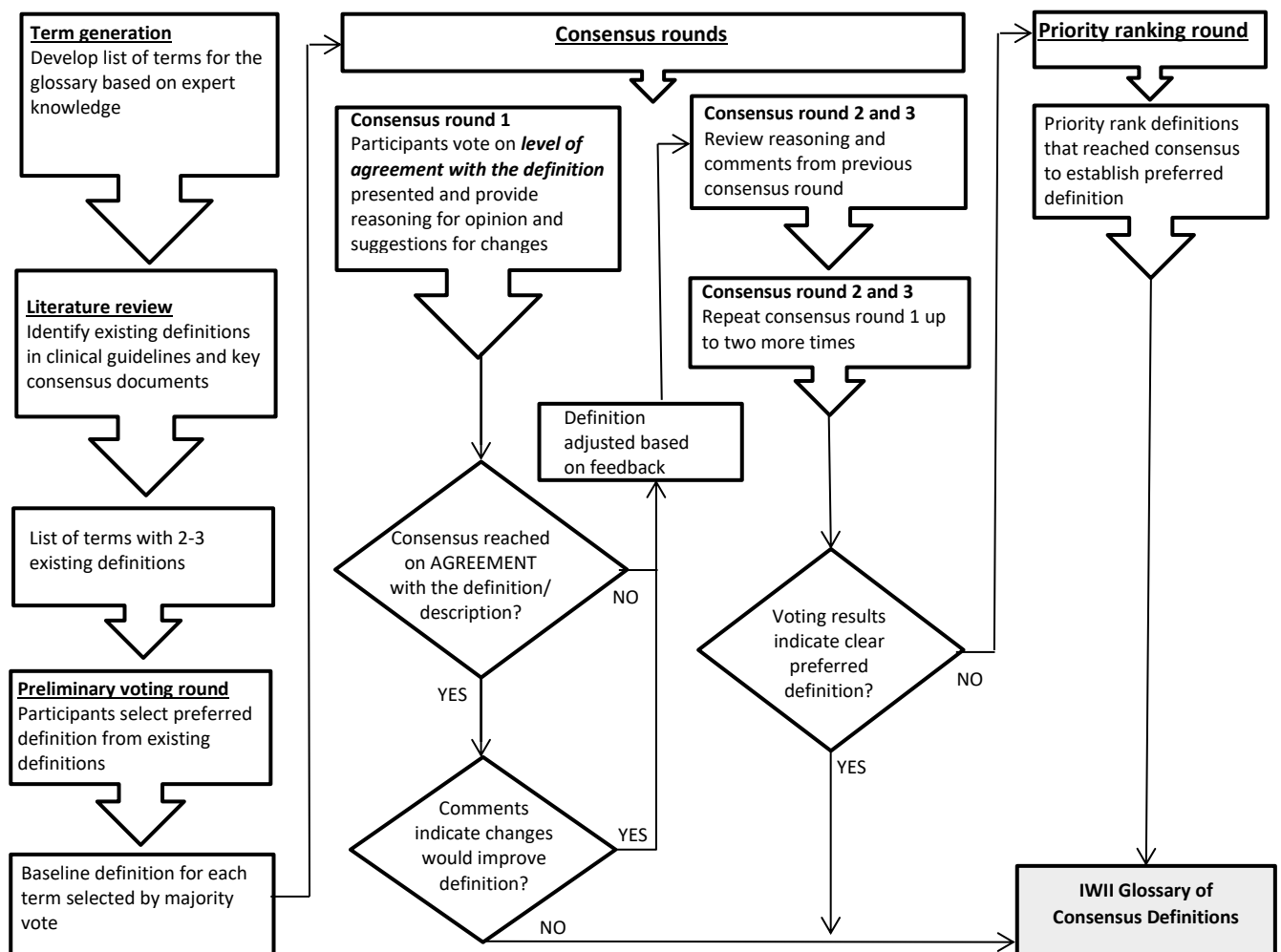
Table 1: Purposive sampling used to select expert participants

Researchers, educators and academics	Maximum of 8 participants Range of specialities including microbiology, pathology, virology and education. Bench researchers will not have background in medicine.
Clinicians	Maximum of 13 participants Range of disciplines including nursing, medicine and podiatry.
Geographic location	At least one participant from each of Europe, Asia, Oceania and US.

Equation 1: Calculating the IPRAS

$$IPRAS = |IPRCP - 5.0| \times 1.5 + 2.35$$

Figure 1: Project methods



The process to achieve consensus definitions consisted of five rounds: an initial preference voting round, three Delphi rounds and a priority voting round (see Figure 1). For this study, a project-specific, online platform was used to facilitate the voting rounds, enabling participants to view and interact with the data throughout consensus building.

In the preference voting round, two-to-three existing definitions identified in the literature were presented for each wound infection term. The expert participants selected their preferred definition from the options. For each term, the definition receiving the highest vote was used as the baseline definition for used at commencement of the consensus voting rounds.

The next three consensus rounds consisted of a Delphi process undertaken using the RAND Appropriateness Method, a nominal group voting methodology that can be used by a panel to reach agreement.¹⁷ Validity, reliability and application of this consensus method is previously reported,¹⁷ including in previous wound-related consensus studies.^{4, 18, 19} The online platform function was designed to calculate results by applying RAND/UCLA methods.

In the first Delphi process round, participants were presented with the preferred definition (established in the preference voting round) for each term and used a 9-point Likert scale to indicate their level of agreement with the definition. Participants also provided a written justification to outline the reasoning behind their level of agreement, as well as any improvements they suggested for the definition.

The RAND/UCLA Appropriateness Method¹⁷ specifies a 9-point Likert scale with tertiles representing agreement, uncertainty or disagreement. We included a descriptor for each point on the scale (tertile one: strongly agree, agree, weakly agree; tertile two: uncertain leaning toward agree, uncertain, uncertain leaning toward disagree; tertile three: weakly

disagree, disagree and strongly disagree) to indicate the direction of agreement and the broad strength. To calculate the vote outcome, the Likert scale points were transferred to a corresponding numerical value. The median Likert scale agreement score was taken as the result. The RAND Appropriateness Method was used to determine if consensus was reached.¹⁷ The 30% to 70% interpercentile range (IPR) was calculated, along with the IPR adjustment for symmetry (IPRAS). The IPRAS is a linear function (see Equation 1) of the distance of the IPR center-point (IPRCP) from the center-point of the Likert scale (5.0). If the IPRAS was higher than, or equal to, the magnitude of the IPR, then agreement was considered to have been reached. Conversely, if the IPRAS was lower than the magnitude of the IPR, then it was considered that there was no agreement.¹⁷ Where there was agreement, and the comments also indicated that no improvements to the definition could be made, the definition was accepted.

When no consensus was reached, or when comments indicated that improvements could be made to the definition, a summary of the experts' reasoning statements was compiled. Commentary in dis/agreement or neutral to the definition was grouped. The research team then adjusted the definition to incorporate concepts identified as improvements by participants. For the next consensus round vote, participants were presented with the refined definitions, together with the voting outcome of the previous round and the summary of the experts' reasonings. A maximum of three consensus rounds, which was considered a feasible process over which to maintain participant engagement,^{4, 19} were conducted.

For some terms, multiple definitions had reached consensus after three voting rounds. Where the voting results indicated a group preference, that definition was selected for the consensus glossary. Where no clear group preference was evident, a final priority ranking round was

undertaken. In this round, participants were presented with all definitions reaching agreement plus a final definition derived from the last round of comments. Participants ranked their preference for definitions from most to least preferred. The group's preferred definition was calculated with a nominal group multi-voting method using weighted ranking scores. The method is previously reported, and based on a review of nominal voting calculation methods.¹⁹

Results

Agreement was reached on definitions for 15 of the initial terms. Three of the terms were discarded: resistance/tolerance, chronic wound infection and bioburden. The term resistance/tolerance was replaced by two distinct terms: antimicrobial resistance and antimicrobial tolerance. Agreement was reached to replace the term bioburden with the term microbial burden. Chronic wound infection was considered by the group to have substantial ambiguity and was removed from the consensus process, with a recommendation from the expert participants that using the term is not encouraged in clinical practice. The final glossary included 18 terms on which definitions were agreed.

Table 2 summarises the results and the survival outcomes for each term. Most vote outcomes achieved consensus in agreement with the presented definition. Agreement ranged from 52.9% to 94.12% in the first consensus round (18 terms), 33.33% to 94.44% in the second consensus round (19 terms) and 55.0% to 80.0% in the third consensus round (6 terms). No definitions received a majority disagreement. However, for some definitions the level of agreement was lower, or the spread of opinion on agreement/disagreement was wide, leading to lack of consensus.

Table 2: Results and survival outcomes for glossary terms in the consensus process

Table 2: Results and survival outcomes for glossary terms in the consensus process

Glossary terms	Consensus Round 1 (n=17-20)		Consensus Round 2 (n=17-19)		Consensus Round 3 (n=20)		Priority ranking
	<ul style="list-style-type: none"> • Agreement* (%) • Median agreement (IPR#) • IPRAS^Y • RAND disagreement index 	Round outcome	<ul style="list-style-type: none"> • Agreement* (%) • Median agreement (IPR#) • IPRAS^Y • RAND disagreement index 	Round outcome	<ul style="list-style-type: none"> • Agreement* (%) • Median agreement (IPR#) • IPRAS^Y • RAND disagreement index 	Round outcome	
Antimicrobial resistance/tolerance	<u>Definition 1</u> 76.47% agreement 8.0 (7.0-8.0) 6.10 Consensus reached	Discard term Two new terms					
Antimicrobial Resistance			<u>Definition 2</u> 76.47% agreement 8.0 (7.0-8.0) 6.10 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			
Antimicrobial Tolerance			<u>Definition 2</u> 82.35% agreement 8.0 (7.8-8.0) 6.70 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			
Antiseptic	<u>Definition 1</u> 94.12% agreement 8.0 (7.8-8.0) 6.70 Consensus reached	Consider with definition 2	<u>Definition 2</u> 89.47% agreement 8.0 (8.0-9.0) 7.60 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			
Biofilm	<u>Definition 1</u> 52.9% agreement 7.0 (2.8-8.0) 2.95 No consensus	Consider with definition 2	<u>Definition 2</u> 61.11% agreement 8.0 (4.1-8.0) 3.93 Consensus reached	<ul style="list-style-type: none"> • Retain definition 2 • Consider with definition 3 	<u>Definition 3</u> 70.0% agreement 8.0 (6.1-8.0) 5.43 Consensus reached	<ul style="list-style-type: none"> • Retain definition 3 • Consider with definition 4 	<ul style="list-style-type: none"> • Rank definitions 2,3 and 4 • Retain definition 4
Chronic Wound Infection	<u>Definition 1</u> 58.82% agreement 7.0 (5.0-8.0) 4.60 Consensus reached	Consider with definition 2	<u>Definition 2</u> 33.33% agreement 2.5 (2.0-6.8) 3.25 No consensus	<ul style="list-style-type: none"> • Discard term 			
Colonisation	<u>Definition 1</u> 70.59% agreement 8.0 (6.6-9.0) 6.55 Consensus reached	Consider with definition 2	<u>Definition 2</u> 94.44% agreement 8.0 (8.0-8.9) 7.53 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			

Glossary terms	Consensus Round 1 (n=17-20)		Consensus Round 2 (n=17-19)		Consensus Round 3 (n=20)		Priority ranking
	<ul style="list-style-type: none"> • Agreement* (%) • Median agreement (IPR#) • IPRAS^y • RAND disagreement index 	Round outcome	<ul style="list-style-type: none"> • Agreement* (%) • Median agreement (IPR#) • IPRAS^y • RAND disagreement index 	Round outcome	<ul style="list-style-type: none"> • Agreement* (%) • Median agreement (IPR#) • IPRAS^y • RAND disagreement index 	Round outcome	
Contamination	<u>Definition 1</u> 58.82% agreement 8.0 (5.8-8.2) 5.35 Consensus reached	Consider with definition 2	<u>Definition 2</u> 83.33% agreement 8.0 (7.1-8.0) 6.18 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			
Exudate	<u>Definition 1</u> 70.59% agreement 8.0 (6.8-8.0) 5.95 Consensus reached	Consider with definition 2	<u>Definition 2</u> 55.56% agreement 7.0 (2.3-8.0) 2.58 No consensus	Consider with definition 3	<u>Definition 3</u> 80.0% agreement 8.0 (7.7-8.3) 6.85 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 3 	
Fibrinous Wound Base/Surface	<u>Definition 1</u> 58.82% agreement 7.0 (6.0-8.0) 5.35 Consensus reached	Consider with definition 2	<u>Definition 2</u> 64.71% agreement 7.0 (5.8-8.0) 5.20 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			
Friable Tissue	<u>Definition 1</u> 94.12% agreement 8.0 (7.8-8.2) 5.88 Consensus reached	Consider with definition 2	<u>Definition 2</u> 82.35% agreement 8.0 (8.0-9.0) 7.60 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			
Hypergranulation	<u>Definition 1</u> 76.47% agreement 8.0 (7.0-8.0) 6.10 Consensus reached	Consider with definition 2	<u>Definition 2</u> 82.35% agreement 8.0 (7.8-8.0) 6.70 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			
Local infection	<u>Definition 1</u> 52.95% agreement 7.0 (5.0-8.0) 4.60 Consensus reached	Consider with definition 2	<u>Definition 2</u> 58.82% agreement 7.0 (3.6-8.0) 3.55 No consensus	Consider with definition 3	<u>Definition 3</u> 70.0% agreement 8.0 (4.7-8.0) 4.38 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 3 	
Maceration	<u>Definition 1</u> 70.59% agreement 7.0 (6.8-9.0) 6.70 Consensus reached	Consider with definition 2	<u>Definition 2</u> 70.59% agreement 7.0 (6.8-8.0) 5.90 Consensus reached	Retain definition 2			
Bioburden	<u>Definition 1</u> 64.7% agreement IPR 8.0 (3.0-8.2)	<ul style="list-style-type: none"> • Discard term • New term 					

Glossary terms	Consensus Round 1 (n=17-20)		Consensus Round 2 (n=17-19)		Consensus Round 3 (n=20)		Priority ranking
	<ul style="list-style-type: none"> • Agreement* (%) • Median agreement (IPR#) • IPRAS[¥] • RAND disagreement index 	Round outcome	<ul style="list-style-type: none"> • Agreement* (%) • Median agreement (IPR#) • IPRAS[¥] • RAND disagreement index 	Round outcome	<ul style="list-style-type: none"> • Agreement* (%) • Median agreement (IPR#) • IPRAS[¥] • RAND disagreement index 	Round outcome	
	3.25 No consensus						
Microbial burden			<u>Definition 1</u> 73.68% agreement 8.0 (7.0-9.0) 6.85 Consensus reached	Consider with definition 2	<u>Definition 2</u> 55.0% agreement 7.5 (3.7-8.0) 3.63 No consensus	Consider with definition 3 and 4	<ul style="list-style-type: none"> • Rank definitions 1, 3 and 4 • Retain definition 4
Pocketing	<u>Definition 1</u> 70.00% agreement 8.0 (6.7-8.0) 5.88 Consensus reached	Consider with definition 2	<u>Definition 2</u> 82.35% agreement 8.0 (7.0-8.0) 6.10 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			
Slough	<u>Definition 1</u> 76.47% agreement 8.0 (7.8-8.0) 6.70 Consensus reached	Consider with definition 2	<u>Definition 2</u> 82.35% agreement 8.0 (7.8-8.2) 6.85 Consensus reached	<ul style="list-style-type: none"> • No improvements • Retain definition 2 			
Surfactant	<u>Definition 1</u> 64.71% agreement 8.0 (5.8-8.0) 5.20 Consensus reached	Consider with definition 2	<u>Definition 2</u> 76.47% agreement 8.0 (7.0-8.0) 6.10 Consensus reached	Consider with definition 3	<u>Definition 3</u> 75% agreement 8.0 (7.7-9.0) 7.38 Consensus reached	Consider with definition 4	<ul style="list-style-type: none"> • Rank definitions 1,2,3 and 4 • Retain definition 4
Systemic Infection	<u>Definition 1</u> 94.12% agreement 8.0 (8.0-9.0) 7.60 Consensus reached	Consider with definition 2	<u>Definition 2</u> 70.59% agreement 8.0 (6.4-8.0) 5.65 Consensus reached	<ul style="list-style-type: none"> • No improvements • Revert to and retain definition 1 			
Wound Cleansing	<u>Definition 1</u> 70.59% agreement 8.0 (6.8-9.0) 6.70 Consensus reached	Consider with definition 2	<u>Definition 2</u> 83.33% agreement 9.0 (8.0-9.0) 7.60 Consensus reached	Consider with definition 3	<u>Definition 3</u> 75.0% agreement 7.5 (7.0-8.0) 6.10 Consensus reached	<ul style="list-style-type: none"> • No improvements 	<ul style="list-style-type: none"> • Rank definitions 1,2 and 3 • Retain definition 2

* Agreement (% participants with response in agree tertile)

Interpercentile range

¥ Interpercentile range adjustment for symmetry

Discussion

Our rapid literature review established that many clinical guidance documents and significant publications in the wound infection field do not include a specific glossary/definition of terms. For example, Cutting (1994)²⁰ presented a new approach to diagnosing wound infection that provided significant clinical guidance at the time, but did not include an explicit glossary or definitions for important terms, including friable tissue, pocketing and exudate. While this could reduce naïve readers' understanding and uptake of the information, clinicians have also been previously shown to have nuanced differences in how they understand these terms.^{6, 12} This finding was confirmed in our study, and is supported by previous authors. For example, Cutting (1994)²⁰ explicitly notes variation in terminology/descriptions in the literature related to the appearance of healthy granulation tissue (e.g., "translucent appearance" versus "fine, granular surface"). We established that existing clinical guidance documents often use the same sources for glossary definitions. We also found that the rapidly evolving science in this field, for example biofilm research, led to definitions in some resources to potentially be outdated. Although our literature review to identify definitions was not intended to be exhaustive, it did support the purpose of our study and intended output. In our study, the feedback provided by the expert participants during the consensus rounds indicated differing expectations of and ideas for glossary definitions. The use of confirmed scientific facts in the description and the conceptual nature of some of the terms required balance and a pragmatic approach. The suggestion to consistently define the terms used in the IWII-WIC by describing the microbial activity presumed (but not scientifically proven) to be undertaken and the response of the host to this activity was made by some participants, consistent with a previous significant position document²¹ on this topic. This approach was considered by some

of the participants to be useful for teaching and conceptualising the continuum of the burden of infection experienced by the patient/host. In 2005, a pivotal position document²¹ on identifying wound infection presented definition of terms used to describe the continuum of infection with respect to the activity of pathogens, including the outcome of host-pathogen interactions. This consensus document was pivotal at the time in suggesting that the activity of microbiomes, defined “colonization” and “infection” with descriptions such as “successfully grow and divide” and “multiplication and invasion of host tissue”, directly relates to the host.²¹ However, almost thirty years following this publication²¹ there remains no robust scientific evidence supporting a direct relationship between the microbial activity and the host’s response (i.e., at what point in the host’s response microorganisms are growing and dividing versus multiplying and invading). All responses from the expert participants were anonymous; however, we hypothesized that differences in opinion on what to include in a conceptual definition might relate to professional background. In incorporating the experts’ feedback to refinement of the definitions, the research team attempted to address the opinions of all participants, who represented a wide range of expertise. The approach taken was consistent with previous significant commentary²¹ on the conceptualised relationship between microbial activity in the wound and the response observed in the host.

Although there was an overall high level of agreement amongst the participants with respect to Likert scores, the comments provided in reasoning statements and suggestions for definition improvements highlighted some areas of discrepancy. One area in which the expert participants had divergent opinion was related to the term “microbial burden”. Comments on this term were divided between experts who use the term “burden” to refer to the quantity (load), quality (species and diversity) and interplay of microbes versus other experts who use

the term to refer to solely to the quantity of microorganisms in a wound. The following comments provided in the experts' reasoning statements illustrate the two schools of thought:

"If microbial burden is just the number of microorganisms present, should the definition then not be limited (*to the first sentence*)?"

"Microbial burden is the number of microorganisms in a wound or tissue."

"The concept of 'burden' is not just quantitatively determined by the number but also by the type of microorganisms (pathogenicity)"

"What about the qualitative aspect of the burden concept?"

We found the literature (both specific to wounds and that discussing microbial burden/load in other contexts) to also be diverse in the way this term is used and understood,^{20, 22-26} noting it was often undefined. Agreement was reached on a definition for microbial burden that included a connection between the quantity of microbes and factors that influence their pathogenicity (see Appendix 1).

The definition for the term biofilm led to substantial debate. Areas of contention appear to arise from the different characteristics of *in vivo* versus *in vitro* biofilm, which have previously been applied interchangeably in the literature.

Some participants referred to adherence of biofilm to the wound surface, as included in definitions some clinical guidance documents.²⁷⁻²⁹ Other comments referred to recent literature^{30, 31} specifying that in contrast to what is observed *invitro*, biofilm does not attach to any surface when in a wound. Examples of differing perspectives included:

“I think 'surface' suffices; however, it seems to be an issue in the feedback that it could be an inanimate or animate surface.”

“Biofilms are surface-attached...”

“*In vivo* biofilm may not be attached to any surface at all.”

Other areas of discussion related to the description of biofilm included reference to a (self-produced) extracellular polymeric substance (EPS) as noted in some previous definitions,^{10, 27-29, 32} but which evolving science^{30, 31} suggests is still poorly understood in the wound environment. Relevant feedback included:

“Biofilms are ... embedded in a self-produced extracellular matrix”

“The EPS is unique to biofilms and should be included in the definition.”

“I agree that the EPS is the main component that builds the biofilm and helps to maintain the biofilm structures...”

“Microbial aggregates are commonly observed and less frequently is a film or EPS.”

As scientific understanding has developed, it is now understood that extrapolating *invitro* observations to *in vivo* biofilm leads to inaccurate characterisation and models.³¹ The final agreed definition for biofilm refers to non-specific unique characteristics and enhanced tolerance to treatment, without precisely describing these features. Because this definition remains broad, while still noting the distinctiveness of biofilm, the definition could apply to what is currently presumed of both *in vivo* and *in vitro* biofilm and may remain relevant as the science in this field evolves.

Bjarnsholt et. al. (2021)³³ have described the impact of mental models on the way health professionals perceive and represent information based on their exposure to information. Our research supported the notion that experts interpret information through a familiar lens to which they are already exposed. For example, many of the participants consistently responded to the consensus process favoring models of biofilm behaviour to which they have previously been exposed but that have more recently been shown to have limited application to clinical wounds. The existing mental models that some of the participants used to frame their knowledge on biofilm may have influenced their ability to reflect on more recent scientific knowledge espoused by other participants.³³ Previous research has also demonstrated that there is significant delay between generation of scientific knowledge and its uptake in clinical practice.³⁴ Our study provides further example of clinical and academic knowledge lagging scientific advance. These findings support the aim of this project to revise and update wound infection related terminology; however, they also highlight both the limitations of our consensus-based methods and the importance of ongoing professional development through knowledge acquisition.

Limitations

There were some limitations to this study. The outcomes of any consensus study reflect the opinions, perceptions and knowledge of participants in the study. The participants in the consensus process were selected by first the wound organisations they represented, and secondly by the researchers, who used purposive sampling to select participants from the nominations to represent a range of different geographic regions and professional fields. However, selection of participants reduces the generalisability of the findings and the consensus achieved on definitions in this study will not necessarily reflect those of the greater

wound community. Although prominent wound organisations involved in this study put forward nominations who were considered to represent the perspectives of their region, the expert participants' perceptions may not represent the broader community of individuals involved in wound infection management. Indeed, no single definition achieved 100% agreement across the experts participating in this process. As discussed, there is a wide variation in the expectation individuals have of the level of detail that should be included in a glossary definition.

Some of the details included in the final definitions in this study (e.g., those used within the IWII-WIC) were considered as helpful for communicating concepts that have not been fully elucidated in the current research. As science advances, the definitions that were agreed on through this process may become obsolete. However, all the final definitions that were adopted in the glossary reached group consensus in agreement by the participating experts. This consensus process did not extend to seeking agreement on criteria to use in identifying and/or diagnosing wound infection. Although there is substantial clinical guidance for health professionals in various guidelines and position documents^{11, 16, 21, 26, 28, 31, 35-39} and wound infection assessment tools,^{36, 37, 40, 41} there has been limited scientific validation of different wound infection diagnostic strategies. Studies that investigate the relationship between microbial burden in a wound and the clinical signs and symptoms that are commonly observed and used to diagnose and assess wound infection in different wound types is an area for further investigation.

The RAND Appropriateness Method is designed for an ideal panel size of 12 to 16 experts. To represent all participating organisations and to meet the purposive sampling, the research team selected 21 participants. Previous experience has indicated that over the course of a

multi-round consensus process, some participants will be unable to contribute to every voting round.^{4, 19} For this study, participation in the voting rounds ranged from 16-20 experts. This higher-than-anticipated participation may have influenced the RAND Appropriateness Method results. However, the expert comments provided additional indication of the opinion and suggested that quantitative vote calculations were reflective of the group consensus.

Implementation and dissemination

The study output is a glossary of terms commonly used in the specialist field of wound infection with definitions that have been agreed on internationally through a formal consensus process. This resource is relevant to clinicians, educators and researchers and is anticipated to facilitate professional communication, clinical documentation, guidelines, academic publications and education resources.

The *IWII Glossary of Consensus Definitions* is provided in Appendix 1. The definitions have been incorporated into the IWII's third edition of *Wound Infection in Clinical Practice*.¹⁶ In addition to the glossary of terms, this publication further discusses and describes the terms included in this study and presents an updated IWII-WIC. The widespread citation of the second edition of the IWII document in the literature suggests that the third edition of this publication will be widely used, contributing to dissemination of the definitions. To further implement uptake of the glossary arising from this study, the IWII has developed a comprehensive dissemination plan including webinars, conference presentations and free resources on the IWII website.

Conclusion

This study identified that there is general agreement between wound infection experts regarding the meaning of most terms used in the field of wound infection, although there are some discrepancies. The output of this study is a glossary of consensus definitions for terms associated with wound infection. Definitions were refined, and consensus agreement was attained across scientists, academics, educators and clinicians around the world. The glossary has informed the content of a consensus document to guide clinical identification and treatment of wound infection, the IWII's third edition of *Wound Infection in Clinical Practice*.⁴² The glossary, and the revised IWII-WIC are free for uptake by wound organisations, clinicians, educators, and researchers to facilitate understanding and conceptualisation when communicating about wound infection.

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APPENDIX 1 – GLOSSARY OF CONSENSUS DEFINITIONS



Glossary of Consensus Definitions

Antimicrobial resistance	Antimicrobial resistance occurs when microorganisms change over time in ways that render the medications used to treat the infections they cause ineffective.
Antimicrobial tolerance	Antimicrobial tolerance occurs when microorganisms have a lower susceptibility to an antimicrobial.
Antiseptic	An antiseptic is a topical agent with broad spectrum activity that inhibits multiplication of, or sometimes kills, microorganisms. Depending upon its concentration, an antiseptic may have a toxic effect on human cells. Development of resistance to topical antiseptics is uncommon.
Biofilm	Biofilms are aggregates of microorganisms that have unique characteristics and enhanced tolerance to treatment and the host defences. Wound biofilms are associated with impaired wound healing and signs and symptoms of chronic inflammation.
Colonisation	Colonisation refers to the presence of microorganisms within the wound that are undergoing limited proliferation. No significant host reaction is evoked and no delay in wound healing clinically observed.
Contamination	Contamination refers to the presence within the wound of microorganisms that are not proliferating. No significant host reaction is evoked and no delay in wound healing clinically observed.
Exudate	Exudate refers to fluid that is released from tissue and/or capillaries in response to injury, inflammation and/or microbial burden. It is mainly comprised of serum, fibrin, proteins and white blood cells
Fibrinous wound base/surface	A fibrinous wound base/surface is a metabolic by-product of healing occurring as a layer that is loosely or firmly adherent to the wound bed. It is composed of serum and matrix proteins that may be white, yellow, tan, brown or green, and has a fibrous or gelatinous texture and appearance.
Friable tissue	Friable tissue is fragile tissue that bleeds easily.
Hypergranulation	Hypergranulation is an increase in the proliferation of granulation tissue such that the tissue progresses above or over the wound edge and inhibits epithelialisation. It presents as raised, soft/spongy, shiny, friable, red tissue.
Local infection	Local infection refers to the presence and proliferation of microorganisms within the wound that evoke a response from the host that often includes delayed wound healing. Local infection is contained within the wound and the immediate periwound region (less than 2cm). Local infection often presents as subtle (covert) signs that may develop into the classic (overt) signs of infection.
Maceration	Maceration refers to wrinkled, soggy and/or soft peri-wound skin occurring due to exposure to moisture. Macerated peri-wound skin usually presents as white/pale and is at increased risk of breakdown.
Microbial burden	Microbial burden is the number of microorganisms in a wound, the pathogenicity of which is influenced by the microorganisms present (i.e., the species/strain), their growth and their potential virulence mechanisms.
Pocketing	Pocketing occurs when granulation tissue does not grow in a uniform manner across the entire wound base, leading to a dead space that can potentially harbor microorganisms.
Slough	Slough is nonviable tissue of varying colour (e.g., cream, yellow, greyish or tan) that may be loose or firmly attached, slimy, stringy, or fibrinous.

Surfactant	A wound cleansing surfactant is a hydrophobic/lipophilic agent that reduces the surface tension between liquid and debris, slough and/or biofilm in a wound. The reduction in surface tension better disperses the liquid, improving the cleansing effect.
Systemic infection	Systemic infection arising from a wound refers to microorganisms spreading throughout the body via the vascular or lymphatic systems, evoking a host response that affects the body as a whole. Signs of systemic infection include a systemic inflammatory response, sepsis and organ dysfunction.
Wound cleansing	Wound cleansing is actively removing surface contaminants, loose debris, non-attached non-viable tissue, microorganisms and/or remnants of previous dressings from the wound surface and its surrounding skin.