Wound Healing for *your* Office

Some science…
Some practical aspects of care

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History of Wound Healing

- Louis Pasteur (1822–1895) proving that germs were always introduced into the wound from the environment
- In 1865, Lister began soaking his instruments in phenol and spraying the operating rooms, reducing the mortality rates from 50 to 15%
- Robert Wood Johnson' s research produced an antiseptic cotton gauze dressing impregnated with iodoform
- Polymeric dressings were developed in the 1960s and 1970s.
- The current practice of wound healing encompasses manipulation and/or use of inflammatory cytokines, growth factors, and bioengineered tissue

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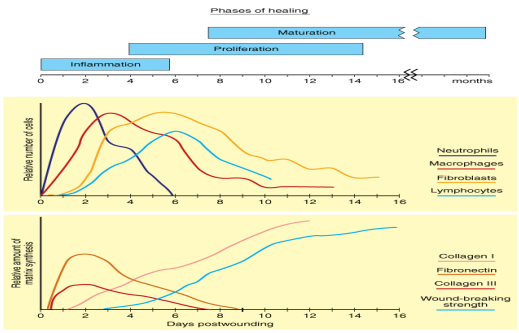
Normal wound healing follows a predictable pattern that can be divided into overlapping phases defined by characteristic cellular populations and biochemical activities:



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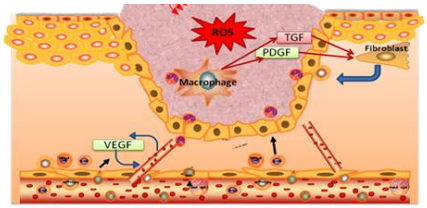
Role of Growth Factors & Cytokines in 'Normal' Healing

- They can be autocrine, paracrine and endocrine.
- Growth factors act on cells via surface receptor binding



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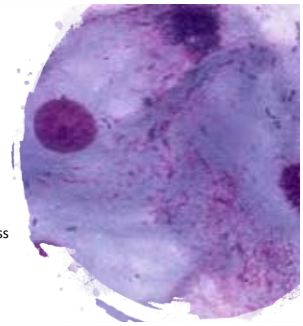
Epithelialization

- Within 1 day of injury
- Rapid mitotic division migrate in a leapfrog fashion until the defect is covered
- Re-epithelialization is complete in less than 48 hours
- Mediated by:
  - loss of contact inhibition
  - Cytokines: fibronectin, cytokines, EGF, TGF , FGF, PDGF, and insulin-like growth factor I.



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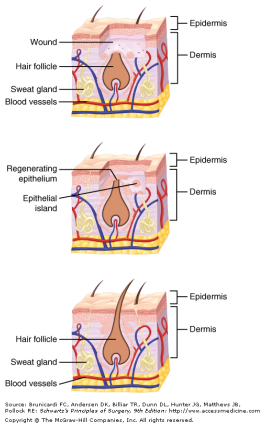
The Amazing Hair Follicle



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Maturation and Remodeling

- fibroplastic phase, characterized by a **reorganization** of previously synthesized collagen
- **Collagen** the net wound collagen content is the result of a balance between collagenolysis and collagen synthesis
- **Wound strength** and mechanical integrity determined by quantity and quality of the newly deposited collagen
- Fibronectin and **collagen type III** constitute the early matrix/ glycosaminoglycans and proteoglycans and collagen type I in the final matrix
- Fibril formation cross-linking result in decreased collagen solubility, increased strength, and increased resistance to enzymatic degradation of the collagen matrix.

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Re-align What Is Easy…
Moist Wound Healing The Remainder

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Time heals most wounds
(note pulling of lateral canthus and alar rim)

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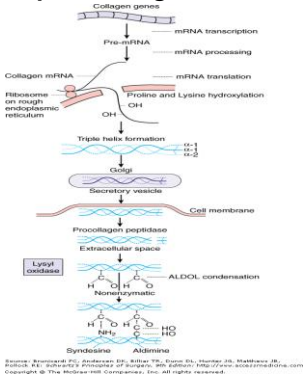
Biochemistry of Collagen

Collagen synthesis is highly dependent on:

a) adequate oxygen supply,
b) presence of sufficient nutrients
c) local wound environment



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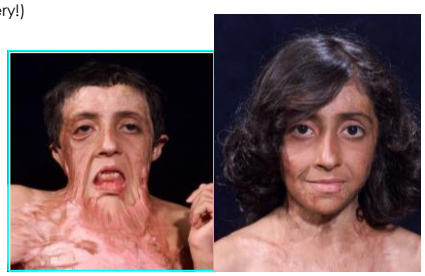
Wound Contraction

- Myofibroblast
- alpha-smooth muscle actin in thick bundles called ***stress fibers.***
- **re organization** of the cytoskeleton is responsible for **contraction**
- We overcome contraction with stretch & exercise
- (or surgery!)



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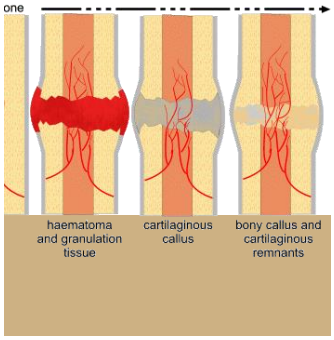

Bone

- Mediated by soluble growth factors and cytokines.
- Differentiation of mesenchymal cells into chondroblasts and osteoblasts.
- PDGF, TGFb , TNF-a, and basic fibroblast growth factor are other growth factors.

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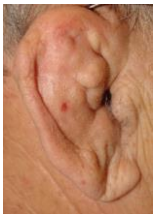
Cartilage

- Avascular and depends on diffusion of nutrients
-
- Healing response depends on the depth of injury
- Superficial cartilage injuries are slow to heal and often result in persistent structural defects
- Deep injuries involve the underlying bone and soft tissue lead to restoration of the structural and functional integrity of the injured site



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Fetal Wound Healing

Dream Healing…Scarless

- Apparent lack of scar formation
- "Transition wound" occurs at the beginning of the third trimester
- Characteristics that may influence the differences between fetal and adult wounds include:
  - Wound environment
  - Inflammatory responses
  - Differential growth factor profiles
  - Wound matrix

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Classification of Wounds

Acute

Chronic

Acute Wounds:

- Acute wounds heal in a predictable manner and time frame
- Process occurs with few, if any, complications, and the end result is a well-healed wound.
- E.g. surgical wounds, clean lacs, minor trauma

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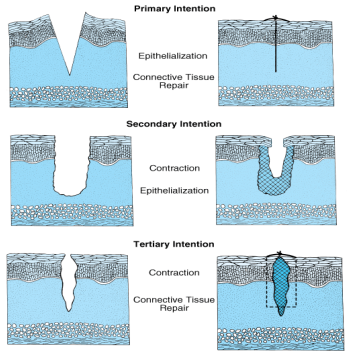

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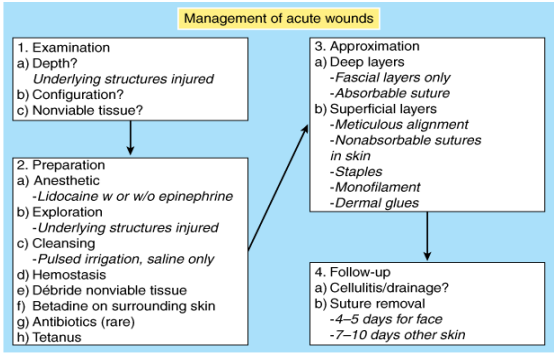

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Local Factors That Affect Wound Healing

- Infection
- Edema
- Ischemia/necrotic tissue in wound
- Topical agents
- Ionizing radiation
- Low oxygen tension
- Foreign bodies…

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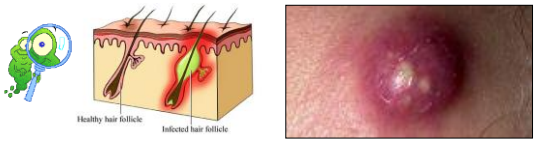
Wound Infection

- The incidence of wound infection is about 5 to 10% nationwide
- Quant & type of bacteria key
- $>10^5$ microorganisms / gm
- *Staphylococcus* species, coagulase-negative *Streptococcus*, enterococci, and *Escherichia coli*



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XRT Ulceration **Debridement / HBO?**

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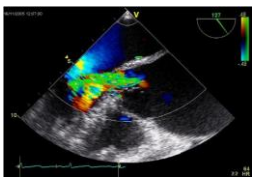
Regional Factors That Affect Wound Healing

- Arterial insufficiency
- Venous insufficiency
- Neuropathy…



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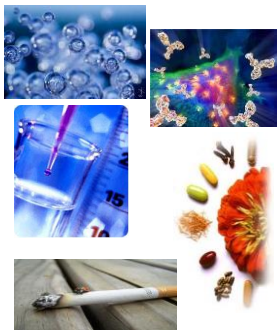
Systemic Factors That Affect Wound Healing

- Nutrition
- Metabolic diseases
  - diabetes
- Immunosuppression
- Connective tissue disorders
- Medications
  - steroids
- Smoking…



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Chronic Wounds

- Failure to proceed through orderly progression
- Not healed in 3 months are considered chronic.

Features:

- Repeated trauma
- Poor perfusion or oxygenation
- Excessive inflammation
- Unresponsiveness to normal regulatory signals
- Failure of normal growth factor synthesis
- Malignant transformation
  - squamous and basal cell carcinomas

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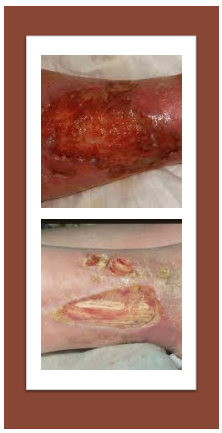

Ischemic Arterial Ulcers

- lack of blood supply, **painful**
- Associated with peripheral vascular disease
- Most distal portions of the extremities
- Diminished or absent pulses with decreased ankle-brachial index
- Poor formation of granulation tissue, dryness of skin, hair loss, scaling
- Shallow with smooth margins, pale base
- Management includes **revascularization** and wound care

Venous Stasis Ulcers

- Due to venous stasis and hydrostatic back pressure
- Neutrophils adhere to the capillary endothelium and cause plugging with diminished dermal blood flow
- Extravasation of hemoglobin and its breakdown cause pruritus and skin damage
- Lipodermatosclerosis
- Failure to re-epithelialize despite the presence of adequate granulation tissue
- **Compression** therapy
- Moist wound environment
- Vasoactive substances and growth factor application, skin substitutes
- Recurrences are largely because of patients' lack of **compliance**

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Mechanism Of Venous Ulcers

Alteration and distention of the dermal capillaries

↓

leakage of fibrinogen

↓

polymerization of fibrinogen into fibrin cuffs

↓

impede oxygen exchange, trap growth factors

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Vein Management

Dietary & lifestyle modification
- Nutritional enhancements
- Smoking cessation
- Weight reduction
- Healthy cardiac status
- Strong psychosocial supports
- Leg elevation
- Progressive resistance exercise

Medical management
- Systemic therapies
  - Oral flavonoids (MPFF)
  - Phlebotonics
  - Pentoxifylline
  - Oral antibiotics
- Topical therapies
  - Antibiotics & antiseptics
  - Iodine preparations
  - Silver sulfadiazine
  - Mupirocin

Dressing & debridement
- Dressing
  - Hydrocolloids
  - Films
  - Alginate
  - Hydrogels
  - Foams
- Debridement
  - Autolytic
  - Chemical
  - Mechanical,
  - Surgical
  - Biological

Compression therapy
- Bandages
  - Elastic
  - Inelastic
  - Single component/layered
  - Multi component/layered
- Stockings
- Intermittent pneumatic compression

Endovenous therapy
- Chemical ablation
  - Foam sclerotherapy
- Thermal ablation
  - Laser ablation
  - Radiofrequency ablation
- Subfascial endoscopic perforator surgery (SEPS)
- Venous stenting

Surgical therapy
- Shave therapy
- Venous striping
- Open surgical ligation
- Skin grafting
- Phlebotomy

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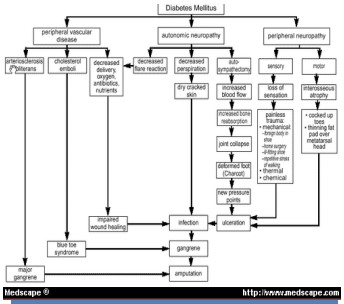

Diabetic Wounds

- 10% to 15% of diabetics
- Neuropathy(60 to 70%)- both sensory and motor
- Ischemia(15 to 20%)
- Treatment involves local and systemic measures

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Prevelance

- 285 million diabetics in USA 2010
- Leading cause of hospital admits for IDDM
- 2.5% of DM population
- 4-25% of all IDDM during lifetime

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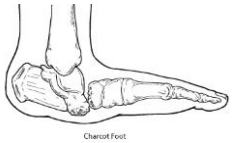
Etiologies



- Peripheral neuropathy
- PAD – DM, TOB, HTN, Lipids, Age, male
- Infx / Osteo
- Charcot changes

- Peripheral neuropathy
- 90% of all etiologies
- Motor
  - Hammer toes, claw foot
- Autonomic
  - Dry skin, cracks, calluses
- Sensory
  - Decreased protective sensation

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Evaluation of Diabetic Foot Ulcers

- Measure the wound – x y z undermining
  - >2cm or deeper than 3mm high likely hood of osteo
- Imaging
  - Can start with foot Xray
  - MRI is most accurate for picking up osteo
- Labs
  - CBC
  - ESR/CRP
  - BCx
  - Wound Cx – quantitative
  - DO NOT CULTURE THE SURFACE SLIME UNLESS WASHED WITH CHLORHEXADINE AND RINSED

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Grading Diabetic Foot Ulcers

Diabetic Foot Infections

Table 1.
Classification of Diabetic Foot Infection

CLINICAL MANIFESTATION OF INFECTION	IWGDF GRADE/IDSA CLASSIFICATION
No systemic or local signs of infection	1 (uninfected)
Local infection* involving only the skin or subcutaneous tissue (without involvement of deeper tissues and without signs of a systemic inflammatory response syndrome†); any erythema present extends > 0.5 to ≤ 2 cm around the wound	2 (mild infection)
Local infection* with erythema > 2 cm around the wound, or involving structures deeper than skin and subcutaneous tissues (e.g., abscess, osteomyelitis, septic arthritis, fasciitis) *and* no signs of a systemic inflammatory response syndrome†	3 (moderate infection)
Local infection* with signs of a systemic inflammatory response syndrome†	4 (severe infection)

IDSA = Infectious Diseases Society of America; IWGDF = International Working Group on the Diabetic Foot.

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OFF Loading

- **Total contact cast** is gold standard
- Plantar ulcers
- Cumbersome
- Cam boot +/- ace wrap
- Can remove for more frequent wound care, better sleep

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When to refer

- Urgent
  - Open wound or ulceration
  - ▶Immediate
- High risk 3
  - Previous hx of ulcer w/ new skin changes
  - ▶Next available out pt
- Moderate risk 2
  - PAD, edema, absent pulses
  - ▶f/u specialist q 2-3 months
- Low risk 1
  - Non changing deformity
  - ▶Referral 1-3 months

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Excess Healing

- **Hypertrophic scars (HTSs) – normal** healing result

Rise above the skin level but stay within the confines of the original wound

- Develop within 4 weeks after trauma
- Independent of site, age, and race
- Rarely elevated more than 4 mm above the skin level
- Stay within the boundaries of the wound
- Occur across areas of tension and flexor surfaces
- May regress during remodeling phase
- STEROID: topical or intralesional Kenalog
- Surgical revision

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Hypertrophic scars (NOT keloids)

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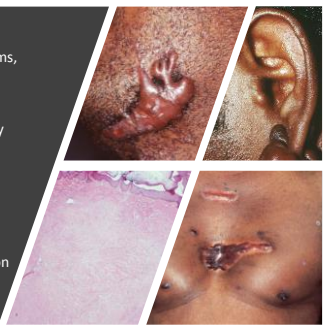
Keloids

- Earlobe, deltoid, presternal, upper back region, eyelids, genitalia, palms, soles, or across joints
- **Overgrowth** - few millimeters to large, pedunculated lesions with a soft to rubbery or hard consistency
- Collagen bundles **random** orientation
- Synthesize collagen at a rate 20x
- **Impaired collagen breakdown**
- Autosomal dominant, (darker pigmentation) with incomplete penetration and variable expression
- STEROID
- SURGERY + XRT



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Translation to patient care

- Minimize discomfort
- Limit time away from work
- Support family
- Restore function
- Cost effective

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Serial Debridement - ***KEY***

- Gauze - 97602
- Irrigation
- Knife
- Scissors
- Curette
  - Removes surface debris
  - Removes biofilms (maybe)
- CPT W/ RVUs
  - 97597

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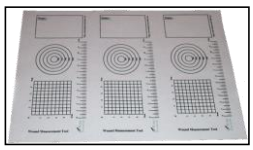
Documentation = $$$

- Measurements X-Y-Z
- Tissue type at depth
- Surface slough description
- Instrument used
- Bleeding
- Control of bleeding
- Dressing / compression



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Moist Healing w Topicals

- **Antibiotics**
  - Bacitracin (gpc)
  - Silvadene – poly microbial
  - Sulfamylon - gnr
  - Dakins – use dilute
  - Betadine – toxic to healing cells, save for dry gangrene
  - VASHE
- Silver coated – change infrequently
  - Gels and gauzes
- Collagens
  - Stimulate healing
- Enzymatic debridement
  - Santyl

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Types of Dressings

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Compression

- Aces
- Coban
  - Whoa – avoid if insensate
- Profore
- Unna boots
- Edemawear – made in NE !!!
- Ted hose
  - Very hard to pull on with older hands

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Negative Pressure vacuum assisted closure

- Decrease edema
- Contract wound
- Avoid surgical closures
- NOT for infections
- If no decrease in wound size in 2-3 weeks change treatment plan

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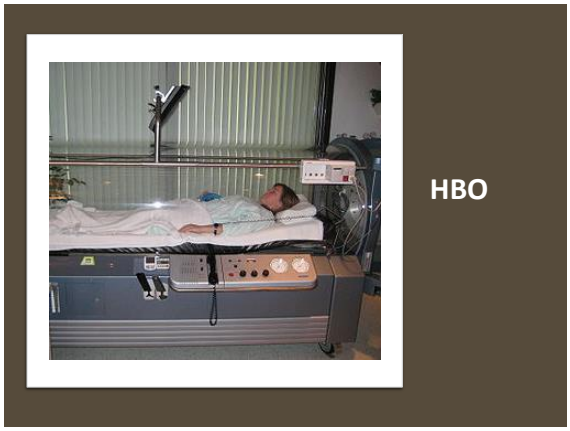

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Advanced wound care

- Cadaver skin
- Xenograft products
  - Amnion
  - Pig
  - Cow
  - Fish
- Collagen matrices
- Allograft products
- Frozen skin components
- Growth Factors
  - PDGF

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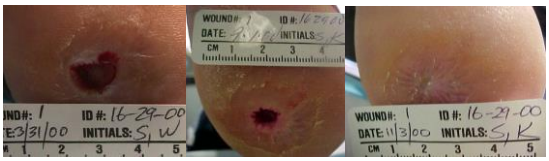
Growth Factor Therapy

- Slow wound healing on a diabetic foot
- Topical PDGF (Regranex)



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Skin Substitutes

- Combine novel materials with living cells to provide functional skin substitutes, providing a bridge between dressings and skin grafts.

Advantages:

- readily available
- not requiring painful harvest
- applied freely or with surgical suturing
- promote healing

Disadvantages:

- limited survival / shelf life
- high cost
- may require multiple applications

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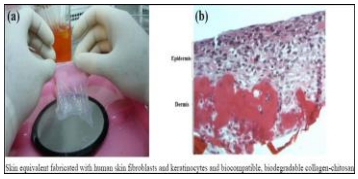
Desired Features of BioEngineered Tissue Substitutes:



Skin equivalent fabricated with human skin fibroblasts and keratinocytes and biocompatible, biodegradable collagen-chitosan

Rapid re-establishment of functional skin (epidermis/dermis)
Receptive to body's own cells (e.g., rapid "take" and integration)
Graftable by a single, simple procedure
Graftable on chronic or acute wounds
Engraftment without use of extraordinary clinical intervention (i.e., immunosuppression)

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Cultured cells as adjunct to wide mesh STSG


Fig. (2-A) Cultured allogenic keratinocyte gafts applied onto meshed skin autograft.

Fig. (2-B): The same case showing complete closure of the interstices of the meshed autograft by the 5th postoperative day.

Fig. (3-A) Split-thickness skin graft donor site covered by cultured allogenic keratinocyte grafts, intraoperative

Fig. (3-B): The same donor site, 7 days postoperatively. See delayed healing of the periphery in areas not

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Bioengineered Dermal Replacement


Prior to Dermagraft application

5 week follow-up after three applications of Dermagraft

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Wound Healing Caveat

For pressure sores and other wounds the end-point is complete wound closure.

If the patient is a candidate for surgery and adequate tissue for a flap is present

Surgical closure is still the fastest way to close any wound !

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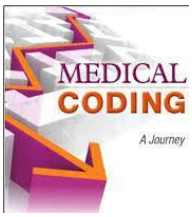
Coding

- CPT
- 97602 – non selective/ dressing changes
- 97597 – sharp selective debridement
- 11055 (1) / 11056 (2) Callus
- 11720(5) / 11721 (10) Nails
- Allograft application:
  - 15271/2 trunk, leg
  - 15275 / 6 face, hand
- Injection 11900
- Biopsy 11105
- ICD-10
- Always code IDDM first
- Get 'wording' from your rep



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The real secret to healing

- Bug the patient
- Hassel them about compliance
- Call them with reminders
- Frequent follow ups
- Set limits and mean it
- Tobacco cessation…
- If non compliant
- Change to palliative care plan

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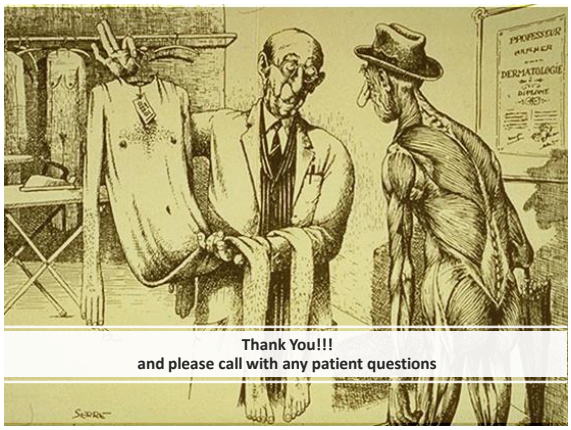

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NAMASTE

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