0848-0858: Principles of wound healing and Treatment of complex wounds.

Marc Gottlieb, MD, FACS

0858-0908 : Comprehensive curriculum in vascular medicine and Treatment of MI and ruptured AAA.

0908-0918 : Principles of vascular pathology and Treatment of systemic atherosclerotic complications.

0918-0928 : Certification course in endovascular and interventional vascular care and vascular surgery.

TED Transformative Endovascular Decisions 2024

PRINCIPLES OF WOUND HEALING

AND

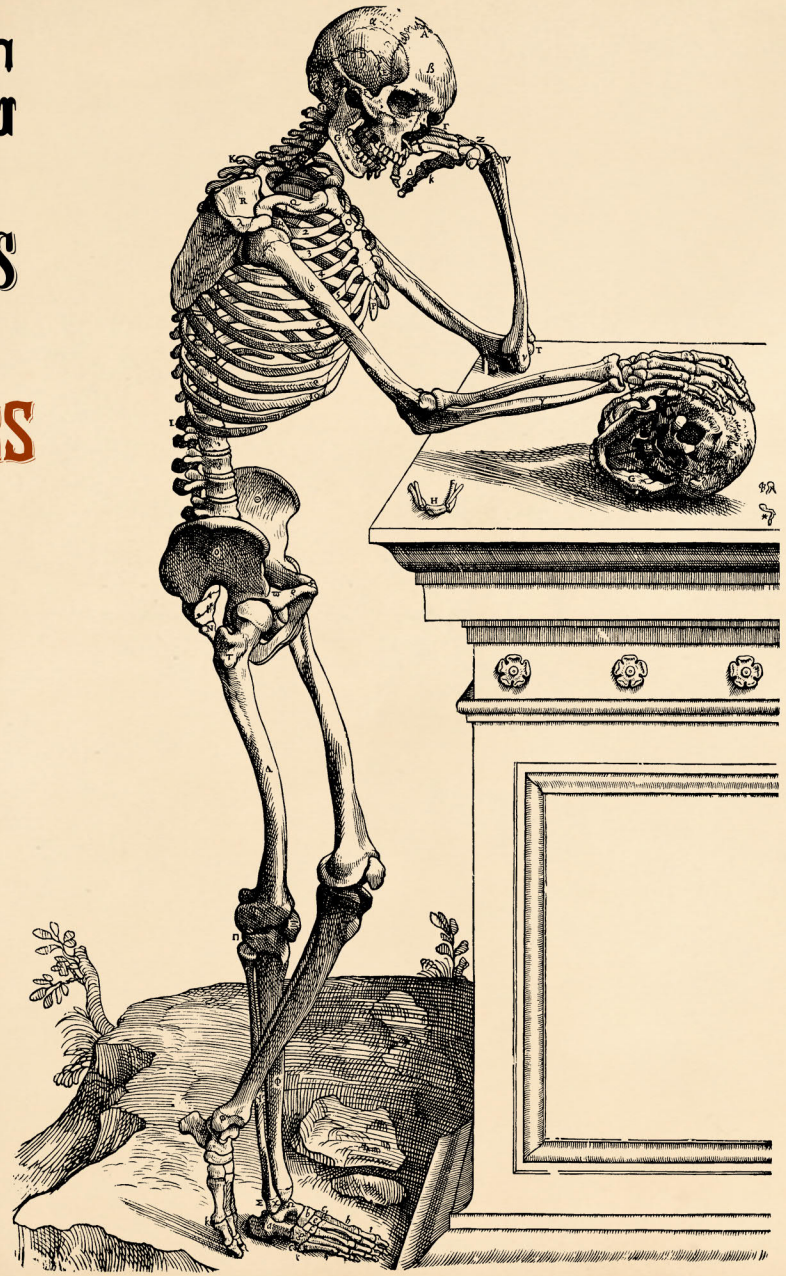
TREATMENT OF COMPLEX WOUNDS

WHAT SHOULD VASCULAR DOCTORS KNOW ABOUT WOUND BIOLOGY & WOUND CARE IN GENERAL?

THE WIDE WORLD OF WOUNDS BEYOND ARTERIOPATHY

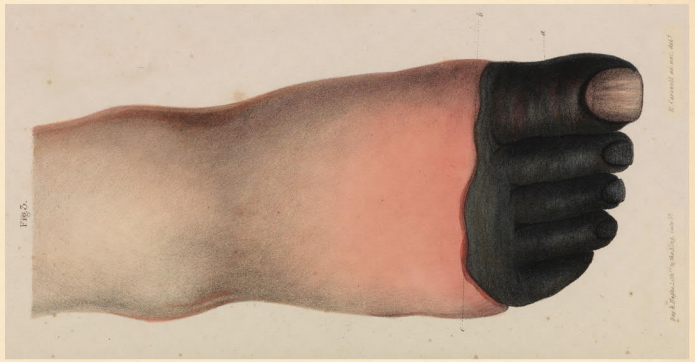
Marc E. Gottlieb, MD, FACS
Phoenix, Arizona

arimedica.com
2024

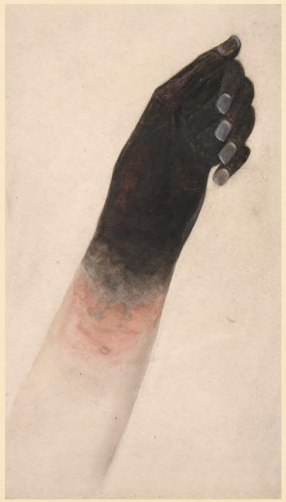


The human skeleton. Andreas Vesalius, Padua, 1543.

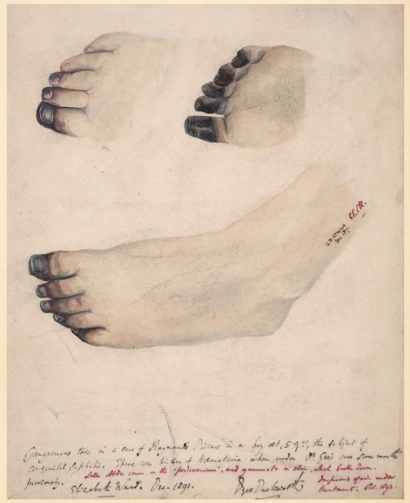
Dry gangrene after ligature of popliteal aneurism. Thomas Godart, London, 1880.



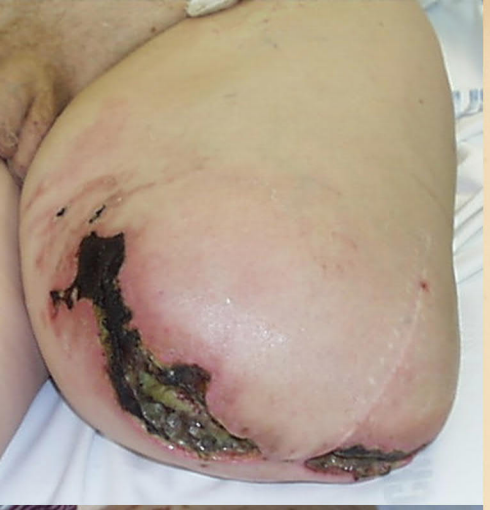
Mortification, gangrene of the toes. Robert Carswell, London, 1837.

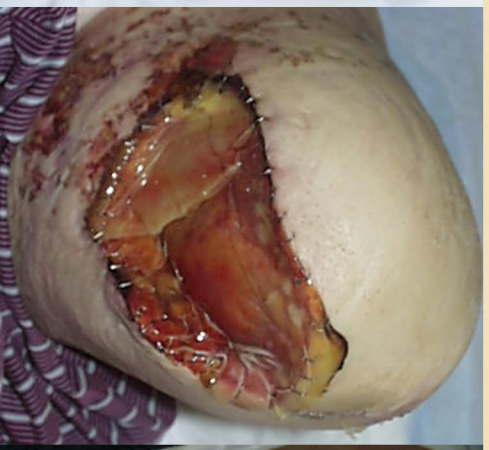


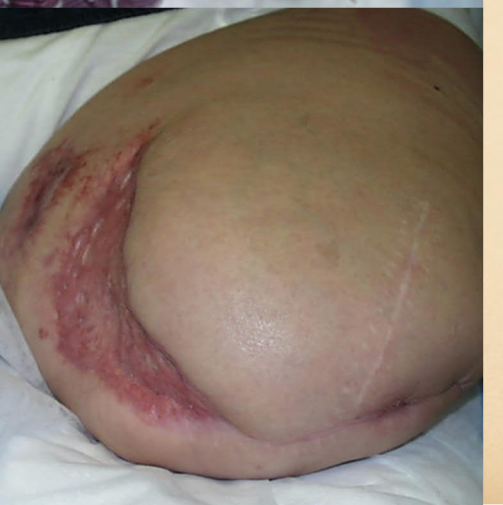
Gangrene of the hand from idiopathic arteritis. Thomas Godart, London, 1880.



Gangrenous toes from Raynaud's Disease, 5 year old boy with congenital syphilis. A.F. Stevens, 1891.







ARTERIOPATHIC & ISCHEMIC WOUNDS

Macro-occlusive wounds

Micro-occlusive

Acute = infarcts

Chronic = ulcers

(Thrombo-infarctive pattern)

(non-pathological wounds)

Special risks of these wounds.

— Due to Ischemia —

infection

pathergy & progressive infarct

amputation

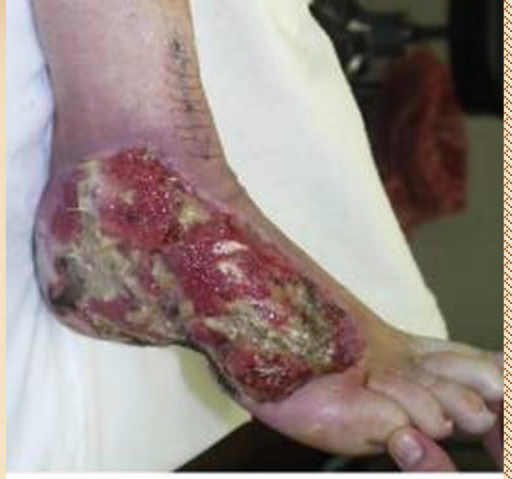
threat to life

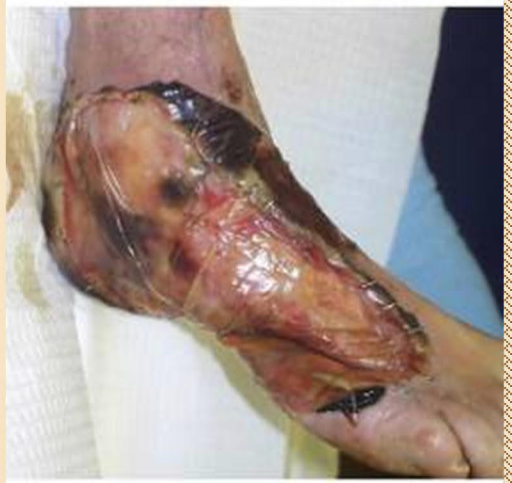
urgent or expeditious eval and rx

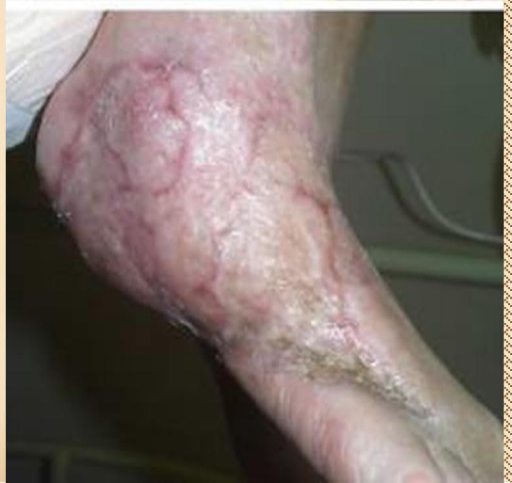
Association with other ulcerogenic dx.

diabetes

Crucial role of vascular therapies to correct primary problem.







OTHER WOUNDS

(The majority)

immune-inflammatory

hematological — hypercoagulable

vasculopathic

mechanical

neuropathic

metabolic

misc others (trauma, cancer, etc.)

pathological vs. non-pathological

mixed pathophysiology

micro-occlusive

autoimmune intrinsification

Subacute, insidious, chronic

Thrombo-infarctive pattern

Inflammatory-lytic pattern

(Pathological and non-pathological wounds)

Special risks of these wounds.

Misery, disability.

No risk for amputation.

Risk to life from underlying disease, not the wounds.

Cardiovascular Care on TV and in the Bizarro World

Patient : *"Doc, I have chest pain."*

Doctor : *"How long, young man ?"*

Patient : *"Oh, a few months, had trouble finding time to check it out, busy at work."*

Doctor : *[to TV nurse] "Nurse, quick, prep for surgery, he needs an emergency heart bypass."*

" Wound Care " in the Real World by "Generic Doctors"

Replace "heart bypass" with :

antibiotics
hyperbaric oxygen
amputation
wet-to-dry
mri
dopplers (in a pt with normal pulses)
etc.

Problems Plaguing Formal Wound Practice

No curriculum,
no formal education,
not taught in schools or residencies.

Monkey see, monkey do
training.

Old wives tales & folklore
diagnosis and care.

Urban intern legend
diagnosis and care.

Inept and harmful care by those with no knowledge of the subject.

Skilled competent care is divided among traditional specialties managing just one facet of all wounds.

Wounds are like any system or disease.

They need experts who know the full spectrum of the problem.
Anatomy, Physiology, Pathology ➜ Diagnosis, Therapeutic, Management

That body of knowledge exists but is underappreciated
or parceled out among traditional specialties.

They need proper comprehensive diagnosis.

They need diagnosis specific rational rx.

Wrong diagnosis = wrong care =
no or bad outcome.

Blind monks examining an elephant, Ukiyo-e print, Hanabusa Itcho (1652–1724)

FIRST IMPORTANT POINT

Real Wound Medicine and Surgery are founded on robust knowledge of wound biology and pathology.

While select wounds are cared for by various specialties, diagnosis and management of all wounds depends on this broad knowledge which transcends any single subset of wounds or their causative diagnoses.

Regarding title subject, "Principles of Wound Healing", main issue is not so much "what's new", but

catching up all doctors to formal principles of diagnosis and treatment that prevail in the traditional well developed specialties.

Some KEY PRINCIPLES of CAP wounds (Chronic and Pathological) and Care.

Chronic wounds cause symptoms, disability, misery. But, aside from advanced arteriopathy, they do not cause life and limb risk (but the underlying dx can).

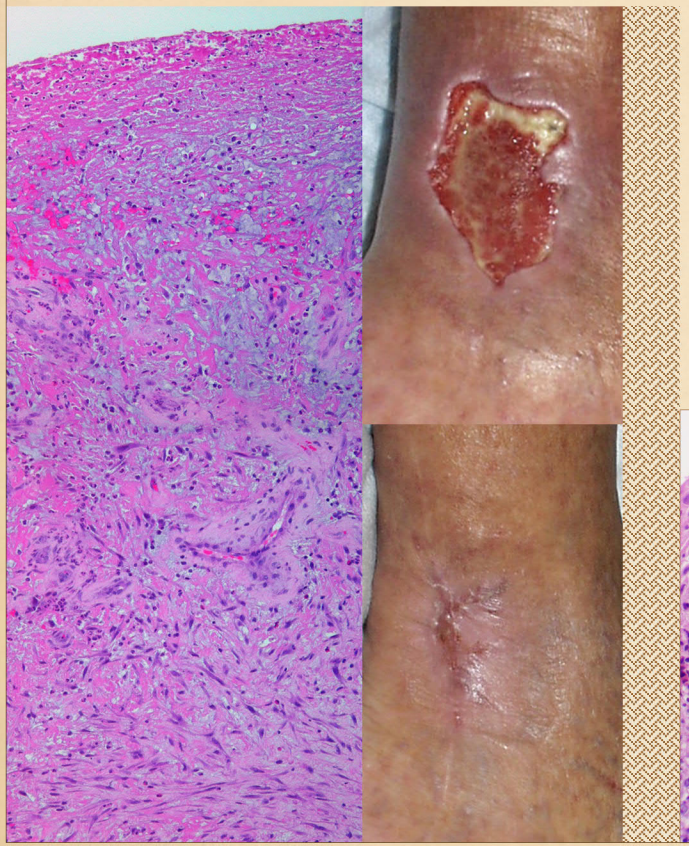
► Do not overestimate severity, do not get pointless misleading tests, avoid errant consults, do not prescribe or endorse errant and injurious care.

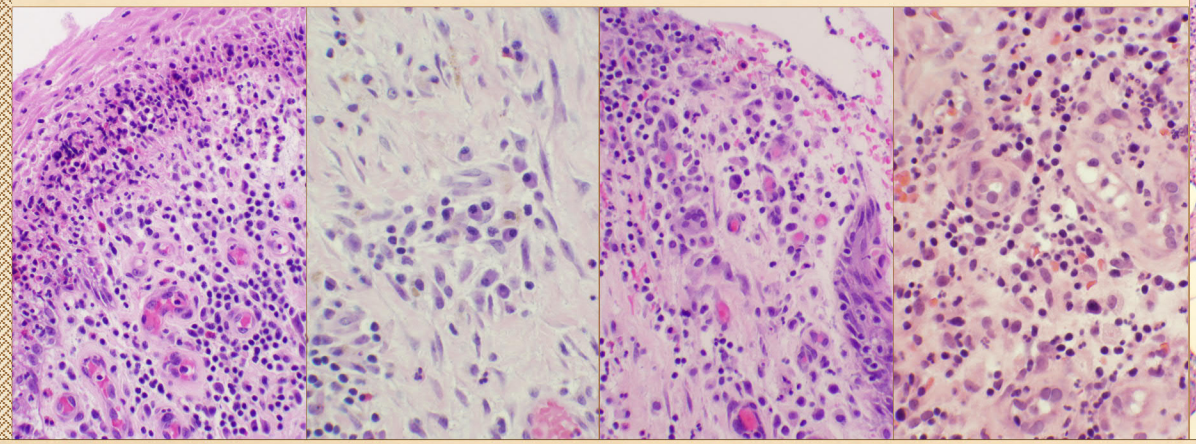
Make proper diagnosis of wound cause, and state of underlying disorders.

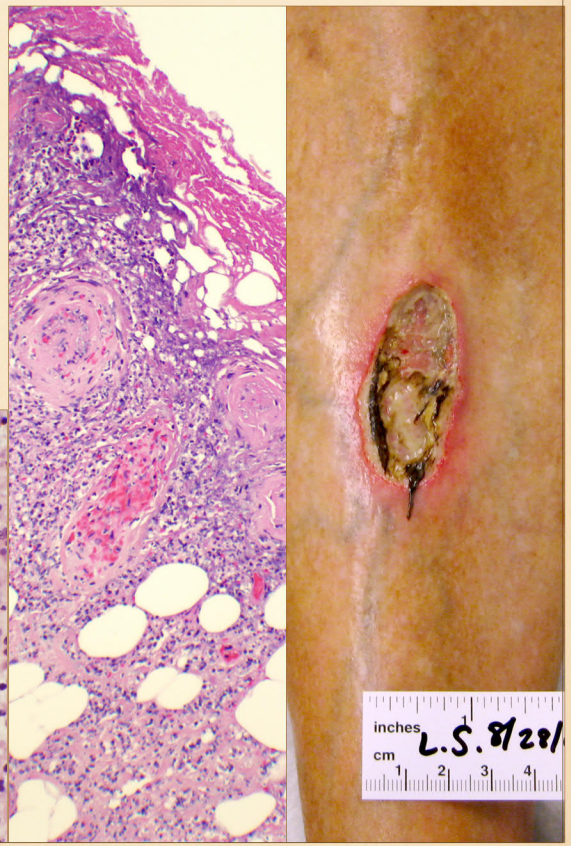
► Practice basic hygienic wound care as treatment is started for underlying causes.

In contrast to trauma & severe arteriopathy wounds, CAP wounds get measured rx & chronic care of dx.

► Surgery and procedures are often required, but the care is ongoing, more "medical" then "surgical".







Normal, healthy, healing

Active ulceration, Inflammatory-lytic

Chronic ulcer, not healing

Active infarct-lysis, chronic non-healing

CHRONIC, PATHOLOGICAL, AND COMPLEX WOUNDS

Understanding these terms. — Types of wounds – Diagnostic categories.

1

Trauma
Acute Illness
Complications of Surgery

Non-pathological
(wound healing is normal)

Large trauma
Burns
Degloving
Fasciitis
Compartment decompression
Complications of surgery

Patient care is complex,
— and —
the wounds can be big and logistically taxing,
— but —
the wounds are physiologically healthy and will heal.

2

Disease Related
Acute & Chronic Wounds,
Non-Pathological

Wounds result from intercurrent disease or extrinsic factors
— and —
patient disease and care can be complex
— but —
wound healing biology is inherently normal.

Wounds may be anatomically complex, invoking surgical closure,
— but —
wounds heal and surgery is eligible once causative factors are alleviated.

Arterial Ulcers

Macro-arterial
Micro-arterial
non-inflammatory, e.g. hyperparathyroid-esd

Mechanical Ulcers

Pressure injury
Msk and motion related
Diabetes

Para-neoplastic

Myeloproliferative

Patient complexity.
Multifactor dx cmplex'y.
Patient care complexity.
Anatomical complexity.

Wounds stressed extrinsically, but intrinsic biology is normal.
Wounds heal when factors are corrected or alleviated.

3

Disease Related
Acute & Chronic Wounds,
Pathological

Wounds related to systemic diseases that effect stroma
— and —
patient disease and care can be complex
— and —
wound healing biology is inherently abnormal.

Wounds may be anatomically simple, expected to heal with basic care,
— but —
wound healing is intrinsically disordered, non-healing, recurrent.

Diseases of Immunity-inflammation

Collagen-vascular & Connective tissue disorders *(cvd-ctd's)*

Vasculitides

Paraproteinemias, light chains, gammopathies, etc.

Diseases of blood and hyper-coagulopathies

Hypercoagulable disorders

Formed element dyscrasias

Other micro-occlusive disorders

Wound "intrinsification"

Acute or "ordinary" wounds which become auto-immunized.

CHRONIC, PATHOLOGICAL, AND COMPLEX WOUNDS

Understanding these terms. — Types of wounds – Diagnostic categories.

Basic Considerations Evaluating a Wound (Problem or otherwise)

Active injury-ulceration -vs-
simple open wound -vs-
stable chronic wound

Healing -versus- closed
Healing -or- not healing
(normal dynamics & timeframe)
(sequential observation)

Pathological -vs-
Non-pathological

Underlying diseases & causes

Anatomical complexity
-vs-
Pathological complexity
-vs-
Patient complexity

CAP Wounds "Chronic and Pathological"

These are chronic non-healing wounds, unresponsive to basic hygienic care, pathergy prone, ineligible for surgery, prone to recurrence,

◆ ◆ ◆

from repetitive injury & inflammation, due to auto-immune cvd-ctd, micro-thrombosis, other blood diseases, misc. other disorders, breeding tertiary tissue immunity and chronic inflammation.

CAP Wounds

are the true intrinsic diseases of wound healing, affecting angiocytes, fibroblasts, and the generic stroma. They are a form of cvd-ctd.

"Wound healing" is simply reassembly of the stroma after traumatic, lytic, or infarctive injury. Any disease disrupting that causes chronic or non-healing wounds.

*** When the injurious or *** disruptive disease is an extrinsic factor, fix those factors to disinhibit the wound.

When the wound fails to heal due to intrinsic disorganization of wound healing biology, healing is hard to induce.

"Complex" Pathology

Most chronic wounds have multiple causative or perpetuating factors.

Venous
macro-vascular hemodynamics
venous vasculitis
chronic panniculitis

Pressure
neuropathy
biomechanics
functional and psychosocial

Diabetic
neuropathy
biomechanics
arterial (not all)
neuro-psychosocial

CAP
hypercoagulability -or-
(allergy, other blood or inflamm'y dx)
systemic autoimmunity
induced local autoimmunity

SECOND IMPORTANT POINT

"Complexity" in a wound has multiple connotations:

anatomical
physiological
pathological
intercurrent disease
patient management

Context and concise diction are required.

Correct comprehensive diagnoses are required.

To heal current wounds & prevent future wounds:

All pertinent diagnoses and extrinsic correctible factors need evaluation and correction.

PRINCIPLES OF WOUND TREATMENT

Healthy wounds heal. — **Sick wounds need diagnosis-specific care.** — **Avoid pathergy & making problems worse.**

Healthy Wounds & Basic Wound Care

It is a robust physiology that always works when not interfered with.

Don't be "That guy".

BASIC CARE "PROGRAM"

Hygiene

Debridement

Topicals

Edema control

Treat aggravating factors.

General patient support

(nursing, supplies, teaching)

Problem Wounds & Diagnosis Related Wounds

"Basic care" might or might not succeed, but all care starts there.

Stabilizing wound, arresting progressive infarct-lysis-ulceration and adverse symptoms are paramount.

Once stable, focus can turn to evaluation and treatment of causative diseases.

When diseases, risks, aggravating factors are corrected, the wound should start healing.

If not, attention turns to closing wound by procedural methods.

CAP Wounds, Ischemia, Inflammation

Ischemia & inflammation-immunity predispose wound to pathergy, progressive infarct-lysis-ulceration, failed surgery, and other complications.

"Basic care" will not heal wound but is mandatory to control acute active state.

Evaluation and rx of underlying disease is essential and high priority.

Non-pathological wounds will then heal.

Pathological, CAP, intrinsic wounds might not, but surgery, biologics, and other Rx are then eligible.

Wound Healing & Closure Principles

1. BASICS
2. Treat underlying disease.

Do not waste time, tissue, and expensive resources on other treatments **until 1 & 2 are satisfied.**

Only then, if wound still is not healing, start "wound healing" therapies and modalities

-or-

if wound meets certain technical criteria dictating prescribed care:

Stimulatory therapies

Regenerative materials

Wound closure surgery

Wound Healing & Closure Therapies

Stimulatory Therapies

Stimulate tissues-cells in extant wnd to reorganize and behave correctly.

platelets, amnion, preserved tissues, living cell skin analogues, physical modalities

Regenerative Matrices

Biological scaffolds for stromal stem cells to create embryonic new tissue.

native-processed, mashups

bovine, porcine, ovine, human, et al.

Surgery

Wound closure surgery, with well defined indications and methods.

simple repairs

grafts

flaps

regenerative matrices

PRINCIPLES OF WOUND TREATMENT – BY DIAGNOSIS

Healthy wounds heal. — **Sick wounds need diagnosis-specific care.** — **Avoid pathergy & making problems worse.**

Arterial and Ischemic

macro-occlusive

High quality topical care.

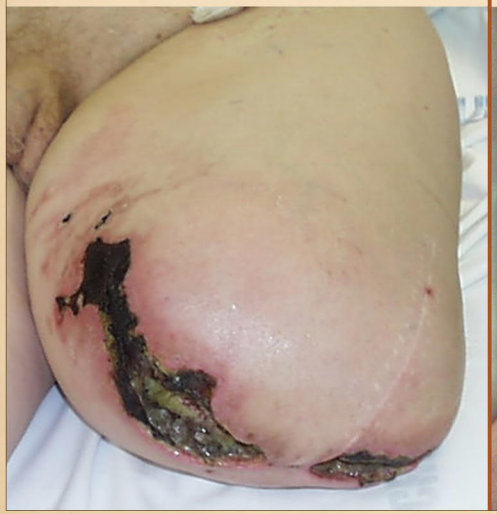
Essential debridement.

Revascularize.

Hyperbaric oxygen until revascularization (or if unsuccessful).

Closure surgery if required, after revasc, grafts or matrices.

If surgery mandatory without revascularization, use matrices.



Hypercoagulable, et al.

ischemic micro-occlusive

High quality topical care.

Essential debridement.

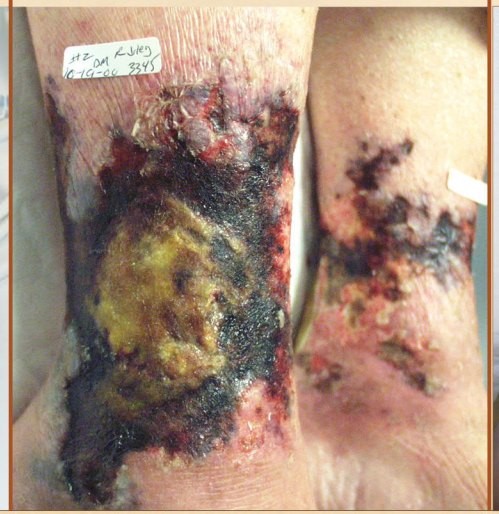
Anticoagulate. Warfarin, heparins.

Hyperbaric oxygen until healing.

Steroids for concomitant cvd-ctd.

Closure surgery if required, all options eligible, but matrices preferred in dubious conditions.

Anticoagulate during surgery.



Immune & Inflammatory

cvd-ctd, vasculitides, neutrophilic dx

High quality topical care.

Essential debridement.

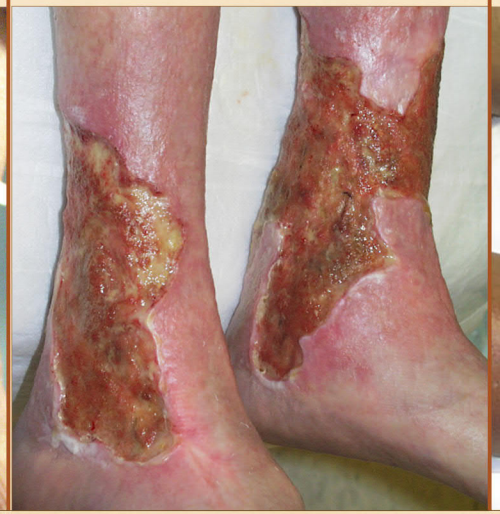
Steroids & anti-immune rx.

Edema control.

Anticoagulants if hypercoagulable.

Closure surgery if required, with regenerative matrices.

Extra steroids in peri-op period. Plasmapheresis for refractory cases.



Venous

venous htn & vasculitis, panniculitis

Topical care.

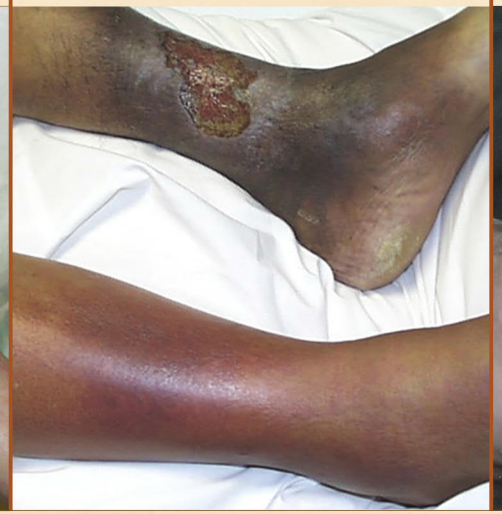
Venous reflux surgery if indicated.

Compression.

Evaluate for hypercoagulability. Anticoagulants if indicated.

Short term steroids as needed for eczema, panniculitis, venous vasculitis.

Many heal with compression only, but if not, skin restoration with matrices.



Diabetes

neuropathic-mechanical, +/- arterial

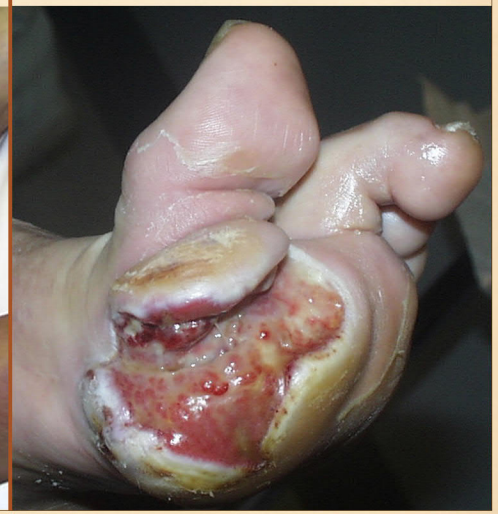
Topical care. Debridement. Vascular evaluation, Rx if indicated.

Mechanical off-loading. TCC.

Surgery for biomechanical balance or correction if required.

Closure surgery as (often) required, (after revasc, if that is needed).

Wound stimulus rx (e.g. amnion), vs. regenerative matrices, vs, local flaps, depending on wound anatomy.



PRINCIPLES OF WOUND TREATMENT – BY DIAGNOSIS

Healthy wounds heal. — **Sick wounds need diagnosis-specific care.** — **Avoid pathergy & making problems worse.**

Pressure

neuropathic-mechanical, psychosocial

Topical care. Debridement.

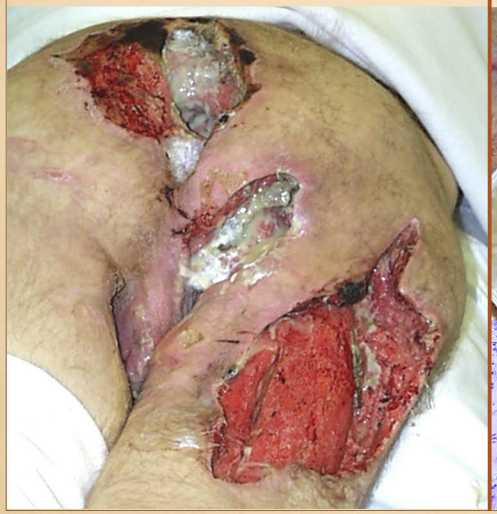
Education. Rehabilitation.

Off-load. Wound closure surgery.

Comprehensive spine injury care.
Urinary hygiene.

Surgery required, flaps.

Long term comprehensive maintenance care and avoidance of future wounds.



Unexpected Surgical Complications

pathergy – evaluate the occult dx

High quality topical care.

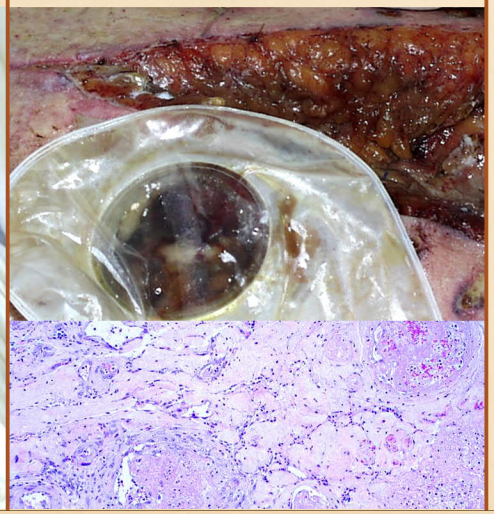
Essential debridement only.

Avoid pathergy and progressive infarct-ulceration-dehiscence.

Anticoagulate. Workup. Steroids.

Diagnosis specific ancillary rx.

Progressive surgery only after diagnoses are made, and causative factors have been treated.



COMPLEX WOUND MGMT

THE GENERAL SCHEMA

(Same as for all medical problems.)

PHASE 1
MANDATORY RX
Wound Control

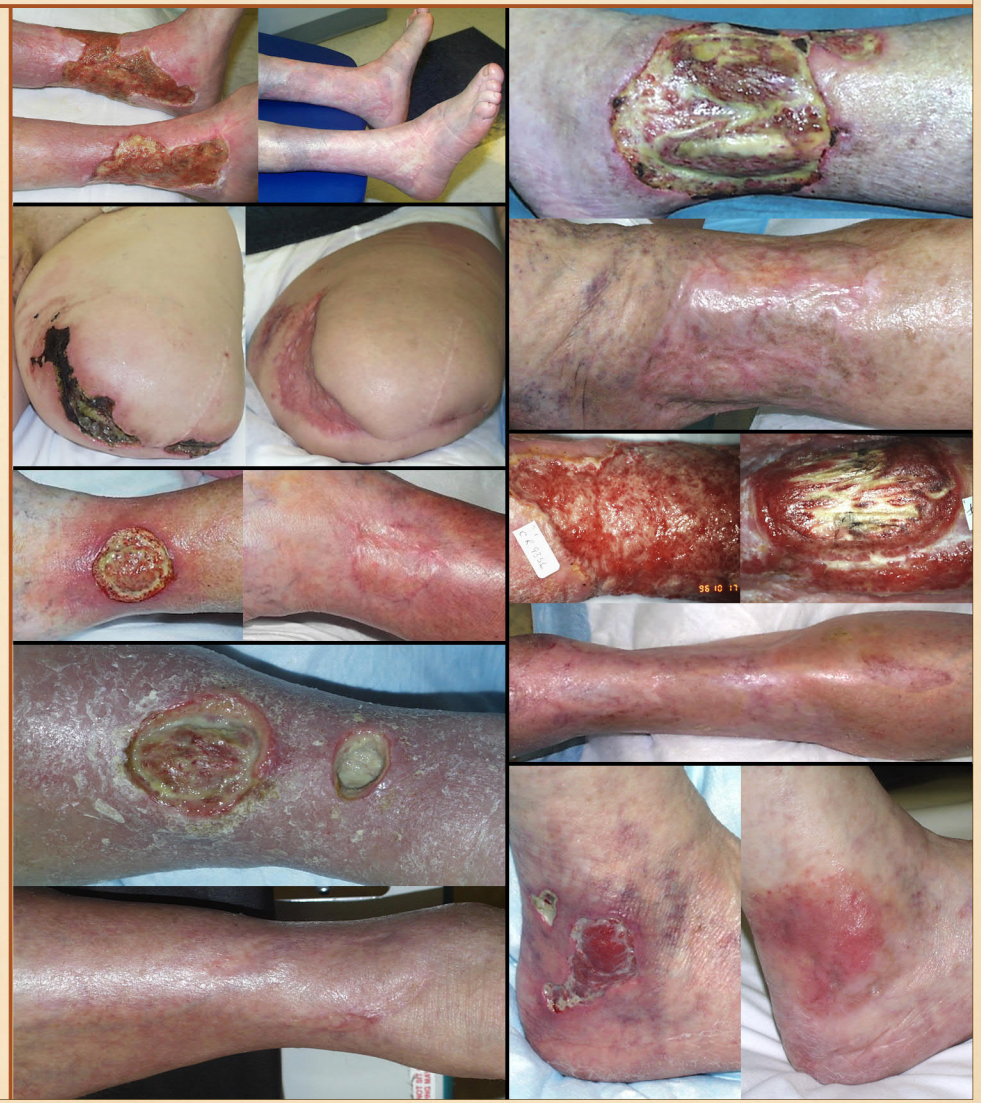
Control disease. Turn wound into a healthy, non-threatening, asymptomatic condition.

PHASE 2
DISCRETIONARY RX
Definitive Care and Resolution

Establish & implement realistic treatment goals for closure, palliation, or other resolution.

PHASE 3
MANDATORY RX
Maintenance Care

Maintain control to prevent flare-ups and recurrence.



ARIMEDICA

Medical education about wounds and other subjects. Presentations

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Many of these files are fully annotated with text to accompany each slide, which obviously makes them more understandable and educational. Alas, many are not, but periodically some notes are added. The status is indicated, starred *** if annotated.

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2018, September 15	Houston, TX	Amniotic Tissue in Complex Hernia Repair & Enterocut. Fistulas
2017, October 27	Phoenix, AZ	Wound Pathergy – When Not to Operate
2017, June 24	Boston, MA	Abdominal Wall (2 parts)
2016, April 13	Atlanta, GA	Debridement (2 parts)
2015, May 7-8	Barcelona Spain	Clinical Use of Integra Dermal Rgeneration Template (3 parts)
2015, April 17	Napoli, Italy	In Situ Tissue Engineering - Embryonic Histogenesis in Matrices
2015, March 19	Phoenix, AZ	Prime Principles in the Surgery of Repair
2011, January 20	Augusta, GA	Integrating New Technologies Into Practice
2011, January 6	Phoenix, AZ	Wound Pathergy – When Not to Operate
2010, May 7-8	Baltimore, MD	Integra Flap Course
2010, February 22-23	Maui, HI	The Physics and Pathology of Wounds (3 parts)
2009, September 26	Miami, FL	(Not) Atypical Wounds & Integrating New Technologies
2009, November 6	Phoenix, AZ	Apligraf – Re-Engineered Living Skin
2006, December 8	St. Thomas, USVI	Integra in Situ Tissue Engineering: Embryonic Histogenesis
2006, August 12	Squaw Valley, CA	Surgical Treatment & Reconstruction of Necrotizing Infections
2006, May 19	Fort Collins, CO	Hypercoagulability – Pre- & Microthrombotic Disorders
2006, May 16	Scottsdale, AZ	Angiogenesis as a Regulated Control System (the VT Model)
2006, March 8	Palm Springs, CA	Apligraf – Re-Engineered Living Skin – Chronic Wounds
2005, December 14	Bethesda, MD	Integra Artificial Skin – Geriatric Population
2005, October 29	Phoenix, AZ	Wounds and Ulcers in Geriatric Patients

Recent

Transcripts, notes, and slides from the most recent presentations.

2021, November 20 – November 23
Las Vegas, NV
Phoenix, AZ

Ventral & Incisional Hernias: Principles of Safe and Effective Restoration (They can be prevented, and they can all be fixed.)
Integra Sponsored Lab and Seminar
Surgery Grand Rounds, HonorHealth John C. Lincoln
Section 1 gives an historical perspective on hernia care and surgery, with emphasis on the recent epidemic rise in failed repairs, hernia recurrence, and failed technologies.
Section 2 discusses technicalities of safe and effective abdominal wall restoration.
Section 3 is a gallery of cases illustrating these points. If these principles are applied during primary laparotomy, hernias can be avoided in the first place. The cases illustrate though that even after multiple failed procedures, complicatons, and progressive damage to the abdominal wall, it can still be salvaged and reconstructed for a long term durable result.

Ventral & Incisional Hernias, and Redo, Complicated, & Failed Hernia Repairs – How Did We Get into Such a Mess? (And How to Get Out of It.)
Presentation format, PDF *(pdf 26 MB)*. *Full page med-res images. No text, annotations.*
Presentation format, PPTX *(pdf 77 MB)*. *Full page hi-res images. No text or annotations.*

2020, September 26
Scottsdale, AZ

Necrotizing Soft Tissue Infections – An Overview for Non-Surgeons
Rocky Mountain Region WOCN _ Virtual Conference
Necrotizing fasciitis has always been a challenging disease with respect to early diagnosis and then the effort and logistics of post-operative care. There is an evolving perception that, on top of these problems inherent to the disease, that modern degradations of competent hospital practices are resulting in unnecessary delays of care and increased morbidity and mortality for this disease – we are going backward. This invitational talk asked to address how nurses and therapists can intervene to help recognize the diagnosis and expedite the correct care of these patients.

Necrotizing Soft Tissue Infections – An Overview for Non-Surgeons.
Presentation format, PDF *(pdf 13 MB)*. *No text, slides as presented September 26, 2020.*

2018, September 20
Phoenix, AZ

Hypercoagulable Disorders – Implications For Wounds & Surgery
Banner University Medical Center - Phoenix
An update on hypercoagulable disorders. There are two main sections. The first presents the usual medical information about physiology, nomenclature, pathology, clinical approach, diagnosis, and treatment. The second part explores the historical reasons why these disorders remain under-appreciated and under-recognized by physicians, and then the physiological reasons why they remain under-appreciated.

Hypercoagulable Disorders – Implications For Wounds & Surgery, Pathophysiology, Clinical Features, Diagnosis & Treatment – AND – Insights About the Historical Understanding of this Subject and Why These Problems Remain Perpetually Under Appreciated, Under Recognized, and Under Treated. Combined With Modern Technology Based Biological Materials.
Presentation format, PDF *(pdf 29 MB)*. *No text, slides as presented January 6, 2011.*
Reader's format, PDF *(pdf 25 MB)*. *** *Full TEXT annotation: small file, low-res images.*

2018, September 15
Houston, TX

Amniotic Tissue in Complex Hernia Repair & Enterocutaneous Fistulas
Baylor Hernia Symposium 2018.
The author's contribution to a symposium on abdominal wall and hernia reconstruction and related problems. This presentation focuses on enterocutaneous fistulas, abdominal wall and hernia problems as they interface with fistulas, and the use of stimulatory and regenerative biologics in the management of these problems.

Amniotic Tissue in Complex Hernia Repair & Enterocutaneous Fistulas – Reconstructive Surgery & Wound Care Principles, Applied to a Notoriously Morbid & Difficult to Treat Problem – AND – Insights Into Effective Management & Cure Utilizing Classic Principles of Plastic Surgery Combined With Modern Technology Based Biological Materials.
Presentation format, PDF *(pdf 15 MB)*. *Full page hi-res images. No text or annotations.*

2017, October 27
Phoenix, AZ

Wound Pathergy – When Not to Operate
Continuation of subject from January 6, 2011 (see below), now fully annotated.
This presentation explains the principles of wound pathergy and the general categories of pathology that cause thrombo-infarctive and inflammatory-lytic necrosis and ulceration (vascular, hematological, hypercoagulable, inflammatory, autoimmune). It then explains

PERTINENT LINKS

Hypercoagulable Disorders – Implications For Wounds & Surgery

Hypercoagulable Disorders — Implications For Wounds & Surgery,
Pathophysiology, Clinical Features, Diagnosis & Treatment
— AND —
Insights About the Historical Understanding of this Subject and
Why These Problems Remain Perpetually Under Appreciated,
Under Recognized, and Under Treated.

Wound Pathergy – When Not to Operate

Principles of Surgery — Wound Pathergy (When Not to Operate) —
Situations to avoid that will cause necrosis, dehiscence,
wound failure, & related complications.

The Physics and Pathology of Wounds

Part 1. The Wound as a System and a Controlled Machine.
Part 2. Auto-Immunopathy & the Intrinsic Disease of Wound Healing.
Part 3. Chronicity and the Physics of Wound Failure.

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February 19, 2024 (original presentation)