Approach to open fractures

Open Fractures

"The bone is a plant, with its roots in the soft tissue, and when its vascular connections are damaged, it often requires, not techniques of a cabinet maker, but the patient care and understanding of a gardener."

Girdlestone

- A 28 year old male patient , victim of RTA , arrived to ER complaining of Right leg pain , wound with sever soft tissue injury as attached in the clinical photo below.

- Define open fracture

- A fracture with an associated break in the skin that is capable of communicating with the fracture and/or its hematoma

Describe the *“big 5”* in open fracture care

The “big 5” in open fracture care

- Treat as an emergency
- Debridement and redebridement
- Stabilize fracture and soft tissue
- Early closure
- Antibiotics

- Describe steps of management to be done in ER and steps done in OR

ER :

1. Urgent IV antibiotics & tetanus prophylaxis
2. extremity stabilization
3. Remove gross debris from wound
4. place sterile saline-soaked dressing on wound

OR :

1. Irrigation & Debridement : 3L for type I , 6L for typeII , 9L for type III
2. Temporary fracture stabilization,
3. Local antibiotic administration and
4. Soft tissue coverage

- Describe Gustillo and Anderson classification

Grade	Wound	Contamination	Soft-tissue damage	Bone injury
I	< 1 cm	Clean	Minimal	Simple, minimal comminution
II	> 1 cm	Moderate	Moderate, some muscle	Moderate comminution
IIIA.	> 10 cm	High	Severe with crushing	Soft-tissue cover possible
IIIB.	> 10 cm	High	Severe loss of cover	Requires reconstructive surgery
IIIC.	> 10 cm	High	Vascular injury requires repair	Requires reconstructive surgery

Would you describe the **infection rate** that could occur in each subtype of Gustillo Classification ?

Classification (Gustilo & Anderson)

Type	Infection rate%
I	**0-2**
II	**2-5**
IIIA	**5-10**
IIIB	**10-50**
IIIC	**25-50**

- Clarify antibiotic coverage and tetanus prophylaxis regarding each type of open fracture according to gustello

Antibiotics based on Gustilo Classification

	Grade I and II	Grade IIIA, IIIB and IIIC	Special considerations
Antibiotics	1st generation cephalosporin (e.g. cefazolin)	1. 1st generation cephalosporin for gram positive coverage 2. Aminoglycoside (such as gentamicin) for gram negative coverage	1. Penicillin should be added if concern for anaerobic organism (farm injury) 2. Flouroquinolones (e.g. ciprofloxacin) should be used for fresh water wounds or salt water wounds (can be used if allergic to cephalosporins or clindamycin 3. Doxycycline and 3rd or 4th generation cephalosporin (e.g. ceftazidime) can be used for salt water wounds

What antibiotic?

Open Fracture Type	*Recommended Systemic Antibiotic Prophylaxis*
Gustilo and Anderson type I	First-generation cephalosporin (cefazolin) Alternative: clindamycin with β-lactam allergy
Gustilo and Anderson type II	First-generation cephalosporin (cefazolin) Alternative: clindamycin with β-lactam allergy
Gustilo and Anderson type III	First-generation cephalosporin (or clindamycin with β-lactam allergy) plus aminoglycoside (gentamicin) Alternatives: Third-generation cephalosporin (ceftriaxone or piperacillin/tazobactam)
Fecal or potential clostridial contamination	Consider addition of penicillin to above regimen (cefazolin/gentamicin)

OPEN FRACTURES	FIRST-GENERATION CEPHALOSPORINS (GRAM-POSITIVE COVERAGE) CEFAZOLIN	IF ANAPHYLACTIC PENICILLIN ALLERGY (INSTEAD OF FIRST-GENERATION CEPHALOSPORIN) CLINDAMYCIN
Wound <1 cm; minimal contamination or soft tissue damage	<50 kg: 1 gm Q 8 hr 50–100 kg: 2 gm Q 8 hr >100 kg: 3 gm Q 8 hr	<80 kg: 600 mg Q 8 hr >80 kg: 900 mg Q 8 hr
Wound 1–10 cm; moderate soft tissue damage; comminution of fracture	<50 kg: 1 gm Q 8 hr 50–100 kg: 2 gm Q 8 hr >100 kg: 3 gm Q 8 hr	<80 kg: 600 mg Q 8 hr >80 kg: 900 mg Q 8 hr
Severe soft-tissue damage and substantial contamination with associated vascular injury	<50 kg: 1 gm Q 8 hr 50–100 kg: 2 gm Q 8 hr >100 kg: 3 gm Q 8 hr	<80 kg: 600 mg Q 8 hr >80 kg: 900 mg Q 8 hr

- Avoid Ciprofloxacin & other fluroquinilones as they inhibit osteoblastic activity
- Avoid high concentration of aminoglycosides as they inhibit osteoblastic function

How long ?

- Initiate within 3 hrs following injury
- Infection rate is doubled if antibiotic administration is delayed > 3hrs
- There is evidence that a single day of antibiotics is as good as a five day regimen in preventing infection

There is no evidence of benefit for the continued administration of antibiotics beyond 24 hours after definitive coverage or débridement and coverage with a sterile dressing

- Do you think that Gustilo–Anderson classification system is a full comprehensive system to deal with open fractures ? Or does it carry **disadvantages** ?

Disadvantages of Gustilo–Anderson classification

1. Definition has undergone many modifications and does not have uniformity in application
2. Includes wide spectrum of Injuries in Type IIIB Injuries
3. Mainly depends on size of the skin wound
4. Does not evaluate the severity of injury to Skin, Bone, Musculotendinous units separately
5. Does not address the question of Salvage
6. Poor interobserver reliability

- So, what other classification system do you know regarding open fractures (that would cover the Gustilo disadvantages)?

- Talk about it

- Ganga hospital classification system (better clarifies type IIIB)
- Mclain modification of gustilo for hand open fractures

- Describe each

Table 2. Parameters of Ganga Hospital severity score[12]

Parameter		Score
Skin losses	No loss	1
	Some loss/degloved	2
	(+2 to above if over bone)	
	Extensive loss/exposed bone	5
Soft tissue injury	No injury	1
	Repairable	2
	Irreparable	3
	Loss of <2 compartments	4
	Loss of ⩾2 compartments	5
Bony injury	Fracture, no bone loss	1 - 2
	Joint involvement	3
	Bone losses: < 4cm	4
	> 4cm	5
Additional risk factors	Age >65	+2 for each
	Contamination	
	Chronic illness	
	Systemic injury	
	Other trauma	

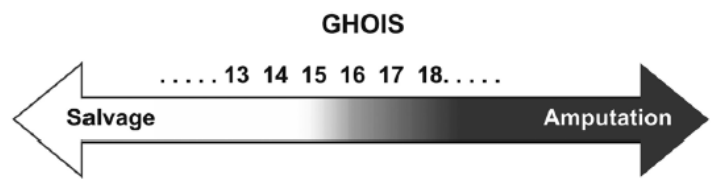


Table 3 Ganga Hospital Open Injury Score (GHOIS)

Covering structures: skin and fascia	
Wound with no skin loss and not over the fracture site	1
Wound with no skin loss and over the fracture site	2
Wound with skin loss and not over the fracture site	3
Wound with skin loss and over the fracture site	4
Wound with circumferential skin loss	5
Functional tissues: musculotendinous and nerve units	
Partial injury to musculotendinous unit	1
Complete but repairable injury to musculotendinous units	2
Irreparable injury to musculotendinous units, partial loss of a c partment, or complete injury to posterior tibial nerve	3
Loss of one compartment of musculotendinous units	4
Loss of two or more compartments or subtotal amputation	5

Skeletal structures: bone and joints

- Transverse or oblique fracture or butterfly fragment <50 % circumference
- Large butterfly fragment >50 % circumference
- Comminution or segmental fractures without bone loss
- Bone loss <4 cm
- Bone loss >4 cm

Comorbid conditions: add 2 points for each condition present

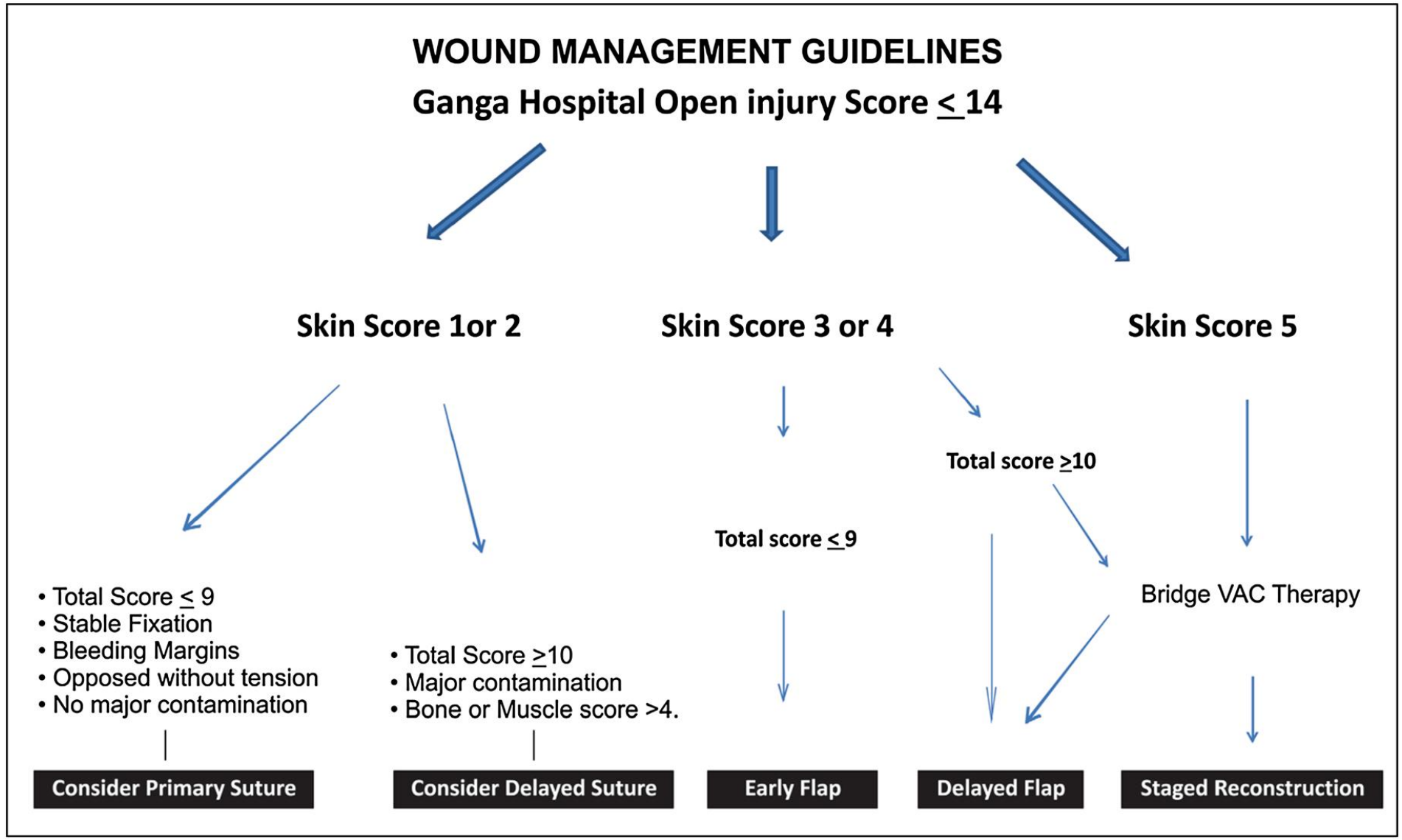
- Injury leading to debridement interval >12 h
- Sewage or organic contamination or farmyard injuries
- Age >65 years
- Drug-dependent diabetes mellitus or cardio respirator diseases leading to increased anesthetic risk
- Polytrauma involving chest or abdomen with injury severity score >25 or fat embolism
- Hypotension with systolic blood pressure <90 mmHg at presentation
- Another major injury to the same limb or compartment syndrome

14 or less salvage and injuries with score of 17 or more have little success with salvage

- Specifically designed for type IllB injuries.
- Assesses severity of injury to skin, muscle, and bone separately.
- Total score predicts amputation.
- Individual score provides guidelines for reconstruction.
- Scoring includes comorbidities that influence outcome.
- Better intra- and interobserver agreement compared with Gustilo classification.

Table 5 Primary closure of open wounds

Indications (all must be present)
Type 1,11 III A and B injuries of limbs without vascular deficit
Wounds without primary skin loss or secondary skin loss after debridement
Ganga Hospital skin score of 1 or 2 and a total score of 10 or less
Injury to debridement interval <12 h
Presence of bleeding wound margins which can be apposed without tension
Stable fixation achieved either by internal or external fixation
Contraindications(any of the below)
Type IMC injuries
Ganga Hospital skin score of 3 or more and a total score of >10
Wounds in patients with severe polytrauma involving and an injury severity score >25
Sewage or organic contamination/farmyard injuries
Peripheral vascular diseases/thromboangiitis obliterans
Drug-dependent diabetes mellitus/connective tissue disorders/ peripheral vasculitis


WOUND MANAGEMENT GUIDELINES
Ganga Hospital Open injury Score ≤ 14
Skin Score 1or 2
Skin Score 3 or 4
Skin Score 5
Total score ≥10
Total score ≤ 9
• Total Score ≤ 9
• Stable Fixation
• Bleeding Margins
• Opposed without tension
• No major contamination
• Total Score ≥10
• Major contamination
• Bone or Muscle score >4.
Bridge VAC Therapy
Consider Primary Suture
Consider Delayed Suture
Early Flap
Delayed Flap
Staged Reconstruction

- GHOIS was found to have 100% sensitivity and 95% of specificity in predicting salvage
- GHOIS score of 17 and above was more accurate for predicting amputation with a sensitivity of 75% and specificity of 93.7%

Back again to the “big 5”

- Treat as an emergency
- Debridement and redebridement
- Stabilize fracture and soft tissue
- Early closure
- Antibiotics

1. Treat as an emergency

- How to deal with open fractures as an emergency ?

- Through dealing with using ATLS protocol (1^{o} + 2^{o})

2. Debridement

- This step has two discreet phases:
  - Wound irrigation
  - Removal of all necrotic or devitalized tissue including bone

What is the most proper way for Irrigation ?

A. The use of **Betadine**

B. High-pressure lavage normal saline

C. low-pressure lavage with normal saline

Answer ??

- low-pressure lavage with normal saline is preferred

- “The solution to pollution is dilution”

- Why not to apply High-pressure lavage ?

1. Because it leads to damage tissues such as periosteum and tendon sheaths
2. It may also push dirt and debris deeper into the tissues.

What about time recommendation for debridement ?

- Current literature suggests no obvious advantage in performing debridement within 6 hours compared to debridement performed between 6 and 24 hours after injury

What factors determine the extent of *Soft tissue* debridement ?

- This is issue is determined through **Muscle viability**, which is assessed through

4 C’s

  - contractility
  - capacity to bleed
  - color
  - consistency

What about Bone debridement, what are the remarkable points you have to consider?

- Remove avascular, contaminated fragments
- Protect soft tissue attachments
- Retain key bone fragments ?
  - articular surface

- Re-evaluate “crucial tissues” at 2nd debridement

When do we need for Second-Look Debridement (redebridement) ?

- High-energy blast injuries
- Severe contamination, farmyard, and sewage contamination
- Delayed presentation >12 hours
- Evidence of infection during debridement
- Initial debridement considered unsatisfactory

3. Stabilize soft tissue and fracture , what do you suggest for open fractures ?

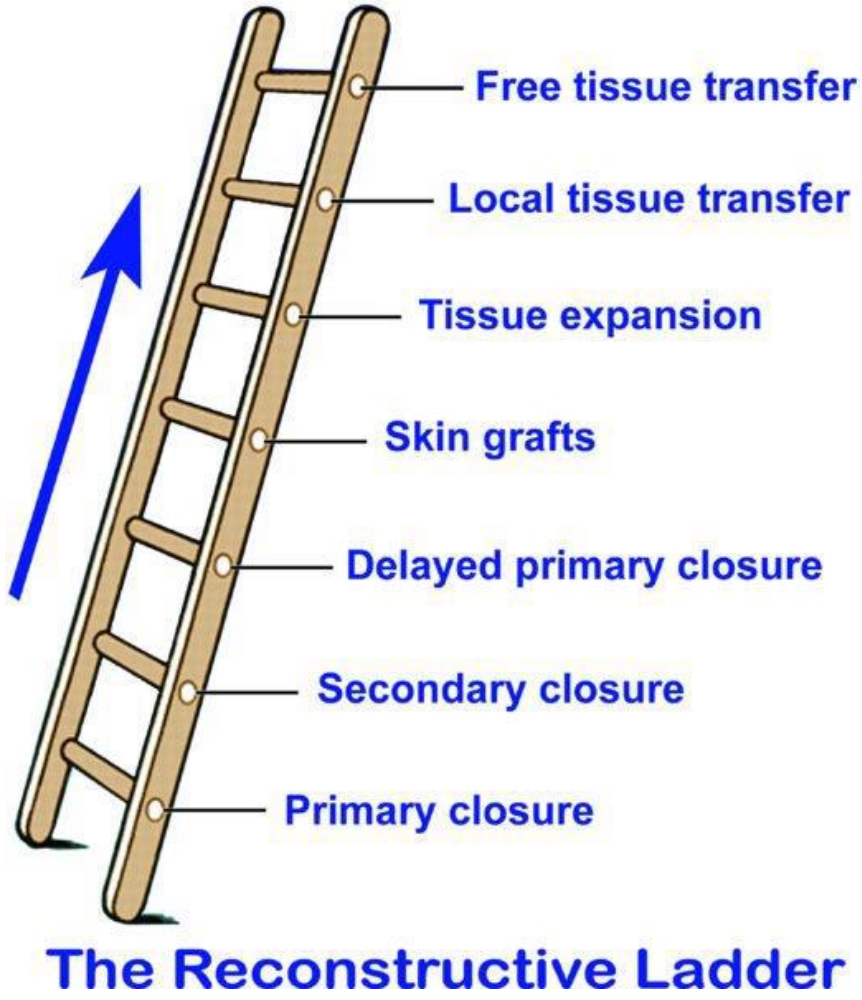
- External fixation:
  - Plan pins
  - Consider temporary versus to completion
  - Understand mechanics
- Internal fixation:
  - Depending on grade, contamination, and delay

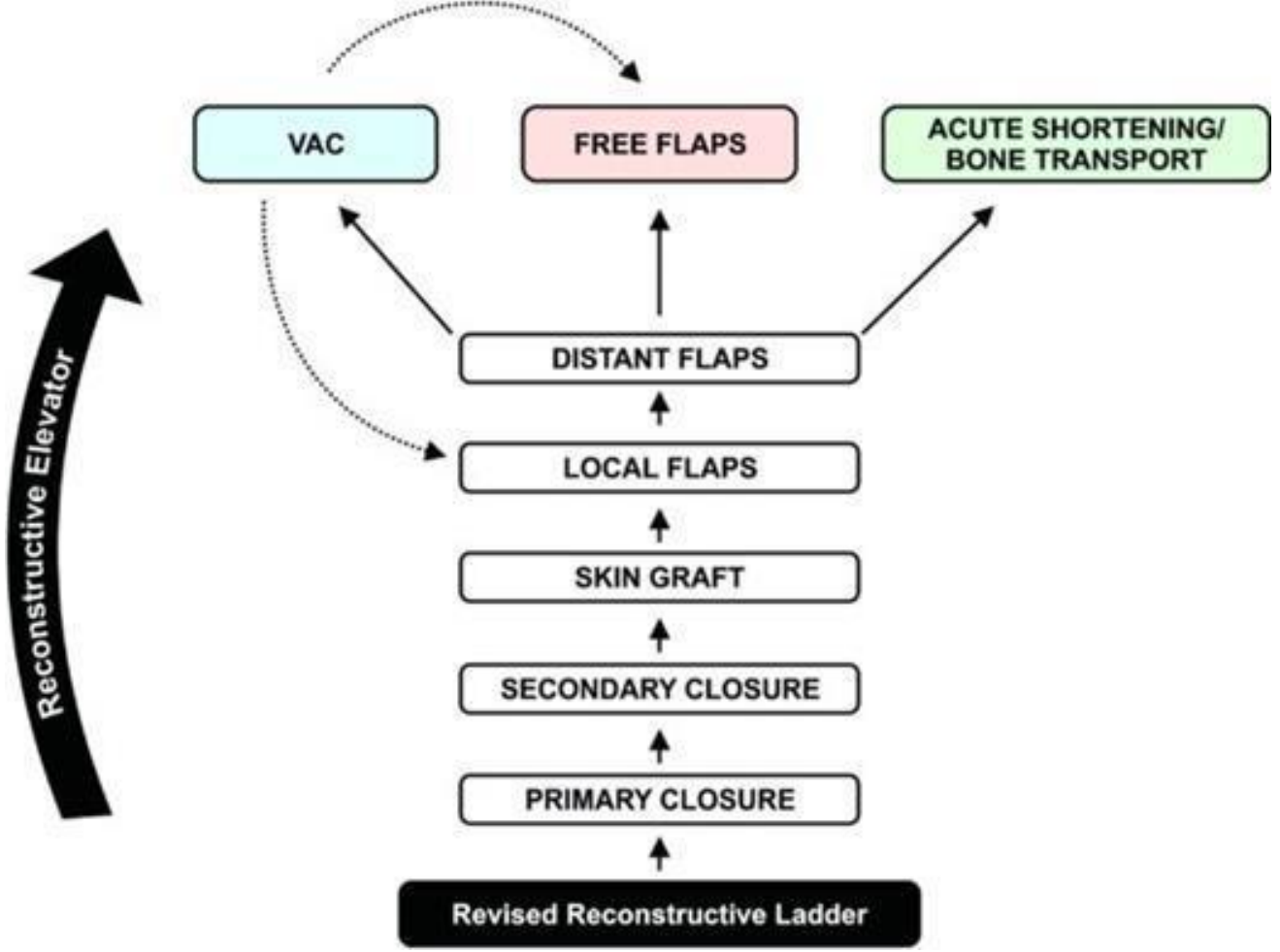
4. What is the propriate timing for Wound Coverage and Closure ?

- A number of studies have shown excellent outcomes with closure performed *within 3 days after injury*
- DeLong et al have shown that closure within 24hrs to be safe
- Hertel et al have found that immediate coverage of type IIIA&IIIB was associated with lower rate of infection….fix and flap

Soft tissue coverage options

- traditional advice was to choose the simplest option as the first choice for soft tissue cover





The revised reconstructive ladder includes the newer methods of reconstruction such as NPWT and acute shortening/bone transport.

The "reconstructive elevator" concept is more popular now where the most appropriate and effective method of cover is chosen as the primary choice, however complex it may be.

5. Antibiotics : are discussed above

Take-home messages

- Treat as an emergency
- Adequate debridement
- Appropriate antibiotics and dressing
- Stabilize fracture and soft tissues