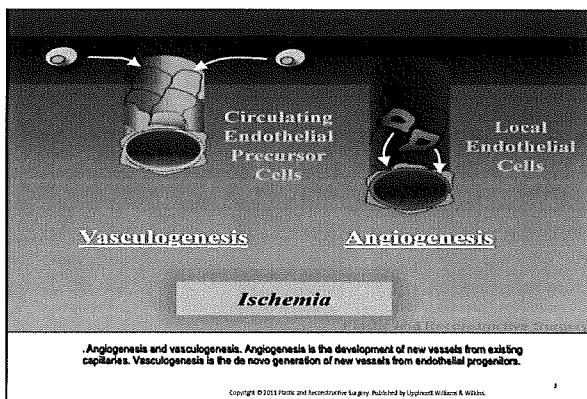
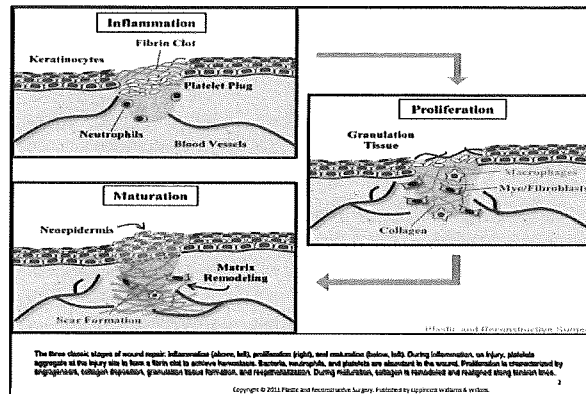


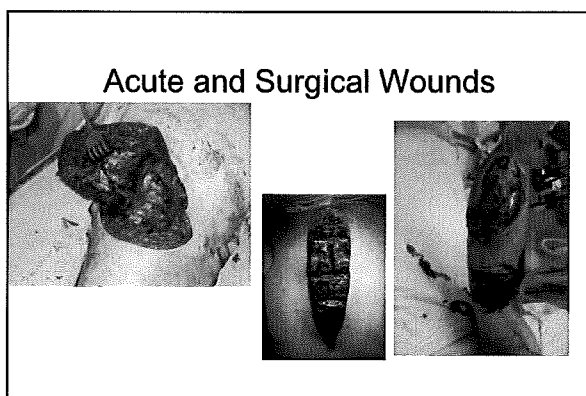
Management of Complex Wounds 2011

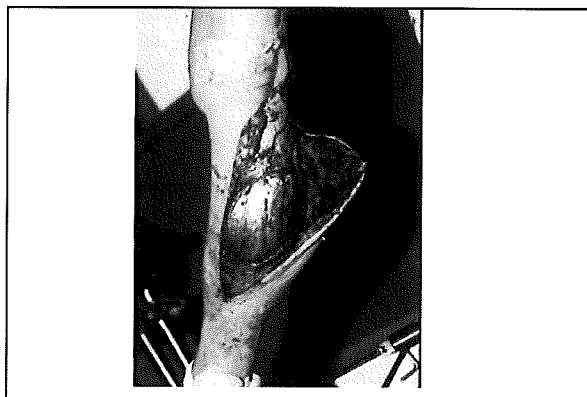
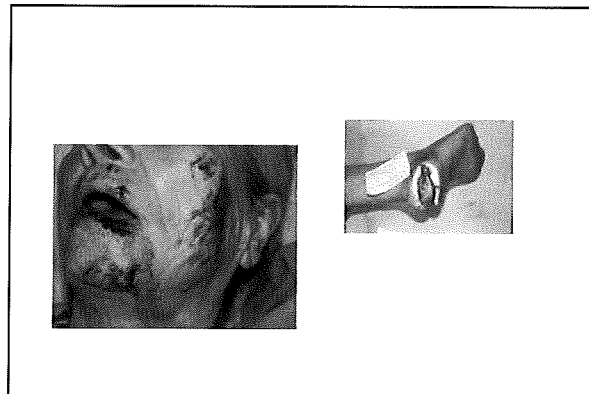
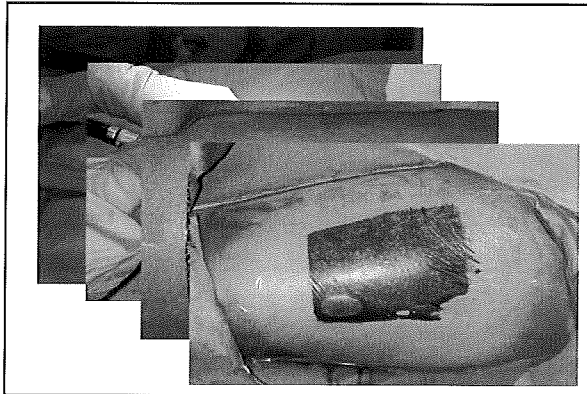
**James Mahoney MD, FRCS(C),
Chief, Division of Plastic Surgery
Medical Director, Wound Healing Program
St. Michael's Hospital
University of Toronto**



- ## Objectives
- Basic aspects of wound management
 - Experience
 - Technical aspects Program or Group development

- ## Clinical Wound Areas
- **Acute Wounds**
 - Surgical incisions, trauma, burns
 - **Chronic Wounds**
 - Pressure sores
 - 80% failure without adequate support
 - Venous ulcers
 - 60% healed @ 12 weeks
 - Size, stripping
 - Diabetic foot ulcers
 - 25% healed @ 12 weeks
 - **Surgical complications - Infection**
- Limited resources**





Characteristics of Acute vs Chronic Wounds 1

- **Clinical**
 - **Necrotic or unhealthy tissue**
 - **Poor blood supply**
 - **No granulation tissue**
 - **Poor re-epithelialization**
 - **Recurrent wound breakdown**

Characteristics of Acute vs Chronic Wounds 2

- **Proteinases**
 - > **in chronic wounds**
 - **Degrade matrix**
 - **Degrade growth factors**
 - **Degrade growth factor receptors**
 - > **in chronic wounds**
 - **Inflammatory cytokines**
 - **Collagenases MMP2 & 9**
 - **Stromelysins MMP3, 10 & 11**
 - **Serine proteinases**
 - < **in chronic wounds**
 - **Tissue inhibitor of MMP's**
 - **A1 – protease inhibitor**
 - **A2 – macroglobulin**

Acute vs Chronic Wounds 3

- **Cellular Features**
 - **Low mitotic activity**
 - **Altered cellular phenotype**
 - **Presence of senescent cells**
 - **Decreased growth factor activity**
- **Keratinocytes**
 - < **surface proliferation**
- **Fibroblasts**
 - **Senescent features**

Characteristics of Acute vs Chronic Wounds 4

- **Bacterial content**
- **More than one strain**
- **Drug resistant organisms**
- **Biofilms**

Characteristics of Acute vs Chronic Wounds 5

- **Complications**
 - **Sinus or fistula formation**
 - **Recurrent infection**
 - **Bone**
 - **Osteomyelitis**
 - **Soft tissue**
 - **Contracture**
 - **Systemic amyloidosis**
 - **Calcification**
 - **Anemia**
 - **Cancer**

Biofilms

- **Bacterial secretion (polysaccharide) providing protection against white blood cells, antibodies, and even therapeutic antibiotics**



Wound Care

- **General Assessment**
 - **History**
 - **Physical examination**
- **Debridement**
- **Dressings**
- **Operative care**
- **Adjunctive therapies**

Nutrition

- **History and physical examination**
 - **80 to 90 percent accurate in evaluating patient nutritional status**
 - **weight loss (20 percent weight loss is indicative of severe malnutrition)**
 - **cachectic with obvious muscle wasting,**
 - **alimentary malabsorption.**

Nutrition

- Corroborating Investigations
 - serum proteins (albumin, <3.5 mg/dl)
 - prealbumin, <15 mg/dl
 - transferrin, <200 mg/dl)
 - nitrogen balancet
 - total cholesterol
 - creatinine

Wound Assessment

- General
- Local
 - Infection
 - Granulation
 - Eschar
 - Exudate
- Investigations
 - Bacteria
 - #
 - Type
 - Host response

Wound Assessment

- D(T)ime – Debridement
- I – Infection
- M - moisture
- E – edge

Wound should be 30% smaller by week 4

Treatment

- Wound
- Cause
- Patient

Wound Treatment

- Goal - healed wound ASAP
- Debridement is #1
- Wound dressing standard - moist wound dressings
- Adjunctive techniques
 - New dressings – skin replacements
 - Bioengineering – Dermagraft, Regranex
 - Surgical treatment –reconstructive techniques
 - Modify the wound
- Lack of standard to evaluate or compare the results

Clinical Aspects of Wounds

- Multifactorial
 - Nutrition
 - Mobility
 - Other diseases - diabetes, vascular disease
 - Incontinence
 - Infection
 - Trauma – pressure, crush, surgery
 - Smoking

Risk Factors

<p><u>Intrinsic Risk Factors</u></p> <ul style="list-style-type: none"> • Gender: male>female at sternal site • Age • Obesity • Current cig smoking • COPD • Poor cardiac function • Prolonged ventilation • Low cardiac output • Diabetes mellitus • Steroid therapy • Staph Aureus nasal carriage • Pre-op length of stay 	<p><u>Surgical Risk Factors</u></p> <ul style="list-style-type: none"> • Prolonged perfusion time • Duration of surgery • Use of intra-aortic balloon pump • Post-op bleeding • Re-operation • Sternal rewiring • IMA in CABG • Type of bone saw • Electrocautery • Shaving methods
---	--

Debridement

- Primary ★
- Wound Healing
 - Primary intention ★
 - Secondary intention
 - Secondary closure
- Tertiary

Debridement → Secondary healing

Technique

- mechanical
- enzymatic (santyl - collagnase)
- dressing
- autolytic (dressing)
- Maggots

Mechanical

- Irrigation – pulsed or pressure
- Rubbing with a blunt object
- Scraping or shaving
- Cutting of tissue
 - Scissors & thumb forceps
 - Scalpel

Warnings

- Anticoagulants
- Ischemia
- Infection
- Consent

Complications

- **Bleeding**
 - Pressure
 - Kaltostat
 - AgNo3
 - Ligation
 - Oversewing
 - Thrombin
- **Exposure of Tissues**
 - Bone
 - Tendon

Diagnosis of Infection

- **Patient assessment** - fever, WBC, BS
- **Local Clinical Assessment**
 - Inflammation (>2cm)
 - Involvement of bone
 - Progressive gangrene
 - Pus
- **Culture**
 - Type
 - Number
- **Classification**
 - Superficial
 - Deep



Technique of Biopsy

- Needle aspiration
- Ultrasound guided aspiration (drain)
- Incision under local anesthetic - swab for culture and tissue biopsy (ER)
- Incision and drainage, exploration, debridement in the operating room

Role of Biopsy - Extensive Necrosis, fasciitis



Antibiotics in Soft Tissue Infection

- Gram stain
- Culture and sensitivity
- Oral for local
- IV for systemic and osteomyelitis
-

Techniques to Reduce Bioburden -1

- **Mechanical debridement**
- **Antiseptics**
 - Betadine on dry eschar
 - Betadine in a wound
 - Iodosorb
 - Hygeol
 - Acetic acid
 - Chlorhexidine

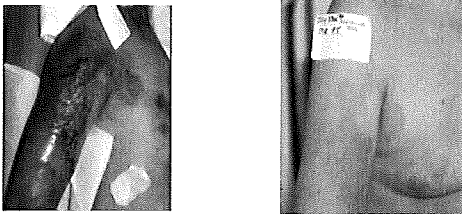
Techniques to Reduce Bioburden-2

- Antimicrobials
 - Flamazine
 - Gentamicin, metronidazole gel
 - Ointments
 - Mupirocin
 - Honey
- Impregnated gauze
 - Tulles, chlorhexidine
- Dressings
 - Hydrocolloid
 - Silver
 - Gels & occlusives = promote healing

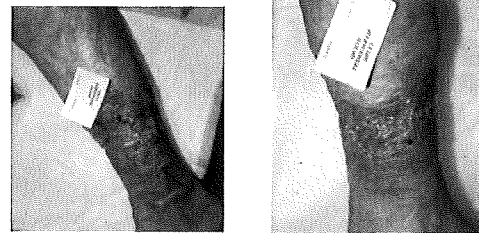
Silver Coated Dressing

- Polyethylene mesh – ionic silver
 - Controls bioburden or colonization by release of silver maintaining a moist environment
 - Broad spectrum
 - Low sensitivity
 - Non-stick
 - Not toxic
 - Efficacy proven
 - Cost – \$8.00, q2days

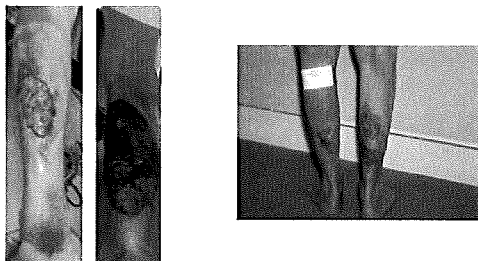
Acticoat in Burns



Ionic silver (Acticoat) With Compression Therapy

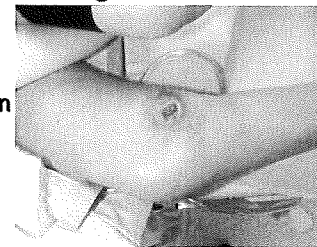


Anticoagulant Induced Skin Loss



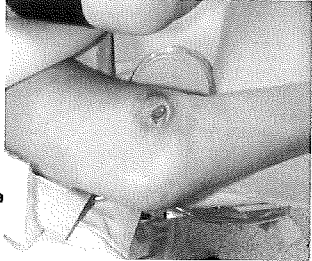
Principles of Wound Healing Dressing

- promote epithelialization, wound contraction
- minimize contamination



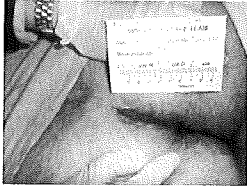
Dressings to Facilitate Healing

- Moist Dressings
- Impregnated Gauze
 - Jelonet, tules, Mesalt
- Films or membranes
- Hydrogels
- Xerogels - alginates
- Hydrocolloids
- Absorptives
 - Foams - Allevyn, Combid
 - Mepilex



Hyalofil (Hyaluronic Acid)

- Carbohydrate of the ECF
- Involved in wound healing
 - Extracellular matrix
 - Involved in the regulation of cellular behavior
- Amorphous fibrous fleece
 - Leg ulcers, sinuses, fistulae
 - Perineal wounds in IBD



Failure to Heal

- Pressure relief
- Time
- Compliance
- Infection
- Ischemia
- Nutrition
- Location

Wounds are Dynamic

- Require re-evaluation for improvement
- If consider the modifiers of the Wound Healing Response
 - Macrobiological
 - Skin graft - surgery
 - Skin substitutes
 - Opsite
 - Biobrane
 - Mechanical
 - VAC
 - Bioengineering
 - Growth factors
 - Replacements

Exogenous Growth Factors

- Platelet derived growth factor*-
 - Platelets, macrophages, endothelium, fibroblasts
- Vascular endothelial growth factor
- Transforming growth factor
- Epidermal growth factor
- Fibroblast growth factor
- Keratinocyte growth factor
- Insulin-like growth factor

Platelet Derived Growth Factor in Diabetic Wounds

- Phase 2 clinical study, 118 patients
- 20 weeks
- Treatment 48% vs control 25% healed @ 20 weeks
- Criticisms – Larger wounds in the control group

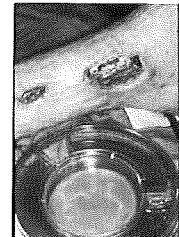
Skin Replacements

- Allograft skin, xenograft skin
- Cultured epithelium – Apligraf – keratinocytes on a matrix
- Dermal Replacement - Dermagraft
 - neonatal fibroblasts on synthetic matrix
- Integra -collagen based dermis & silicone epidermis

- Alloderm -cadaver dermis, porcine dermis

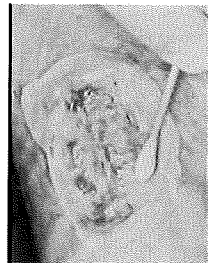
Dermagraft

- Matrix
 - Collagen, fibronectin
- Fibroblasts
 - Young & persist
 - Release growth factors
 - > @ thawing
- GAGs

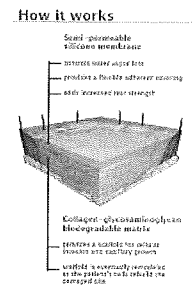


Dermagraft

- Applied as a skin graft
- Applications
 - 4 for diabetic foot ulcers
- Cost - \$640.00 / application
- Outcome – 20 % increase in healing in diabetic foot ulcers



Integra



Alternative therapies

- **Topical hyperbaric oxygen and low energy laser for the treatment of diabetic foot ulcers.**
 - impression is that topical hyperbaric oxygen alone or in combination with a low power laser are valuable adjuvants to conventional therapy for diabetic foot ulcers.
 - Landau Z; Arch Orthop Trauma Surg 1998;117(3):156-8
- Systemic HBO
 - Series of treatments

Hyperbaric Oxygen in Vasculitis



Stem Cells

Plastic and Reconstructive Surgery

Fig. 8. Future potential applications of stem cells for wound healing. (Left) To address the concern that wounds are a dynamic and diverse environment, microfluidomechanical (MEM) systems technologies could be applied to wounds to detect changes in oxygenation, pH, temperature, ion levels, and so forth, so that precise combinations of cells, nutrients, and growth factors can be delivered through microfluidic channels. (Second from left) With inductive "smart" scaffolds, the scaffold biomaterials, when applied to the wound, will include appropriate local and systemic drugs and nutrients to augment wound healing. (Second from right) With composite dressings, agent-specific stem cells could allow reconstruction of the skin. If dermal-like mesenchymal-based dressings are used for deeper wounds and epidermal-like ectodermal-based dressings are used for superficial wounds. (Right) The development of sophisticated delivery systems could allow for easier and more efficient delivery of cells, nutrients, and growth factors to the wound site.

Pain

- Non – stick
- Avoid tape
- Dissolving vs removable vs staples

Scars

- 5-0 doesn't leave stitch marks
- Larger sutures and staples do (<1 week)
- Bio-oils, Vit E rationale
 - Itchy
 - Lubricate
 - Sensitivity
- Remove dissolving sutures if exposed

Principles of Wound Treatment

- Know the categories
- Select - safe, effective, user friendly, cost effective
- Change - type according to the patient's wound, it is dynamic
- Practice to learn the advantages of the different types

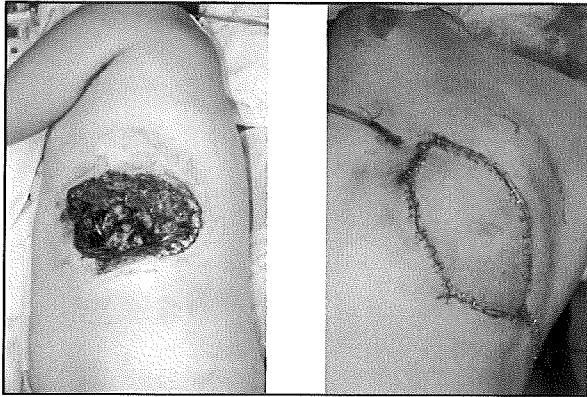
Reconstructive Options

Distant flap	Free flap
Local flap	Tissue expansion
Skin graft	Distant flaps
Primary closure	Local flaps
	Dermal matrices
	Skin graft
	Negative pressure wound therapy
	Closure by secondary intention
	Primary closure

Plastic and Reconstructive Surgery




Options in Soft Tissue Reconstruction

- Direct Closure
- Primary
- Delayed primary
- Tissue approximators
- Skin Graft
- Local Skin Flaps
 - Random
 - Axial
 - Fasciocutaneous
- VAC
- Distant Skin Flaps
 - Cross leg flap
- Muscle flaps
 - local muscle and skin graft
 - musculocutaneous flaps (STSG donor)
- Free flap
 - a. muscle, bone, skin
 - b. named artery or perforator



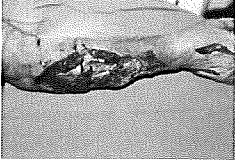

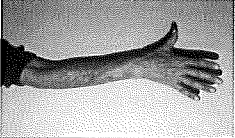
Traumatic Skin Wounds

- Etiology
 - Crush
 - Laceration
 - avulsion

Blunt Trauma

- Hematoma
 - Undermining
 - Necrosis

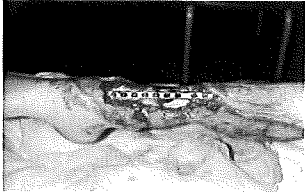




Reconstruction of Multiple Tissues Lower Extremity

Breast, Head and neck, Trunk

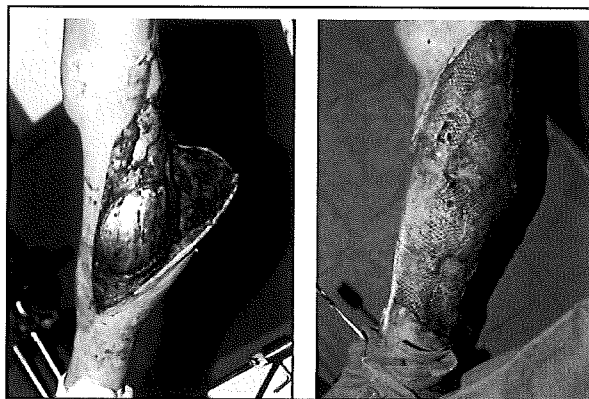
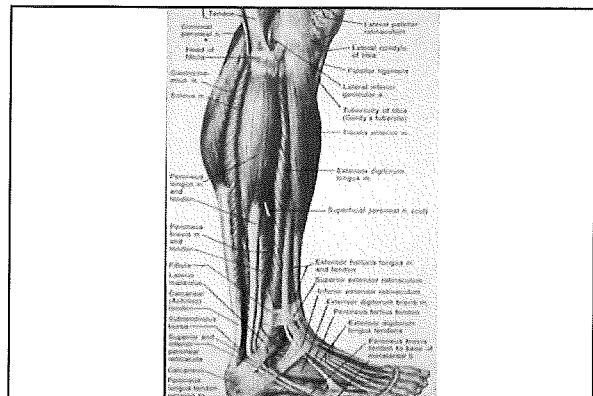
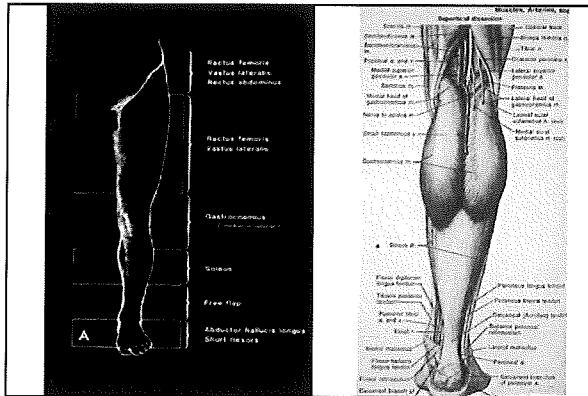
The Problem – Soft Tissue

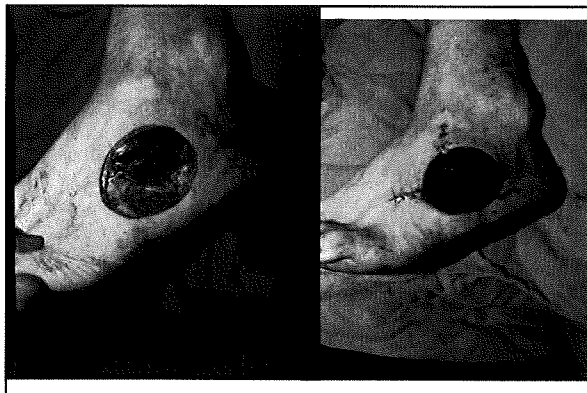
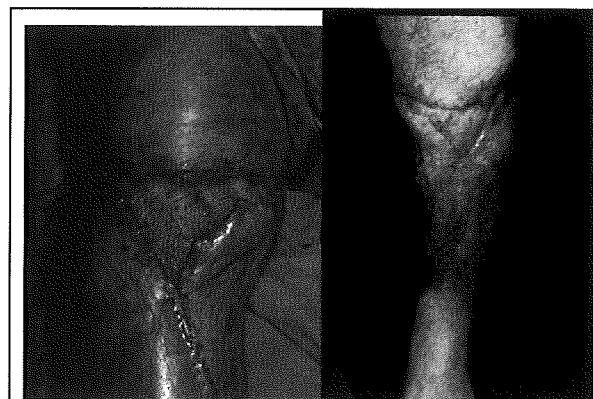
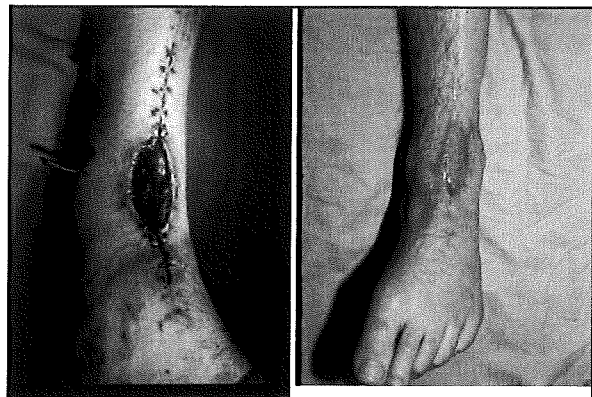
- Support
- Special needs i.e. sensation
- Cover
- Durability
- Cosmesis

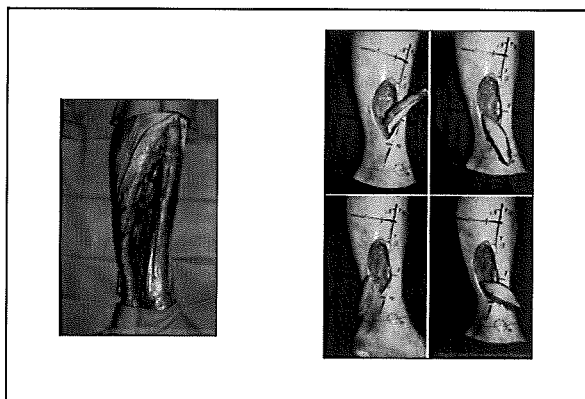
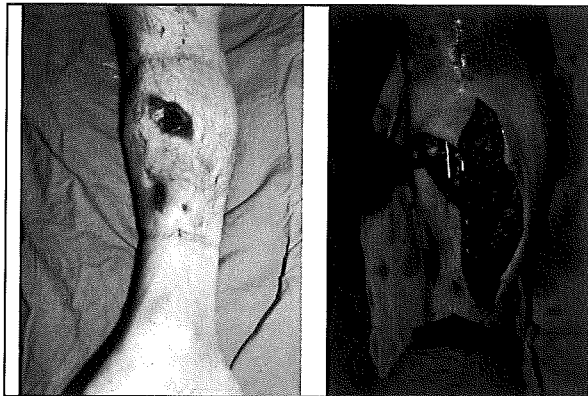


The Problem - Timing

Timing	Failure rate	Infection rate	Bone healing	Hospital
<72 hours	1%	2%	68 months	27 days
72 hours-3 weeks	12%	18%	123 months	130 days
> 3 weeks	10%	6%	29 months	256 days







Indications for Microsurgical Reconstruction

- Size of defect
- Earlier recovery
- ambulation
- fracture healing
- BTW
- Decreased revisionary or complication rate
- Cosmesis

General Assessment

- Age
- Medical status
 - Diabetes
 - Smoking
 - Vascular disease
- Ambulation
- Nerve function
- Occupation
- Motivation

Planning - General

- Positioning
- Left Latissimus to Right Posterior Tibial
- Tourniquet
- Patient temp, fluid status
- Postoperative care
- Flap Monitoring
 - Clinical
 - Tissue oxygen
 - Laser Doppler
 - Ultrasound

Planning - Recipient

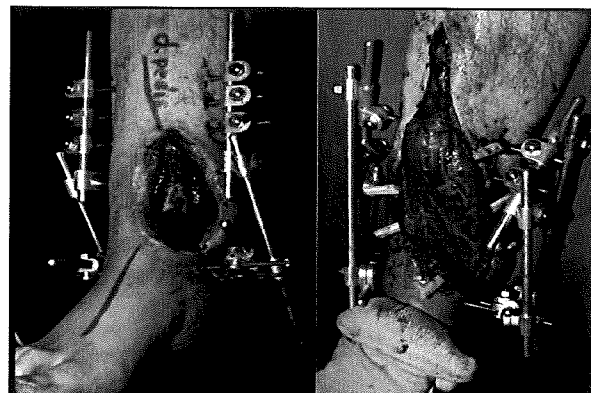
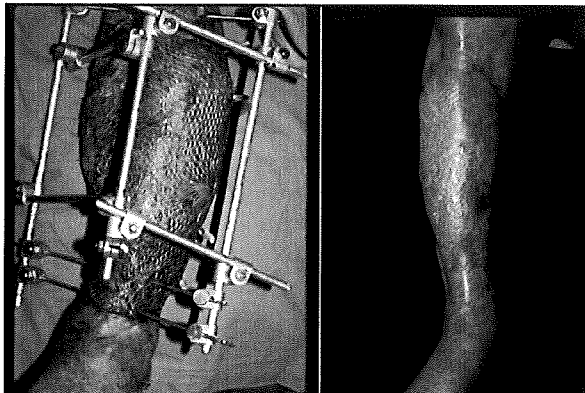
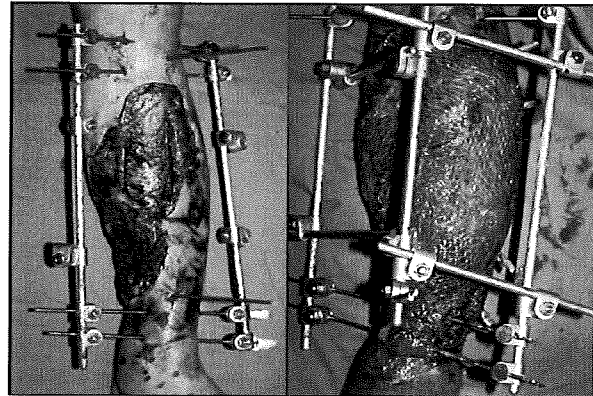
- Angiogram
- Debridement - size, dead space,
- Vascular pedicle length and position - rectus, vein graft
- Anastomosis = E to E, E to S, Vein graft

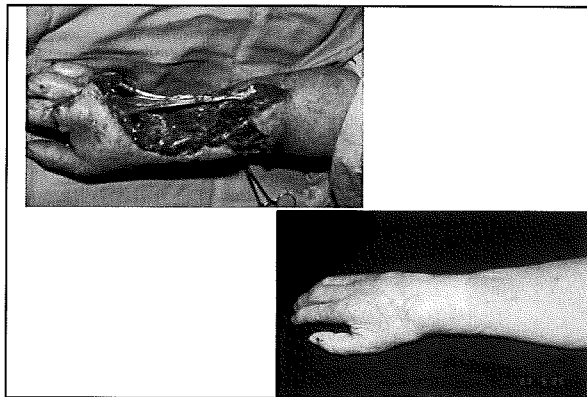
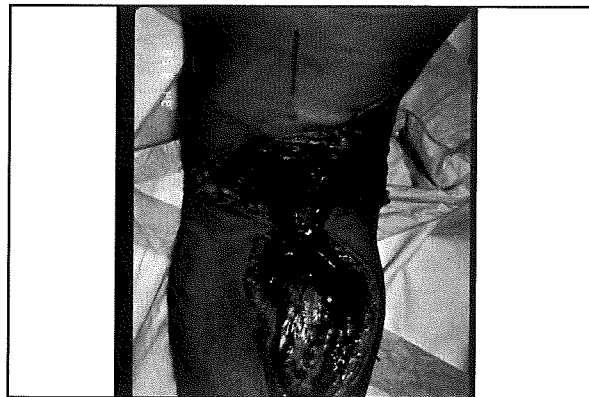
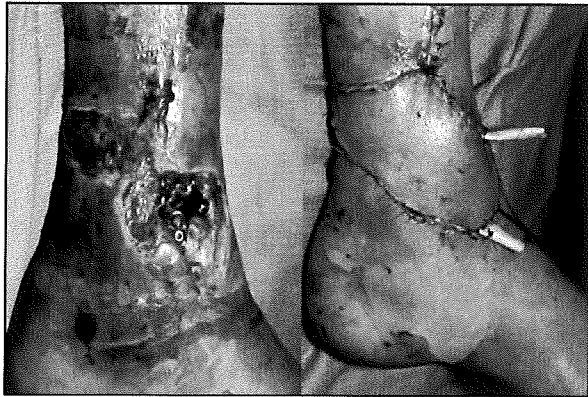
Planning - Donor

- Scar
- Functional loss
- Closure
- Drains

Acute Trauma

- Adequate debridement
- Timing
- Immediate
- Delayed - < 5-7 days (#s, degloving)
- Secondary
 - earlier is better - < spasm, easier dissection, < infection (3.6% vs 38%)





New Trends

- NPWT
- Stem cells (fat origin)
- Biologicals (bioengineering)
 - Skin
 - Bone
 - Osteoset
 - Hydroxyapatite
 - Protein
 - Growth factors
 - Blood vessels
- Mechanical instrumentation
 - Versajet
 - Ultrasound

Mechanism of Action

- Open cell reticulated foam and fenestrated connecting tube
- Occlusive dressing applied over wound
- 25-200mmHg sub-atmospheric pressure applied

Severe Foot Crush Injury

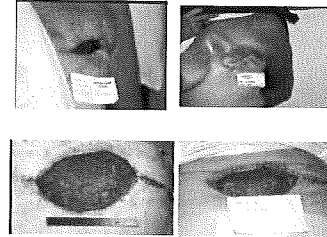
- ORIF, wound dehiscence

Clinical Experience (Case Series)

- Sternal infections
- Skin grafting
- Burns
- Skull defects
- Acute traumatic wounds
- Surgical complications

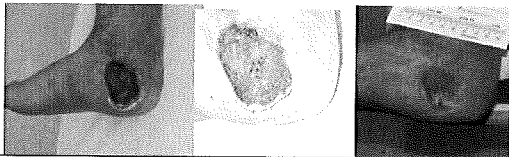
Wound Preparation

- Poor vascular bed
- Extent of sinus formation, dead space
- Difficult wound contour
- Goal – improve ASAP
- Outcome – healed

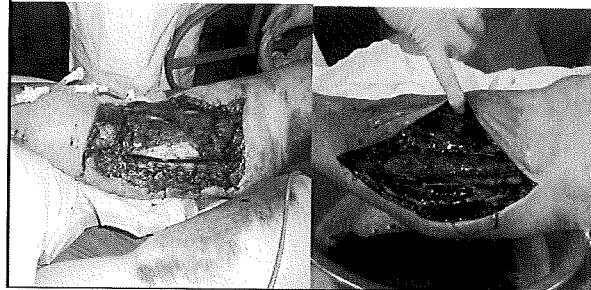


Wound Preparation

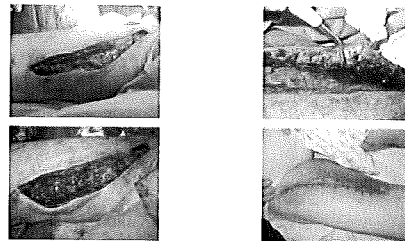
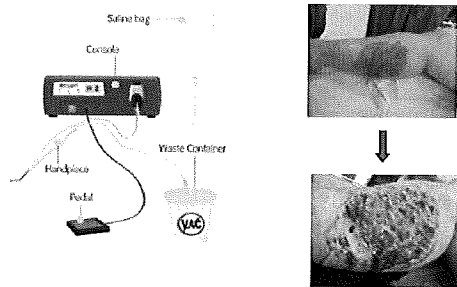
- Chronic Unstable Wound, 30 year man
- Protein C deficiency, DVT
- Debridement, VAC X 1 wk, STSG

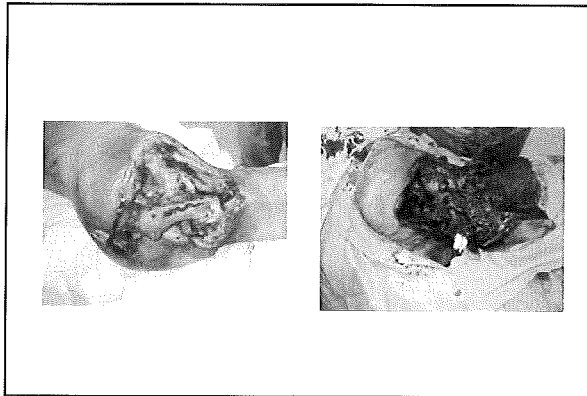


Acute Wound Management



VERSAJET® An Advanced Hydrosurgery Product






Questions

Diabetes

- Neuropathy
- Vasculopathy
- Infection
- Wound healing


Presentation

- ↑ WBC not always present (20% normal, 7% ↓)
- Skin involvement does not usually indicate severity of underlying process
- Many cases are initially seemingly innocuous; 30% had seen M.D. in past 48 hours
- Need to mark & document margins
- ++Pain often best sign/symptom (odor)
- **Diagnosis - BIOPSY**



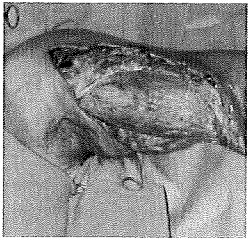
Pathophysiology

- Organisms spread from the subcutaneous tissue along the superficial and deep fascial planes
- Facilitated by bacterial enzymes and toxins
- Causes vascular occlusion, ischemia, and tissue necrosis; superficial nerves are damaged → paresthesia




Pathophysiology

- M1&3 surface proteins ↑ the adherence of Streptococci & protect against phagocytosis by PMN's
- Streptococcal pyrogenic exotoxins A, B & C are produced by strains causing NF
- Pyrogenic exotoxins & streptococcal superantigen (SSA) lead to the release of cytokines and a septic picture



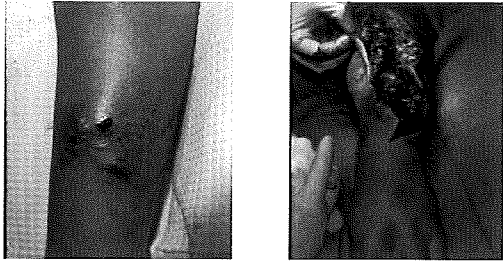
Treatment

- Immediate supportive care
- Antibiotics
- Wound debridement
- Ancillary measures
 - IV Ig (Immunoglobulin)
 - Hyperbaric oxygen
- Wound closure



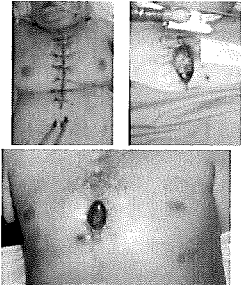
Necrotising Fasciitis

Type I - Mixed organisms




Sternal Infections

- Clinical wound signs
 - Redness
 - Tenderness
 - Drainage
- Systemic signs
- Sternal Instability



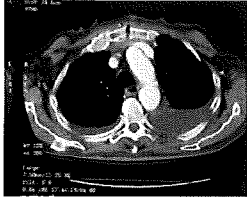
Diagnosis of Sternal Instability

- Click
- Compression
- Flail
- X-ray
 - Pulled out or broken wires



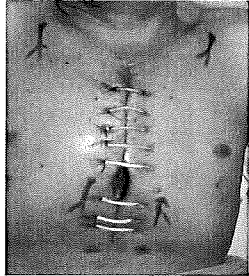
Investigation

- X-rays
 - Soft Tissues – gas
- CT scan
 - Substernal collection
 - Retrocardiac abscess
- Bone scan



Operative Treatment of Infection

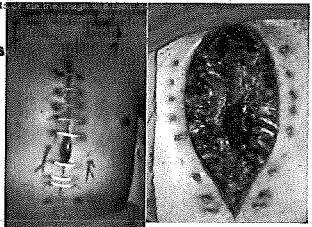
- Debridement - bone, necrotic soft tissue
- Irrigation
- Antibiotics
- Soft tissue reconstruction
- 1 or 2 stages



Surgical Treatment - Sternum

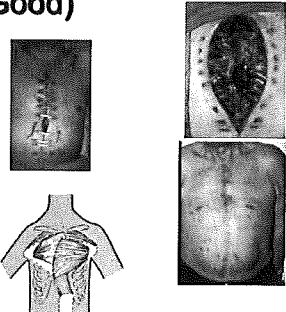
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- Principles
 - Debridement
 - Excision of necrotic tissue
 - Sternectomy
 - Soft tissue reconstruction
 - Multiple drains
- Outcome
 - Healed @ 6 weeks



Surgical Treatment – Sternum (Good)

- Soft Tissue Reconstruction:
 - Muscle
 - Omentum

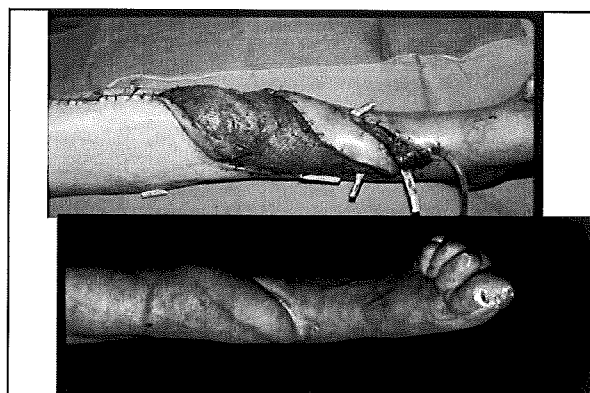
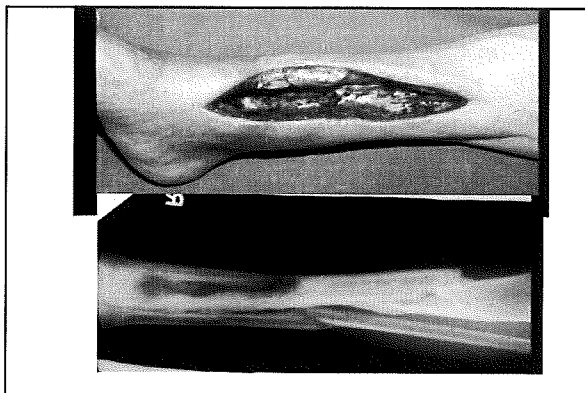


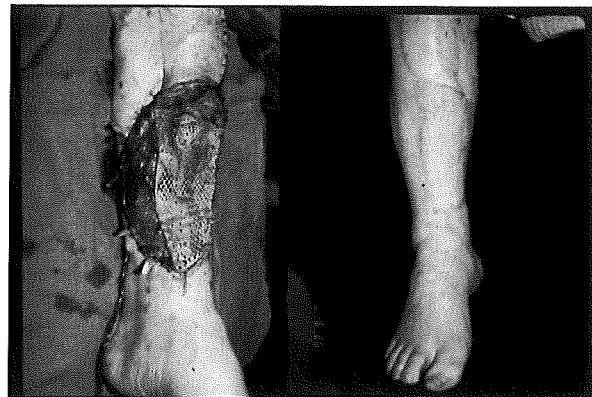
Infection

- Acute
 - Debridement
 - multiple surgical with lavage
 - Antibiotic beads
 - Once clean reconstruct

Infection

- Chronic
 - Chronic with nonunion
 - 2 stages
 - Soft tissue
 - Bone



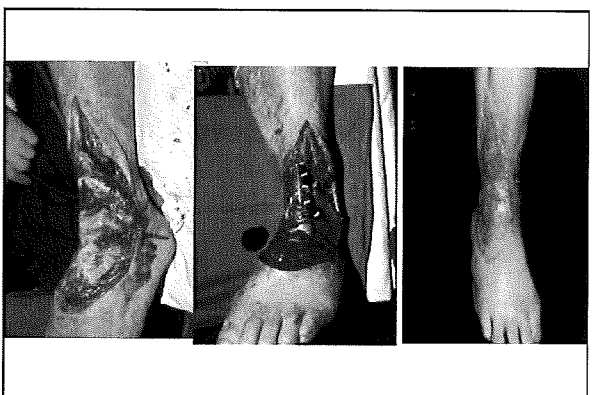


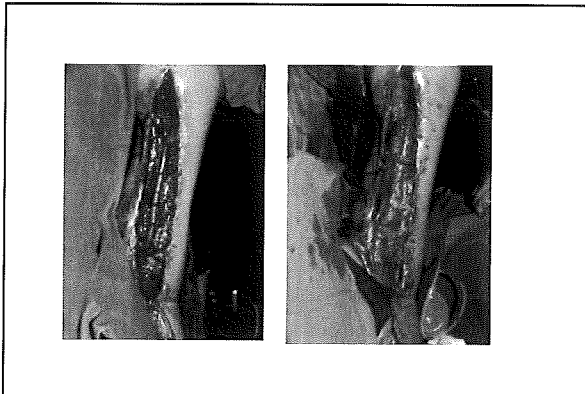
Tumor Resection

- Specialized Centers
- Frequency less
 - prostheses vs allografts
 - better primary management of dead space
- Factors (Peat et al)
 - Size of the defect
 - Radiation

Special Coverage Problems

- Vessels
- Prostheses
- Allografts
- Radiation





Results

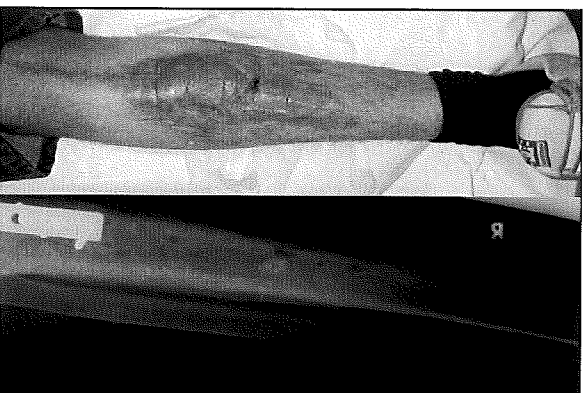
- Patient selection
- Fracture classification
- Functional problems
- Pain
- Fracture Fixation
 - plates
 - nails
 - fixators
 - ilizarov

Reasons for Failure (personal)

- A-V fistula
- Spasm
- Technical error
- Complication related to #
- Patient factors

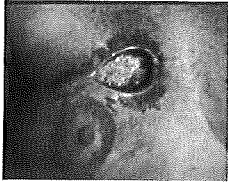
Tibial Osteomyelitis, Compartment

Tibial Osteomyelitis, Compartment



Surgical Complications

- Areas
 - Breast
 - Sternum
 - Abdomen
- Surgical principles
 - Debridement
 - Reconstruction
- Outcome
 - Healed @ 6 weeks



Questions to Ask

- Goal
- Alternative approaches
- Recommend therapy - duration
- Evaluate the outcome

How do you get started?


- Interest
 - Institutional issue – pressure relief, products - \$
- Program development
 - Manpower –
 - physicians
 - MDs
 - Vascular, ortho, plastic surgery
 - Internists, Intensivists
 - Referring physicians
 - Nursing
 - Ancillary – chiropody, OT, PT
 - Cost
 - Outcome measures

In 2007 today we have a team including:

- Clinical nurse specialists
- Occupational Therapist (consultant - seating and offloading)
- Physiotherapist (consultant - seating and offloading)
- Pharmacist (measures patients for compression hosiery)
- Vascular Laboratory Technology
- Orthopedic Surgery (consultant)
- Vascular Surgery (consultant)
- General Surgery (consultant & nurse)
- Statistician
- Plastic Surgery
- Cardiac surgery
- ENT

Activities:

- Wound Management Clinic (1/2 day per week)
- Weekly Wound Care Rounds
- Consultation and care of patients in all programs within St. Michael's Hospital
- Input into budget decisions
 - Pressure relief
 - Dressing materials



OUTCOME MEASURES

1. Yearly hospital-wide prevalence and incidence studies for pressure ulcers
 - P & I - 2 x year in the high risk areas
2. Use of Risk Assessment Tool on all inpatient units
3. Use of protocols/guidelines that will facilitate optimal care for patients with actual skin breakdown

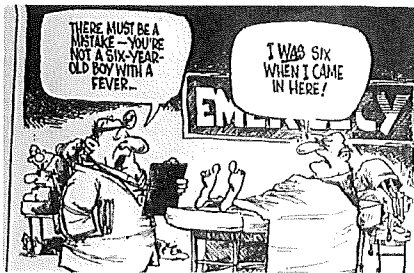
Community Resources

- **Clinical nurse specialists**
 - Review dressing orders
 - Change the dressing orders
- **Budget and contract issues**
 - Resource limitations
 - More than 50% of the total budget is spent on wound management

Questions or comments

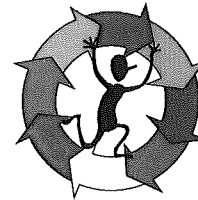
Benefits of VAC Therapy

- **Decreased LOS**



Team approach is very important

Patient is the centre of the team



IV, Breast Ca, Prednisone, Cellsept



