Signalment: Hunter, a 17 month old MN Great Dane

History: Owner reported that Hunter ran into road chasing another dog, and was hit by a car in his left rear leg. The owner wrapped his leg in a towel and he presented to the VMSG Emergency Service. The dog was reportedly normal prior to the episode. He has a history of IBD and skin allergies, and was being treated with budesonide, cetirizine and Mometamax.

Clinical Exam: Hunter presented in mild shock with an elevated heart rate of 180 and fair pulses. He also had abrasions on his lateral and medial aspects of RTL antebrachium and right lateral thoracic region. The medial aspect of his LPL hock, distal paw (distal from metatarsal-phalangeal joint) and medial aspect of P3 of digit 3 had suffered a degloving injury. There was also shearing injury to P1-3 of the 2nd digit with bone visible. There was significant hemorrhage, with some arterial bleeding evident.

Laboratory findings: At presentation, blood work was unremarkable, with a PCV of 46%, TS of 7.0, and lactate of 2.1. This decreased to 36%, 5.2 and 1.2 respectively after fluid resuscitation with 5L of plasmalyte IV.

Diagnostic findings: Two-view thoracic radiographs were obtained following fluid resuscitation, showing no abnormalities. A lateral radiograph of the left tarsus showed soft tissue swelling and cutaneous irregularity of the left tarsus/distal extremity that was most severe medially. No osseous or articular lesions were appreciated.

Diagnosis: The dog was diagnosed with a degloving and shearing injury to the distal left thoracic limb, with bone exposure but no apparent fractures/luxations.

Treatment/Management: 16ga IV catheters were placed in each cephalic vein, and the patient was bolused 5L plasmalyte IV. Hydromorphone 0.1mg/kg was given IV for analgesia, and a pressure bandage was placed over the LPL wounds while radiographs were obtained. A 500ml bolus of vetstarch was given over 30 minutes. The pressure bandage was removed, the wound was lavaged and a hemoclip was placed on the bleeding arterial vessel. A wet-to-dry bandage was placed and the patient was started on Baytril 10mg/kg IV q24h and Unasyn 30mg/kg IV q8h. The wet-to-dry bandages were changed the next day. The following day, a bandage encompassing the hock lesion and metatarsal/phalangeal wounds was placed using the VAC system, using intermittent settings of 125mmHg with 5 minutes on and two minutes off. The VAC system was removed two days later and superficial debridement was performed. VAC sponges were placed in the medial pocket of the metatarsal/phalangeal wound for further debridement and the VAC system was replaced, not including the hock wound. Wet-to-dry bandages were placed over the hock wound. The hock wound was debrieded the next day and a non-adherent dressing was placed. The following day, the VAC bandage was removed and a granulation bed was present. Non-adherent dressings were placed on all wounds and covered with a modified RJ bandage. The patient was discharged on Clavamox, Baytril and tramadol.

The next day, seven days following the initial injury, the patient returned for a bandage change. Friable, bleeding, unhealthy granulation tissue was present on all wounds, and a small pocket of pus was seen when the bandage was removed from a focal site along the exposed bone along the metatarsus. A culture was taken and a penrose drain was placed. The wounds were rebandaged with a non-adherent dressing and a modified RJ bandage. The following day, there was significant strike-through of the bandage. The granulation bed appeared unhealthy, being dark red, friable and bleeding easily. The drain was removed. Medi-Honey calcium alginate dressings for moderate-to-highly exudative wounds were applied to the wounds and rebandaged with a modified RJ.

Wound culture showed infection with enterococcus spp. and methicillin-resistant Staphlococcus schleiferi coagulans. He was started on amoxicillin, clindamycin, and enrofloxacin.
The bandages continued to be changed every 1-2 days for 2 weeks, then extended to every 3 days, and then to every week. Honey was applied with each bandage change until epithelialization was complete. After that, collisate was applied to the wounds instead. Although there was initially concern over whether the wound would be able to close without skin grafting, the addition of the honey assisted in the production and maintenance of a healthy granulation bed, which progressed to epithelialization and effective healing by second intention.

**Discussion:**

Honey has been used for millennia in the treatment of wounds due to the many benefits it conveys. General effects of honey on wound healing include: causing contraction, promotion of the formation of granulation tissue, promotion of epithelialization of wounds, stimulation tissue growth and synthesis of collagen, angiogenesis in the bed of wounds, reduction of postoperative adhesions, reduction of edema, reduction of inflammation, deodorization of wounds, promotion of moist wound healing, facilitation of debridement, and reduction of pain (2,3). Interestingly, stimulatory effects have been obtained when honey has been administered orally or parenterally, suggesting that a tissue growth factor may be also involved, rather than the stimulation of growth being purely a consequence of wound acidification or improved nutrition of the tissue (3).

**Antimicrobial Properties:** The antimicrobial properties of honey can originate from several of its qualities. Honey has a high osmolarity, thereby dehydrating and potential inhibiting bacteria. Honey produces low levels of hydrogen peroxide when it is diluted due to the presence of glucose oxidase. This is in sufficient concentration to be antibacterial, yet dilute enough to be nontoxic while promoting fibroblast proliferation and angiogenesis. Honey also has an acidic pH and contains many volatiles, organic acids and flavonoids in addition to beeswax, pollen and potent phytochemical properties derived from the plants whose nectar the bees harvested which all inhibit bacterial growth (2). One study attempted to induce resistance in vitro with both *S.aureus* and *P.aeruginosa* using MediHoney in increasing sublethal doses. No resistance was noted, indicating that honey may contain components that inhibit the ability of bacteria to form resistance (3).

**Adverse Reactions:** Based on the human literature, there is no evidence that honey application can cause severe adverse reactions; reported reactions are no worse than other wound dressings with only about 5% of patients experiencing adverse effects, such as pain on application (1,3). Honey does not have the problem of systemic absorption, in contrast to alcohol or silver based dressings, so it can be used even on patients with diabetes mellitus without adverse effects on glucose levels (3).

**Use of Honey:** Medical grade honey, such as MediHoney, is gamma irradiated to inactivate any potential Clostridial contamination, which has been occasionally found in honey (3). In this way, it is preferred to honey that is typically consumed. In addition, medical honey, such as Manuka honey, is typically of the *Leptospermum spp.*, which has been shown to have additional antibacterial properties not associated with hydrogen peroxide (1). Medical honey dressings should be kept in contact with the wound for at least 12 hours, but preferably 24 hours (3). One study performed evaluating the use of honey on distal limb wounds in horses showed that the beneficial effects of Manuka honey on wound healing extended only to the first 21 days following the injury. After that time, wounds not treated with honey appeared to heal faster (1). Wounds should continue to be treated with honey until epithelialization has occurred, and then the healing area should continue to be protected until scar tissue formation is complete.

### References