

Wound Moisture Tracking in the Presence of Antibacterial Honey and during Topical Negative Pressure Therapy.*

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Professor Trish Connolly has worked across Europe in the medical industry and academia, researching and developing medical devices. Her work took her to Italy and Switzerland before she resettled in her native Glasgow on her appointment as Professor of Bioengineering at the University of Strathclyde. She is currently Director of Strathclyde Institute of Medical Devices (SIMD) which was launched in October 2006. In 2009 she also became CEO of Ohmedics, a spin out of the University of Strathclyde to commercialise her work on a pioneering wound moisture monitor to bring better wound management to patients. Since the end of 2010 she has been involved in a further initiative launched by the University and SIMD - Strathclyde MedTech - a means of assisting Scottish SMEs in the medical technology field. Professor Connolly's extensive experience in bioengineering, both at industrial and academic level, gives her the advantage of being able to see projects through from research and development to full commercialisation. Her focus has mainly been on medical diagnostics, and in recent years her research has focused on point of care instrumentation and tests including minimally invasive monitoring systems.

RESUME

Suivi du niveau d'humidité des plaies en présence de miel antibactérien et au cours d'un traitement par pression négative.

Les changements inutiles de pansements au cours des opérations militaires, à l'hôpital ou au domicile du blessé, compromettent la guérison et peuvent augmenter le risque d'infection locale. Dans cet article, nous décrivons un dispositif médical qui permet de contrôler l'humidité dans la blessure sans qu'il soit nécessaire de changer le pansement. Nous décrivons les résultats de deux études cliniques. Dans la première, on suit le niveau d'humidité de la blessure au cours d'un traitement par compression, avec application de miel médical (Medihoney™ Antibacterial Medical Honey™, Comvita), pratiqué dans les hôpitaux de Glasgow (NHS Greater Glasgow & Clyde) et de Jeddah (King Abdullazziz University Hospital). Les premiers résultats d'une deuxième étude concernent le suivi du niveau d'humidité de blessures au cours d'une thérapie par pression négative (TPN). L'objet de ces études est d'établir si on obtient un bon niveau d'humidité sous les pansements, pour assurer la cicatrisation des blessures, et d'évaluer l'adéquation du suivi du niveau d'humidité sous pansement en utilisant comme dispositif médical un capteur à usage unique estampillé CE.

KEYWORDS: Moisture Tracking, Wounds, Antibacterial Honey, Negative Pressure.

MOTS-CLÉS : Niveau d'humidité, Blessures, Miel antibactérien, Pression négative.

INTRODUCTION

Proper moisture balance is well accepted as an essential part of the wound-healing environment^{1, 2, 3}. The need for moisture balance in wound healing has resulted in the availability of a number of moisture control wound dressings, including; hydrogels, hydrocolloids, alginates, and foam dressings. One of the main objectives of such dressings is to achieve the optimum healing environment and allow the wound to progress to healing undisturbed. This, in turn, should promote cost-effectiveness both in terms of consumables and staff time to carry out wound care. In recognition of this,

moisture in the wound environment is now key consideration in clinical practice in concepts such as the TIME guidelines, which classifies the four main components of wound bed preparation as:

- T** - Tissue management
- I** - Control of infection and inflammation
- M** - Moisture imbalance
- E** - Advancement of the epithelial edge of the wound.

Due to the wide variety of dressings, possible additives and therapeutic approaches, achieving the correct moisture level in the wound environment relies almost entirely on clinical judgement and experience. To help

guide clinical practice of wound exudates management, TIME classifies dressing moisture levels as ranging from **Dry** to **Moist** to **Wet** to **Saturated** and finally to **Leaking**. With the exception of strikethrough or leaking, these judgements rely on dressing removal to allow direct observation of the wound. Observational judgments are therefore inherently subjective and depend on the skill and motivation of clinicians.

In 2009, a diagnostic sensor for wound moisture tracking was introduced^{4, 5}. to allow clinicians to monitor wound moisture without the need to remove the dressing. This device, (WoundSense™, Ohmedics Ltd) utilises a sterile moisture sensor that is placed on the wound before the dressing is applied. The sensor measurement is based upon low current electrical impedance measurements, taken via a pair of silver chloride electrodes. The moisture sensor is a flexible, sterile device comprising of a pair of silver chloride screen printed electrodes covered by a non-adherent porous wound gauze (Figure 1). The connectors to the sensor are then tucked away in the patient bandage or taped down at the side of the dressing (Figure 2) until a wound moisture reading is to be taken. To check moisture, the connectors to the sensor are attached to a moisture meter (Figure 3) and a reading is taken. The meter provides a 'drop'scale reading of moisture in the wound in five bands:

- 1 drop  = **Dry**
- 2 drops  = **Dry to Moist**
- 3 drops  = **Moist**
- 4 drops  = **Moist to Wet**
- 5 drops  = **Wet**

Figure 1: Moisture Sensor.



Figure 2: Connectors to sensor taped down on dressing.



Figure 3: Moisture meter showing five drop moisture scale¹.



Importantly, the use of the sensor enables more informed decisions to be made about dressing changes without disturbing the wound bed or unnecessarily opening a dressing, minimising the risk of infection. In addition to this, many dressings rely on moisture to activate an antimicrobial agent such as silver. To maximise the benefit of such dressings it is important that the wound environment does not remain too dry. The ability to monitor the moisture levels in wound environments without removing the dressing can aid clinicians in maximising the benefit of such dressing.

This paper presents two wound care studies in which moisture levels in the wound bed were monitored during treatment using the WoundSense. The aim of these studies were to determine if an appropriate moisture environment was maintained to promote good wound healing and to assess the suitability of wound moisture tracking during treatment using a CE-Marked disposable sensor. One study examines moisture tracking during compression therapy and the application of honey (Medihoney™ Antibacterial Medical Honey™, Comvita). The second study reports on moisture tracking levels in wounds dressed with topical negative pressure (TNP) dressings.

Study 1 – Compression Therapy and the use of Medihoney™

Patients from NHS Greater Glasgow and Clyde, UK, and King Abdullaziz University Hospital, Kingdom of Saudi Arabia, were recruited according to local ethics or audit procedures as appropriate by the attending clinician. Patient 1 was treated for a leg ulcer with a compression therapy dressing (with the sensor placed over the ulcer area). Patient 2 was treated by the application of honey (Medihoney™ Antibacterial Medical Honey™, Comvita) to the wound followed by the sensor and then a light gauze dressing.

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The moisture sensor, a flexible, sterile device comprising a pair of silver chloride screen printed electrodes covered by a non-adherent porous wound gauze, was placed in the dressing as part of standard care for managing firstly a venous leg ulcer under compression and secondly, a small, but full thickness leg wound. The active part of the sensor (the wound contact end of the silver electrodes) was centred over the wound and then bound in place with a compression bandaging system comprising a two-layer absorbent padding system and a short-stretch bandage or in the second case, a light gauze dressing and bandage. In the honey treatment the sensor was placed on top of the honey layer on the wound and the covering was then applied.

Moisture measurements were performed regularly, usually daily. The moisture measurement was taken using the hand-held WoundSense meter, which provides a reading on the moisture drop scale within around 30 seconds. Wound dressings were replaced according to the normal procedure of the attending clinician during these studies, regardless of the meter reading, and photographs were taken to visually validate the hydration measurement and wound status.

Results of Study 1

The results showed that the meter tracked moisture well and that moist readings indicated healing wounds under the dressing. Results in all five bands of the five drop scale were observed and corresponded to the status of the wound on dressing removal. Figure 4 below shows the wound of Patient 1 on a dressing change (week 2 of treatment). Sensor readings that week for dressing were moist; the dressing was changed after 7 days and photographed.

Figure 4: Patient 1. (A) Wound in Week 2, reading Moist = 3 drops. (B) Wound in Week 4, reading moist = 3 drops but wound now only 7mm long and healed, removed from compression.



The results for Patient 2 are shown in Figure 5 and Figure 6. This is a wound that progressed quickly into edge advancement and closer during the week of treatment. Figure 6 tracks the moisture profile of the honey-treated wound under the dressing during treatment.

Figure 5: Patient 2. (A) Wound at beginning of treatment. (B) Honey dressing and sensor before covering. (C) Wound at end of treatment week.

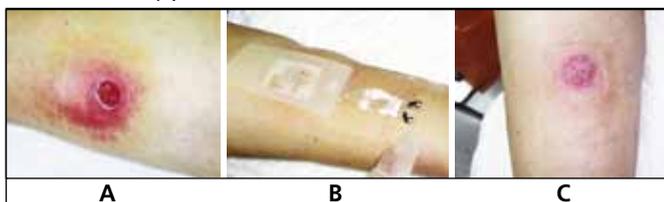
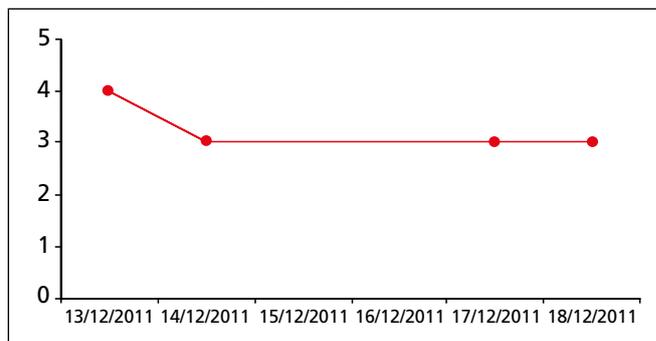


Figure 6: Moisture profile of Patient 2's wound (taken daily before dressing change) during week of treatment.



Conclusions and Discussion of Study 1

The moisture sensor, WoundSense™, was used to indicate the presence of moisture at the surface of wounds underneath the dressings without disturbing the wound environment. The sensor indicated moist in the presence of healing wounds, which corresponds to the accepted theory of wound healing in a moist environment. Identifying varying degrees of moisture in a dressing without the need for dressing removal, the wound monitor will be a useful tool to aid clinical judgement and enhance wound management protocols. Moreover, the device may be used in a military, hospital or primary care setting so will be a valuable tool for a variety of wound care challenges. The system is simple to use and therefore can be used in remote or telehealth regimes where daily patient visits to the clinic or community nurse visits are not available to track the dressing status and need for dressing changes.

Study 2 – Moisture Levels in Topical Negative Pressure: Early Results

Topical Negative Pressure (TNP) is the cornerstone of traumatic wound management at The Royal Centre for Defence Medicine (RCDM) at Queen Elizabeth Hospital, Birmingham, containing and isolating the wounds prior to reconstructive surgery. The majority of injured soldiers returning to the UK from Afghanistan have suffered blast injuries or gunshot wounds mostly affecting their limbs. A key concept in the management of these injuries is reconstruction in the sub-acute stage, which allows time to achieve an optimal condition where the patient is systemically well enough to promote a successful outcome. The benefits of TNP are widely recognised and are specifically useful in the setting of military injuries where high amounts of exudate are problematic and numerous operations are required before the wound is ready for closure⁶.

The drainage of exudate from a wound bed by application of constant negative pressure is seemingly counterintuitive to achieving a moist wound environment.

Furthermore, there is little literary evidence to support the claim that TNP promotes an environment ideal for moist wound healing. It is therefore the aim of this audit to:

1. Confirm the levels of moisture in military wounds treated with TNP.
2. Whether pump pressure may be correlated with wound moisture levels.
3. Explore how moisture levels under TNP dressings change throughout the course of TNP therapy.

4. Determine whether current practice of adjusting pump pressure based on exudate levels enables an optimum moist wound-healing environment.

Using the WoundSense™ moisture meter (Ohmedics, UK), moisture recordings are measured three times per day at set times (early morning, midday and evening) from the initial application of TNP for a maximum of three weeks or until TNP is no longer required for the wound being assessed if earlier. Photographs of the wound at each dressing change are taken, as they are beneficial to correlate wound changes with moisture levels throughout TNP treatment.

Early results of this study indicate that there is little moisture at all on the wound bed during regular TNP with a good seal achieved in the dressing. When TNP is combined with irrigation however, a much more moist wound healing environment is obtained. Moisture tracking during TNP therapy may provide a valuable tool to clinicians when managing traumatic military wounds where high levels of exudates can be problematic. A full review of this study will be published following completion of this study.

CONCLUSION

Up to now, healthcare professionals have been guided by their clinical instincts to determine which wounds are safe to close, and which dressings are appropriate for each wound. The quality of decision made depends largely on the level of clinical experience and availability of information on a given wound. The new wound monitoring devices detailed above will give the clinician more information on which to base their decision-making, which can only be good for clinicians, healthcare providers and, most importantly of all, patients.

ABSTRACT

Unnecessary dressing changes in the field, hospital or home setting disturb healing and increase the possibility

of infection entering the wound. We report a device that monitors the moisture level at the wound bed while leaving the dressing undisturbed, with dressing changes taking place only when necessary. Here, two clinical studies are presented. One study examines moisture tracking during compression therapy and the application of honey (Medihoney™ Antibacterial Medical Honey™, Comvita) carried out with patients from NHS Greater Glasgow and Clyde, UK, and King Abdullaziz University Hospital, Kingdom of Saudi Arabia. Early indications from a second study reports on moisture tracking levels in wounds dressed with topical negative pressure (TNP) dressings. The aim of these studies was to determine if an appropriate moisture environment was maintained to promote good wound healing and to assess the suitability of wound moisture tracking during treatment using a CE-Marked disposable sensor.

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