

# A clinical evaluation of Algivon® Plus manuka honey dressings for chronic wounds

## KEY WORDS

- ▶▶ Odour
- ▶▶ Quality of life
- ▶▶ Wound management
- ▶▶ Wound pH

This study reviews the literature on manuka honey and presents the results of an evaluation of Algivon® Plus with 100% medical grade manuka honey with a superabsorbent, secondary (Eclipse®) or foam dressing. Data were collected on the frequency of dressing changes and the products used. Dressing changes were performed by the tissue viability nurse consultant on days 1, 7, 14, 28, 35, 42, 49 and 56. Inpatient dressing assessments were performed twice weekly. Patients discharged to the community were assessed every Monday. The TIME framework was used to assess periwound skin, maceration, dermatitis and inflammation. All wounds were photographed. The volume, colour and odour of exudate were recorded using Likert-type scales and the wound pH was measured. Patient outcomes measured were pain, sleep, exudate odour and impact on quality of life. Following the use of Algivon® Plus, debridement to a clean wound bed generally occurred by day 7, with healing starting from day 14. The pH of the wound tissue was found to relate to the tissue type present. Patients slept for longer and were less affected by exudate and its associated odour as the study progressed. The dressings used were endorsed by best practice and resulted in positive clinical outcomes of healing or progression to healing.

## LINDA RAFTER

*Honorary Professor; Nursing, Faculty of Health and Life Sciences, De Montfort University, Leicester; and Tissue Viability Nurse Consultant, Wound Care Solutions*

## TIM REYNOLDS

*Consultant Chemical Pathologist/Divisional Medical Director (CH&CSS)/Research and Development Lead, Burton Hospitals NHS Foundation Trust*

## MARK COLLIER

*Lead Nurse/Consultant – Tissue Viability, United Lincolnshire Hospitals NHS Trust*

## MARK RAFTER

*Managing Director, Wound Care Solutions*

## MALCOLM WEST

*BioMedical Scientist at Burton Hospital NHS Foundation Trust*

Chronic wounds can have a significant impact on a patient's quality of life (Cutting, 2010). A recent and comprehensive health economic evaluation estimated that wounds cost the NHS £5.3 billion annually (Guest et al, 2015). Management of these complex wounds therefore requires a pragmatic approach to ensure the most suitable resources for the clinical circumstances are used to ensure good patient outcomes.

## HONEY

Honey has been employed in wound care since ancient times. The Egyptians, Hippocrates and Democritus in Ancient Greece, Galen in Ancient Rome, and Avicenna in Medieval times all recorded the healing properties of honey (Zumla et al, 1989; Jones, 2001). China and other nations have used honey as remedy for nearly every illness (Al-Waili et al, 2011). During the first part of the 20th century, honey dressings were part of everyday wound care, but with the discovery of antibiotics in the 1930s and 1940s their use declined. With the advent of

antibiotic-resistant bacteria, honey is now being used more frequently.

Manuka honey is non-cytotoxic to human tissue (Cooper et al, 2010). Over the past 10 years, the range of honey dressings available on the market in the UK has increased (Stephen-Haynes, 2011). Honey is now being re-established as a valuable agent in wound care management (Cutting 2007). A recent Cochrane review (Jull et al, 2015) on honey as topical treatment for wounds concluded that there is evidence it accelerates the healing of partial-thickness burns compared with conventional dressings. Honey is more effective than antiseptics for treating infected surgical wounds (Jull et al, 2015).

White (2015) suggests there are four main criteria that any dressing must meet. It must:

- ▶▶ Provide sustained broad-spectrum antibacterial action
- ▶▶ Be efficacious against biofilm
- ▶▶ Be efficacious in the presence of exudate
- ▶▶ Be safe.

Figure 1. Patient questionnaire on wound odour and quality of life\*

**1. Please tick which face is closest to your pain level (Wong and Baker, 1989)**

**2. Please tick which of these descriptions closely describe your type of pain today? You can choose more than one.**

Sharp/stabbing	Dull/aching	continuous	intermittent	burning	
----------------	-------------	------------	--------------	---------	--

**3. Please tick how many hours sleep you are having?**

No sleep	2-4 hours	4-6 hours	6-8 hours	Over 8 hours	
----------	-----------	-----------	-----------	--------------	--

**4. Please tick which descriptions closely describe your type of odour from your wound today. You can choose more than one.**

No odour	Odour on dressing removal	Odour evident on exposure of wound	Odour evident at arm's length	Odour evident on entering the room	Odour evident when entering the house
----------	---------------------------	------------------------------------	-------------------------------	------------------------------------	---------------------------------------

**5. Please tick which descriptions closely describe the impact odour has on your life.**

Odour has no affect	Aware of odour	Concerned other people can notice odour	Reluctant to socialise	Affects appetite	Nauseated from odour
---------------------	----------------	---	------------------------	------------------	----------------------

\*Adapted from the 3M TELER® note-making system (Rafter and Oforka, 2014)

Manuka honey has all of the beneficial criteria necessary for an ideal dressing material for wounds (Oryan et al, 2016). It is an antimicrobial agent, promotes autolytic debridement, stimulates the growth of wound tissue thus hastening wound healing in dormant wounds, and initiates anti-inflammatory activity that rapidly reduces pain, oedema and exudate production (Oryan and Zaker, 1998; Bittmann et al, 2010). Honey also has anti-inflammatory and antioxidant activities that boost the immune system (Oryan et al, 2016).

The pH of honey is between 3.2 and 4.5 (acidic), which makes it an unsuitable environment to support bacterial growth as most microbes prefer a neutral or slightly alkaline pH of 7 for growth (Ortiz-Vazquez et al, 2013). During dilution, the glucose in honey catalyses into gluconic acid and hydrogen peroxide, creating an acidic environment (Bittmann et al, 2010; Ortiz-Vazquez et al, 2013). As

honey is a super-saturated solution of sugars with low water content, sugars readily bind to the water molecules, making them unavailable for micro-organisms (Cooper, 2006).

**Algivon® honey**

Algivon® honey products are comprised of 100% medical-grade manuka honey, giving them reliable levels of antimicrobial properties. Algivon® honey's osmotic effect helps to debride and deslough wounds and reduce the odour associated with infection while maintaining an optimum moist wound healing environment. Manuka honey has been found to be more effective than other honey samples (Cooper and Gray, 2012).

Cooper (2011) demonstrated that Algivon® manuka honey not only prevents biofilm formation, but also inhibits established biofilms in a timely and correct manner. Algivon® manuka honey has been demonstrated *in vitro* to be effective against *Staphylococcus aureus*, Methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococci (Cooper, 2011). Higher concentrations of honey were required to inhibit established biofilms than to inhibit planktonic cells (Cooper and Gray, 2012).

**AIM AND OBJECTIVES**

This evaluation aimed to determine the clinical efficacy and cost-effectiveness of Algivon® Plus honey dressings in 40 chronic wounds. The primary objective was to evaluate these dressings in clinical practice by:

- ▶▶ Identifying the incidence of chronic wound infection
- ▶▶ Identifying the action by which Algivon® dressings provide sustained broad-spectrum antibacterial action
- ▶▶ Assessing wound bed progression towards healing
- ▶▶ Assessing the level of exudate on dressing removal.
- ▶▶ Measuring the pH of the wound bed

The secondary objectives were to:

- ▶▶ Monitor patient perceptions of odour, pain and overall comfort
- ▶▶ Monitor patient perceptions of the dressing's ability to help heal wounds
- ▶▶ Identify infection and wound healing properties.

## METHODOLOGY

The tissue viability team was alerted by the nursing staff about patients who had chronic wounds that required management with Algivon® Plus. Nursing staff gave the patients a leaflet explaining the evaluation and discussing what their involvement would entail. Patients were then asked if they wanted to participate. A written consent form was obtained from the patient or a relative.

An evaluation form was designed based on a previous study (Rafter and Oforke, 2014). The same assessor performed the evaluation on all patients. Patients' age, sex, nutritional status, medical conditions, wound information (including site and duration) were recorded. If a patient withdrew from the evaluation for any reason, this was noted.

Patient eligibility criteria were: aged 18 years or older; written, informed consent to participate or witnessed verbal consent or consultee agreement; and the expectation of being able to comply with a follow-up schedule of twice weekly inpatient assessments followed by once weekly community assessment after discharge. Patient exclusion criteria were: unwillingness to participate; clinically infected wounds; and changes in the patient's condition such that normal treatment was being compromised. The study was registered with the clinical evaluation department in the hospital where the evaluation was completed and approved before commencing.

### Dressing regimen and assessment

Algivon® Plus honey dressing was used as the primary dressing with Eclipse® superabsorbent secondary dressing (Advancis) or foam dressing. Data were collected on the frequency of dressing change and the dressing products used.

Every patient had their dressing change performed and monitored by the tissue viability nurse consultant on days 1, 7, 14, 28, 35, 42, 49 and 56. The regimen required a dressing change every 48 hours. Inpatient dressing assessments were thus performed twice weekly to ensure that the regimen was being followed. Patients discharged to the community had their dressings changed on Wednesdays and Fridays by the district nursing teams. Dressing changes and a full tissue viability assessment were performed every Monday.

Any additional dressing changes and their frequency were recorded.

A wound assessment using the TIME (Tissue management, Inflammation and infection control, Moisture balance, Epithelial (Edge) advancement) framework was completed at each dressing change (European Wound Management Association, 2004; Dowsett, 2008). The action of the honey on the wound bed and periwound skin, as well as the presence of any maceration, dermatitis and inflammation, was evaluated. All wounds were photographed to allow for comparison over time. The volume of exudate on dressing removal was recorded using a Likert-type scale where 1=none, 2=light, 3=moderate, 4=heavy and 5=excessive. Exudate colour was recorded using a Likert-type scale where 1=serous, 2=haemoserous, 3=purulent and 4=none. The characteristics and amount of odour on dressing removal were recorded using a Likert-type scale where 1=none, 2=mild, 3=moderate and 4=offensive (World Union of World Healing Societies, 2007). The tissue viability nurse used a modified Baker and Haig scale (Poteete, 1993) for her odour assessment, while the patients used the questionnaire, based on the TELER® note making system, which had been used in a previous study (Rafter and Oforke, 2014) (*Figure 1*).

The pH of the wound bed was tested at each dressing change with a pH strip. The test strip was held in place on the wound bed for 15 seconds, then the tester 30 seconds while the strip developed before taking a reading.

A wound swab was performed on days 1, 14, 35 and 49 at dressing change to assess the microbiology of the wound bed. The swab was rolled across the wound surface and then placed in charcoal medium. All of the swabs were hand delivered to the microbiology laboratory within 48 hours.

Patients were encouraged to record their perceptions of pain on dressing change on days 1, 3 and 7 using a numerical pain score of 0–10 (Wong and Baker, 1998) (*Figure 1*). This pain scale also included a description of the type of pain as sharp/stabbing, dull/aching, continuous, intermittent or burning. Patients' sleep patterns over the 7 days were measured in the patient questionnaire. The type of odour from the wound and impact of the odour on quality of life was recorded (*Figure 1*). Patients' opinions of Algivon® Plus dressing, odour, pain and overall comfort were investigated to determine how the dressing performed in clinical practice.

Table 1. Patient demographics (n=22).

	Age	Body mass index	Malnutrition Universal Screening Tool	Waterlow score
Minimum	42	16	0	12
25th centile	67	21	0	16
Median	72	24.9	0	21
Mean	72.381	29.248	0.667	20.857
75th centile	79	37.5	2	23
Maximum	95	68	4	34
Standard deviation	12.596	12.130	1.155	5.597

Table 2. Locations of participants' wounds.

Location of wound	Number of wounds
Toes	5
Foot	9
Forefoot	1
Heel	5
Leg	11
Knee	2
Hip/buttock/sacrum	6
Spine	1

Table 3. Types of wounds.

Type of wound	Number of wounds
Pressure ulcer	11
Trauma	9
Leg ulcer	13
Diabetic foot ulcer	3
Surgical	4

**Data analysis**

Data analysis was carried out by an independent statistician using Microsoft Excel and VassarStats (<http://vassarstats.net>). Data were analysed for all continuous variables. Apparently non-Gaussian or ordinal data were assessed using non-parametric statistical tests (Mann–Whitney, Kruskal Wallis or Chi-squared tests). T-tests were applied to Gaussian data.

**RESULTS**

Twenty-two patients were recruited — 11 females and 9 males — with a total of 45 wounds. Evaluation was incomplete for five wounds as three patients died and two were withdrawn from the study as they were non-concordant with the dressing regimen. A total of 40 chronic wounds in 22 patients were therefore evaluated. Patients were followed-up after discharge from the acute general hospital into the community setting. There were 170 assessments performed in the hospital and 101 in the community.

Participants' ages ranged from 42 to 95 years, a slightly skewed distribution, and body mass index (BMI) had a significantly skewed distribution with a long, positive tail. The mean Waterlow scores did not significantly vary, however there were differences in the mean Malnutrition Universal Screening Tool scores, see *Table 1*. The 22 patients had differing levels of mobility. Two were independently mobile, two required assistance, five walked with a frame and unaided, and 12 were bedfast/used a wheelchair. In addition to this, participants had differing mental states. Half were lucid, five were lucid with poor memory, one was confused at times and four had dementia.

The locations and types of wounds varied, see *Tables 2* and *3*. The length of time participants had lived with their wounds ranged from over 1 month to over 2 years. The majority of wounds had lasted over 2 months (n=14) or over 2 years (n=12).

**Wound assessment**

Debridement to a clean wound bed was fairly rapid, see *Figure 3*. Algivon® Plus started to debride and change the wound bed from day 7 onwards. The wounds healed fairly rapidly from 14 days onwards, see *Figure 4*. Algivon® Plus appears to be effective, given that these were chronic complex wounds and many had been present for over 2 years.

Despite 108 wound swab samples being taken to assess the microbiology of the wound bed, we were unable to analyse the effectiveness of Algivon® Plus in treating infections as many patients were on antibiotics. The number of wounds not treated with antibiotics does not decrease until 21 days into the evaluation. The wound swabs taken from patients using Algivon® Plus dressings but not receiving antibiotics cultured non pathogenic, suggesting that the honey dressings were effectively treating the chronic wounds (Cooper, 2011).

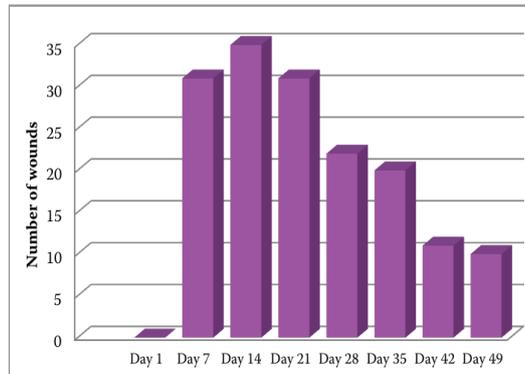


Figure 3. Length of time taken to achieve a clean wound bed (full debridement).

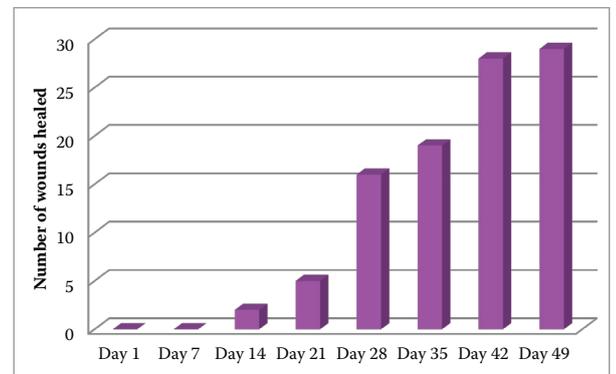


Figure 4. Wound healing over time.

**Clinical observations**

**Periwound edges**

Over the 8-week assessment period, a total of 271 dressing changes were carried out. The periwound skin condition was assessed at every dressing change. The majority of wounds (167) had red/inflamed wound edges and 46 wounds had dry flaky skin. Only 54 of the wounds had maceration and four wounds had excoriation.

**Odour**

After the assessment period, 79 wounds had no odour, 67 slight odour, 66 wounds had moderate and 28 wounds offensive odour. At the start of the study, 8 had no odour, 6 slight odour, 22 had moderate and 4 wounds had offensive odour.

**Exudate level**

After the assessment period 31 wounds had no exudate, 153 low level exudate, 26 wounds had moderate exudate, 16 wounds had a high level of exudate and 14 wounds excessive exudate. At the start of the study, 0 wounds had no of exudate, 21 had low level of exudate, 3 moderate of level exudate, 6 high level of exudate, 0 wounds had excessive level of exudate.

**Pain**

Figure 5 shows clinicians’ perceptions of patients’ pain scores. Patients did experience pain on dressing change, but this appeared to decrease after day 14. The pain experienced mirrored the amount of analgesia that was taken by the patient. As wound healing progressed, patients required less analgesia.

**pH**

The results of the pH tests demonstrated that the pH of the wound bed was related to the type of tissue present, see Table 4. T-tests were carried out on the pH data collected during this evaluation to establish whether Algivon® Plus made a significant difference to wound bed pH (with  $p < 0.05$ ). Structural equation modelling T-tests found that necrotic tissue pH was significantly different to both slough and granulation tissues. Slough was significantly more acidic than granulation tissue and granulation tissue was significantly more alkaline than epithelial tissue. There were no significant differences in the pHs between necrotic and epithelial tissues or between slough and epithelial tissues. There were too few epithelialised samples to make a fair comparison with non-epithelialised tissue. Results do, however, enable us to identify with reasonable confidence the change in pH from necrotic to sloughy to granulating wound conditions. The large number of granulation samples taken makes the structural equation modelling very tight, and therefore believable.

**Environment and compliance**

It was observed that inpatients were compliant with their care pathway. Patients in the community and at home were less compliant, e.g. they were less likely to elevate their lower legs.

**Patient questionnaire responses**

The patient questionnaires were only filled in by the 11 lucid patients. It is impossible to gain any statistical information from such a small number of individuals. Four of the 11 patients reported

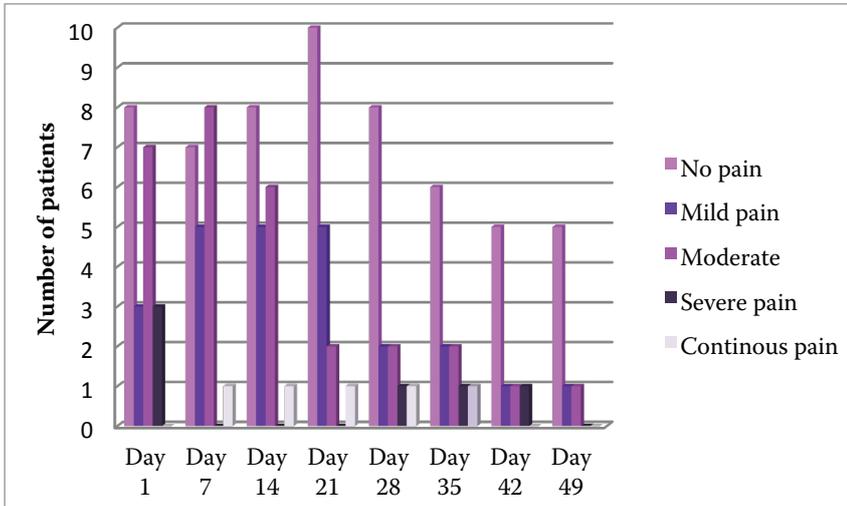


Figure 5. Clinicians' observations of patients' pain levels at dressing change.

Tissue type	pH level (range)
Epithelial	6.5 (±0.73)
Granulation	7.0 (±0.65)
Slough	6.4 (±0.77)
Necrotic	6.0 (±0.61)

pain on dressing change, but no obvious pattern was observed. The sleep patterns of patients at the first assessment varied from 2 to 6 hours and at the second assessment at 14 days, had improved to 6 to 8 hours. This improvement remained the same after this point in the evaluation. The amount of sleep patients got increased as their wounds began to heal.

The effect of odour on patients' quality of life can be seen in Figure 6. Most patients experienced no odour after day 7.

All patients found the Algivon® Plus dressing comfortable/very comfortable to wear. No dressing-related adverse events were recorded.

**DISCUSSION**

The chronic wounds included in this evaluation were taken from a convenience sample in an acute hospital. Participants' age, BMI and Waterlow and Malnutrition Universal Screening Tool scores were similar. The BMI scores indicated that 70% of this sample fell into the obese category. Lincolnshire Research Observatory (2015) has found that Lincolnshire is the county with the greatest rate of obesity in the East Midlands. According to the latest

statistics, 69.91% of county residents are considered overweight or obese. The correlation between obesity and deficient wound healing has long been established (Pierpont et al, 2014).

The results of this evaluation concur with previous studies on chronic wounds using honey. Yapucu and Eser (2007) demonstrated a statistically significant mean decrease in ulcer size at 5 weeks in the honey dressing group. Some pressure ulcers had completely healed at 5 weeks in this study. In our evaluation, there were wounds that debrided from day 4 and healing was started from day 14 of the evaluation. This was observed clinically, even in significantly compromised patients.

**Clinical observations**

Application of honey dressing provides a moist environment that induces rapid debridement of wounds (Sazegar et al, 2011; Sukur et al, 2011; Maddocks et al, 2013). The high osmotic in-honey activation of proteases by hydrogen peroxide is beneficial in two ways: it induces rapid debridement and painless lifting of sloughy and necrotic tissue (Manyi-Loh et al, 2011). This was observed clinically by the authors of this paper.

Honey is useful in managing red or inflamed wounds as it reduces oedema, inflammation and pain, facilitates debridement and deodorises wounds. It supports the synthesis of collagen, stimulating the growth of fibroblasts and epithelial cells and promoting granulation tissue (Molan, 2001; 2002; Al-Mamary et al, 2002; Al-Waila, 2011). Unlike other honey dressings on the market that need to be cut to size, with the risk other products in the honey may harm the surrounding skin, Algivon® Plus dressing does not require cutting.

High exudate levels are due the inflammatory increase in vessel permeability and fluid movement into the soft tissue (Cutting, 2007). The exudate levels were lower than expected in our evaluation due to the anti-inflammatory action of the manuka honey within the Algivon® Plus dressings.

The number of patients who had odorous wounds reduced during the course of the evaluation. It is known that the physical properties of honey help control odour by the autolysis of nonviable tissue and control of inflammation control (Chang and Cueller, 2009).

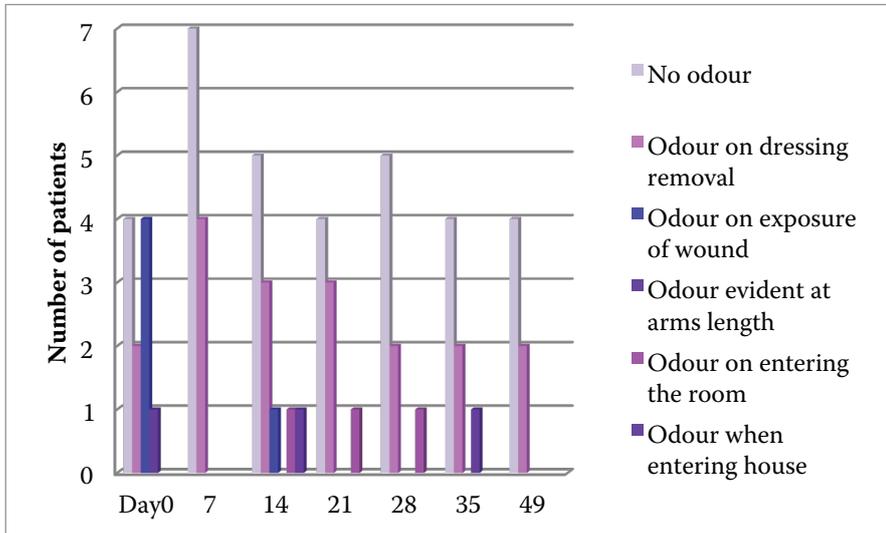


Figure 6. Patients’ perceptions of odour from their wounds.

The pH measure has not been very well researched and it was interesting to find that Algivon® Plus honey decreases the pH of the wound bed, promoting wound healing. Chronic wounds have a more alkaline environment. The acidification of the wound environment has been proposed as a mechanism by which honey induces healing (Oryan et al, 2016).

We found that antibiotics were being used in clinical practice even if the patient was not clinically unwell. The World Health Organization (Sprenger, 2015) states that we are over-using antibiotics and often prescribing them in the wrong context. We need to slow down the development and spread of resistance so that the antibiotics we have continue to work for as long as possible. The focus on the Surviving Sepsis Campaign in hospitals appears to have increased the use of antibiotics.

**Secondary dressing effects**

White (2016) states that an appropriate product and secondary combination should be used. The results of this chronic wound evaluation demonstrated that Eclipse® Super Absorbant was an appropriate secondary dressing. Exudate levels were as low as those achieved in Rafter et al (2015). This finding was further endorsed by the state of the periwound edges, which were not macerated and excoriated, indicating the correct frequency of dressing change (every 48 hours) was employed.

**DECLARATION**

*This article was supported by an educational grant from Advancis Medical. The authors would like to thank Mark Collier, Nurse Consultant, and his tissue viability team at the United Lincolnshire Hospitals NHS Trust, and in particular, Helen Wilkinson and Katie Dalton (Tissue Viability Nurses) for their help with this evaluation.*

**Improving patient outcomes**

As clinicians we need to be aware the four principles involved in improving patient outcomes. First, we need to understand our patient’s experience of the dressing we used to help debride and promote wound healing. Second, there needs to be evidence behind the wound dressing we are using and the choice we have made from the selection available. Third, we need to ensure the primary and secondary wound dressings are stored appropriately so they perform as well as possible. Fourth, we need to optimise the wound dressing used as part of the patient care pathway and deliver it in a timely manner (Picton and Wright, 2013). All antimicrobials, including honey, should be used in an appropriate and structured manner for limited periods (Wounds UK Best Practice Statement, 2010).

Consistent delivery of the care pathway by the same assessor is ideal. In our evaluation this was possible, but the reality is that in hospital and community settings it is often not the same nurse delivering the care pathway. The regimen of 48-hourly dressing changes produced very good patient outcomes and was very cost-effective.

**Limitations**

This evaluation had a few limitations. As the sample size was small, a larger controlled/comparative trial in chronic wounds using Algivon® Plus against a competitor’s honey product needs to be undertaken to confirm and establish the results. Data were only collected over a 6-month period and the twice weekly assessment in hospital was very labour intensive. All patient assessments were undertaken by one tissue viability nurse consultant, who maintained consistency in care. As there was no comparative honey product, statistical analysis was not pertinent for this evaluation.

The recruitment of patients with the same type of wound resulted in a participant pool consistent with chronic wounds. It was not possible to obtain all patients’ perceptions of the dressings, however, as a number of the participants were not lucid.

**CONCLUSIONS**

This evaluation of Algivon® Plus dressings has provided a valuable insight into the management of chronic wounds in patients in an acute hospital and community environment. The Algivon® Plus

and secondary dressings used in this evaluation had positive clinical outcomes, with healing or progression to healing in the majority of cases.

The results of this evaluation endorse best practice in chronic wound management. Delays in healing due to infection and other complications can add to healthcare costs, whereas comprehensive assessment and the effective management of chronic wounds can expedite healing in this very complex client group.

WUK

### REFERENCES

- Al-Waili NS, Salom K, Bulter G, Al Ghamdi AA (2011) Honey and microbial infections: a review supporting the use of honey microbial control. *J Med Food* 14(10): 1079–96
- Al-Mamary M, Al-Meerri A, Al-Habori M (2002) Antioxidant activities and total phenolics of different honey. *Nutr Res* 22(9): 1041–7
- Ansari MJ, Al-Ghami A, Usmani Set al (2013) Effect of jujube honey on *Candida albicans* growth and biofilm-forming abilities. *Arch Med Res* 44(5): 352–60
- Poteete V (1993) Case study: eliminating odours from wounds. *Decubitus* 6 (4) 43–46
- Bittmann S, Luchter E, Thiel M et al (2010) Does honey have a role in paediatric wound management? *Br J Nurs* 19(15): S19–24
- Chang J, Culler NG (2009) The use of honey for wound care management: A traditional remedy revisited. *Home Healthc Nurse* 25(5): 309–16
- Cooper R (2010) Biofilms and wounds: much ado about nothing? *Wounds UK* 6(4): 84–90
- Cooper R (2006) The antibacterial activity of honey. In: White R, Cooper, R, Molan P, eds. *Honey: A Modern Wound Management Product*. Wounds UK, Aberdeen
- Cooper R, Jenkins L, Rowlands R (2011) Inhibition of biofilms through the use of manuka honey. *Wounds UK* 7(1): 24–32
- Cooper R, Gray D (2012) Is manuka honey a credible alternative to silver in wound care? *Wounds UK* 8(4): 54–64
- Cutting K (2010) Wound dressings: 21st century performance requirements. *J Wound Care* 19(5 suppl): 4–9
- Cutting K (2007) Honey and contemporary wound care: an overview. *Ostomy Wound Manage* 53(11): 49–54
- Dowsett C (2008) Using the TIME framework in wound bed preparation. *Br J Community Nurs* 13(6): S15–21
- European Wound Management Association (2004) *Position document: Wound bed preparation in practice*. MEP Ltd, London
- Guest JF, Ayoub N, McIlwraith T (2015) Health economics burden that wounds impose on the National Health Service in the UK. *BMJ* 5(12): e009283
- Knight A (2013) The therapeutic effects of honey. *Plymouth Student Science* 6 (1): 376–85
- Lu J, Tunbull L, Burke CM et al (2014) Manuka-type honeys can eradicate biofilms produced by *Staphylococcus aureus* strains with different biofilm-forming abilities. *PeerJ* 2: e326
- Jones R (2001) Honey and healing through ages. In: Munn P, Jones R, eds. *Honey and Healing*. UK International Bee Research Association, Cardiff: 1–4
- Jull AB, Cullum N, Dumville JC et al (2015) Honey as topical treatment for wounds. *Cochrane Database Syst Rev* DOI: 10.1002/14651858.CD005083. pub4
- Maddocks SE, Jenjins RE (2013) Honey: a sweet solution to the growing problems of antimicrobial resistance? *Future Microbiol* 8(11): 1419–29
- Majtan J, Bohova J, Horniackova M et al (2014) Anti-biofilm effects of honey against wound pathogens *Proteus mirabilis* and *Enterobacter cloacae*. *Phytother Res* 28(1): 69–75
- Majtan J (2011) Methylglyoxal – a potential risk factor of manuka honey in healing of diabetic ulcers. *Evidence-Based Complementary Alternative Medicine* 2011: 1–5. DOI: 10.1093/ecam/nea013
- Manyi-Loh CE, Clarke AM, Ndip RN (2011) An overview of honey: therapeutic properties and contribution in nutrition and human health. *African Journal of Microbiology Research* 5 (8): 884–52
- Mikkelsen H, Duck Z, Lilley KS, Wech M (2007) Interrelationships between colonies, biofilms, and planktonic cells of *Pseudomonas aeruginosa*. *J Bacteriol* 189(6): 2411–6
- Merckoll P, Jonassen TØ, Vad ME et al (2009) Bacteria, biofilms and honey: A study of the effects of honey on planktonic and biofilm-embedded chronic wound bacteria. *Scand J Infect Dis* 41(51): 341–47
- Molan P (2001) Honey as a topical antibacterial agent for treatment of infected wounds. *Wound Wide Wounds*. Available at: <http://bit.ly/1uXdgZ3> (accessed 25/10/17)
- Molan P, Rhodes T (2015) Honey: A biological wound dressing. *Wounds* 27(6): 141–51
- Ortiz-Vazquez E, Cuevas-Glory L, Zapata-Baas G et al (2013) Which bee honey components contribute to its antimicrobial activity? A review. *African Journal of Microbiology Research* 7(51): 5758–65
- Oryan A, Alemzadeh E, Moshiri A (2016) Biological properties and therapeutics activities of honey in wound healing: a narrative review and meta-analysis. *J Tissue Viability* 25(2): 98–118
- Oryan A, Zaker SR (1998) Effects of topical application of honey on cutaneous wound healing in rabbits. *Zentralbl Veterinarmed* 45(3): 181–8
- Picton C, Wright H (2013) *Medicines Optimisation: Helping Patients to Make the Most of Medicines*. Royal Pharmaceutical Society, London
- Pierpont YN, Dinh TP, Salas RE et al (2014) Obesity and surgical wound healing: A current review. *ISRN Obes* 2014: 638936
- Lincolnshire Research Observatory (2015) *JSNA Topic: Obesity (All Ages)*. Available at: [www.research-lincs.org.uk/Home.aspx](http://www.research-lincs.org.uk/Home.aspx) (accessed 25.10.17)
- Rafter L, Oforka E (2014) Standard versus polymeric membrane finger dressing and outcomes following pain diaries. *Wounds UK* 10(2): 40–9
- Rafter L, Anthony D, Collier M, Rafter M (2015) Stopping the strikethrough: An evaluation of patient outcomes on four superabsorbent dressing. *Wounds UK* 11 (3): 78–85
- Sazegar G, Seyed Reza AH, Behravan E (2011) The effects of supplemental zinc and honey on wound healing in rats. *Iran J Basic Med Sci* 14(4): 391–8
- Stephen-Haynes J (2011) Achieving clinical outcomes: the use of honey. *Wound Essentials* 6: 14–9
- Singh MP, Chourasia HR, Agarwal M et al (2012) Honey as complementary medicine: a review. *Int J Pharma Bio Sci* 3(2): 12–31
- Sprenger M (2015) *How to stop antibiotic resistance? Here's a WHO prescription*. World Health Organization. Available at: [www.who.int/mediacentre/commentaries/stop-antibiotic-resistance/en/](http://www.who.int/mediacentre/commentaries/stop-antibiotic-resistance/en/) (accessed 25.10.17)
- Surviving Sepsis Campaign (2016) *Surviving Sepsis Campaign response to Sepsis-3*. Available at: [www.survivingsepsis.org/SiteCollectionDocuments/SSC-Statements-Sepsis-Definitions-3-2016.pdf](http://www.survivingsepsis.org/SiteCollectionDocuments/SSC-Statements-Sepsis-Definitions-3-2016.pdf) (accessed 25.10.17)
- Sukur SM, Halim AS, Banga Singh KK (2011) Evaluations of bacterial contaminated full thickness burns wound healing in Sprague Dawley rats with Tualang honey. *Indian J Plast Surg* 44(4): 112–7
- White R, Cutting K (2008) Critical colonisation of chronic wounds: microbial mechanisms. *Wounds UK* 4(1): 70–8
- White R (2015) High oxygenation state Ag oxyalts: the clinical and scientific rationale for inclusion into a wound dressing. Presented at: Wounds UK Conference, Harrogate, UK, 9–11 November
- White R (2016) Manuka honey in wound management: greater than the sum of it's parts? *J Wound Care* 25(9): 539–43
- Wong D, Baker C (1998) Pain in children: comparison of assessment scales. *Pediatr Nurs* 14(1): 9–17
- World Union of Wound Healing Societies (2007) *Principles of Best Practice. Wound exudate and role of the dressing. A consensus document*. MEP Ltd, London. Available at: [www.woundsinternational.com/pdf/content\\_42.pdf](http://www.woundsinternational.com/pdf/content_42.pdf) (accessed 25.10.17)
- Wounds UK Best Practice Statement (2010) *The use of topical antiseptic/antimicrobial agents in wound management*. Wounds UK, Aberdeen
- Yapucu Güneş U, Eşer I (2007) Effectiveness of honey dressings for healing of pressure ulcers. *J Wound Ostomy Continence Nurs* 32(2): 184–90
- Zumla A, Lulat A (1989) Honey: a remedy rediscovered. *JR Soc Med* 82(7): 384–5