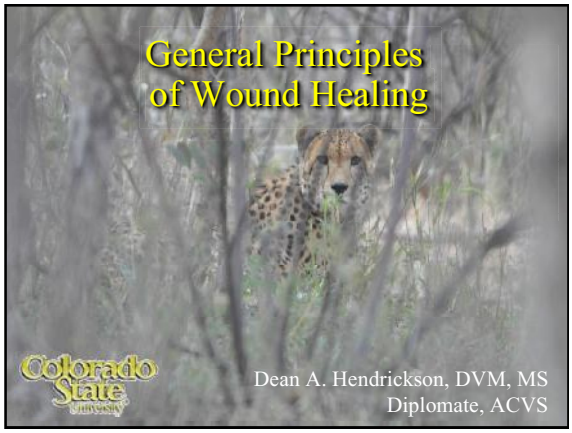


Behavioral Objectives

- The participant will be able to evaluate the severity of traumatic wounds, including the different effects of wound bacteria.
- The participant will be able to prepare wounds for wound cleaning.
- The participant will be able to clean wounds and make decisions regarding topical antiseptic and antibiotic use.

Behavioral Objectives

- The participant will be able to evaluate wound and the most appropriate type of wound debridement.
- The participant will be able to determine the best type of wound therapy including primary closure, delayed primary closure, or second intention healing.

Behavioral Objectives

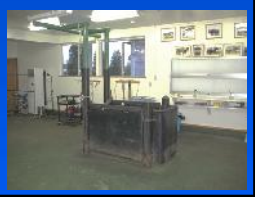
- The participant will be able to understand the principles behind moist wound healing.
- The participant will be able to understand the different phases of wound healing.
- The participant will able to discuss the principles involved with the different advanced wound care dressings, and the best times to apply them.

Wound Time Line

- Trauma
- Thorough history
- Thorough physical examination
- Wound preparation
  - Hair Removal and Wound Cleaning
- Wound Debridement
- Wound Exploration
- Wound Therapy
  - Primary closure, Delayed primary closure, Second intention healing, Grafting

Do everything to set yourself and your patient up for success

- Environment
  - Clean
  - Controlled
  - Light
- Sedation
- Twitch
- Local Anesthetic

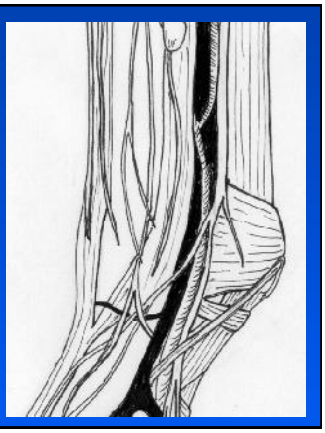


Preparation

- Clip hair
  - Water soluble lubricating gel
    - K-Y jelly
- Clean area
  - Sterile saline
  - Antiseptic
  - Water
  - Wound Cleanser

Cannon bone - high tensile wire

Know the Anatomy



Wound Cleaning

- One of most important steps in wound healing is proper cleaning and thorough exploration of the wound
- Cross contamination should be avoided in all cases
- Aseptic technique
  - Open synovial structure
  - Open fractures

Dirty > Contaminated > Clean/Contaminated > Clean

Wound Bacteria

- Wound contamination
  - Bacteria not replicating within the wound
- Wound colonization
  - Replicating Bacteria w/o trauma to animal
  - May be beneficial by reducing adherence of pathogenic bacteria to wound bed
    - *Corynebacteria sp.*, coagulase negative staphylococci, and viridans streptococci
- Wound infection
  - Bacteria replicating and causing trauma to animal

Wound Infection

- Development is dependent on:
  - Dose of bacteria
  - Virulence of the bacteria
  - Host resistance
  - Amount of necrotic tissue
- Resistance helped with:
  - Careful cleaning
  - Adequate debridement

Chronic Wound Infection

- Fragile granulation tissue
- Weak collagen in disorganized patterns
  - Low tensile strength
  - Reduced wound contraction
- Infection should be considered in any wound that fails to heal despite providing the best possible wound-healing environment.

Diagnosis of Wound Infection

- Clinical assessment
  - Local and systemic inflammatory response
  - Evidence of infection:
    - Periwound cellulitis
    - Erythema
    - Swelling
    - Increased local temperature
    - Increased exudate with or without odor is often present

Covert Wound Infection

- Less obvious clinical signs:
  - loss of granulation tissue
  - change in the character of granulation tissue
    - Edematous
    - pale gray or deep maroon in color
    - tissue that is more friable

Addition of Foreign Material

- Osteomyelitis
- Necrotic tissue
- Orthopedic implants
- Suture material
- Reduce volume of bacteria necessary for an infection to 10^4 organisms per gram of tissue

Microbiological Assessment

- Quantitative
  - Determine amount of bacterial load present in a wound
  - Greater than 10^5 organisms per gram of tissue
- Qualitative

Wound Cleaning Agents/Techniques

- Most wound-cleansing agents/techniques will cause trauma to wound bed
  - Chemical trauma results in cellular toxicity when the cleaning agents are not biocompatible.
  - Mechanical trauma occurs when mechanical forces such as scrubbing or high pressure, are used.
  - Benefits of a clean wound must be weighed against the trauma that the agent will cause

Bottom Line

- You must determine if the cleaning agent will eventually speed up or retard wound healing.
- "Don't do to a wound what you wouldn't do to your own eye."

Scrubbing

- Woven or non-woven gauze
- Mechanical trauma
- Use minimal amount of force necessary

Lavage

- Irrigation force
- Higher pressures -vs- lower pressures
- 15 pounds psi

Saline

- Normal or isotonic saline (0.9% NaCl)
- Mildly contaminated wounds
- Sterile saline should be used around synovial structures
- 2 teaspoons of salt to one liter of boiling water
- May actually be better to use a polyionic replacement fluid: normasol-R

Hypertonic Saline

- Wound lavage and debridement
- For large wounds use a weed sprayer
- 200 grams/liter
  - ~ 9 level tablespoons
  - ~ ½ cup
- Warm to boiling water

Antiseptic Agents

- Balance between bacterial reduction and cellular toxicity
- Tatnall FM et.al. Comparative study of antiseptic toxicity on basal keratinocytes, transformed human keratinocytes and fibroblasts. Skin Pharmacology. 1990 3:157-163
  - Cells exposed to recommended concentrations of common antiseptics for 15 minutes
  - Evaluated at 24 hours
  - All antiseptics killed 100% of cells

Fleming 1919

- "It is impossible to sterilize a wound with an antiseptic."
- No controlled clinical study to date has been able to disprove this conclusion.

Povidone-Iodine

- Gold standard
- Many positive reports
  - Likely that benefit achieved with PI is associated with debridement that occurs
- Study: topical antibiotic silver sulfadiazine, povidone-iodine, or saline-soaked gauze
  - PI least effective in reducing bacterial numbers in the wound
- Study: saline alone twice the amount of epithelial ingrowth -vs PI

Chlorhexidine

- Discovered 1946
- Wide spectrum of activity, low systemic absorption and low systemic toxicity
- Longer residual effect than PI
- Contraindicated for use around the cornea, the middle ear, and synovial structures
- Chlorhexidine gluconate to cleanse patients in a medical intensive care unit: the effectiveness of source control to reduce the bioburden of vancomycin-resistant enterococci. Vernon MO et.al. Arch Intern Med. 2006;166:306-312

Chlorhexidine continued

- Drosou A et.al. Antiseptics on wounds: an area of controversy. Wounds 2003; 15: 149-66
  - Seven animal studies and three human studies
  - Few adverse effects on healing
  - There is insufficient data to assess safety and efficacy
- Main RC. Should chlorhexidine gluconate be used in wound cleansing? J Wound Care 2008; 17:112-114
  - "There is a strong argument that the existing evidence highlights the need for practitioners to reconsider the ritualistic use of chlorhexidine of any concentration on open wounds unless further evidence can prove that its benefits outweigh any ill effects."

Hydrogen Peroxide

- Popular for its effervescent effects
- Bubbling activity can be mistaken for antibacterial activity, which is actually quite low
- Benefit: might loosen and hasten the removal of necrotic debris in the wound
- Should be discontinued once the necrotic tissue has been removed

WebMD

Acetic Acid (Vinegar)

- Possible efficacy against Pseudomonas sp. and other aerobic gram-negative rods
  - Inability of these bacteria to tolerate the low pH environment caused by the acetic acid
- Low pH may not biocompatible with the wound tissue
- Recommendations: 15-min/day soak or compress
- May help with odor control
- Should be terminated once infection is under control

1:3 Dilution

Dakin's Solution

- 0.5% solution of sodium hypochlorite (bleach)
- World War I
- Chemical debriding agent
- Should only be used if necrotic tissue is present

A toxicity index of skin and wound cleansers used on in vitro fibroblasts and keratinocytes.

- Wilson JR, Mills JG, Prather ID, Dimitrijevich SD.
- Adv Skin Wound Care. 2005 Sep;18(7):373-8.
- Seventeen cleansers and 3 liquid bath soaps
- Serial 10 fold dilutions
- Fibroblasts
  - Least: Shur-Clens, SAF-Clens, and saline
  - Most: Dial Antibacterial Soap and Ivory Liqui-Gel
- Keratinocytes
  - Least: Biolex, Shur-Clens, and Techni-Care
  - Most: Hydrogen peroxide, modified Dakin's solution, and povidone iodine

Summary of Cleaning Agents

- Magical dilutions
- Test tube -vs- wound environment
- Antiseptics are useful to clean the very surface of a wound or the area surrounding a wound but they will not penetrate deeper into the wound to kill bacteria
- Consequently, because of their cellular toxicity, they are probably not the best choice for wound cleaning and should not be used in clean wounds

Antiseptics -vs- Antibiotics

- There is limited evidence that topical antiseptics reduce the bacterial load in wound tissue
- Topical or systemic antibiotics are needed to achieve this effect
- Most important thing we do is reduce foreign material to limit the ability of bacteria to replicate

Topical Antibiotics

- Effective in reducing bacterial numbers in human burn patients
- Avoid commonly used systemic antibiotics
- Use for two weeks or less
- Use an appropriate antibiotic
  - Bacterial culture and sensitivity

Silver

- 0.5% silver nitrate solution
- Silver sulfadiazine cream
- Silver impregnated dressings
- Burn patients


Smith Nephew Acticoat

- Cream removed and replaced at least daily
- Silver impregnated dressings to stop bacterial penetration

- Study: Collagenase better than silver
- Study: Silver in horses less granulation tissue

Effects of Silver on Fibroblast Migration

- Mechanisms of delayed wound healing by commonly used antiseptics. Thomas GW, Rael LT, Bar-Or R, Shimonkevitz R, Mains CW, Slone DS, Craun ML, Bar-Or D. J Trauma. 2009 Jan;66(1): 82-90.
- Povidone-iodine, Hydrogen Peroxide, Chlorhexidine, Silver containing antispetics
- Cell proliferation and migration assays
- P-I and H2O2 reduced migration and proliferation
- CHD and Silver reduced proliferation at high dose
- The silver-containing antiseptics may even increase the proliferative potential of fibroblasts in culture.

Nitrofurazone

- Study: triple antibiotic ointment, povidone iodine, silver sulfadiazine and nitrofurazone
  - Nitrofurazone significantly retarded the healing rate
- Study: Concentration of 0.02% had a dose-dependent toxicity to cells, yet minimal effect against microorganisms
- It can not be recommended to use nitrofurazone on healing wounds

Triple Antibiotic:
Neomycin/Polymixin B/Bacitracin

- Studies: Benefit of triple antibiotic ointment when compared to other topical antiseptic or antimicrobial agents
- Antibiotics work in a synergistic fashion
- More recent studies have shown that a moist wound-healing environment may be as beneficial as triple antibiotic in reducing bacterial numbers and more beneficial in stimulating wound healing

Surfactant Based Wound Cleansers

- Minimally Toxic and Irritating
- Polysorbate 20
- Isotonic and pH-Balanced
- Should be rinsed off after application

Methods of Debridement

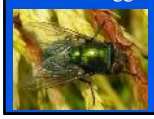
- Autolytic Debridement
- Enzymatic (Chemical) Debridement
- Mechanical Debridement
- Sharp Debridement
- Biological Debridement

Autolytic Debridement

- Autolysis is the breakdown of necrotic tissue by enzymes
- Achieved under occlusive dressings
- Wound bed must remain in contact with the wound fluid
- The WBC's and enzymes and the warm environment enhance the natural digestion of necrotic tissue
- Takes between 72 and 96 hours to start after placing moist dressing

Biological Debridement - Maggots

- Maggot therapy
- Practiced since antiquity
- Larvae of Lucilia sericata (greenbottle fly)
- Digest necrotic tissue and pathogenic bacteria
- Rapid and selective debridement
- Patient reluctance on the human side
  - Maggots in a bag



- Amino acid derivatives from Lucilia sericata excretions/secretions may contribute to the beneficial effects of maggot therapy via increased angiogenesis.
  - Bexfield A et.al. Br J Dermatol. 2009 Oct 3. Epub
- Lucifensin, the long-sought antimicrobial factor of medicinal maggots of the blowfly Lucilia sericata.
  - Ceřovský V et.al. Cell Mol Life Sci. 2009 Nov 18. Epub

Enzymatic (Chemical) Debridement

- Topical application of proteolytic substances (enzymes) to breakdown devitalized tissue
- As with other debridement techniques, the area first is flushed with saline. Any crust of dead tissue is etched in a crosshatched pattern to allow the enzyme to penetrate.

Mechanical Debridement

- Removal of devitalized tissue by physical forces other than those above.
- Examples:
  - Wet-to-dry dressing
  - Wound irrigation
  - Gauze manipulation

Sharp Debridement

- Scalpel
- Laser
- Quickest and most efficient method of debridement
- Preferred method if there is rapidly developing inflammation of the body's connective tissues (cellulitis) or a more generalized alized infection (sepsis) that has entered the bloodstream

Questionable Skin Flaps

- It is generally better to suture skin flaps if possible even in viability is questionable
- At least the wound can be fully or partially closed, and even if the wound edge becomes devitalized some of the flap will survive

Wound Evaluation
Black-Yellow-Red-Pink

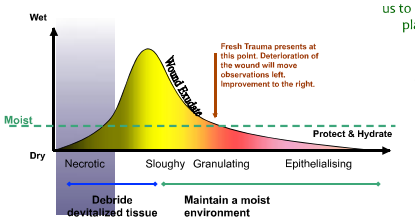
- Black = Necrotic
- Yellow = Fibrinous
- Red = Granulation
- Pink = Epithelium

Wound Evaluation
Black-Yellow-Red-Pink

- Black = Necrotic
- Yellow = Fibrinous
- Red = Granulation
- Pink = Epithelium

Wound Evaluation
Georgie Hollis

What we see in practice is based on observations that indicate the underlying process of healing. It helps us to decide on the best plan of action…..



The products we choose are simply designed to help us assist the process by creating the optimal environment for healing to occur and to reduce the risks of complication…

Treatment

- Primary closure
- Delayed primary closure
- Second intention healing

The Basics of Suture Materials

- Many different types of suture material
- Absorbable versus non-absorbable
- Monofilament versus multifilament

Absorbable

- More reactive short term less reactive long term
- Used when the suture will be buried
- Can be used in the skin
  - May take up to 60 days for the suture to absorb and fall out.
- Different absorption times

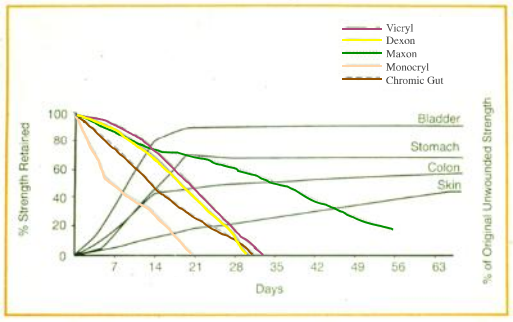
Non-absorbable

- Less Reactive short term
- Skin suture
- Used when holding strength is important after typical absorption time have been exceeded

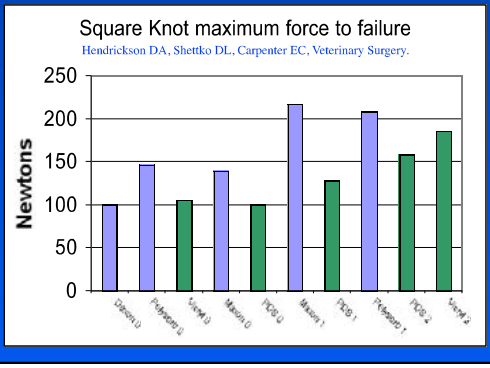
Absorption Times
(from longest to shortest)

- Maxon
- Dexon
- Polysorb
- Biosyn
- Caprosyn
- Chromic gut
- PDS
- Vicryl
- Vicryl Rapide
- Monocryl
- Chromic gut

Suture Strength vs Tissue Strength



Suture Knot Strength



Monofilament	Multifilament
•Less reactive	•More Reactive
•Less inflammation	•More inflammation
•More memory	•Less memory
•Poor handling characteristics?	•Better handling characteristics?
•Decrease the chance of wicking	•Increase chance of wicking
•Less knot security?	•More knot security?

Surgical Staples

- Stainless steel
- Titanium
- Very inert
- Can reduce surgical time

Knot Geometry

- Very important factor in determining the volume of suture material used
- Larger suture leads to larger volume
- More suture throws leads to larger volume
- Surgeons throw leads to larger volume
- In general use the smallest size suture and the fewest throws possible, and surgeons throw only when tension requires it
- All suture becomes foreign material as soon as it is placed regardless of how much it costs!

Square Knot

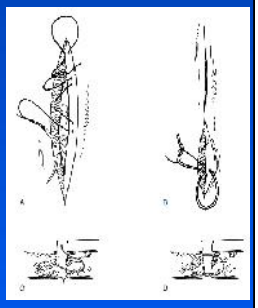
Surgeons Knot

Square -vs- Surgeons

Slip Knot

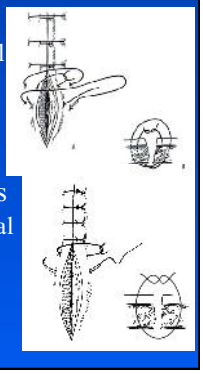
Suture

- Sub Cutaneous
  - Absorbable suture material
  - As small of diameter as possible
  - Use to close dead space not really part of tension relieving
  - Surgeons knots only if needed

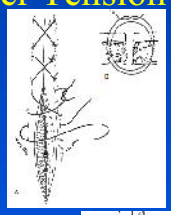


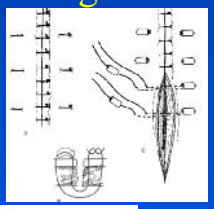
Suture

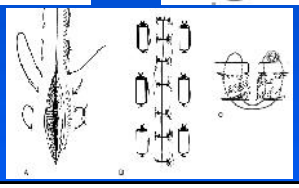
- Skin
  - Monofilament suture material
  - Nylon
  - Maxon
- Cutting needle
- Use tension relieving sutures
  - Large diameter suture material
  - Near-far-far-near pattern
- Tissue apposition sutures imbetween



Other Tension Relieving Patterns







Mystery Case

Primary Closure

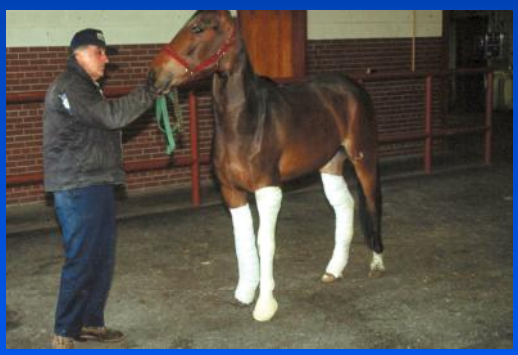
- Requires clean, minimally contaminated wound
- Debride wound edges
- Clean wound thoroughly
- Use tension relieving sutures
  - Large diameter suture material
  - Near-far-far-near pattern
- Tissue apposition sutures

Skin Staples

- Great for closing lacerations where local anesthetic can not be used such as in show horses
- Requires minimal to no tissue loss
- Can twitch and close lacerations

Cannon Laceration

Carpal Laceration



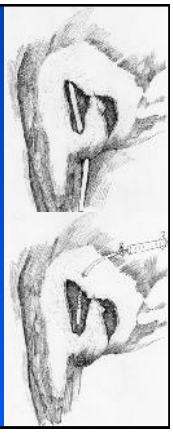
Delayed Primary Closure

- Clean and debride
- Bandage to keep clean
- Change bandage every day to assess granulation tissue and cleanliness of the wound.
- Suture laceration using both tension relieving sutures and tissue apposition sutures


Courtesy Dr. Gayle Trotter

Dead Space

- It is important to minimize the dead space by suturing when possible
- If the dead space can not be closed, passive or active drainage should be instituted
  - Passive drain: Penrose
  - Active drain: Positive pressure drain



Second Intention Healing

- Used especially in wounds where there is not enough skin to close over the wound
- Contamination is to severe to allow closure
- The wound is generally debrided and bandaged to prevent further contamination. Generally don't recommend the use of any topical agents as they tend to impede healing
- May require skin grafting to provide more cosmetic appearance
- Generally requires the use of dressings

Wound Dressing Evolution

1600	1800	1900	1960	1980	2000
cotton linters	linters	non-woven swabs	non-wovens	plastic films	growth factors
paper	fibers	sleeve dressings	plastic films	hydro-colloids	delivery systems for active agents
feathers	cotton gauze	adhesive pads		gums	
dust	knitted fibers	plasters/ strips		hydrogels	bio-enginered products

H. Bloom (Army Surgeon)

- Cellophane dressing for second degree burns.
- Lancet 1945; 2:559
- Burn wounds at WWII prisoner of war camp
- Sterilized cellophane
  - Semipermeable membrane to reduce bacterial penetration
- Less pain at dressing change and with movement
- Less loss of plasma
- Less infection
- Maceration of surrounding tissues

JP Bull, Squire JR, Topley E.

- Experiments with occlusive dressings of a new plastic.
- Lancet 1948; 2:213-214
- Transparent nylon dressing
  - Stopped bacterial and fluid penetration
  - No fluid collection or maceration of normal skin
  - Wounds healed faster and required fewer dressing changes

George Winter

- Formation of the scab and the rate of epithelization of superficial wounds in the skin of the young domestic pig. Nature. 1962 Jan 20;193:293-294.
- Effect of air exposure and occlusion on experimental human skin wounds. Nature. 1963;200:378
- Demonstrated that occlusion nearly doubles the rate of re-epithelialization when compared to air exposed wound

Moist Wound Healing Principles

- A full thickness wound kept in a moist environment will usually re-epithelialize in 12-15 days.
- The same wound exposed to air will take 25-30 days to heal
- Wound exudate not lost via absorption by gauze
- Wound exudate remains in contact with wound bed
- Wound exudate contains healing "rich" properties

Moist Wound Healing

- Neutrophils and other WBC's play important role in wound repair
  - Phagocytosis of bacteria
  - Stimulate release of factors that in turn stimulate cellular proliferation
  - More neutrophils can invade a moist occluded wound than in a dry wound

Moist Wound Healing

- Occlusion provides constant thermal regulation
- Fine balance between drying out and maceration of peri-wound tissue

Exposed wounds to air are:

- More inflamed
- Painful
- Itchy
- Have thicker crusts
- Scar more

Pros and Cons of MWH

Pros

- Faster epidermal and dermal repair
- Decreased pain
- Decreased inflammation
- Cost-effective
- Enhanced Autolytic Debridement

Cons

- Bacterial colonization
- Folliculitis
- May cause trauma to peri-ulcer borders
- Allergies to dressing material

Phases of Wound Healing

- Necrotic/Heavily Exudating Wounds - Debridement Dressings: Curasalt, Kerlix AMD
- Dry Wounds - Moistening: Gel Dressings
- Granulation Tissue Defects - Calcium Alginate: Curasorb
- Epithelialization - Semi-Occlusive Foam: COPA/Hydrasorb

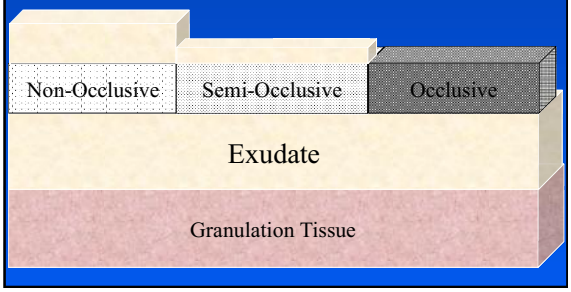
Why are Dressings Used?

- **Absorption:** Contain drainage and exudate
- **Packing:** Minimize dead space
- **Debridement:** Remove nonviable tissue
- **Clean / Prep:** Minimize risk of infection
- **Compression:** Provide pressure as required
- **Support:** Control or immobilize a body area
- **Protection:** From trauma and contamination
- **Moisture:** Maintain proper moisture balance at wound site

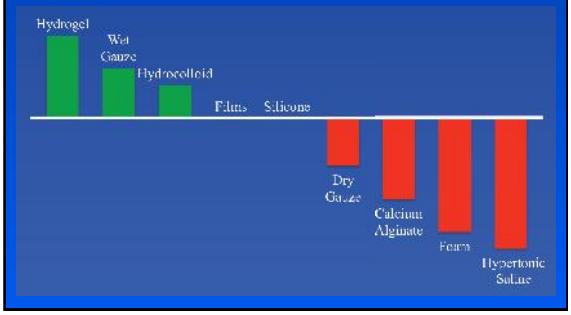
Advanced Dressings

- Designed to encourage moist wound healing
- Different dressings should be used for different stages of wound healing
- Dressings should be changed based upon wound exudate, and wound characteristics

Dressing Occlusiveness



Moisture:
Supply –vs- Removal



Debridement Dressings

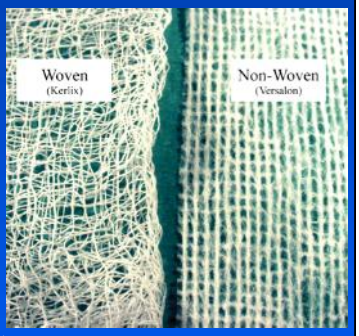
Saline
Hypertonic Saline
Antimicrobial Dressing
Honey

Wet Gauze

- Tends to dry out
- Amount of moisture retention dependent upon many factors:
  - secondary dressing
  - amount of solution and type of gauze
  - frequency of dressing change
  - Moistened up to 6 times daily

Woven -vs- Non-Woven Gauze

- **Woven Gauze**
  - Made of 100% Cotton
  - High Strength
  - Vertical Wicking Ability
  - Relatively Adherent
  - Superior Debridement Characteristics
  - Superior Prepping Characteristics
- **Non-Woven**
  - Synthetic Blends
  - Low Lint Levels
  - Low Strength
  - Highly Absorbent
  - Horizontal Wicking Ability
  - Less adherent



Hypertonic Saline Dressings Curasalt®

- Pre-moistened Wet Dressing
- Designed for **infected** or **heavily exuding** wounds ONLY
- 20% vs 0.9%
- Osmotic Action
- Non-Selective Debridement

Presentation

24 hours

96 Hours

Corynebacterium psuedotuberculosis

Day 1 *Day 6*

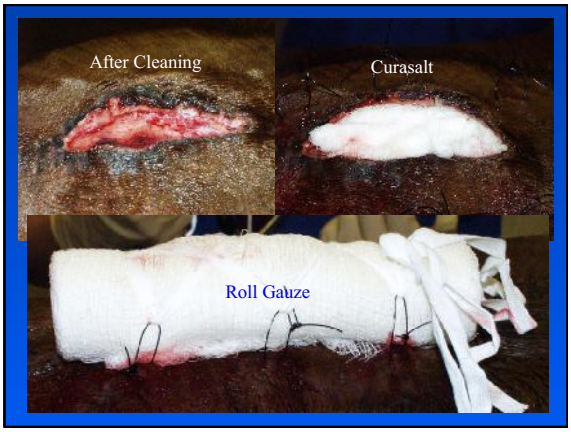
After 10 Days Curasalt therapy

8 months later with Hydrasorb therapy

Heel Bulb Laceration

One Month Later

Incisional Dehiscence



Day 3 Day 7

Dressing Changes

- Depends on:
  - The amount of exudate
  - The character of the exudate
  - Amount of necrotic tissue
- At least every 3 days to prevent dilution of the hypertonic saline.
- Cover with plastic if necessary

Other Debridement Dressings

- Sugar
- Honey
  - Effects of honey and sugar dressings on wound healing. J Wound Care. 2007 Jul;16(7):317-319
    - Mphande AN, Killowe C, Phalira S, Jones HW, Harrison WJ.
  - Honey appears to be more effective than sugar in reducing bacterial contamination and promoting wound healing, and slightly less painful than sugar during dressing changes and motion.

Manuka honey vs. hydrogel--a prospective, open label, multicentre, randomised controlled trial to compare desloughing efficacy and healing outcomes in venous ulcers

- Gethin G, Cowman S. J Clin Nurs. 2009;18:466-74
- OBJECTIVE: Comparison of desloughing efficacy after four weeks and healing outcomes after 12 weeks in sloughy venous leg ulcers
- 108 patients with venous leg ulcers
- No antibiotics or immunosuppressant therapy
- Honey group had increased incidence of healing, effective desloughing and a lower incidence of infection than the control.
- Effective desloughing significantly improves healing outcomes.

Is manuka honey the best type of honey for wound care?

- Majtan J, Majtan V. J Hosp Infect (2009) in press
- Control Sugar solution of similar osmotic nature

Table 1 Minimum inhibitory concentrations (%) of different honeys towards standard strains and clinical isolate

Bacteria	Type of honey					
	Manuka	Acacia	Rape	Meadow	Forest	Control
Staphylococcus aureus (2022)	12.5	50	50	50	25	50
Staphylococcus aureus (MRSA)	12.5	50	50	25	25	>50
Klebsiella pneumoniae (4985)	12.5	50	50	50	50	50
Pseudomonas aeruginosa (1960)	25	50	25	25	12.5	50
Proteus spp. (1799)	25	25	25	25	12.5	>50
Serratia marcescens (303)	25	50	25	25	25	>50
Listeria monocytogenes (4699)	12.5	25	25	25	25	>50
Staphylococcus epidermidis (4418)	6.25	50	25	25	6.25	>50

Numbers in parentheses as designated in the Czech Collection of Microorganisms.

Greater One Horned Rhino

1 Week Later

After Curettage
Calcium Alginate Dressing

2 weeks after Curretage

Applying Honey to Alginate Dressing

3 Months after initial injury

Antimicrobial Dressing Kerlix® A.M.D.

- A.M.D. = Anti-Microbial Dressing
- Polyhexamethylene Biguanide=PHMB (0.2% concentration)
- Dressings incorporating PHMB as antimicrobial component
- KERLIX® Super Sponge, Roll gauze
- Telfa
- Excilon - designed to go around catheters

Antimicrobial Dressing

PRODUCT CLAIMS

- Resists bacterial colonization within the dressing
- Reduces bacterial penetration through the dressing
- Kills bacteria by disrupting outer phospholipid membrane allowing cytoplasm to leak out

Other PHMB uses include:

- Contact lens solutions
- Baby wipes

Effective Against

- Candida albicans
- Escherichia coli
- Pseudomonas aeruginosa
- Staphylococcus aureus
- Staphylococcus epidermis
- Enteerococcus faecalis
- Enterobacter cloacae
- Klebsiella pneumoniae
- Proteus mirabilis
- Serratia marcescens


Dorsal Spinous
Process Fracture
And Sequestration

2 Days After Surgery

4 Days After Surgery

2 Weeks After Surgery

Dressing Changes

- Depends on:
  - The amount of exudate
  - The character of the exudate
  - Amount of necrotic tissue
- In surgical incisions every 5 days.
- In necrotic wounds at least every 3 days to prevent dilution of the PHMB.
- Premoisten in dry wounds/cover

Negative Pressure Wound Therapy

- VAC therapy
- Sub-atmospheric pressure application
- Indication:
  - Highly exudative wounds
  - Wounds with large dead space
  - Infected Wounds

Moisturizing Dressings

Hydragels

Hydragel Wound Dressings
CURAFIL™ Amorphous Hydragel
CURAGEL™ Pad Hydragel
KRUUSE Hydrogel

- What are they?
  - A moist, medical grade gel that is intended to promote moist wound healing
  - Used for dry wounds
  - Composed of water, glycerin, polymer

Applications

- What Types of Wounds Are They Used on?
  - Dry to moist wounds with cavities
  - First and second-degree burns
  - Cuts
  - Abrasions
  - Minor irritations of the skin

Old Laceration

Dressing Changes

- Depends on:
  - The amount of exudate
  - The character of the exudate
- Can be left on up to 5 days

Granulation and Wound Contraction Dressings

Calcium Alginate

Replacement Tissue Dressings

Growth Factors

Platelet Rich Plasma

Calcium Alginate Dressings Curasorb®

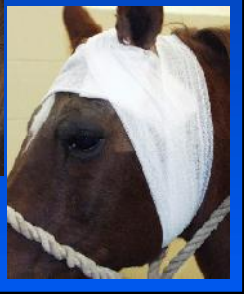
- soft, nonwoven fabric pads composed of Sodium and Calcium Alginate, a derivative of seaweed
- interacts with sodium in wound
- absorb up to 20 times its weight in exudate
- used for moderate to heavily draining wounds

Applications

- Wounds where granulation tissue needs to be stimulated
- Dehisced Surgical Wound
- Abrasions
- Lacerations
- Skin tears
- Pressure ulcers
- Other external wounds with moderate to heavy exudate

Corynebacterium pseudotuberculosis





Flexural Deformity, Skin Abrasion

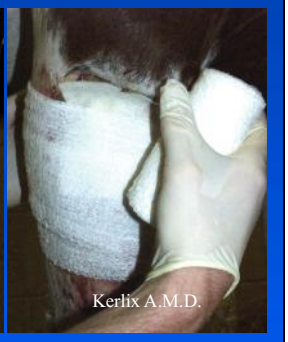
3 months later

Antebrachium Laceration

Pre Constant Clens

Post Constant Clens

Curasorb



Kerlix A.M.D.

May 18

May 21 May 22 May 25

Mandible Fracture
48 hrs Curasorb

Greater One Horned Rhino

7 months later

Dressing Changes

- Depends on:
  - The amount of exudate
  - The character of the exudate
- Can be left on for 5 to 7 days
- Cover with plastic in dry wounds

Topical Dressings: Collagen

- Important component of normal skin
- Final wound healing is dependent on the production, maturation, and degradation of collagen
- Final wound strength determined by the character and quality of collagen

- Exogenous collagen
  - Hydrophilic
    - moist wound environment
    - potentially cleaner wound environment
  - Study: Dogs less inflammation, greater percentage of epithelialization
- Forms: powders, gels, and sponges
- Scaffold for fibroblasts
- Chemotactic agent
- Granulation stage of wound healing.

Topical Dressings: Maltrodextrans

- Polysaccharide powders from plant starches
- Studies: Inhibit the growth of some bacteria
  - *Psuedomonas aeruginosa*, *Staphlococcus aureus* and *Bacteroides fragilis*.
  - Alteration in cell wall function
- Provide nutrition in form of glucose
- Study: Horses better tissue-healing than nitrofurazone.
- Granulating stage of wound healing

Replacement Tissue Dressings

- Provide a framework over which other cells migrate
- Stimulant to form the tissue that is desired
- Porcine small intestinal sub-mucosa
  - Replace lost vessels and to repair intestinal defects
  - Recently skull defects, tendon injury, skin wounds

- ACell extracellular matrix scaffold
  - Porcine bladder
  - Provides structural and functional proteins
  - Influence how cells attach, express their genes, and eventually differentiate
  - Studies: Affect the type of cells recruited
  - Not rejected by the host unlike other xenographic transplants, and that they are eventually completely replaced by host cells
  - Tissue types invading: urinary tract, dura mater, esophagus, musculotendinous tissues, and blood vessels
  - Possible antimicrobial activity

- Equine amnion
  - Biological dressing
  - Studies: reduces wound retraction and granulation tissue formation, and improves epithelialization.
  - Used in skin grafting as a non-adherent dressing
  - Drawback is the availability and the amount of time necessary for preparation.

Growth Factors

- Popular in experimental studies for repairing wound tissue.
- Cytokines
  - Chemotactic effects, mitogenic effects, and activating effects, which simulate production of the extracellular matrix components.
- Platelet-derived growth factor
  - Decreasing wound-healing times by acting as a chemotactic agent and mitogen for fibroblasts, smooth muscle cells and inflammatory cells.

- Transforming growth factor-beta (TGF-β)
  - Chemotactic agent for fibroblasts and macrophages, a mitogen for macrophages, smooth muscle cells and osteoblasts.
  - Inhibitory effect on endothelial cells, various epithelial cell types and lymphocytes.
- Transforming growth factor-alpha (TGF-α)
  - Potent angiogenesis factor.

- Epidermal growth factor
  - Potent chemotactic and mitogenic agent for keratinocytes and fibroblasts.
- Fibroblast growth factor
  - Mitogenic for mesenchymal cells, and endothelial cells and stimulates keratinocytes.
- Keratinocyte growth factor
  - Highly specific mitogen for keratinocytes and stimulates migration of keratinocytes.
- Insulin-like growth factor
  - Stimulates the synthesis of glycogen, protein and glycosaminoglycans.
  - Increase collagen synthesis by fibroblasts.

Summary

- Growth factor soup -vs- purified growth factors
- Present in wound exudate during moist wound healing
- Greatest benefit in the granulating and epithelialization stages of wound-healing and will be used with other synthetic dressings

Platelet Rich Plasma

- Commercial
- Autologous
- Growth factors
- Fibrin scaffold

Hyperbaric Oxygen Tx

- "A treatment modality in search of an indication" - Plastic and Reconstructive Surgeon October 2008
- Wound healing
  - Granulation tissue formation
  - Epithelialization
  - Wound infection
- Expense
- Availability

Epithelialization Dressings

Semi-Occlusive Foam

Semi occlusive foam dressing COPA, Kerlix AMD Foam, KRUUSE Foam Dressing

- Semi-occlusive
- Use on mildly exudative wounds
- Minimized exuberant granulation tissue

Day 60 Wound after treatment with Panalog

Day 1 Treatment with Hydrasorb

Day 10

Day 17

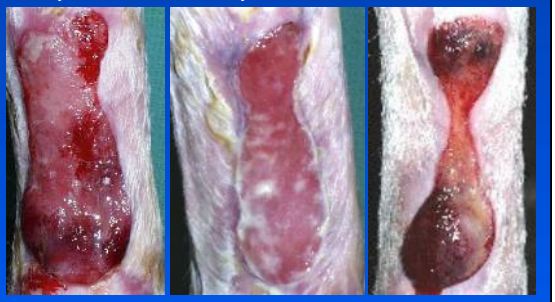
Day 26

Day 30 Last Hydrasorb treatment

Day 66

36 Days of non-adherent dressing with Panalog application. Note the exuberant granulation tissue at the proximal and distal extent of the wound.

Day 1 foam | Day 26 foam | Day 66 overall Day 40 Panalog



October 18th: Initial Curasalt Therapy

December 7th: 7 weeks

March 13th: 5 months

Debride Granulation, Hydrasorb

June 10th: 8 months

July 1

October 1

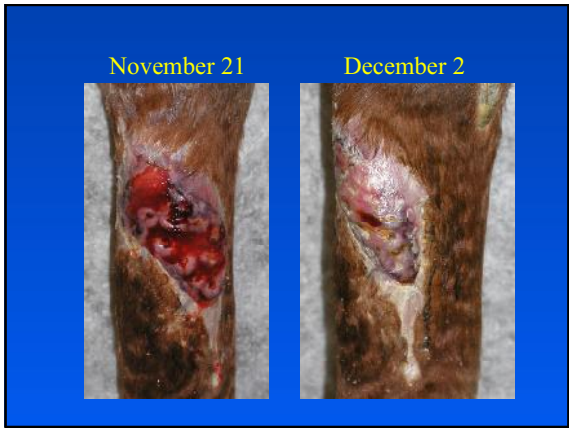
October 15

October 24

October 27

October 29


November 5
November 12


November 21
December 2

Dressing Changes

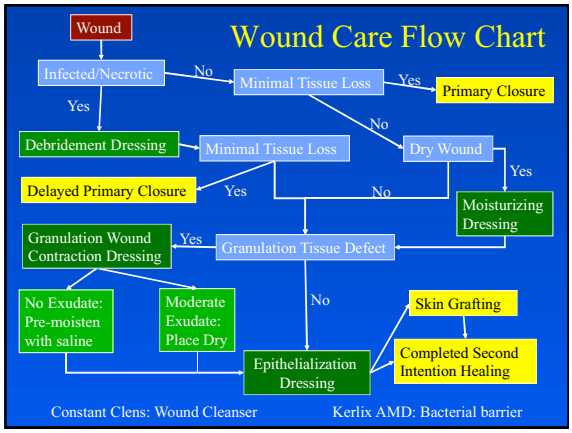
- Depends on:
  - The amount of exudate
  - The character of the exudate
- Can be left on for 5 to 7 days

Silicone Dressing

- Indication
  - Recurrent exuberant granulation tissue (after surgical excision)
- Mechanism of action
  - Occlusion of microvessels
- Disadvantage
  - Expense
  - Collection of exudate/Odor

Dressing Changes

- Depends on:
  - The amount of exudate
  - The character of the exudate
- Can be left on for 5 to 7 days


Wound Care Flow Chart
Wound
Infected/Necrotic
No
Minimal Tissue Loss
Yes
Primary Closure
Yes
No
Debridement Dressing
Minimal Tissue Loss
Dry Wound
Yes
Delayed Primary Closure
Yes
No
Moisturizing Dressing
Granulation Wound Contraction Dressing
Yes
Granulation Tissue Defect
No
Skin Grafting
No Exudate: Pre-moisten with saline
Moderate Exudate: Place Dry
Completed Second Intention Healing
Epithelialization Dressing
Constant Clens: Wound Cleanser
Kerlix AMD: Bacterial barrier


Wound Care Management
for the Equine Practitioner
Made Easy Series
Teton NewMedia
Teton NewMedia
www.tetonnm.com