Interventions to treat foot ulcers in people with diabetes

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1404/7/8

epidemiology

The prevalence of foot disease is estimated as~ 6.3%

cited as high as 13% in some population studies

These wounds are more common among patients with DM2 and are positively associated with duration of disease and increased burden of complications .

expected that 19%-34% of patients will experience a DFU in their life.

Attention!!

12-24% of individuals with a foot ulcer require amputation.

In fact, every year approximately 5% of diabetics develop foot ulcers and 1% require amputation.

Causes of dfu:

Neuropathy
Arterial insufficiency
truama
Chronic diabetic complications
Foot deformities
Poor hygiene
Improper habits and beliefs

- Diabetic foot ulcers can be classified based on the underlying mechanisms or ulcer features.
  - Based on the underlying mechanisms
    - Neuropathic
    - Ischemic
    - Infectious
    - Traumatic?
    - Atypical
  - Based on the ulcer features
    - Wagner classification
    - University of Texas classification

WAGNER DIABETIC FOOT ULCER CLASSIFICATION SYSTEM

Grade	Description
0	No ulcer, but high-risk foot (e.g., deformity, callus, insensitivity)
1	Superficial full-thickness ulcer
2	Deeper ulcer, penetrating tendons, no bone involvement
3	Deeper ulcer with bone involvement, osteitis
4	Partial gangrene (e.g., toes, forefoot)
5	Gangrene of whole foot

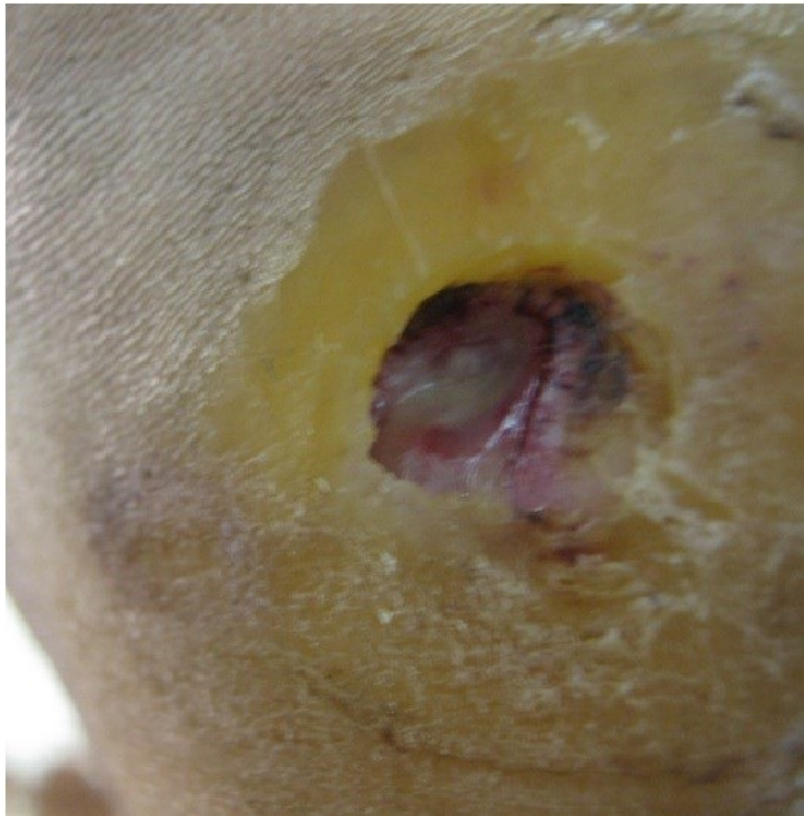
	GRADE				
STAGE		0	1	2	3
	A	Pre-ulcerative lesions No skin break	Superficial wound No penetration	Wound penetrating tendon or capsule	Wound penetrating bone or joint
	B	With infection	With infection	With infection	With infection
	C	With ischemia	With ischemia	With ischemia	With ischemia
	D	With infection and ischemia	With infection and ischemia	With infection ad ischemia	With infection and ischemia

Figure 2.

The University of Texas Wound Classification System.

- **Chronic pressure (neuropathic)**
  - Painless/callus/ pulse+/pressure site/pink
- **Ischemic**
  - Painful/Bulla/Pulseless/Tip of fingers/red
- **Infectious**
  - below or between toes/purulent/deep ulcers
- **Traumatic**
  - Every location and shape
- **Atypical**
  - Unexpected location, presentation or behavior

Neuropathic ulcer



Neuropathic ulcer

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Neuropathic ulcer on charcot foot

Ischemic ulcer

Ischemic ulcer

INFECTIOUS ULCERS

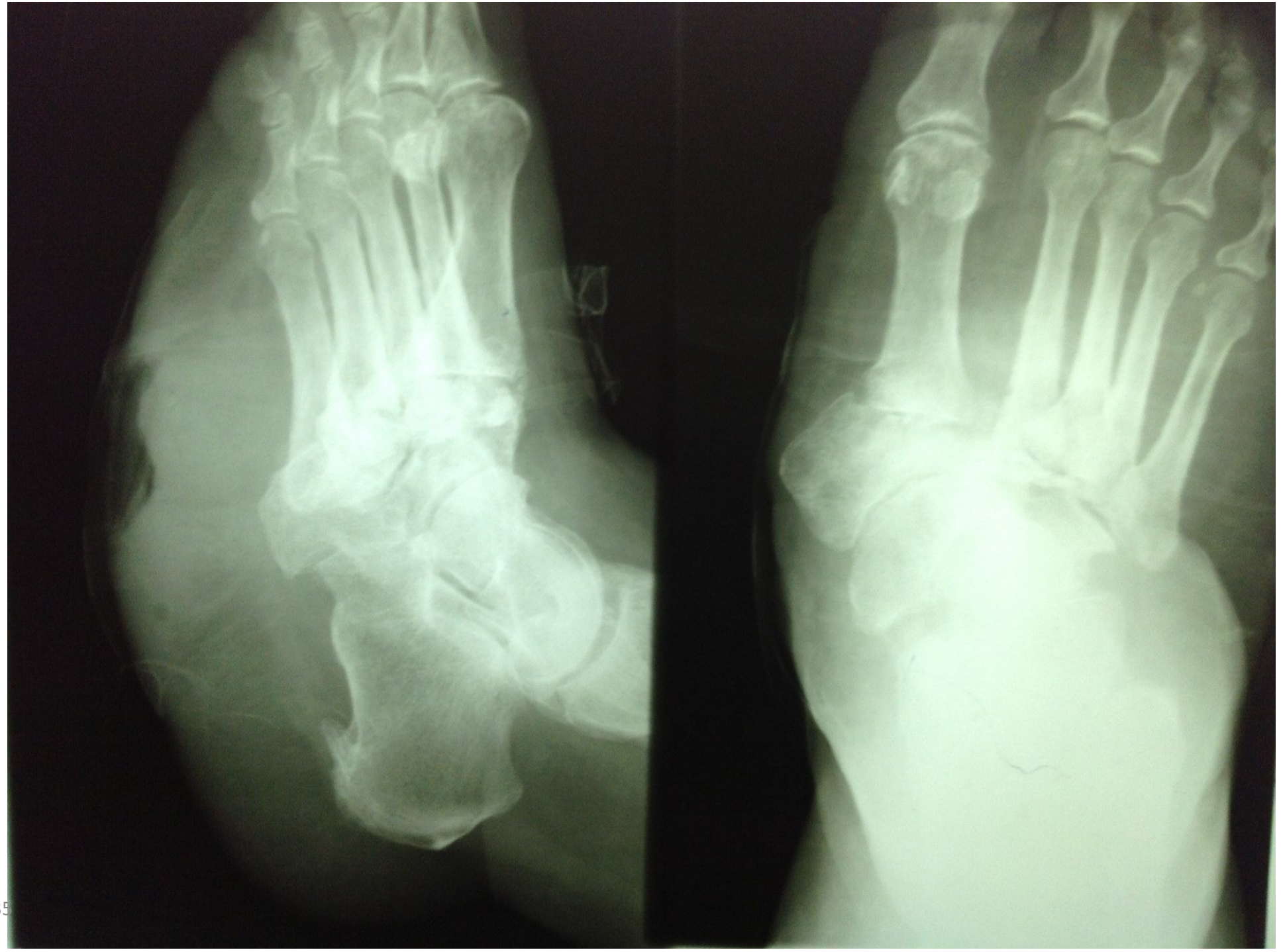
INFECTIOUS ULCERS

PRIMARY INFECTIOUS ULCER

- Traumatic DFUs are very prevalent and have different characteristics.
- They may mimic other types of DFUs.
- They can be diagnosed by history and clinical examination.
- Mechanical
- Heat
- Cold
- Chemical and Others

Traumatic ulcer

Charcot foot



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Approach to the patients

1) limb preservation

salvage of a limb that would have otherwise required surgical amputation.
requires a series of steps including:
re-establishing adequate perfusion
serial debridement
appropriate wound coverage
aggressive infection management
correction of underlying biomechanical abnormalities

Approach to the patients:

- The role of team/ multidisciplinary approach
- History and physical examination
- Neurologic evaluation
- Vascular evaluation
- Bacteriologic investigation
- Imaging
- Others

Approach to the patients

indications of urgent admission

- Sepsis or moderate to severe infection
- Sever ischemia or gangrene
- Exposed bone or joint
- Bad clinical background
- Unstable situation

Principles of ulcer treatment

- Relief of pressure and protection of the ulcer
- Restoration of skin perfusion
- Treatment of infection
- Local wound care
- Metabolic control and treatment of comorbidity
- Education for patient and relatives

Relief of pressure and protection of the ulcer

- Mechanical off-loading
- Total contact casting or other casting techniques
- Temporary footwear
- Individually moulded insoles and fitted shoes
- Non-weight bearing
  - limitation of standing and walking
  - crutches, etc

Off loading

Off loading shoes, ortho wedge, boot

Restoration of skin perfusion

- Arterial revascularization procedures:

- results do not differ from people without DM, but distal revascularization procedures (angioplasty or bypass-surgery) are needed more frequently.

- The benefits of pharmacological treatment to improve perfusion have not been established.

Restoration of skin perfusion

- Emphasis should be placed on CVD risk reduction
- (cessation of smoking, treatment of hypertension and dyslipidaemia, use of aspirin).

Treatment of infection

- Superficial ulcer with skin infection

  - debridement with removal of all necrotic tissue and oral antibiotics targeted at Staphylococcus aureus and streptococci

Treatment of infection

- Deep (limb-threatening) infection

1) surgical drainage as soon as possible (emergency referral) removal of necrotic or poorly vascularized tissue, including infected bone revascularization if necessary

2) broad-spectrum antibiotics intravenously, aimed at Gram-positive and negative micro-organisms, including anaerobes

Debridement:

- for removing the barriers to healing, thereby stimulating the growth of new tissue and wound closure.

- The first step is aggressive debridement through the use of surgical, autolytic, mechanical, or biological methods to remove all necrotic tissue, slough, and firm eschar, since each of these impede healing.

- Debridement may also promote healing by creating a clean wound surface free of senescent cells and biofilms, which shield bacterial colonies and may make them more resistant to infection management.

Methods of wound debridement

Surgical and sharp using scalpel and scissors. Highly selective with rapid results. Should only be undertaken by a skilled practitioner.
Mechanical such as hydrotherapy and wound irrigation. Rehydration can ease removal of the surface eschar and removes surface debris. However, these are relatively slow techniques and there is little evidence to support their use. Potential for cross infection needs to be considered if using hydrotherapy. There is also a theoretical risk of fluid embolism and promotion of infection if irrigation is too vigorous.
Autolytic using hydrocolloids and hydrogels. Rehydration of necrotic tissue through the use of a hydrogel or by keeping the wound moist, and removal of devitalised tissue using the body's own enzymes. This method is in common use but prolongs the time needed for debridement.
Enzymatic using preparations such as streptokinase or streptodornase or bacterial-derived collagenases. Streptokinase and streptodornase aim to break down and rehydrate necrotic tissue, but despite being available for more than 30 years, there is little evidence to support their use over alternative methods. Also, the need to score the eschar before application may increase the risk of damage. Bacterial-derived collagenases show great potential and may promote healing.
Biological such as maggot therapy. The larvae of Lucilia sericata (greenbottle fly) digest necrotic tissue and pathogens. This technique is rapid and selective, although much of the evidence to support its use is derived from anecdotal reports.
Chemical such as hypochlorite. No longer widely used as application can be painful and underlying tissue is damaged.

1. Surgical and Sharp Debridement

- **Best for:** Deep or severe wounds with extensive necrotic tissue
- **Advantages:** Fast and effective removal
- **Disadvantages:** Requires high skill; risk of bleeding or damage to healthy tissue
- **Use:** Performed by surgeons or trained professionals in clinical settings

2. Mechanical Debridement (هیدروتراپی و شستشوی زخم)

- **Best for:** Superficial or chronic wounds
- **Advantages:** Accessible; can be done in clinics or at home
- **Disadvantages:** Non-selective; may remove healthy tissue
- **Use:** Includes wound irrigation, wet-to-dry dressings, or hydrotherapy

3. Autolytic Debridement (هیدروژل و هیدروکلوییدها برای آبرسانی)

- **Best for:** Small to moderate wounds in stable patients
- **Advantages:** Painless; preserves healthy tissue
- **Disadvantages:** Slow process; not suitable for infected wounds
- **Use:** Uses hydrogel or hydrocolloid dressings to activate the body’s own enzymes

4. Enzymatic Debridement (کلاژنازهای باکتریایی)

- **Best for:** Patients who cannot undergo surgery or have chronic wounds
- **Advantages:** Selective; can be used at home
- **Disadvantages:** Expensive; requires prescription
- **Use:** Uses enzymes like collagenase to break down necrotic tissue

5. Biological Debridement(لارو مگس)

- **Best for:** Chronic wounds resistant to other treatments
- **Advantages:** Highly selective and effective
- **Disadvantages:** May be emotionally distressing for patients
- **Use:** Sterile maggots (Lucilia sericata) digest dead tissue and bacteria

6. Chemical Debridement (hypochlorit)

- **Best for:** Limited and specific cases
- **Advantages:** Can be effective in certain conditions
- **Disadvantages:** Painful; may harm surrounding healthy tissue
- **Use:** Uses agents like hypochlorite; rarely used today

debridement

Debridement with Maggot Therapy

Larvae of *Phaenicia (Lucilia) sericata*

Live maggots

Local wound care

Common goals of negative pressure wound therapy(vacuum)

- Promote rapid reduction in wound volume
- Promote growth of granulation tissue and contraction of wound edges
- Manage exudate
- Prepare the wound bed for transition to another treatment modality such as surgical closure, or a flap or graft
- Reduce bioburden

Local wound care

Common goals of negative pressure wound therapy

- Decrease hospital stay length
- Decrease morbidity and mortality
- Decrease frequency of dressing change
- Prevent deterioration of the wound
- Minimize contamination and wound odor by providing a temporary barrier
- Improve quality of life

NPWT Contraindications

Do not use NPWT in wounds where there is evidence of the following:

- Exposed vital organs
- Inadequate debridement of the wound
- Untreated osteomyelitis or sepsis within the vicinity of the wound
- Untreated coagulopathy
- Necrotic tissue with eschar
- Malignancy in the wound
- Allergy to any component required for the procedure

NPWT Precautions

- Reasons to use NPWT with caution:
- Active bleeding or a risk of bleeding (eg, there is difficultly achieving wound hemostasis, patient is taking anticoagulants)
- An exposed blood vessel close to the wound
- Difficulty maintaining a seal
- Uncontrolled pain
- Evidence of previous patient noncompliance with or intolerance to the procedure

Foundational VAC therapy

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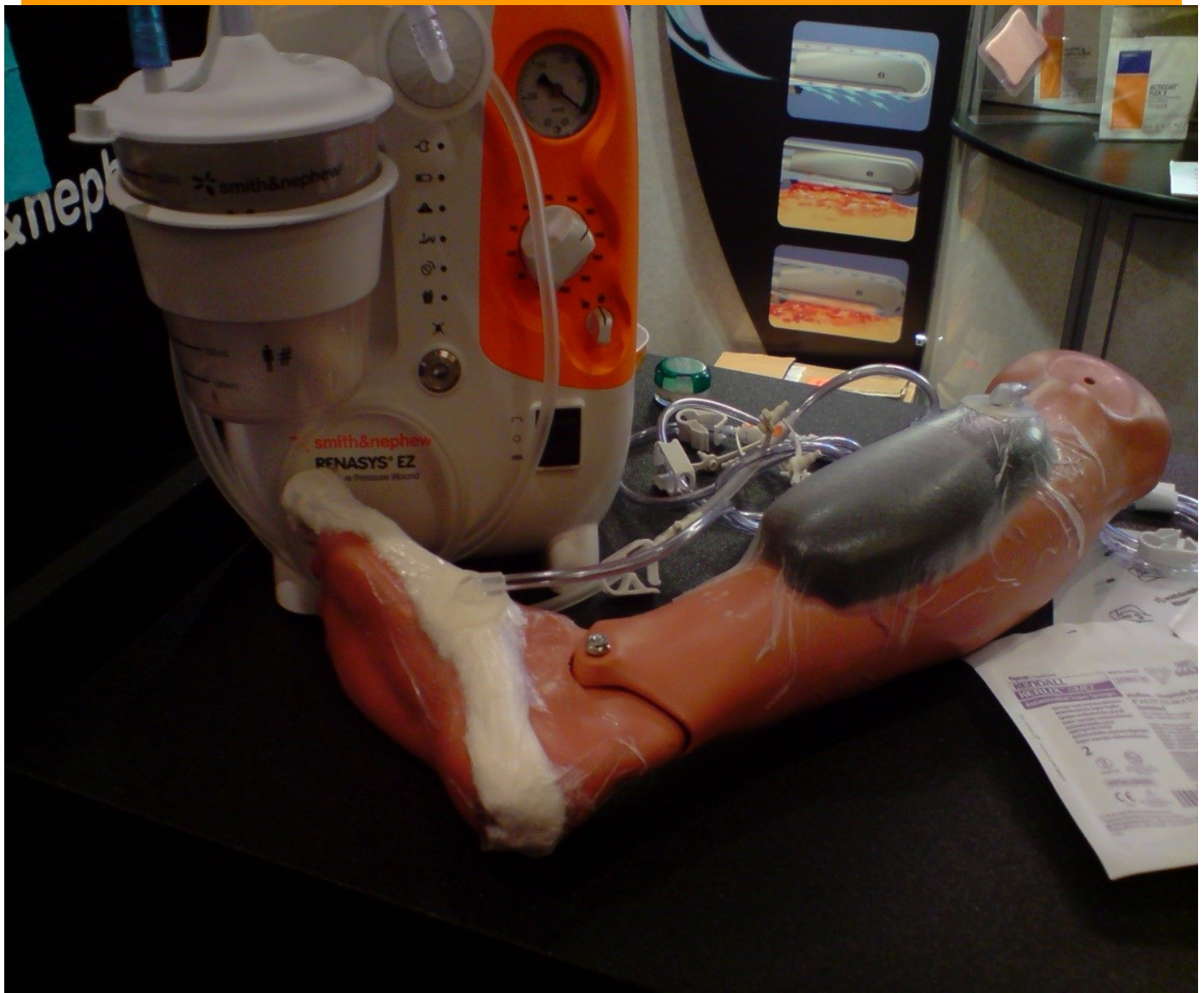
Foundational VAC therapy



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Vacuum therapy

Metabolic control and treatment of comorbidity

- Glucose management
- Cardiovascular management
  - **Lipid management**
  - **Blood pressure management**
- Kidney management
- Others

Hyperbaric Oxygen Therapy

- Patients undergoing HBO therapy enter a chamber filled with 100 percent oxygen atmosphere pressurized to 2.0 to 2.5 ATA (atmospheric pressure absolute), which is equivalent to the pressure 10-15 meter below sea level.

Hyperbaric Oxygen Therapy

- Hyperbaric oxygen therapy treatment “force feeds” oxygen through the lungs to the rest of the body.

- A 90-minute treatment in this hyperbaric environment induces “hyperoxygenation” with oxygen levels over 10 times the normal amount in the bloodstream.

Interestingly, oxygen under hyperbaric conditions “behaves as drugs” and hyper-oxygenation causes:

- a decrease in leg edema and excessive inflammation
- an increase in the growth factors and receptors (VEGF and PDGF)
- doubled flexibility of red blood cells
- increase in bactericidal capacity
- mobilization of the stem cell within the bone marrow to increase the circulating progenitor cells within the blood stream eightfold

Hyperbaric oxygen chamber

Guidelines For HBO In Diabetic Foot Wounds

- Presence of diabetes and lower extremity wounds

- Thirty days of standard wound care have shown no improvement

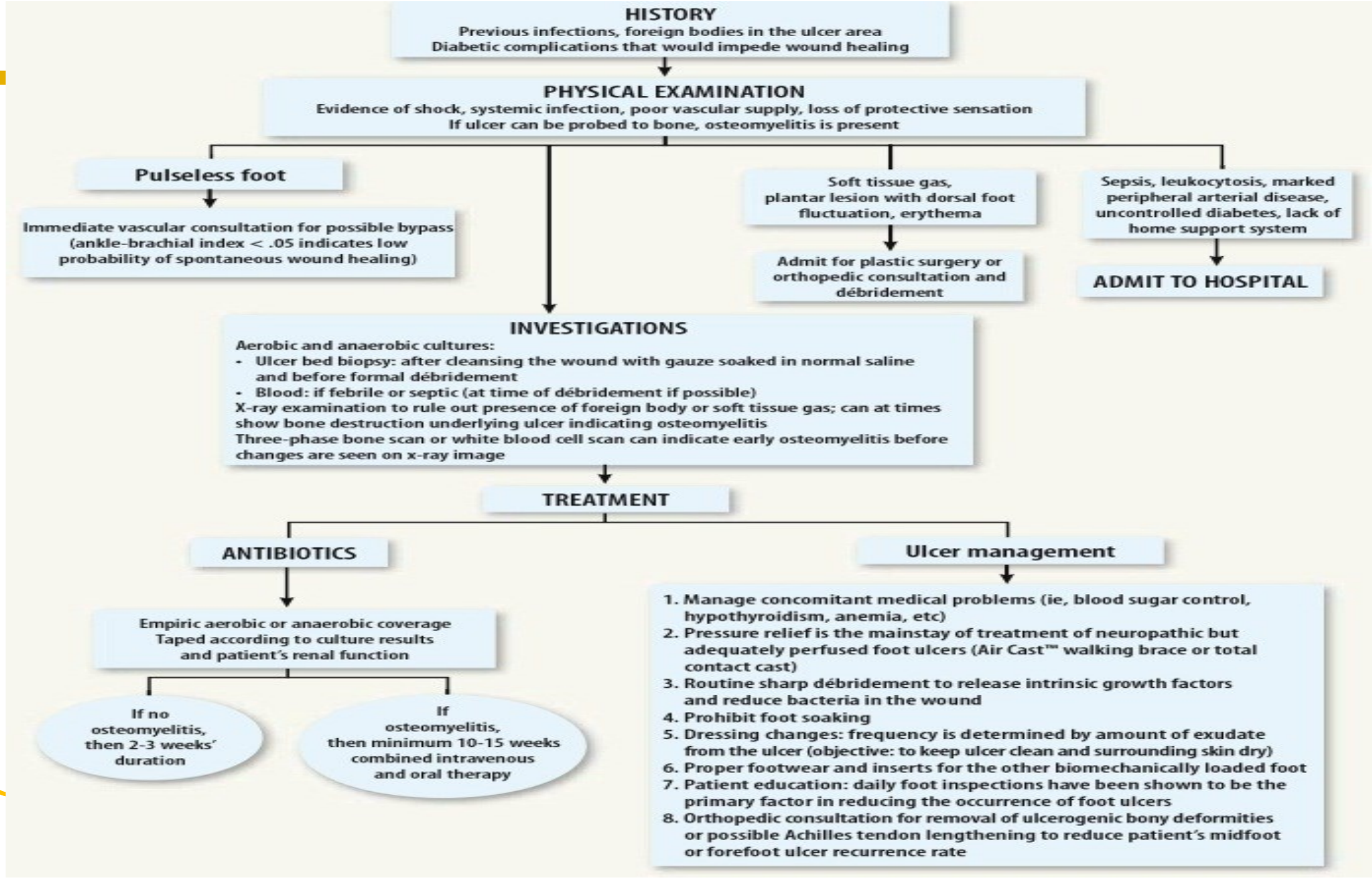
- Wounds must be Wagner Grade III (deep wound with abscess, osteomyelitis or tendonitis extending to those structures), Wagner Grade IV (gangrenous toes and forefoot) or V (gangrenous foot).

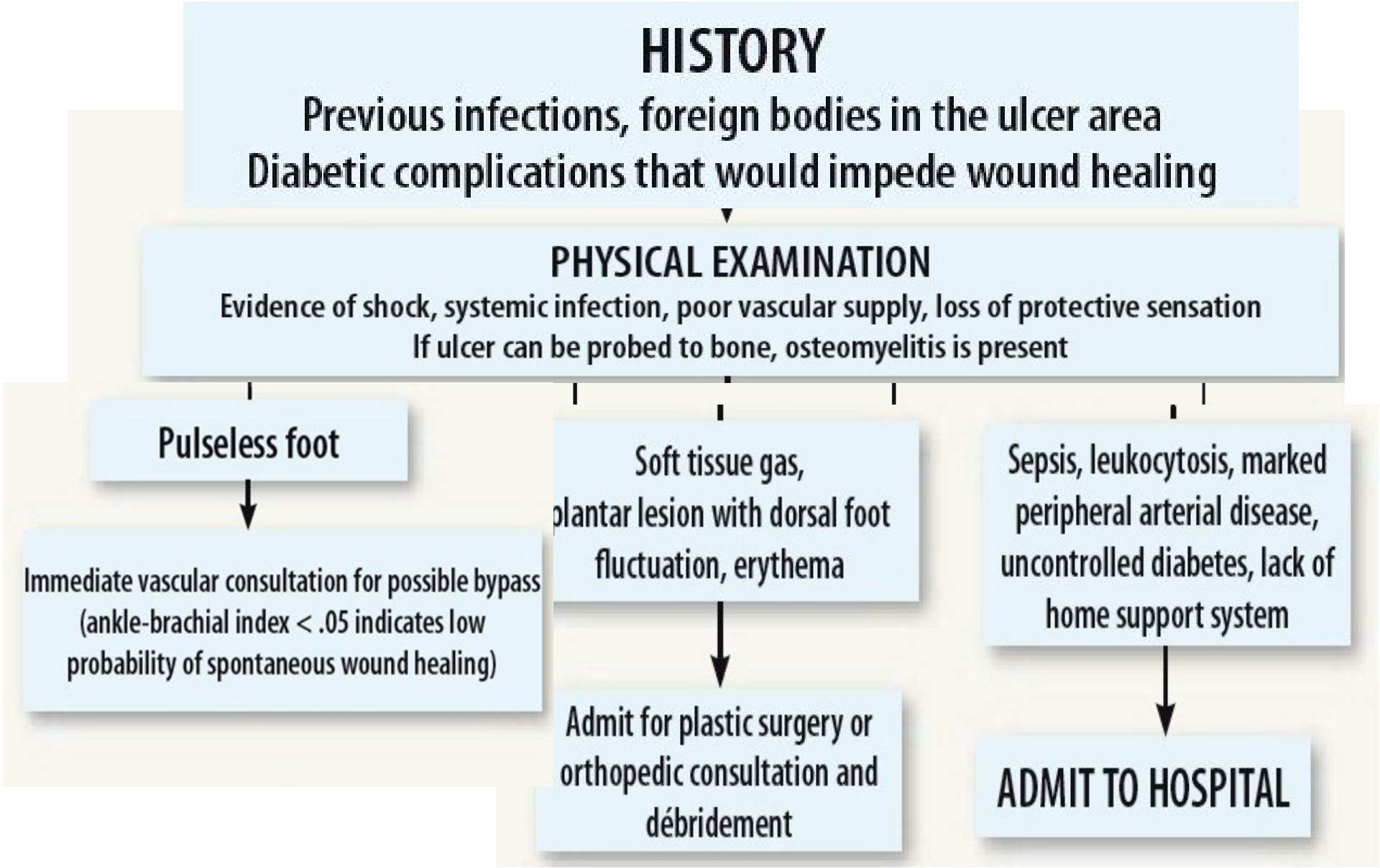
Complications of hyperbaric oxygenation

- The risk versus benefit ratio of HBO is remarkably favorable.
- The most common side effect of HBO is otic barotrauma and Claustrophobia
- No fire accidents or fatalities have been reported in the United States with medical HBO chambers.

Conclusion:

- Is there any infection?
- Is there ischemia?
- Is there excess necrotic tissue?
- Is there deep tissue loss?
- Is there pressure ulcer?
- Is there deformity?
- Is there atypical wound behaviour?


HISTORY
Previous infections, foreign bodies in the ulcer area
Diabetic complications that would impede wound healing
PHYSICAL EXAMINATION
Evidence of shock, systemic infection, poor vascular supply, loss of protective sensation
If ulcer can be probed to bone, osteomyelitis is present
Pulseless foot
Immediate vascular consultation for possible bypass (ankle-brachial index < .05 indicates low probability of spontaneous wound healing)
Soft tissue gas, plantar lesion with dorsal foot fluctuation, erythema
Admit for plastic surgery or orthopedic consultation and débridement
Sepsis, leukocytosis, marked peripheral arterial disease, uncontrolled diabetes, lack of home support system
ADMIT TO HOSPITAL
INVESTIGATIONS
Aerobic and anaerobic cultures:
- Ulcer bed biopsy: after cleansing the wound with gauze soaked in normal saline and before formal débridement
- Blood: if febrile or septic (at time of débridement if possible)
X-ray examination to rule out presence of foreign body or soft tissue gas; can at times show bone destruction underlying ulcer indicating osteomyelitis
Three-phase bone scan or white blood cell scan can indicate early osteomyelitis before changes are seen on x-ray image
TREATMENT
ANTIBIOTICS
Empiric aerobic or anaerobic coverage
Taped according to culture results and patient's renal function
If no osteomyelitis, then 2-3 weeks' duration
If osteomyelitis, then minimum 10-15 weeks combined intravenous and oral therapy
Ulcer management
1. Manage concomitant medical problems (ie, blood sugar control, hypothyroidism, anemia, etc)
2. Pressure relief is the mainstay of treatment of neuropathic but adequately perfused foot ulcers (Air Cast™ walking brace or total contact cast)
3. Routine sharp débridement to release intrinsic growth factors and reduce bacteria in the wound
4. Prohibit foot soaking
5. Dressing changes: frequency is determined by amount of exudate from the ulcer (objective: to keep ulcer clean and surrounding skin dry)
6. Proper footwear and inserts for the other biomechanically loaded foot
7. Patient education: daily foot inspections have been shown to be the primary factor in reducing the occurrence of foot ulcers
8. Orthopedic consultation for removal of ulcerogenic bony deformities or possible Achilles tendon lengthening to reduce patient's midfoot or forefoot ulcer recurrence rate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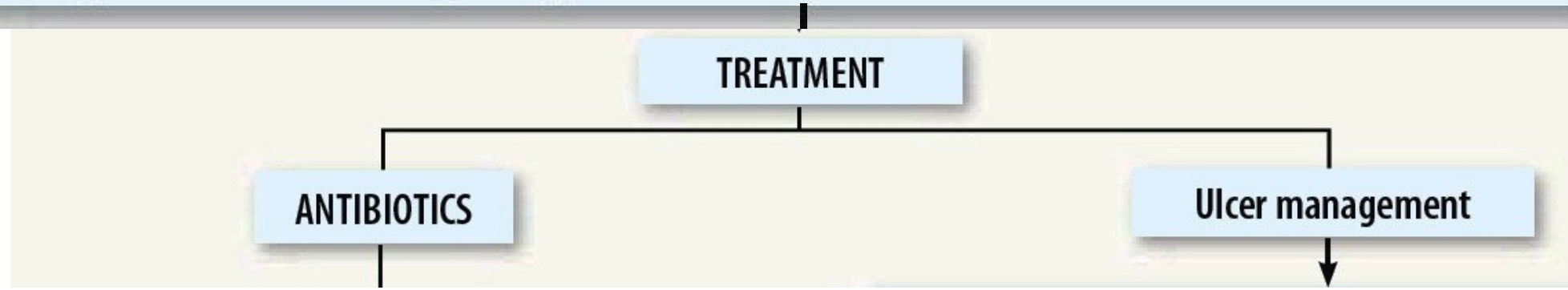

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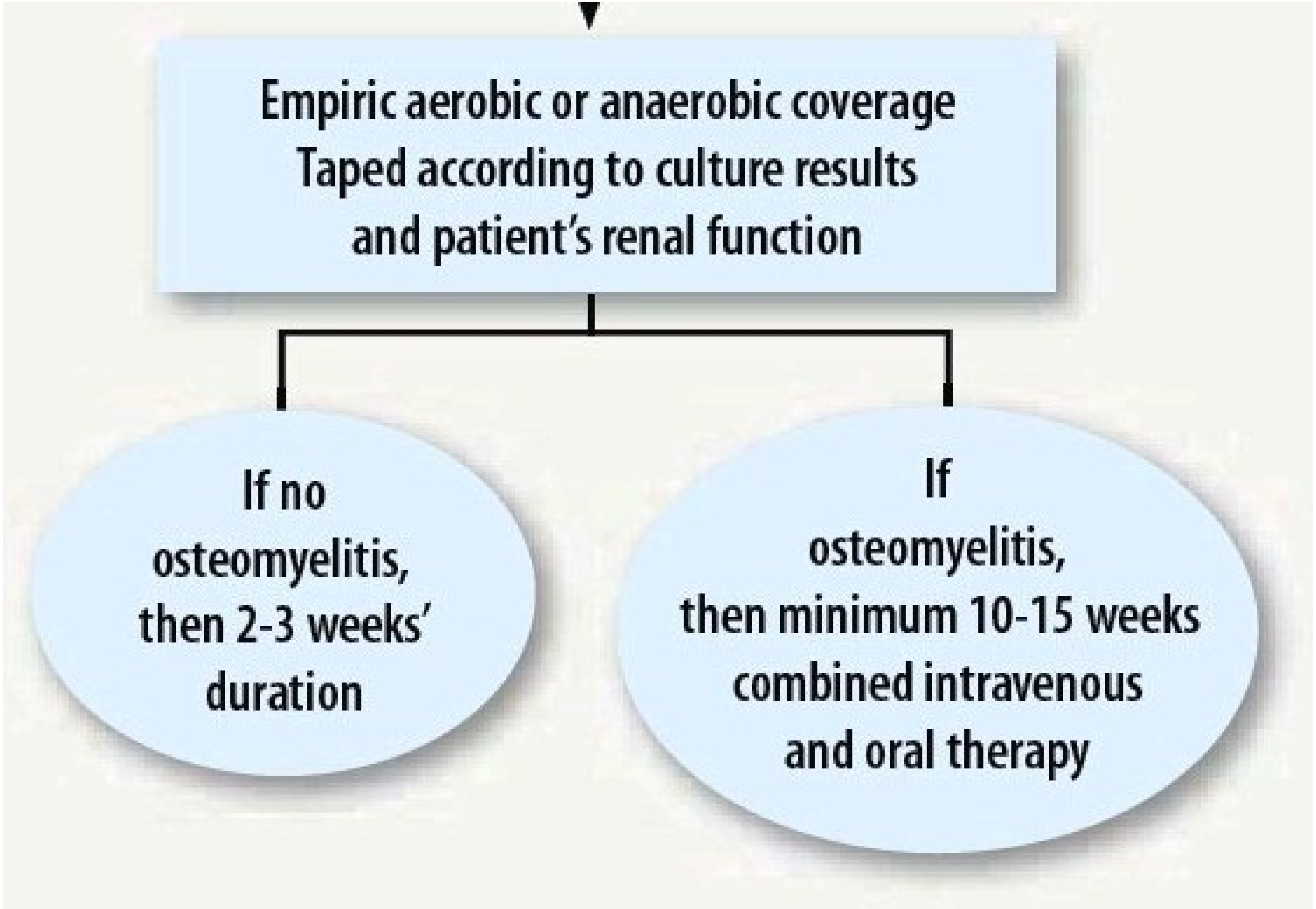
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Take home message

- Always think to the underlying mechanism of ulcer:
- Ischemic?
  - Pulses present or absent?
- Neuropathic?
  - Usual site or atypical position?
- Infective?
  - Extent of necrosis
  - Collection?
- Traumatic?

In refractory ulcers or unusual presentations:

- Detect uncovered situation:
  - Off loading
  - Vascular supply
  - Infection
  - Debridement
- Consider adjuvant therapy
- Detect atypical ulcers

With regards

THANKS FOR YOUR KINDNESS