Management of Thoracic Trauma

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Quiz!

What is the role of trauma surgery in emergency chest trauma patients?

- 30/M, 서울 중구 거주
- 20분 전 NMC 앞에서 **우측** 가슴을 칼에 찔림
- ER 도착 5분 후 심정지
- 3분만에 흉부외과 의사 도착
- 현재 EM에서 CPR 중

→ What should we do?

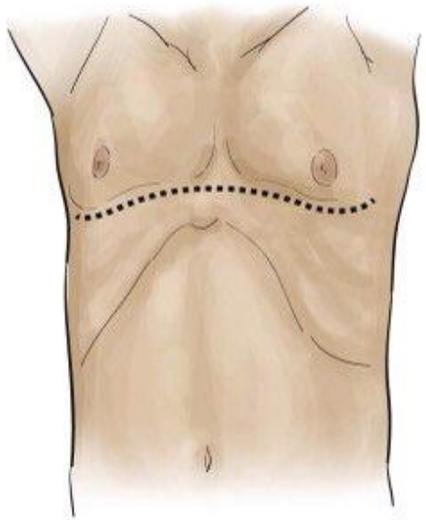
WHAT IS THE **NEXT STEP**?

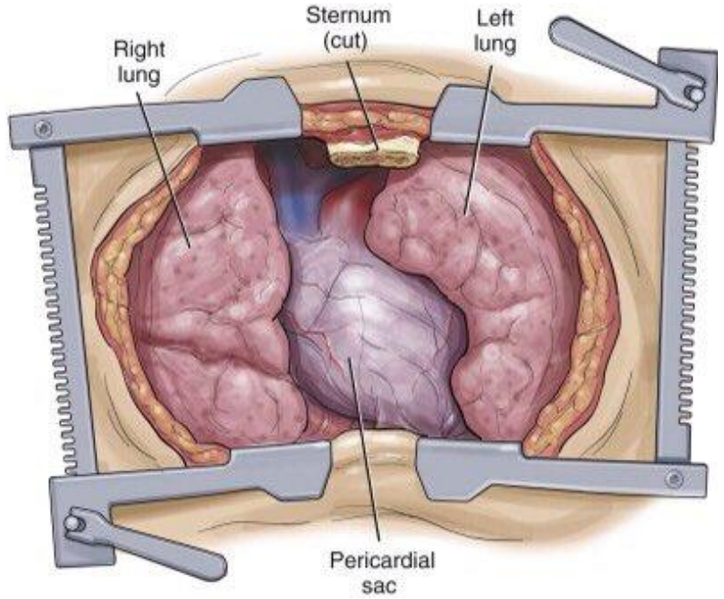
1. Chest tube insertion, Rt.
2. Running to OR
3. ECMO
4. REBOA
5. Sternotomy
6. Rt. Thoracotomy
7. Lt. Thoracotomy
8. Clamshell thoracotomy
9. Transfer
10. DNR..

Choose only ONE in 10 seconds

Answer

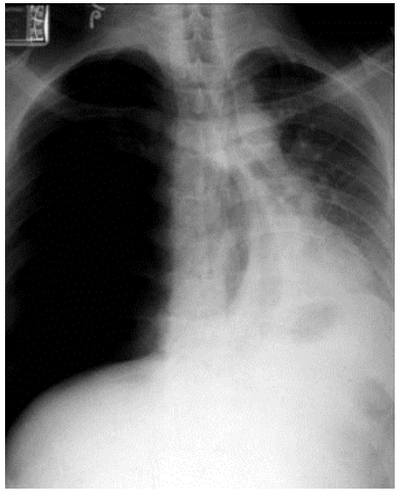
1. Chest tube insertion
2. Running to OR
3. ECMO
4. REBOA
5. Sternotomy
6. Rt. Thoracotomy
7. Lt. Thoracotomy
8. **Clamshell thoracotomy**
9. Transfer
10. DNR..



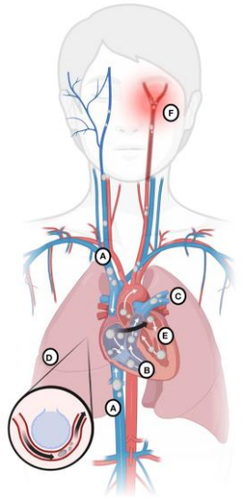


Cardiac arrest

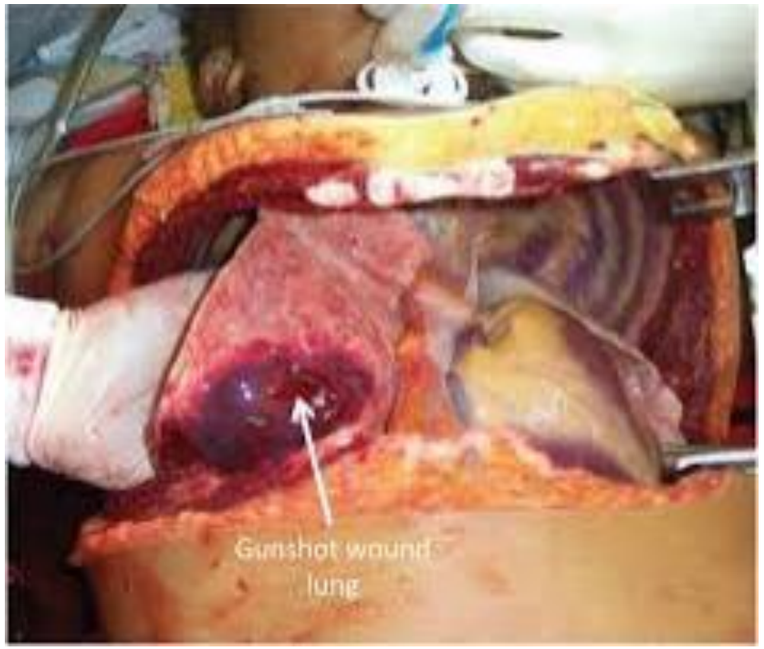
- Hypovolemic shock?
- Tension hemopneumothorax?
- Aspiration and desaturation?
- Air embolism?
- Lung only?
- Rt. Heart?
- IMA? Intercostal a.?



Overview of Air Embolism



Clamshell thoracotomy



→ Release tension hemopneumothorax

→ Open cardiac massage

→ Aortic cross clamping (≒ REBOA)

→ Approach to Rt. Lung, hilum and Rt.side heart

→ Temporary bleeding control with Hilum twist or clamp

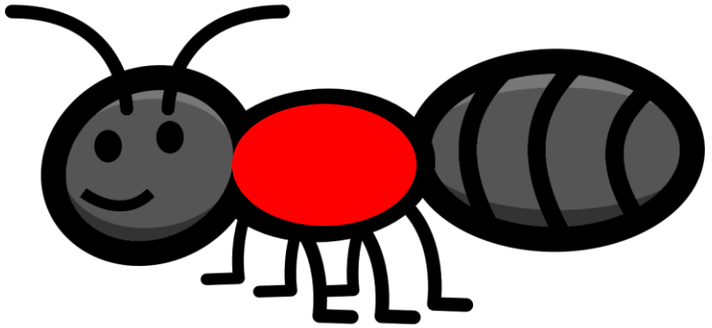
→ Massive transfusion, Tractotomy, …… and SAVE THE LIFE! (~15%)

Thoracic trauma in KOREA

- 전체 사망 원인의 ~9%
- 연령별 사망원인 1위
  - **10대: 외상**
  - **20대: 외상**
  - **30대: 외상**
  - 40대 이상: 암
- 전체 외상 환자 중 **흉부** 외상 환자: 37.3%
- **중증 외상 환자** 중 **흉부** 외상 환자: **58.9%**

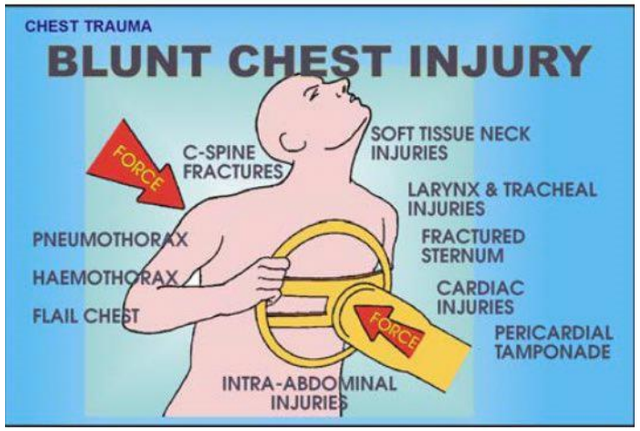
YOUNG, ACTIVE WORKER

Important to bring the patient
BACK TO SOCIETY



Classification and mechanism of injury

- Blunt: m/c
  - Motor vehicle accidents
  - Falls from height
  - Physical assault
  - Blunt object injury
- Penetrating: life threatening
- Blast



Immediate resuscitation

Primary survey

- Airway obstruction
- Tension pneumothorax
- Massive hemothorax
- Cardiac tamponade
- Open pneumothorax
- Tracheobronchial injiury

Immediate resuscitation

Secondary survey

- Simple pneumothorax
- Hemothorax
- Pulmonary contusion
- Flail chest
- Blunt cardiac injury
- Aortic rupture
- Diaphragmatic rupture
- Esophageal rupture

TRAUMA

PRIMARY: Survey SECONDARY:

A IRWAY
- HAVE AIRWAY BOX, INTUBATION SUPPLIES, SUCTION READY
- TALKING?
- ANY OBVIOUS OBSTRUCTION?

B REATHING
- BILATERAL BREATH SOUNDS?
- HAVE BAG-VALVE MASK, RESPIRATORY THERAPY READY

C IRCULATION
- FEMORAL OR CAROTID PULSES?
- HAVE IV ACCESS, BLOOD PRODUCTS READY

D ISABILITY
- GCS E4 V5 M6
- IF GCS < 8, INTUBATE !!!

E XPOSURE
- REMOVE ALL CLOTHING, JEWELRY, DENTURES, PROSTHETICS, ETC.

"HEAD TO TOE"

HEAD:
- SKULL — STEP OFFS, DEFORMITIES, BATTLE SIGNS
- SCALP — LACERATIONS
- EYES — PUPIL SIZE & REACTIVITY, PERIORBITAL ECCHYMOSIS?
- EARS — HEMOTYMPANUM?
- NOSE — BLOOD IN NARES? DEVIATION?
- MOUTH — MISSING TEETH? TONGUE OR LIP LACERATIONS?

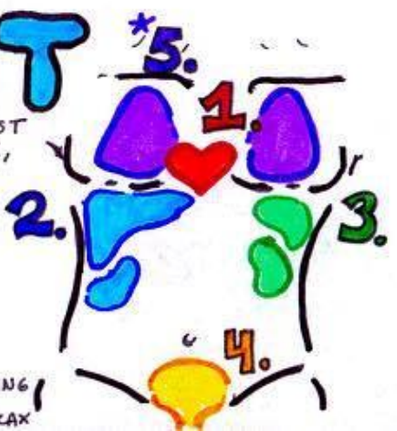
BODY:
- CHEST — RIB OR STERNAL TENDERNESS?
- ABDOMEN — SOFT? NONTENDER? NML BOWEL SOUNDS?
- PELVIS — GROSSLY STABLE? RECTAL TONE? BLOOD IN ORIFICES?
- FLANK — TENDER? ECCHYMOSIS?
- SPINE — MIDLINE TENDERNESS? NEURO DEFICIT?

LIMBS:
- ARMS — PULSES? SENSATION? DEFORMITY?
- LEGS — PULSES? SENSATION? DEFORMITY?

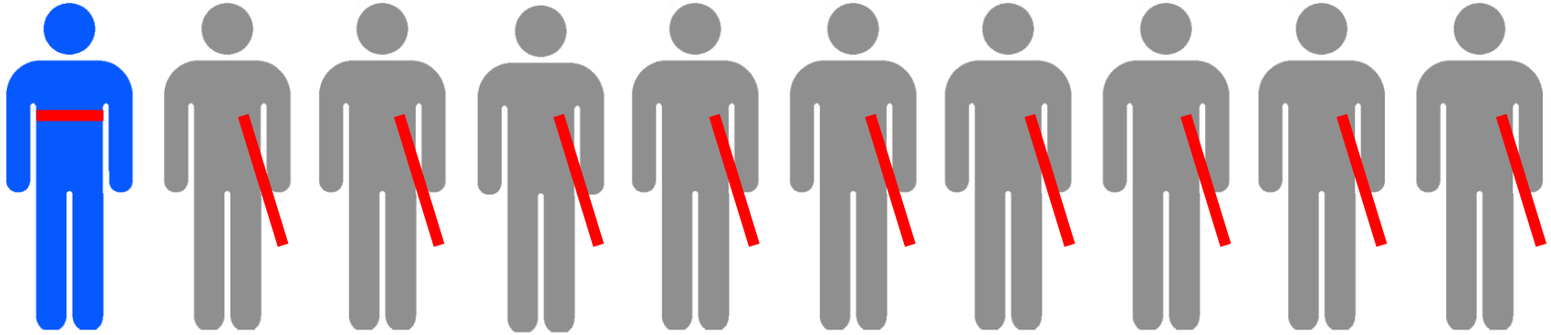
ADJUNCT TO PRIMARY/SECONDARY SURVEY → **e-FAST**

1. SUBXYPHOID — PERICARDIAL EFFUSION
2. RUQ — FLUID BTWN LIVER & KIDNEY
3. LUQ — FLUID BTWN SPLEEN & KIDNEY
4. BLADDER — FLUID IN PELVIS
5. LUNG — LUNG SLIDING FOR PNEUMOTHORAX

IF POSITIVE FAST & PT IS UNSTABLE, GO STRAIGHT TO OR!!!!!!



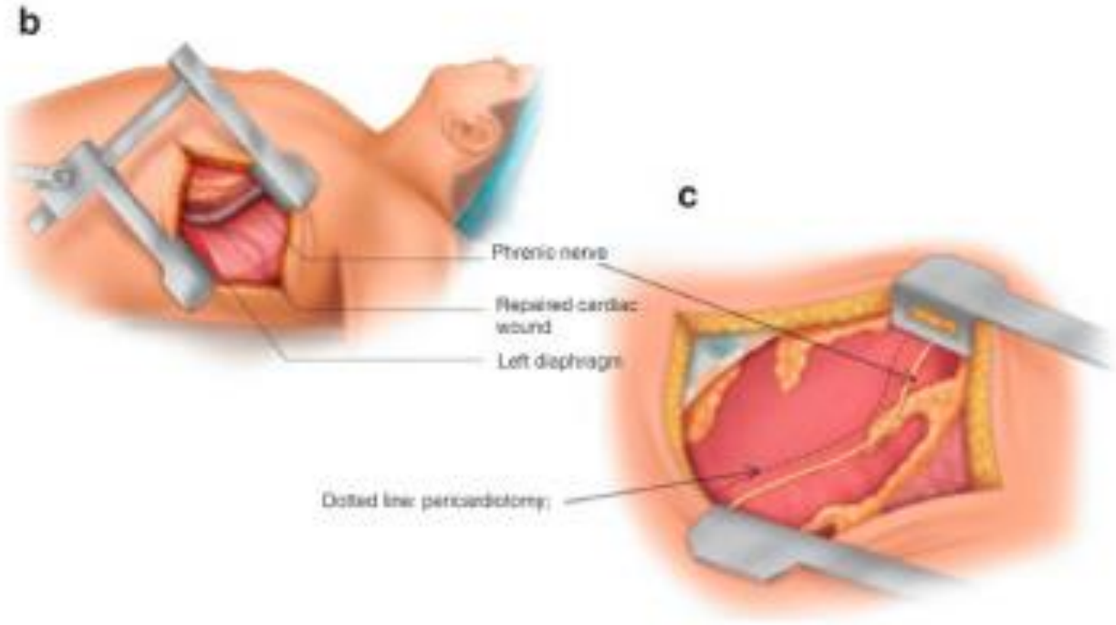
Thoracostomy

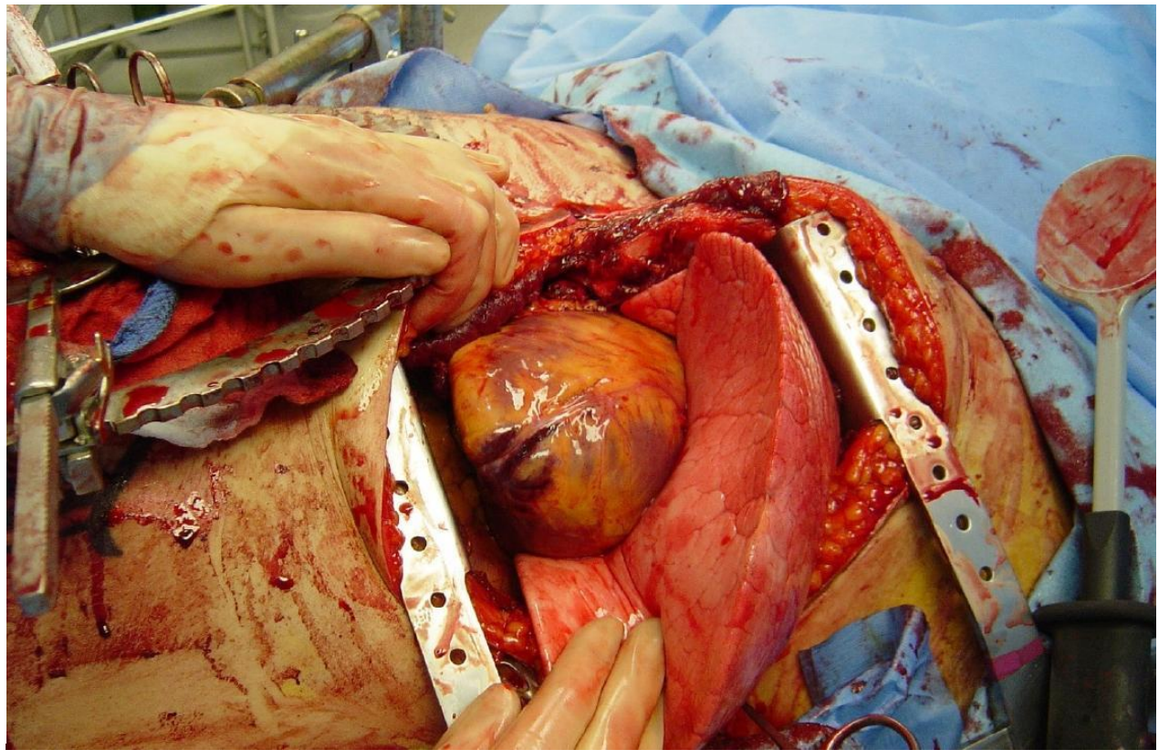


- *Only **10 ~ 15%** of all chest wounds require thoracotomy*
- ***85%** can be managed with a closed tube thoracostomy **

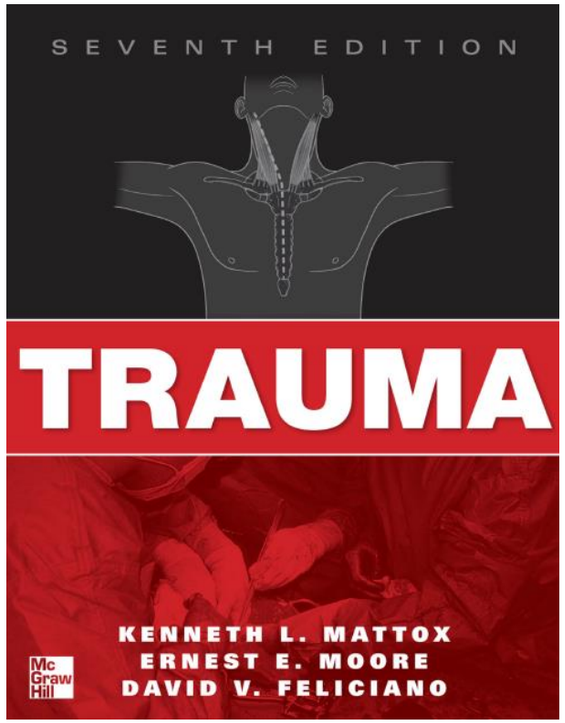
* LoCicero J 3rd, Mattox KL. Epidemiology of chest trauma. Surg Clin North Am. 1989;69(1):15-19.

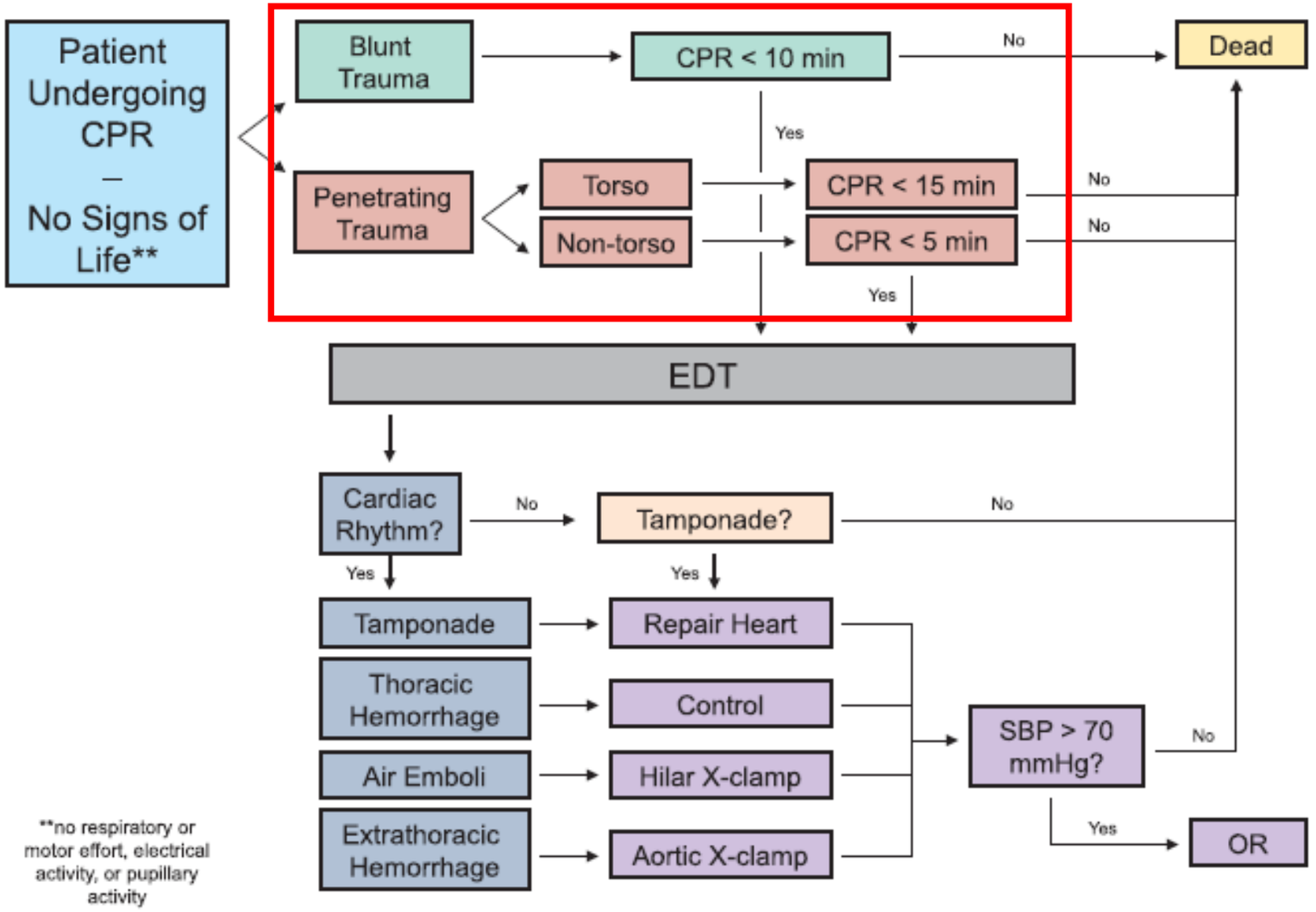
Emergency **D**epartment **T**horacotomy (**R**esuscitative **T**horacotomy)



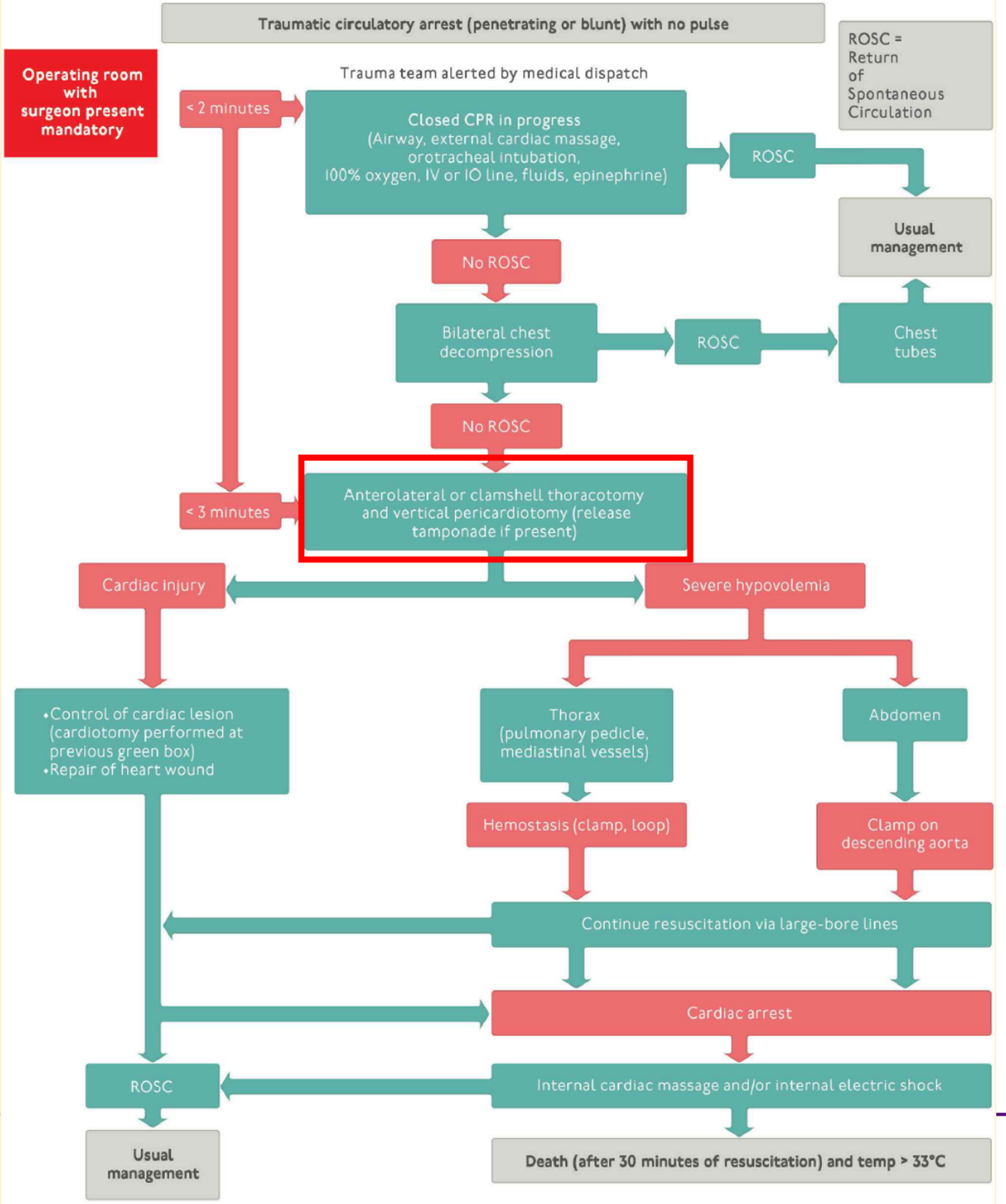


Indication of EDT





ATLS protocol



Open cardiac massage

In animal studies

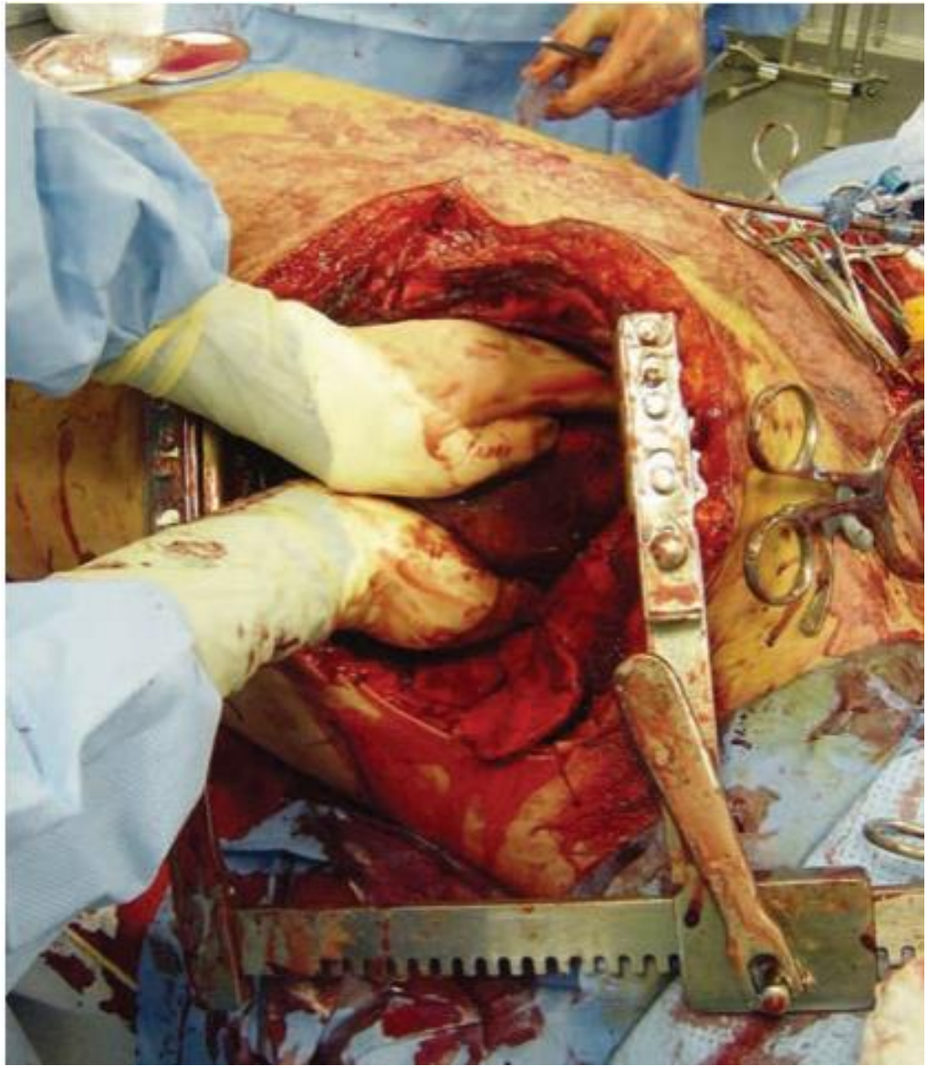
External: 25% of CO

Open cardiac: 60 to 70% of CO

In a small study of 10 patients

Coronary perfusion pr.

: 400% greater with open cardiac

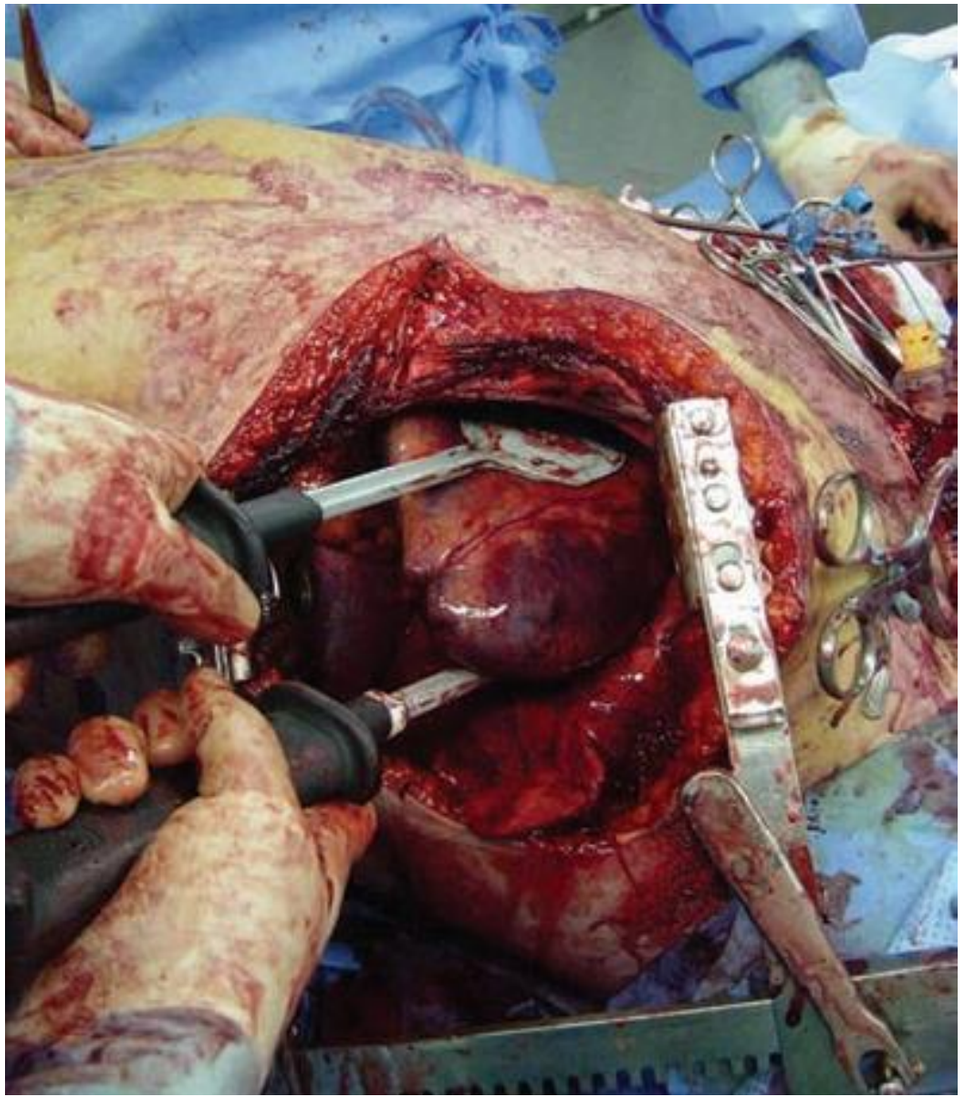


Open cardiac massage

Two-hand ("clapping") technique

- The wrists placed together
- The thumb adjacent to finger
- Apex to base

Internal defibrillation (10-50 J)



Aortic Cross Clamping

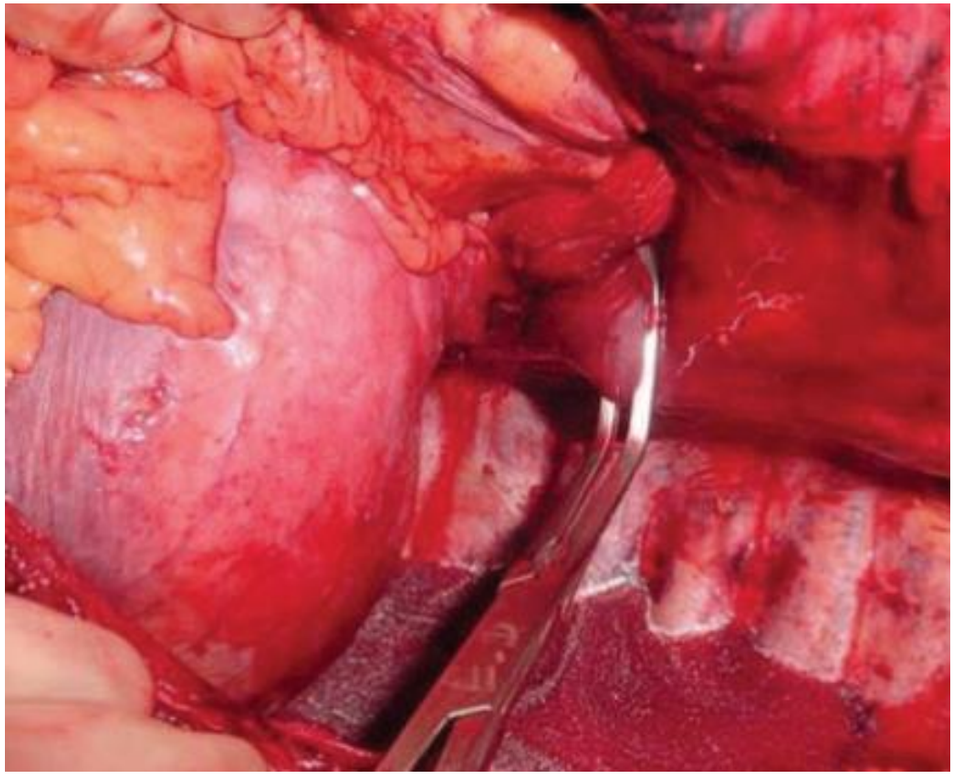
Redistribution (heart, brain)

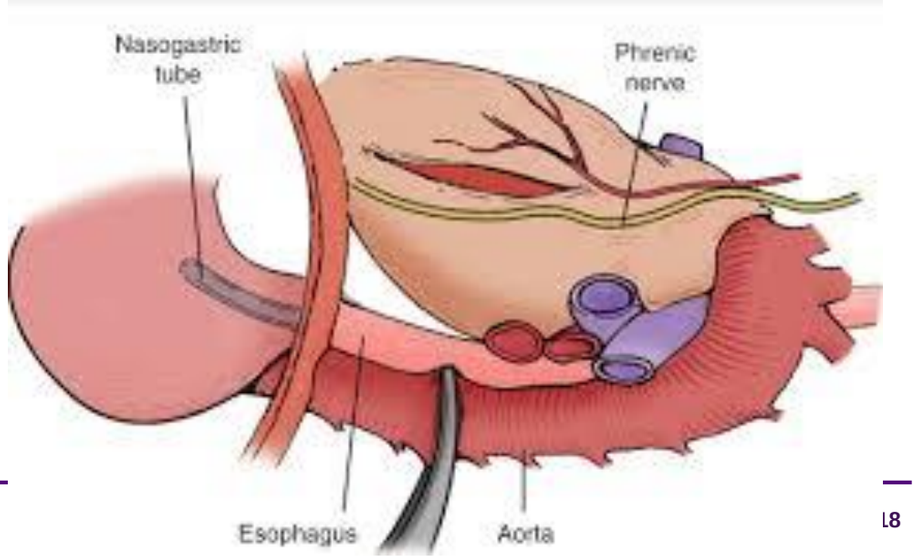
Subdiaphragmatic loss

Just above the **diaphragm**

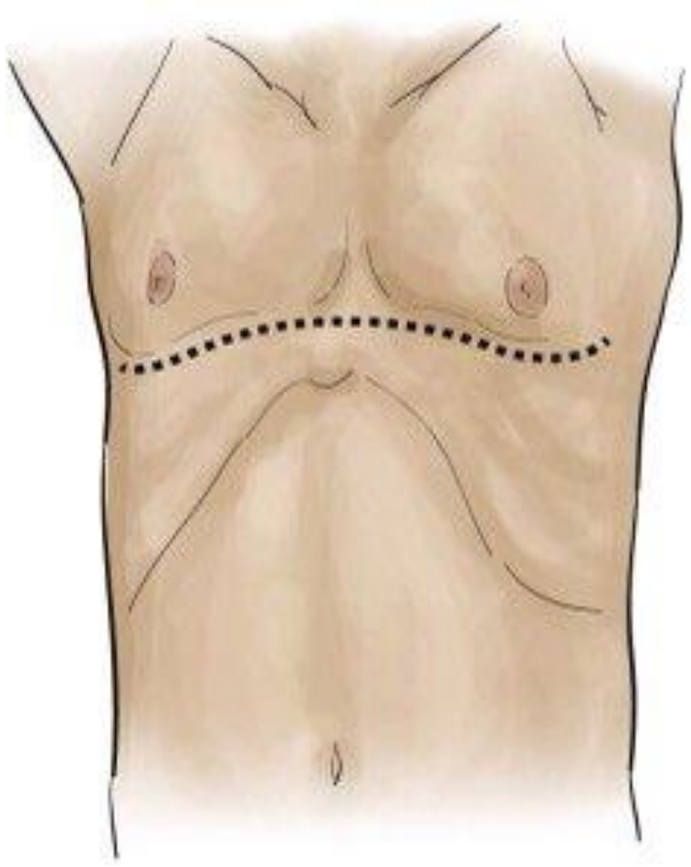
Reposition to **lower level**

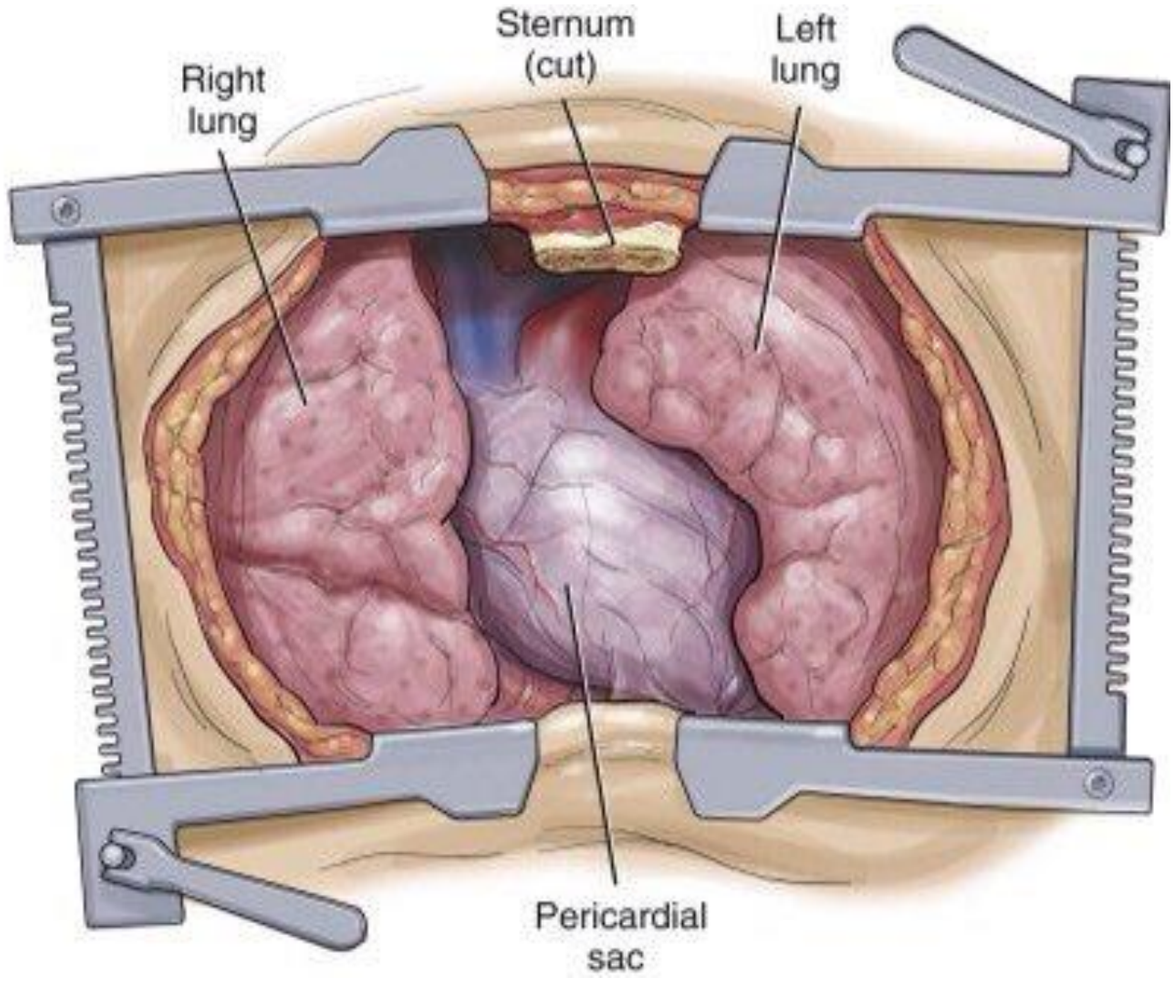
No more than **30mins**





Bilateral anterior thoracotomy (Clamshell thoracotomy)

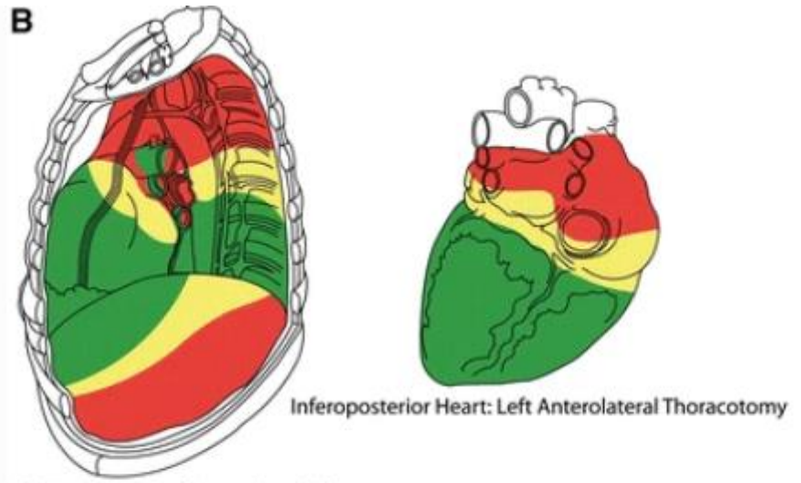




World J Surg. 2013 Jun;37(6):1277-85. doi: 10.1007/s00268-013-1961-5.

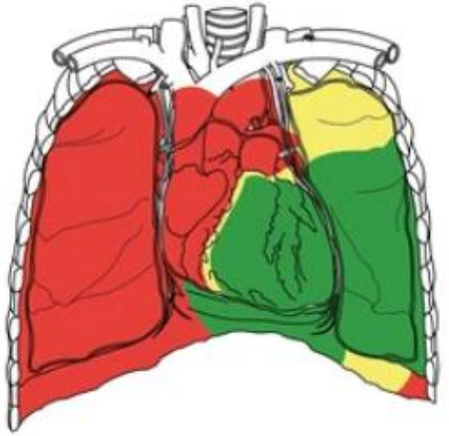
Bilateral anterior thoracotomy (clamshell incision) is the ideal emergency thoracotomy incision: an anatomic study

Eric R Simms [1], Alexandros N Flaris, Xavier Franchino, Michael S Thomas, Jean-Louis Caillot, Eric J Voiglio



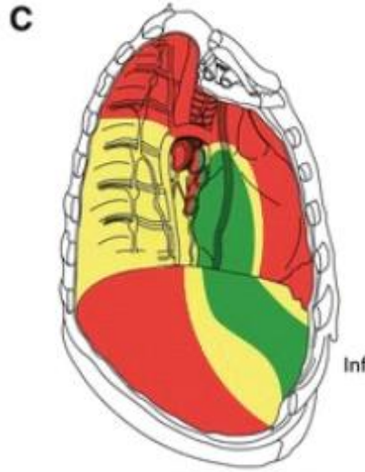
Inferoposterior Heart: Left Anterolateral Thoracotomy

Left Hemithorax: Left Anterolateral Thoracotomy



Anterior Thorax: Left Anterolateral Thoracotomy

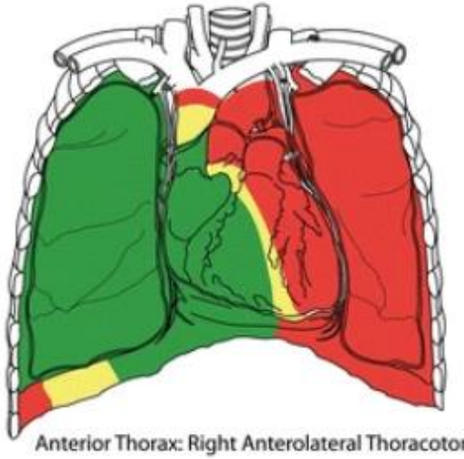
LAT



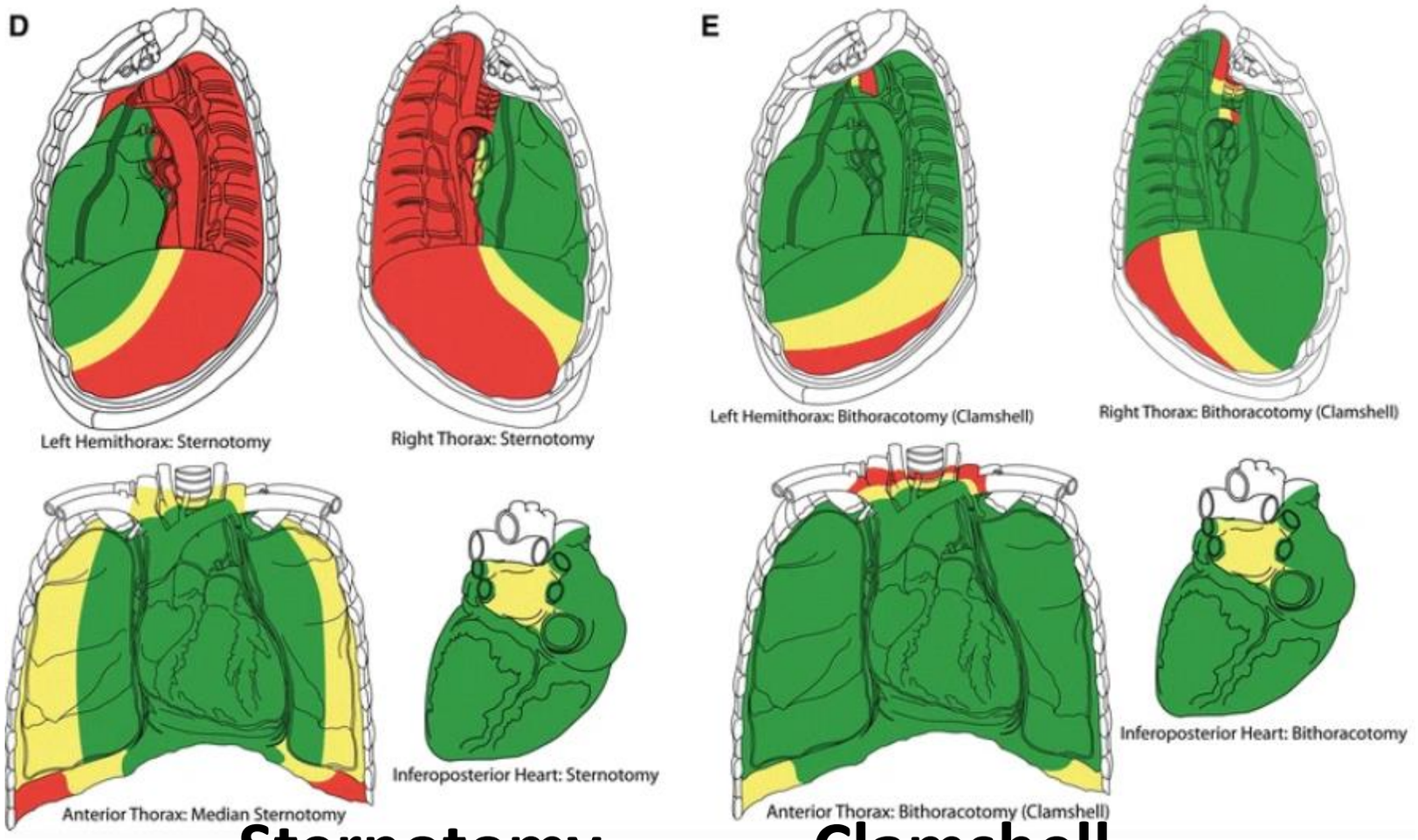
Inferoposterior Heart: Right Anterolateral Thoracotomy

Right Thorax: Right Anterolateral Thoracotomy

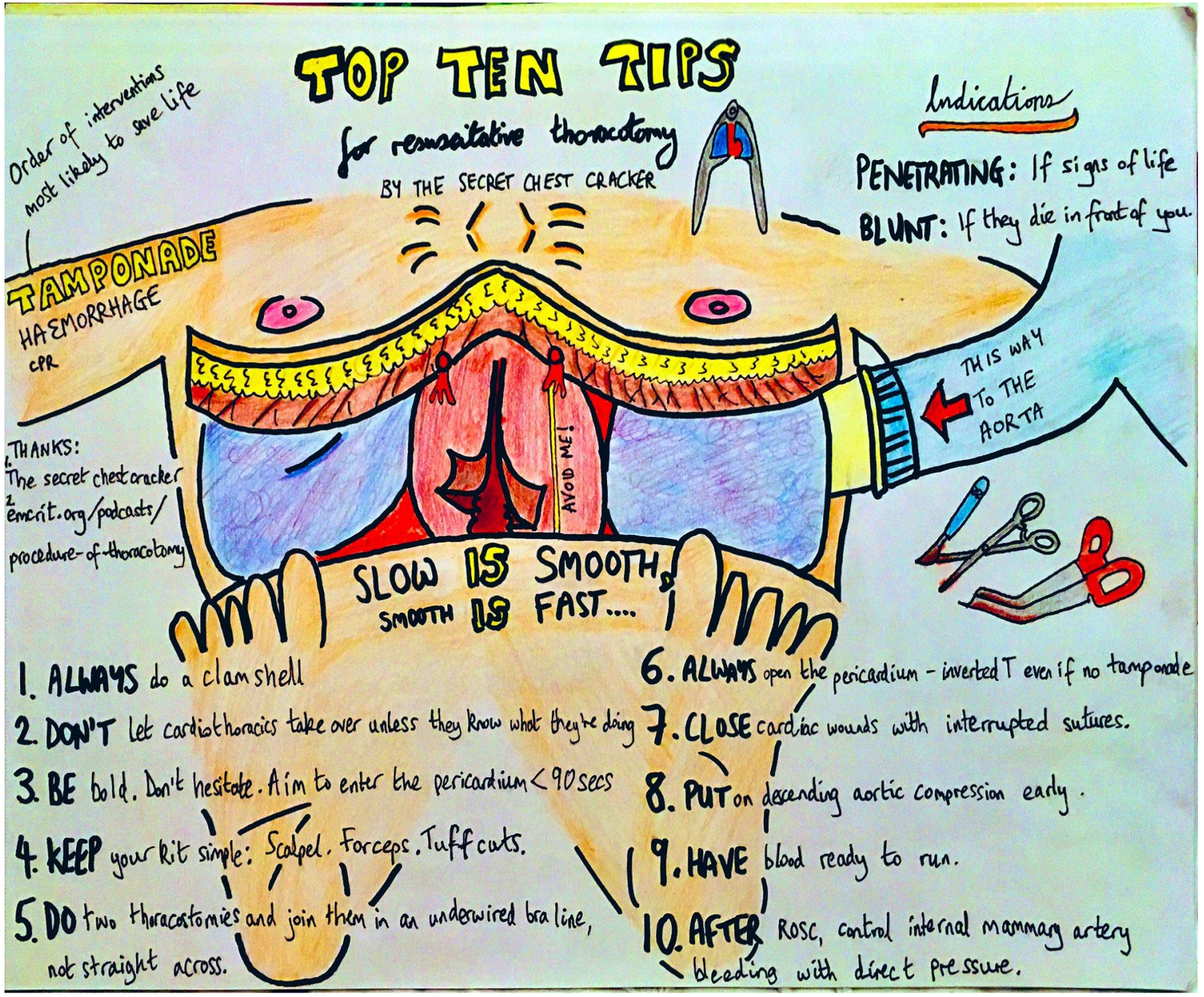
RAT

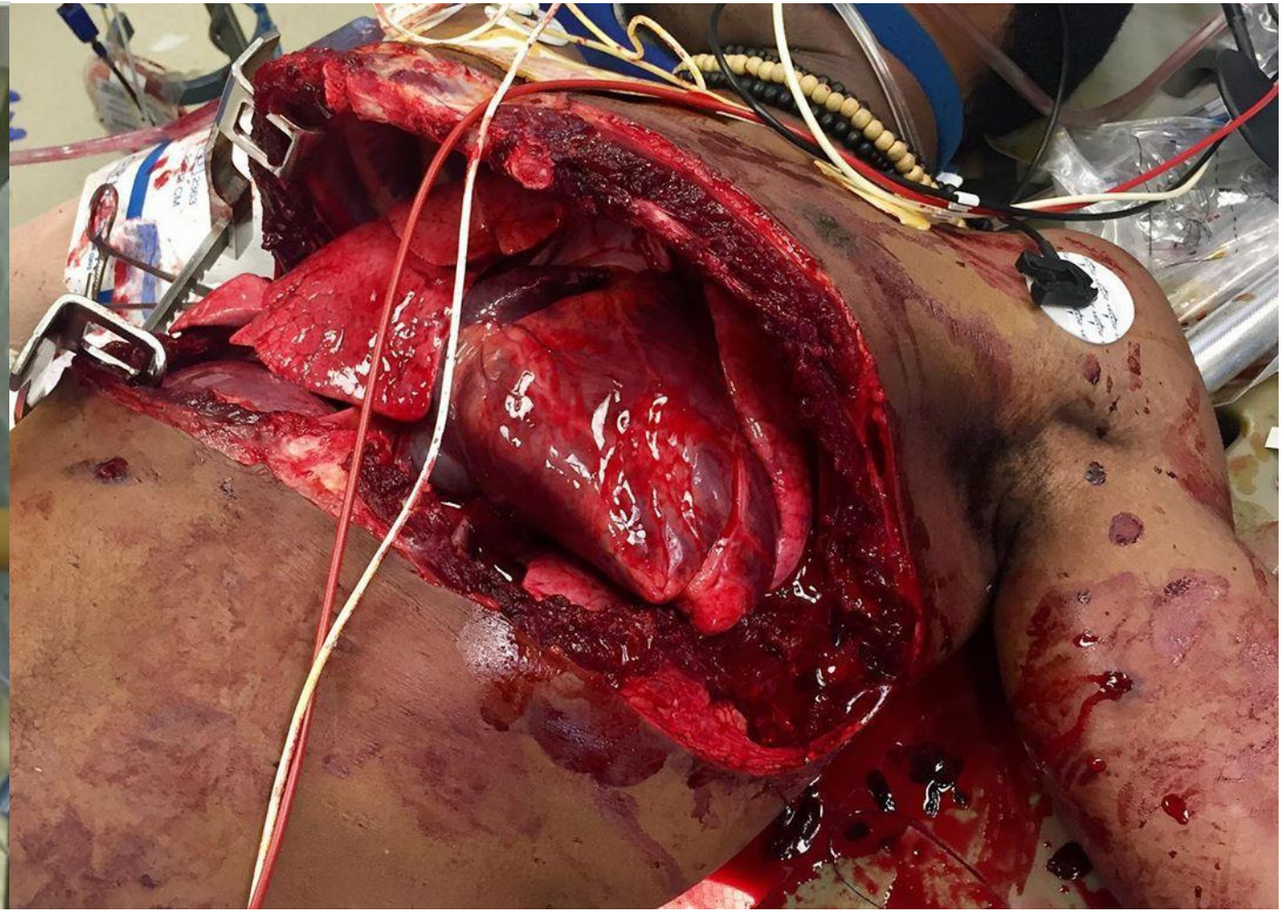


Anterior Thorax: Right Anterolateral Thoracotomy



Sternotomy **Clamshell**


TOP TEN TIPS
for resuscitative thoracotomy
BY THE SECRET CHEST CRACKER
Order of interventions most likely to save life
TAMPONADE
HAEMORRHAGE
CPR
Indications
PENETRATING: If signs of life
BLUNT: If they die in front of you.
THIS WAY TO THE AORTA
AVOID ME!
THANKS:
The secret chest cracker
emcrit.org/podcasts/procedure-of-thoracotomy
SLOW IS SMOOTH,
SMOOTH IS FAST....
1. ALWAYS do a clam shell
2. DON'T let cardiothoracics take over unless they know what they're doing
3. BE bold. Don't hesitate. Aim to enter the pericardium < 90 secs
4. KEEP your kit simple: Scalpel. Forceps. Tuff cuts.
5. DO two thoracostomies and join them in an underwired bra line, not straight across.
6. ALWAYS open the pericardium - inverted T even if no tamponade
7. CLOSE cardiac wounds with interrupted sutures.
8. PUT on descending aortic compression early.
9. HAVE blood ready to run.
10. AFTER ROSC, control internal mammary artery bleeding with direct pressure.



Management of specific injuries

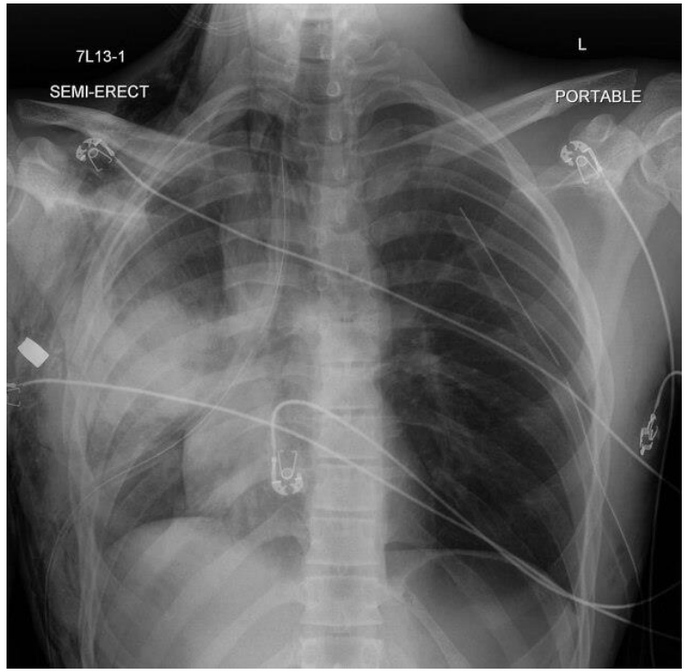
Blunt Cardiac Injury

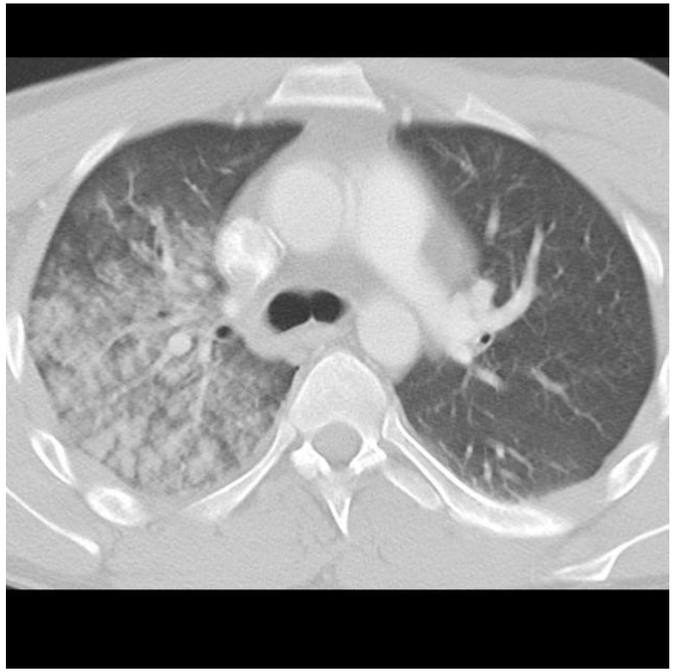
- Myocardial rupture
  - Hemopericardium
- Septal and valvular injury
  - Tear of the leaflet
  - Tear of the papillary muscle or chordae tendineae
- Myocardial infarction
  - Coronary artery dissection, laceration, and thrombosis
- Cardiac dysfunction
  - myocardial contusion
- Arrhythmia
  - persistent tachycardia, new bundle branch block, a.fib..
- **Concomitant injury**
  - **Sternal fracture (!)**

Management of specific injuries

Blunt Pulmonary Injury

- Pneumothorax
- Hemothorax
- Tracheobronchial injury
- Pulmonary contusion

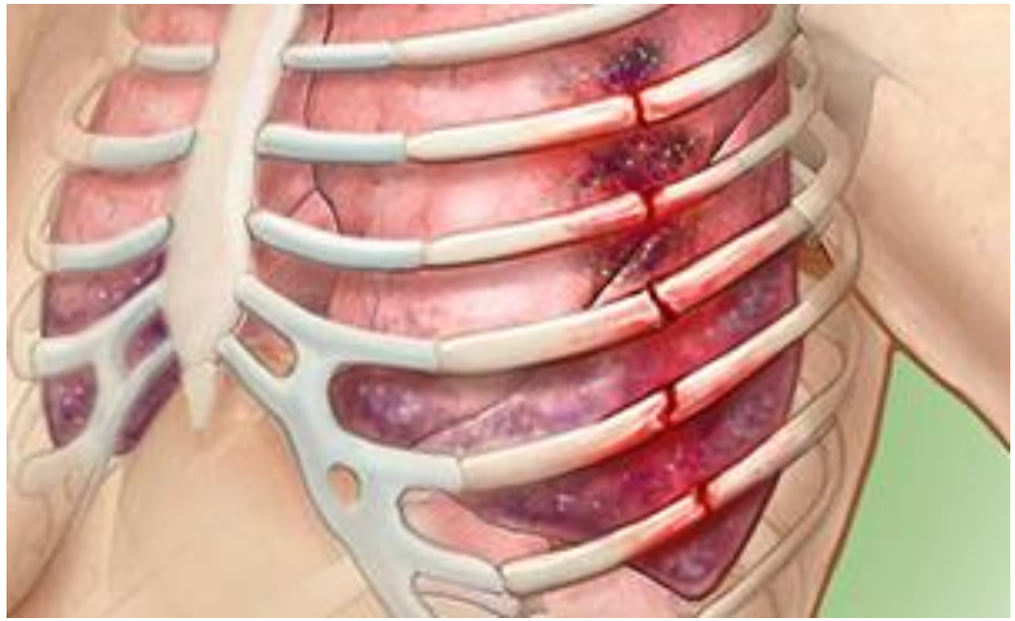




Management of specific injuries

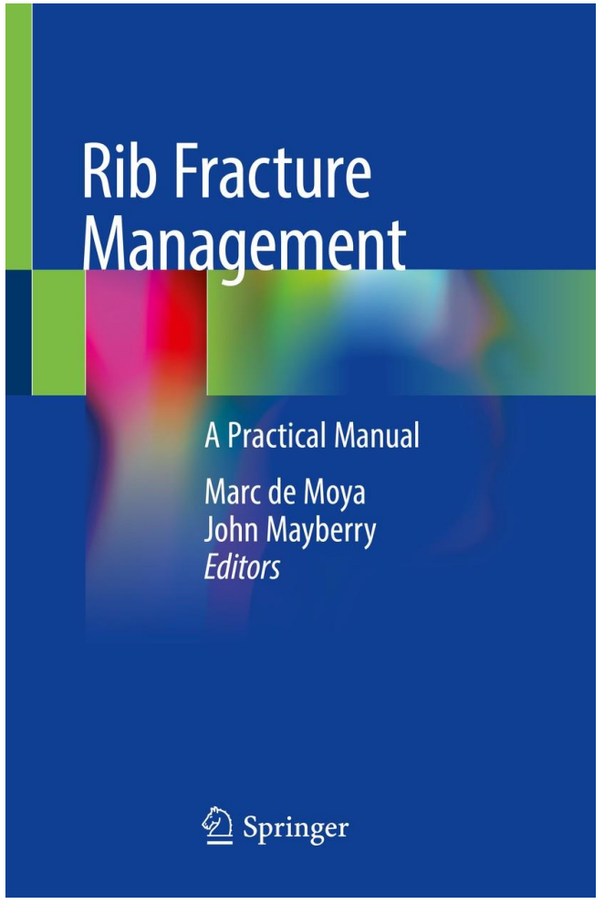
Blunt Chest Wall Injury

- Sternal fracture
- Scapula fracture
- Rib fracture
- Flail chest
- Sternoclavicular dislocation
- Thoracic spine fracture



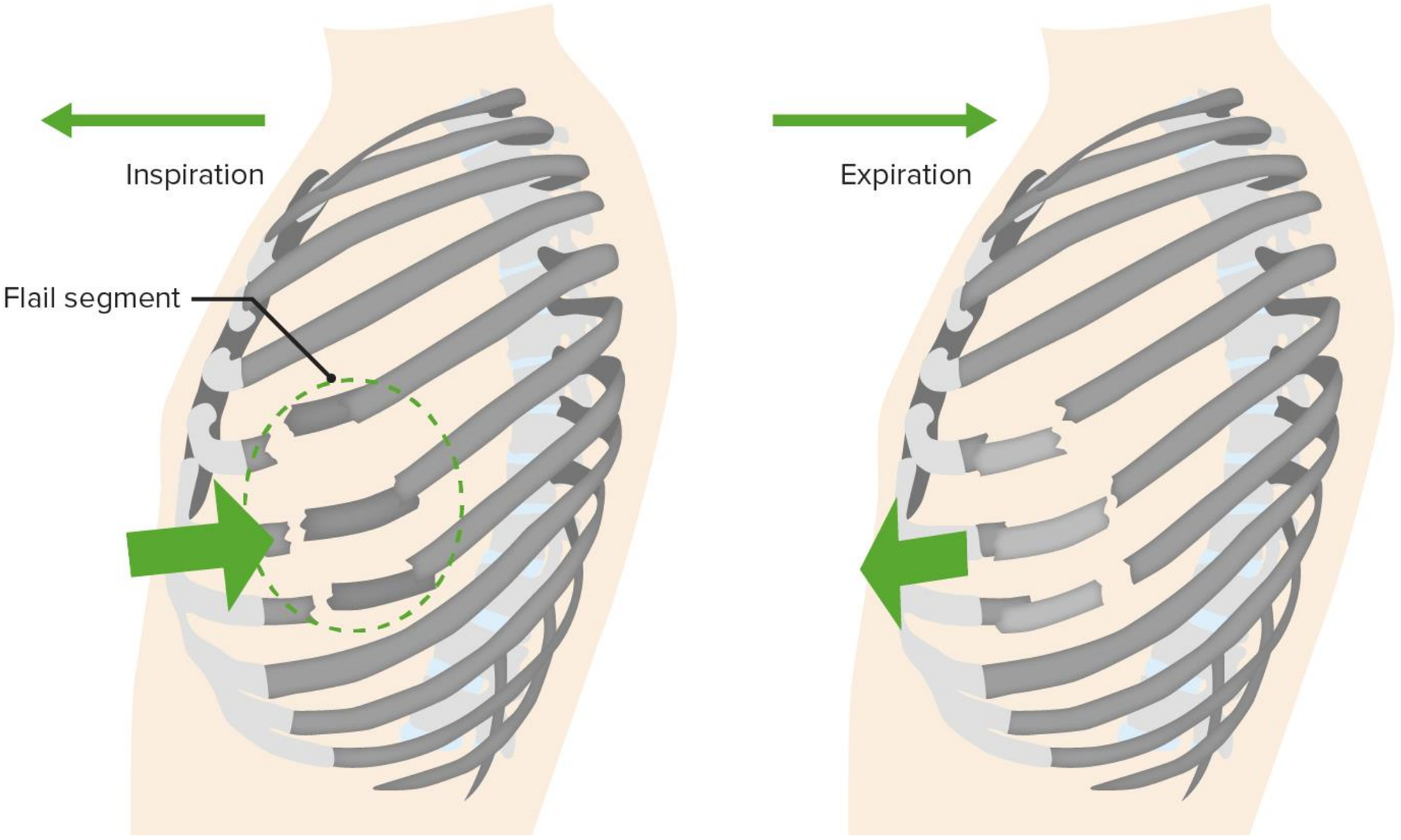
Management of specific injuries

Rib fractures

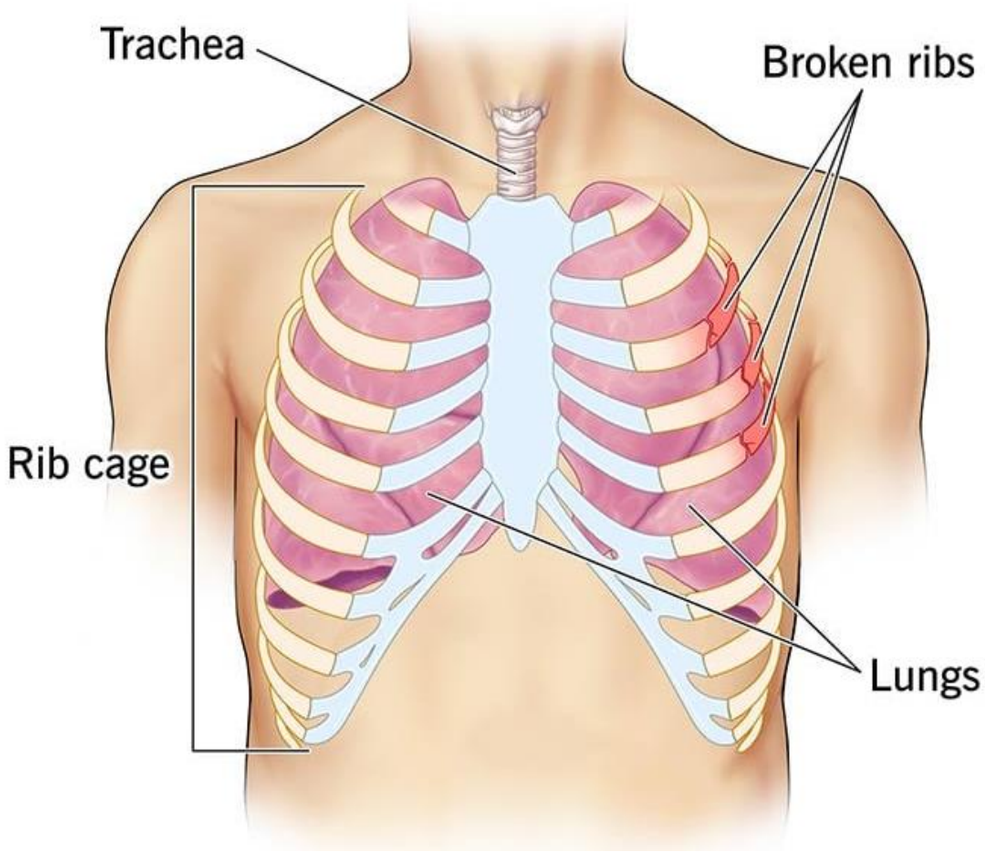


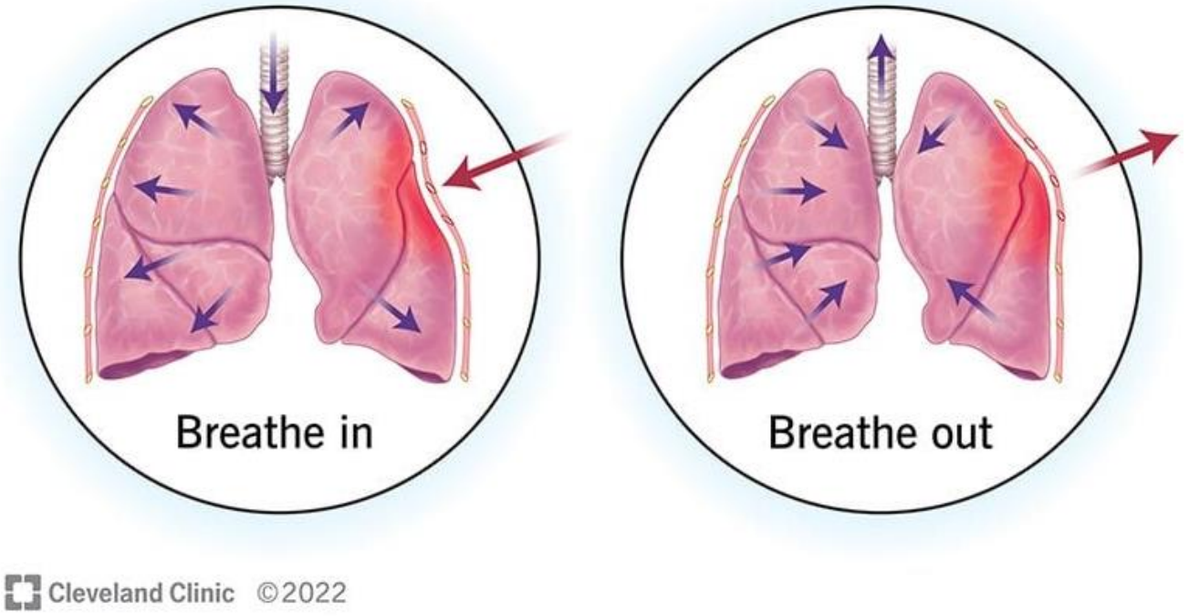
CWIS
Chest Wall Injury Society

Flail chest



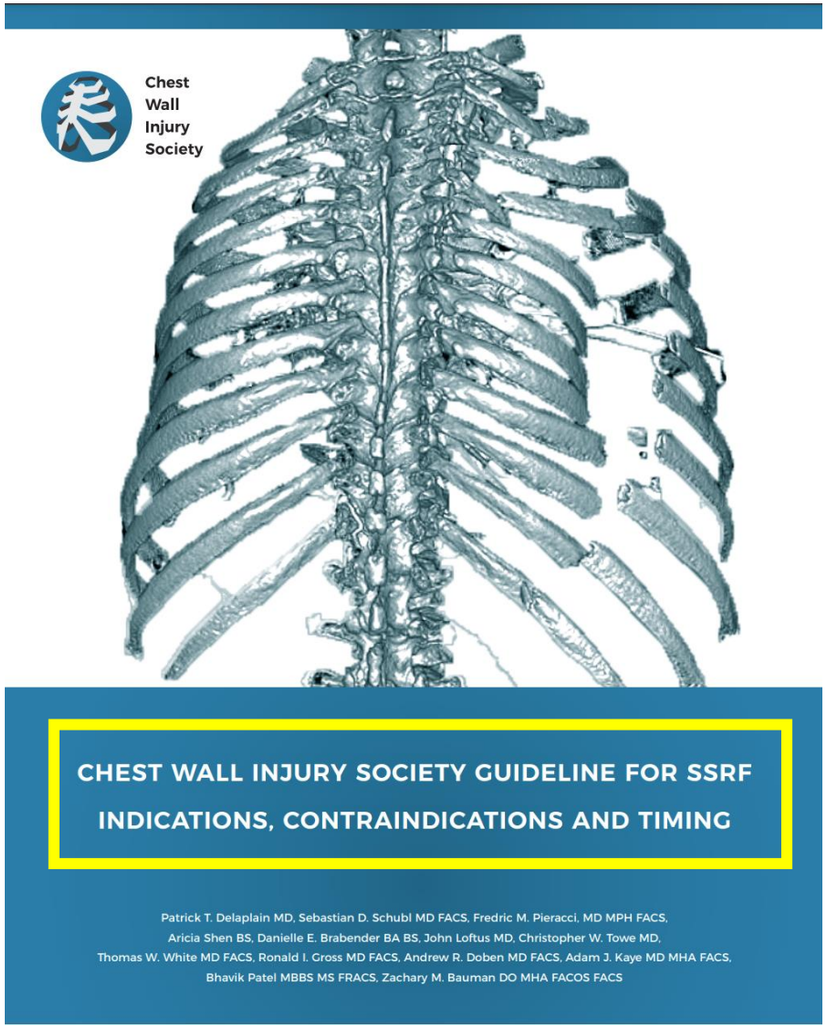
Paradoxical respiration

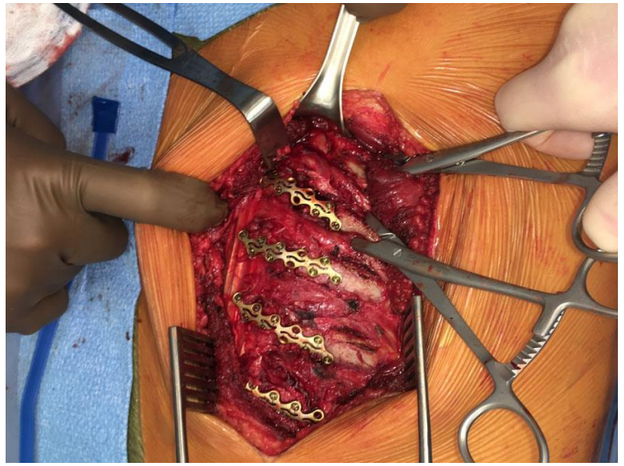




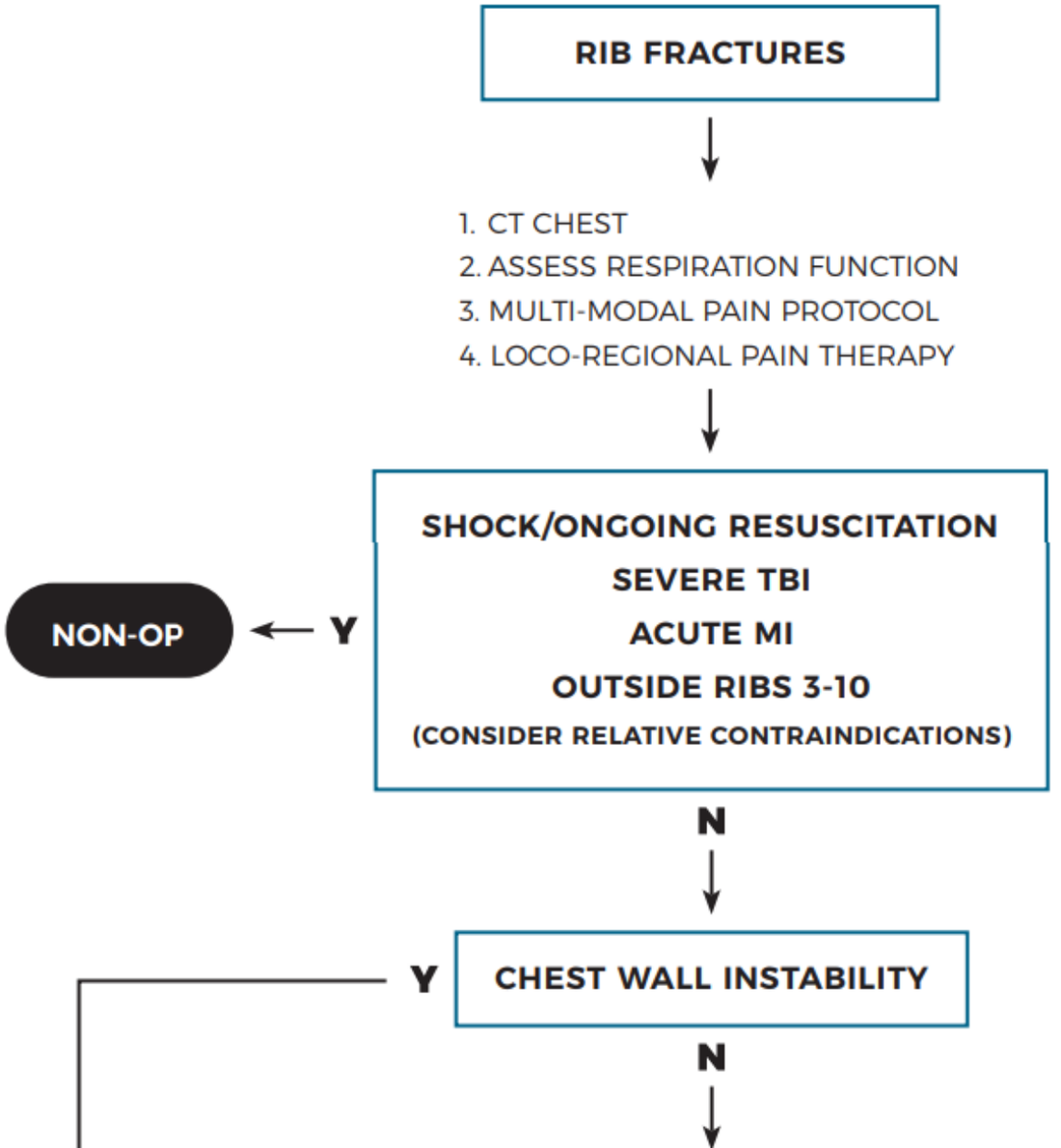
Surgical Stabilization of Rib Fracture (SSRF)

Chest
Wall
Injury
Society





SSRF ALGORITHM



DEFINITIONS OF TERMS

SEVERE TBI

- Any GCS <8
- Signs of intracranial hypertension

RELATIVE CONTRAINDICATIONS

- Age <18 years
- Significant comorbidities
- Unstable Spine injury
- Empyema
- Prior chest wall radiation
- Mild/moderate TBI

CHEST WALL INSTABILITY

Flail Segment

- 3+ ipsilateral consecutive ribs with fractures in 2 locations
- Clinical finding of paradoxical motion

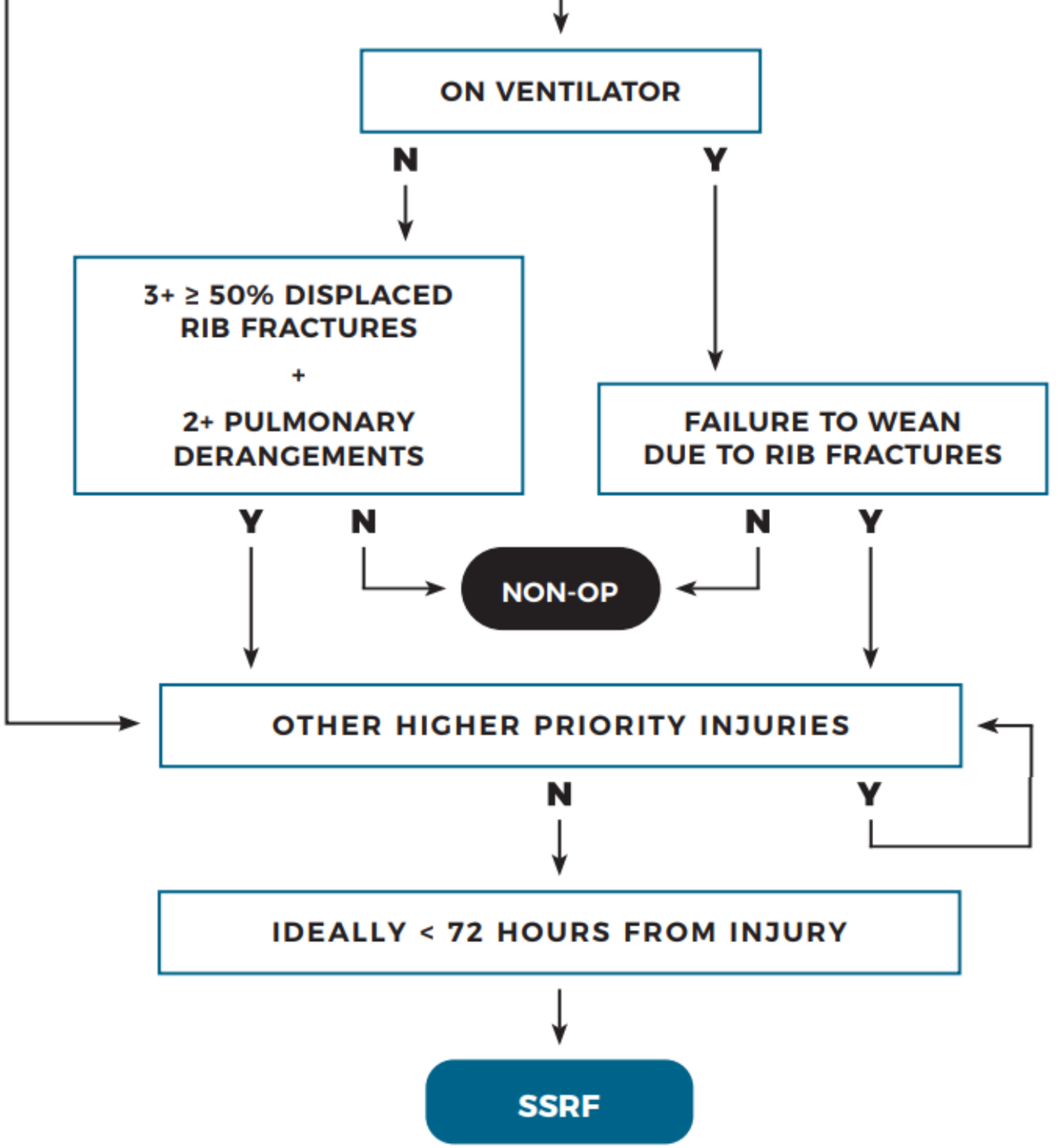
Offset fractures

- 3+ ipsilateral rib fractures with displacement of 100% of rib width on axial CT

Instability or "clicking" on palpation or reported by the patient

3+ > 50% DISPLACEMENT

- Three ipsilateral consecutive or non-consecutive ribs each with a fracture displaced 50% of the rib width on axial CT



PULMONARY DERANGEMENTS

- Respiratory rate >20
- Incentive spirometry <50% of predicted
- Numerical pain score >5/10
- Poor cough

FAILURE TO WEAN

Must be clinically determined to be related to the rib fractures

Unable to progress to spontaneous breathing trial after 48 hours

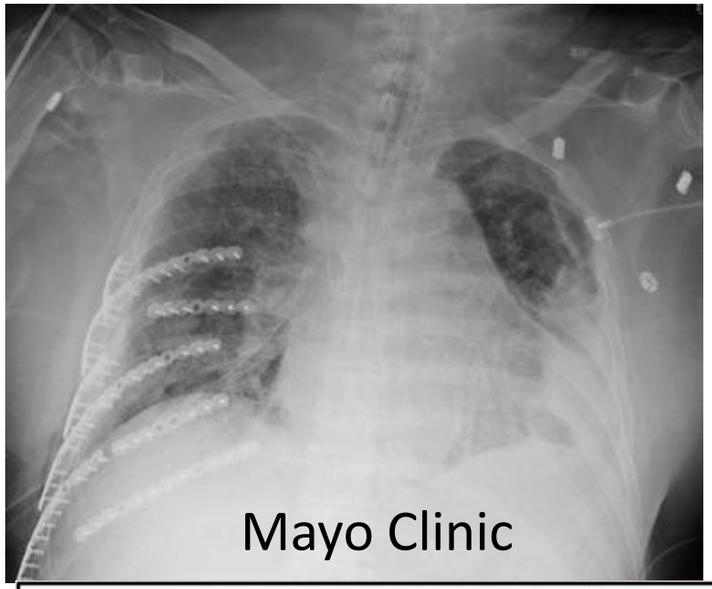
Able to obtain spontaneous breathing trial for 60 minutes but develops >2 of the following

- Increased resp. rate >35
- Increased heart rate >140
- Oxygen saturation <90%
- RSBI >105
- Anxiety
- Diaphoresis
- Agitation

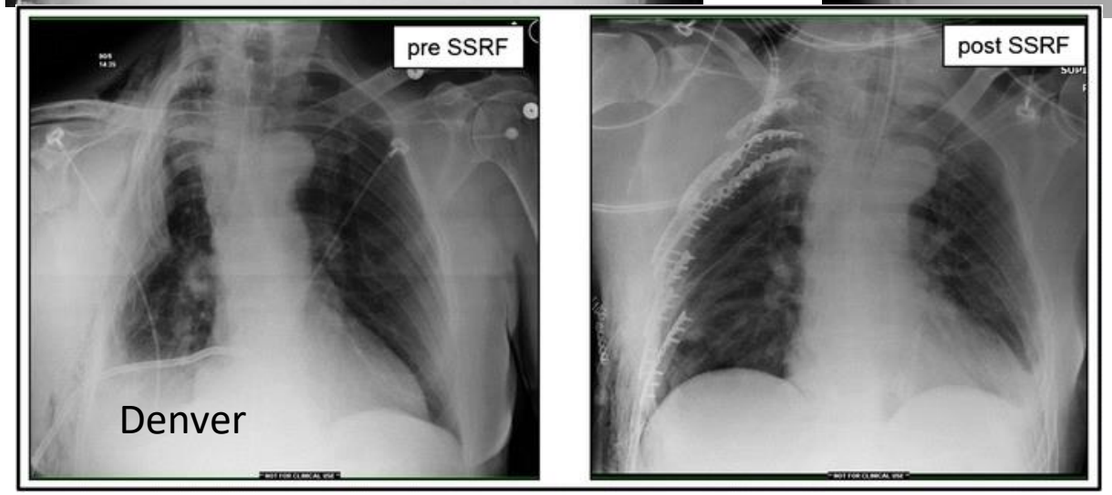
Of note: Ventilator weaning should be at the discretion of the treating bedside physician.

HIGHER PRIORITY INJURIES

- Pre-operative spinal injury
- Open Abdomen
- Significant vascular trauma
- Pelvic external fixation

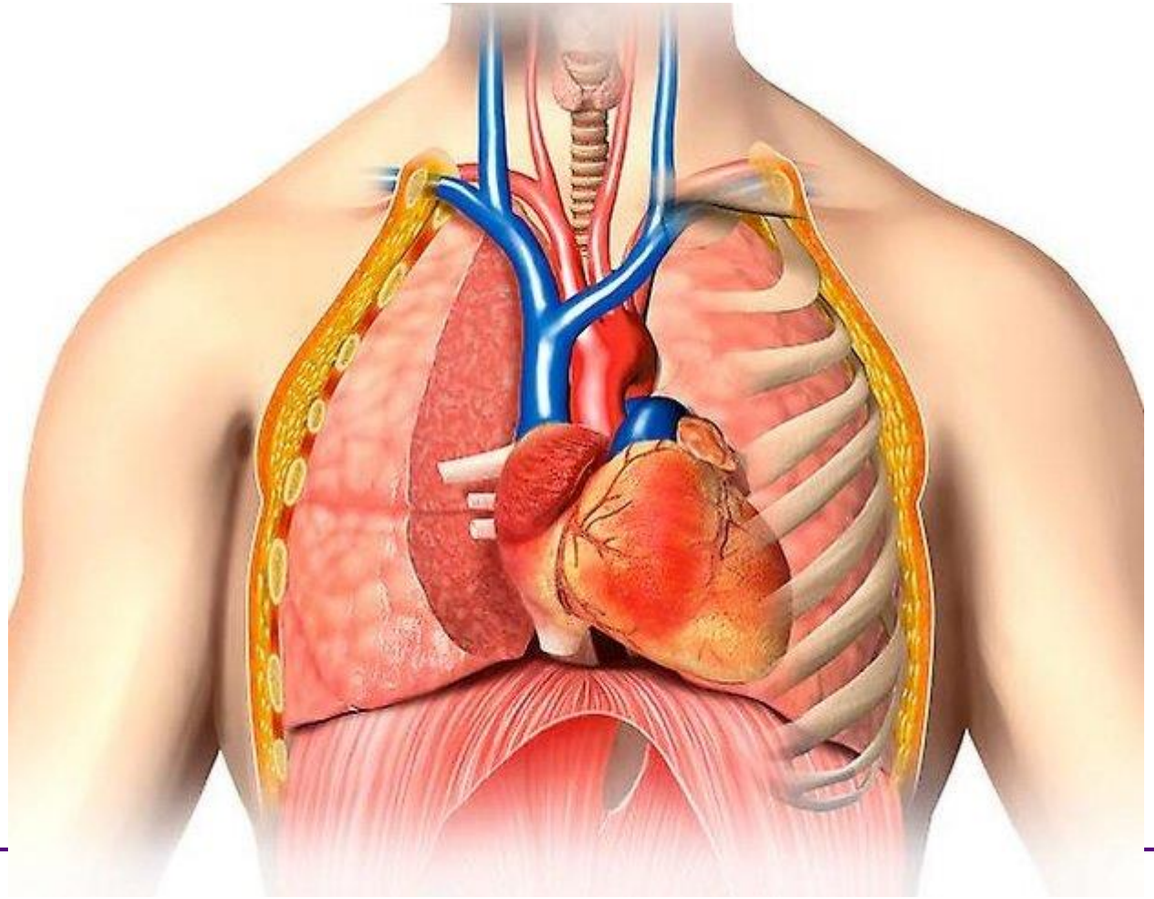

Mayo Clinic


PENNSYLVANIA


pre SSRF
post SSRF
Denver

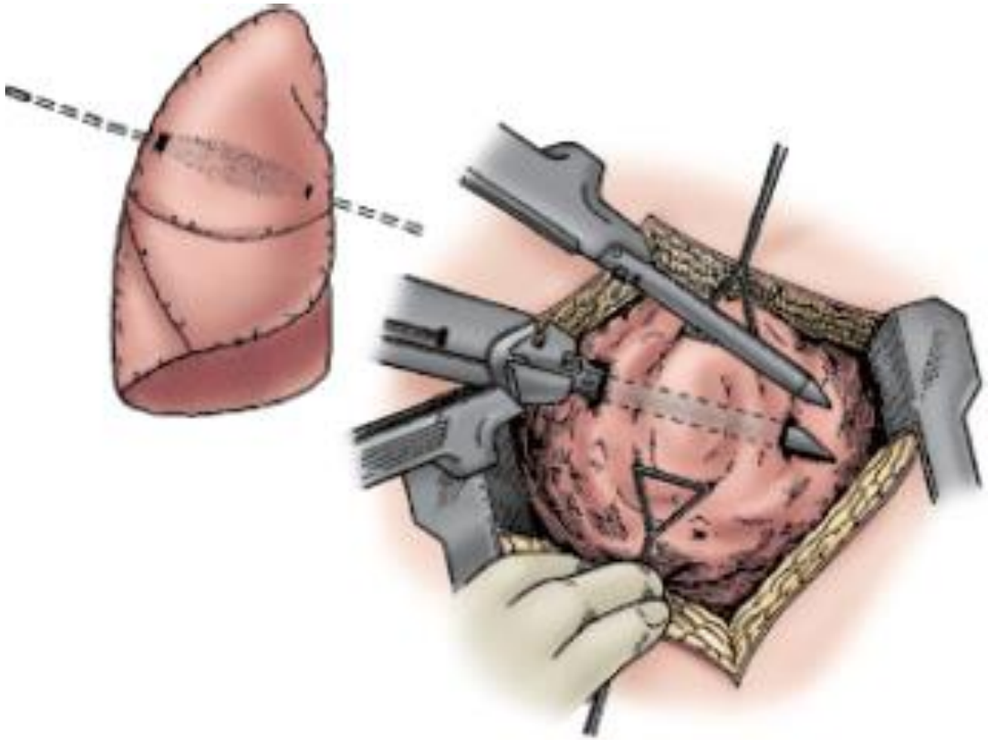
Management of specific injuries

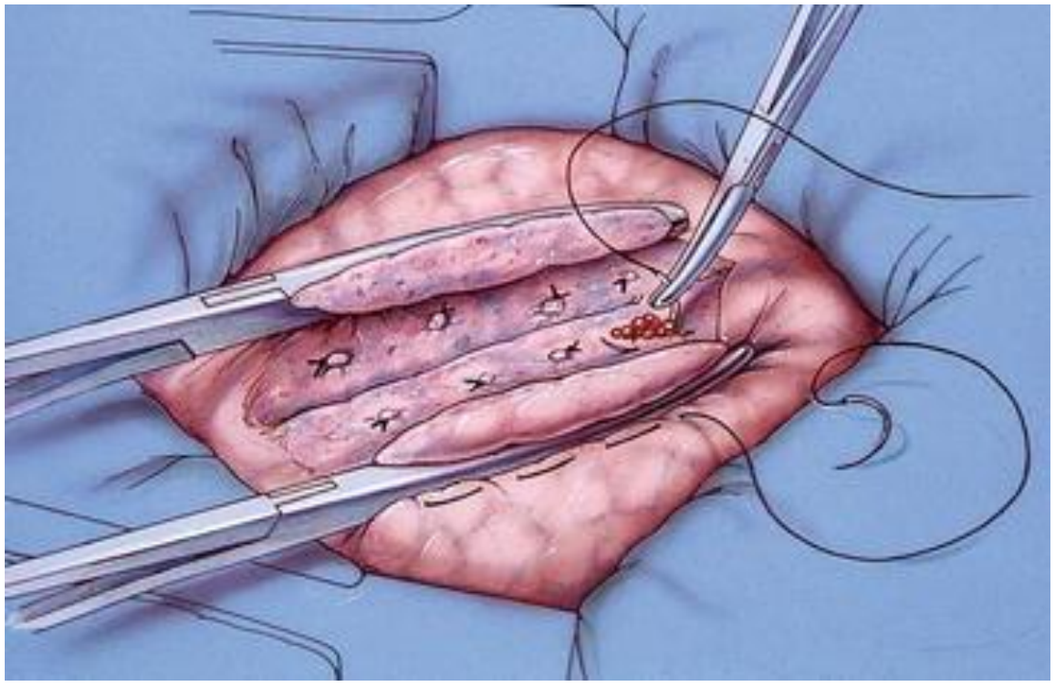
Penetrating thoracic Injury



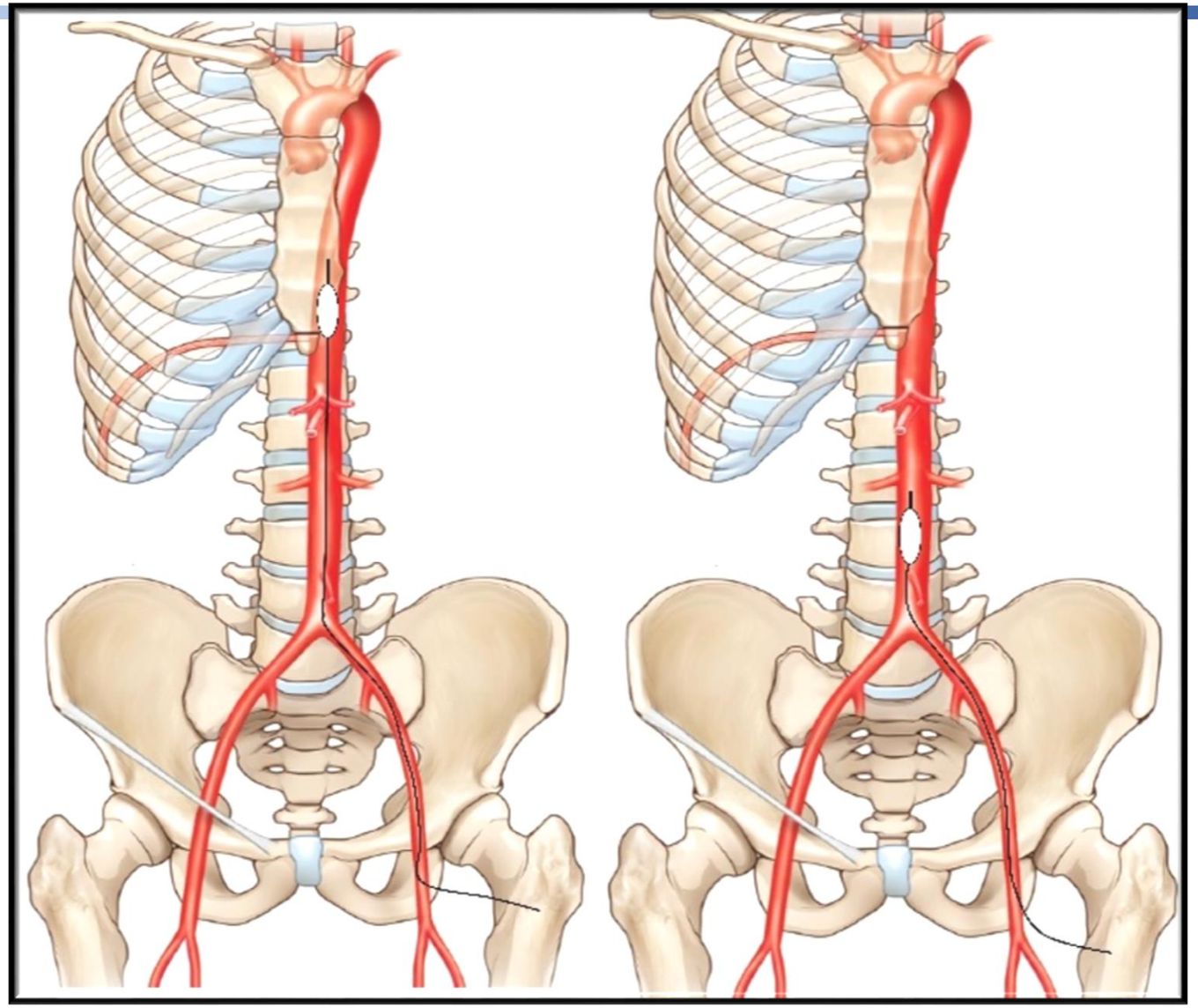
Management of specific injuries

Pulmonary tractotomy





REBOA (Resuscitative Endovascular Balloon Occlusion of the Aorta)

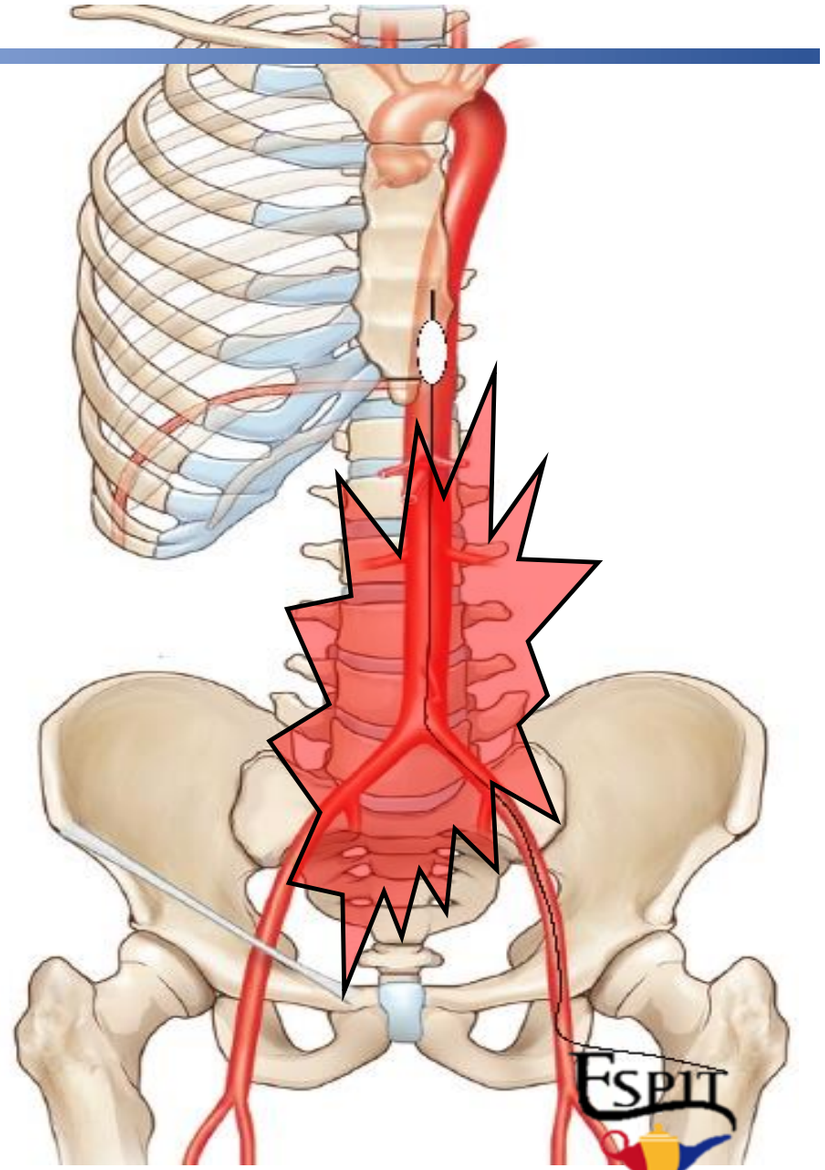


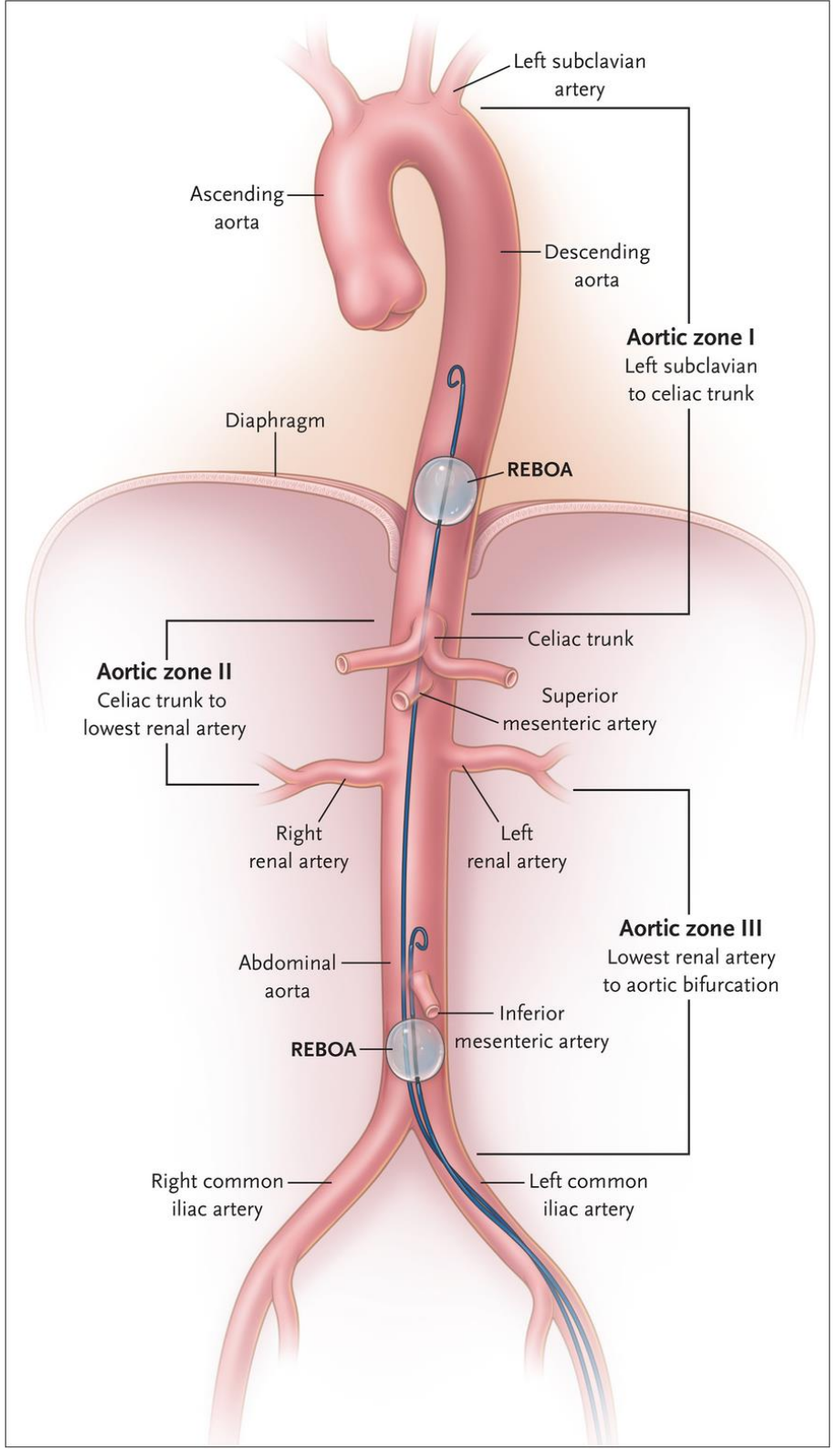
NCTH (Non-compressible torso hemorrhage)

Table 1. *Non-compressible torso hemorrhage, which consists of one of the anatomi et al.[5].*

Anatomic criteria
1. Pulmonary injury (massive haemothorax, pulmonary va
2. Solid organ injury = grade 4 (liver, kidney, spleen)
3. Named axial torso vessel
4. Pelvic fracture with ring disruption

1 - Santo Amaro University, Discipline of General Surgery and Trauma, São Paulo, SP Center, Baltimore, MD, USA. 3 - University of New South Wales, School of Medicine,




Left subclavian artery
Ascending aorta
Descending aorta
Aortic zone I
Left subclavian to celiac trunk
Diaphragm
REBOA
Celiac trunk
Aortic zone II
Celiac trunk to lowest renal artery
Superior mesenteric artery
Right renal artery
Left renal artery
Aortic zone III
Lowest renal artery to aortic bifurcation
Abdominal aorta
Inferior mesenteric artery
REBOA
Right common iliac artery
Left common iliac artery

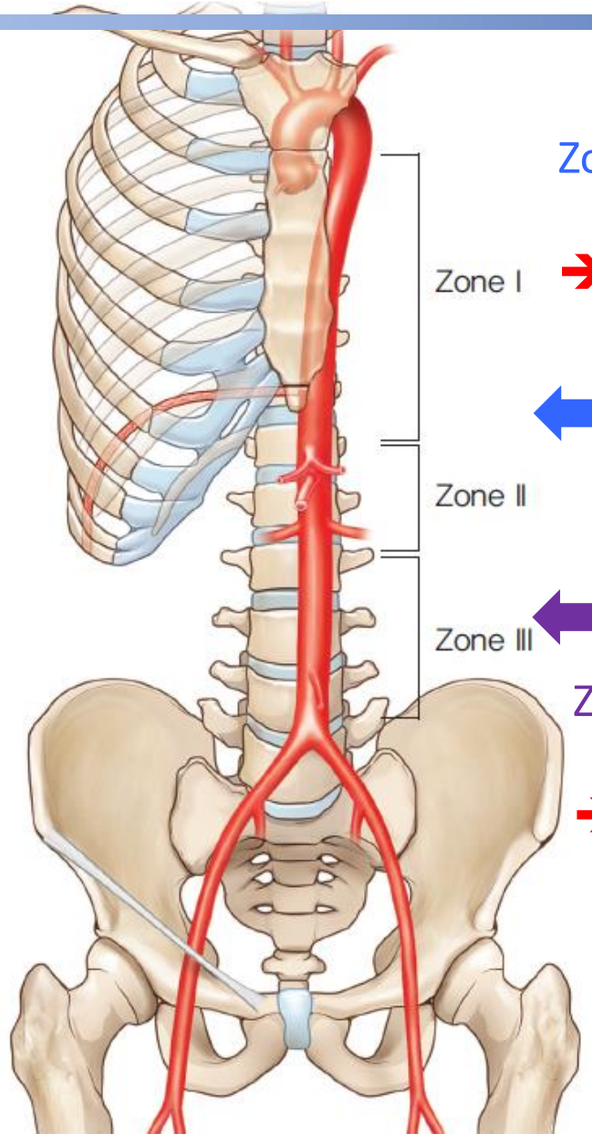
J Thorac Dis. 2018 Sep;10(9):5550-5559

Balloon inflation to occlude the aorta flow

Zone 1: from left subclavian a.
to celiac trunk
➔ Abdominal
or truncal hemorrhage

Xyphoid

Zone 2: from the celiac trunk
to lowest renal a.
➔ No occlusion



Umbilicus

Zone 3: from the lowest renal a.
to aortic bifurcation
➔ Pelvic hemorrhage

Blunt trauma without open wound

- Pneumothorax or hemothorax

→ Clean thoracostomy

Clean thoracostomy

- Q.

① Continuous while having a chest tube

② Once before and once after placing the chest tube

③ Only once before chest tube placement

④ No antibiotics required

Clean thoracostomy

- A.
  - Continuous while having a chest tube
  - Once before and once after placing the chest tube
  - Only once before chest tube placement
  - ✓ No antibiotics required *

* Freeman JJ, Asfaw SH, Vatsaas CJ, et al. Antibiotic prophylaxis for tube thoracostomy placement in trauma: a practice management guideline from the Eastern Association for the Surgery of Trauma. Trauma Surg Acute Care Open. 2022;7(1):e000886.

Penetrating trauma (without esophageal injury)

- Prophylactic intravenous antibiotics should be administered

→ Cefazolin 2 g IV Q8h

Use for 24 hours after surgery

* Sanabria A, Valdivieso E, Gomez G, Echeverry G. Prophylactic antibiotics in chest trauma: a meta-analysis of high-quality studies. World J Surg. 2006;30(10):1843-1847.

Chest trauma with esophageal injury

- Broad-spectrum intravenous antibiotics
  - Covering aerobes and anaerobes
  - Ampicillin/sulbactam (3 gm QID)
  - Piperacillin/tazobactam (3.375 gm QID)
  - Clindamycin (900 mg TID) + Ciprofloxacin (400 mg BID)
  - Carbapenem

* Sanabria A, Valdivieso E, Gomez G, Echeverry G. Prophylactic antibiotics in chest trauma: a meta-analysis of high-quality studies. World J Surg. 2006;30(10):1843-1847.

Chest trauma with esophageal injury

+ Antifungal coverage
  - Long-term antacid therapy
  - Steroids or other immunosuppressive therapy
  - HIV infection
  - Known esophageal candidiasis

→ Fluconazole 400 mg QD

* Sanabria A, Valdivieso E, Gomez G, Echeverry G. Prophylactic antibiotics in chest trauma: a meta-analysis of high-quality studies. World J Surg. 2006;30(10):1843-1847.

Cardiac injury

- Cardiac laceration or rupture
- Cardiac operation with/without CPB

- Standard preoperative antibiotics should be administered

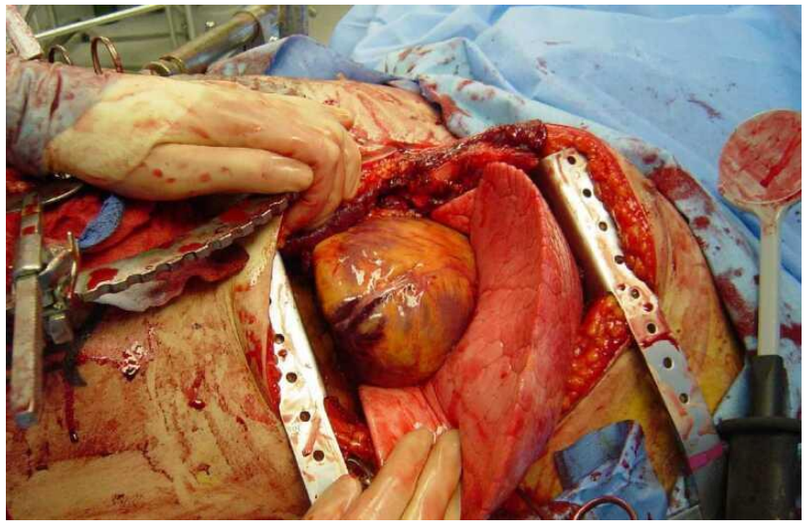
→ Cefazolin
(Redose interval: 4 hours)
→ or Vancomycin
- Frequent MRSA infections
- Patients previously colonized with MRSA
- Penicillins or cephalosporins allergy

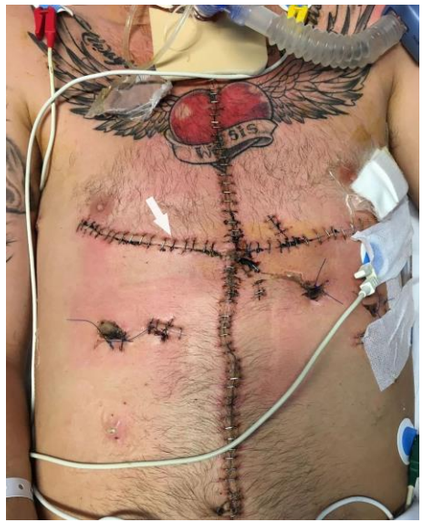
Resuscitative thoracotomy

- Recommended before any cardiothoracic surgery
- Procedure should not be delayed for antibiotic administration

± Enteric gram-negative bacilli

- Aminoglycoside (gentamicin 5 mg/kg IV)
- Fluoroquinolone (ciprofloxacin 400 mg IV or levofloxacin 500 mg IV)





* Weare S, Gnugnoli DM. Emergency Room Thoracotomy. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan.

Pulmonary and tracheobronchial injury

- Lung contusion:
  - For treatment of advanced pneumonia
  - Not prophylaxis
- Traumatic pulmonary pseudocyst:
  - Still controversial
  - Infected?
- TBI:
  - Non-operative management

  → Broad-spectrum antibiotic coverage

Chest wall pain after trauma

- Impaired function, recovery, and quality of life
- Prolonged opioid use/opioid-induced adverse events
- Morbidity
  - Pneumonia
  - Ileus
- Health economic impact
  - Increase length of stay, time to discharge, readmission rates
  - Increase cost of care

Pain management

- NSAIDs
- AAP
- Opioids
- Gabapentin
- IV & Epidural PCA
- Intercostal nerve block
- Paravertebral catheter
- Subcutaneous catheter

→ **Multimodal management**

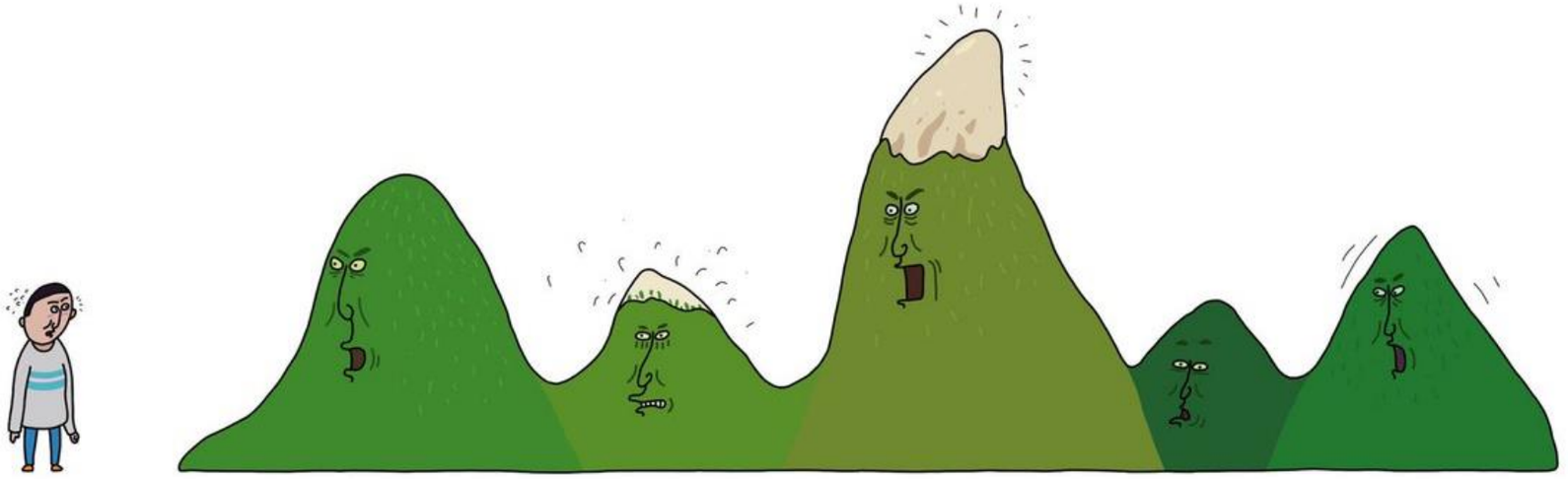
Physiotherapy and rehabilitation

- Early physiotherapy → reduced respiratory complications and length of stay
- Encourage physiotherapy as early as possible
- Rehabilitation is an essential component of successful treatment of **thoracic trauma**


외상전용장비


Sara Plus

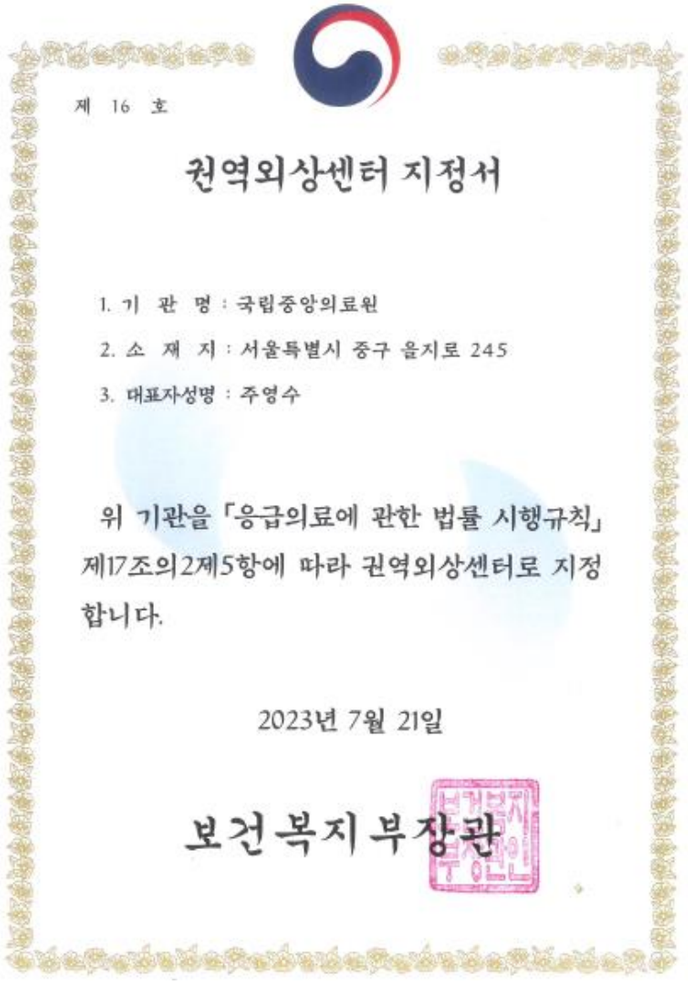
Trauma..



ER **OP.** **ICU** **Consult op.** **Rehab.**

서울권역외상센터

서울권역외상센터 지정 ‘23.07.21.



제 16 호

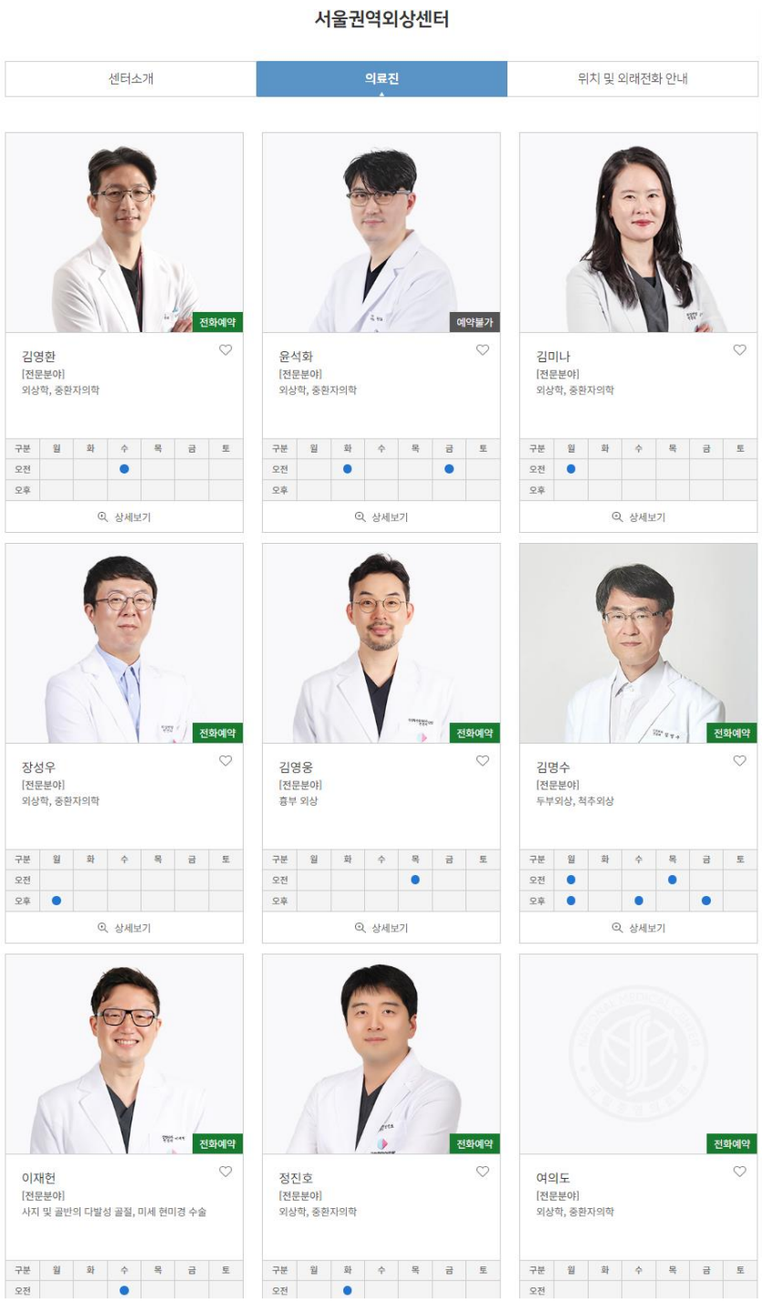
권역외상센터 지정서

1. 기 관 명 : 국립중앙의료원
2. 소 재 지 : 서울특별시 중구 을지로 245
3. 대표자성명 : 주영수

위 기관을 「응급의료에 관한 법률 시행규칙」 제17조의2제5항에 따라 권역외상센터로 지정합니다.

2023년 7월 21일

보건복지부장관

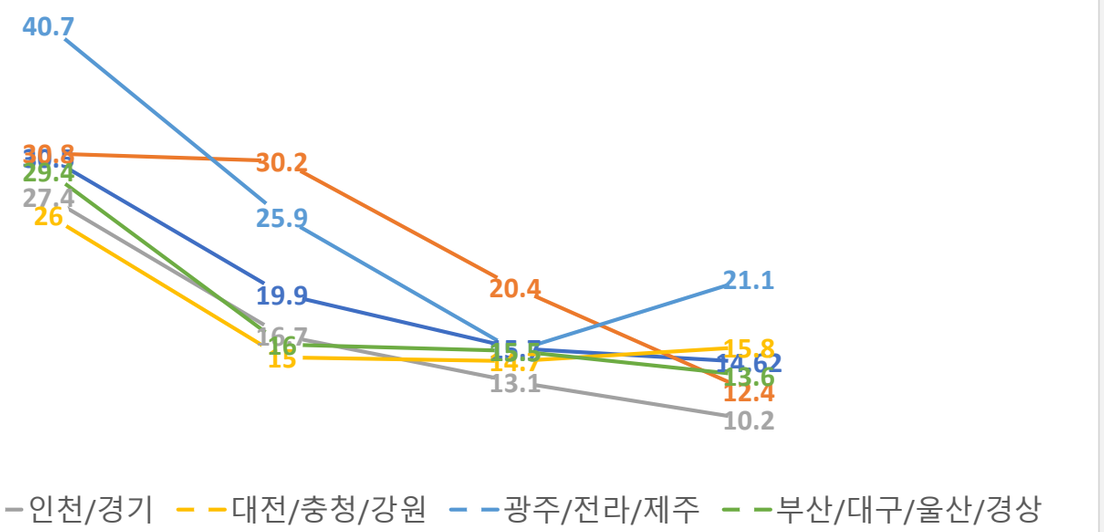


서울권역외상센터

전국 권역외상센터 현황_ 17개소

전국 예방가능 외상사망률

2019년 예방 가능 외상 사망률('22년 3월 보건복지부 발표)



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전국	30.5	19.9	15.7	14.62	
서울	30.8	30.2	20.4	12.4	
인천/경기	27.4	16.7	13.1	10.2	
대전/충청/강원	26	15	14.7	15.8	
광주/전라/제주	40.7	25.9	15.5	21.1	
부산/대구/울산/경상	29.4	16	15.5	13.6	

국립중앙의료원 신축이전

NMC 신축·이전 부지 문화재 정밀발굴조사 마무리

이영재 기자 | 승인 2023.11.22 12:57

출토 유물·유구 기록보존 결정...사업 지연없이 추진

■ 국립중앙의료원 신축·이전 부지.

국립중앙의료원(NMC) 신축·이전 부지 내 문화재 정밀발굴 조사가 10월 30일 문화재청으로부터 완료조치 통보를 받았다. 이에 따라 NMC 신축·이전 사업은 문화재 조사에 따른 지연없이 이어갈 수 있게 됐다.

출처: 의협신문