The Potential of Advanced Hydrothermic Wound Therapy:

A Traditional Review of Wound Temperature and Hydrotherapy

By Corey Heerschap, MScCH (WPC), BScN, RN, CETN(C), IIWCC

Hydrotherapy and warmth have been used in wound healing since ancient times.[1] As wound healing technology develops, both mediums have advanced, yet the combination of these treatments has yet to be explored. This article reviews current literature on both hydrotherapy and heat in wound healing and discusses the potential clinical benefits of combining these treatments.

Hydrotherapy

Whirlpool therapy, one of the oldest forms of hydrotherapy, was at one time a common form of wound treatment, delivered through submersion of the wound for 10 to 20 minutes at temperatures between 33.3°C and 35.6°C.[2] Whirlpool therapy has been used to remove necrotic tissue and wound debris, increase circulation at the wound site, reduce pain and accelerate healing.[2] Mounting evidence, however, has described risk of wound maceration, tissue damage due to water pressure and increased risk of *Pseudomonas aeruginosa* development. In addition, a lack of high-quality evidence has moved whirlpool therapy from a common treatment to an outdated practice.[2] Tao, Butler and Luttrell,[2] and Sussman[1] note there is a shortage of randomized controlled trials on whirlpool treatments for wound healing. To date, there have been two randomized controlled trials conducted that have shown a positive correlation between whirlpool therapy and increased wound healing.[1]

New Technology

More recently, there has been an introduction of new hydrotherapy-based wound treatments such as the combination of negative pressure and fluid instillation therapy. This technology allows for a cycle of fluid instillation that dwells at the wound site for a set period, followed by negative pressure wound therapy.[3] Initial case series research has shown favorable results in 98% of cases where normal saline was instilled for a dwell time of 10 minutes.[4] In these instan-

© Serg_v/123RF Stock Photo

ces, new granulation tissue was described as beefy red and moist, and allowed for effective surgical closure through skin grafting, primary suturing or a surgical flap.[4]

Wounds in which healing was previously stalled, some of which had been using traditional negative pressure therapy, were found to develop granulation tissue with this new technology.[4] Lessing, James and Ingram[5] found that including a five-minute saline dwell time between 2.5-hour episodes of negative pressure wound therapy increased tissue granulation by 40%, 44% and 57% respectively as compared to dynamic, continuous and intermittent negative pressure therapy. Although these findings consider the combination of a saline dwell and negative pressure wound therapy, the question is how great an impact would the saline alone have had with a greater dwell time and without the aspect of negative pressure? As Gupta, et al.[3] have noted, at this time there is no consistent or widely accepted practice regarding dwell time for the instillation of fluids into a wound.

Instillation therapy allows many of the benefits of whirlpool therapy, such as softening of tissue and loosening of debris. It can accomplish this without the risks of high levels of pressure, and without a basin of fluid, which is associated with a higher risk of infection. As the instilled fluid dwells only on the wound bed, the periwound area is protected, decreasing the risk of maceration.

Interestingly, however, almost a decade ago, Sussman noted that future research should focus on determining the optimum fluid temperature to best promote wound healing.[6] Yet, even with the advancements in not only hydrotherapy but all wound care treatments, there is a scarcity of literature that addresses the issue of warmth and wound healing.

Heat

Heat is lost nearly three times faster at the area of moist skin, such as a wound, compared to intact skin.[7] A wound device has been developed that provides non-contact heat to the wound site at 38°C.[8] Three randomized controlled trials have evaluated the normothermic wound ther-

© stockbroker/123RF Stock Photo

apy dressing and found wounds healed significantly faster with heat than with standard moist wound healing.[8–10] Santili, Valusek and Robinson[11] made a connection between this heat-based wound dressing and a significant decrease in pain on venous leg ulcers. However, it was noted that the underlying mechanism for this decrease in pain was not clear.[11]

The body has a sophisticated system for thermal regulation. Core body temperature for humans ranges between 36°C and 38°C.[12] In contrast, the skin can vary significantly in temperature, averaging between 28°C and 34°C depending on the time of day and exposure.[12] To determine the mean body temperature, or the mass weighted temperature of body tissues, Lenhardt and Sessler[13] discuss what they have determined to be an accurate and precise calculation first proposed by Burton in 1935. The mean body temperature can be calculated using the equation MBT = 0.64. TCore + 0.36. TSkin.[13] If this calculation was used with the lowest core temperature of 36°C and nude skin temperature of 28°C, this would provide an estimated mean body temperature of 33.12°C. McGuiness, Vella and Harrison[14] found that average wound beds, when covered with a variety of dressings, were slightly lower than 33°C. This leads one to question if our current advanced dressings are maintaining enough heat at the site of the wound for optimal healing to occur.

. . . there is a need to explore the potential benefits to wound healing of the combination of hydrotherapy and heat, referred to here as advanced hydrothermic wound therapy

Note that vasodilation occurs at two-tenths of a degree higher than 37°C of core body temperature.[12] Skin temperature reacts in much the same way. With a skin temperature higher than the core body temperature, local heating activates an increase in local sweating or vasodilation.[12] Regulating the wound temperature may also allow for regulation of vasodilation and the inflammatory response. Gibson, Cullen, Legerstee, Harding and Shultz[15] discuss that, in order to correct delayed wound healing caused by an imbalance of inflammatory-based cytokines and free radicals, a reduction in inflammation and protease activity while promoting a moist wound environment is required.

MacFie, Melling and Leaper,[16] in a review of wound-warming therapies, concluded that there is a real possibility such technologies can lead to improved patient outcomes, shorter hospital stays and decreased costs. Localized wound warming was found to increase tissue perfusion and oxygenation while also decreasing infection rates.[16] Wound-warming therapies were also noted to improve collagen synthesis; however, further research is necessary to confirm these findings.[16]

The Role of Dressings

Lionelli and Lawrence[17] have provided criteria for what makes a wound dressing desirable, including the following: protecting the wound, absorbing exudate, preventing heat and fluid loss, removing dead space, limiting trauma on removal, being attractive visually, as well as creating a warm, moist, occluded environment, and minimizing pain. Given these criteria, there is a need to explore the potential benefits to wound healing of the combination of hydrotherapy and heat, referred to here as advanced hydrothermic wound therapy.

Advanced hydrothermic wound therapy would act in a similar fashion to a blister, the cover dressing acting as the body's skin to maintain instilled fluid at normothermic temperatures while providing an enclosed moist region at the area of damaged tissue.

Vasodilation and vasoconstriction play an important role in the inflammatory process. For example, vasodilation leads to increased capillary pressure, allowing plasma protein molecules to pass into the wound tissues as well as assist in bringing inflammatory cells from the circulatory system into the wound bed.[18] The ability to regulate this aspect of the inflammatory process using temperature regulation directly at the wound site through a hydrotherapy medium may bring a completely new toolset to wound care clinicians. Temperature regulation may also allow for a true normothermic wound-healing environment to be calculated using the mean body temperature equation discussed previously.

Given the vast number of wound-cover dressings on the market, there is a need for future research to focus on which materials are best able to regulate wound temperature. Future studies should assess the impact of a true normothermic wound environment based on mean body temperature, as well as the potential clinical benefits of advanced hydrothermic wound therapy.

Conclusion

Research regarding hydrotherapy and heat in wound healing remains scarce, yet there remains great potential in combining these two wound-healing mediums. As wound healing becomes more advanced and technology develops, it is important not to lose sight of the significant number of factors that affect wound healing. This review brings to light the potential impact that an advancement such as advanced hydrothermic wound therapy, or the combination of hydrotherapy and heat may have on wound healing. The potential for this scarcely explored aspect of wound healing—to provide a moist wound-healing environment while also regulating temperature—may have significant practice implications.

***Corey Heerschap** is a wound/ostomy clinical nurse specialist in the Interprofessional Practice Department at the Royal Victoria Regional Health Centre in Barrie, Ontario.*

Key Points

- ✔ There remains a scarcity of literature that focuses on either hydrotherapy or temperature and their effects on wound healing, although they continue to be used in modern wound-healing technologies.
- ✔ The purpose of this article is to provide an overview of current literature on hydrotherapy and temperature effects on wound healing and to discuss the potential combination of hydrotherapy and heat in wound technology, termed advanced hydrothermic wound therapy.
- ✔ There is great potential in the combination of hydrotherapy and heat in wound healing, demonstrating the importance of further research.
- ✔ Future research should review the temperature management capabilities of current wound dressings as well as the effects of a true normothermic wound environment on wound healing based on mean body temperature.

References

1. Sussman C. Hydrotherapy. In: Sussman C, Bates-Jensen B, editors. A Collaborative Practice Manual for Health Professionals. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2012. p. 727–50.
2. Tao H, Butler JP, Luttrell T. The role of whirlpool in wound care. J Am Coll Clin Wound Spec. 2012;4(1):7–12.
3. Gupta S, Gabriel A, Lantis J, et al. Clinical recommendations and practice guide for negative pressure

wound therapy with instillation. Int Wound J. 2016;13(2):159–74.

4. Brinkert D, Ali M, Naud M, Maire N, Trial C, Teot L. Negative pressure wound therapy with saline instillation: 131 patient case series. Int Wound J. 2013;10(suppl. 1):56–60.
5. Lessing MC, James RB, Ingram SC. Comparison of the effects of different negative pressure wound therapy modes—continuous, noncontinuous, and with instillation—on porcine excisional wounds. Eplasty. 2013;13:e51.
6. Sussman C. Whirlpool. In: Sussman C, Bates-Jensen B, editors. A Collaborative Practice Manual for Health Professionals. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2007. p. 644–64.
7. Maglinger PE, Sessler DI, Lenhardt R. Cutaneous heat loss with three surgical drapes, one impervious to moisture. Anesth Analg. 2005;100(3):738–42.
8. Kloth LC, Berman JE, Nett M, et al. A randomized controlled clinical trial to evaluate the effects of noncontact normothermic wound therapy on chronic full-thickness pressure ulcers. Adv Skin Wound Care. 2002;15:270–76.
9. McCulloch J, Knight CA. Noncontact normothermic wound therapy and offloading in the treatment of neuropathic foot ulcers in patients with diabetes. Ostomy Wound Manage. 2002;48(3):38–44.
10. Whitney JD, Salvadalena G, Higa L, et al. Treatment of pressure ulcers with noncontact normothermic wound therapy: Healing and warming effects. J Wound Ostomy Continence Nurs. 2001;28:244–52.
11. Santilli SM, Valusek PA, Robinson C. Use of a noncontact radiant heat bandage for the treatment of chronic venous stasis ulcers. Adv Wound Care. 1999;12:89–93.
12. Arens E, Zhang H. The skin's role in human thermoregulation and comfort. In: Pan N, Gibson P, editors. Thermal and MoistureTtransport in Fibrous Materials. Cambridge, England: Woodhead Publishing Limited; 2006. p. 560–602.
13. Lenhardt R, Sessler DI. Estimation of mean-body temperature from mean-skin and core temperature. Anesthesiology. 2006;105(6):1117–21.
14. McGuiness W, Vella E, Harrison D. Influence of dressing changes on wound temperature. J Wound Care. 2004;13(9):383–85.
15. Gibson D, Cullen B, Legerstee R, et al. MMPs made easy. Wounds International. 2009;1(1). Available from: www.woundsinternational.com.
16. MacFie CC, Melling AC, Leaper DJ. Effects of warming on healing. J Wound Care. 2005;14(3):133–36.
17. Lionelli GT, Lawrence WT. Wound dressings. Surg Clin N Am. 2003;83:617–38.
18. Sussman C, Bates-Jensen, BM. Skin and soft tissue anatomy and wound healing physiology. In: Sussman C, Bates-Jensen BM, eds. A Collaborative Practice Manual for Health Professionals. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2012. p. 38.

NURSES • PRIMARY CARE • ALLIED HEALTH PRACTITIONERS • UNREGULATED CARE PROVIDERS

Advance your career . . .

WoundsCANADA Institute

. . . from virtually anywhere!

New! Wounds Canada Institute offers a wide range of educational programs, consisting of online modules, webinars and/or skills labs, to help you reach your full potential. Regardless of your role in health care, you will find cost-effective programs to suit your learning needs.

Learn best practice approaches for:

- Diabetic foot
- Pressure injuries
- Surgical wounds
- Venous leg ulcers
- Skin physiology
- Wound management

Register online and start learning now!

View the full program list at www.WoundsCanadaInstitute.ca.

Powered by WoundsCANADA.ca