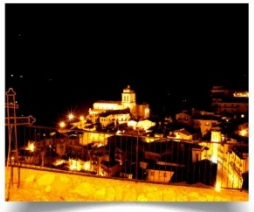
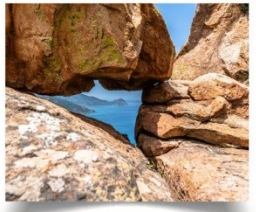




2 Congresso Nazionale

GESTIONE DEL TRAUMA DI INTERESSE CHIRURGICO

Gestione integrata del trauma maggiore dalla scena dell'evento alla cura definitiva

31 maggio -1 giugno 2023 - Petralia Sottana (PA)

Thoracic damage control in unstable patient

G. Di Grezia

Thoracic trauma: what we know

- **Second cause** of **death** for trauma
- Causing **20%** of deaths

- Most injuries can be **treated without surgery**
  - 90% blunt trauma
  - 70/80% **penetrating trauma**

Severe chest trauma and the trauma system

- The **trauma system** does **not** always **succeed** in **primary centralization** due to:
  - **Penetrating** trauma
  - **Severity** of clinical conditions
  - Hub center **distance**
- The general surgeon may be **out** of his **comfort zone**:
  - **Abolition** of the **residency** in emergency surgery by the EU
  - **Abdominalization** of emergency surgery

The unstable patient with closed or penetrating chest injury

- Agonic
- U

Misurati (37.0°C)

pH	↓ 7.30	
pCO_2	↑ 54	mmHg
pO_2	↓ 54	mmHg
		mmol/L
		mmol/L
		mmol/L
		mmol/L
		mg/dL
		mmol/L
		g/dL
		%
		%
		%
		%
		%
		mmol/L
		mmol/L
		mmHg
		mmol/L
		%
		°C
		%

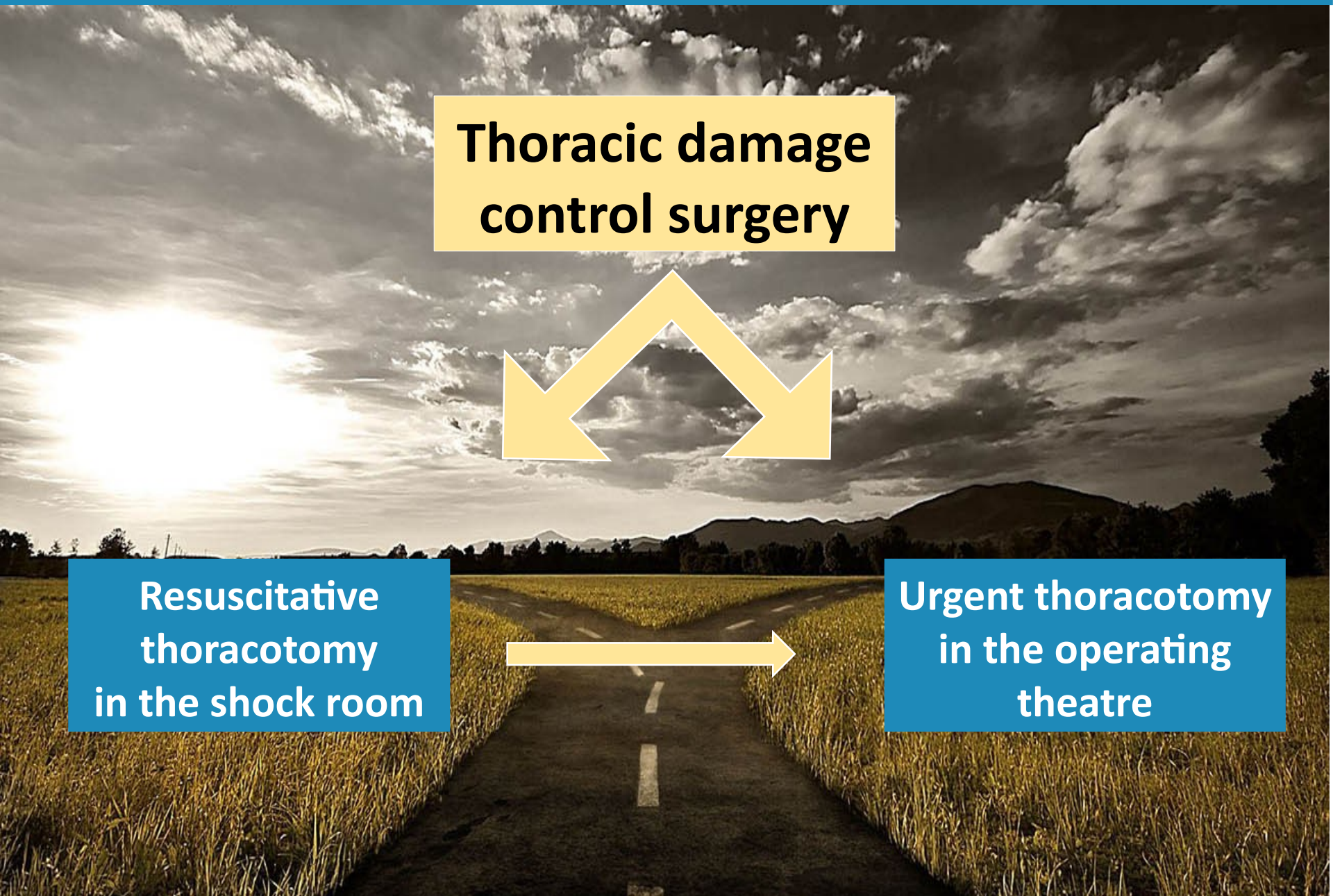
TABLE 3-1 SIGNS AND SYMPTOMS OF HEMORRHAGE BY CLASS

PARAMETER	CLASS I	CLASS II (MILD)	CLASS III (MODERATE)	CLASS IV (SEVERE)
Approximate blood loss	<15%	15–30%	31–40%	>40%
Heart rate	↔	↔/↑	↑	↑/↑↑
Blood pressure	↔	↔	↔/↓	↓
Pulse pressure	↔			
Respiratory rate	↔			
Urine output	↔	↔	↓	↓↓
Glasgow Coma Scale score	↔	↔	↓	↓
Base deficit[a]	0 to –2 mEq/L	–2 to –6 mEq/L	–6 to –10 mEq/L	–10 mEq/L or less
Need for blood products	Monitor	Possible	Yes	Massive Transfusion Protocol

peripheral perfusion monitoring

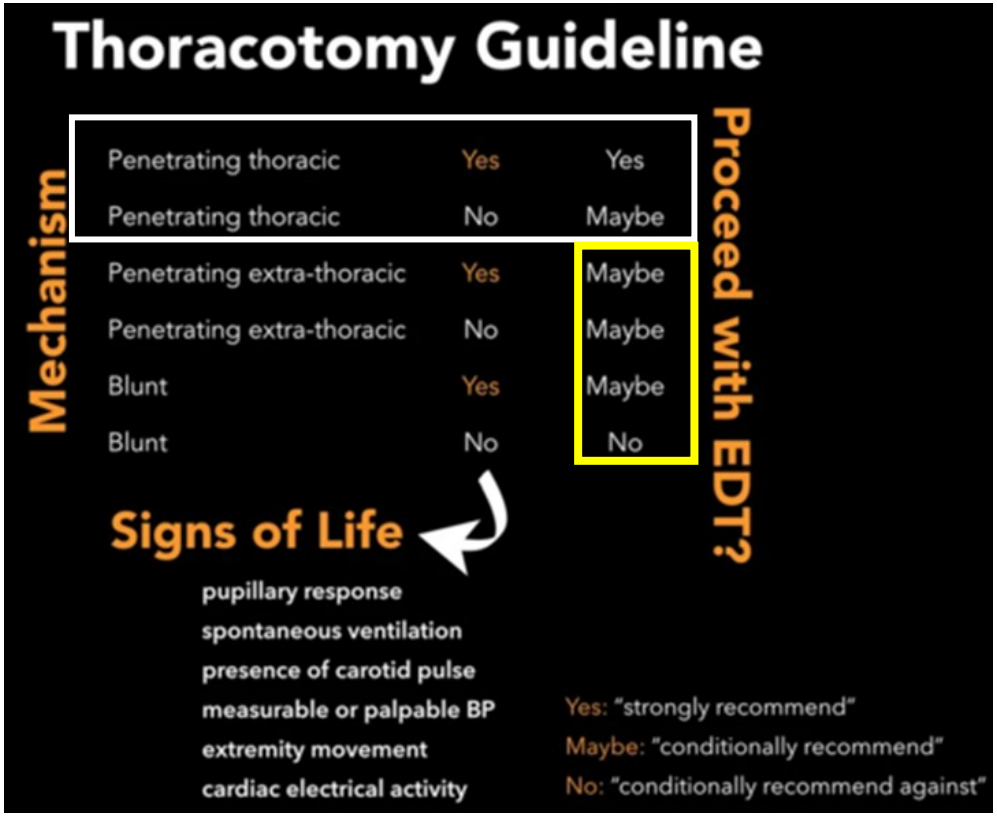
[a] Base excess is the quantity of base (HCO_3^-, in mEq/L) that is above or below the normal range in the body. A negative number is called a base deficit and indicates metabolic acidosis.

Thoracic damage control



Resuscitative thoracotomy

- **Heart injuries**
  - **Most** patients with traumatic heart injuries **die** on the **trauma scene**
- Patients arriving **alive** in the **emergency department** in agonic conditions are **candidates** for **resuscitative thoracotomy**
  - Penetrating trauma
  - PEA
  - Signs of life



Resuscitative thoracotomy outcome

Injury	Survival (%)	Neurologic outcome (%)	Recommendation
Penetrating Thoracic with Signs of Life	182/853 (21.3)	53/454 (11.7)	++
Penetrating Thoracic without Signs of Life	76/920 (8.3)	25/641 (3.9)	+
Pen. Extrathoracic with Signs of Life	25/160 (15.6)	14/85 (16.5)	+
Pen. Extrathoracic without Signs of Life	4/139 (2.9)	3/60 (5)	+
Blunt with Signs of Life	21/454 (4.6)	7/298 (2.4)	+
Blunt without Signs of Life	7/995 (0.7)	1/825 (0.1)	NR

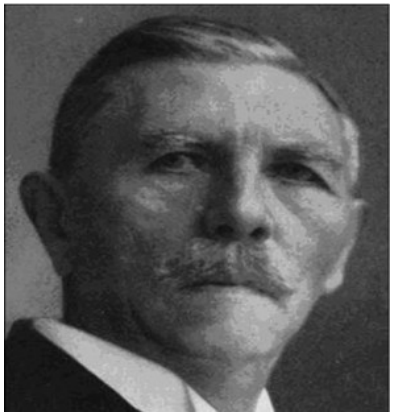
++- strong recommendation
+- conditional recommendation
NR- Not Recommended

Summary

Patients most likely to respond favorably to EDT include victims of penetrating trauma with signs of life upon presentation to the emergency room or patients who lose signs of life within 10 minutes of arrival

History of resuscitative thoracotomy

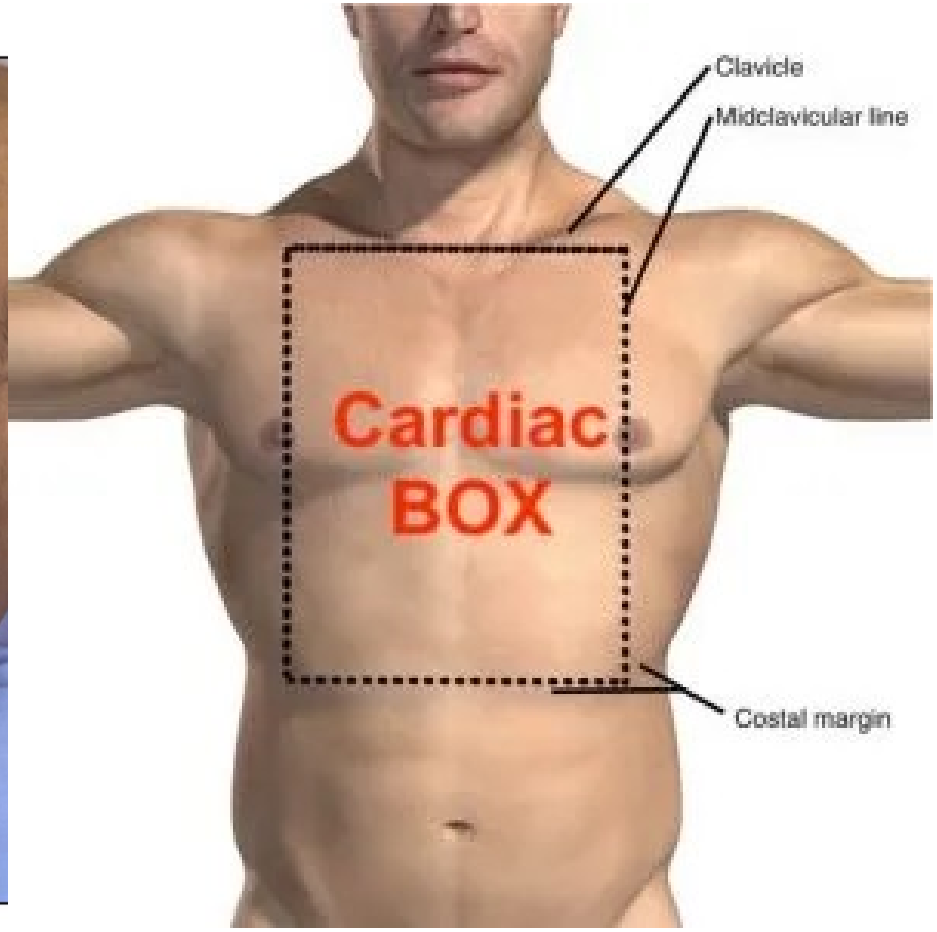
1895
Axel Cappelen



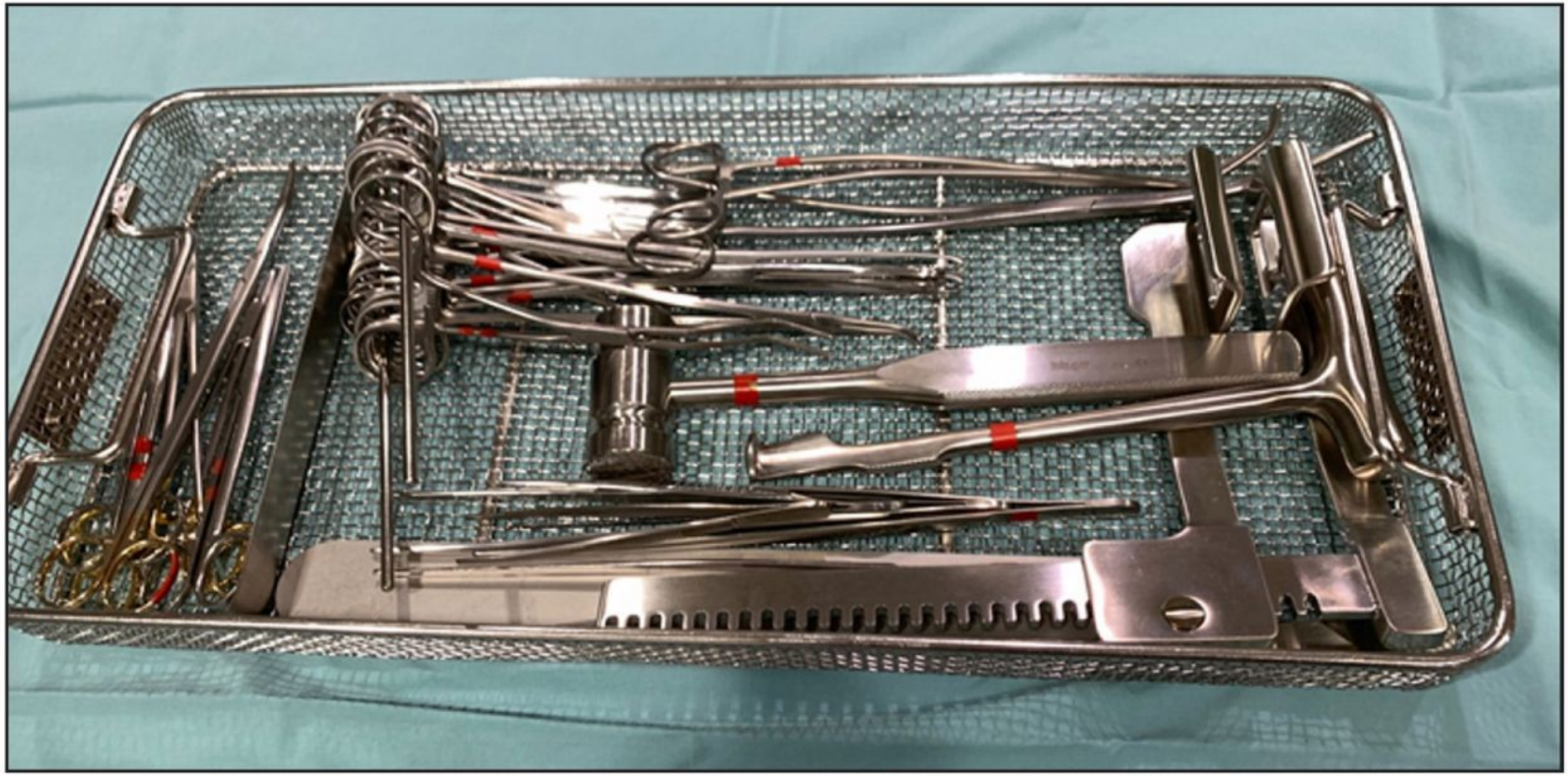
1896
Ludwig Rehn

1897
Antonio Parrozzani

Cardiac box

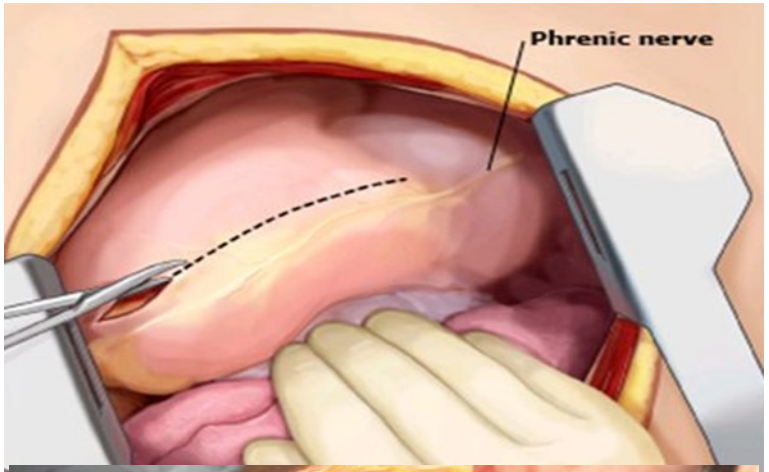


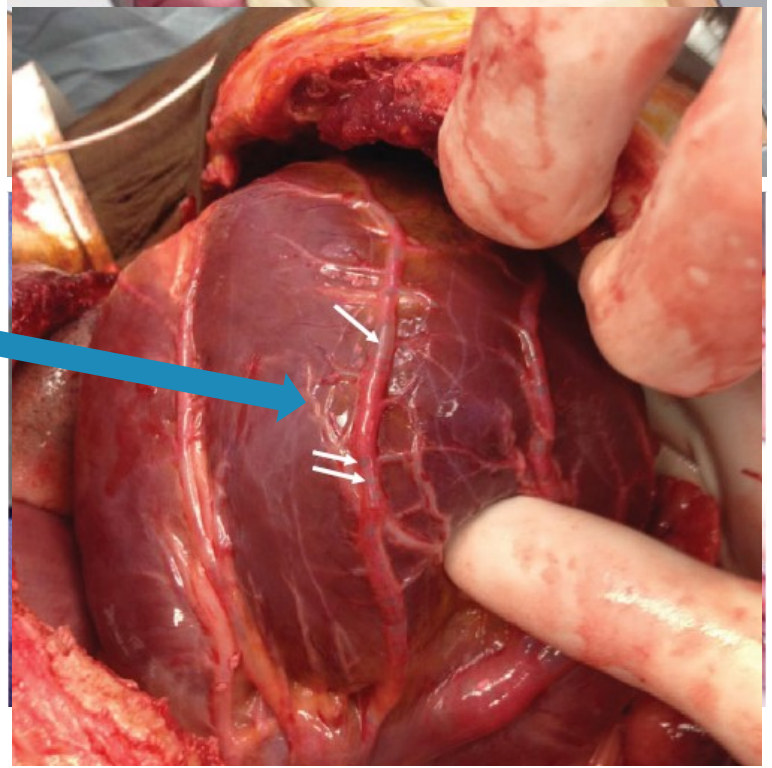
Surgical kit



The five objectives of resuscitative thoracotomy

- Pericardiotomy (cardiac tamponade)
- Initial treatment cardiac injuries
- Descending aorta cross clamping
  - Blood flow centralization
  - Clamping above the diaphragm (minimize spinal hypoperfusion)
- Internal cardiac massage
- Pulmonary hilum clamping
  - Risk of gas embolism
  - Reduction of bleeding in severe lung injury





Cardiac injury in resuscitative thoracotomy

Urgent thoracotomy: main enemies

AIR

- Tension pneumothorax
- Persistent pneumothorax
  - Tracheobronchial tear

The main goals of TDCS are to **stop bleeding** and maintain oxygenation through the **reduction of positive intrathoracic pressures**

Blood

- **Hemorrhage from systemic vessels**
  - e.g. intercostal, mammary, supraaortic great vessels
- **Pulmonary parenchyma**
  - Peripheral, hilar/perihilar injuries
- **Hemopericardium/cardiac lesion**

EVERYTHING ELSE IS SECONDARY IF THESE OBJECTIVES ARE ACHIEVED

Which patients?

Dynamics

- **Penetrating (stab wound + / gunshot wound -)**
- Blunt

Hemodynamics

- BE - lactate – parameters (BP, capillary refill)
- **Fluid/blood response**

Basic diagnostic exams

- **E-FAST- thoracic x-ray (shock room)**
- CT if it does not delay a clear surgical choice

Thoracostomy tube

- **Output**

Urgent thoracotomy: indications

- Thoracotomy performed within the first two hours is considered as "**urgent thoracotomy**"

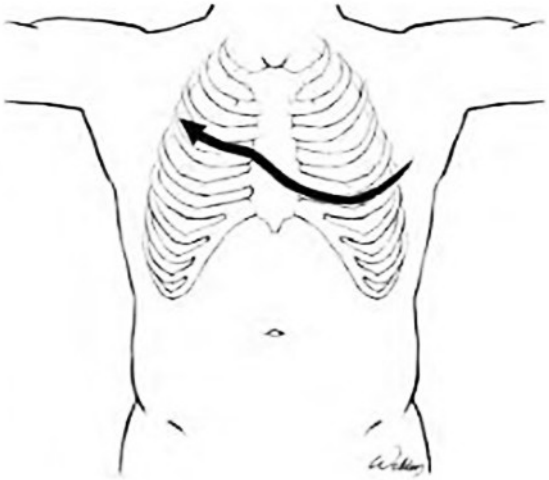
- Main indicators for urgent thoracotomy:
  - Chest tube output >**1500 mL**
  - Evidence of persistent bleeding **200 to 300 ml/h**
  - **Hemopericardium** without tamponade
  - **Severe hemodynamic conditions**

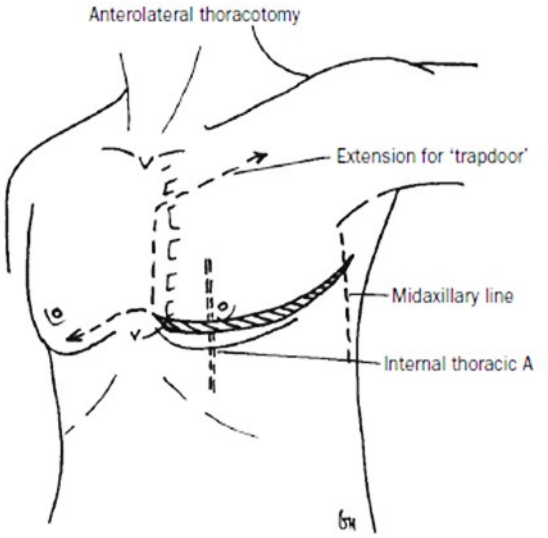
Which chest incision?

- There are three main types of thoracotomy:
  - **Anterolateral**
  - Posterolateral
  - Median sternotomy
- The anterolateral thoracotomy
  - Quick
  - Minimal muscle sacrifice
  - It's a excellent incision for
    - Anterolateral mediastinum and pleural cavity
    - Lung peripheric surgery
- Starts from the sternal border at the level of the 5th intercostal space and extends to the posterior axillary line

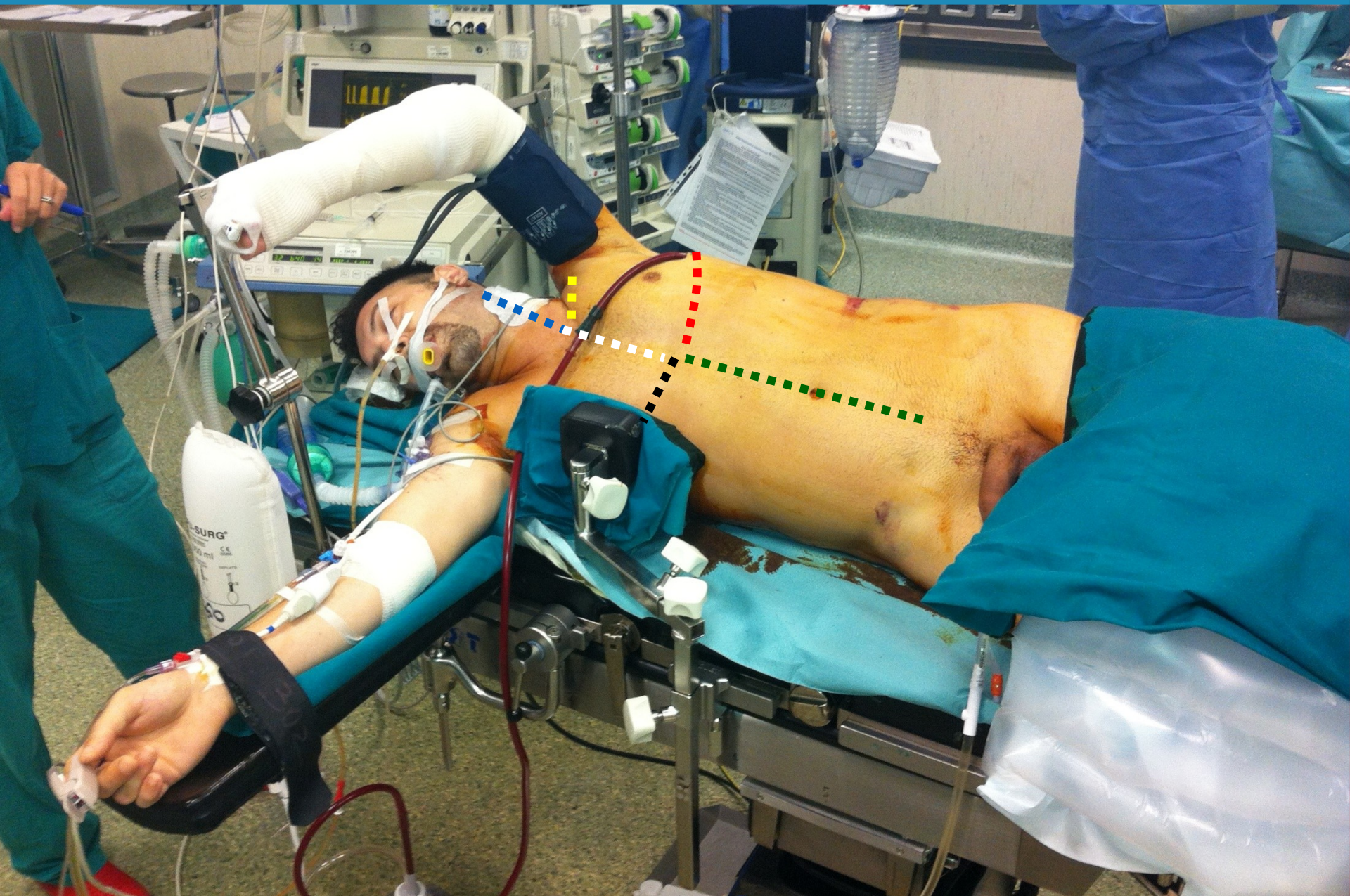
Antero-lateral thoracotomy

- Advantages
- **Possibility of extension**
  - Transversal section of the sternum with ascent to the IIIrd space or symmetrical (**clamshell**)
  - Median sternotomy (trapdoor)
  - Possible further extension supraclavicular (subclavian injury)
  - Laparotomy
- Lung parenchymal domain (+/-)





Damage control approach to the chest

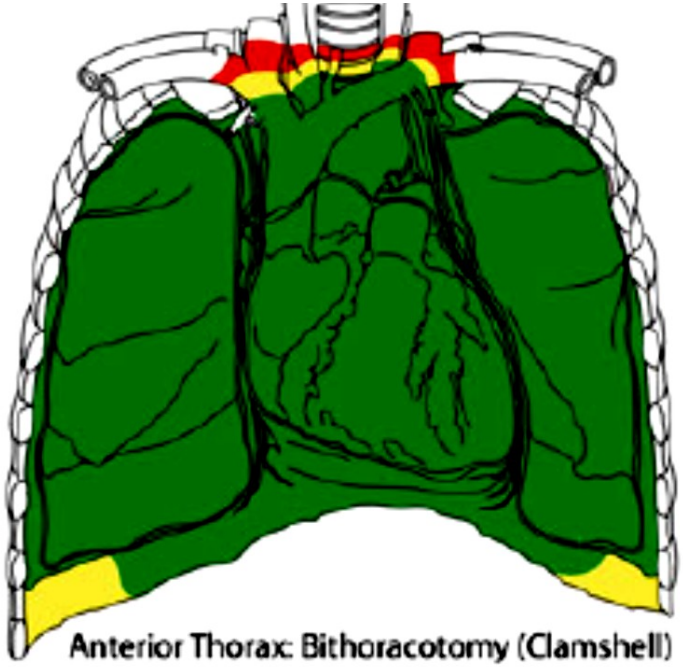


Clamshell

Although several incisions have been described for use in ET, the clamshell incision is the superior incision for patients arriving at the hospital in extremis. While the LAT and RAT may have utility in specific injury patterns, they remain a wise choice only because of ease of conversion to clamshell incision if further control is mandated. Median

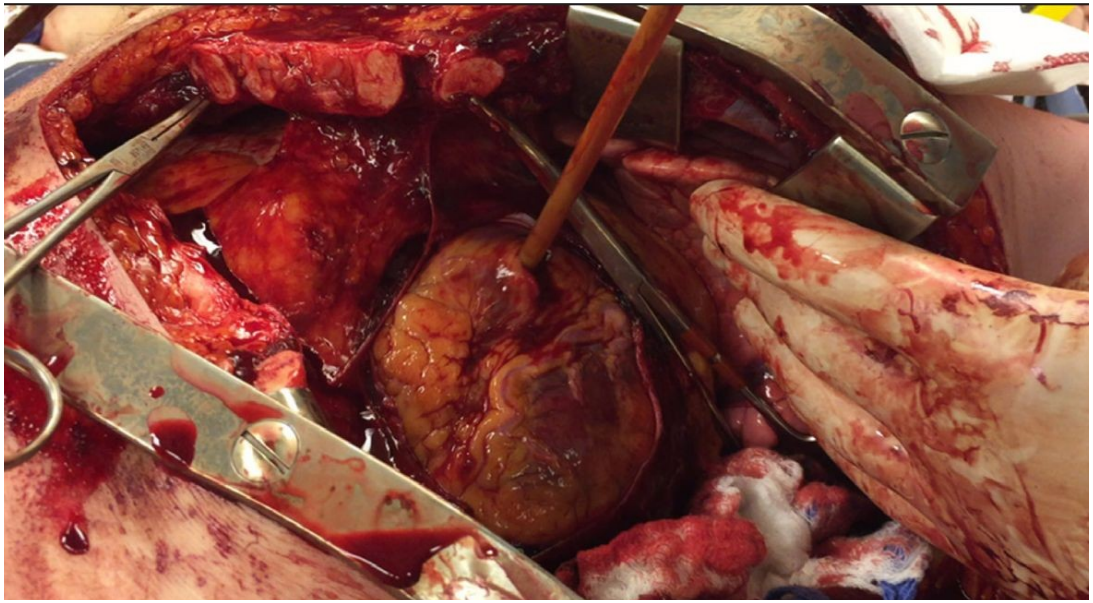
thoracic structures in ET. For physicians with only modest experience with ET, the clamshell incision is the only incision needed to optimize a patient's chance of survival. For trained surgeons, the clamshell incision may also be considered the initial incision of choice for an ET.

Clamshell

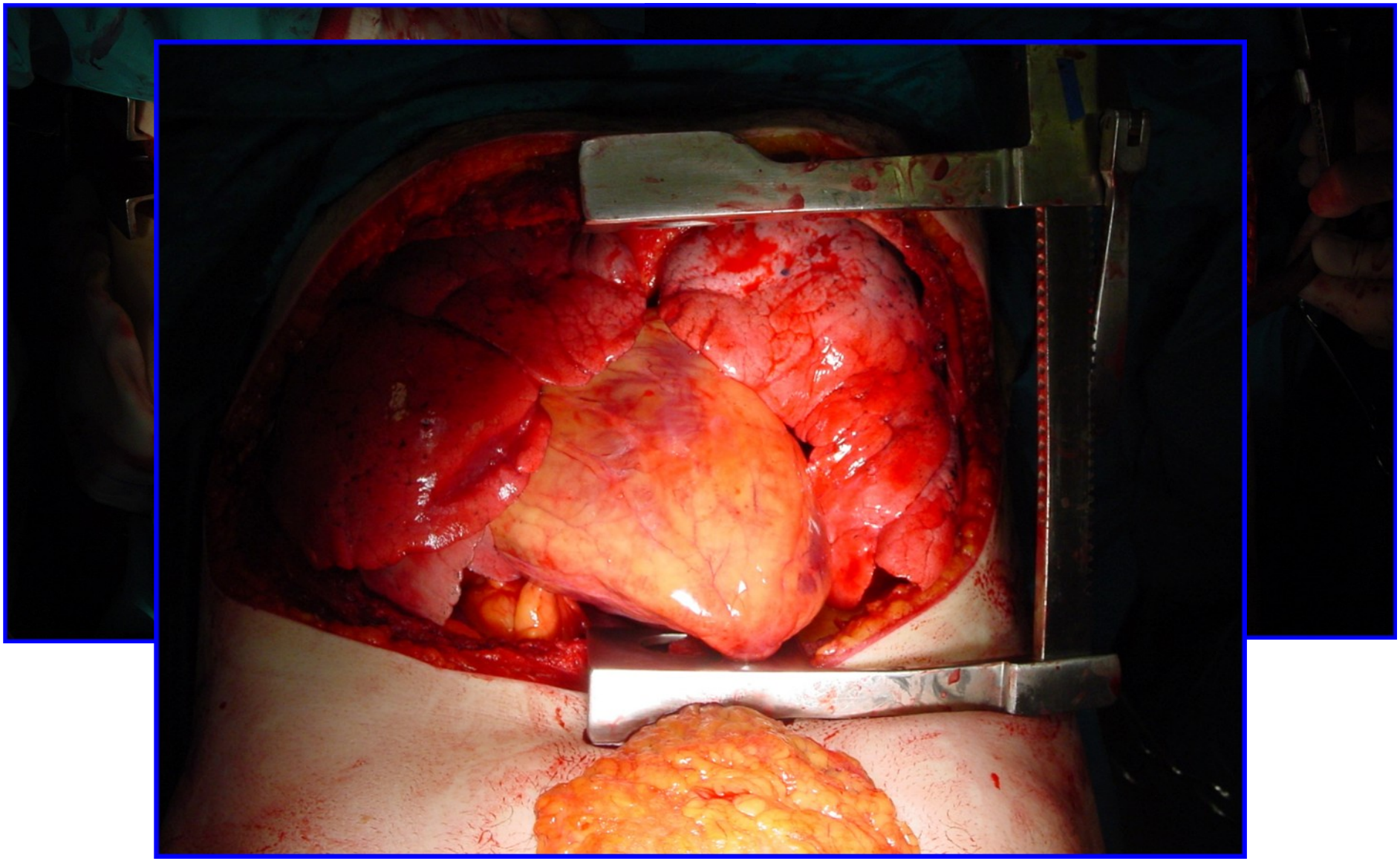


Anterior Thorax: Bithoracotomy (Clamshell)

Inferoposterior Heart: Bithoracotomy



Clamshell



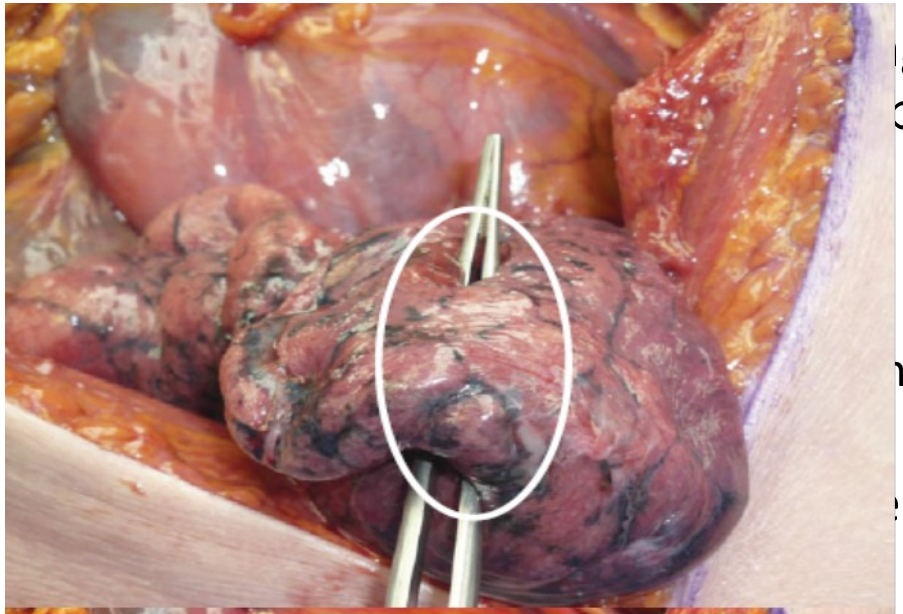
The great doubt of the unlucky surgeon

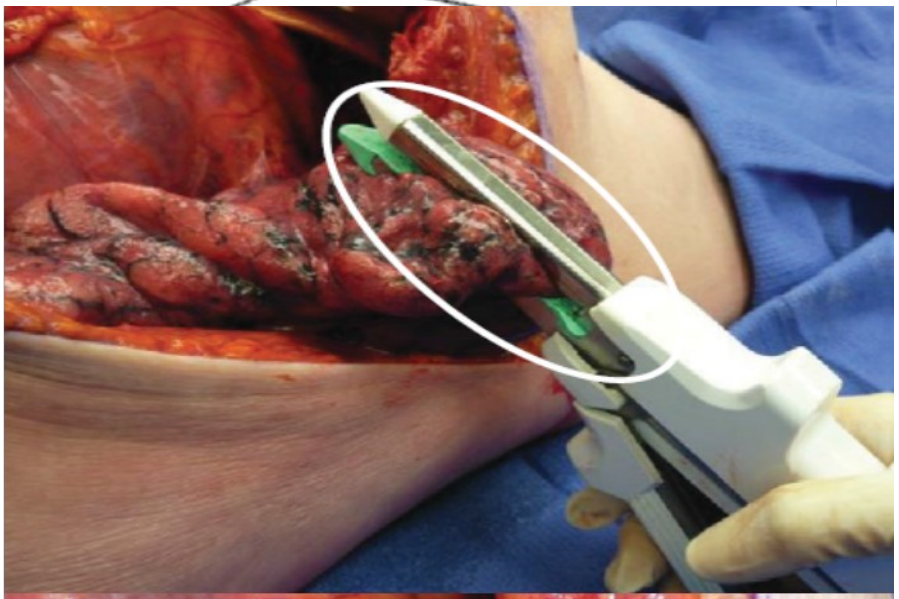
“Will I be able to stop the bleeding?”

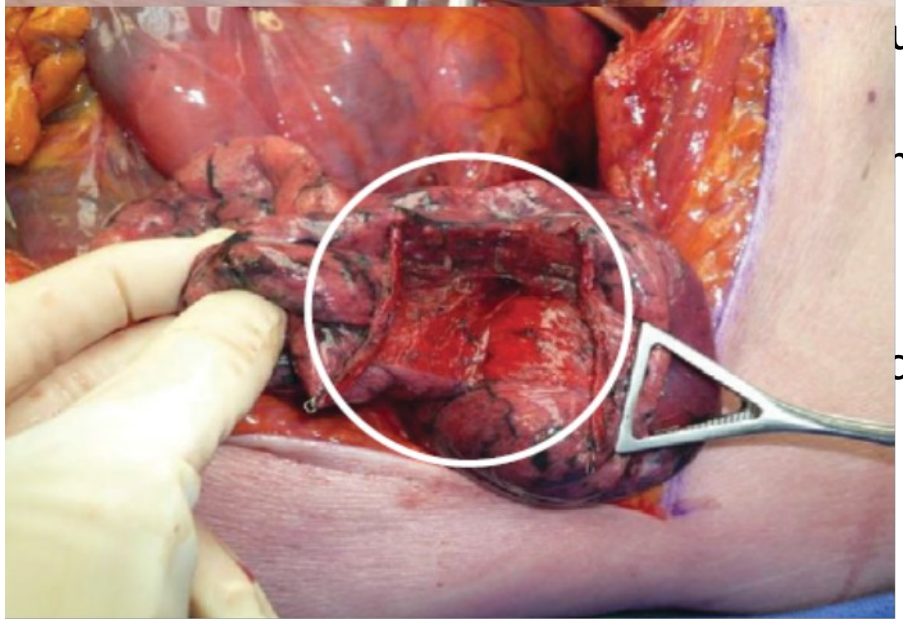
The lung injury

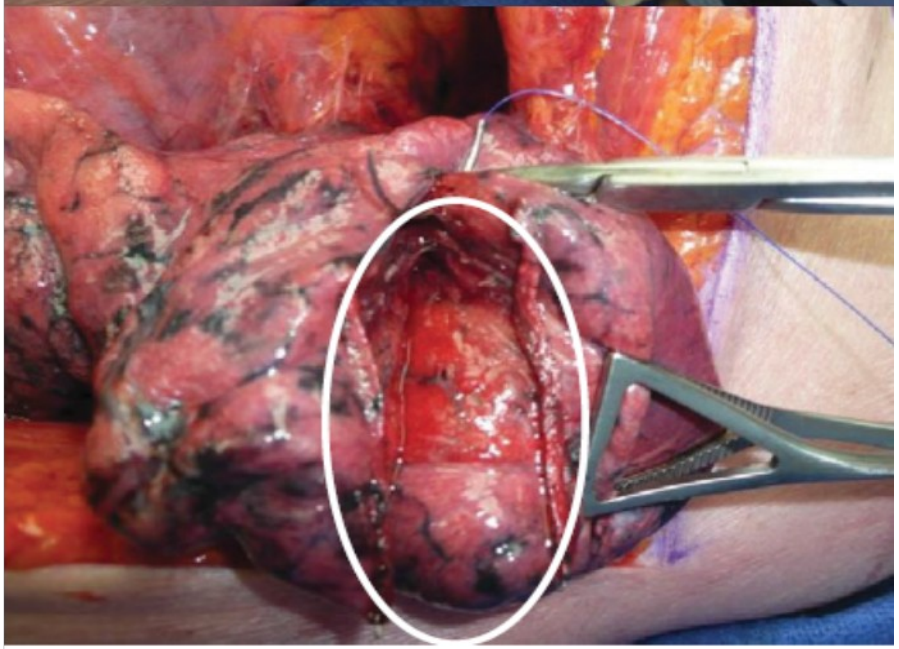
- The surgeon rarely encounters a lung lesion with difficult bleeding control
  - Pulmonary vascularization: **high flow and low pressure**
  - Pulmonary parenchyma rich in **thromboplastin**
- However, there are situations where the bleeding can be massive
  - **Anatomical location** of the lesion
  - Lesions **deeply penetrating** the parenchyma
  - **Hilar injuries**
  - **Multiple/diffuse** parenchymal lesions
  - **Patient's metabolic exhaustion** (coagulopathy + acidosis + hypothermia)

Pulmonary tractotomy

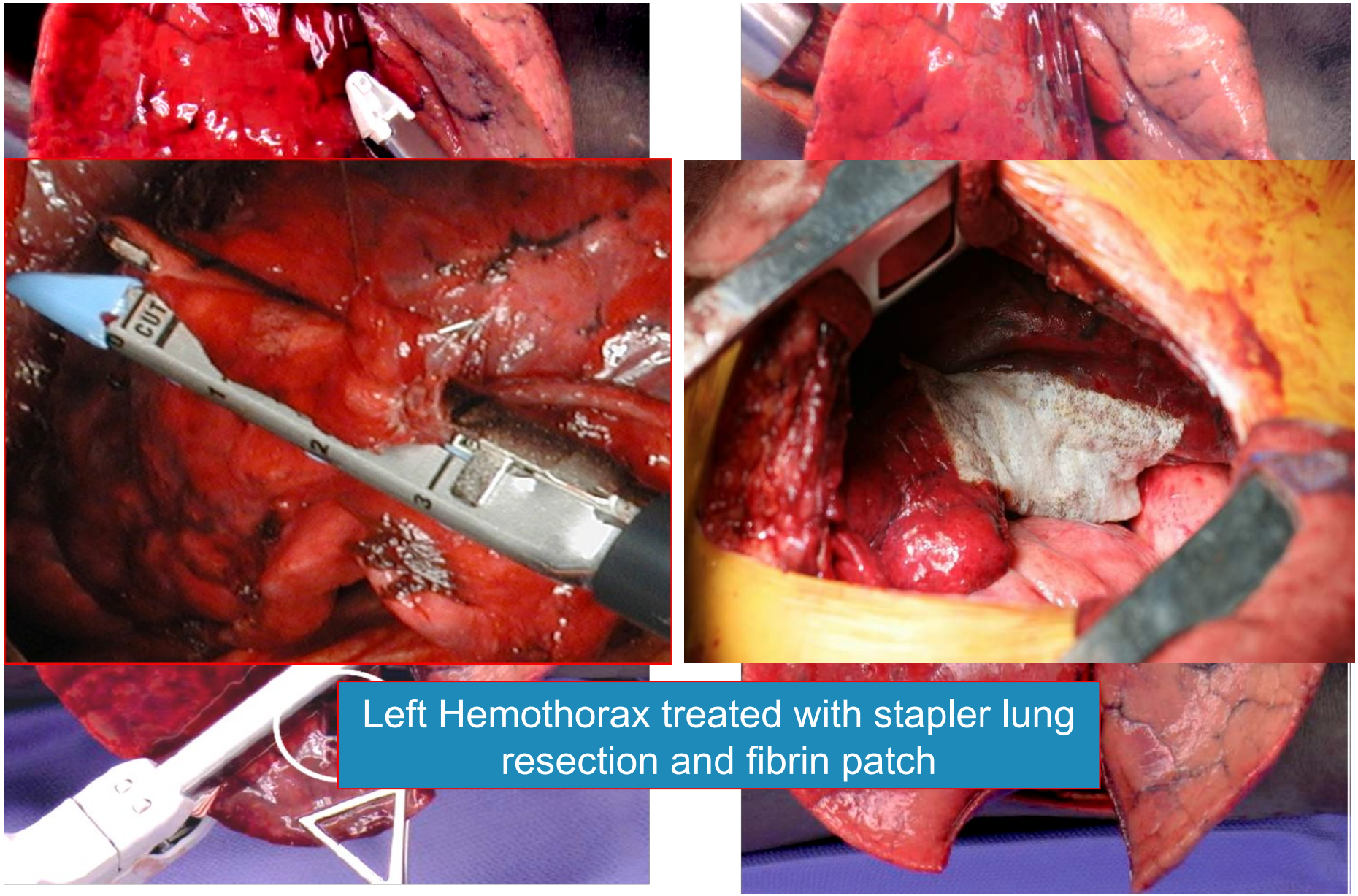








Wedge resection

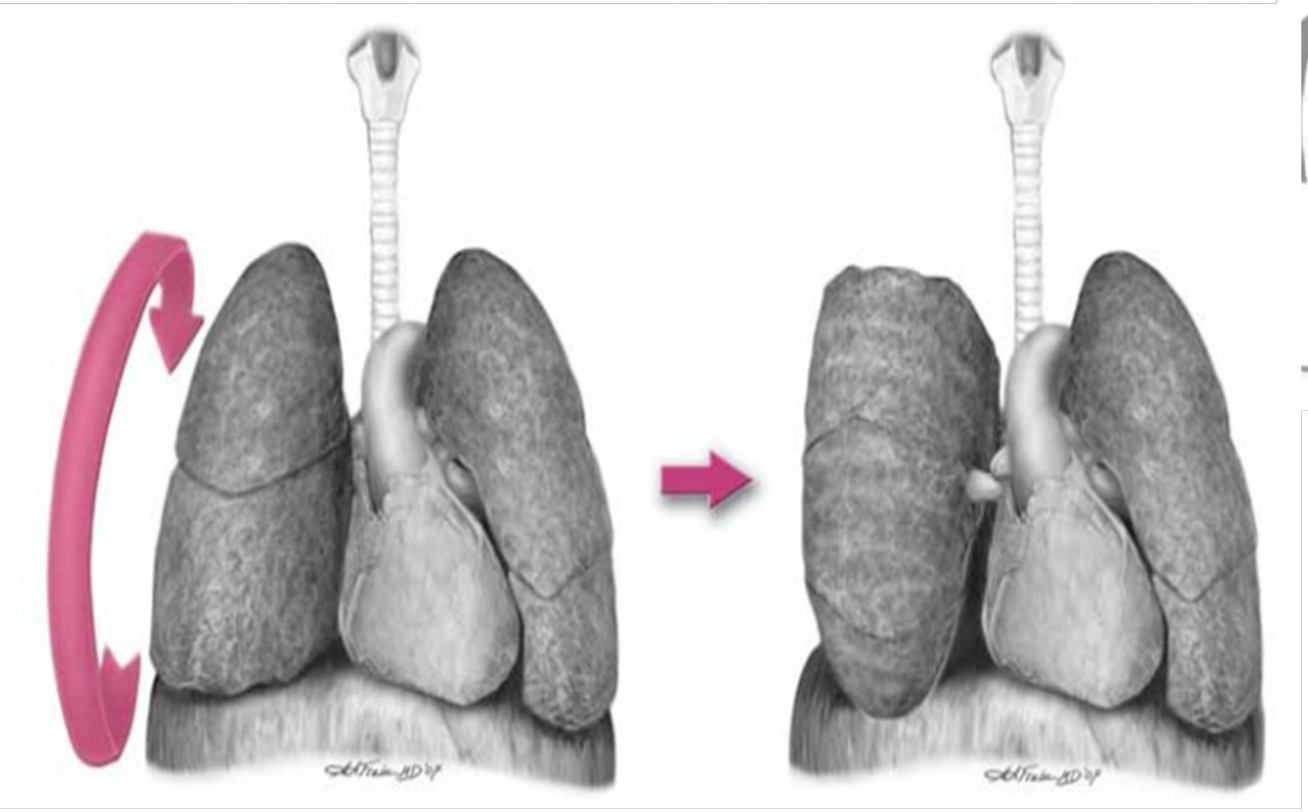


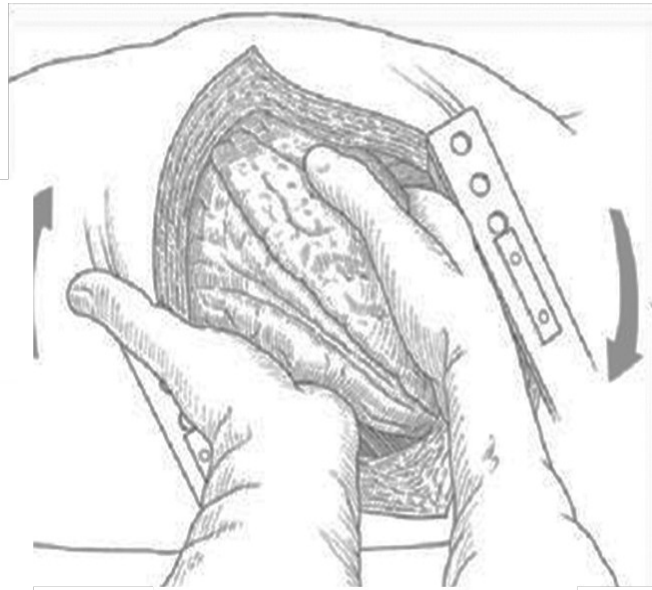
Left Hemothorax treated with stapler lung resection and fibrin patch

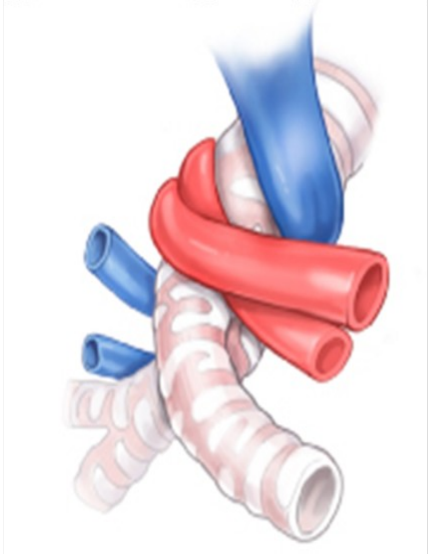
Pulmonary hilum injury

- Injury often fatal
  - Very critical patients
  - Profuse bleeding into the pleural cavity
- Emergency thoracotomy mandatory
  - Initial manual or tourniquet hilar bleeding control
  - Lung mobilization (inferior pulmonary ligament section)
  - Placement of a large vessel clamp around the hilum
- Check for the repairability of the hilar vascular lesion (quickly!)
  - Maneuver not tolerated well by the patient
  - The partial arterial lesions or the lateral venous lesions can be repaired
  - Venous transection implies a corresponding lobectomy
  - Total hilar injury usually requires a pneumonectomy (high mortality rate)

Temporary hemostasis: lung twist

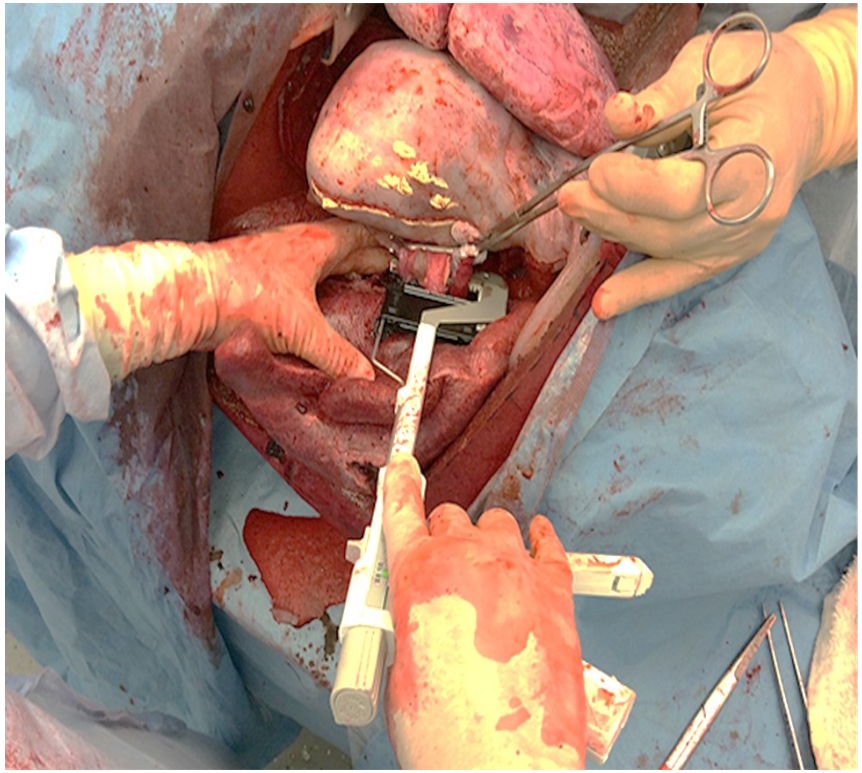






Last resort: the pneumonectomy

- When pneumonectomy is unavoidable, it can be done quickly using a stapler with a vascular charge (TA better!!!! ....too bad they don't produce them any more)
- After stapling and pneumonectomy, do not release the stapler
  - Reinforce mechanic suture on the emerging vascular and bronchial structures



Outcome / lung sparing

Management of traumatic lung injury: a Western Trauma Association Multicenter review.
Karmy-Jones R, Jurkovich GJ, Shatz DV, Brundage S, Wall MJ Jr, Engelhardt S, Hoyt DB, Holcroft J, Knudson MM.

143 pazients (28 blunt - 115 penetrating)	
surgery	**mortality**
Suture	9%
Tractotomy	13%
Wedge resection	30%
Lobectomy	43%
Pneumonectomy	>65%

Thoracic packing

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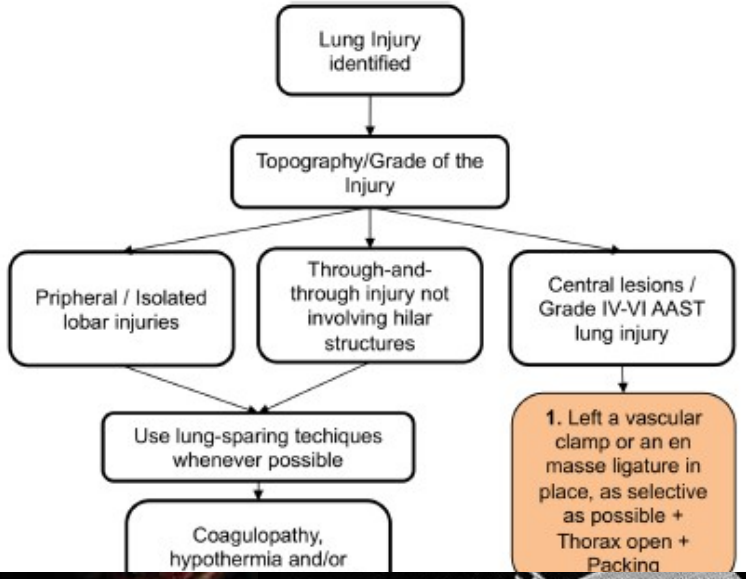
European Journal of Trauma and Emergency Surgery
https://doi.org/10.1007/s00068-020-01428-8

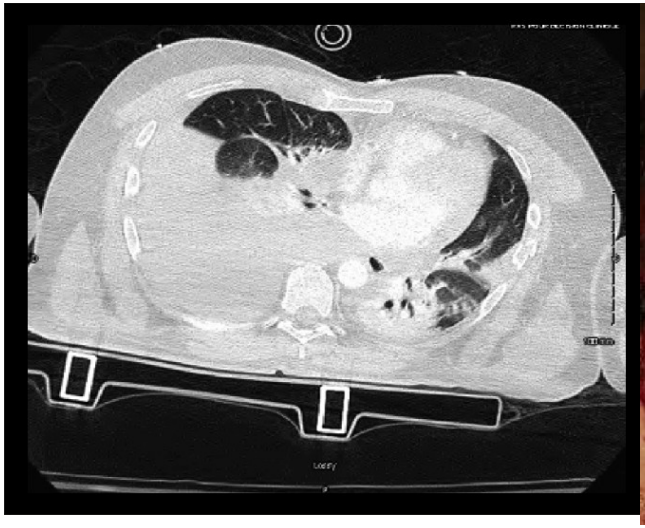
REVIEW ARTICLE

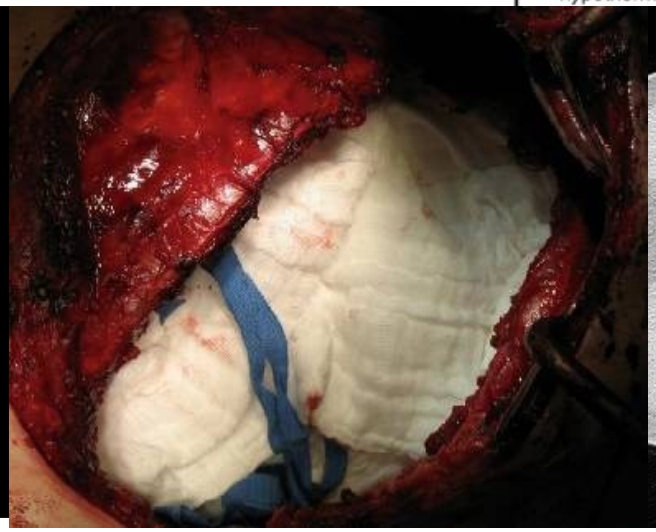
The tenets of intrathoracic packing during damage control thoracic surgery for trauma patients: a systematic review

Ramiro Manzano-Nunez[1,2] · Julian Chica[1,2] · Alexandra Gómez[1] · Maria P. Naranjo[1] · Harold Chaves[3] · Luis E. Muñoz[3] · Javier E. Rengifo[4] · Isabella Caicedo-Holguin[5] · Juan C. Puyana[6] · Alberto F. García[2,3]

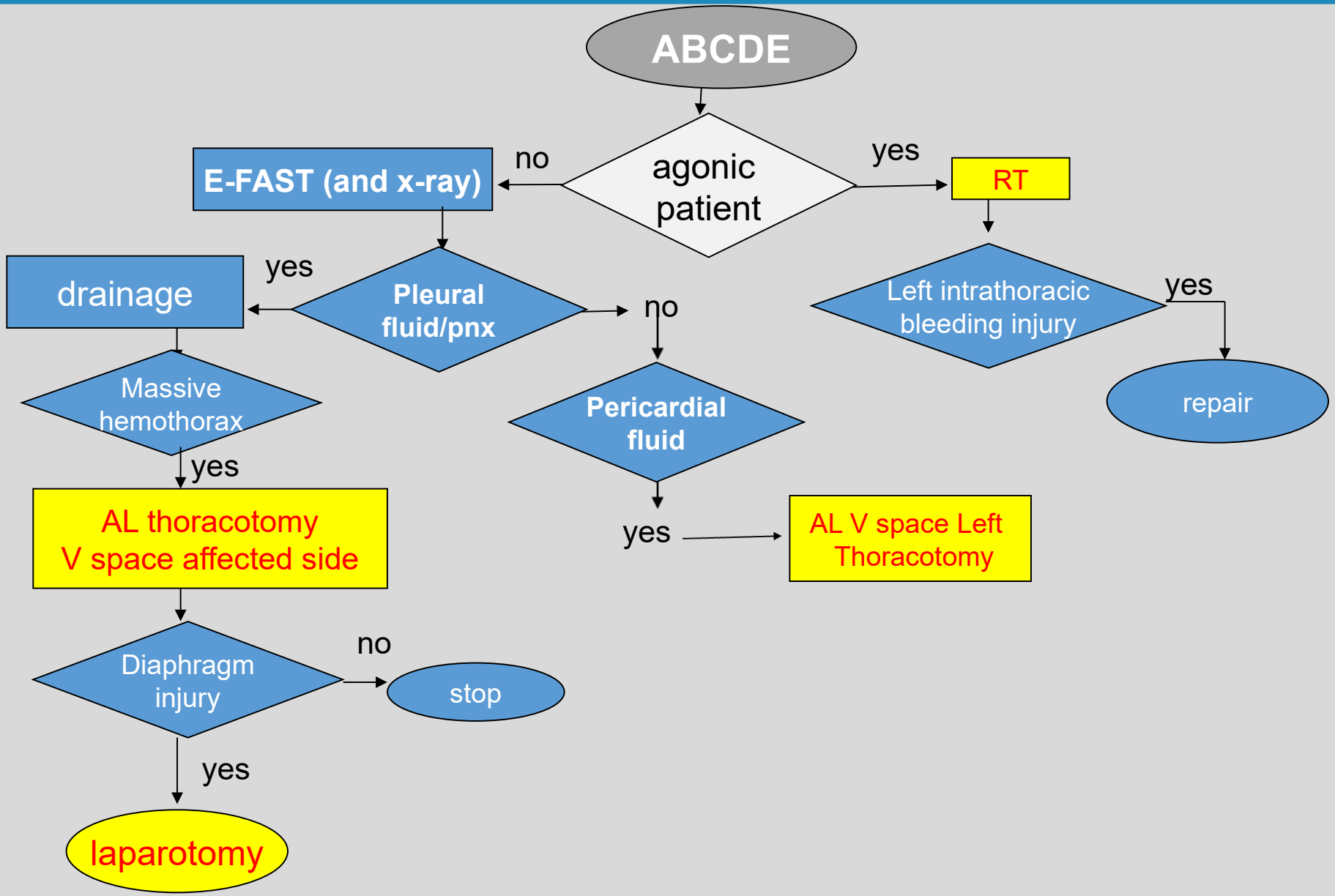


Conclusion

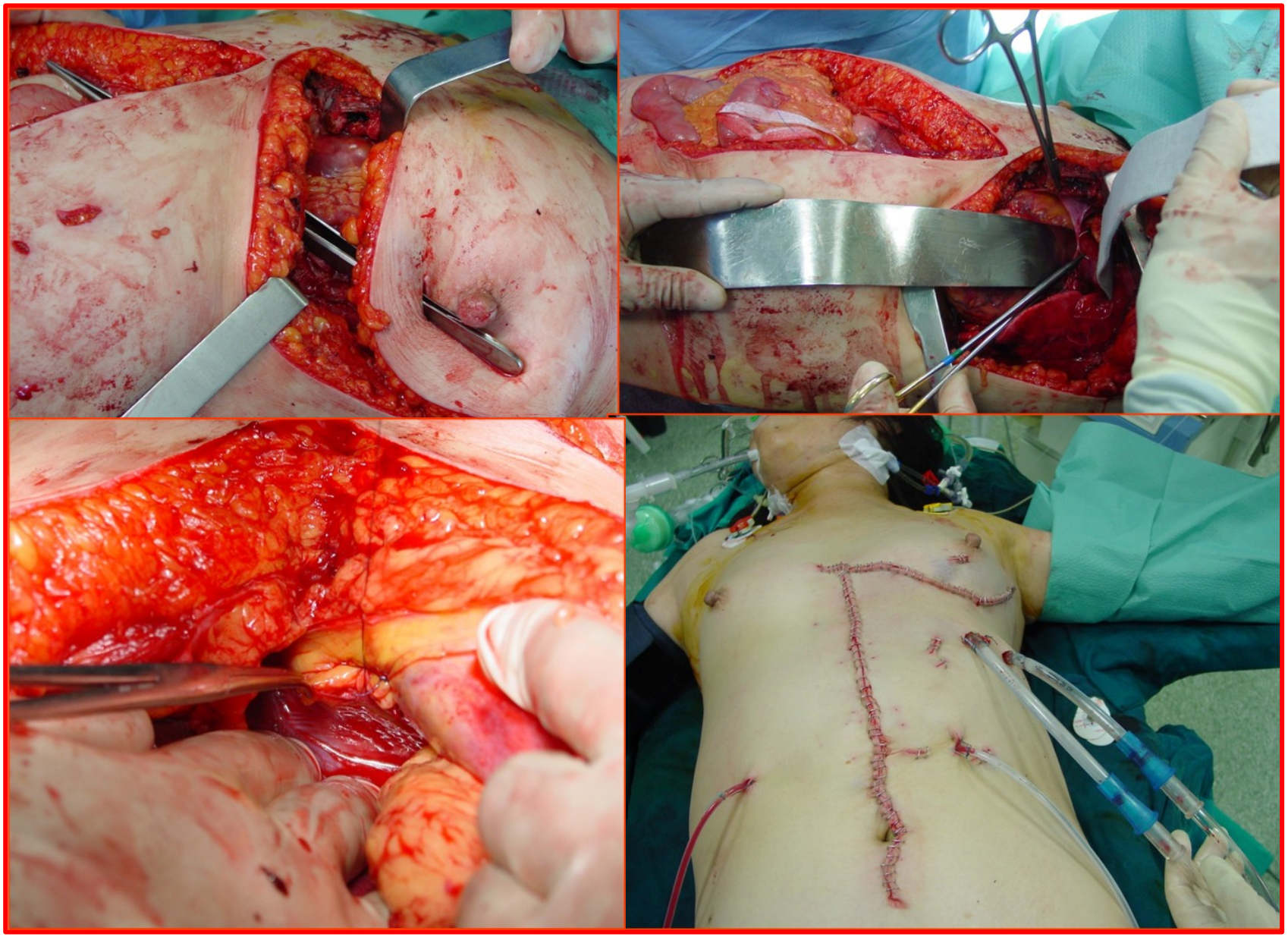




Algorithm


ABCDE
agonic patient
no
yes
E-FAST (and x-ray)
RT
drainage
yes
Pleural fluid/pnx
no
Left intrathoracic bleeding injury
yes
repair
Massive hemothorax
Pericardial fluid
yes
AL thoracotomy V space affected side
yes
AL V space Left Thoracotomy
Diaphragm injury
no
stop
yes
laparotomy

Thoraco-abdominal stab wound



Conclusions

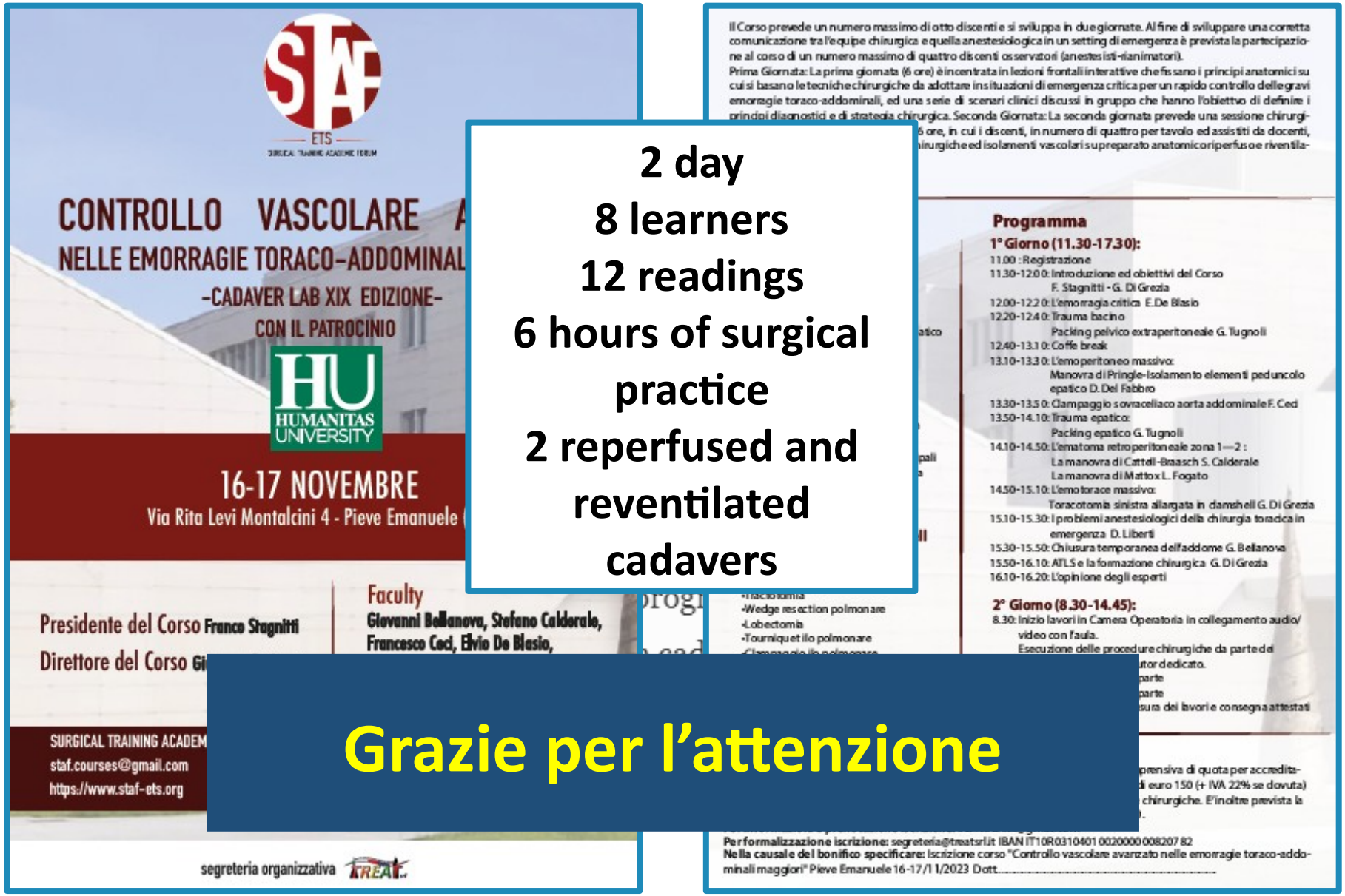
- In penetrating chest wounds bilateral or thoraco-abdominal injuries may require a sequential approach

- In agonic patient start always with EDT. Following steps are indicated by intra-operative findings

- In unstable, non-agonic patient approach primarily the affected side as indicated by E-FAST/xray

- With preparation, emergency surgeon can streamline the response to one of the most acute, time-dependent and complex surgical case

How to train for this?



2 day
8 learners
12 readings
6 hours of surgical practice
2 reperfused and reventilated cadavers

Grazie per l'attenzione