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When and How to Perform Cultures on Chronic Wounds?

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ABSTRACT

PURPOSE: The purpose of this Evidence-Based Report Card was to examine current best evidence related to when and how to perform cultures on chronic wounds to guide clinicians in determining the appropriate treatment.

QUESTION: (1) When should cultures be performed on chronic wounds? and (2) What is the best method or technique to perform a culture on a chronic wound?

SEARCH STRATEGY: A search of the literature was performed, resulting in 45 publications relevant to the topic. Following a review of titles and abstracts, 7 studies were identified that met inclusion criteria. Key search terms used were "chronic wound," "chronic infected wound," "wound culture," "specimen collection," and "wound swab." Strength of the evidence was rated based on the methodology from Essential Evidence Plus: Levels of Evidence and Oxford Center for Evidence-Based Medicine, adapted by Gray and colleagues.

FINDINGS: Seven studies were identified as pertinent to the topic on wound culture and meeting inclusion criteria. The study designs included 1 randomized controlled trial, 1 quasi-experimental comparative study, 1 systematic review, 1 scoping literature review, 1 integrative literature review, and 2 professional organization expert panel reviews (consensus statement and position statement). Of the 7 studies, 3 studies suggest that classic signs of infection may not always be present but culturing may be indicated when additional signs such as pain, necrotic tissue, prolonged or delayed healing, and wound bed deterioration occur. Four studies report that a quantitative culture of wound tissue is the gold standard to obtain a wound culture, but the swab method is an acceptable alternative option. Two articles demonstrate the Levine technique is more reliable than the Z-technique to determine microbial load in the wound bed. The strength of the evidence was identified as 2 level A studies, 1 level B study, and 4 level C studies. Using Johns Hopkins methodology, the quality of the studies was deemed either high quality or good quality.

CONCLUSION/RECOMMENDATION: Evidence indicates that identification of potential chronic wound infection should be considered early using clinical signs such as pain, necrotic tissue, delayed healing, and wound deterioration (in addition to classic signs of infection) to determine the need for collecting a culture (Strength of Recommendation Taxonomy [SORT] level 2); and when a culture is deemed necessary, swab culture using the Levine method is a clinically practical alternative if performed correctly (SORT level 1).

KEY WORDS: Chronic infected wound, Chronic wound, Levine method, Specimen collection, Wound culture, Wound swab.

INTRODUCTION

There is variation in the definition of a chronic wound, but most agree it is a wound that has not healed in 4 to 6 weeks or a wound that has not proceeded through a normal healthy healing process.[1] Appropriate management of the chronic wound is not only an issue in the United States but also a global issue.[1,2] In most developed counties, it is estimated that up to 2% of the population will have a chronic wound during their lifetime. The most common types of chronic wounds include diabetic foot ulcers, venous ulcers, peripheral vascular-related wounds, and pressure injuries.[1] In developed countries, it is estimated that chronic wounds affect 6.5 million patients with a cost of $25 billion to $50 billion per year and growing quickly.[3,4] Infection is common in chronic wounds and results in delayed healing, adding to increased health care costs.[2] In a study by Fife and Carter[4] of 5240 patients with 7099 wounds, several factors were identified that increased the cost of wound care, one of which was infection and use of systemic antibiotics ($P = .003$).

Chronic wounds cause morbidity and mortality and can lead to sepsis and increased length of hospital stay.[5] Early detection of wound infection is imperative. However, identification of infection in a chronic wound is often difficult.[6] Current practice demonstrates that clinicians rely heavily on their own experience as to when a wound should be cultured.[6] The lack of consensus on when a wound is identified as infected persists despite consensus documents produced by organizations such as the European Wound Management Associate (EWMA)[7] or the World Union of Wound Healing Societies (WUWHS).[8] This lack of evidence and agreement among experts adds to variation in practice among clinicians to determine when culture and treatment to eliminate infection are warranted.[9]

The common classic signs of infection are erythema, edema, purulence, and odor.[2] The accuracy of clinical signs of infection in the chronic wound bed is confounded as they often do not present with classic signs of infection due to patient's frequent

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comorbidities such as diabetes, immunocompromised status and peripheral vascular disease.[7,8] It is estimated that clinicians who base their opinion of the existence of infection on patient's physical signs and symptoms are often incorrect. Correct diagnoses are estimated to be between 32% and 58% of the time.[10]

In summary, there is variation in chronic wound practice among clinicians in determining when anti-infective treatment is warranted and the best method to perform cultures on chronic wounds. The purpose of this Evidence-Based Report Card (EBRC) is to identify and examine the best evidence related to when and how cultures should be performed on chronic wounds to best guide clinicians in determining the appropriate treatment.

QUESTION

The search questions and key words were developed using the PICO model; P = population, I = intervention or area of interest, C = comparison, and O = outcome.[11] Specifically, we asked 2 questions: (1) When should cultures be performed on chronic wounds for microbial load? and (2) What is the best method or technique to perform a culture on a chronic wound?

P = Adult population in acute care and outpatient care settings with chronic wound
I = Chronic wound infection
C = Culture method (swab method)
O = Timing of when to perform a culture and accuracy of the culture method

METHOD/SEARCH STRATEGY

A systematic search of the literature was performed using the CINAHL, MEDLINE, and PubMed databases. Key search terms used were "chronic wound," "chronic infected wound," "wound culture," "specimen collection," and "wound swab." Search filters for all databases included English language and published between 2000 and 2014. Inclusion criteria were publication relevant to the topic, available in English, and published in peer-reviewed journals. The types of studies searched included randomized controlled trials (RCTs), controlled clinical trials, quasi-experimental, cohort, cross-sectional, survey, prevalence or incidence, case-control, cases series, and quality improvement. Studies were limited to those that included human subjects. Additional inclusion criteria were studies using established qualitative methodologies as appropriate to the research question, systematic and other types of reviews such as expert panel reviews, and meta-analyses. Exclusion criteria were articles with abstract only; abstract in English, but full article in a non-English language; narrative papers, opinion, commentary, and descriptive papers; single case reports; conference abstracts or other brief reports with insufficient detail to enable an appraisal of the study methodology; duplicate reports of research; studies focusing on infants and children; and animal studies. Strength of evidence was evaluated using rating methodology from Essential Evidence Plus: Levels of Evidence and Oxford Center for Evidence-Based Medicine, and adapted by Gray and colleagues (Table 1).[12,13] Quality of the studies was rated using the Johns Hopkins Evidence-Based Practice methodology.[14]

FINDINGS

Forty-five publications were identified initially; 27 were excluded after review of the title and abstract as not meeting all inclusion criteria, resulting in 18 publications. Seven were identified that met the inclusion criteria (Figure).[5,7,8,10,15-17] They included 1 RCT,[15] 1 quasi-experimental comparative,[17] 1 systematic review,[10] 1 scoping literature review,[16] 1 integrative literature review,[5] and 2 professional organization expert panel reviews.[7,8] See Table 2. The prospective RCT compared 2 paired wound-swabbing techniques, the Levine technique versus Z-technique, in determining the causative organisms in infected cutaneous wounds.[15] One scoping literature review compared 6 studies (3 review articles, 2 observational studies using a cross-sectional design, and 1 RCT) that evaluated wound-swabbing techniques, Levine technique versus Z-technique, and compared them to wound biopsy.[16] One quasi-experimental study compared culture swab with curetted tissue to define an agreement between those 2 approaches on aerobic and anaerobic bacterial burden.[17] The systematic review by Reddy and colleagues[10] reviewed 15 studies to determine if there is a preferred swab technique to use.[10] The integrative review by Bonham[5] examined literature on swab cultures for the diagnosis of wound infection.[5] One publication described a consensus panel review of the literature to provide a clear guidance on diagnosis of wound infection,[8] and one position document described the understanding/identifying wound infection.[7]

The RCT and the quasi-experimental comparative study had small sample sizes (n = 50 and n = 12, respectively).[15,17] The scoping review by Rondas and colleagues[16] included studies with sample sizes (n = 38-83) from different settings, that is, university teaching hospital, Veterans Affairs Medical Center, and university-based chronic wound center.[16] The systematic review by Reddy and colleagues [10] included 15 studies with a cumulative sample of 985 participants with 1056 chronic wounds. Each study sample varied between 36 and 83 patients.[10] Bonham's[5] integrative literature review examined only swab cultures on human subjects that had a reference standard and a procedure for collecting the swab cultures. The 2 reports by prominent wound expert organizations[7,8] examined literature describing clinical signs and symptoms leading to an infected wound bed[7] and reported the consensus opinion of international experts treating wound infection in different situations and position document by 4 authors.[8]

Using the methodology described previously,[12,13] studies were appraised and rated for their strength. There were 2 level A studies,[10,15] 1 level B study,[17] and 4 studies rated as level C.[5,7,8,16] Using the Johns Hopkins methodology,[14] the quality of the studies was deemed either high or good.

TABLE 1.
Method for Rating the Strength of the Evidence[a]

Rating Label	Definition
A	Evidence based on consistent results of RCTs, other experimental designs, or systematic reviews supported by meta-analysis
B	Evidence based on inconsistent findings from RCTs or evidence based on findings from nonrandomized studies with a control group and/or well-designed observational (cohort or case-control) studies
C	Evidence based on single-group studies, expert consensus or opinion, current or best practice, physiological theory or principles, case series, or case studies

Abbreviation: RCT, randomized control trial.
[a]From Essential Evidence Plus: Levels of Evidence and Oxford Center for Evidence-Based Medicine, adapted by Gray and colleagues.[12,13]

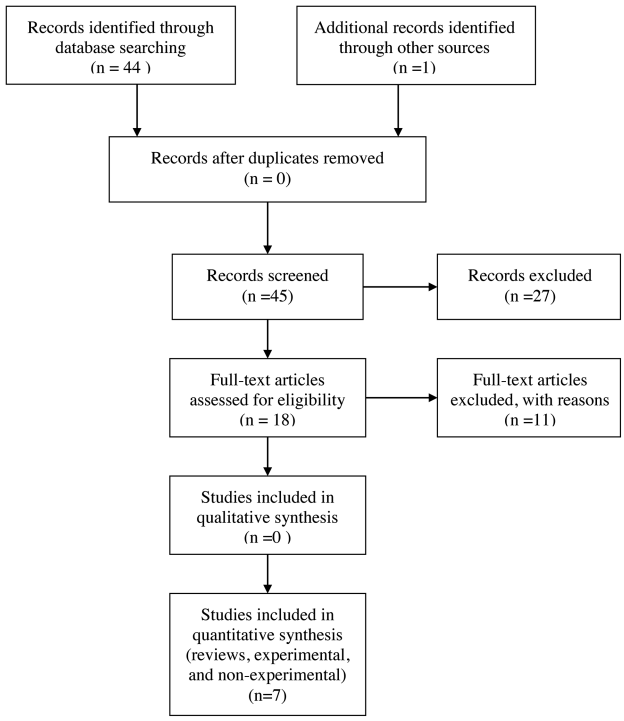

Figure 1. PRISMA flow diagram.

Summary of Findings

When should a Chronic Wound be Cultured for Microbial Load?

There is a lack of clarity as to when a wound becomes infected and how to clearly identify the microbial load so that clinicians can properly apply systemic antimicrobial therapy.[1] All wounds are contaminated by bacteria, and when the host does not respond to contamination by producing more white blood cells, it can lead to colonization and, in turn, can further lead to infection or not.[1] The continuum of the microbial load is a progression from a contaminated wound bed (not infected) to colonized, followed by critical colonized wound bed (infected).[5,7,8,11] Siddiqui and Bernstein[1] reported microbial load changes overtime and that it is a dynamic environment. This evolution is difficult for the naked eye to evaluate.

Contamination of a chronic wound means that the existence of bacteria is in low amounts and nonreplicating, but the longer a wound remains unhealed, the more likely it will acquire more bacteria and they will start multiplying.[18] In a colonized wound, the bacteria multiply but the surface wound tissue is not damaged.[1] Infection occurs when bacteria has invaded wound tissue to the point that it causes surface and deeper tissue damage, which can lead to local infection or cause systemic infection.[8] A wound at this stage should have a culture taken, but it is difficult to determine a wound at this stage with the naked eye.[18] Critical colonization is often described quantitatively as a bacterial burden of greater than 10^5 colony-forming units per gram of tissue.[5] If critical colonization is not treated, the wound will progress to an infection where microbes will damage the deeper tissues.[18] If this occurs, microbes can easily gain access to the systemic circulation and cause more damage to the host's skin and underlying structures, as well as sepsis.[18] When there are unclear guidelines to identify infected chronic wounds, clinicians may obtain random cultures.

Three of the articles in this EBRC reviewed literature that described signs and symptoms when the chronic wound bed is infected and warrants a culture to evaluate what type of microbial causes the infection.[7,8,10] Reddy and colleagues[10] reported that classic signs and symptoms of infection (purulent exudate, erythema, heat, and edema) are not always present and an increased pain sensation may be a sign of infection. In 2 articles, the WUWHS and the EWMA reported additional clinical signs and symptoms to consider when infection is suspected: tissue becomes necrotic, prolonged healing, and deterioration of the wound bed.[7,8]

What Is the Best Culture Technique to Sample for Microbial Load?

There are three techniques that can be used to identify colonization or infection.[5,19] The three techniques are deep–tissue or punch biopsy, needle aspiration and swab culture.[5,19] The swab culture technique is most commonly used because it is practical, simple, noninvasive and cost effective.[5,19] Swab culture of a chronic wound does may not identify all types of microbes and does may not identify any microbial load in the deep tissue, and it may only identifies surface bacteria.[1] Wound biopsy sent for culture and sensitivity testing, on the other hand, is the gold standard in identifying bacteria in the wound bed.[1] However, this is more invasive for the patient, causes pain, and is more expensive.[1,5] The simple swab culture is the most commonly used technique because it is practical, noninvasive and cost-effective and in most cases, can identify the bacteria causing wound infection that can guide toward antibiotics via sensitivity testing.[5]

Five articles discussed the best sampling technique to evaluate the chronic wound for infection.[5,10,15-17] The gold standard to evaluate wound infection in a chronic wound is tissue biopsy.[5,8,15,16] However, tissue biopsy is not always feasible and not everyone has the skills to do a tissue culture.[5] Reddy and colleagues[10] stated that when a swab culture needs to be done, it needs to be done correctly. However, there is question over which swab culture technique is best. Bonham[5] reported in her review that if a swab culture were to be done, the Levine technique would be the recommended method and needed to be done correctly to identify the bacteria causing infection.[5] The WUWHS simply reported that a swab culture can be misleading because the true bacteria causing infection may present itself underneath the wound bed.[8]

The 2 techniques for swab cultures are the Levine technique and Z-technique. The Levine technique requires twirling the end of a sterile cotton-tipped applicator on a 1-cm^2 area for 5 seconds with enough pressure to cause minimal bleeding of the underlying tissue versus Z-tract or 10-point zigzag over the whole wound bed.[5] There are limitations in using a swab culture to identify pathogens causing wound infection. Swab culture reflects surface bacteria rather than the pathogen invading the deeper tissue.[5] However, other investigators report that swab cultures have sufficient correlation with biopsy to identify bacterial burden.[5]

Four articles evaluated the swab techniques, the RCT by Angel and colleagues,[15] the scoping review by Rondas and colleagues,[16] the quasi-experimental study by Smith and colleagues,[17] and the systematic review by Reddy and colleagues.[10] Angel and colleagues[15] compared the Levine technique versus Z-technique on 50 subjects and found that, overall, the Levine technique is superior to the Z-technique when swabbing a clinically infected wound. The results revealed that the Levine

TABLE 2.
Literature Summary

Author/Citation	Study Design and Strength (Level and Quality)	Sample Size and Description	Intervention/Outcome Measures	Key Findings	Limitations
Angel and colleagues[15]	(RCT) Prospective RCT of 2 paired wound-swabbing techniques (level A—good quality)	Study setting: An 855-bed university teaching hospital in Australia 50 patients recruited from the inpatient and outpatient settings	Purpose: Compare 2 wound-swabbing techniques, Levine technique vs Z-technique, in determining the causative organism in infected cutaneous wounds	Overall, the Levine technique provides the clinician with evidence of superiority over the Z-technique when swabbing a clinically wound. To use the Levine technique, the wound needs to be at least 1 cm^2. To use the Z-technique, the wound must be of the sufficient size to have a 10-point zigzag crossing the entire wound bed. Swab cultures do not detect biofilms.	Study conducted in Australia. Results should not be generalizing to the US population. Sample size small Swabs might not detect any bacteria in a biofilm. Order of swab cultures on the same patient was randomized by flip of the coin.
Bonham[5]	Literature review (level C—good quality)	Literature review: 19 studies from 1950 to 2008 -15 studies compared swab culture to tissue biopsy as the reference standard -2 compared swab cultures to needle aspirations -1 study compared swab cultures to clinical signs and symptoms of infection -1 compared semiquantitative to quantitative swab cultures Expert opinion about swab cultures: -1 systematic review -1 practice guidelines -9 review articles -3 studies about infection diagnosis were reviewed -Swab culture procedures from 22 expert opinion articles were retrieved to complete the review process	Purpose: Examine research and published expert opinion about swab cultures for the diagnosis of wound infection The results will be used to propose a guideline for performing swab cultures. Inclusion criteria for the literature review: Swab cultures were performed on human subjects and compared to a reference standard and 1 or more aspects of the procedure for collecting the swab culture were described.	Data have shown that tissue biopsy is a valid and reliable method to diagnose wound infection but is an invasive procedure and can be impractical in some settings. Findings of the literature review: When a swab is taken properly, it can identify bacteria and guide antibiotic therapy.	None stated

(*continues*)

TABLE 2.
Literature Summary (*Continued*)

Author/Citation	Study Design and Strength (Level and Quality)	Sample Size and Description	Intervention/Outcome Measures	Key Findings	Limitations
European Wound Management Association (EWMA)[7] position document: *Identifying Criteria for Wound Infection*	Position document reviewing 4 articles (level C—high quality)	Paper 1: Understanding wound infection: (Article only) Understand what occurs in the wound bed before infection and understand critical colonization Paper 2: "Clinical Identification of Wound Infection: A Delphi Approach" 54 wound care experts generated criteria for wound infection in different types of wounds Paper 3: Identifying criteria for pressure injury infection Delphi approach Sample size of literature review unknown		Paper 1: No study. By Moffatt CJ: Development of infection is dependent on host immune response and virulence of microorganism. Full holistic assessment on a patient is required to assess wound infection. Paper 2: Cutting KF, White RJ, Mahoney P, et al: Cellulitis, malodor, pain, delayed healing, and/or deterioration of wound/wound breakdown are criteria for identifying infection in acute wounds, arterial ulcer, burns, diabetic foot ulcer, pressure injury, and venous leg ulcer. Paper 3: Sanada H, Nakagami G, Romanelli M: Grade 3 and 4 (now known as stage 3 and 4) pressure injuries are chronic open wounds. Pressure injury often in the pelvic region with a risk of increased contamination from feces or urine, and it often contains necrotic material that has been shown to have a high level of aerobes and anaerobes. Needs early recognition in identifying wound infection to prevent complications, such as osteomyelitis and bacteremia.	
Reddy and colleagues[10]	Systematic review w/meta-analysis methods (level A—good quality)	15 studies reviewed These 15 studies included 985 patients with a total of 1056 chronic wounds	Purpose/Objective: To determine the accuracy of clinical symptoms and signs to diagnose infection in chronic wound and to determine whether there is a preferred noninvasive method for culturing wounds One author identified potential studies Three authors independently reviewed studies for quality (used Simel[24] for the level of evidence) One author extracted data for diagnostic text	Prevalence of infection of chronic wound in all 15 studies was 53%. Two studies showed a likelihood of infection with increased pain in ulcer. Signs of purulent exudates, erythema, heat, and edema (classic signs of wound infection) not helpful to diagnose infection of chronic wound. A quantitative swab culture with a Levine technique helpful to identify and predict wound infection when comparing with other noninvasive diagnostic tests of infection in the chronic wound.	Studies reviewed had limited quality.

(*continues*)

TABLE 2.
Literature Summary (*Continued*)

Author/Citation	Study Design and Strength (Level and Quality)	Sample Size and Description	Intervention/Outcome Measures	Key Findings	Limitations
Rondas and colleagues[16]	Literature review—scoping (level C—good quality)	6 studies reviewed: 3 = reviews 2 = observational studies using a cross-sectional design 1 = RTC	Purpose: Review articles to evaluate wound-swabbing technique (Levine technique vs Z-technique) and comparing it with a wound biopsy	When comparing the Levine technique with Z-technique, it is suggested that the Levine technique is the most valid method to demonstrate infection of a chronic wound.	Varied results in the literature make it difficult to draw sound conclusions.
Smith and colleagues[17]	Comparative, quasi-experimental Comparing paired culture results with swab vs curetted tissue (level B—good quality)	9 clients and 12 wounds A total of 38 cultures (19 swab cultures and 19 tissue cultures) Participants had chronic open VSU that was at least 8 wk old, except for 1 wound that was due to recurrent tissue necrosis from local drug injection Additional eligibility to participate in the study: Participants could not have any soft-tissue infection or any local cellulitis. This was assessed by the study physician.	Purpose: To compare results from swab cultures and tissue cultures collected from the same chronic wound bed Tissue samples were collected postdebridement using a sterile curette. One swab and one tissue culture were taken on each visit.	Swab cultures and curetted tissue cultures resulted in similar results in recovering aerobic and anaerobic bacterial burden. Swab technique is not inferior to curetted tissue culture.	Small study sample Participants came from a needle exchange program and therefore are not a representative of the general population. Cultures from wounds with no clinical signs of infection
World Union of Wound Healing Societies (WUWHS)[8] Principles of Best Practice: *Wound infection in Clinical Practice. An International Consensus*	Consensus opinion of an international panel of experts treating wound infection in different situations (level C—good quality)	19 references reviewed 13 expert working groups from Australia, USA, the United Kingdom, Germany, Japan, Canada, Sweden, South Africa, and Italy	Purpose: Provide clear and safe guidance on diagnosis and topical/systematic treatment of bacterial wound infection Outcome measures: 1. Principle of best practice 2. Diagnosis 3. Management 4. Topical antimicrobial 5. Systemic antimicrobial	Wounds often contain bacteria and without a detrimental effect. Presence of bacteria may result in a spectrum of bacteria virulence (contamination, colonization, localized infection, spreading infection, systemic infection). Diagnosis of a wound infection is often on clinical grounds. Assessment for a wound infection should be on the patient, the tissue around the wound, and the wound itself for signs and symptoms of infection. Factors likely to increase wound infection: comorbidities, medication, and psychosocial factors. Chronic wounds that are at risk for infection are necrotic tissue, of prolonged duration, large or deep wounds, anatomically near a potential contamination (eg, anal) area. Different wound etiology may produce varying signs and symptom of infection. Wound swab is widely used but may mislead the true pathogen-causing infection, as it may be present underneath the wound bed. Wound biopsy provides the most accurate information about the type and quantity of pathogenic bacteria but is invasive.	Expert opinion

Abbreviations: RCT, randomized controlled trial; VSU, venous stasis ulceration.

technique detected more organisms than the Z-technique. Investigators reported that there is growing evidence supporting wound swab culture compared to tissue biopsy.[15] Rondas and colleagues[16] reviewed studies (n = 38-83) comparing wound swabs using the Levine technique with Z-technique and compared it to a tissue biopsy. They had varied results but recommended the Levine technique over Z-technique and suggested that it is a valid method to demonstrate infection of a chronic wound.[16] Reddy and colleagues[10] in their systematic review[10] reviewed literature for the preferred swab technique and concluded that a quantitative swab using the Levine technique is helpful to predict wound infection. They reviewed 15 studies, including 985 patients with 1056 wounds.[10] The authors stated a limitation was that the studies reviewed had poor validity.[10] Smith and colleagues[17] compared swab cultures with tissue cultures. They compared 19 paired cultured, curetted tissues, and swab cultures from 9 clients that totaled 12 venous wounds that were at least 8 weeks old. These wounds were cleaned and debrided prior to sampling and then curetted for a tissue culture and swabbed for a culture. Their results demonstrated that culture swabs recovered more organisms than the curetted tissue culture. This study suggests that a swab culture technique is not inferior to curetted tissue cultures. Limitation to the study was that it had a small sample size and therefore results cannot be projected to the general population. This is a fairly recent study and adds to the body of evidence that a swab culture provides a comprehensive description of the wound flora.

SORT Statement

The Strength of Recommendation Taxonomy (SORT), developed by Ebel and colleagues,[20] addresses the quality, quantity, and consistency of evidence and allows the rating of bodies of evidence using a systematic and structured method. Using an adapted criterion of the SORT methodology described by Gray and colleagues,[12] we accorded the body of evidence related to a recommendation for when a culture should be performed on the chronic wound bed as a level 2 evidence and for our second PICO question, "What is the best method to take a culture?" we rated the evidence as level 1. SORT level 2 is based on results of 1 level A study or of inconsistent (mixed) findings from 2 or more level A studies. SORT level 1 is based on consistent findings from 2 or more studies with level A evidence recommendation. See Table 3.

TABLE 3.
Strength of Recommendation for Treatment (SORT)[a]

Level of Recommendation	Description
Level 1	Based on consistent findings from 2 or more studies with level A evidence
Level 2	Based on results of 1 level A study or on inconsistent (mixed) findings from 2 or more level A studies
Level 3	Based on studies whose highest level of evidence is B
Level 4	Based on level C evidence (expert opinion, case series/case studies, etc)

[a]From Essential Evidence Plus: Levels of Evidence and Oxford Center for Evidence-Based Medicine, adapted by Gray and colleagues.[12,13]

Recommendation for Practice

Evidence indicates that identification of potential chronic wound infection should be considered early using clinical signs such as pain, necrotic tissue, delayed healing, and wound deterioration (in addition to classic signs of infection) to determine the need for collecting a culture (SORT level 2). When a culture is deemed necessary, swab culture using the Levine method is a clinically practical alternative if performed correctly (SORT level 1).

Clinical Implications

There were other sources of evidence that were not included in the 7 studies answering the PICO question due to not meeting all inclusion criteria but worth mentioning. Miller and colleagues[21] in Australia evaluated nurses' clinical judgment of wound infection and found no association between nurses' observations and the bacterial burden or presence of infection. Another study conducted by Bamberg and colleagues[6] surveyed 345 wound care clinicians using a 34-item questionnaire on chronic wound infection. The participants were registered nurses, physical therapists, and physicians from acute care, wound clinics, nursing homes, veterans hospitals, and prison health services 69% held certification in wound care. They cared for a variety of wounds such as venous ulcers, pressure ulcers, arterial insufficiency ulcers, frostbite, wound grafts, and lymphatic wounds. The results demonstrated that clinicians relied on clinical characteristics to diagnose wound infection along with patient-reported symptoms.[6] Respondents indicated that 79% of wounds had a positive sign of infection and a positive culture.[6] In addition, 12% of clinicians cultured wounds before treatment was begun.[6] One can assume that this might have been part of their algorithm to care for chronic wounds, but it could also be viewed as routine culturing.

Siddiqui and Bernstein[1] discuss the bedside mnemonic NERDS and STONEES as a potential way to differentiate critical colonization and infection.[22] NERDS refers to a nonhealing wound, presence of inflammatory exudate, red and bleeding wound, debris in the wound, and smell or odor from the wound.[1] STONEES refers to wound size increase, increased wound temperature, one can probe to the bone, new area of wound breakdown, exudates, edema, and erythema, and smell.[1,23] I found no studies of NERDS and STONEES but they were mentioned in many text books and articles.

There is a need for thorough education of clinicians in screening chronic wounds for wound infection, followed by a culture to make definitive diagnosis of wound infection.[6] The review and consensus document by the WUWHS[8] responded to this need through development of its consensus statement. In the consensus statement, signs and symptoms of infection for the chronic wound were traditional clinical symptoms such as abscess, cellulitis, inflammation, and purulence, but the WUWHS added additional criteria because, often, the traditional symptoms were absent.[8] Additional criteria for chronic wound infection were delayed healing, discoloration, friable granulation tissue that bleeds easily, unexpected pain/tenderness, pocketing at the base of wound, bridging of the epithelium or soft tissue, an abnormal swelling, and additional tissue breakdown around the wound.[8] While the position document was reviewed by wound care professionals in the United Kingdom, one can apply these additional signs and symptoms of infection across all chronic wounds as is evidenced by the commonly used mnemonics mentioned previously. It is reasonable to conclude that a well-trained wound care clinician can identify changes in the chronic wound, using the aforementioned

signs and symptoms of a wound infection. This supports the work of Bonham[5] and her literature review and guideline development of swab culture technique.

CONCLUSIONS

Infection is common in chronic wounds and results in delayed healing, adding to increased health care costs.[2] However, identification of infection in a chronic wound is often difficult.[6] This leads to variation in practice among clinicians to determine when treatment to eliminate infection is warranted and what the best culture method is.[9] This EBRC answers our 2 PICO questions and provides 2 recommendations for practice that are supported by a thorough review of the current evidence using objective and structured methodology.

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