CUTTING EDGE LASER TECHNOLOGIES

Michelle Trappler, VMD, DACVS

THE VETERINARIANS

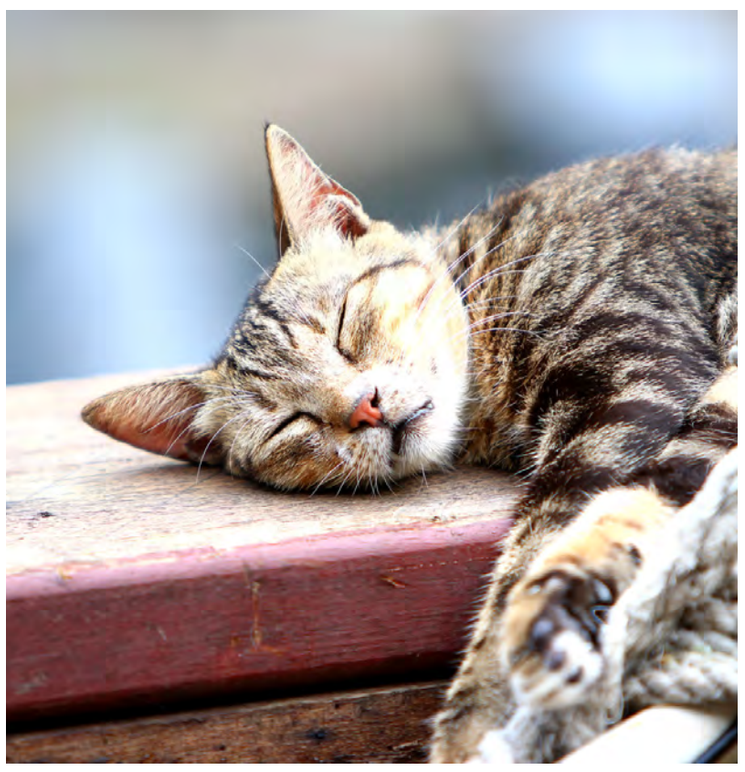
# SURVIVAL GUIDE

# TO WOUND MANAGEMENT TECHNIQUES

How to leverage new techniques, and technology to improve wound care management.

# CONTENT

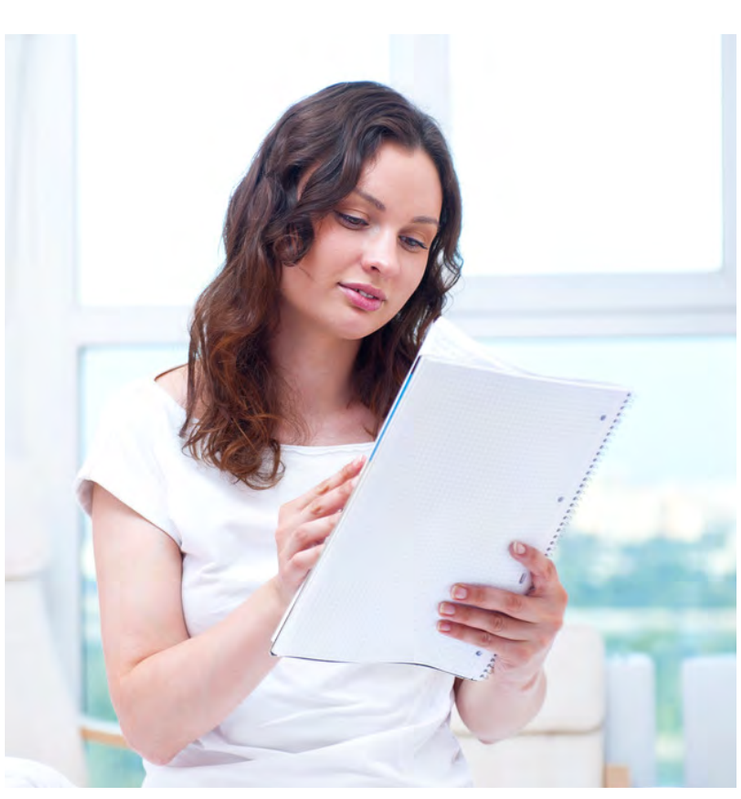
















**FOLLOW US**

facebook.com/celasers
linkedin.com/celasers
twitter.com/celasers


www.celasers.com | info@celasers.com.com

# 03 | ABOUT THE PRESENTER


Dr. Michelle Trappler and her husband Dr. Ricardo Loinaz

# MICHELLE TRAPPLER, VMD, DACVS

Dr. Michelle Trappler graduated from veterinary school at the University of Pennsylvania in 2008. She completed a rotating internship at Coral Springs Animal Hospital in Coral Springs, Florida, followed by a surgical internship at Dallas Veterinary Surgical Center in Dallas, Texas.

Dr. Trappler completed a 3-year surgical residency at Veterinary Specialty and Emergency Center (VSEC) and became board-certified in small animal surgery with the ACVS in 2014. Following her residency, she completed a 1-year sports medicine and arthroscopy fellowship at Veterinary Orthopedic and Sports Medicine Group (VOSM). Dr. Trappler enjoys all aspects of soft tissue and

"Continued on page 4”

orthopedic surgery and has a particular interest in wound healing and regenerative medicine.

Dr. Trappler and her fellow veterinarian husband moved to Puerto Rico in 2015 to pursue their dreams of living life near the beach (highly recommended). She is now attempting to master work-life balance as a small animal surgeon at the Centro Especialistas de Veterinarios in San Juan, Puerto Rico. During her free time, Dr. Trappler enjoys baking, cooking, photography and exploring beautiful Puerto Rico and beyond.

This eBook in Michelle's words:

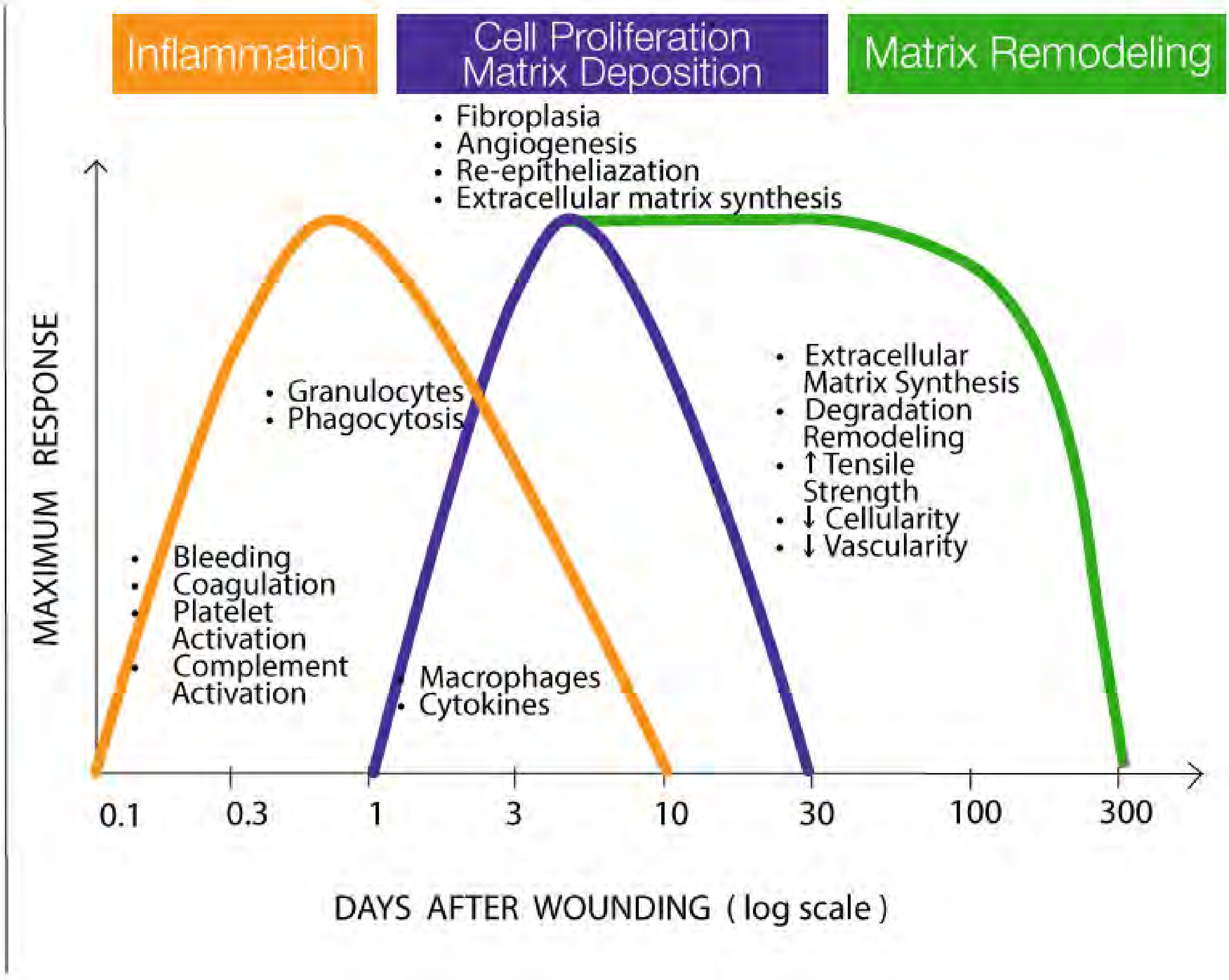
**"Hello and thanks so much for joining us for our webinar today and thanks to our sponsors, Cutting Edge. Today we are going to be talking about novel techniques and technology in veterinary wound management.**

**To start, we are going to briefly review the wound healing stages and refresh our memories about what exactly happens when in wounds, and who the major players are. Then we will discuss novel management techniques and any recent supporting literature. Finally, I have included some case studies to demonstrate these wound healing techniques in practice."**

THE VETERINARIANS GUIDE TO WOUND MANAGEMENT TECHNIQUES

# 05 | WOUND HEALING & TREATMENT

CELASERS.COM




# STAGES OF WOUND HEALING - INFLAMMATION

The first stage of wound healing, is inflammation. Inflammation begins immediately after wounding and lasts for approximately 5 days following. This phase is marked by immediate vasoconstriction, followed by increased vascular perm about 5-10 minutes later. Increased permeability leads to leakage of clotting factors and fibrin into the wound, and contributes in the formation of a blood clot. This clot helps provide a barrier to fluid loss and infection, which are very important for good wound healing.

"Continued on page 7”

# STAGES OF WOUND HEALING - DEBRIDEMENT

DEBRIDEMENT is a sub-phase of inflammation. Debridement occurs when neutrophils and monocytes enter the wound area, usually within 6-12 hours of wounding.  These cells help prevent infection and phagocytize debris and organisms.

It has been found that monocytes are essential for wound healing, while neutrophils are not! Monocytes (which convert to macrophages in the tissue, usually within 48 hours) synthesize growth factors (basic FGF, EGF, PDGF, VEGF, TGF a and b) that are responsible for tissue formation and remodeling. They also direct other macs and other cell types to site of wound to stimulate repair via cytokines.

# STAGES OF WOUND HEALING - REPAIR

Next we move into the repair phase. This phase begins 3-5 days post wounding and overlaps with the end of inflammation. During this phase, macrophages stimulate DNA and fibroblast proliferation. Fibroblasts are entering the wound just prior to new capillary buds, allowing for angiogenesis.

Collagen fibers begin to reorganize around 5 days post wounding, and this translates as an increase in wound strength.  You see conversion from type III collagen, which is the immature form, to type I collagen (mature) as wound matures. The maximum levels of collagen are found within 2-3 weeks post-wounding.

During this  repair phase, granulation tissue forms at 0.4-1mm/day at wound edges. This can help give you an idea of how long granulation will take depending on the size of your wound.

# STAGES OF WOUND HEALING - MATURATION

Wound maturation begins at approx 17-20 days post injury. During this phase, the collagen content decreases and the collagen that remains reorganizes (realigns itself along lines of tension). The thickness of the collagen increases

"Continued on page 8”

and so does the degree of cross linking. The amount of type III collagen, which is disorganized and present only in early wounds, decreases and  type I, which is stronger and present in larger quantities in scar tissue. increases. Nonfunctional collagen is degraded by MMPs. In maturing wounds (so after about 17-20 days), the rate of collagen synthesis and lysis is the same.

We see the most rapid gain in wound strength between 7-14 days after injury, which is where we determine 10-14 days for suture removal standards for surgical wounds. Even though this maturation phase has the most rapid gain in strength, wounds still only regain about 20% of their final strength in the first 3 weeks. Over time, wounds continue to gain additional strength, but only to a maximum of approximately 80% of original strength.

Ok, now that we remember the nitty-gritty of wound healing, let's get to the good stuff. What products and techniques we can use to maximize and accelerate wound healing?

# WOUND CARE PLAN

This is an all-encompassing plan for the medical, financial, time and emotional hurdles that you may need to overcome during the course of treating your wounded patient. If it sounds overwhelming, that's because it is! However, it is extremely important and will help you ultimately be successful in getting that pet home and healed.

It becomes easier to predict as you gain experience with wounds. Client communication is ABSOLUTELY KEY in these cases! I always warn my owners, "this is going to be a process". Plans will be altered, antibiotics will change and things will come up, this is the nature of wounds. Adaptability is key in these cases, and you need owners to be on board.

This plan does not have to be a formal process, but it does have to occur. I usually just have a heart to heart with owners and explain all of this. I tell them, "By the end of this, we are going to be very good friends. I am going to see you regularly for a while. If you're not okay with this, then we need to come up with a different approach".  Usually once you take the time to explain it to them, they are comfortable- Then 3 weeks later when they may be getting impatient, I remind them... "Remember, I told you we were going to be seeing a lot of each other....." This usually gets them back on board.

One way to keep clients happy is if you can tell them what to expect, especially from a financial standpoint. Do your best to estimate the cost for owners, even if you have to break it into phases for them. There is also a helpful checklist from Clinician's Brief that is a great tool for reminding us what to include in

"Continued on page 9"

estimates. To me, its almost like the “Kirby’s rule of 20” for wounds- a great reminder of all the things that can go into wound care. Check it out on their website here.

Also, while we are discussing plans, make sure you culture your wounds! If something falls apart 6 days down the road, the last thing you want it to have to wait another 3-5 days for culture results, so always keep that in mind during your initial debridement.

# WOUND CLASSIFICATION

Let’s talk briefly about types of wounds. Remember, all wounds are classified according to how they were created and the level of contamination. Surgical wounds are generally in the first two categories- clean and clean contaminated. These wounds can usually be treated and closed in a one-step procedure.  An example of a clean wound is a surgical incision.  Today we are going to be focusing on the second two categories, the contaminated and dirty or infected wounds. These wounds require more significant debridement and generally warrant a delayed closure situation.

## CLEAN

Created under surgical, aseptic conditions. A clean-contaminated wound is created when you enter the GI, respiratory, or urinary tract, but have minimal contamination.

## CLEAN-CONTAMINATED

A clean-contaminated wound is created when you enter the GI, respiratory, or urinary tract, but have minimal contamination.

## CONTAMINATED

Gross contamination (bites, GSW, degloving). Examples contaminated wounds include bites, GSWs, degloving wounds, etc.

## DIRTY & CONTAMINATED

Infection already present - Dirty and infected wounds are easy- these are already visibly infected by the time they get to you.

# INITIAL WOUND CARE

Your patient may present with wounds after any number of traumatic situations- HBC, dog bites/wounds, a traumatic fall, etc. It is essential to critically evaluate your patient first for any life threatening injuries and address those completely prior to making a wound management plan. I am not going to go into the details of trauma assessment and treatment, but it is important to remind everyone because it is easy to be distracted by a nasty open wound and forget about shock and fluid resuscitation.

I will say, while you are assessing and treating your patient, take a few simple steps to protect the wound:

- **Sterile water soluble lubricant can be placed in a wound bed to protect from nosocomial infection and prevent the wound bed from drying out while you stabilize your patient.**

- **Sterile moist gauze should be placed over wounds and the wound wrapped or covered.**

- **Adjacent hair should be clipped and the skin prepped as if going to surgery, if the patient can tolerate this without discomfort.**

THE VETERINARIANS GUIDE TO WOUND MANAGEMENT TECHNIQUES

# 11 | NOVEL WOUND MANAGEMENT TECHNIQUES

CELASERS.COM

# LAVAGE & DEBRIDE

Once your patient is stable, you can begin to address the wound. For contaminated and dirty wounds, this always requires some degree of debridement and lavage.

When you are forming your wound care plan, keep in mind that traumatic wounds can take 2-3 days to fully declare themselves. Owners should be prepared for delayed closure and possible dehiscence if wounds are closed too quickly.

Continued on page 13

# LAVAGE

To lavage the wound, a dilute chlorhexidine solution of 0.05% is recommended. Higher concentrations of chlorhex can actually be toxic to tissues and are not recommended. Using the equation C1V1=C2V2, where C is concentration and V is volume, we can determine that adding 25 ml's of 2% chlorhex solution to a liter bag of saline gets us pretty close to 0.05%.

In order to dislodge bacteria from the wound surface, which is what we are trying to accomplish with our lavage, along with the removal of debris, a lavage pressure of 8 psi is required. There are a few ways to achieve this. A 35- or 60ml syringe with an 18 gauge needle on it can generate 7-8psi. However, a 2010 study by Gall and Monnet in AJVR found that pressures generated with this method are variable and can lead to excessive lavage pressure.

For wounds where you need a large volume of lavage, you can attach a 3-way stopcock to your fluid line from your liter of saline on the ingress port, the syringe to the second ingress port, and put the 18 gauge needle on the egress port. You can then lavage the entire liter simply by toggling your stopcock. Alternatively, you can pressurize a liter fluid bag to 300 mm Hg, and that should deliver about 7-8psi.

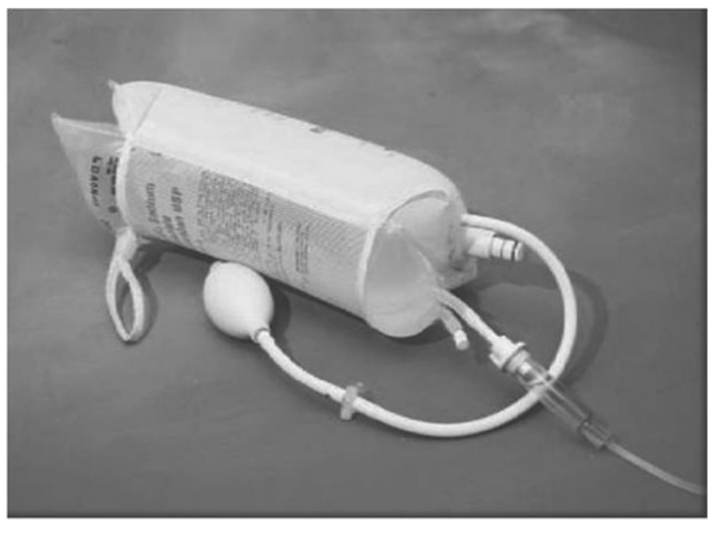
## CLEAN

Gently clean wound area with dilute chlorhexidine (0.05%) and/or sterile saline

- C1 x V1=C2 x V2
- 25 mls of 2% Chlorhexidine into 1L bag of saline = 0.05% chlorhexidine

## LAVAGE PRESSURES: 8 PSI

- 35 or 60 ml syringe, 18 gauge needle
- 1L bag pressurized to 300 mm Hg



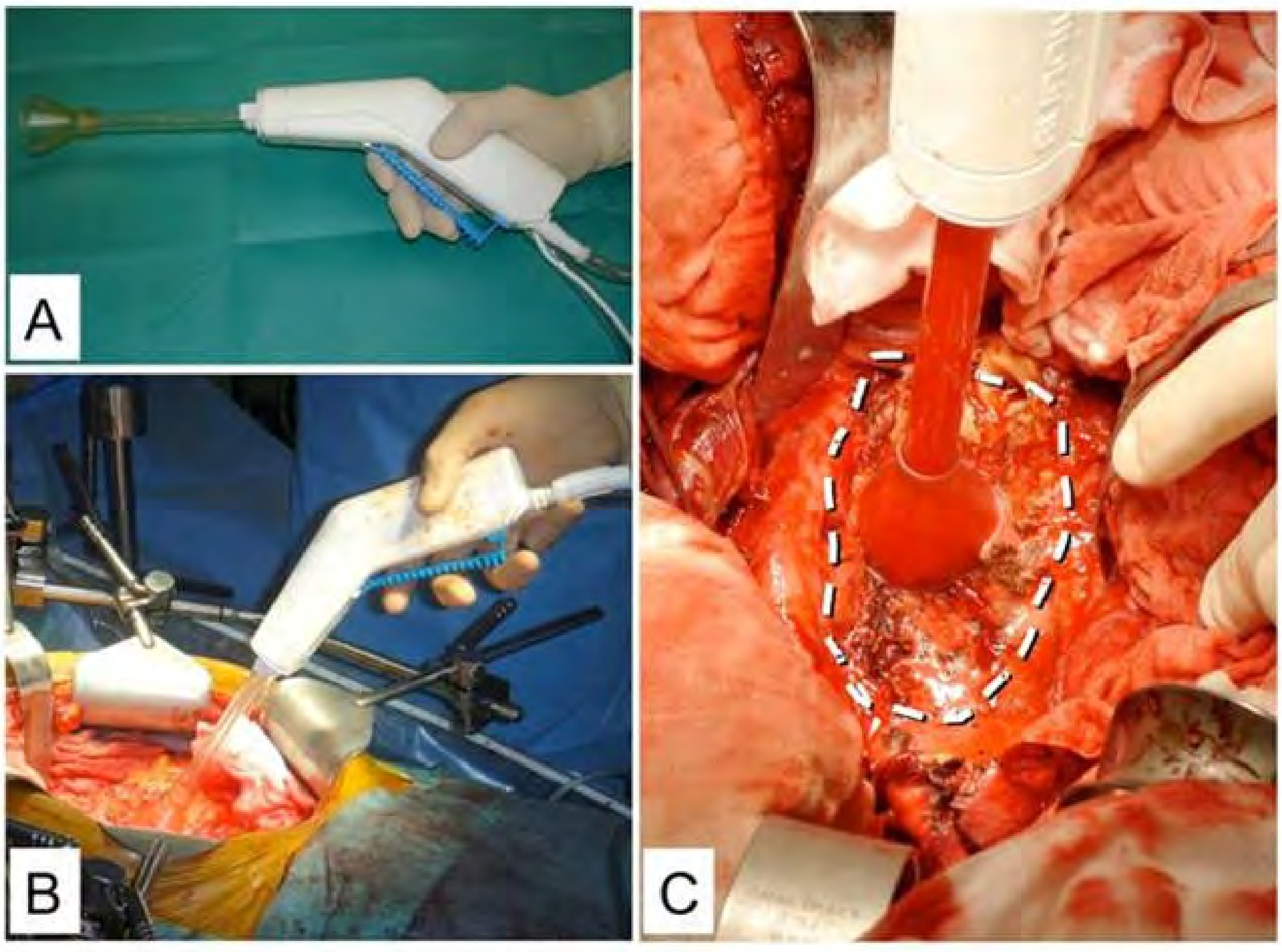
# PULSATILE LAVAGE

This method of wound cleansing is known by various names, including “jet lavage”, “mechanical lavage”, “pulsatile lavage”, and “mechanical irrigation”.

This is a form of mechanical hydrotherapy that uses a pressurized, pulsed solution to irrigate and debride wounds of necrotic tissue. In most cases, suction is used with pulsed lavage to remove both wound debris and irrigation solution.

Pulsed lavage appears to improve growth of granulation tissue by debriding the wound bed of devitalized tissue without disrupting the underlying normal tissues. In addition, the negative pressure created by the suction may stimulate granulation.

There are currently two companies that I know of that is marketing to veterinarians- stryker and microaire. However, there are many different units available in the human market and you may be able to find these second-hand.



# PULSATILE LAVAGE

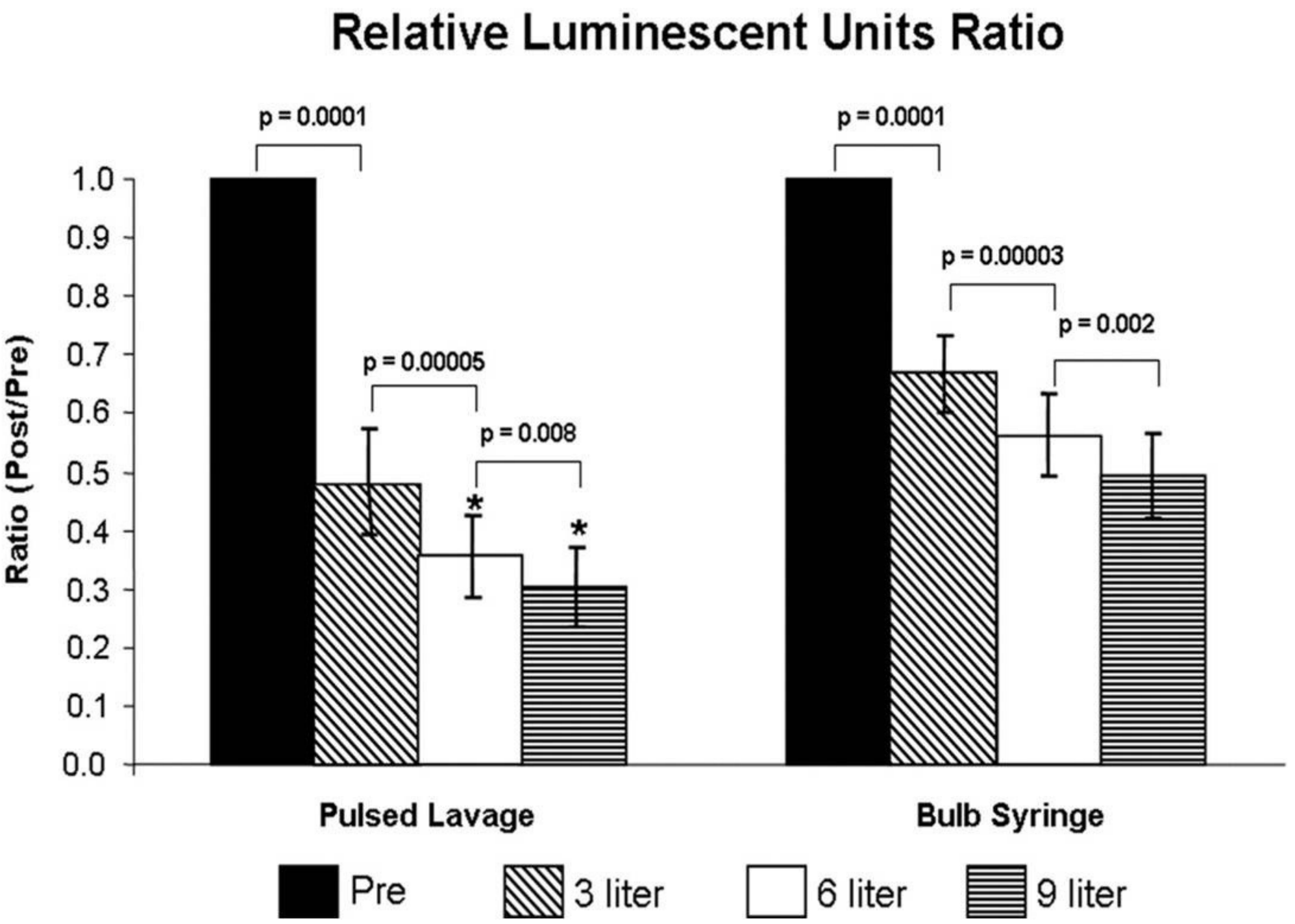
Research on the benefits of pulsatile lavage first began in the 1960s and has continued in the recent decades. A study in 2006 used a bioluminescent bacteria in a musculoskeletal wound model.

They compared lavage using a bulb syringe versus a pulsatile lavage system at three time points- after 3,6, and 9L of irrigation. Pulsed lavage decreased the amount of relative luminescent units by 52%, 64%, and 70% at 3, 6, and 9 L, respectively.

The bulb syringe irrigation reduced the amount of relative luminescent units by 33%, 44%, and 51% at these same time-points. Significant differences in luminescence were noted between the two groups after both 6 and 9 L of irrigation.

Pulsed lavage was more effective than bulb syringe irrigation in reducing bacterial luminescence after both 6 and 9 L of irrigation.  They also found that pulsed lavage irrigation with 3 L of saline solution resulted in a reduction of approximately the same amount of bacteria as did irrigation with 9 L with use of a bulb syringe.

Take away message? Pulsed lavage was more effective at clearing bacteria AND at lower lavage volumes.  So if you are in a practice that sees a lot of wounds, like an emergency or referral situation, this toy could really be worth having around.



# DEBRIDE

Now let’s talk about the other half of lavage and debride -the debridement. Healing is delayed if any necrotic tissue is left in the wound, so it is essential that devitalized tissue is removed from the wound by débridement. Persistence of dead or damaged tissue, foreign bodies, and microorganisms can compromise local defense mechanisms and delay healing.

The goal of débridement is to obtain fresh clean wound margins and wound bed for primary or delayed closure.  Like we discussed before, wounds can take several days to fully declare themselves.

Additionally, patients may not be stable for general anesthesia for days post-presentation. Often multiple cycles of lavage and debridement are required prior to definitive closure of the wound.

There are 5 major categories of debridement:

**SHARP / SURGICAL**

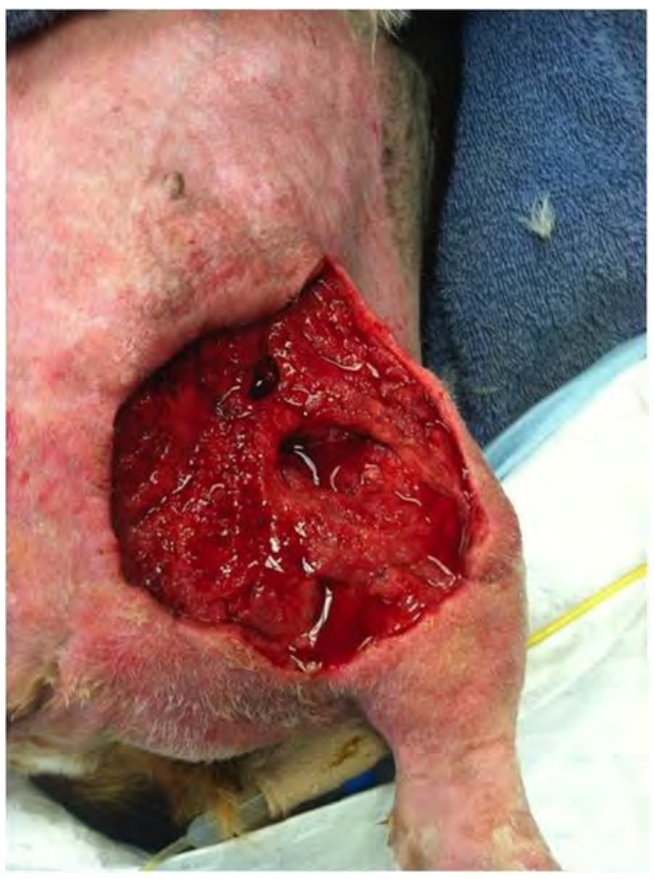
**AUTOLYTIC**

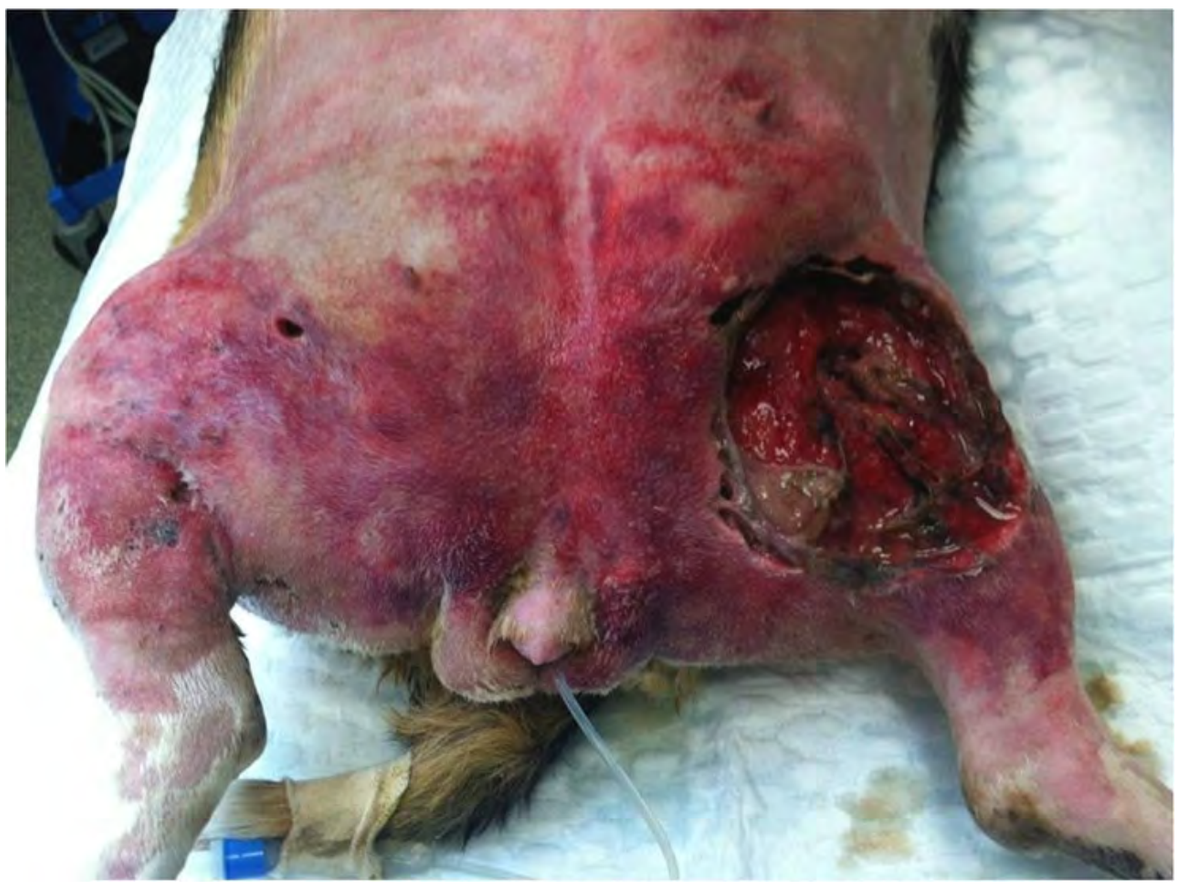
**MECHANICAL**

**ENZYMATIC**

**BIOSURGICAL**

Often we use a combination of techniques to turn a wound like this one we see on the top, into a wound like this on the bottom, that is ready for closure.





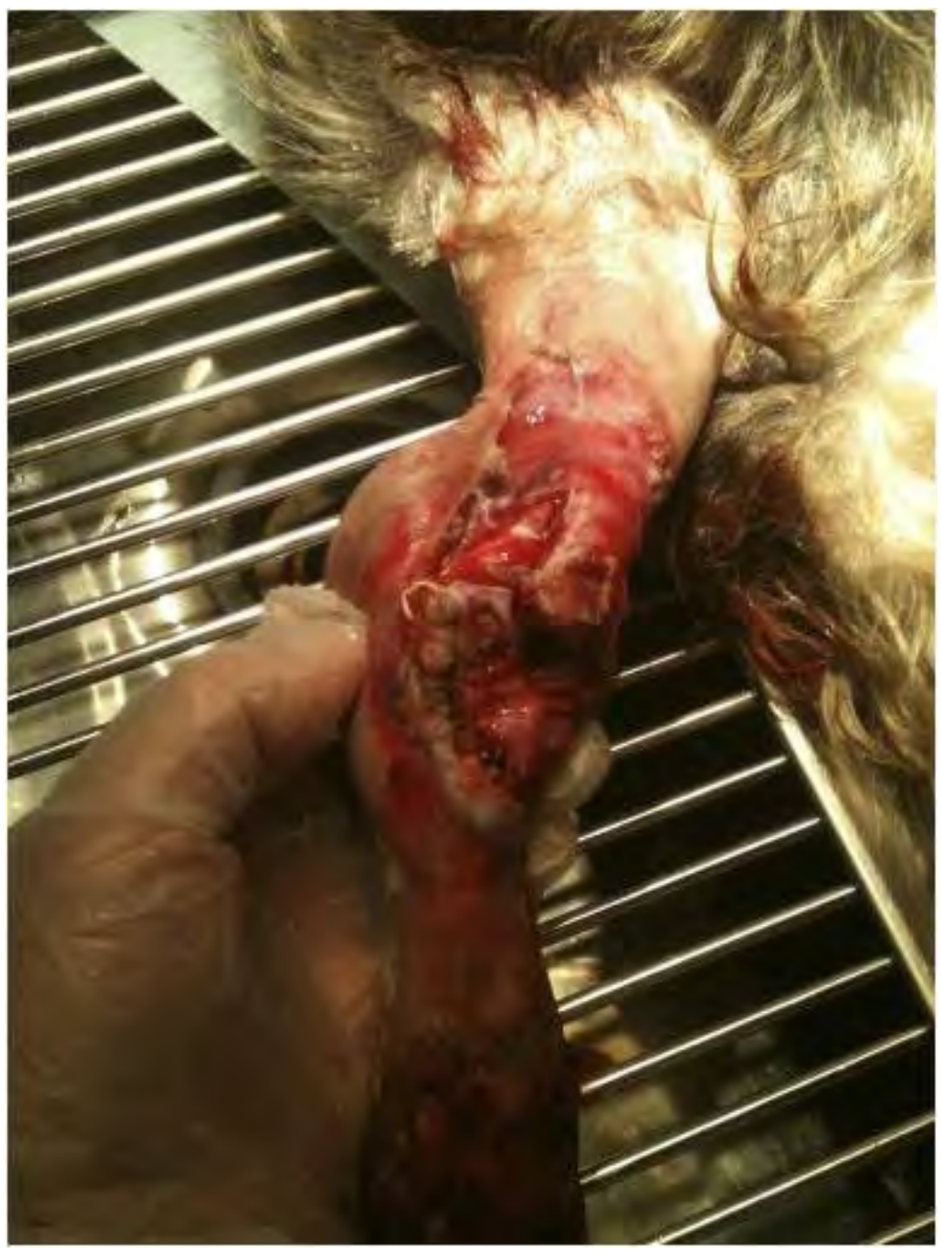
# DEBRIDE - SURGICAL

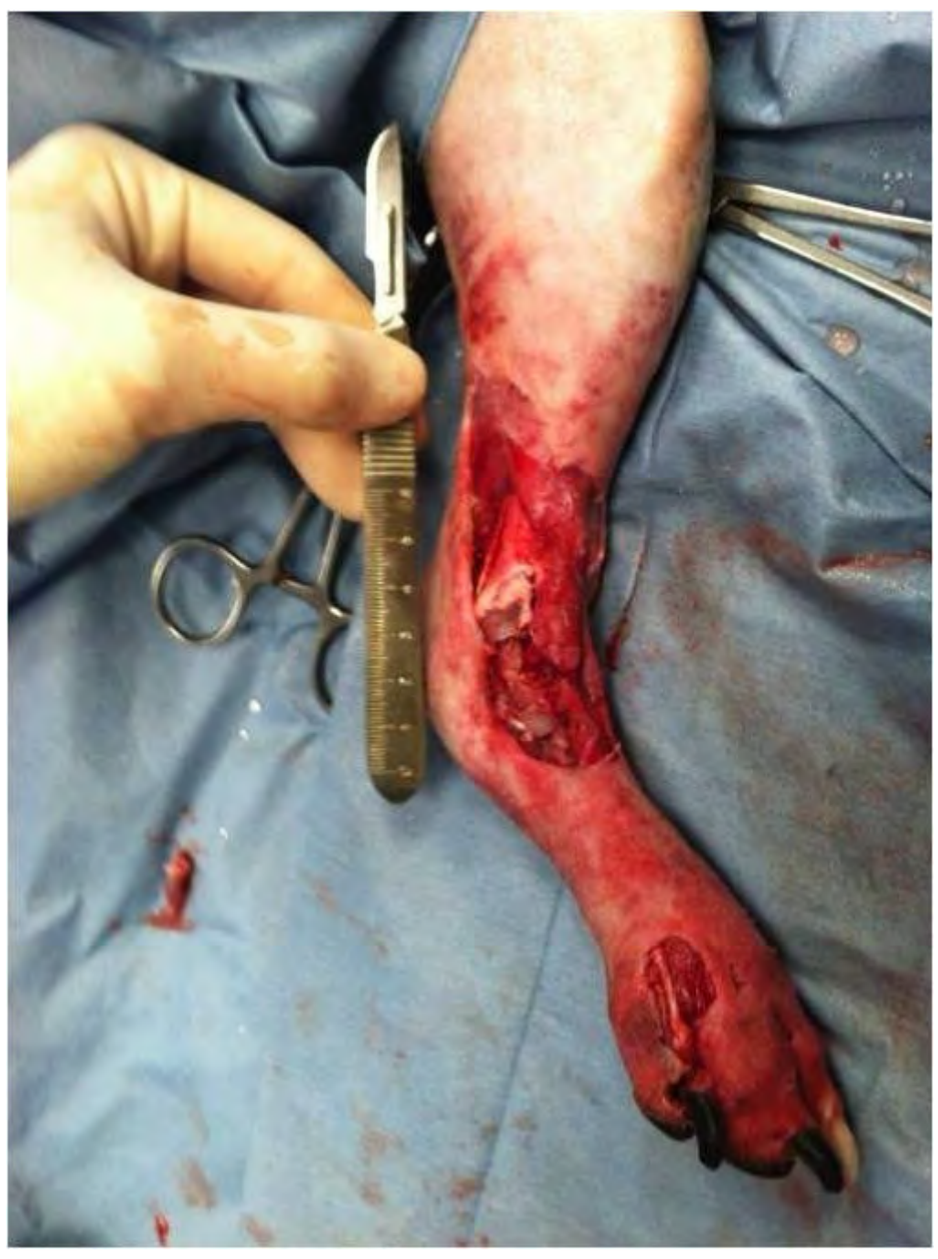
Surgical debridement is probably the one that we are all most comfortable with. If you see necrotic or infected tissue, you cut it out. However, this is a fairly non-selective method of debridement, as we are relying on the gross appearance of tissue to determine it’s viability. Hence why it is so important to let the tissue declare itself before deciding that a wound is ready to close.

Also, this can be difficult to effectively employ if you have areas of exposed tendon, ligament or bone. You want to remove the devitalized tissue, but you must balance that with the risk of causing joint instability or loss of function of a tendon or ligament.

Sharp debridement can include the use of scalpel blades, scissors, electrosurgery or surgical lasers. It also includes the use of a scalpel blade being drug across the tissue surface, in a scraping manner more than a slicing manner. This is the same motion that you use when doing a skin scraping for Demodex.

I use this technique frequently when I have a wound with road debris or hair present, or when I am trying to remove only the surface layer of a wound bed. It's also helpful in more mature wounds when there is a biofilm or a slime layer over the granulation tissue.





# DEBRIDE - AUTOLYTIC

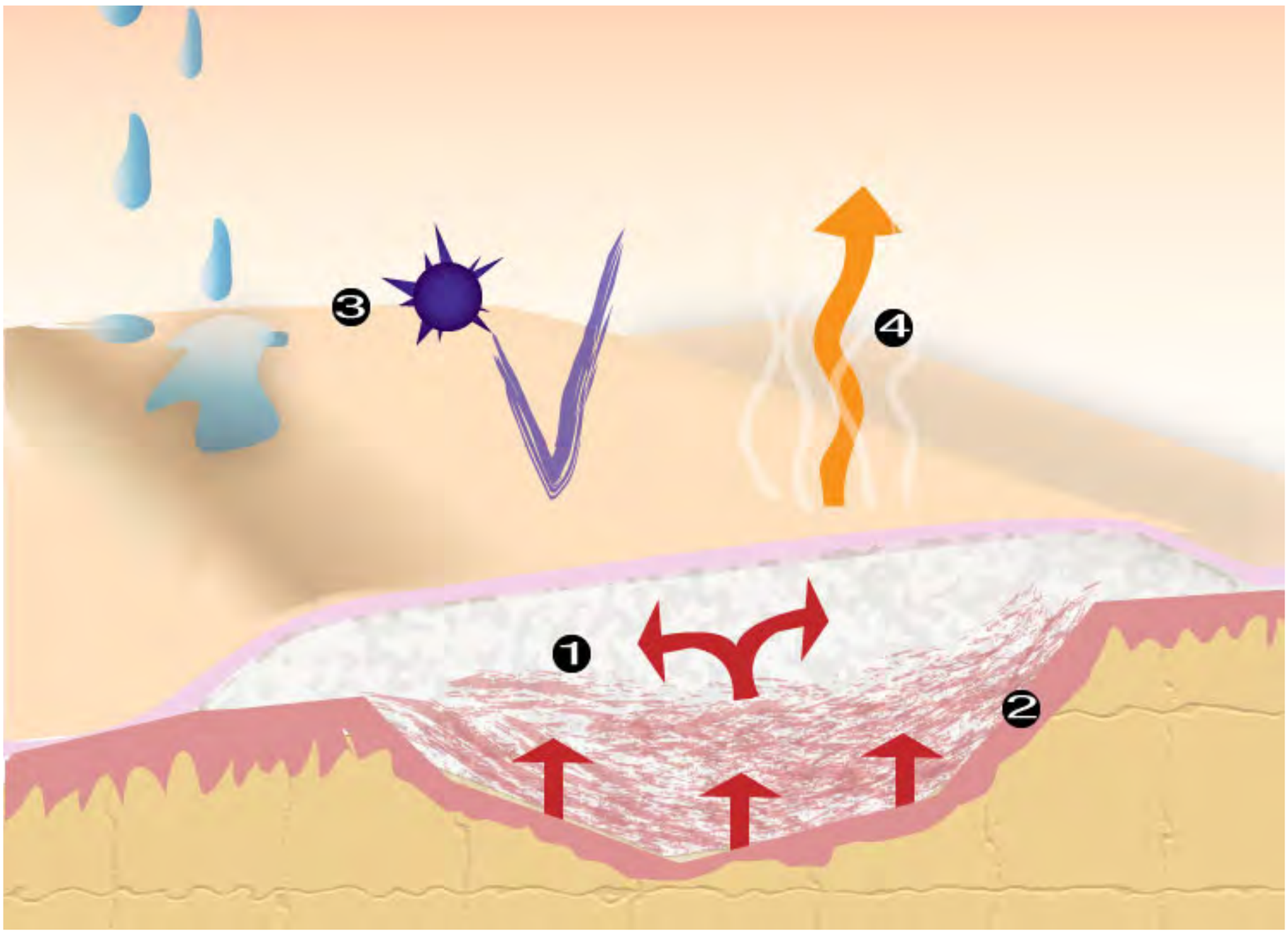
Autolytic debridement is the creation of a moist wound environment, which allows endogenous enzymes and white blood cells to dissolve non-viable tissue, but preserves intact healthy tissue.

As a  result, it is very specific. It also stimulates angiogenesis and collagen synthesis and creates a barrier to bacteria, H20. Creation of this moist wound environment generally occurs within 72-96 hours under an occlusive bandage like the example seen here.

Which means you only need to do bandage changes every 3-4 days at first. This is great for unstable patients who may not tolerate daily sedation or anesthesia for wound care.

The other benefit is that the rate of epithelialization is twice as fast for wounds kept moist with occlusive dressings than for air- exposed wounds.

- **Occurs within 72-96 hours under occlusive bandage**
- **Creation of moist wound environment allows intrinsic enzymes and WBCs to dissolve non-viable tissue**
- **Stimulates angiogenesis and collagen synthesis**
- **Creates a barrier to bacteria, H20**



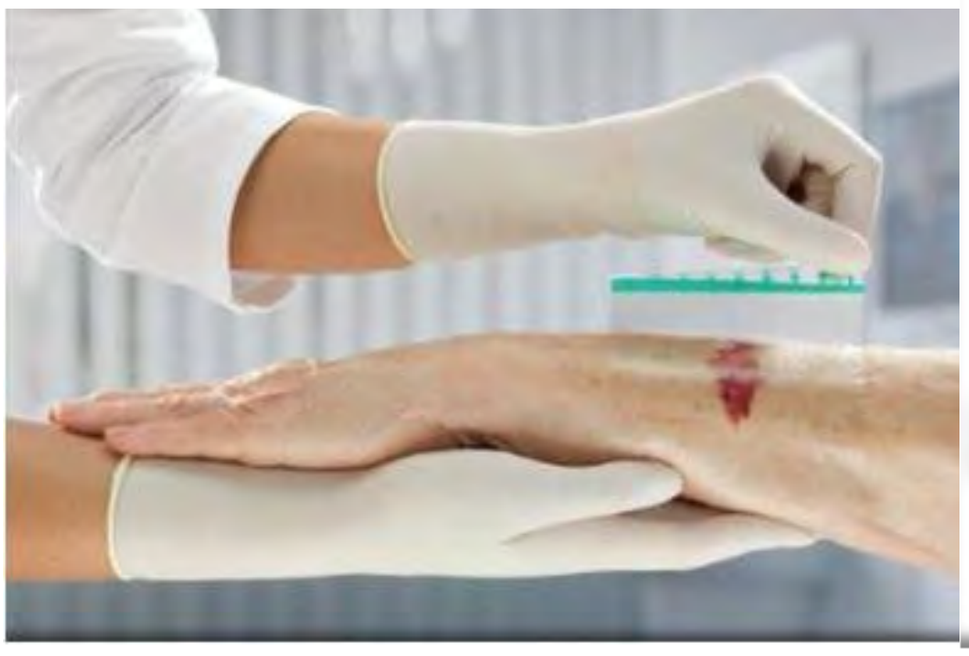
# DEBRIDE - AUTOLYTIC

Some examples of contact layers that facilitate autolytic debridement include:

**Calcium alginate:**
Indications: moderate to high exudate, need for debridement or granulation
Felt-like sheet or rope turns to hydrophilic gel during interaction with wound fluid
Hemostatic properties: removal before fully gelled (2 to 3 days) may damage granulation tissue

**Polyurethane foam:**
Indications: moderate to high exudate, need for granulation tissue and epithelialization
Exudate is wicked into foam
You can also use if you have a dry wound bed by pre-moistening foam to add moisture. Change every 3 to 7 days; up to twice daily on highly exudative wounds

**Polyurethane film:**
Indications: minimal to no exudate, need for epithelialization
Sheet, jelly, powder, and rope forms available
Adhesive perimeter to be applied directly over intact skin adjacent to wound.
May use as a bacteria- and waterproof cover over other dressings
Not indicated in infected wounds
The above dressings (with the exceptions of hydrocolloid, hydrogel sheet, and polyurethane film) may be used in infected wounds but must be changed daily.

# DEBRIDE - AUTOLYTIC

## HYDROCOLLOID:

Indications:


- **Low to moderate exudate, need for granulation or epithelialization**
- **Sheet, paste, granular, and powdered forms; turns to a gel during interaction with wound fluid**
- **Change every 2 to 7 days**
- **Contraindicated in infected wounds; adherence to skin around the wound can interfere with wound contraction**

## HYDROGEL:

Indications:


- **low to no exudate, or need for debridement or granulation**
- **Sheet turns to gel in wound; also available as an amorphous gel**
- **Can donate moisture to desiccated wounds**
- **Change every 3 to 7 days**
- **If wound is infected, use amorphous gel if it can be changed daily; sheet is not recommended**

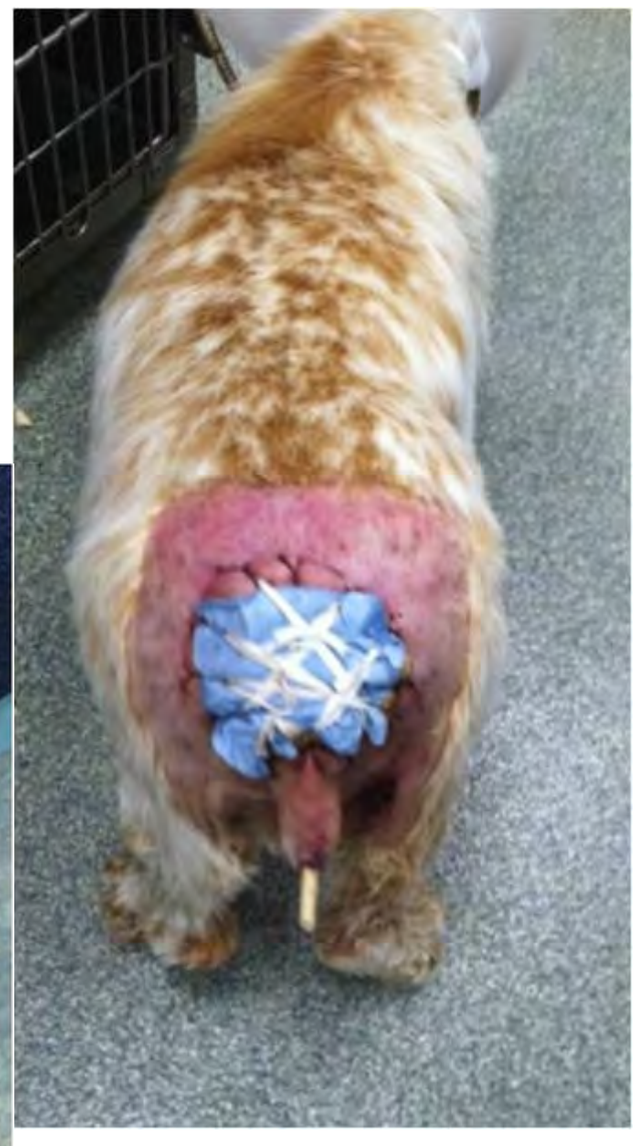
# DEBRIDE - MECHANICAL

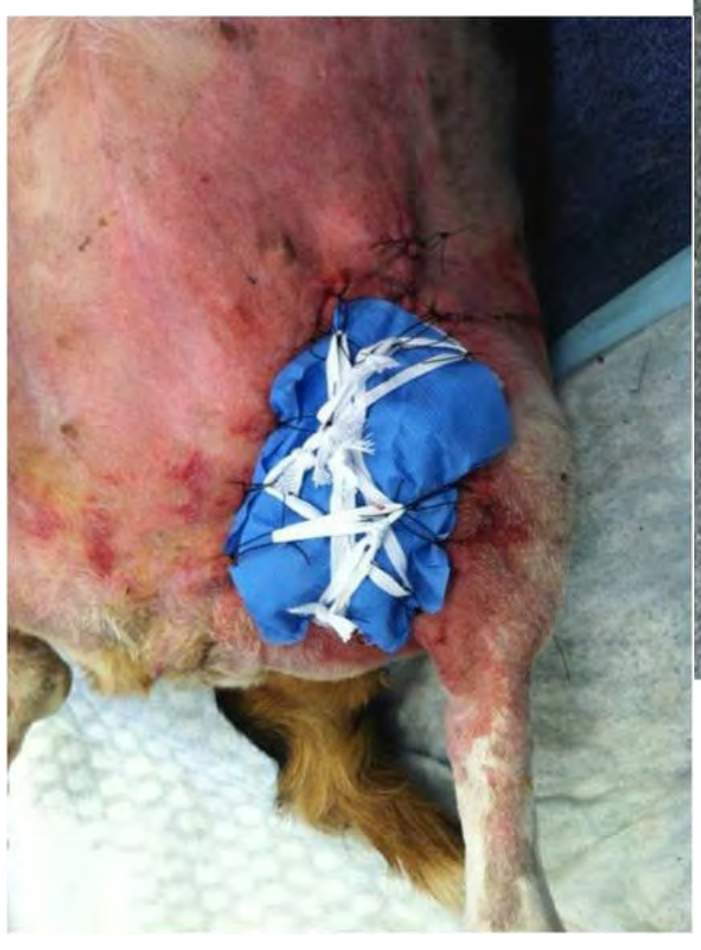
Mechanical debridement includes our old friends the wet-to-dry and dry-to-dry bandages. These bandages are applied to a wound bed and then as they dry and adhere to the wound surface. When they are removed, the debris and necrotic tissue is removed along with the contact layer. Unfortunately, so is the newest layer of epithelium, so these bandages are considered non-selective debridement.

They do help to protect the wound and maintain a moist wound healing environment.  They also absorb exudate from the wound bed. The amount of exudate is how I decide whether I am using a wet or dry contact layer. Highly effusive wounds get too dry since they are providing their own fluid to adhere to the gauze, Moderately effusive wounds or less get a wet to dry. Generally I start with a wet to dry and convert to dry to dry if I am not getting good enough debridement after the first day or so. Remember, these bandages need to be changed at least every 24 hours!

For wounds in difficult locations, we often employ tie-over bandages, as pictured here on the right. For areas that are difficult to bandage, you can pre-place loops of suture around the wound bed and then use those to secure your bandage in place. Always put more loops than you need, because there never seem to be enough at subsequent bandage changes. Make sure you always cover these with a non-permeable or low permeability material so that if the exudate gets to the outer layer of your bandage, you are not then wicking environmental bacterial down into the wound. The wrapper that comes on surgical gowns, drapes or the blue material that you use to wrap surgery packs is great for this purpose.

- **Mechanical removal of debris and necrotic tissue**
- **Protect wound**
- **Maintain moist wound environment**
- **Absorb exudate**
- **Non-selective**
- **Creates barrier to bacteria, H20**





# DEBRIDE - MECHANICAL

Even with tie-overs sometimes we cannot adequately keep a bandage in place, This is especially true for wounds of the flank or lateral thorax, high motion areas like the axilla or inguinal area, etc.

In October 2006 in Clinician's Brief, Hodge and Degner reported a novel bandaging technique that is useful for large wounds that require mechanical debridement or wounds on these difficult areas. If you have used tie over bandages on these, you know that they will often slide ventrally. This simple technique uses loban to keep the contact layer in place.

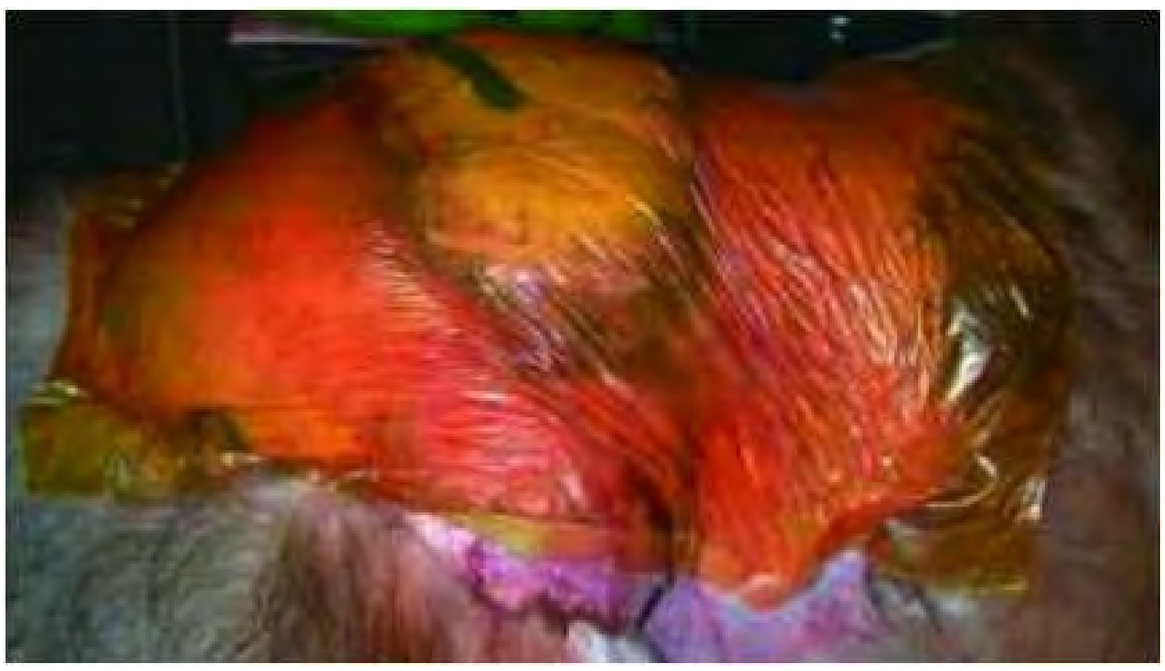
The nice thing about this technique is that you don't have to remove all of the ioban at each dressing change, you can excise the ioban over the wound only, change the dressing, and then replace the ioban on that section.

- **Clip wide area**

- **Prep area, degrease with alcohol**

- **Lap sponges over wound**
- **Spray with adhesive skin glue (Vi-Drape)**

- **Allow glue to dry until tacky**
- **Loban over wound and adjacent skin**



# DEBRIDE - ENZYMATIC

Enzymatic agents break down necrotic tissue and liquefy coagulum and bacterial biofilm, allowing better antibiotic contact with wounds and enhanced exposure for development of cellular and humoral immunity. These products they do not damage viable tissue if used properly.

Granulex spray- balsam peru, castor oil, and trypsin. The balsam peru stimulates capillary beds to increase circulation at the wound bed. Castor oil prevents desiccation, and the trypsin debrides and liquefies proteins. This component can cause local inflammation and some febrile reactions, so monitor carefully.

Santyl spray, ointment - collagenase based spray. Good for ulcers, pressure sores, burns.

Papain-based products (e.g., Accuzyme, Ziox) are also used for enzymatic debridement; however, such agents have recently been taken off the market because of the concern about side effects.

- **Breaks down necrotic tissue**
- **Liquefies coagulum and biofilm**
- **Granulex V Spray**
  - **Balsam peru**
  - **Castor oil**
  - **Trypsin**
- **Santyl**
  - **Collagenase**


# DEBRIDE - BIOSURGICAL

Last, but not least, we have bio-surgical debridement, or medical maggots. Medical maggots are specially raised “Germ-free” bottle fly (Lucilia sericata) larvae. They dissolve necrotic tissue using proteolytic enzymes, secrete antimicrobials, and dissolve biofilm.

They are available through Monarch Labs.

A single maggot may consume up to 75 mg of necrotic tissue each day and are very selective at removing only damdaged tissue. Medicinal maggots are applied to the wound at a density of five to eight per square centimeter. A hole is cut into a self-adhesive hydrocolloid dressing that matches the wound dimensions.

This dressing is applied to the wound to prevent the maggots from crawling onto intact skin and to absorb wound secretions. The dressing is covered to trap the maggots in the wound, changing absorbent layers as necessary.

Maggots are usually applied for two 48-hour cycles each week.

- **Bottle fly larvae placed in wounds for 2-3 days**
- **Debride only necrotic tissue**

  **(Available through Monarch Laboratories)**


Before treatment During treatment After treatment

THE VETERINARIANS GUIDE TO WOUND MANAGEMENT TECHNIQUES

# 26 | TOPICAL WOUND HEALING ENHANCERS

CELASERS.COM

# TOPICAL WOUND HEALING ENHANCERS

Once your patient is stable, you can then begin to address the wound. For our contaminated and dirty wounds, this always requires some degree of debridement and lavage.

When you are forming your wound care plan, keep in mind that traumatic wounds can take 2-3 days to fully declare themselves. Owners should be prepared for delayed closure and possible dehiscence if wounds are closed too quickly.

# TOPICAL WOUND HEALING ENHANCERS

**The effect of short- and long-term treatment with manuka honey on second intention healing of contaminated and non contaminated wounfs on the distal aspect of the forelimbs in horses.**

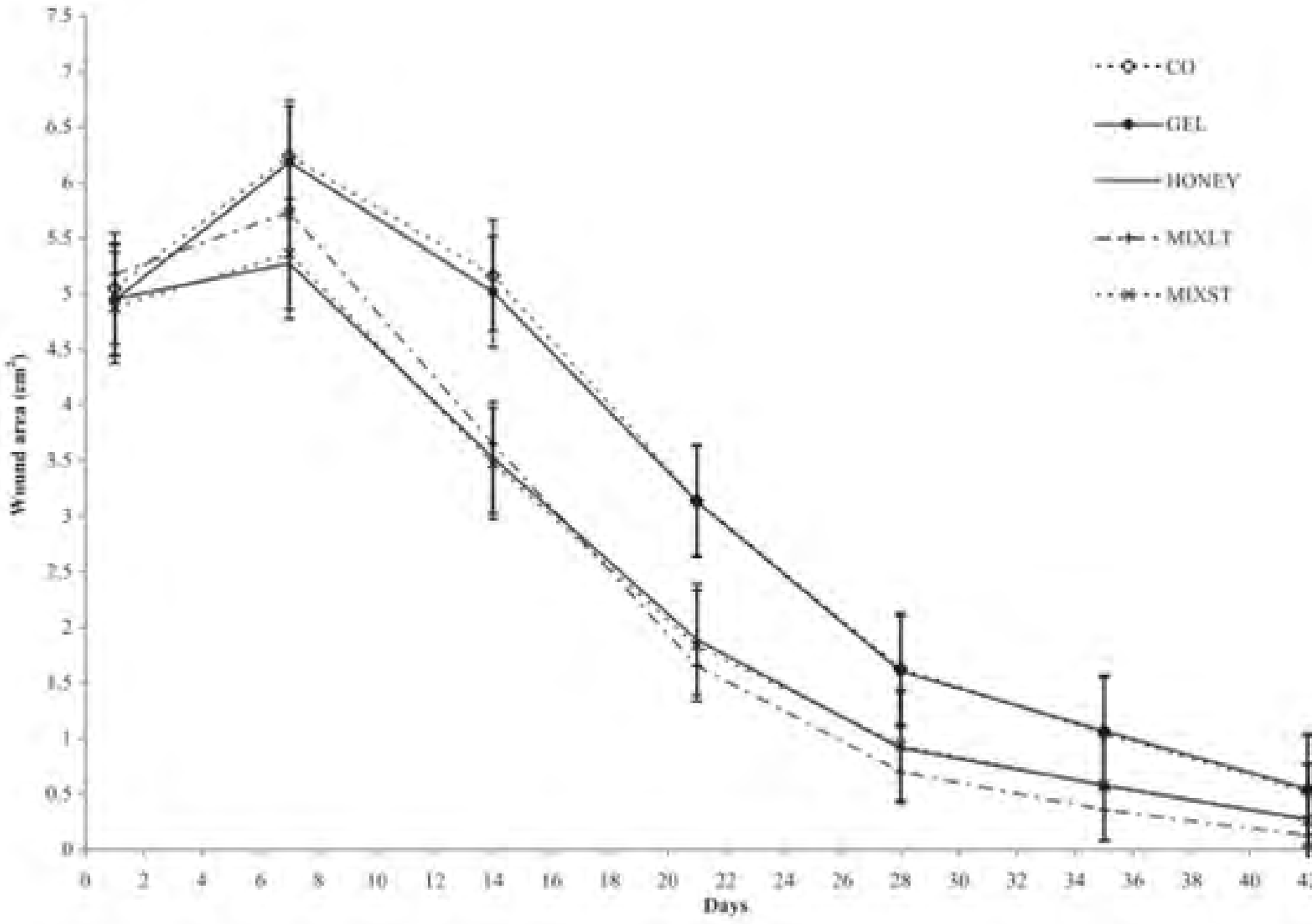



**Figure 1** Combined data from wounds with and without fecal contamination. Mean wound area ($cm^2$) for the different treatment groups: HONEY, pure manuka honey; MIXST, manuka honey gel applied for 12 days; MIXLT, manuka honey gel applied until healing was complete; GEL, gel control; CO, untreated control over the 42-day period. The horizontal axis shows days (1–44) and the vertical axis shows the wound area ($cm^2$). Bars represent one standard error either side of the mean.

Study Objectives:

To compare the effects of manuka honey and manuka honey gel on second intention healing of noncontaminated distal limb wounds and those contaminated with feces.

Study Design:

Experimental study. Animals: Standardbred horses (n = 10). Methods: Five full-thickness wounds (2 × 2 cm) were created on both metacarpi. Wounds on 1 forelimb were covered with horse feces for 24 hours. Wounds on the contralateral limb were left uncontaminated. Wounds were assigned to the following 5 different treatments: manuka honey, manuka honey gel or gel applied for 12 days, manuka honey gel applied throughout healing and untreated control. Wound area was measured on day 1 then weekly until day 42 and time to complete healing was recorded.

Results:
Wounds treated with manuka honey gel throughout healing healed faster than all other wounds ($P < .05$). Wounds treated with manuka honey and manuka honey gel for 12 days healed faster than gel control and untreated control wounds ($P < .05$). Wounds treated with manuka honey and manuka honey gel for 12 days and throughout healing were smaller than gel control and untreated control wounds until day 35 ($P < .05$). Wounds contaminated with feces had greater retraction for 7 days, but healed faster than noncontaminated wounds ($P < .05$).

Conclusions:
Treatment of wounds with manuka honey and manuka honey gel reduced wound retraction and overall healing time compared with gel and untreated control wounds.

## The antimicrobial activity of honey against common equine wound bacterial isolates.

Delayed healing associated with distal limb wounds is a particular problem in equine clinical practice. Recent studies in human beings and other species have demonstrated the beneficial wound healing properties of honey, and medical grade honey dressings are available commercially in equine practice. Equine clinicians are reported to source other non-medical grade honey for the same purpose.

This study aimed to assess the antimicrobial activity of a number of honey types against common equine wound bacterial pathogens. Twenty-nine honey products were sourced, including gamma-irradiated and non-irradiated commercial medical grade honey, supermarket honey, and honey from local beekeepers.

To exclude contaminated honey from the project, all honey was cultured aerobically for evidence of bacterial contamination. Aerobic bacteria or fungi were recovered from 18 products. The antimicrobial activity of the remaining 11 products was assessed against 10 wound bacteria, recovered from the wounds of horses, including methicillin-resistant Staphylococcus aureus and Pseudomonas aeruginosa.

Eight products were effective against all 10 bacterial isolates at concentrations varying from <2% to 16% (v/v). Overall, the Scottish Heather Honey was the best performing product and inhibited the growth of all 10 bacterial isolates at concentrations ranging from <2% to 6% (v/v). Although Manuka has been the most studied honey to date, other sources may have valuable antimicrobial properties.

Since some honey were found to be contaminated with aerobic bacteria or fungi, non-sterile honey may not be suitable for wound treatment. Further assessment of gamma-irradiated honey from the best performing honey would be useful.

# VETERICYN VF & HYALURONIC ACID GEL

## VETERICYN VF

is a topical wound spray. The active ingredient is hypochlorous acid, which is the active ingredient in bleach, but the pH of Vetericyn is within a physiologic range, so it doesn't harm healthy tissue and does not sting when applied.

Vetericyn products assist in the mechanical removal of cellular debris, senescent cells, necrotic tissue, and foreign material from the skin and wound surface through debridement. Wounds that have established granulation beds have faster healing than wounds left on their own.

I have used it in a liquid spray, but it also comes in a hydrogel formulation, an ophthalmic wash and an otic rinse. I have used it most commonly on wounds with an established healthy granulation bed, but it can also be used as the source of moisture on wet to dry bandages.

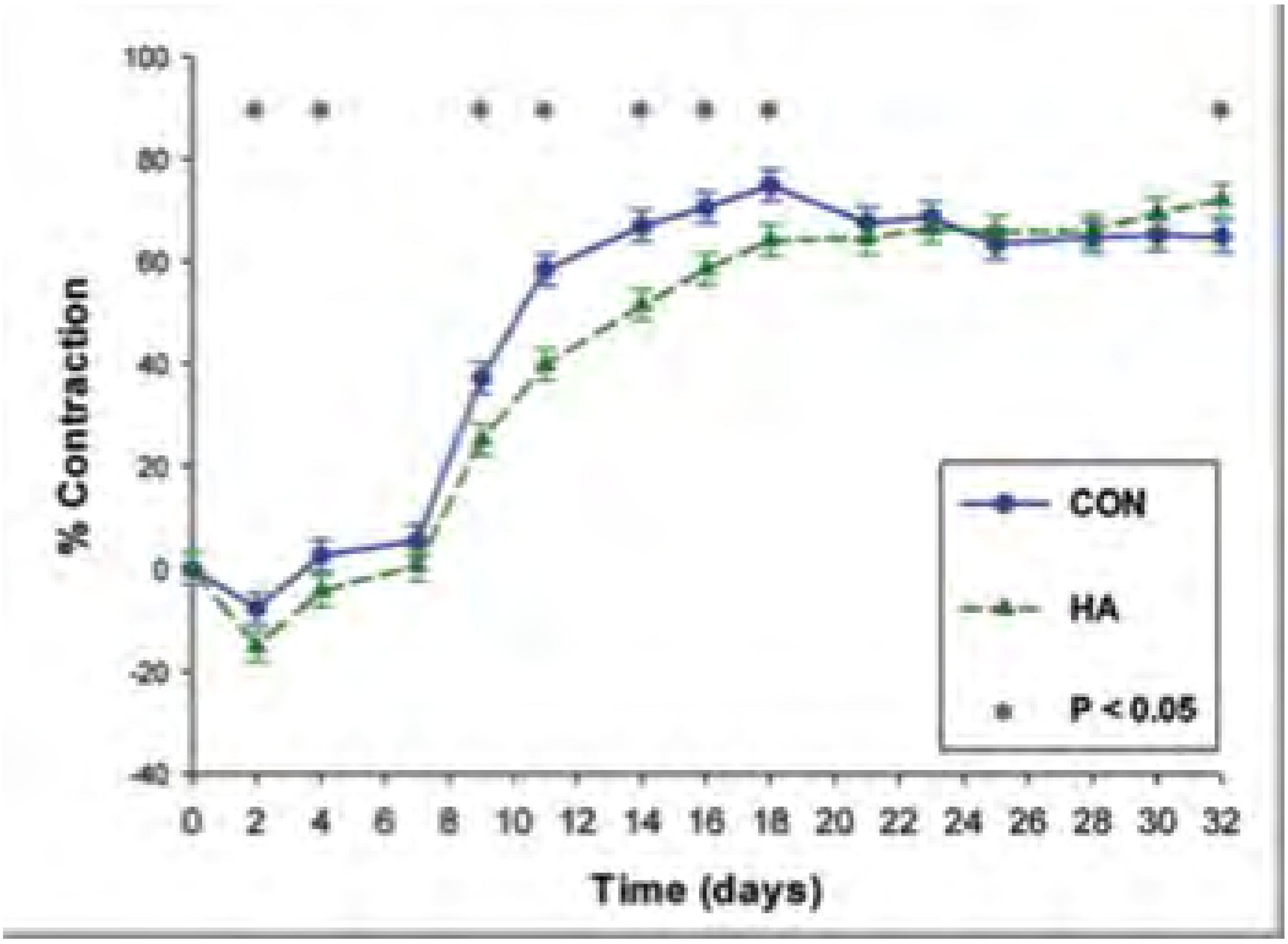
From my own anecdotal use, I feel like wounds contract much faster than with a simple non-adherent contact layer alone. I was introduced to this product by an equine surgeon and he also feels that he sees less proud flesh in equine wounds, likely due to accelerated contraction and healing that he sees. I was not able to find any scientific literature on this product, but it has my seal of approval.

# HYALURONIC ACID

or HA, is a hot topic right now in orthopedics for use as a post-arthrotomy joint lavage solution, in addition to the traditional use as an intra-articular injection. A study out of Michigan State University, where a lot of wound healing research is done by Bryden Stanley, looked at an HA gel for topical wound therapy of acute, full thickness skin wounds.

Basically, they created two exactly identical wounds on a cohort of dogs and then compared the wound size, % contraction and % epithelization of the control wounds versus the HA gel wounds. Here's what they found that was most interesting: This graph looks at percent wound contraction compared to initial wound size at day 0. There was initial wound retraction on both groups (which happens in all wounds) and this was followed by significantly less contraction in (HA) compared with control (CON) wounds between days 2 and 4, and at all data points up to day 18. But, from day 25 onwards, HA-treated wounds contracted more than control wounds.

This reached significance at day 32, which happened to be the end of the study. So, HA gel does not appear to help with wound healing when used early on, but there could be some promise for use in later wound healing stages.



# REDIHEAL - BORATE GLASS NANOFIBERS

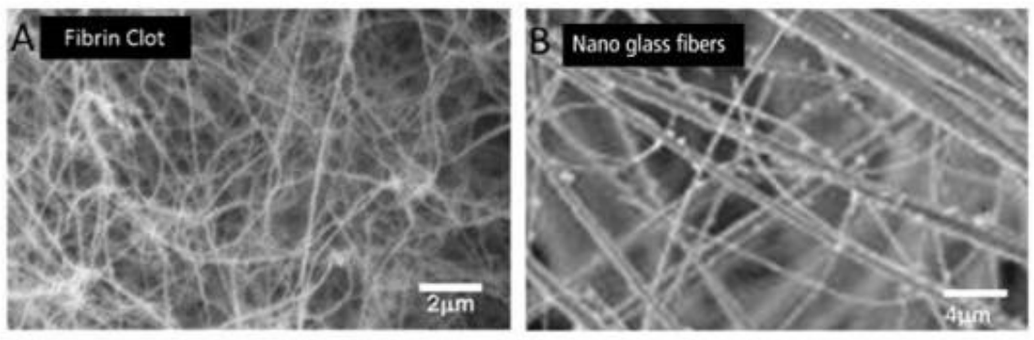
Borate-based biologic glass nanofibers release elements into wound bed to stimulate angiogenesis.  It has a microstructure similar to fibrin, which traps platelets and amps up wound healing.

It is currently being used in human medicine (DermaFuse) for diabetic ulcers and bed sores with great success. I have used it for many wounds and find that I get excellent results and wounds tend to heal without a scar. It's great for deep wounds or wounds where you have a large pocket because you can pack the material into the wound. I also find it helpful for rub sores under bandages, chronic wounds, and wounds where you might want to use VAC, but cannot due to financial or patient constraints.

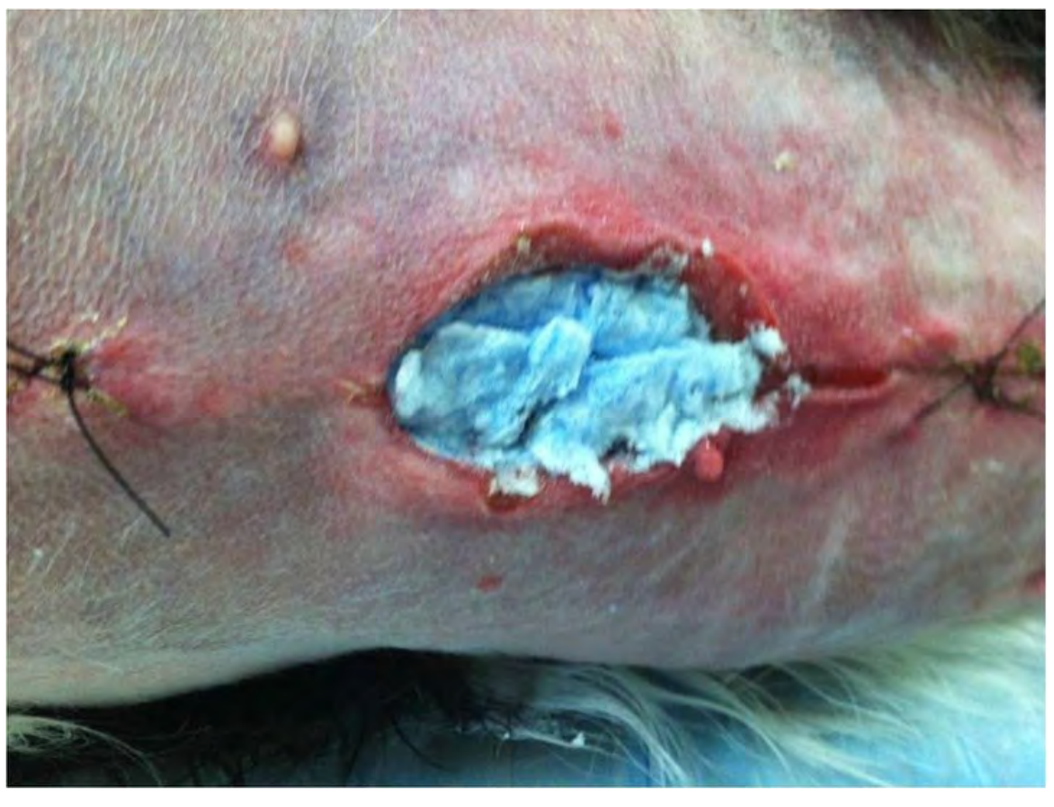
One pod costs the veterinarian about $25, so it is quite reasonable, especially considering the accelerated rate of healing that you see. I generally can use one pod per 3 cm x 3cm wound area and often don't use the entire thing. I will save the pod for the same patient at the next visit.

I generally change these bandages every 3-5 days, maybe even weekly if it is not very effusive. The body will absorb the material over time, so If you change the bandage and there is still blue goo in the wound, you can go a day or two longer for the next change, as long as all other factors look good.

Lavage and clean the wound just like you would any other wound. I do not ever leave bandages on for longer than 7 days.





THE VETERINARIANS GUIDE TO WOUND MANAGEMENT TECHNIQUES



# 33 | ADDITIONAL WOUND TECHNOLOGIES

CELASERS.COM

# ADDITIONAL WOUND TECHNIQUES

Some wounds will require more aggressive or more sophisticated management. There is a technique that has become popular over the last decade or so and continues to evolve in its indications is vacuum assisted wound closure, called negative pressure wound therapy.

I have used this technique for several dozen wounds at this point, and find that it great accelerates wound healing and increases the likelihood of success in the more difficult of cases.

# VAC THERAPY

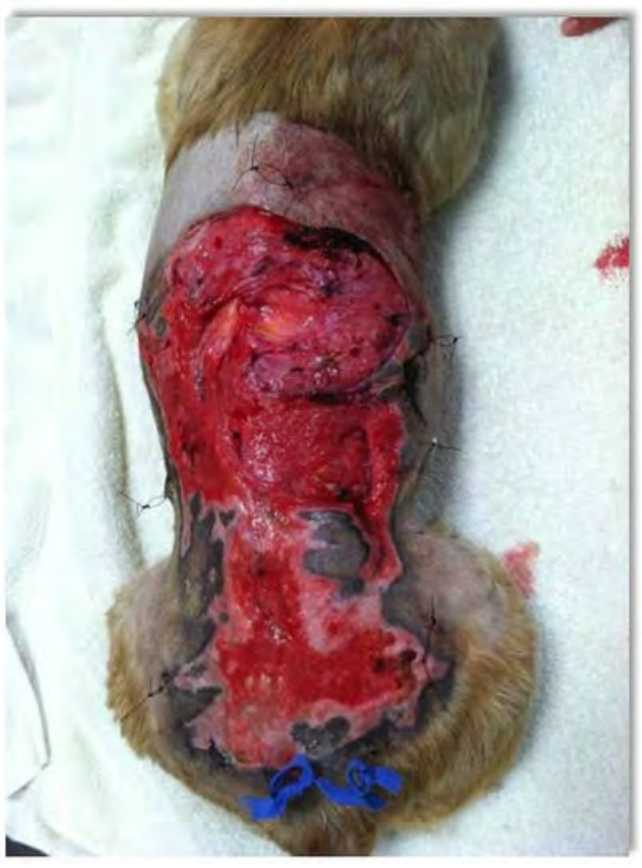
VAC involves an application of sub-atmospheric pressure to a wound bed. VAC therapy is not a substitute for conventional wound management. The principles of adequate wound debridement and lavage must be followed initially.

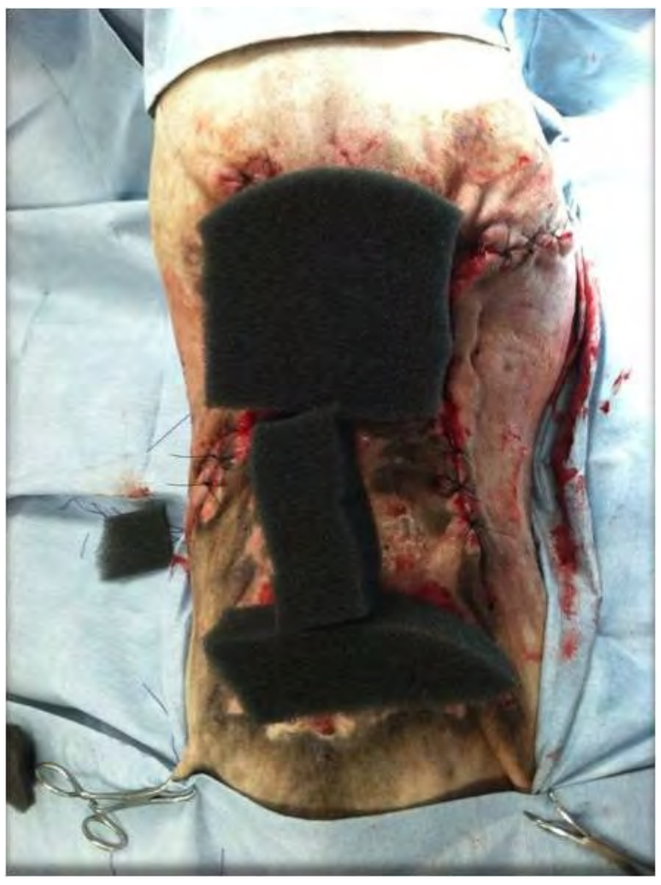
I usually employ a 24 to 48-hour period of standard wet-to-dry dressing management prior to application of the VAC.  The basic process of applying a VAC bandage includes an open-cell foam or gauze placed into the wound defect. This is then covered with an occlusive dressing, and then a suction device is used to apply the negative pressure.

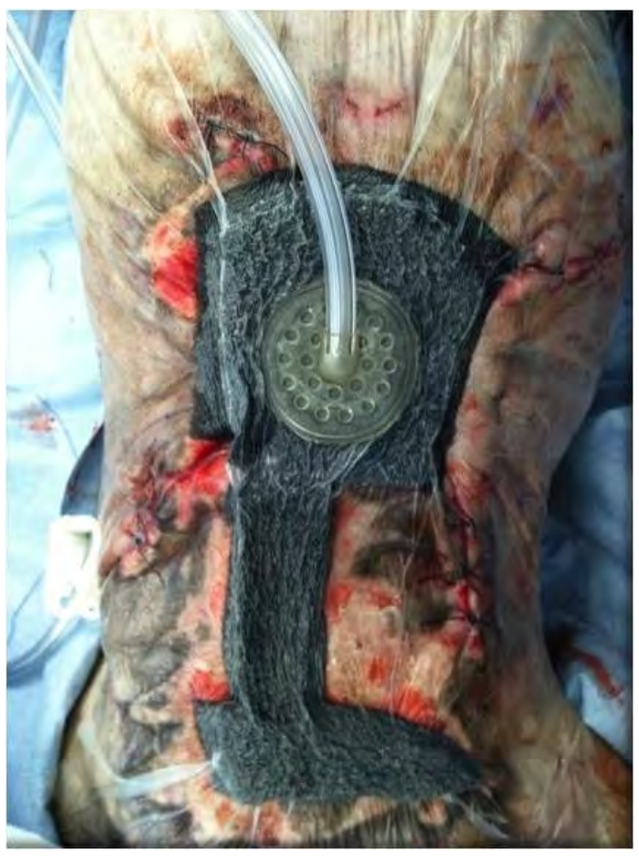
An airtight seal is vital to the success of VAC therapy; the hair surrounding the wound should be clipped, an adhesive paste is used as a sealant around the wound circumference and a protective bandage is applied.

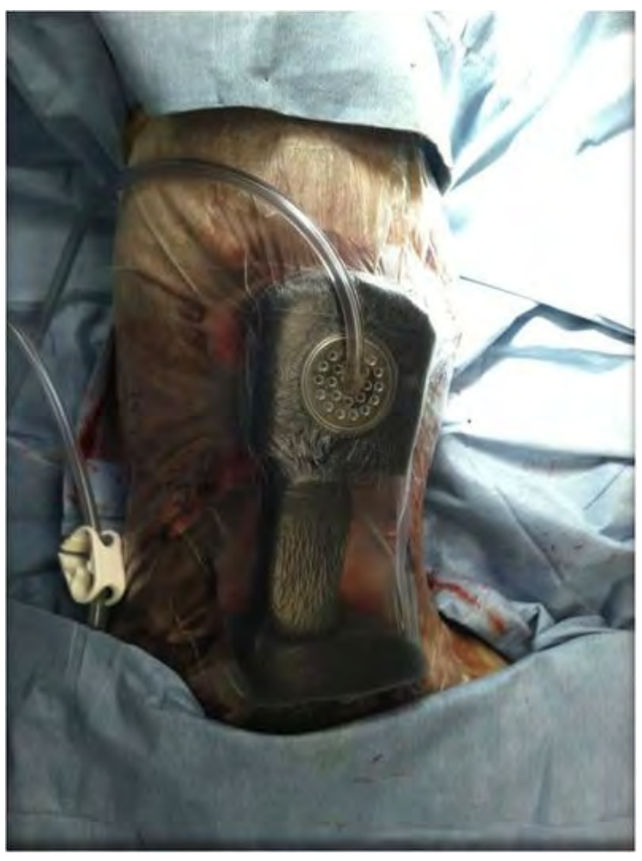
The KCI Animal Health (San Antonio, Texas) and the Talley Group (Lansing, MI) are actively marketing to veterinarians. You can also make a DIY system in your hospital with a little creativity and a lot of patience. I can tell you from experience though that the commercial systems are easier to use.

- **Open cell foam or gauze placed in wound defect**
- **Covered with an occlusive dressing**
- **Negative pressure applied to wound bed**









# BASIC BENEFITS OF VAC THERAPY

- **Reduction of fluid/edema**
- **Removes Harmful Enzymes that inhibit wound healing**
- **Facilitates Bacterial Clearance**
- **Decreases Local Interstitial Pressure, reopening collapsed capillaries in the wound bed, improving perfusion**
- **Mechanical deformation- application of macro and micro strain**
- **Macro strain physically draws wound edges together**
- **Application of micro strain has several effects. This is similar to the effects used in distraction osteogenesis**
- **Increased metabolic rate of cells**
- **Fibroblast proliferation and migration**
- **Increased tissue granulation**
- **ECM production**
- **Increases local tissue perfusion**
- **Opens Small Capillaries**
- **Increases Local Blood Flow**
- **Improves Neutrophil Function**
- **Less Potential for Anaerobic Colonization**
- **Provides protection from hospital environment**
- **Physical barrier limits cross-contamination**
- **Decreased risk of nosocomial infection**

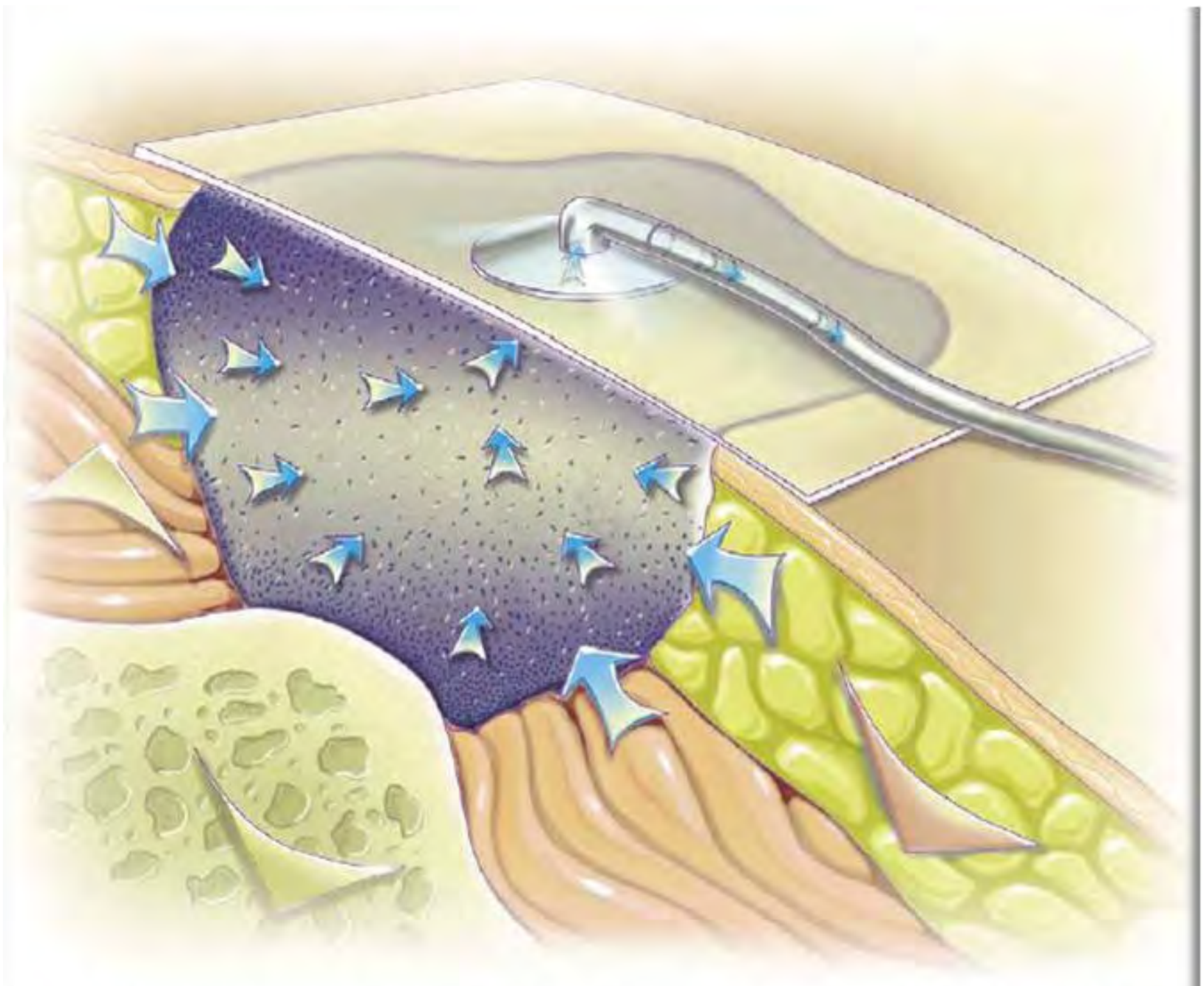


Fig. 1. Dressing *in situ* (reproduced with permission from KCI Medical Ltd).

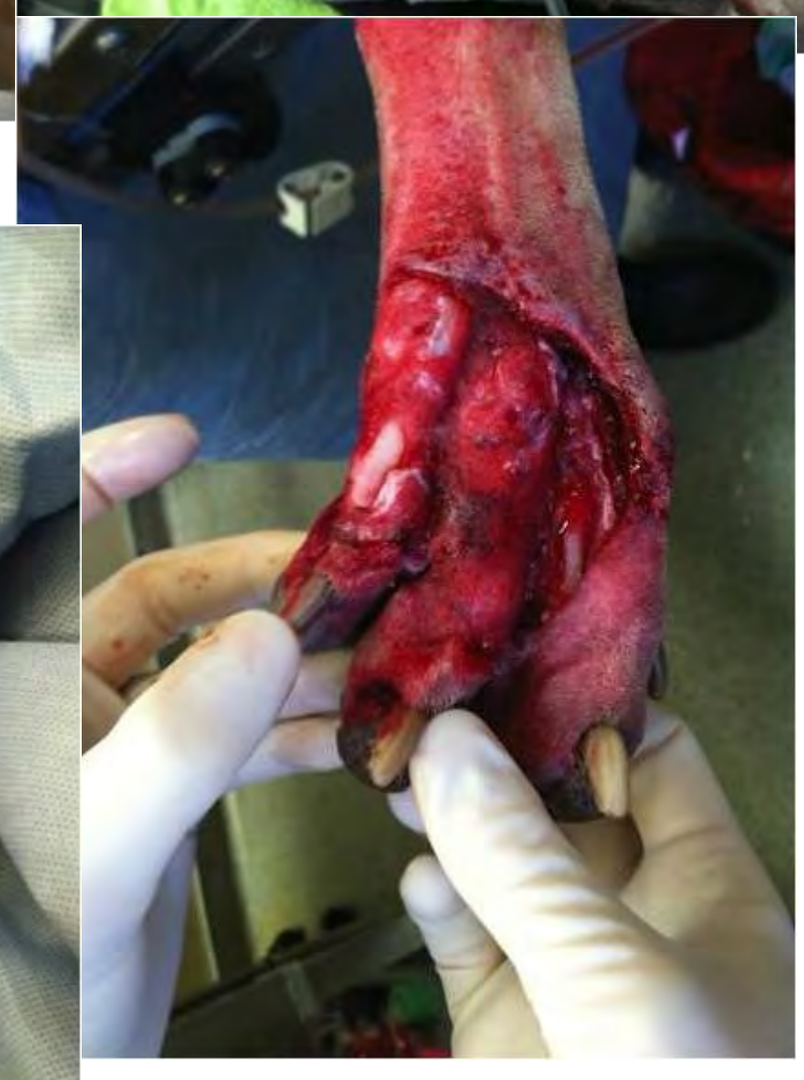
VAC therapy is excellent for use over exposed bone or hardware  and has the additional plus of being easy to apply over difficult areas.

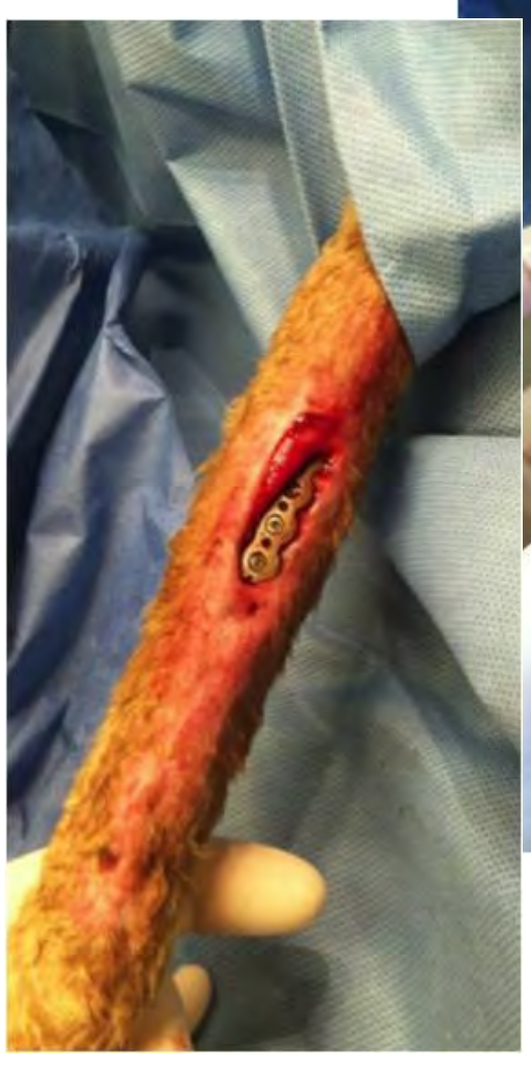
It can also be used over skin grafts, over incisions with increased tension, for drainage of septic abdomens, for seroma prevention and for thoracic wounds or infected median sternotomy wounds.

- Excellent over exposed bone and hardware
- Easy to apply to difficult areas

Can also be used:

- Over skin grafts
- Over incisions with increased tension
- For drainage of septic abdomens
- For seroma prevention
- For thoracic wounds or infected median sternotomy incisions





# NEGATIVE PRESSURE WOUND THERAPY

**Experience in 45 dogs.**

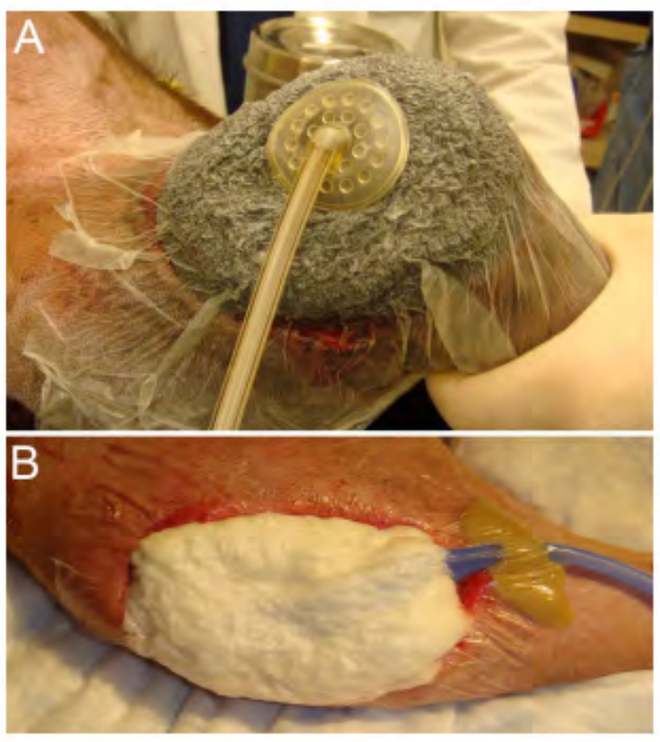
Two VAC papers out there that are essential to mention are the 2014 VetSurg paper from Bryden Stanley at Michigan State and the 2007 paper from Ron Ben-Amotz on distal extremity wounds. These two papers represent the most significant case numbers to date in the veterinary literature for use of VAC. The Ben-Amotz paper was one of the first papers with a significant number of cases to be reported in veterinary medicine.

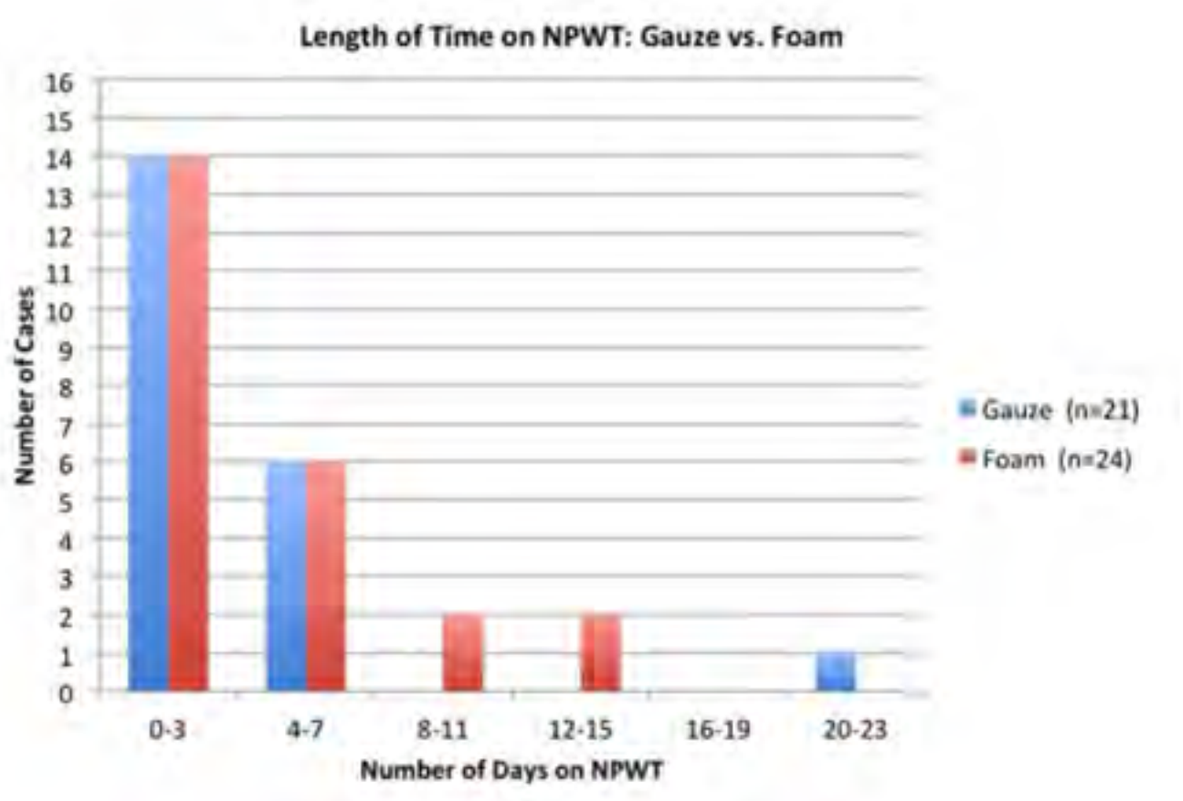
The 2014 Pitt and Stanley paper outlined the use of VAC in 45 dogs with cutaneous wounds from 2006-2011. They had 45 dogs with 53 wounds to which VAC was applied, and they used both foam and gauze-based contact layers with commercially available VAC systems. Wounds were found on the trunk or or proximal or distal limbs with similar frequency. Mean time between presentation and VAC placement was 2 days.

34 of the wounds were fresh and had no granulation tissue present at the start of treatment. These wounds were treated for a mean of 4.2 days after wounding. The remaining 11 dogs had wounds with granulation tissue already present and were previously classified as chronic, non-healing wounds. These were treated for a mean of 87 days post-wounding. Overall, median VAC use was 3 days, and the mean hospitalization was 7.8 days.

A majority (62%) of these wounds were definitively closed and were all haled within 14 days. The remaining 18 wounds were allowed to heal by second intention, and the mean time for complete healing of the second-intention wounds was 21 days. 96% of the wounds healed successfully, and two of the dogs died prior to definitive closure.

If you are interested in trying VAC therapy in your clinic, I highly recommend giving this paper a read. It covers a lot of the lessons learned over several years of VAC use.



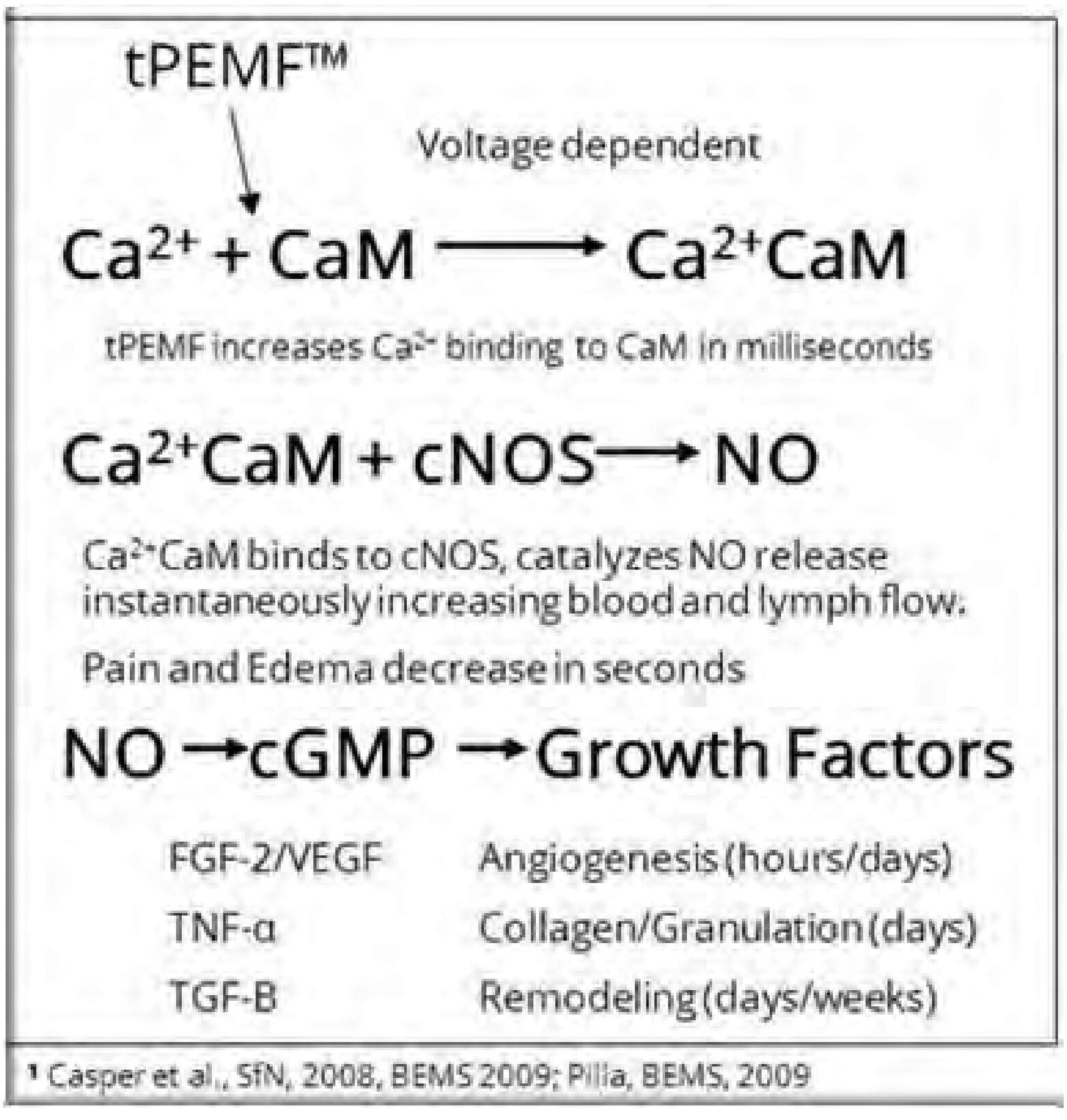
# TPEMF

**"Targeted Pulsed Electromagnetic Field Therapy"**

The next topic is targeted pulsed electromagnetic field therapy. This technology uses electromagnetic fields in the ultra-low frequency range (0.5 to 18 Hz) to modulate the calcium-calmodulin dependent, cGMP nitric oxide signaling pathway.

Nitrous oxide reduces pain, improves blood flow, and reduces edema. It also further triggers downstream effects, including the production of cGMP, the ‘energy’ molecule that then drives growth factor production. These growth factors support new blood vessel formation, tissue regeneration and then, ultimately, to tissue remodeling.

Relevant to this topic, it has been shown that exposure to picotesla electromagnetic field treatment improves the strength of sutured wounds and speeds contraction of open wounds in rats. Experimentally, pulsed electromagnetic field treatment of open wounds enhances wound epithelialization and may promote early wound contraction without adverse effects on perfusion or tensiometric, histologic, clinicopathologic, or electroencephalographic parameters.




[1] Casper et al., SfN, 2008, BEMS 2009; Pilla, BEMS, 2009

# ASSISI LOOP

One use that is available for our veterinary patients is the Assisi loop. The AssisiLoop is a disposable, portable device that delivers a targeted pulsed electromagnetic field.

A 2012 study looked at nonhealing, chronic diabetic wounds in people that had failed other wound care methods. Use of a PEMF device similar to the Assisi loop significantly decrease wound size and discomfort in all 4 patients during a 6 week study period, and all went on to heal completely with the continued use of the device. (The use of a portable, wearable form of pulsed radio frequency electromagnetic energy device for the healing of recalcitrant ulcers: a case report.  Rawe IM, Vlahovic TC. Int Wound J. 2012 Jun;9(3):253-8. )

Two 2014 studies also looked at soft tissue healing with PEMF  and found that it positively impacts fibroblast growth in damaged human patellar tendons. The second study looked at wound healing in diabetic rats and found that PEMF treatment significantly enhanced wound closure (days 10 and 14 post-wounding) and re-epithelialization (day 10 post-wounding), and that there were significantly more myofibroblasts in the PEMF group during these wound times, although these improvements were no longer observed at later stages of the wound healing process. This suggests that PEMF may help with wound contracture and closure during healing.

Studies in rats with full-thickness cutaneous wounds and induced tendon defects showed a 59% increase in wound strength and a 69% increase in tendon strength after 21 days of treatment, as compared to sham-treated rats. So, all of these studies suggest that the Assisi loop can be of benefit in wound cases. Anecdotal reports from users also report a decrease in swelling associated with wounds and experimental studies report a decrease in edema in an animal model. These all sound like benefits in the wound healing category.

The AssisiLoop comes in standard or automatic versions. The company recommends the standard version for chronic cases and patients with degenerative conditions. This device treats for 15 minutes and then turns off automatically when the treatment is completed.

The automatic version is recommended for acute in-hospital use for post-op patients and our patients with wounds. This device will treat for 15 minutes intervals every 2 hours while the unit is in place. So you can have this in your clinic and use it on your post-operative patients, treating every 2 hours as they are recovering from surgery. This gives us the ability to improve wound healing



Continued on page 41

and patient comfort without having to add another drug to our treatment plan. Even better, owners can also take this technology home with them to continue treating at home or to use for chronic conditions.  The cost to the veterinarian is about $150 per unit, which will provide 100 (for the automatic loop) or 150 (for the standard loop) treatments.

I should also mention that the electromagnetic field that is generated can penetrate through fur, bandages, casts, etc, which is especially helpful in our immediately post-op hospitalized patients.

**AUTOMATIC**


**STANDARD**

# LASER THERAPY

Our last wound healing technology today is Laser therapy.- Laser (Light Amplification of Stimulated Emission of Radiation).

We are using different wavelengths of light to create healing effects in tissues. Indications for laser therapy (which is what I will be talking about specifically here today) include conditions that have pain, inflammation, and wounded or damaged tissue.

For example, I use the laser in my practice for a variety of cases, including on the incision immediately post-op, for muscle sprains and strains, ligamentous injuries, IVDD dogs, osteoarthritis, other chronic inflammatory conditions like ear infections and lick granulomas and wound healing.

So there are lots of indications for laser therapy aside from just wound healing. This is a modality that can be used in a variety of ways in your practice to elevate the standard of care and to generate income for the practice at the same time. It’s important to note that laser therapy should NOT be used in cases of neoplasia.

THE VETERINARIANS GUIDE TO WOUND MANAGEMENT TECHNIQUES



# 43 | MLS LASER THERAPY

CELASERS.COM

# MLS LASER THERAPY

Cutting Edge's MLS Laser Therapy Technology was specially designed to deliver multiple wavelengths simultaneously. An energetic synergy is created when delivering these wavelengths that produces greater anti-inflammatory and analgesic effects than either wavelength can produce on its own while minimizing the risk of thermal damage. It is this combination of continuous and pulsed emissions that characterizes MLS and distinguishes it from other Class IV lasers.

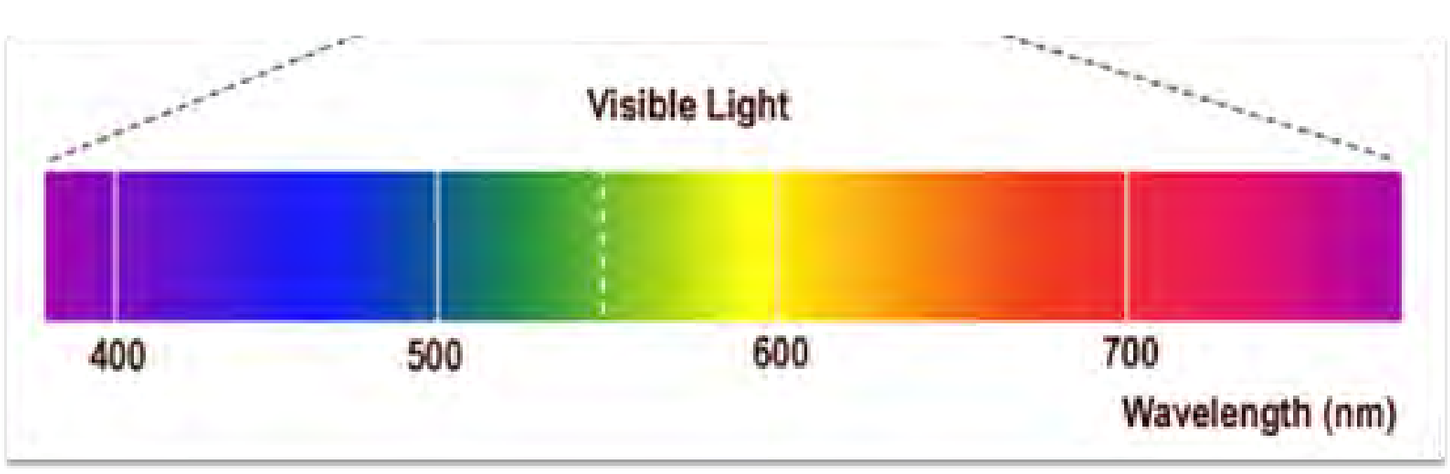
The wavelengths of light used for therapeutic purposes in the MLS system include 808nm (anti-edemic and anti-inflammatory) and 905nm (analgesic). There is also a 635nm wavelength used to help visualize the therapy area. As you can see on this electromagnetic spectrum to the right, the therapeutic wavelengths are outside of the visual light spectrum, so without the 635 nm as a marker, you wouldn’t be able to see where you are treating.

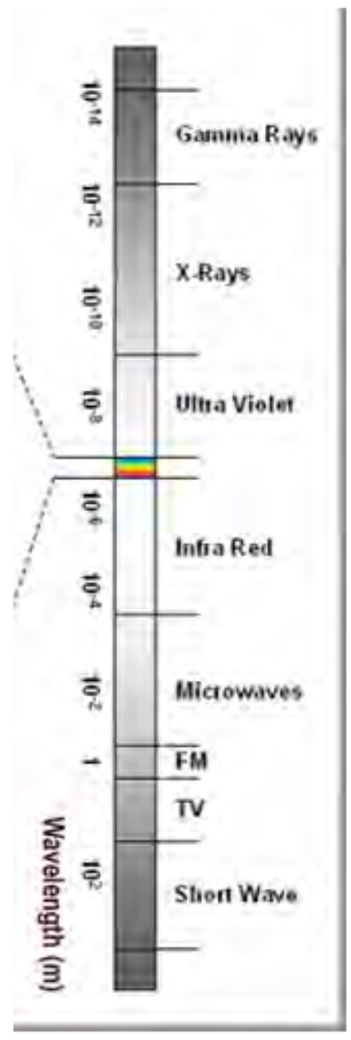
This combination of wavelengths provides tissue penetration of about 3-4cm.

# MLS LASER TECHNOLOGY

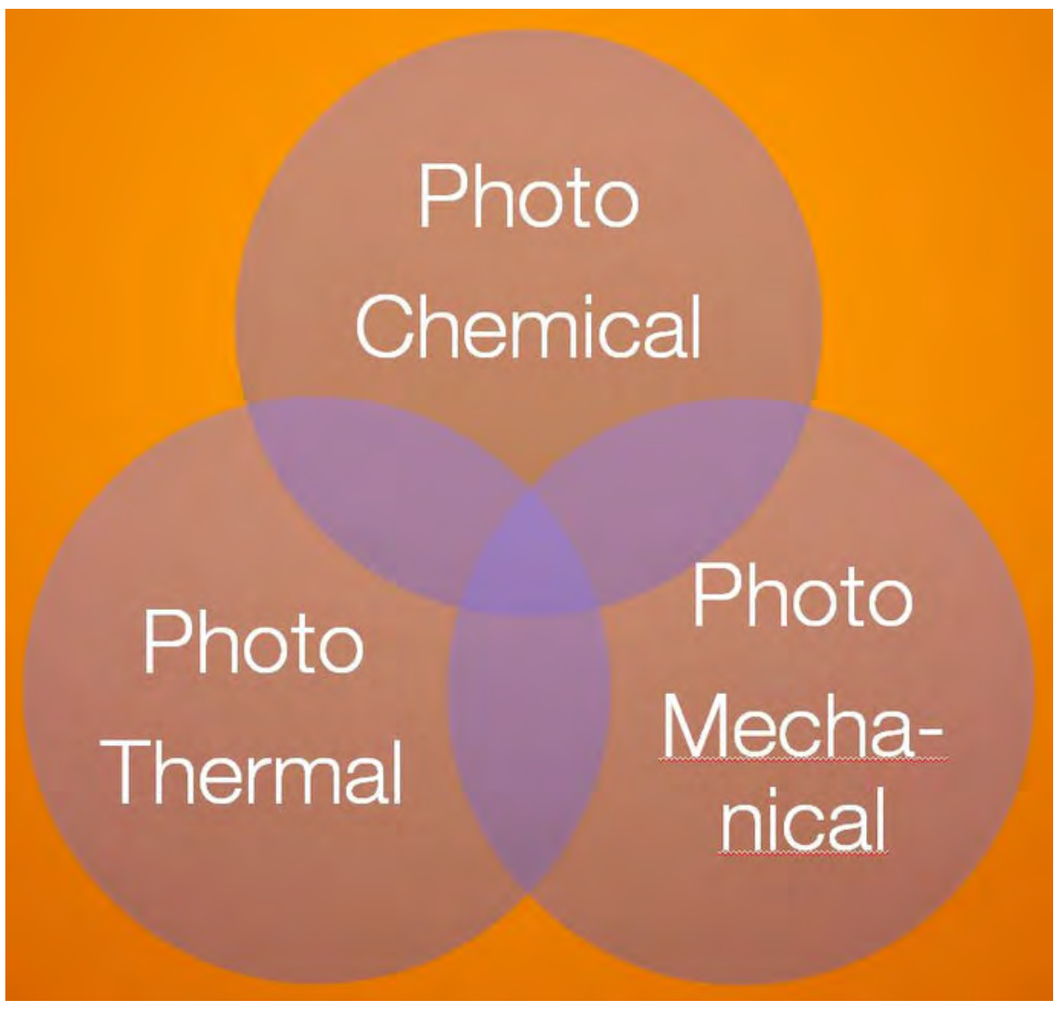
## Class IV Laser - for wound healing

- **808 nm - anti-edema, anti- inflammatory**
- **905 nm – analgesic**
- ***635 nm – visualization of therapy area**




## Primary Biological Effects




Laser produces several Primary Biological Effects, which can be broken down into photochemical, photothermal, and photomechanical effects.

Photochemical effects:

- Direct transfer of energy to the biological sublayers (endogenous or exogenic chromophores).
- Enzymatic activation
- Increase in ATP production
- Modulation of cellular metabolism
- Effect on pain perception threshold

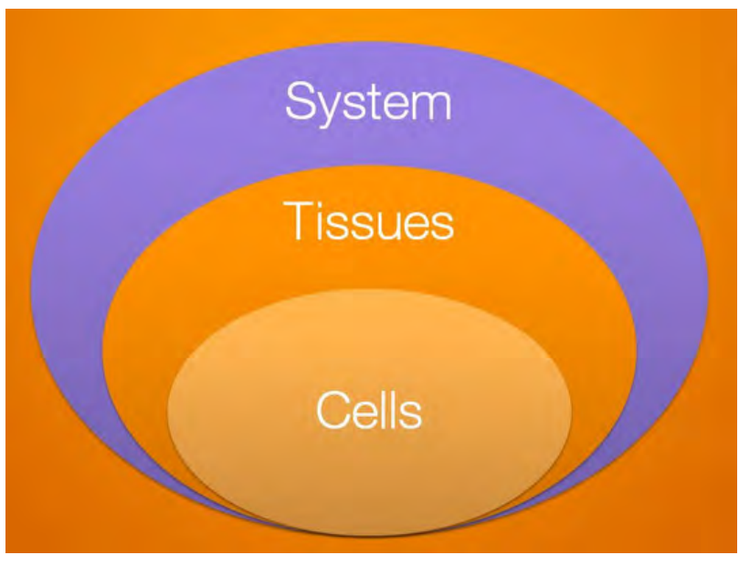
Continued on Page 42

Photothermic interaction is based on the conversion of radiation into thermal energy which, at a microscopic level, occurs through the inelastic encounter between excited molecules following the absorption of photons.

Photothermal effects include:
- Increase in circulation
- Increased supply of oxygen and nutrients

Photomechanical Effects:
The absorption of energy involves the formation of mechanical waves.
Production of an extracellular matrix (important in tissue repair & regeneration)
Acceleration of lymphatic peristalsis
Re-absorption of edemas
Reactivation of microcirculation

## Secondary Biological Effects




These primary biological effects create Secondary Effects on cells, tissues and the overall system.

Effects on Cells:
- Increase in ATP synthesis
- Increase in the production of RNA
- Increase in cellular proliferation
- Induction of differentiation processes
- The release of growth factors  leads to an Increase in the production of molecules of the extracellular matrix (fibroblasts & chondrocytes)

Effects on Tissues:
- Modulation of the inflammatory process
- Remodeling of the extracellular matrix
- Induction of lymphatic and vascular regeneration
- Stimulation of the endothelial function
- Reduction of the edema
- Prevention against the formation of scar tissue

Continued on page 43

Effects on System include analgesic effects, anti-inflammatory, anti-edema effects, and biostimulatory effects.

### Analgesic effect:

- Blocking of pain stimulus conduction

Hyperemia and “wash out” of the algogenic  or pain-inducing substances
Increase in endorphin synthesis
Pain threshold modulation

### Anti-inflammatory and anti-edema effect:

Increase in the caliber and modulation of lymphatic and capillary permeability
Hyperemia and “wash out” of the pro-inflammatory molecules

### Biostimulating effect:

Increase in the supply of nutrients, oxygen, and growth factors
Cellular function activation
Modulation of cell proliferation and differentiation (e.g., nerve regeneration)
Increase of matrix protein synthesis
Reduction of scar tissue formation

*Ok, so how does all this biological benefit translate to my patient?*

When it is broken down to the smaller and experimental levels, research in animal models is generally supportive of laser therapy in particular for improvement of wound healing. However, when clinical studies are done to try and show the benefit of laser therapy, no studies have been able to document the benefits to date.

Two of the most notable studies in veterinary medicine are both from Bryden Stanley’s group again. In both studies, wounds were created on the trunk of 10 healthy dogs.

In the first study, which was all male dogs, the laser therapy consisted of a dual diode laser (7.5 mW/diode) at 635 nm and total energy density of 1.125 J/cm(2). There was also a control group that had the same therapy with the exception of the laser treatment.  The wounds were evaluated for percent contraction and percent epithelization. Biopsies were also performed and the wounds assessed histologically. When they looked at the two groups, there was no apparent benefit to the laser therapy.

The second study was very similar but used healthy female dogs and a different laser protocol. The TX group received LLLT once daily for 5 days with a 980-nm laser and a total energy density of 5 J/ cm2. Unfortunately, again, they were not able to demonstrate a benefit of laser therapy.  It is important to note that the authors emphasized that no standardized LLLT protocol exists for

wound healing in veterinary medicine, and underscored the need for continued research in this area.

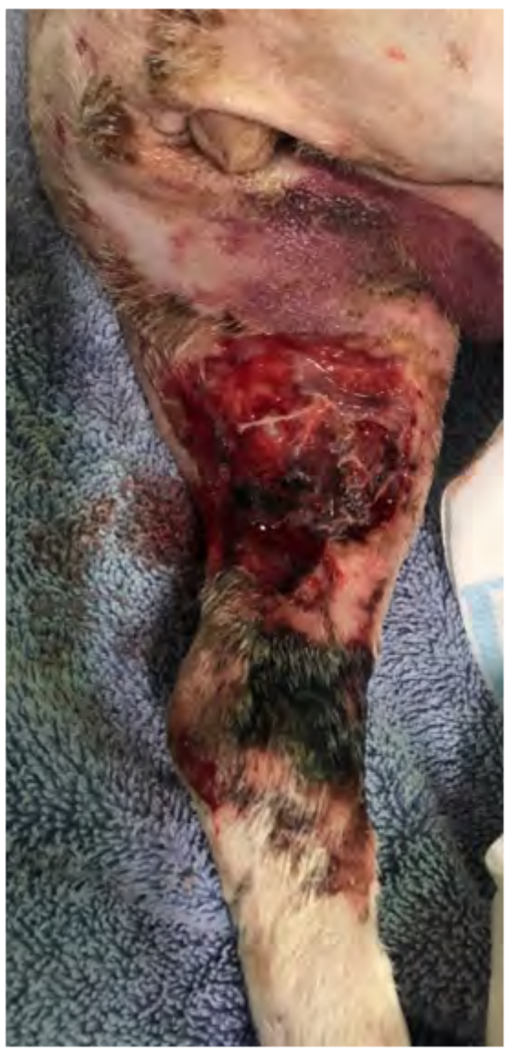
As I mentioned earlier I have had access to a Cutting Edge laser in my practices for the past several years, and have used these on numerous wound healing cases. I have seen the benefit in all of my patients from using the laser.

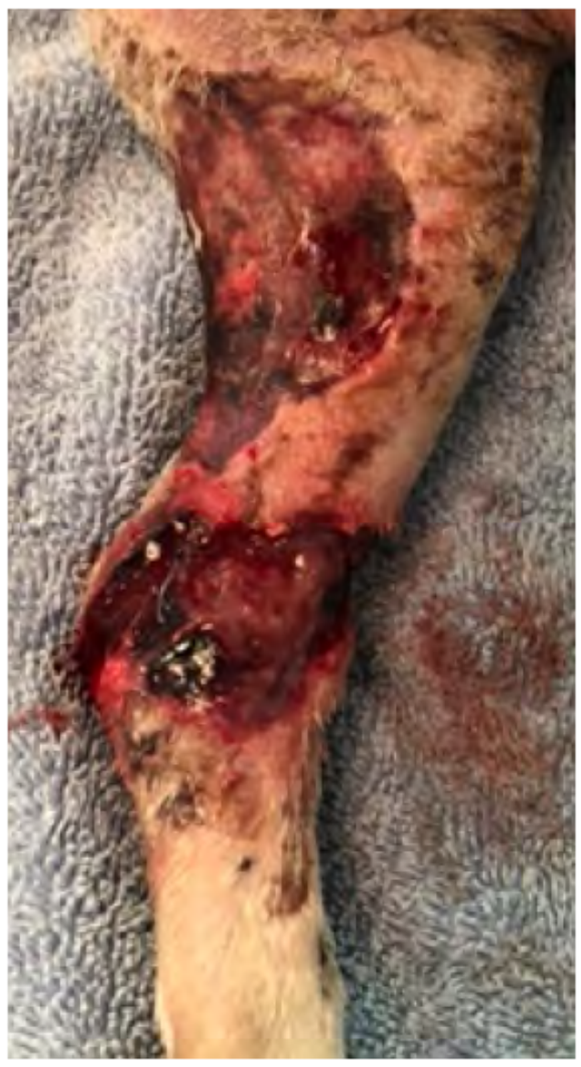
While this is anecdotal evidence at best, I truly believe in the benefits of laser in terms of wound healing, infection, and comfort for patients. I am sure that as this novel technology continues to be investigated and studies refined, there will be clinical studies that support the use of therapeutic lasers in wound healing.

To emphasize this, I wanted to show you a few recent cases that I have used the Cutting Edge laser on...

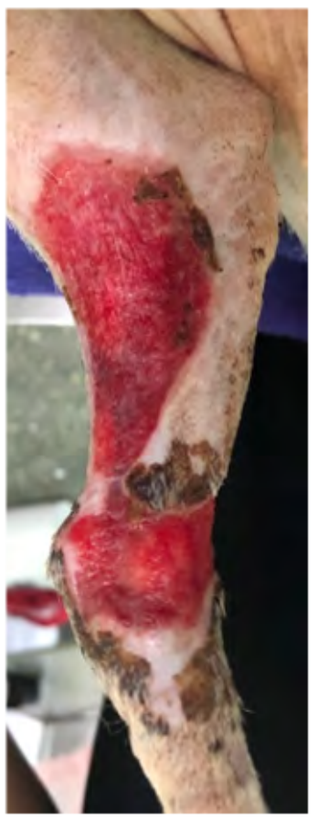
**Cuca-Jack Russel Terrier, HBC, multiple fxs and severe degloving wounds on medial and lateral thigh.**

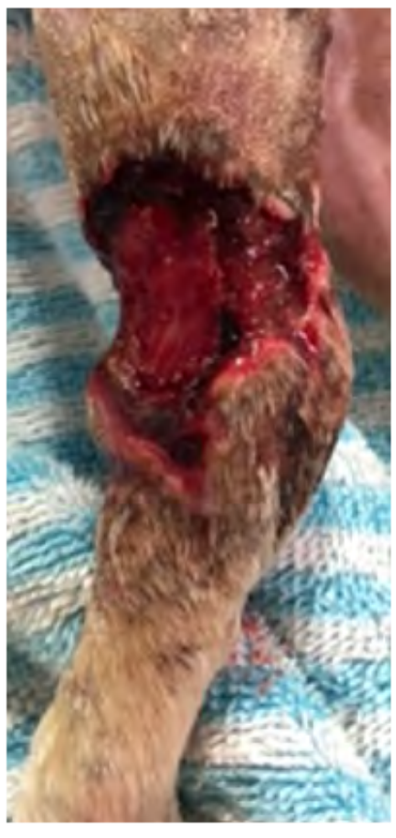
**Medial June 1st**
**June 13th pre and post debride**
**Last seen June 25**
**Unfortunately lost to follow up**

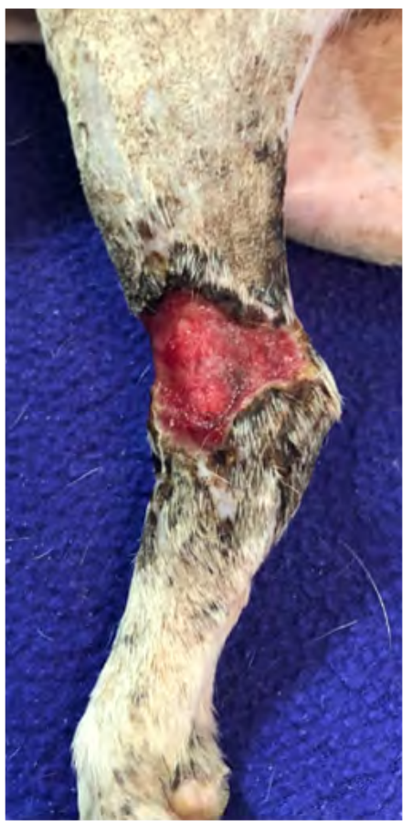




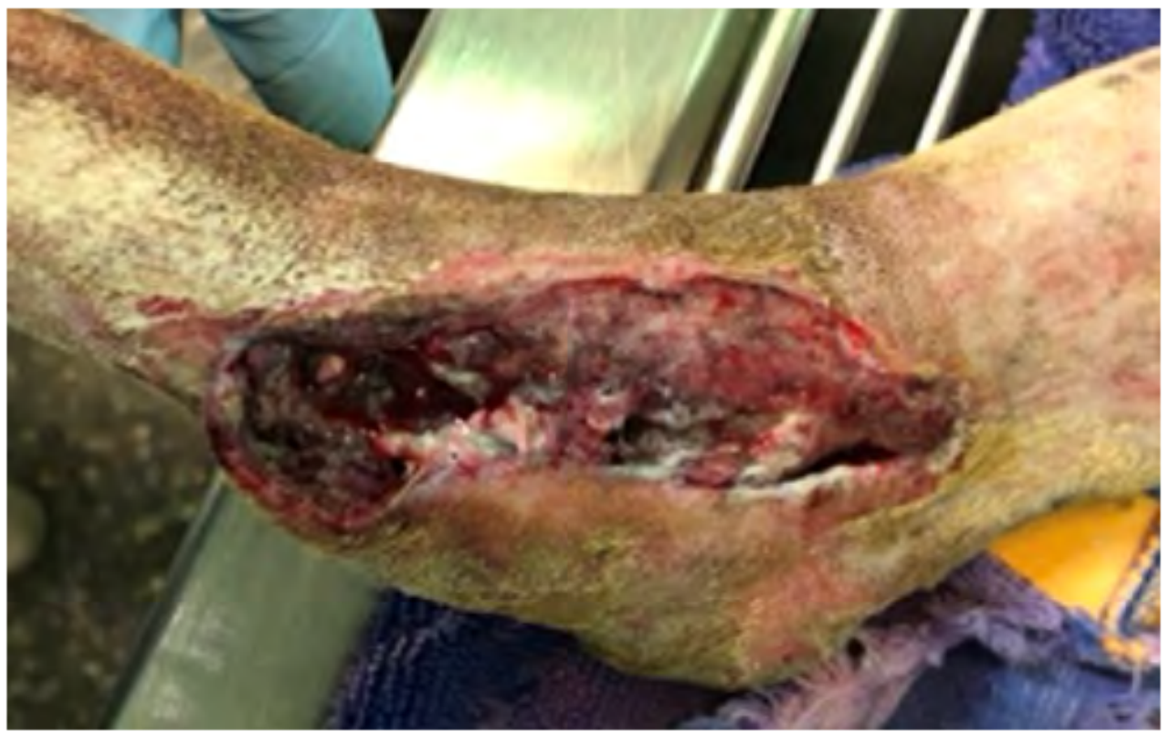
This case was hospitalized for wound care and for surgical repair of her fractures. The first two pictures were on the day of the presentation, which was 3 days post-injury. All the way to the left is the pre-debridement image and post debridement in the center. The picture to the left is 12 days later following daily bandage changes with wet to dry and then non-adherent bandages and daily laser therapy using the wound healing and contamination setting.



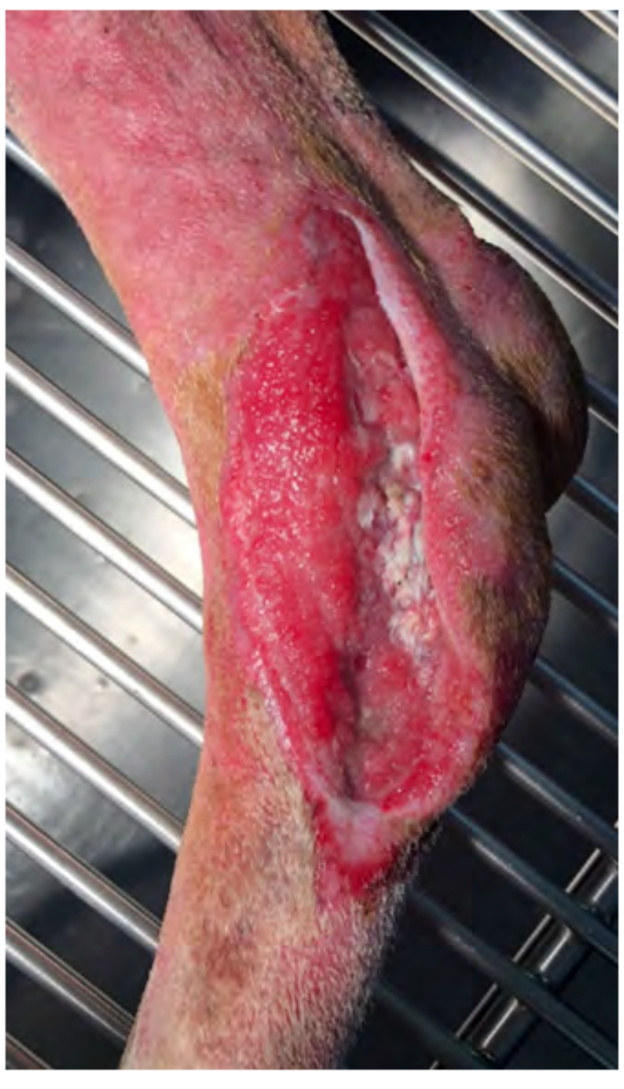


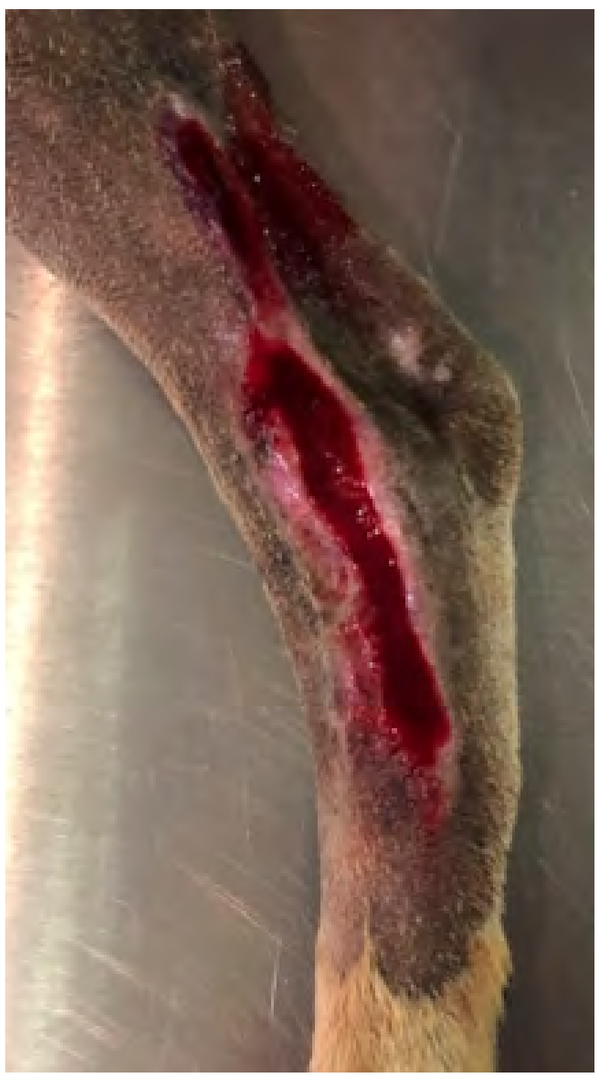


**Tonka, a 10-year-old Boxer that was hit by a car and had a severe medial degloving wound on his hock with exposed bone and collateral ligament damage. Tonka was also treated with several days of wet to dry bandages, vetericyn therapy and every other day laser therapy (again on WH&C setting).**



The image on the left is the day of presentation, center image is 1 week later. You can see how healthy that granulation bed is and how the wound has already begun to contract. There was also a lateral splint placed in this bandage for collateral support. The image to the right is after a partial wound closure and every third-day laser therapy for a period of time.





# SO NOW WHAT?!

**OK, so you have worked very hard for several days, and now you finally have a beautiful, healthy, bleeding wound bed. Now, what....? Well, if we hark back to second-year vet school, you will remember there are 3 major ways a wound can heal.**

To start, we have first intention healing or primary closure of a wound. This is what happens when you make an incision and then close it back up- not the case in our talk today. But, this also applies to when you place a flap or graft over a wound bed, which is certainly a possibility now that you have a gorgeous bed of granulation tissue to support that skin graft. Graft away friends, and might I suggest the VAC over your graft for a few days to increase your graft take?

Ok, now let's look at this bite wound/laceration/ dehisced surgical wound that you have been treating all of these days. You have enough tissue and you can cover the entire wound bed. Everything looks healthy, so you can close it up. You are employing delayed primary closure. Confusingly enough, this is called third intention healing. I like to think of it as delayed primary- You have apposed wound edges, just not right away.

Lastly, let's pretend you are treating a wound and after 3 debridement surgeries, 6 days of daily bandage changes, and lots of supportive care, your owners are out of money. I know, never happens, right? They can't afford another trip to the OR to close the wound that you have been working so diligently on. That's ok because you have done such a great job getting that nice granulation bed, that the wound is now ready to contract and epithelialize on its own. This is second intention healing. These wounds are healing by approximation of wound margins occurs via reepithelialization and wound contraction by myofibroblasts. Keep in mind that sometimes the epithelial cells quit before the wound is closed, and then you may have to do a little delayed primary closure at the end. Also, contracture of wounds in certain locations, like over joints,  may be detrimental to long-term function, and in these cases, delayed primary closure is often preferred. At the very least, make sure you warn the owners of this possibility.

There are a lot of new and exciting wound healing technologies out there. Wound management can be challenging, but can also be fun in that no two wounds are ever the same. Successful wound management requires creativity and adaptability. But it always comes back to the basics.

So next time you are faced with an overwhelming wound management case, you can never go wrong with a wet- to-dry for a day or two, and then see how the wound is behaving. In the meantime, you can do some research and decide how to tackle your next wound adventure.

# THANKS FOR READING

For more information about MLS Laser Therapy, click below or simply give us a call at 800-889-4184 to schedule your complimentary in-office laser demonstration.

**Request More Information**

CUTTING EDGE™
LASER TECHNOLOGIES

800.889.4184 | www.celasers.com