#### **Wound Dressings**

#### Introduction

- Wound management requires dressing materials and techniques that address the specific needs of the injury
- Dermatologists manage wounds of all types, from surgical incisions to poorly healing chronic wounds

#### The History of Dressings

- 1600 BC: Linen strips soaked in oil or grease and covered with plaster used to occlude wounds
- "Closed wounds heal more quickly than open wounds"
  - Edwin Smith Surgical Papyrus, 1615BC
- 1891: Woven absorbent cotton gauze

#### The History of Dressings

- 1800's: Lister links pus with infection
- The incorrect notion that pus *always* means infection interfered with the acceptance of occlusive dressings
- Until the mid-1900's, it was firmly believed that wounds healed more quickly if kept dry and uncovered (just like mom told you)

#### The History of Dressings

- 1948: Oscar Gilje describes "moist chamber effect" for healing ulcers
- 1962: Winter conducts landmark study demonstrating the efficacy of moist wound healing by occlusive dressings:
  - -30% greater benefit of occlusive dressings versus air drying of wounds
- Numerous studies to date support this concept

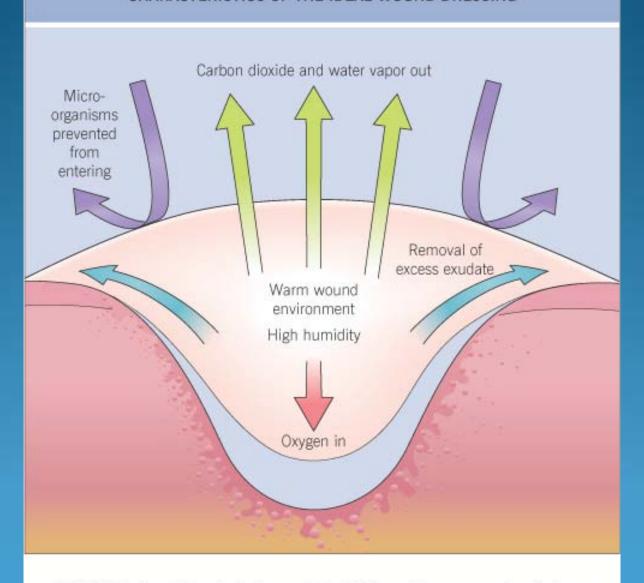
#### The Functions of a Wound Dressing

- Substitute for the lost native epithelium
- Provide the optimum environment for healing by protecting the wound from trauma, bacteria
- Conform to wound shape
- Absorb wound fluids
- Provide pressure for hemostasis
- Eliminate or decrease pain

#### The Functions of a Wound Dressing

- Promote re-epithelialization during the reparative phase of wound healing
- Easy application/removal with minimal wound injury

#### CHARACTERISTICS OF THE IDEAL WOUND DRESSING



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#### Ideal Dressing Composition

 Inert material that does not shed fibers or compounds into the wound which may evoke a foreign-body, irritant, or allergic reaction

#### Moist Healing Environment

- A dressing's capacity to maintain a moist environment is of prime importance in healing
- Moisture suppresses tissue dessication/eschar formation, allowing efficient keratinocyte migration and re-epithelialization
- Moisture decreases the amount of lost dermis and adnexal structures, thus improving the cosmetic outcome of the injury

#### Moist Healing Environment: Theoretical Advantages

- Endogenous growth factors critical to healing are found in wound fluids and may be more available in a moist environment
- Ability to confer an electrical gradient between the wound bed and normal skin, thus promoting epidermal cell migration from normal skin to wound bed

#### The Role of Oxygen

"Leave it open, let the air get to it"...

Well, actually...

#### The Role of Oxygen

- For years it was thought that oxygen availability was of primary importance in the rate of wound healing
- Studies show that the oxygen requirement for optimal fibroblast proliferation is *low*

#### The Role of Oxygen

- A matter of delicate balance:
  - Cells need O<sub>2</sub> for migration and mitosis, but...
  - Hypoxia promotes angiogenesis, and...
  - Epidermal cell migration and granulation tissue formation are *inhibited* at high O<sub>2</sub> levels

#### Conclusions about Oxygen

- Acute wounds that heal under occlusion demonstrate accelerated healing, greater resistance to breaking open, and better cosmetic outcomes than those that heal open to the air
- Chronic wounds are often less painful and have superior granulation tissue formation as a result of occlusion

## But how to achieve the correct oxygen balance?

 A semi-permeable dressing can provide the appropriate oxygen tension for wound repair to proceed efficiently

### Traditional Wound Dressings



#### Traditional Wound Dressings

- Conventional dressings are categorized by:
  - Composition of materials (natural, synthetic, or semisynthetic)
  - Dressing technique (layered, pressure, non-pressure)
  - Wound Type
    - Post-surgical, Traumatic, Etc.

## Traditional Dressings: Technique

- Layered Dressing: (pressure or non-pressure)
  - Contact/Interface layer: non-adherent, fluidpermeable, in direct contact with wound
  - Absorbent layer: "wicks in" exudate and molds dressing to wound shape
  - 3. Wrap Layer: retains underlying layers
- Ex. Telfa/Cotton gauze/Cover-roll

## Traditional Dressings: Technique

- Advantages: hemostasis, wound stability, decreased edema, low cost
- Disadvantages: adherence to wound, ischemia/necrosis; bulk; frequent changes

#### Post-Surgical Wounds

#### • Primary Closure:

- Wounds are clean, free of debris, and sutured by aseptic technique
- Sutures provide hemostasis, reduce the chances of infection, and may improve ultimate cosmesis
- Upon suture removal, external splinting (Steri-Strips) supports the tissue and enables favorable collagen remodeling that may limit scar formation and tissue hypertrophy







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#### Post-Surgical Wounds

- Second Intention Healing
  - Moisture at the wound bed is key to healing
  - Topical ointment covered by a *semi-occlusive dressing* is the treatment of choice
  - Management includes monitoring for signs of infection and prevention of dessication until re-epithelialization occurs











# Topical Wound Healing Agents "Put some salve" on it"

#### Topical Wound Healing Agents

- Wound healing. The effects of topical antimicrobial agents. *Geronemus et al.*
- The effect of four topical antimicrobial agents on the rate of reepithelialization of clean wounds was evaluated in white domestic pigs

#### Topical Wound Healing Agents

- Increased healing rate:
- Neosporin Ointment
- Silvadene and its vehicle
- Decreased healing rate:
- Furacin
- Pharmadine (povidoneiodine) – no effect

The effects of these agents cannot be explained on the basis of their antimicrobial activity

#### Topical Wound Healing Agents

• Various opinions/preferences among practitioners... some evidence based, most habitual

A lecture unto itself...

## Occlusive Dressings

## Occlusive Dressings: 5 Classes

- Polymer Films
- Foams
- Hydrogels
- Alginates
- Hydrocolloids

# Polymer Films (Tegaderm)



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#### Polymer Films

- Thin, elastic, self-adhesive transparent sheets
- Polyurethane or other synthetic material
- Semi-permeable:
  - Gas-permeable: O<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>O vapor
  - Impermeable to proteins, fluids, bacteria

#### Polymer Films: Indications

- Uncontaminated, superficial wounds
- IV sites
- Skin tears
- Superficial decubitus ulcers
- Split-thickness skin graft donor sites
- Laser wounds
- Mohs surgery defect sites

## Polymer Films: Advantages

- Translucent- visual wound monitoring
- Permeable to water vapor- less maceration
- Reduces post-op pain
- Bacterial barrier

#### Polymer Films: Disadvantages

- Difficult to handle
- Adherence to wound bed
  - Blister Film; Omniderm: no adhesive
- Non-absorbent, allowing exudate accumulation
  - Buchan et al: fluid accumulation is bactericidal and has no negative effect on healing
  - Puncture; drains for fluid aspiration
- Bacteria accumulation
  - No correlation with increased rate of infection

### Polymer Films

- Opsite
- Tegaderm
- Silon-TSR
- Blister Film
- Omniderm
- Polyskin II
- Bio Thin Film





- Semi-occlusive/semi-permeable
- Hydrophilic foam with hydrophobic backing
- Bilaminate Structure:
  - Inner layer: absorbent, gas-permeable polyurethane foam mesh
  - Outer layer: semi-permeable, non-absorbent membrane (polyurethane, polyester, silicone, or Gore-Tex) surrounded by a polyoxyeythylene glycol foam

- Most are non-adherent and require a secondary dressing; some adhesive brands available
- Marketed to retain absorbed fluid, despite the addition of pressure (ex. sacral ulcers)

#### Polymer Foams: Indications

- Chronic wounds
  - Diabetic, venous, sacral ulcers
- Dermabrasion; laser resurfacing wounds
- Mohs wounds
- Burns

#### Polymer Foams: Advantages

- Very absorbent, maintains moist environment
- Adherent and non-adherent forms available
- Prevents leakage and barricades against bacteria
- Silicone-based rubber foams (Silastic) molds and contours to wound shape- good for packing cavities or deep ulcers
- Less cost, skilled nursing not required

#### Polymer Foams: Disadvantages

- Opaque- no visual monitoring of wound
- Frequent changing, every 1-3 days
- Cannot use on dry wounds
- Possible undesirable drying effect on inadequately exudative wounds

- Reston
- Cutinova
- Lyofoam
- Flexzan
- Biopatch
- Crafoam
- Biatain



## Biopatch Polymer Foam



# Hydrogels: Sheets & Gels





- 96% water
- Cross-linked hydrophilic polymer sheets, gels, or impregnated dressings
- Polyvinyl alcohol, polyacrylamides, polyethylene oxide, or polyvinyl pyrrolidone

- Semi-permeable with outer membrane in place
- Semi-transparent
- Semi-adherent or non-adherent, thus may require a 2<sup>nd</sup> dressing
- Highly absorptive: 100-200% of their volume
- Soothing, cooling effect as hydrogels decrease the temp of cutaneous wounds

- Poor bacterial barriers: selectively permit Gram negative organisms to proliferate
  - Antibiotic ointment usually applied under dressing

#### Hydrogels: Sheet Form

- Hydrophilic polymer is sandwiched between two removable thin sheets of polyethylene film, with some types containing a supportive inner gel mesh
- For application, the film on the contact side is removed, leaving the outer film in place.
- Semi-permeable to gases and water vapor

#### Hydrogels: Sheet Form

- If the outer film is also removed, the dressing becomes permeable to fluid and exudate can pass to a secondary gauze dressing
- The polymer sheet can be removed easily without trauma to the wound bed

#### Hydrogels: Gel Form

- Cornstarch-derived polymerized compound that forms a gel upon hydration at the time of its use
- Available in a powdered or pre-mixed form
- Applied wet to the wound defect and requires a secondary outer dressing
- Water application is required for removal

#### Hydrogels: Indications

- Laser resurfacing
- Dermabrasion
- Ulcers
- Superficial thermal burns
- Chemical peels
- Graft donor sites
- Partial thickness wounds

## Hydrogels: Advantages/Disadvantages

- Advantages:
- Reduction in post-op pain/inflammation
- Accelerate wound healing versus telfa/gauze (Geronemus et al)

- Disadvantages:
- Bacterial growth
  - Studies show no increase in infection rate
- Frequent dressing changes because of absorption capacity

- Sheets:
  - Vigilon, Nu-Gel, Flexderm, Carradres, CarraSorb
- Gels:
  - Cutinova Gel, Biolex, Tegagel, Carrasyn
- Impregnated Dressings:
  - Tegagel Wound Filler with Gauze, DermaGauze, GRX Wound Gel





## Alginates



#### Alginates

- Natural complex polysaccharide derived from algae or kelp (seaweed)
  - An extraction process produces a sodium salt form of alginic acid
  - Sodium ions are then exchanged for Ca, Zn, Mg
  - Alginate fiber results, and is woven into a dressing

## Alginates (are cool)

- Upon application to wound, an ion exchange between the Ca within the alginate fibers and the Na from the blood or wound exudate occurs
- This forms a soluble sodium alginate gel that provides a moist wound healing environment
- Unique mechanism requires wound exudate to generate the gel

### Alginates: Hemostatic Dressings

• The release of free Ca by the alginate fibers during ion exchange augments the clotting cascade in the wound bed, resulting in *hemostatic* properties

#### Alginate Gels

- Highly absorbent, non-adherent
- May remain in place for several days
- The gel conforms to wound shape
- Requires a second dressing to secure it in place
- If allowed to dessicate, it adheres to and irritates wound

## Alginates: Advantages/Disadvantages

- Advantages:
- Soluble, removal by saline irrigation with less pain
- Metabolized by the body- no adverse effects if material remains on wound
- 40 years experience

- Disadvantages:
- Yellow-brown color confused with pus
- Requires 2<sup>nd</sup> dressing
- Unpleasant odor

#### Alginate Gels: Indications

- Highly exudative wounds
  - Wound fluid transforms alginates into a gel matrix
- Full-thickness burns
- Surgical wounds/Mohs defects
- Refractory decubiti and chronic ulcers

#### Alginates

- Sorbsan
- Algiderm
- AlgiSite
- Kaltostat
- Fibracol Plus
  - Collagen+Alginate



## > smith&nephew ALGINATE DRESSING









Smith & Nephew offer an Alginate Dressing which is available in a range of sizes.

To establish whether this product is available in your market, please select from the country drop down list below:



## Hydrocolloids

#### **Colloid Chemistry**

 Mutually attractive charges exist between the particles, contributing to the diffusable properties of colloids

#### **Colloid Chemistry**

- Gels and jellies are types of colloids, characterized by the strength of attraction of the particles to the continuous medium and the proportion of water within that medium
- This property accounts for the absorptive and expansive capacity of gels, which function as a semi-permeable membrane
  - This occurs b/c the particle concentration of the gel is higher than that of the surrounding medium, thereby drawing water from the surroundings into the gel, resulting in gel swelling

#### **Colloid Chemistry**

- Cells and tissues throughout the body are comprised of colloids
- Colloid dressings are designed to simulate the natural environment found on cell surfaces in order to facilitate the healing process

# To understand colloids you must understand colloid chemistry

- Colloids/hydrocolloids are 2-phase systems comprised of the uniform dispersion of one phase of matter as unfilterable small particles into another phase of matter
- The 2 phases can be described as the dispersed/ discontinuous phase and the dispersing/ continuous medium

#### **Colloid History**

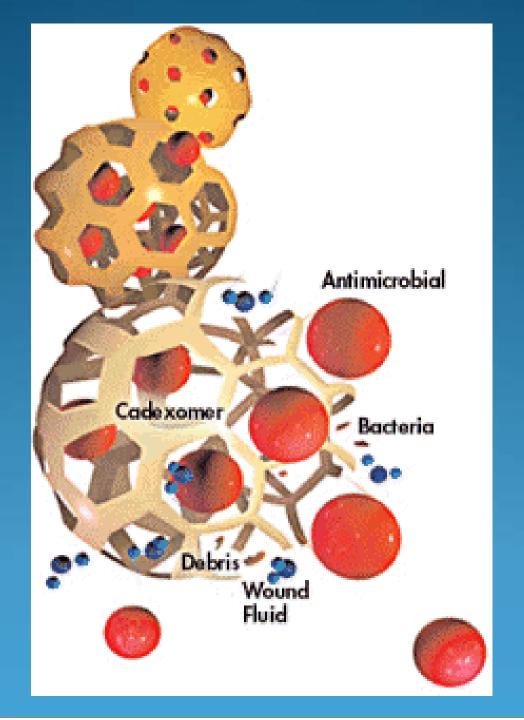
- Colloid dressings were first used as ostomy products
- Chronic ulcers and fissures at ostomy sites were found to heal rapidly when colloid bandages were used
- Now widely used as wound dressings, many forms are available

## Hydrocolloid Types: Cadexomer-Iodine Beads

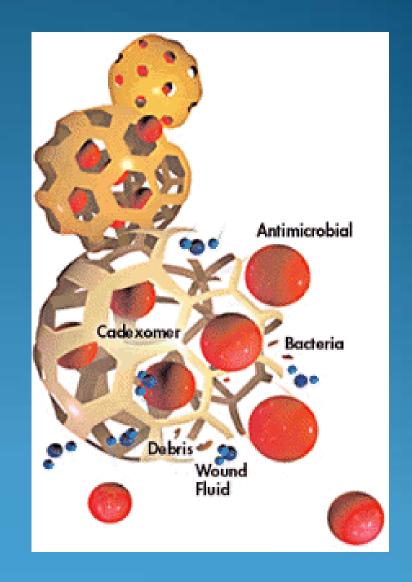
- Chemically modified starch polymer manufactured as a highly hydrophilic network of beads combined with immobilized iodine
- Polymer slowly releases iodine at the wound site as the porosity of beads increases with water absorption
- A gel is formed from the process and absorbs exudate

## Hydrocolloid Types: Cadexomer-Iodine Beads

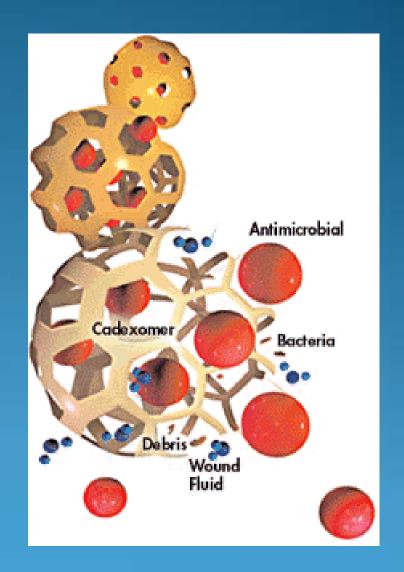
- Iodine confers antimicrobial activity with little or no cytotoxic effects
- Bacteria and cellular debris are trapped in the spaces between the beads and are removed with irrigation during dressing changes



When Iodosorb beads are applied to the wound, wound exudate is absorbed by the cadexomer polymer, which in turn swells and forms a protective gel over the wound surface



As a result of the swelling, the size of the pores of the cadexomer carrier is increased. The antimicrobial, which is held within the matrix, is progressively released against the flow gradient, to exert its microbicidal action on organisms both at the wound surface and in the gel.



## Hydrocolloid Types: Cadexomer-Iodine Beads

- Highly exudative wounds (leg ulcers)
- Layer of beads is applied to wound and covered with a pad or other 2<sup>nd</sup> dressing
- Dressing removal: remove 2<sup>nd</sup> dressing, irrigate wound with sterile water or saline, reapply fresh layer of beads while wound is still wet
- Frequency of dressing changes varies with degree of saturation

## Hydrocolloid Types: Cadexomer-Iodine Beads

- The iodine is absorbed
- Caution/Contraindications:
  - Thyroid disorders
  - Iodine sensitivity
  - Young children
  - Pregnancy/lactation

### Iodosorb (Cadexomer-Iodine)



## Hydrocolloid Types: Dextranomer Beads

- 90% dextranomer (cross-linked dextran) with polyethylene glycol and water
- Dry powder of porous, hydrophilic beads that swell and form a gel upon direct placement into exudative wounds
- No antibacterial activity and less absorptive than cadexomer-iodine

### Hydrocolloid Types: Dextranomer Beads

- Suction/capillary action removes necrotic tissue
- Covers and conforms to contour and depth of wound, allowing superficial debridement
- Will delay healing if allowed to dry, so do not leave on wound > 24 hours
- Requires a 2<sup>nd</sup> dressing

#### Hydrocolloid Types: Sheets

- Bilayered sheets (Duoderm most common):
  - Inner adhesive layer: hydrophilic colloid base that is a mixture of pectin, karaya, guar, or carboxymethyl cellulose and an adhesive
  - Outer impermeable layer: polyurethane
- A gel is formed in the presence of exudate and, as a unit, the dressing is impermeable to water vapor and gases

#### Hydrocolloid Sheet (Duoderm)



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#### Hydrocolloids

- N-Terface: Synthetic, non-adherent, high-density plastic woven polymer
- Fluid is able to flow through the matrix to be absorbed by an overlying dressing without adherence to the new epithelial surface

#### Hydrocolloids: Indications

- Burns
- Partial thickness wounds; dermabrasion
- Traumatic lacerations
- Donor graft sites, excisions
- Chronic ulcers
- Bullous disorders, EB

#### Hydrocolloids: Advantages

- Sheets:
  - Cut to shape of wound, self-adherent, waterproof
  - No 2<sup>nd</sup> dressing required
  - Cushioning/pressure-relieving effect, increases as dressing absorbs exudate (good for bony sites)
  - Decreased skilled nursing time because of fewer dressing changes
  - Painless dressing changes

### Duoderm (polymer blend)



#### Hydrocolloids: Advantages

- Beads:
  - Gel formed prevents dressing adherence to wound
  - Accumulated exudate in moist, impermeable environment provides source of phagocytes and endogenous enzymes, resulting in autolytic debridement

#### Hydrocolloids: Disadvantages

- Maceration of surrounding skin
- Leakage of excessive tissue exudate
- Excessive granulation tissue growth into matrix
  - Traumatizes tissue upon removal
- End-product is yellow-brown, thick, foul smelling gel resembling pus
- Bacterial colonization under occlusive dressing
  - Studies show no increased infection rates

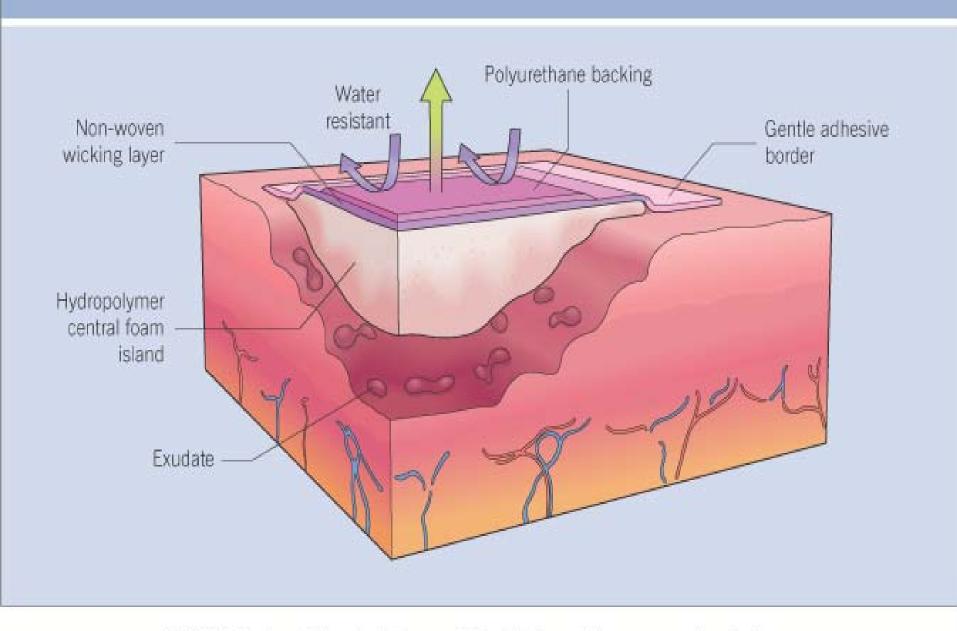
#### Hydrocolloids

- Cadexomer-Iodine Beads
  - Iodosorb
- Dextranomer Beads
  - Debrisan
- Polymer blend
  - N-Terface, Duoderm, Sorbex, Tielle

#### Composites

- Combine two or more types of semi-occlusive dressings into one product
- Engineered to maximize efficiency and comfort of dressings by expanding absorbency while decreasing the chance of maceration
- No retention dressing required
- Improved waterproof coverings enable the pt to bathe or shower

#### AN EXAMPLE OF A COMPOSITE DRESSING



#### Alldress Composite

• Alldress is a multi-layered, sterile, secondary composite wound dressing. It can be used during all phases of wound care to include the necrotic (black), the inflammatory (yellow), and the granulating (red) phase.

#### Alldress Composite



#### Repel Sterile Composite

- MPM Repel™ Wound Dressing (Sterile Composite)
- Waterproof, can be left on while showering.
- Can be wiped off when soiled.
- Maintains a moist wound environment
- Dressing is non-adherent to tissue, reducing trauma during dressing changes.

#### Repel Sterile Composite

- Center layer absorbs exudate, reducing number of dressing changes.
- Top layer allows gaseous exchange while protecting the wound from contaminates.
- Absorptive qualities virtually eliminates dry wound maceration.
- Can be used on infected wounds.
- Replaces gauze tape and scissors.

### Repel Sterile Composite



#### Dressings for Leg Ulcers

- Moisture retention is best accomplished with occlusive dressings at the ulcer site
- No particular category of occlusive dressing shown to be superior over others
- Choice rests on patient and physician preference

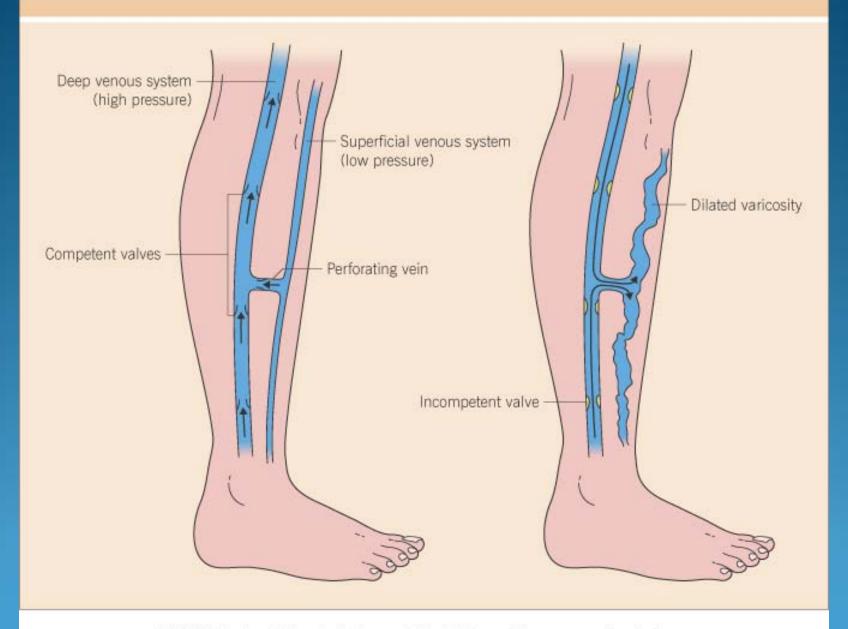
### Leg Ulcers: Compression is key!

- Compression:
  - Mechanically reduces edema
  - Promotes fibrinolysis which improves blood flow
  - Increases healing rates

"High compression is better than low, and compression without a moist dressing is better than a moist dressing without compression"

- Fletcher et al

#### VENOUS BLOOD FLOW IN THE LOWER LEG



# Dressing Options for Chronic Leg Ulcers: Occlusive Dressings

- Polymer films (Tegaderm)
- Polymer Foams (Cutinova)
- Hydrogels (Vigilon)
- Alginates (Kaltostat, Fibracol Plus)
- Hydrocolloids (Duoderm, N-Terface)

# Dressing Options for Chronic Leg Ulcers: Compression Dressings

- Range from adhesive, relatively non-absorbent to moderately compressive and absorbent
- Traditional compression ("pressure") dressings comprised of non-adherent contact layer/absorbent layer/outer layer

# Dressing Options for Chronic Leg Ulcers: Compression Dressings

- Definitive optimal pressure required to prevent capillary leakage is unknown
- Recommendation for leg ulcers is 30-40mmHg at the ankle

#### **Compression Stockings**

- Patient afforded freedom to apply/remove
- Difficult for elderly or arthritic patients
- Some have silk inner linings or zippers for easier use

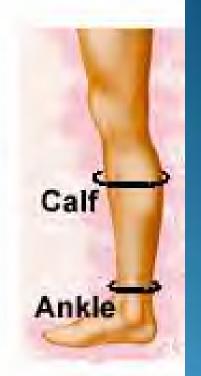
# Jobst Stockings





#### Relief Knee-High SIZING CHART

SIZE	Ankle Circ.	Calf Circ.
S	7" - 8 1/4" (18-21 cm)	11" - 15" (28-38 cm)
M	8 3/8" - 9 7/8" (21-25 cm)	11 7/8" - 16 1/2" (30-42 cm)
L	10" - 11 3/8" (25-29 cm)	12 1/2" - 18 1/8" (32-46 cm)
XL	11 1/2" - 13" (29-33 cm)	13 3/8" - 19 5/8' (34-50 cm)



#### Compression Bandages: Unna Boot

- Paul Gerson Unna: 1880s
- Created for the Rx of venous stasis ulcers and some selected eczematous eruptions
- Original boot: cotton bandage impregnated with zinc oxide, gelatin, and glycerin paste
- Considered the Rx of choice for stasis ulcers

#### **Unna Boot**

- Applied in a <u>semi-rigid</u> state, it confers semi-rigid compression with the advantage of a moistureretaining occlusive dressing
- Applied by a trained medical professional
- Changed weekly unless wound drainage is heavy

#### **Unna Boot**

- Correct application prevents:
  - Excessive or abnormal pressure to the limb
  - Compromised circulation
  - Further skin breakdown or additional ulcers
  - Further limb deterioration

#### **Unna Boot**

- Healing time for ulcers treated with Unna Boots alone was less than half the time required to heal ulcers treated only with support stockings
- Compression plus occlusion results in increased healing rate of venous ulcers versus compression alone

#### Unna Boot Dressing Recipe

- 1. Base Coat:
  - White Petrolatum, Silvedene, TAC ointment, etc.
- 2. Paste Dressing
  - Zinc oxide, calamine, ichthammol- soothing
  - Coal tar- anti-inflammatory
  - Clioquinol- deodorizing, anti-bacterial
  - Preservative free and combo formulas available

#### Unna Boot Combo Paste Dressings

- **Gelocast**: calamine, glycerin, zinc oxide
  - Other Ingredients- Gelatin, Imidazolidinyl Urea, Magnesium Aluminum Silicate, Methylparaben, Propylparaben, Simethicone, Sorbitol, Water.
- Tenderwrap: calamine, petrolatum, zinc oxide
- Primer: zinc oxide, no gelatin or preservatives

#### Unna Boot Dressing Recipe

- 3. Elastic Compression Bandage
  - Coban, ACE Wrap, others

#### Apply Paste Layer





#### Primer Modified Unna Boot

- 100% soft cotton gauze impregnated with nonhardening zinc oxide paste.
- No gelatins or preservatives.



# Comression layer (Coban)





## Flexible Compression Bandages

- Categorized as elastic or inelastic, single or multi-layer, long or short stretch compression, and cohesive wrap
- Difficult to determine the proper amount of tension needed to safely and effectively achieve the desired goal
- Multi-layer compression superior to single layer

# Multi-Layer Flexible Compression Bandages

- Four distinct layers
- Orthopedic wool layer- absorbs exudate and redistributes pressure around the ankle
- 2. Crepe bandage- smoothes wool layer and increases absorbency
- 3. Light elastic compression bandage
- 4. Outer elastic cohesive bandage

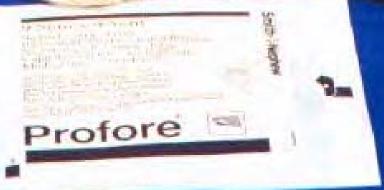
# Multi-Layer Flexible Compression Bandages

- Remains in place up to one week
- Advantages: absorption and even distribution of pressure throughout the leg
- Multi-layered compression systems are available commercially in complete kits (Profore)

# **Profore** Multi-Layer System







# Other types of wound dressings

#### Hyaluronic Acid Ester Dressings

- Biodegradable, biopolymer of esterified hyaluronic acid, known as 'HYAFF'
- Serves as a cell carrier of cultured keratinocytes
- Cells grow on the HA membrane into a multilayer that functions similarly to human epidermis
- Manufactured as sheets and ribbons

#### Hyaluronic Acid Ester Dressings

- Used on exudative wounds (ulcers)
- Degrades on contact with exudate and forms thick gel
- Gel lasts 3 days, degrades, and releases HA into wound
- Application: sheets cut to fit wound, packed in, and covered with absorbent or occlusive dressing

#### **Growth Factors and Heat**

- Endogenous factors (PDGF, EGF) critical to wound healing are being investigated for application as exogenous substances to wounds
- Infrared energy and radiant heat for refractory leg ulcers is under investigation

#### Enzyme Debridement Agents

- Debridement facilitates granulation and reepithelialization of wounds
- Methods
  - Surgical
  - Mechanical: irrigation, wet to dry, dextranomers
  - Autolytic: occlusive + compression dressings
  - Chemical: proteolytic enzymes
  - Biosurgical: maggots and leeches

#### Topical Enzyme Agents

- Collagenase (Santyl)
  - removes devitalized tissue without damage to healthy tissue; promotes granulation and re-epithelialization
- Papain (Panafil)
  - digests devitalized tissue, harmless to viable tissue
  - urea required as an activator

#### Enzyme Debridement Agents

- Trypsin (Granulex)
  - Processed in combination with:
  - Balsam of Peru: stimulates capillaries; bactericidal
  - <u>Castor oil</u>: reduces dessication, cornification, pain

# Tissue-engineered Skin Equivalents

#### Tissue-engineered Skin Equivalents

- New group of wound dressings derived from cultured keratinocytes and fibroblasts
- Blurred distinction between wound dressings and tissue-engineered skin
- Indicated for chronic, refractory ulcers
- Advantage is the avoidance of skin grafting, which creates another painful, slowly healing wound

## **Apligraf**

- Only FDA-approved skin substitute for Rx of venous ulcers
- Bilayered human skin equivalent of living human keratinocytes (epidermal) and fibroblast-seeded bovine collagen (dermal)
- Derived from human neonatal foreskin

## Apligraf

- Produces matrix proteins and growth factors
- Capable of self-repair if wounded
- Compression + Apligraf increases healing rates of chronic ulcers versus compression alone
- \$1000 per graft; limited shelf life
  - Small wounds may need only one application
  - Larger wounds may need several

#### Apligraf (Organogenesis/Novartis)



# Apligraf Application



# Apligraf: Secondary Dressing



Apligraf: Compression Dressing



#### Biobrane (Bertek Pharma)

- Synthetic bilaminate biocomposite of nylon mesh bonded to silicone film membrane, coated with a porcine dermal collagen-derived peptide
- Semi-permeable: water vapor loss rates similar to normal skin
- Introduced in 1979 for burns and donor sites

#### Biobrane

- Collagen component of dressing preferentially adheres to fibrin in the wound
- No dressing changes required
- Expensive
- Higher infection rates vs. other dressings



Biobrane 5"x5", 5"x15", 10"x15", 15"x20" Biobrane-L 5"x5", 5"x15", 10"x15"



# INSTAT Collagen Absorbable Hemostat

- Two easy-to-use formats for precise application
  - Pad
  - Powder
- Absorbed in 8 to 10 weeks
- Excellent wet tensile strength to maintain integrity in the wound
- Lyophilized sponge format provides easy, fast application and removal

# INSTAT Collagen Absorbable Hemostat

- Can be shaped or trimmed to fit irregular or hard-to-reach areas
- Sutures easily
- Controlled application minimizes product waste
- Handles easily without sticking to wet gloves or instruments

## Wound Dressings: General Principles

 Dressings should provide the optimum environment for rapid healing by protecting the wound from further trauma or bacterial invasion

• Dressings that provide a moist environment and prevent eschar formation allow wounds to reepithelialize and heal faster than if left uncovered

• Semi-permeable or occlusive dressings provide a moist environment, retain wound fluid that contains growth factors conducive to healing, and promote a low tissue oxygen tension that stimulates angiogenesis and collagen deposition

- A traditional layered dressing consists of a nonadherent contact layer, an absorbent layer, and a securing layer
- Newer, advanced technology dressings include:
  - Hydrogels, alginates, foams, films, hydrocolloids

 Tissue-engineered skin equivalents have been developed combining living keratinocytes and fibroblasts from human foreskins with bovine collagen