The inciting cause and severity of the wound dictate the duration of treatment, required materials/equipment, and labor intensity. Despite the availability of cutting-edge antibiotics, age and underlying disease or concurrent illness may contraindicate administration.

Many “old-school” remedies are re-emerging and have shown to be beneficial in wound treatment, including wounds that are complicated, nonhealing, and/or infected. These topical treatments kill bacteria using pH and osmolarity, avoiding induction of bacterial resistance.

Since each wound and patient is unique, there is no one set of rules regarding therapy. In addition, wounds change during the healing process, so a therapy used in the initial stages may delay healing if used too long. Proper research and knowledge of topical therapies is vital to correct usage and successful treatment.

**INDICATIONS**

All of the topical therapies discussed in this article are indicated for full thickness wounds without granulation tissue or those with superficial infections. Many of the therapies are bacteriocidal and promote granulation. See the Table for indications for specific therapies.
WOUND PREPARATION
Prior to application of topical treatments, the wound bed must be properly prepared:
1. Protect the wound with a water-soluble sterile lubricant.
2. Clip and clean the surrounding skin to prevent further contamination.
3. Lavage the wound bed under 7 to 8 psi of pressure with sterile 0.9% saline or, preferably, a buffered sterile solution that is isotonic, such as lactated Ringer’s solution.
   - Body-temperature lavage with a spray nozzle provides sufficient pressure to clean the wound to remove gross debris.
   - A 35- or 60-mL syringe and 18-gauge needle will provide adequate pressure for difficult to access areas/pockets.
4. After wound lavage, dry the area around the wound with sterile gauze. Depending on the topical therapy, the wound bed may also need to be dried. However, care should be taken not to disturb newly formed granulation tissue or delicate epithelial tissue.

INDICATIONS FOR SPECIFIC WOUND THERAPIES

<table>
<thead>
<tr>
<th>Wound Therapy</th>
<th>Indications</th>
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<td>Granulated sugar</td>
<td>• <em>Pseudomonas</em> or gross infections in full-thickness wounds</td>
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<td></td>
<td>• Large, highly exudative contaminated wounds that need cleaning and</td>
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<td></td>
<td>debridement</td>
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<td>Honey</td>
<td>• Partial-thickness wounds; especially those causing discomfort</td>
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<td>• Infected wounds</td>
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<td>• Wounds that need increased granulation and epithelialization</td>
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<tr>
<td>Vinegar (acetic acid)</td>
<td>• Small, full-thickness wounds infected with <em>P aeruginosa</em> and <em>S aureus</em></td>
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<tr>
<td></td>
<td>• Moderate, partial-thickness wounds infected with <em>P aeruginosa</em> and *S</td>
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<tr>
<td></td>
<td>aureus</td>
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<tr>
<td>Diluted sodium hypochlorite solution 0.5% (Dakin’s solution)</td>
<td>• Wounds infected with bacteria and fungi</td>
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<td>• Wounds that need additional granulation</td>
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<td>• Sensitive, painful wounds (the solution is nonirritating at 0.5% or lower</td>
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<td></td>
<td>concentrations)</td>
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<td>Maggots</td>
<td>• Debridement of necrotic tissue</td>
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SUGAR
For centuries granulated sugar has been used to treat wounds, such as mechanical injuries, ulcers, and burns. Sugar is a desirable treatment because it:

- Has antibacterial effects against organisms, such as Escherichia coli, Pseudomonas aeruginosa, and Streptococcus canis
- Improves superficial debridement
- Enhances tissue growth and epithelialization
- Promotes rapid wound healing
- May decrease malodor from the wound
- Is inexpensive and easy to obtain.

Mechanism of Action
Sugar has high osmolality, which draws water and nutrient-rich lymph into the wound, nourishing the regenerating tissues. In addition, the high osmotic stress caused by sugar on bacteria interferes with cell signaling and cell wall permeability, leading to bacterial death. Bacterial cells are affected by osmotic stress because they rapidly divide, which makes them more susceptible to metabolic attacks. Sugar also attracts macrophages and forms a protective layer of protein by accelerating sloughing of devitalized tissue and allowing a granulation bed to form. This protein layer is created from inflammatory cells and sloughing dead cells.

Application
1. Lavage & Debridement: See Wound Preparation, page 11. Due to sugar’s debriding properties, grossly contaminated wounds may not need superficial debridement. The wound represented in the figures below typically receives 1 liter of lavage at initial cleaning and 500 to 1000 mL of lavage at each bandage change.
2. Application: A copious layer (at least 1–2 cm thick) of sugar should be applied to the entire wound,
including undermined areas (Figures 1 through 3). It is important that the entire wound be filled with sugar because the wound’s osmolarity must remain high to effectively kill bacteria.  

3. Bandaging: The primary bandage layer should consist of an adherent contact layer (large amount of sterile absorbent gauze or lap sponges) (Figure 4). A second layer should be used to hold the primary absorbent layer in place (Figure 5). This should be followed by a protective tertiary layer (Figure 6).

4. Bandage Changes:
   - Bandages need to be changed (following Wound Preparation steps 1 through 3) once to twice daily depending on the amount of exudate produced or if strikethrough is found in the tertiary layer.
   - If the sugar layer is saturated, bandage changes need to take place more frequently. This is evident when there is (1) a granular sanguinous layer and no sugar covering the wound or (2) a naked wound and complete absence of sugar. If either condition is present, perform bandage changes more frequently until the wound exudate diminishes.
   - Large and infected wounds are edematous; therefore, bandages for these wounds should be changed at least twice daily. These frequent bandage changes will help keep the osmolarity high within the wound. Severely infected wounds may take 5 or more days to become “clean.”
   - As granulation tissue forms, the frequency of bandage changes may be decreased to once daily and eventually every other day. A general rule of thumb to follow is when white, dry, granulated sugar is still present, bandage changes can be less frequent.

5. Length of Treatment: Treatment with sugar should continue until pockets and undermined tissue are closed and debridement is complete. Presence of a granulation bed and epithelialization are also indicators that sugar treatment may be stopped (Figure 7). Once healthy granulation tissue is present, superficial infections are much less likely and a simple, nonadherent primary bandage layer can be used.

Disadvantages
Potential disadvantages of sugar bandages include:
   - Difficulty in applying the primary and secondary bandage layers to assure a 1-inch layer of sugar covers the entire wound.
   - The frequent bandage changes required for this modality. In our experience sugar bandages need to be changed more frequently than wet-to-dry bandages due to the exudative nature of the wounds and quickly saturating sugar layer.
   - Sugar bandages lose their osmotic pull once the sugar starts dissolving, while wet-to-dry bandages wick away moisture and facilitate mechanical debridement.

HONEY
Historical documentation suggests Egyptians used honey as a topical wound treatment for over 4000 years. Not until the past decade has interest in honey as an adjunct to wound therapy accelerated in medical practice. Honey has antibacterial activity and enhances both granulation and epithelialization of wounds.
UniqUe TheraPies for DifficUlT WoUnDs

4,6 infected surgical wounds) treated with honey heal faster than those treated with conventional therapies. Studies have shown that acute wounds (eg, burns, lacerations) and chronic wounds (eg, pressure ulcers, infected surgical wounds) treated with honey heal faster than those treated with conventional therapies.  

SELECTING HONEY FOR HEALING

Unpasteurized honey derived from particular floral sources in New Zealand and Australia, such as Manuka honey, has enhanced antibacterial activity and better healing properties than store-bought honey and honey from bees fed sugar for commercial honey production. Unpasteurized honey also allows activation of glucose oxidase. Bacteria and fungi successfully treated by these types of honey include:

- Escherichia coli
- Proteus mirabilis
- Pseudomonas aeruginosa
- Salmonella typhimurium
- Serratia marcescens
- Staphylococcus aureus
- Streptococcus pyogenes
- Candida albicans.

Some studies have used store-bought honey but research favors unpasteurized honey from the places mentioned above. Honey is not created equal and antibacterial activity can vary as much as 100-fold. While any unpasteurized honey is effective for wound treatment, the antibacterial activity of different honeys can be compared by adding each one to milk and quantifying how long it takes the milk to sour. Although unsterile honey may contain Clostridia spores, no problems have been reported to date.

Mechanism of Action

The antibacterial effects of honey can be attributed to its high osmolarity, acidity, and peroxide activity.

- Increased osmolarity draws fluid and lymph from the underlying tissues and this fluid provides nourishment to the healing wound.
- Honey’s pH (3.6–3.7) creates the desired acidic environment that has been shown to decrease bacterial growth, increase fibroblast activity, and increase oxygen release, all of which further promote wound healing.
- Glucose oxidase produces hydrogen peroxide and gluconic acid, which provide the main antibacterial qualities of honey. The well-tolerated, low levels of hydrogen peroxide promote angiogenesis and fibroblast activity, enhancing oxygen delivery to tissue.

Research suggests that honey’s ability to enhance wound healing is related to release of inflammatory cytokines from surrounding tissue and attraction of macrophages to further cleanse the wound. Honey also appears to:

- Accelerate sloughing of devitalized tissue
- Provide local nutrition
- Decrease inflammatory response with a protective layer of protein from wound turnover
- Improve epithelialization.

Application

1. Lavage & Debridement: See Wound Preparation.
2. Application: The amount of honey applied to the wound depends on the size of the wound. For ease of application, presoak gauze or absorbent pads in honey prior to application instead of pouring honey directly onto the wound.
3. Bandaging: Since honey does not interfere with bandage absorbency, wound exudate will stay contained within the bandage. However, to prevent honey from oozing from the dressing, a secondary occlusive or absorbent dressings may be warranted.
4. Bandage Changes: Frequency of bandage changes depends on how rapidly the honey is diluted by the wound exudate or whether strikethrough occurs.

Disadvantages

Disadvantages of using honey on topical wounds include:

- Honey’s sticky consistency, which makes it difficult to use.
- Its cost and limited availability (see Selecting Honey for Healing), which may delay initiation of treatment (it typically takes 7 to 10 days for honey to arrive and it costs approximately $20 for 10 to 12 ounces).
- The pain it appears to cause when applied to full-thickness wounds; however, discomfort has not been noted when applied to partial-thickness wounds.

VINEGAR

Vinegar (acetic acid) has been used to fight infections since 300 BC. Despite its antimicrobial properties, its use in wound treatment is controversial.

Nontoxic concentrations (< 0.0025%) are slightly effective as an antibacterial agent against gram positive and negative bacteria, such as S aureus and P aeruginosa. At this concentration, vinegar has no detrimental effects on fibroblasts and keratinocytes; however, it’s ineffective against E coli, Bacteroides fragilis, and Enterococcus. Studies have shown that diluted vinegar (2% acetic acid) is effective for treating ear infections, but the low pH may irritate inflamed skin.
Application
1. **Lavage & Debridement**: See **Wound Preparation**.
2. **Application**: Acetic acid is applied directly onto the wound or soaked into the primary bandage layer prior to application.
3. **Bandaging**: After acetic acid has been applied to the wound, gauze or a nonadherent dressing is added. By using an absorptive secondary layer, the acetic acid becomes the base of a wet-to-dry bandage and provides antibacterial effects topically. Alternatively, using a nonadherent or occlusive secondary layer helps keep the acetic acid on the wound for prolongation of antibacterial effects but does not mechanically debride it. The remainder of the dressing continues as it would for a standard modified Robert Jones bandage.

Disadvantages
Common canine and feline ear cleansers containing acetic acid are frequently used. However, their concentrations may vary, which affects efficacy. They also lack broad-spectrum efficacy and have a narrow safety margin compared to commonly used solutions, such as chlorhexidine and povidone iodine. However, chlorhexidine can be irritating and povidone iodine is inactive in organic material and can cause sensitivity/allergy issues in some patients, providing a place for both acetic acid and Dakin’s solution (see below) in wound therapy.

**DILUTED SODIUM HYPOCHLORITE SOLUTION 0.5%**
When initially discovered, sodium hypochlorite’s composition was unknown, but its bleaching and disinfecting properties were noted. A diluted sodium hypochlorite solution (Dakin’s solution) at 0.5% concentration has:
- High germicidal activity
- No irritating contaminants.

At this concentration, it may be applied continuously for > 7 days without irritation. Studies have shown that a modified Dakin’s solution, 0.025%, is therapeutically as efficacious as a fluid dressing. At this concentration, the solution preserves its bactericidal properties and is not detrimental to wound healing. At a 0.25% concentration, the solution is effective against gram positive and negative bacteria, fungi, and viruses.

Application
1. **Lavage & Debridement**: See **Wound Preparation**.
2. **Application**: Similar to vinegar, Dakin’s solution may be applied directly onto the wound or soaked into the primary bandage layer.
3. **Bandaging**: The remainder of the dressing is applied as you would to create a wet-to-dry bandage.
4. **Length of Application**: Application of Dakin’s solution is recommended for 7 days or less. It is efficacious against bacteria, but will not debride the wound, encourage macrophages, relieve edema, or provide anti-inflammatory properties.

**Disadvantages**
Similar to vinegar, disadvantages of Dakin’s solution are its limited spectrum of efficacy and narrow safety margin when compared to chlorhexidine and povidone iodine.

**MAGGOT THERAPY**
In the early 1800s, it was accidentally discovered that maggots prevented infection and accelerated wound healing in soldiers with battle injuries. They were intentionally introduced into wound management shortly after; however, it wasn’t until recent years that their popularity increased in human medicine due to increasing antimicrobial resistance.

Maggot therapy refers to the application of disinfected fly larvae to a wound; specifically, the common green bottle fly, *Lucilia sericata*. Common applications include:
- Debridement of necrotic tissue
- Infection control (microbial killing & antifungal activity)
- Stimulation of granulation tissue.

Although little is known about specific advantages and disadvantages of maggots in veterinary wound management, information is extrapolated from human reports/research. In addition, experienced practitioners report that maggot therapy is beneficial and safe.

Application
1. **Obtaining maggots**: Medical maggots are easily accessible and can be obtained from distributors in the U.S., such as Monarch Labs (monarchlabs.com).
2. **Application**: The number of maggots needed for treatment varies based on wound size and amount of necrotic tissue.
3. **Bandaging**: A porous bandage should be placed to

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**MAKING DAKIN’S SOLUTION (0.5%)**
The ingredients required to make Dakin’s solution include tap water, baking soda, and household bleach.
1. Boil 4 cups or 32 ounces of tap water in a clean pan (with the lid on) for 15 minutes.
2. Remove the pan from heat.
3. Using a sterile measuring spoon, add ½ teaspoon of baking soda and 3 ounces or 95 mL of bleach.
4. Place the solution in a sterile jar, close the lid tightly, and cover the entire jar in aluminum foil to protect it from light.
Throw away any unused portion 48 hours after opening. Unopened jars can be stored at room temperature for 1 month after preparation.
prevent escape of maggots while allowing them to breathe. The bandage should remain in place for approximately 3 days, at which time the maggots are removed or replaced. 

Cost of treatment varies based on the individual wound. In a human study of necrotic venous ulcers, the average cost of maggot therapy was approximately half the cost of conventional treatment and required fewer applications to achieve the same end result.

Disadvantages
According to practitioners, the most common disadvantage of maggot therapy is that it may take 24 to 48 hours to receive maggots. In addition, application takes longer because the dressing must withstand any efforts the patient may make to remove it. 

Human patients undergoing maggot wound debridement frequently complain about discomfort or pain associated with movement of maggots within the wound.

CONCLUSION
Using unique, and what may be considered “old school,” remedies for treating wounds that are infected or nonhealing may be the ideal option for companion animal patients. As long as current research supports a modality, clinicians should not be afraid to use it when indicated. Topical old-school agents are not susceptible to bacterial resistance and offer practical, low-cost alternatives to more expensive and potentially toxic antibiotics.

References