The Importance of Acidic pH on Wound Healing

Why All the (pH)uss About Microenvironments?

By Martha Kelso, RN, HBOT, CEO, WCP

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The Wound Microenvironment

Every wound or ulcer has factors that influence the wound bed environment and how it reacts. Many of these factors occur at a microscopic level and therefore can be referred to as the wound microenvironment. Inside this microenvironment, factors are at play that influence whether a wound heals or becomes chronically stalled.

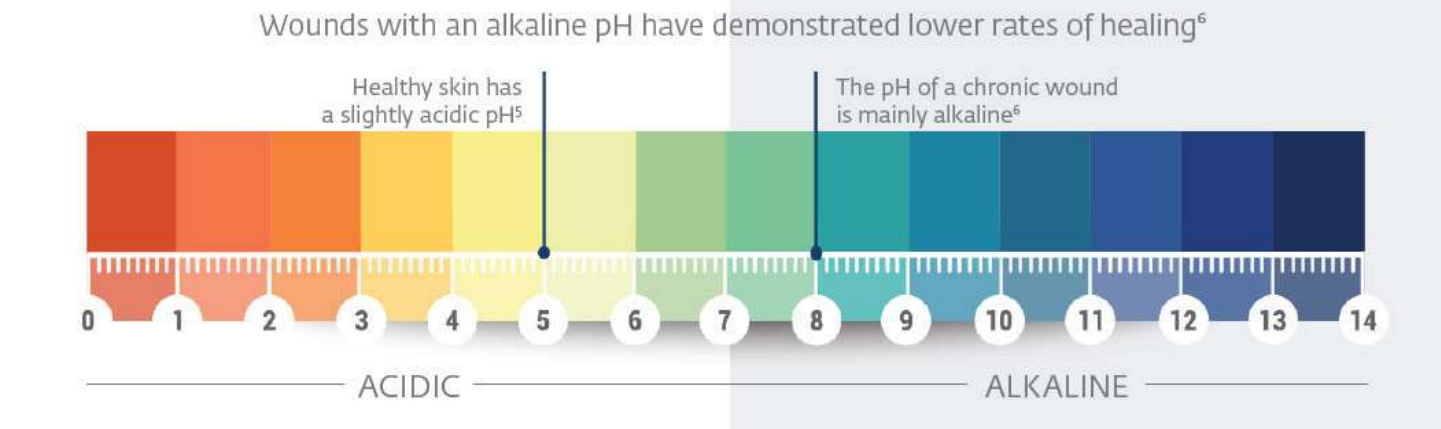
The microenvironment is critical to healing or delay of wound healing. For example, elements inside the microenvironment determine whether the wound becomes colonized versus critically infected. Those same elements determine whether proteases (i.e. MMPs) create prolonged inflammation and therefore delay wound healing.

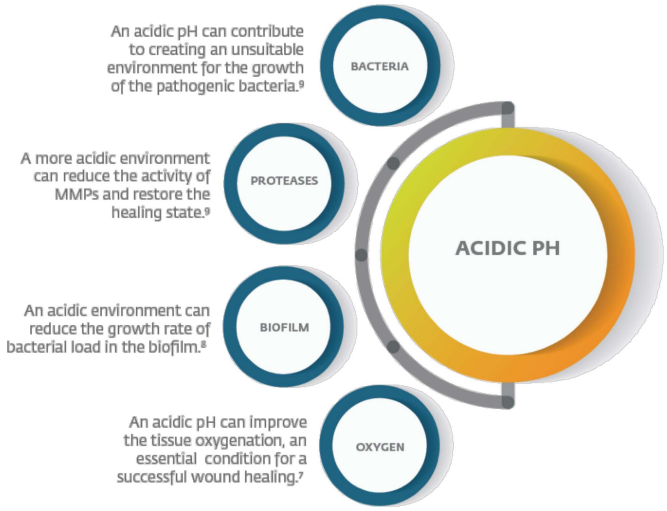
Another important consideration is the oxygen level . Is there enough oxygenation? Are we stunting oxygenation or promoting adequate oxygenation to our wound microenvironment? Is our wound microenvironment promoting positive wound healing factors through the pH of the wound or are we allowing wounds to become chronically stalled? These factors are relevant for consideration and these questions are valid when considering influences on the healing process (or lack thereof). As clinicians and nurses, we should be cognizant of these factors or elements, recognize their importance, and understand how to mitigate their existence in favor of a positive outcome.

Benefits of Acidic pH

Chronic wounds are ideal microenvironments for bacterial growth. In fact, bacterial infection is one of the most prevalent causes of poor wound healing. Wound bed bacteria can spread into surrounding tissue, resulting in a localized infection. If that infection is left untreated, the spread of bacteria can result in a systemic infection. The cost associated with wound infections and/or sepsis can be extraordinary. Treating the side effects of antibiotic usage also can be expensive. Research shows that an alkaline pH in the wound bed can contribute to creating an unsuitable environment for healing by encouraging the growth of pathogenic bacteria. In contrast, an acidic wound bed can stunt pathogenic bacteria growth and keep the wound bed microenvironment in check and moving toward the desired healing trajectory.

In chronic wounds, an imbalance often exists between how much oxygen the tissue needs to regenerate or heal versus how much oxygen is readily available to help with the task. Inadequate oxygenation can slow the healing process or cause the wound to stall completely. Lack of oxygen also can encourage other types of anoxic bacteria to proliferate in the wound, further damaging or destroying the already suffering microenvironment. An acidic pH can improve the tissue oxygenation, which is an essential condition for successful wound healing.





When considering stalled tissue in the microenvironment, consider removing others culprit, such as MMPs, that can lead to delayed wound healing when present in excess by suppressing tissue proliferation and migration. A more acidic environment can reduce the activity of MMPs and restore the healing state in the wound. Bacterial biofilm can maintain prolonged inflammation in the wound microenvironment, ultimately leading to the failure of wound healing. Conversely, an acidic environment can reduce the growth rate of bacterial load in the biofilm.

Most wound beds are predominately alkaline; however, an acidic wound bed has a positive influence on wound healing. Healthy skin has a slightly acidic pH, ranging from 4.0 to 6.3. The chronic wound generally has an alkaline pH, ranging from 7.15 to 8.93. Wounds with an alkaline pH have demonstrated lower rates of healing. An acidic environment in a wound bed is an additional benefit that can reboot the wound towards healing.

Ideal Wound Cleansing

Incorporating a wound cleanser that encourages a shift of the wound bed microenvironment from chronically stalled to healing is prudent. Cleansing of a wound is generally performed to remove surface contaminants, bacteria, nonviable tissue, and exudate from the wound bed and surrounding skin. With the right cleansing agent, you also can effectively remove stimulants and localized barriers (as reviewed above) in the wound microenvironment to get the healing process moving. In addition, by choosing the right cleanser, healthy cells and tissue can be safely preserved and even stimulated to continue growing.

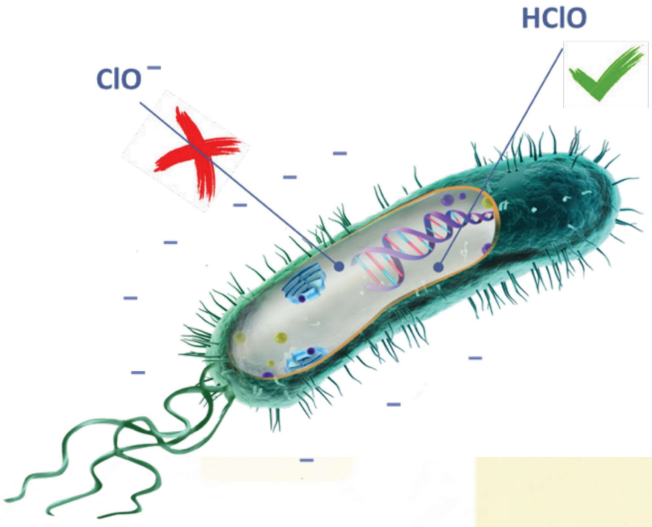
Research has shown that antiseptic wound cleansers have a negative impact on healing. Some examples of antiseptic products included in these studies are alcohols, iodine, chlorhexidine gluconate, silver, and hydrogen peroxide. Products that are cytotoxic damage human cells and/or wound tissue and consequently slow down or stall wound healing. Bactericidal properties in a wound cleanser do not have to be cytotoxic.

Saline solution encourages removal of microorganisms and biological and environmental debris. Most saline solutions, however, do not contain a preservative. Saline solution is not cytotoxic but it is not bactericidal either. Once applied to the wound, bacterial growth can occur and expose the wound to opportunistic microorganisms. Hypochlorous acid, on the other hand, is produced naturally by the body's immune cells in response to invading pathogens. When used as a wound cleansing agent, it acts as a preservative by inhibiting the growth of microorganisms within the solution and therefore within the wound microenvironment.

Ideally, your wound cleansing agent would not contain any sodium hypochlorite (NaOCl) since this can increase the solution's pH. We don't want to harm healthy tissue or healthy skin. Instead, we want to establish the ideal microenvironment and support the physiological healing process. Removing inflammatory stimulants and local barriers is ideal. Preservation of tissue safety is a key component of balancing or modulating the wound microenvironment. This balance can be achieved when using an ideal wound cleanser. Reach for an acidic noncytotoxic bactericidal cleansing agent for your wound cleansing practices.

Science

Hypochlorous acid can easily penetrate pathogenic cells and destroy them from the inside. Because pathogen's cell was are negatively charged, sodium hypochlorite (also known as Dakin's solution) cannot easily penetrate them. At the same concentration, the biocidal activity of hypochlorous acid is 80 times stronger than sodium hypochlorite. Despite hypochlorous acid and sodium hypochlorite looking similar, they are still quite different. Keep in mind that hypochlorous acid is one of the major inorganic bactericidal compounds of innate immunity and is effective against a broad range of microorganisms.



Indications and Application

Nexodyn, one brand of hypochlorous acid, has been cleared by the Food and Drug Administration (FDA) for several indications, including leg ulcers, stasis ulcers, diabetic ulcers,

Stage I-IV pressure ulcers, postsurgical wounds, grafted and donor sites, 1st and 2nd degree burns, minor cuts, minor burns, superficial abrasions, and minor skin irritations. Nexodyn should be used with each dressing change. The whole ulcer or wound should be abundantly sprayed with Nexodyn then allowed to dry. No rinsing is required. Additional applications of Nexodyn can be repeated consecutively if necessary or desired. Once the solution has dried in the wound bed, you can then follow with your standard dressing change as ordered. Nexodyn does not harm the skin if sprayed outside the wound.

Conclusions

Nexodyn is an FDA-cleared hypochlorous acid-based wound cleanser developed for the topical treatment and use in the field of acute and chronic wound management. This version of hypochlorous acid has a desired acidic pH of 2.5-3.0 as well as a high purity of free chlorine species derived from HClO. The free chlorine species has 40-70 ppm and long stability of 30 days from first date of opening.

Despite the bactericidal activity of Nexodyn being fast and effective to the bacteria listed at the end of this article, it is not cytotoxic to human cells at the 40-70 ppm. An additional benefit is how fast and simple applying Nexodyn is when used for wound irrigation during your normal treatment regimen. Nexodyn is a cost-effective solution for wound cleansing with many benefits that should be incorporated into your daily wound routine and cleansing practice. Choosing this wound cleansing agent will benefit the wound microenvironment, encourage wound healing through modulation of key wound factors that could stall out wound healing, and is easy to use.

The antimicrobial preservative effectiveness of hypochlorous acid has been demonstrated against the organisms in the table below with in vitro testing (Time Kill Assay):

Pathogenic Bacteria	Log Reduction / Exposure Time
Staphylococcus aureus	99.9992% (5.11 Log_{10}) after 15 sec
Staphylococcus pyogenes	99.9958% (4.38 Log_{10}) after 15 sec
Staphylococcus epidermidis	99.9499% (3.30 Log_{10}) after 15 sec
Pseudomonas aeruginosa	>99.9999% (> 6.11 Log_{10}) after 15 sec
Escherichia coli	>99.999% (> 5.55 Log_{10}) after 15 sec
Multi-drug resistant (MDR) Staphylococcus aureus	>99.999% (> 5.44 Log_{10}) after 15 sec
Extended-spectrum beta-lactamase (ESBL) producing Enterobacteriaciae	>99.9999% (> 6.23 Log_{10}) after 15 sec
Vancomycin intermediate resistant Staphylococcus aureus (VISA)	>99.999% (>5.84 Log_{10}) after 15 sec
Multi-drug resistant (MDR) and OXA-48 producing Klebsiella pneumoniae	>99.999% (> 5.32 Log_{10}) after 15 sec
Extended-spectrum beta-lactamase (ESBL) producing Proteus mirabilis	>99.999% (>5.99 Log_{10}) after 15 sec
Multi-drug resistant (MDR) Escherichia coli	>99.999% (>5.92 Log_{10}) after 15 sec
Candida albicans	>99.999% (>5.01 Log_{10}) after 15 sec

Martha Kelso, RN, HBOT, CEO, WCP Wound Care Plus, LLC, *is the founder and Chief Executive Officer of Wound Care Plus, LLC (WCP). As a visionary and entrepreneur in the field of mobile medicine, she has operated mobile wound care practices nationwide for many years. She enjoys educating on the art and science of wound healing and how practical solutions apply to healthcare professionals today. Martha enjoys being a positive change in healthcare impacting clients suffering from wounds and skin issues of all etiologies.*

This white paper has been produced through collaboration between Wound Care Advisor, Angelini Pharma, and the author.

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