

# C L I N I C A L M A N A G E M E N T

# extra

## Local Wound Care for Malignant and Palliative Wounds



**CATEGORY 1**

1 Credit



**ANCC**

2.6 Contact Hours

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Dr Woo has disclosed that he is/was a recipient of grant/research funding from Mölnlycke, 3M, KCI, BSN Medical, Systagenix, Medline, and Ogenix; he was a recipient of grant/research funding from the Canadian Association of Wound Care and the Registered Nurses Association of Ontario; he is/was a consultant/advisor to ConvaTec and Hollister; and is a consultant/advisor to Healthpoint and the Canadian Association of Wound Care; and is/was a member of the speaker's bureau for Coloplast and Mölnlycke. Dr Sibbald has disclosed that he is a recipient of grant/research funding from 3M, Smith & Nephew, and ConvaTec; is a consultant/advisor to Coloplast, Covidien, and Mölnlycke; and is a member of the speaker's bureau for KCI, Johnson & Johnson (Systagenix), the Government of Ontario, and the Registered Nurses Association of Ontario. The authors have disclosed they will discuss unlabeled/investigational uses for Biatain Ibu.

All staff and faculty, including spouses/partners (if any), in a position to control the content of this CME activity have disclosed that they have no financial relationships with, or financial interests in, any commercial companies pertaining to this educational activity.

This continuing educational activity will expire for physicians on September 30, 2011.

### PURPOSE:

**To enhance the clinician's competence in providing local wound care for malignant and palliative wounds.**

### TARGET AUDIENCE:

**This continuing education activity is intended for physicians and nurses with an interest in skin and wound care.**

### OBJECTIVES:

**After participating in this educational activity, the participant should be better able to:**

- 1. Apply patient prognosis to realistic outcomes, patient education, and pain management strategies.**
- 2. Demonstrate ability to assess wounds and select appropriate dressings.**
- 3. Analyze patient scenarios for use of various non-dressing wound treatment modalities.**

## INTRODUCTION

Wounds being treated as part of palliative care, including malignant wounds, are a subgroup of chronic cutaneous wounds that are often complex and recalcitrant to healing and may not follow a predictable trajectory of repair despite standard interventions and treatment of the underlying malignancy.<sup>1</sup> The exact mechanisms that contribute to poor wound healing remain elusive but likely involve an interplay of systemic and local factors. To establish realistic objectives, wounds are classified as healable, maintenance, and nonhealable, based on prognostic estimation of the likelihood to achieve healing.<sup>2</sup> Table 1 illustrates wound prognosis and realistic outcomes.

After reading this article, clinicians will be better able to evaluate the key challenges and select the appropriate strategies to provide comprehensive care for patients with malignant wounds.

## PALLIATIVE WOUNDS

Patients at the end of their lives are vulnerable to skin breakdown that may not always be prevented, as a result of the deterioration of the body and multiple systems failure that are intrinsic to the dying process. Underlying physiological changes lower tissue perfusion that compromise cutaneous oxygen tension, delivery of vital nutrients, and removal of metabolic wastes.<sup>7</sup> In fact, observable signs of skin changes and related ulceration have been documented in more than 50% of individuals within 2 to 6 weeks prior to death.<sup>8</sup>

Wounds and associated skin changes that develop in palliative patients are generally considered as nonhealable in light of poor health condition and the demands of treatment that may outweigh the potential benefits. These patients often suffer from conditions that are incurable but life-limiting including malignancy, severe malnutrition, advanced diseases associated with

**Table 1.**  
**WOUND PROGNOSIS AND REALISTIC OUTCOMES**

Wound Prognosis	Can the Cause Be Treated?	Coexisting Medical Condition/Drugs	Goal/Objective
Healable	Yes, the cause has been corrected or compensated with treatment For example, a malignant wound can be excised with clear resection margins	Coexisting medical conditions and drugs that do not prevent healing	<ul style="list-style-type: none"> <li>Promote wound healing</li> <li>For example, venous ulcers: 30% smaller<sup>3</sup> by week 4 to heal by week 12</li> </ul>
Maintenance	No, poor treatment adherence or lack of appropriate resources For example, a patient declines surgery for repair of a defect secondary to breast surgery and radiation that is negative for residual malignancy	Coexisting medical conditions and drugs that may stall healing; eg, hyperglycemia <sup>4</sup>	<ul style="list-style-type: none"> <li>Prevent further skin deterioration or breakdown, trauma, and wound infection</li> <li>Promote patient adherence</li> <li>Advocate for patients to acquire appropriate resources</li> <li>Optimize pain and other symptom(s) management<sup>5</sup></li> </ul>
Nonhealable, palliative, or malignant	No, a cause that is not treatable For example, there is widespread metastasis, including the skin, advanced stages of cutaneous malignant conditions, and chronic osteomyelitis	Coexisting medical conditions that would prevent normal healing, <sup>6</sup> such as advanced terminal diseases, malignant conditions, poor perfusion, malnutrition with low albumin (<20 mg/dL) or negative protein balance, significant anemia (hemoglobin <80 g/dL), or high-dose immunosuppressive drugs	<ul style="list-style-type: none"> <li>Prevent further skin deterioration or breakdown, trauma, and wound infection</li> <li>Promote comfort</li> <li>Optimize pain and other symptom management<sup>5</sup></li> </ul>

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major organ failure (renal, hepatic, pulmonary, or cardiac), and, in some cases, profound dementia.<sup>9,10</sup> Management of these cutaneous palliative wounds is challenging to patients and their healthcare providers. Although wound healing may not be realistic, it is imperative to maintain patients' dignity and quality of life by addressing psychosocial concerns (fear of dying), empowering patients' independence, promoting the highest achievable quality of life and activities of daily living, and optimizing pain management.<sup>11,12</sup>

## MALIGNANT WOUND

A malignant wound can result from

- tumor necrosis,
- fungating tumor cells,
- ulcerating cancerous wound, or
- malignant cutaneous wound.

Infiltration of malignant cells in these wounds is secondary to local invasion of a primary cutaneous lesion or metastatic spread.

The following scenarios should raise the index of suspicion of malignancy:

- Wounds that are a manifestation of primary skin cancer and certain types of malignancies: for example, basal cell carcinoma, squamous cell carcinoma, melanoma, Kaposi sarcoma, cutaneous lymphomas, and cutaneous infiltrates associated with leukemia.<sup>13</sup>
- Be cautious of wounds in patients with a history of cancer to rule out cutaneous metastasis. Malignant wounds have been estimated to affect 5% to 19% of patients with metastatic disease.<sup>14-16</sup> In another study, Lookingbill et al<sup>17</sup> reported that 5% of cancer patients develop malignant wounds. The chest and breasts and the head and neck, followed by the abdomen, are the most common sites where metastatic malignant wounds develop.<sup>18-20</sup>
- Wounds that do not heal over a long time may exhibit chronic inflammation that can undergo malignant transformation. A Marjolin ulcer or a squamous cell carcinoma may develop in an area of chronic inflammation.<sup>21,22</sup> These changes have been documented from a chronic osteomyelitis sinus, persistent trauma, and burn scar.<sup>23,24</sup>
- Chronic wounds in patients with chronic immunosuppression and drugs that can predispose patients to skin ulceration (eg, azathioprine, methotrexate, and cyclosporine therapy) and other immunodeficiency disorders, including HIV infection.<sup>14,24</sup>
- Wounds secondary to treatment of malignancies, such as late radiation therapy change breakdown or the development of a secondary malignancy.<sup>25</sup>

Extension of a tumor to the surface of the skin may initially present as localized raised induration and evolve to a

fungating or ulcerative skin lesion (Figure 1). Fungating lesions are fast growing and typically resemble a cauliflower or fungus-shaped structure extending beyond the skin surface.<sup>26</sup> On the other hand, ulcerative lesions are characterized by deep craters with raised margins. As the tumor continues to grow, disrupting blood supply and outstripping local tissue perfusion, hypoxia is inevitable, creating areas of necrosis.<sup>26,27</sup> The presence of necrotic tissue establishes an ideal milieu for secondary bacterial proliferation. Vertical extension of the tumor, however, may reach the deeper structure, leading to sinus or fistula formation. Obstruction of normal vascular and lymphatic flow has been linked to copious exudate production and edema.<sup>28-32</sup>

## MANAGEMENT OF MALIGNANT WOUNDS: HOPES

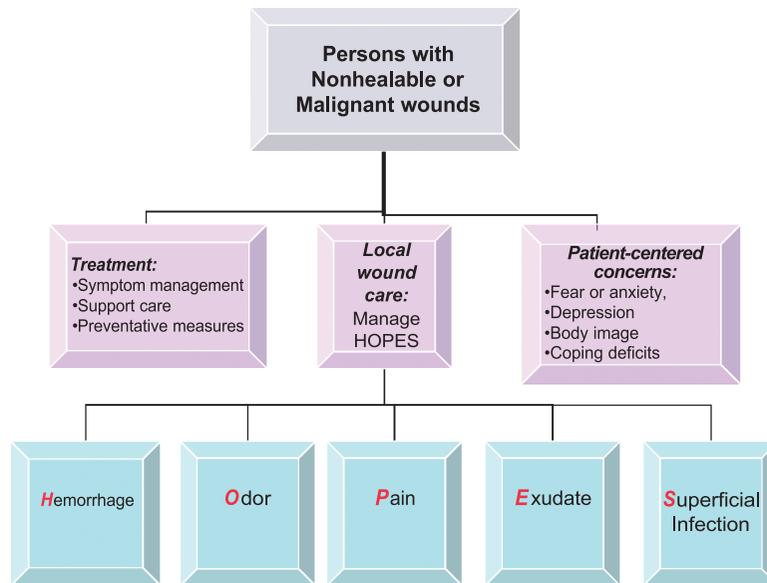
A systematized and comprehensive approach is required to manage the complexity of malignant and palliative wounds and optimize patient outcomes. The plan of care begins with treating the wound cause where possible and addressing patient-centered concerns prior to local wound care. In addition to treating the cause, based on previous study results,<sup>19,33,34</sup> local wound care must be modified to address several key concerns, including hemorrhage, odor, pain, exudate, and superficial infection (HOPES). Wound management for malignant wounds is outlined in Figure 2.

**Figure 1.**  
**FUNGATING LESIONS RELATED TO METASTATIC CERVICAL CANCER**



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**Figure 2.**  
**WOUND MANAGEMENT FOR NONHEALABLE AND MALIGNANT WOUNDS**



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## TREATMENT APPROACH

Although the management of palliative and advanced malignant wounds is centered on symptom management, other supportive strategies to prevent exacerbation of existing wounds and emergence of new ulcers are equally important.<sup>35–44</sup>

Under judicious deliberation, therapies including radiotherapy, surgery, laser therapy, chemotherapy, and hormonal blocking agents may be considered to reduce the tumor size and alleviate associated symptoms.<sup>45–47</sup> Topical application of anticancer agents, such as mitomycin and imiquimod, may delay tumor progression.<sup>48,49</sup>

## PATIENT-CENTERED CONCERNS

Malignant and palliative wounds constitute a significant source of emotional distress to patients and their families.<sup>11</sup> To address patient-centered concerns,<sup>50–52</sup> clinicians must engage, empathize, educate, and enlist their patients in the overall plan of care.<sup>53–55</sup>

## LOCAL WOUND CARE ISSUES: HOPES

### H: Hemorrhage or Bleeding

The granulation tissue within a malignant wound is often friable and bleeds easily because of local stimulation of vascular

endothelial growth factor, resulting in excess formation of abundant but fragile blood vessels. Reduced fibroblast activity and ongoing thrombosis of larger vessels in infected and malignant wounds may compromise the strength of collagen matrix formation, rendering the granulation less resilient to trauma.<sup>56</sup> Even minor trauma from the removal of wound dressings that adhere to wound surface could provoke bleeding.<sup>57</sup> Overall health conditions (eg, abnormal platelet function, vitamin K deficiency) may also put patients with cancer and other terminal diseases at risk of bleeding. Frank hemorrhage can occur as the tumor erodes into a major blood vessel.

A variety of hemostatic agents can be applied topically to control hemorrhage (Table 2). These topical hemostatic agents vary in cost, application, and mechanisms. Examples include natural hemostats (calcium alginates, collagen, and oxidized cellulose), coagulants (absorbable gelatin powder from absorbable gelatin sponge or topical thrombin), sclerosing agents (silver nitrate, trichloroacetic acid), vasoconstrictors (epinephrine), fibrinolytic inhibitors (tranexamic acid), and astringents (alum solution, sucralfate).<sup>58–60</sup> For minor bleeding, agents such as calcium alginates are readily available as a wound dressing. Calcium, as part of the alginate, is released into the wound in exchange for sodium, potentially triggering the coagulation cascade. The sodium

**Table 2.**  
**TOPICAL HEMOSTATIC AGENTS**

Category	Example	Comments
Natural hemostats	Calcium alginates Collagen Oxidized cellulose	<ul style="list-style-type: none"> <li>• Control minor bleeding</li> <li>• Available as a dressing material</li> <li>• Bioabsorbable</li> </ul>
Coagulants	Gelatin sponge Thrombin	<ul style="list-style-type: none"> <li>• Expensive products</li> <li>• Risk of embolization</li> </ul>
Sclerosing agents	Trichloroacetic acid Silver nitrate	<ul style="list-style-type: none"> <li>• May cause stinging and burning upon application</li> <li>• Leaves a coagulum that can act as a proinflammatory stimulus</li> </ul>
Fibrinolytic antagonists	Tranexamic acid	<ul style="list-style-type: none"> <li>• Oral agent</li> <li>• Gastrointestinal adverse effects (nausea/vomiting)</li> </ul>
Astringents	Alum solution Sucralfate	<ul style="list-style-type: none"> <li>• May leave a residue on wound</li> </ul>

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alginate then converts the fiber to a hydrogel, promoting local comfort and protection. In severe cases, suturing a proximal vessel, intravascular embolization, laser treatment, cryotherapy, radiotherapy, and electrical cauterization may be necessary.<sup>58</sup>

### O: Odor

Unpleasant odor and putrid discharge are associated with increased bacterial burden, particularly involving anaerobic and certain Gram-negative (eg, *Pseudomonas*) organisms.<sup>56</sup> Metabolic byproducts that produce this odor include volatile fatty acids (propionic, butyric, valeric, isobutyric, and isovaleric acids), volatile sulfur compounds, putrescine, and cadaverine. To eradicate wound odor, metronidazole as an anti-inflammatory and anti-infective agent against anaerobes has been demonstrated to be efficacious.<sup>61,62</sup> Topical application of metronidazole is readily available as a gel and cream. Alternatively, gauze can be soaked with intravenous metronidazole solution to use as a compress, or tablets can be grinded (only with a fume hood to avoid inhalation of aerosolized particles) into powder and sprinkled onto the wound surface. Some patients derive the greatest benefit if the metronidazole is administered orally.

Activated charcoal dressing has been used to control odor with some success. To ensure optimal performance of charcoal

dressing, edges should be sealed, and the contact layer should be kept dry.<sup>26–30,63</sup> If topical treatment is not successful or practical, putting odor-absorbing agents such as kitty litter or baking soda (not charcoal; only works as a filter) beneath the bed may reduce odor.

### P: Pain

Pain is consistently reported by patients as one of the worst aspects of living with chronic wounds impacting on their quality of life.<sup>64</sup> Wound-related pain is frequently experienced during dressing changes. Dressing materials adhere to the fragile wound surface because of the glue-like nature of dehydrated or crusted exudate; each time the dressing is removed, potential local trauma may evoke pain. Granulation tissue and capillary loops that grow into the product matrix, especially gauze, can also render dressing removal traumatic.<sup>57</sup> According to a review of dressings and topical agents for secondary intention healing of postsurgical wounds, patients experienced significantly more pain with gauze than other types of occlusive dressings.<sup>65</sup> Nonetheless, gauze continues to be one of the commonly used dressing materials, indicating a need to bridge research to practice.<sup>33</sup> Careful selection of dressings with atraumatic and nonadherent interfaces, such as silicone, has been documented to limit skin damage/trauma with dressing removal and minimize pain at dressing changes.

Avoidable pain may also result from damage to the peri-wound skin. Too frequent or too aggressive dressing removal can strip away the outer layers of the epidermal stratum corneum, irritating the skin.<sup>66</sup> Clinicians are advised to perform gentle and infrequent dressing removal, particularly in fragile palliative care patients. Some patients may develop contact irritant and allergic dermatitis to corrosive wound exudate and dressing components, resulting in local erythema, edema, and blistering on the wound margins. Patch testing is required to determine allergy. To minimize trauma induced by too vigorous or too frequent adhesive dressing removal, a number of sealants, barriers, and protectants, such as wipes, sprays, gels, and liquid roll-ons, are useful on the periwound skin (Table 3).<sup>67</sup>

Topical agents or dressings play a critical role in alleviating wound-related pain. Slow-release ibuprofen foam dressings (available in Canada and Europe, but not in the United States) have demonstrated reduction in persistent wound pain between dressing change and temporary pain on dressing removal.<sup>68</sup> Clinicians outside the United States may consider the use of topical morphine (which is not currently approved by the US Food and Drug Administration) and lidocaine/prilocaine for acute or procedure-related pain.<sup>69</sup> However, the lack of pharmacokinetic data for the use of topical morphine precludes the routine clinical use of these compounds at this time. There are many advantages to using local rather than systemic treatment.

**Table 3.****STRATEGIES TO PROTECT PERIWOUND SKIN**

Type	Description	Application	Comments
Silicone	Polymers that include silicone together with carbon, hydrogen, oxygen	Apply to periwound skin	Allergy is rare; certain types of silicone product are tacky, facilitating dressing adherence to the skin without any adhesive
Zinc oxide/ petrolatum	Inorganic compounds that are insoluble in water	Apply a generous quantity to skin	May interfere with activity of ionic silver
Acrylates	Film-forming liquid skin preparation to form a protective interface on skin attachment sites	Spray or wipe on skin sparingly	Allergy is uncommon; facilitates visualization of periwound skin
Hydrocolloid or adhesive film dressing	A hydrocolloid wafer consists of a backing with carboxymethylcellulose as the filler, water-absorptive components, such as gelatin and pectin (commercial gelatin desserts), and an adhesive	Window frame the wound margin to prevent recurrent stripping of skin	Allergies have been reported from some colophony-related adhesives (Pentylin H) associated with some hydrocolloid dressings

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Any active agent is delivered directly to the affected area, bypassing the systemic circulation, and the dose needed for pain reduction is low with minimal risk of adverse effects.

For severe pain, clinicians may need to consider oral agents combining long-acting narcotics (oral, patch), as outlined in the World Health Organization Pain Ladder, with adjunctive agents for the neuropathic component and short-acting agents for breakthrough. In resistant cases, clinicians may consider using general anaesthesia, local neural blockade, spinal analgesia, or general anesthesia or using mixed nitrous oxide and oxygen.<sup>70,71</sup>

Next to dressing removal, wound cleansing is also likely to evoke pain during the dressing change. In a recent study by Woo,<sup>72</sup> patients with chronic wounds rated cleansing as the most painful part of dressing change. Routine practice of using abrasive materials and gauze to scrub the wound surface is discouraged. Techniques that involve compressing and irrigation may be less traumatic and painful. In the presence of unexpected pain or tenderness, clinicians should consider antimicrobial therapy for wound infection. Gardner et al<sup>73</sup> evaluated the validity a checklist of 12 clinical signs and symptoms to identify localized chronic wound infection (n = 36). Subjects with no indications of wound infection did not express increased levels of pain. Pain is a useful indicator of infection with high specificity value (100%) and interrater reliability ( $\kappa$  = 0.73) from this small study.<sup>73,74</sup>

A systematized approach to wound-related pain is summarized in Figure 3 based on a previous published model for the management of wound-related pain.<sup>75</sup>

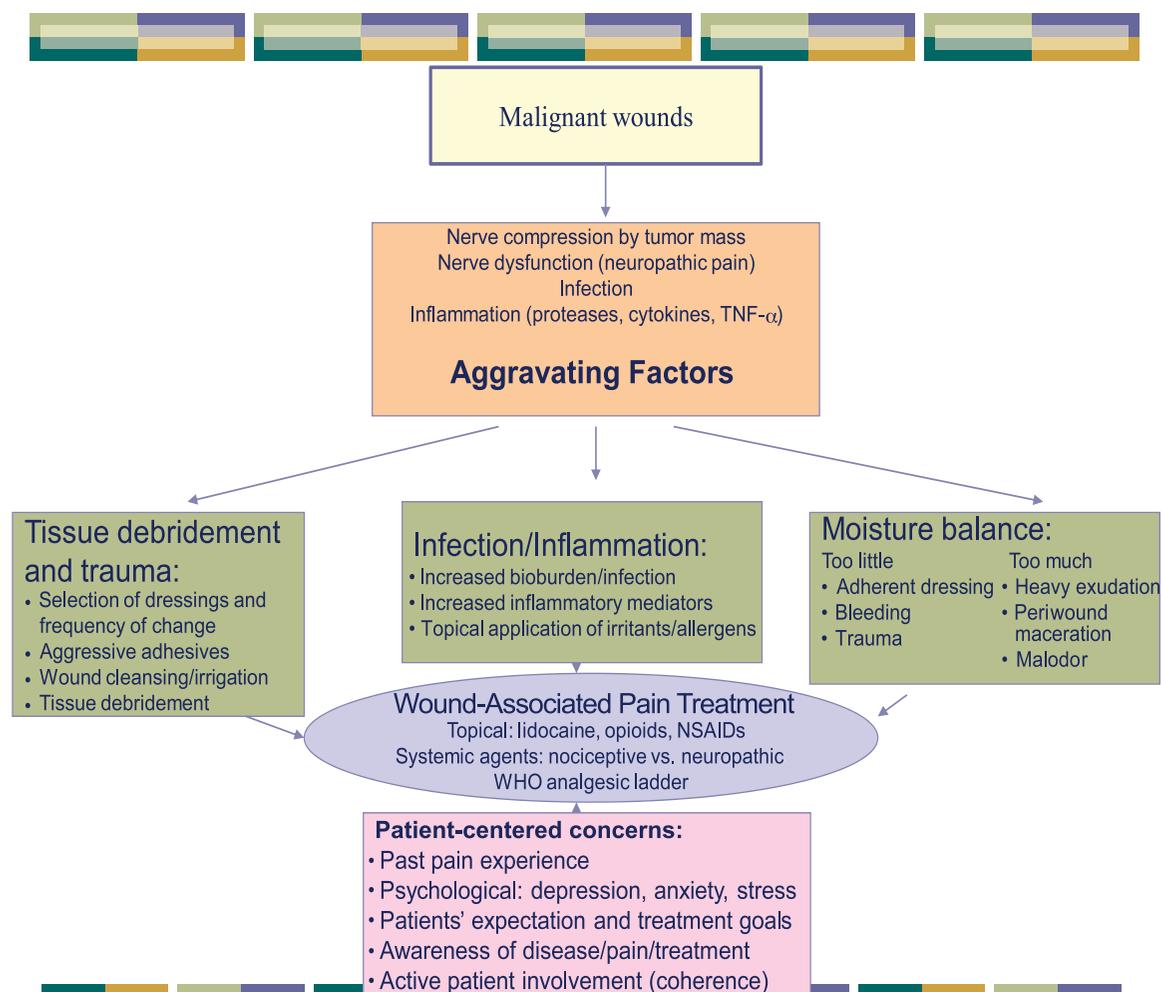
## E: Exudate

Exudation is promoted by inflammation that may be associated with infection. Vasodilation and increased permeability of the capillaries permit the passage of fluid and cellular elements to travel through the vessel walls. Excessive moisture creates an ideal wound environment for bacteria to proliferate, especially when the host defense is compromised. Moisture is contraindicated in nonhealable wounds; hydrating gels and moisture-retentive dressings (hydrocolloids) should be avoided.<sup>76</sup> To contain and remove excess exudate from the wound, a plethora of absorbent dressings has been developed. Major categories of dressings include foams, alginates, and hydrofibers, along with superabsorbent products based on diaper technology.<sup>26–30,76–78</sup>

## SUPERFICIAL INCREASED BACTERIAL BURDEN AND DEEP INFECTION

All chronic wounds contain bacteria. Critical to wound management is whether bacterial balance is maintained (contamination or colonization) or bacterial damage (critical colonization or localized infection) has occurred.<sup>56</sup> In brief, contamination refers to bacteria on the surface of a wound. When bacteria attach to tissue and proliferate, colonization is established. With compromised host resistance in palliative patients, bacteria can cause local tissue damage in the superficial wound compartment. This phenomenon is referred to in the literature as critical colonization, increased bacterial burden, covert infection, or localized infection. Some bacteria prefer the superficial and relatively hypoxic wound environment—not all species have the virulence to invade the deep compartment. When the bacteria invade and damage the

**Figure 3.**  
**PAIN IN PATIENTS WITH MALIGNANT WOUNDS**



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surrounding and deeper or surrounding structures, the classic signs and symptoms of deep tissue infection are revealed.<sup>56</sup>

Wound bacterial damage can be divided into superficial and deep component.<sup>56</sup> Signs of surface-increased bacterial burden may include the signs represented by the letters in the mnemonic NERDS: **n**onhealing, **e**xudate, **r**ed-friable tissue, **d**ebris, and **s**mell. Signs of deep and surrounding-skin bacterial infection include the components of the mnemonic STONEES: **s**ize increase, **i**ncreased **t**emperature, **o**s or probing to bone, **n**ew areas of breakdown in the surrounding tissue, **e**rythema and/or edema, **e**xudate, and **s**mell. If 3 or more signs of NERDS or STONEES are present, this indicates probable superficial critical colonization or bacterial damage or deep infection. Exudate and

smell are present in both compartments; thus, an additional criterion is necessary to delineate superficial, deep infection, or both. By focusing on salient clinical signs to separate superficial and deep compartment involvement, the clinician can consider therapeutic options that are most appropriate and cost-effective. Superficial bacterial burden can be reduced by topical antimicrobial agents, whereas deep- and surrounding-wound infection would usually require systemic antimicrobial therapies.<sup>79,80</sup>

## TREATMENT OF WOUND INFECTION

Preventing infections is important for palliative care patients. Debridement is a crucial step to remove devitalized tissue, such as firm eschar or sloughy material, which serves as growth media

**Table 4.**  
**USE OF SILVER DRESSINGS<sup>2</sup>**

<b>S</b>	Signs of increased bacterial burden	Silver should be used when bacterial damage is a concern (differentiate superficial from deep wound infection using NERDS and STONEES signs)
<b>I</b>	Ionized silver	Only ionized silver exerts antimicrobial effect Requires an aqueous environment
<b>L</b>	Log reduction over time	Quick kill time is desirable
<b>V</b>	Vehicle for moisture balance	Select dressing materials to match moisture level
<b>E</b>	Effects on viable cells	Watch for toxic effect on viable cells
<b>R</b>	Resistance	Resistance is rare, requires 3 mutations to develop resistance to silver

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for bacteria. Aggressive debridement is not recommended in malignant wounds in light of the potential risk of causing pain or bleeding and creating a larger and deeper portal for bacterial invasion.<sup>81</sup> Under judicious deliberation, conservative debridement of nonhealable wounds may be appropriate by trimming loose, hanging fibrin to reduce necrotic mass and associated odor. The purpose of conservative debridement is to enhance the quality of life and decrease the risk of bacterial proliferation and infection and not to cut into viable tissue or facilitate healing. Alternatively, the risk of wound infection has been demonstrated to decrease by using moisture-retentive dressings and hydrogel to promote autolytic debridement.

Cleansing solutions, including saline or water, are usually recommended to remove surface debris because of their low tissue toxicity. Topical antimicrobial products are available, but no one product is indicated or suitable for all patients.<sup>2</sup> Many active ingredients in dressings are released into the wound surface compartment, but they require wound fluid or exudate to diffuse into the tissue. Despite the lack of randomized controlled trial evidence of complete wound healing, silver dressings are one of the most popular topical agents.<sup>82</sup> For silver to exert an antimicrobial effect, it must be activated into ionic form in the presence of an aqueous wound environment, which is contraindicated for nonhealable wounds (Table 4).

Bacteria can be entrapped and sequestered in the microarchitecture of a dressing, where they may be inactivated. In nonhealable wounds where bacterial burden was more of a concern

than tissue toxicity, antiseptics including povidone-iodine, chlorhexidine, and their derivatives are propitious treatment options<sup>2</sup> (Table 5). Unlike silver products that require an aqueous environment to be released and activated, these antiseptics can exert their antimicrobial effect even in a relatively dry environment.

Other topical antimicrobial agents are summarized in Table 6. If the infection is promulgated systemically, systemic agents must be administered. Prophylactic use of antibiotics has not been demonstrated to facilitate wound healing.<sup>83</sup> All of these agents, except metronidazole, and silver sulfadiazine creams have been associated with an increasing incidence of allergic sensitization. Silver sulfadiazine is not recommended to be used in patients with sulfa sensitivity. The documented rate of sensitization to silver sulfadiazine remains low, possibly because the sulfa molecule is bound in a large organic complex. Creams, ointments, and gels are antibacterial, but they do not have the autolytic debridement or moisture balance properties of moist interactive dressings. For some malignant and palliative nonhealable wounds, these are still excellent topical treatment options.

## CONCLUSIONS

Management of patients with malignant and palliative wounds is challenging. This article highlights the key local wound care issues including HOPES. A holistic approach is crucial to enhance the activities of daily living and quality of life for persons with malignant and palliative wounds. After reading this article, clinicians should be better able to evaluate the key challenges and select the appropriate strategies to provide comprehensive care for patients with malignant wounds.

## PRACTICE PEARLS

A systematized and comprehensive approach is required to manage the complexity of malignant and palliative wounds and optimize patient outcomes.

Local wound care must be modified to address several key concerns including those demonstrated in the mnemonic HOPES:

- **H** (hemorrhage): Consider dressings with calcium alginates for minor bleeding
- **O** (odor): Apply topical metronidazole or activated charcoal dressings
- **P** (pain): Select dressings with atraumatic and nonadherent interfaces, such as silicone
- **E** (exudate): Moisture is contraindicated in nonhealable wounds; consider foams, alginates, and hydrofibers, along with superabsorbent products based on diaper technology
- **S** (superficial bacterial burden): Use topical antimicrobial agents for superficial wound infection and systemic antimicrobial therapies for deep- and surrounding-wound infection.

**Table 5.**  
**ANTISEPTIC AGENTS**

<b>Class and Agent</b>	<b>Action</b>	<b>Effect in Healing</b>	<b>Effect on Bacteria</b>	<b>Comments</b>
Alcohols • Ethyl alcohol • Isopropyl alcohol	Dehydrates proteins and dissolves lipids	Cytotoxic May cause dryness and irritation on intact skin	Bactericidal and viricidal on intact skin; not for use on open wounds	Used as a disinfectant on intact skin; stings and burns if used on open skin
Biguanides • Chlorhexidine up to 2%  • Polyhexamethylene biguanide	Acts by damaging the cell membranes	Relatively safe; little effect on wound healing; toxicity—small effect on tissue	Highly bactericidal against Gram-positive and Gram-negative organisms	Highly effective as hand washing agent and for surgical scrub; binds to stratum corneum and has prolonged residual effect
Halogen compounds • Sodium hypochlorite	Lyses cell walls	Acts as a chemical debrider and should be discontinued with healing tissue (high tissue toxicity)	Dakin solution and Edinburgh University Solution of Lime (buffered preparation) can select out Gram-negative microorganisms	High pH causes irritation to skin
Organic iodine • 10% povidone-iodine	Oxidizes cell constituents, especially sulfoxyl protein groups; iodinates proteins and inactivates them	Povidone-iodine cytotoxicity depends on dilution; potential toxicity in vivo related to concentration and exposure	Prevents and controls bacterial growth in wounds; resistance has not been reported; broad spectrum of activity, although decreased in the presence of pus or exudate	Toxicity is of concern with prolonged use or application over large areas; potential for thyroid toxicity (measure sensitive thyroid-stimulating hormone if used on large wounds for >3 mo and relatively contraindicated in the presence of thyroid disease)
Organic acid • Acetic acid (0.25%–1%) or diluted vinegar (1-part vinegar and 5-part water)	Lowers surface pH	Cytotoxicity in vitro; in vivo is concentration dependent	Effective against <i>Pseudomonas</i> ; may be useful for other Gram-negative rods and <i>Staphylococcus aureus</i>	Often burns and stings on application, but this effect will be mitigated with pain medication or neuropathy
Peroxides • 3% hydrogen peroxide	May induce cell death by oxidative damage	Can harm healthy granulation tissue and may form air emboli if packed in deep sinuses	Very little to absent antimicrobial activity (only for a few seconds when fizzing)	Acts more like a chemical debriding agent by dissolving blood clots and softening slough. Safety concerns: deep wounds due to reports of air embolisms

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**Table 6.**  
**TOPICAL ANTIMICROBIAL AGENTS**

Agent	Vehicle	<i>Staphylococcus aureus</i>	<i>Streptococcus</i>	<i>Pseudomonas</i>	Anaerobe	Comments
Gentamicin sulfate cream/ointment	Alcohol cream base or petrolatum ointment	✓	✓	✓		<ul style="list-style-type: none"> <li>• Good broad-spectrum vs Gram-negative</li> <li>• Discourage topical use due to increased resistance</li> </ul>
Metronidazole cream/gel	Wax-glycerin cream and carbogel 940/propylene glycol gel				✓	<ul style="list-style-type: none"> <li>• Good anaerobe coverage and wound deodorizer</li> </ul>
Mupirocin 2% cream, ointment	Polyethylene glycol (ointment)	✓	✓			<ul style="list-style-type: none"> <li>• Good for MRSA</li> <li>• Excellent topical penetration</li> <li>• Used predominantly perirectal, nasal colonization</li> </ul>
Polymyxin B sulphate • Bacitracin zinc	White petrolatum ointment	✓	✓	✓		<ul style="list-style-type: none"> <li>• Broad spectrum</li> <li>• Low cost</li> <li>• Increased incidence of allergic sensitivity</li> </ul>
Polymyxin B sulfate • Bacitracin zinc-neomycin	White petrolatum ointment	✓	✓	✓		<ul style="list-style-type: none"> <li>• Neomycin is a potent sensitizer and may cross react with other aminoglycosides in 40% of cases</li> </ul>
Polymyxin/gramicidin Silver sulfadiazine	Cream Water-miscible cream	✓ ✓	✓ ✓	✓ ✓		<ul style="list-style-type: none"> <li>• Broad-spectrum coverage</li> <li>• Do not use in sulfa sensitive individuals</li> <li>• Short half-life</li> <li>• Neutropenia is possible</li> <li>• May leave pseudoeschar on wounds</li> </ul>

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