#### TRAUMAR

# Life-threatening injuries in THORAX

Our Mission Your Life

#### **Trauma Center**

#### Department of thoracic and cardiovascular surgery

#### **Dankook University Hospital**

Associate prof. Sung Wook Chang MD. PhD.





# Initial assessment for trauma care



#### **KEY POINTS**

- The goal of the initial assessment is the rapid identification and treatment of life-threatening injuries.
- Structured handoffs from EMS improve communication to the trauma team.
- The resuscitation bay should contain all instruments and equipment required in a major trauma.
- Trauma team composition should have sufficient personnel to both assess and treat the severely injured.
- The team leader should be the most senior person on the team with an understanding of injury.
- Coordination of care by the team leader is crucial to successful trauma assessments and resuscitation.

- The initial assessment should follow the standard primary and secondary survey algorithms as outlined in Advanced Trauma Life Support (ATLS).
- Patients who arrive in shock require even more rapid assessment and treatment by the most senior personnel.
- Initiating the resuscitation with intraosseous access can be lifesaving in patients in shock.
- Early arterial access for subsequent resuscitative endovascular balloon occlusion of the aorta (REBOA) deployment should be considered for patients presenting with subdiaphragmatic life-threatening hemorrhage.



#### ATLS<sup>®</sup> Advanced Trauma Life Support<sup>®</sup>

**TENTH EDITION** 

#### **Student Course Manual**





#### NINTH EDITION

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#### **OBJECTIVES**

After reading this chapter and comprehending the knowledge components of the ATLS provider course, you will be able to:

- Identify and describe treatment of the following life-threatening injuries during the primary survey: airway obstruction, tracheobronchial tree injury, tension pneumothorax, open pneumothorax, massive hemothorax, and cardiac tamponade.
- 2. Identify and describe treatment of the following potentially life-threatening injuries during

the secondary survey: <u>simple pneumothorax</u>, <u>hemothorax</u>, <u>flail chest</u>, <u>pulmonary contusion</u>, <u>blunt cardiac injury</u>, <u>traumatic aortic disruption</u>, <u>traumatic diaphragmatic injury</u>, and blunt <u>esophageal rupture</u>.

 Describe the significance and treatment of subcutaneous emphysema, thoracic crush injuries, and sternal, rib, and clavicular fractures.

# Life-threatening injuries during the primary survey

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# Immediately life-threatening injuries

- Many patients with thoracic injuries: death after visiting the hospital
- Could be prevented with prompt diagnosis and treatment
- Due to: Hypovolemia, Hypoxia, Hypercarbia, Acidosis
- Initial assessment and treatment
  - Primary survey and resuscitation
- You must treat hypoxia in your primary survey, if no airway and oxygenation established, do not move on to your secondary survey!

# Objectives

- Identify and initiate treatment of the following injuries
- During primary survey
  - Airway obstruction
  - Tracheobronchial tree injury
  - Tension pneumothorax
  - Open pneumothorax
  - Massive hemothorax
  - Cardiac tamponade

# Airway

- Major injury affecting the airway
- Patency and air exchange
  - 1) Listening for air movement
  - 2) Inspecting the oropharynx for foreign-body obstruction
  - 3) Observing for intercostal and subclavicular muscle retractions.
- Laryngeal injury → Airway part

# Injury to the upper chest

- Palpable defect in the region of sternoclavicular joint
- Dx: Posterior dislocation of the clavicular head
  - → Upper airway obstruction
- PEx: Stridor, marked change of voice
- Tx: Reduction





# Tracheobronchial tree injury

- Unusual but potentially fatal condition
- Blunt trauma: within 1 inch of the carina
- Most patient: die at scene
- Sign and Sx: Hemoptysis, subcutaneous emphysema, tension pneumothorax

Incomplete expansion of the lung after closed thoracostomy

- Suspicion: Continuous and massive air leakage
- More than one chest tube often is necessary to overcome a severe air leak



- Dx: Bronchoscopy
- Suspected → immediate surgical consultation
- Temporary intubation of opposite mainstem bronchus
- Tx: Immediate operation
  - Stable V/S case → may be delayed







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#### Heparin-free extracorporeal membrane oxygenation in a patient with severe pulmonary contusions and bronchial disruption

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#### Case

- M/35
- 지게차와 벽 사이에 끼이는 사고
- 청주 OO병원: Respiratory arrest → CPR (5min)

Bilateral closed thoracostomy 후 전원 됨



#### Progression note

- ◆ Initial V/S and ABGA
- 160/100 mmHg- 104/min 32/min 92%
- 7.22 59 64 87%
- ♦ One more C-thoracostomy (32Fr) on Rt. Side
- 124/75 103/min 19/min 100%
- 7.40 33 83 96%
- ◆ ICU transfer

#### ◆ ICU management

- PC-SIMV mode, Pip:26, PEEP:7, RR:20/min, FiO<sub>2</sub> 0.5
- ABGA 7.30 55 87 96%
- Rt.: Continuous and massive air leakage, Lt.: Air leakage
- ◆ 8 hour later (2016-03-16 06:00), BP and Saturation fluctuation
- PC-SIMV mode, Pip:30, PEEP:10, RR:24/min, FiO<sub>2</sub> 0.9
- ABGA 7.30 56 82 95%, P/F ratio: 91
- 100/55 120/min 26/min 100%

1<sup>st</sup> ECMO → 2<sup>nd</sup> Bronchochoscopy → prn) Operation

#### Bronchoscopy under Veno-venous ECMO support











## Breathing

- Temporarily releasing the cervical collar with cervical stabilization
- Expose the chest and neck



# Breathing

- Temporarily releasing the cervical collar with cervical stabilization
- Expose the chest and neck
- Respiratory movement and quality of respiration
  - Observing(cyanosis, symmetrical movement), Palpation and Listening
- Neck vein distention by disturbance of venous return

- Tension pneumothorax, Cardiac tamponade, Diaphragm rupture etc.



# Tension pneumothorax

- Pathophysiology
  - One-way valve

Inspiration

Expiration

- Inspiration Air leak into pleural space Trapped during exhalation
  - $\rightarrow$  Increase of the pleural pressure  $\rightarrow$  Mediastinal shift
  - → Compression of the uninjured lung
  - → Kinking and compression: superior/inferior vena cava
- Obstructive shock due to decreasing the venous return

- Tension pneumothorax
- Most common cause: Mechanical ventilation with positive-pressure
- Caution: Simple pneumothorax  $\rightarrow$  Tension pneumothorax
- Signs and Symptoms
  - Chest pain
  - Respiratory distress
  - Tachycardia
  - Hypotension
  - Tracheal deviation away from the side of injury
  - Unilateral absence of breath sounds
  - Elevated hemithorax without respiratory movement
  - Neck vein distention
  - Cyanosis (late manifestation)



- Similarity in their signs Cardiac tamponade
  - Differentiation: Hyperresonant sound on percussion

Absent breath sound, deviated trachea

• Tx: Immediate decompression by needle thoracostomy (2<sup>nd</sup> ICS, midclavicular line)

Definitive treatment: closed thoracostomy





- Similarity in their signs Cardiac tamponade
  - Differentiation: Hyperresonant sound on percussion

Absent breath sound, deviated trachea

- Tx: Immediate decompression by **finger thoracostomy**
- Because of 1) variable chest wall thickness

2) kinking of the catheter

- Needle decompression:2<sup>nd</sup> ICS, midclavicular line
- $\rightarrow$  5<sup>th</sup> ICS, slightly anterior to the midaxillary line.
- Initially finger thoracostomy



■ FIGURE 4-2 Finger Decompression. Tension pneumothorax can be managed initially by rapidly applying the finger decompression technique.

#### Open pneumothorax

• Normal physiology – Negative pressure of intra-thoracic cavity

Inspiration: -9 to -12cmH2O, Expiration : -3 to -6cmH2O

• Defect of chest wall  $\rightarrow$  Equilibration  $\rightarrow$  Impairment of effective ventilation



FIGURE 4-3 Open Pneumothorax. Large defects of the chest wall that remain open can result in an open pneumothorax, or sucking chest wound.



On inspiration, dressing seals wound, preventing air entry

## Open pneumothorax

• Tx: Promptly closing the defect

with sterile occlusive dressing (3 sides)

Closed thoracostomy (remote from the wound)

Definitive surgical closure of defect



Expiration allows trapped air to escape through untaped section of dressing





## Circulation

- Pulse check: Quality, Rate, Regularity
- Skin color and temperature
- Cardiac monitor and pulse oximeter



- Thoracic injury and dysrhythmia  $\rightarrow$  susceptible to myocardial injury
- Pulseless electrical activity (PEA)
  - → Tension pneumothorax, Cardiac tamponade, Profound hypovolemia etc.

## Massive hemothorax

Pathophysiology



- Accumulation of blood  $\rightarrow$  Compressing the lung

→ Inadequate ventilation, Hypotension and Shock

• Differentiation: Hyporesonance(dullness) on injury side (hemothorax)

No elevation of the affected hemithorax during respiration

- Association with breathing and circulation
- Accumulation of more than 1500mL of blood, 1/3 or more of chest cavity

- Most commonly cause: Penetrating injury (vascular injury), from Blunt injury
- Rarely neck vein distention due to severe hypovolemia
- Tx: Restoration of blood volume using large IV lines, Closed thoracostomy
- Indication of thoracotomy (operation)
  - Initial evacuation: more than 1500mL
  - Continuing blood loss (200mL/hr for 2-4 hours),
  - Persistent need for blood transfusion, Increased hemothorax on Chest X-ray
  - Penetrating anterior chest wound(medial) or posterior wound(scapula)
    - → Potential damage to Great vessels, Pulmonary hilar structures, and Heart injury
#### Massive hemothorax d/t penetrating injury

- In patient with penetrating trauma → operative exploration
  - → Very important area: mediastinal box
    - d/t great vessel including hilum
      - heart injury



Source: D. J. Sugarbaker, R. Bueno, Y. L. Colson, M. T. Jaklitsch, M. J. Krasna, S. J. Mentzer, M. Williams, A. Adams: *Adult Chest Surgery*, 2nd Edition: www.accesssurgery.com Copyright © McGraw-Hill Education. All rights reserved.

### Different presentations

Tension pneumothorax vs. Massive hemothorax

TABLE 4-I DIFFERENTIATING TENSION PNEUMOTHORAX AND MASSIVE HEMOTHORAX							
	PHYSICAL SIGNS						
CONDITION	BREATH SOUNDS	PERCUSSION	TRACHEAL POSITION	NECK VEINS	CHEST MOVEMENT		
Tension pneumothorax	Decreased or absent	Hyperresonant	Deviated away	Distended	Expanded immobile		
Massive hemoth <mark>orax</mark>	Decreased	Dull	Midline	Collapsed	Mobile		

## Cardiac tamponade

- Pathophysiology (Pericardial sac)
  - Blood → restrict cardiac activity and filling
  - slowly: less urgent
  - abrupt: small amount  $\rightarrow$  severe and urgent
- Beck's triad





- Venous pressure  $\uparrow$  , Arterial pressure  $\downarrow$  , muffled heart sound
- Caution: Hypovolemia  $\rightarrow$  No neck vein distention



Cardiac tamponade

- Dx: Echocardiogram, Focused Assessment with Sonography for Trauma (FAST)
- Suspicion: No response to usual resuscitation



- Tx: Prompt evacuation of pericardial blood
  - Pericardiocentesis (In case of clot → failure ↑)
  - Pericardiotomy via thoracotomy







## Relief of tamponade



### Penetrating cardiac injury

- Etiology: About RV 40%, LV 40% RA 24%, LA 3%
- Always hemopericardium
- Foreignbody
  - Right-sided foreign bodies: embolize to the pulmonary artery
  - Left-sided foreign bodies: systemic embolization
- latrogenic injury: Central venous catheterization, Coronary catheterization,

Cardiac massage(CPR), pericardiocentesis...

- Wound: Epigastrium and/or precordium → strongly suspicion
- Treatment
- ① Anterolateral thoracotomy: extended across the sternum
- ② Sternotomy: cardiopulmonary bypass (CPB)
- ③ Cardiorrhaphy (including temporary techniques to control bleeding)
  - Finger occlusion
  - Partial occluding clamp
  - Foley balloon catheter
  - Skin staples
  - Avoiding injury to the artery



#### Case

- M/71, Driver TA
- X-ray: Sternum fracture, Hemothorax Lt.
- Closed thoracostomy: initial 1100mL
- CT: Pericardial fluid(+)
- Pericardiocentesis: failed
- Pericardiotomy → Fresh blood → Operation



#### CyberLink PowerDirector www.seathlatelun.co.kr RV Rupture from blunt chest trauma

# Potentially life-threatening injuries

# during the secondary survey



## Objectives

- Eight lethal injuries
  - Simple pneumothorax
  - Hemothorax
  - Flail chest
  - Pulmonary contusion
  - Blunt cardiac injury
  - Traumatic aortic dissection
  - Traumatic diaphragmatic injury
  - Blunt esophageal rupture

## Simple pneumothorax

- 10% to 30% in blunt chest trauma
- Almost 100% with penetrating chest trauma
- Air in the pleural space



- $\rightarrow$  disruption between visceral and parietal pleura  $\rightarrow$  allow the lung collapse
- May occur in the absence of rib fractures from:
  - Paper-bag effect: A sudden increase in intrathoracic pressure

( the chest wall is compressed against a closed glottis)

- Ventilation/Perfusion mismatch
- Affected side: decreased breathing sound, hyperresonance on percussion
- Dx: Chest X-ray. Extended FAST (E-FAST), Chest CT
- Tx: Closed thoracostomy
- General anesthesia or positive-pressure mechanical ventilation without C-tube
  - Simple pneumothorax -> Unexpected tension pneumothorax
- In case of air transportation (helicopter)

- Pneumothorax should undergo closed thoracostomy due to altitude



#### Hemothorax

- Cause
  - : lung laceration, intercostal vessel or internal mammary artery injury

thoracic spine fracture, rib fracture, diaphragm injury etc.

• Tx: Closed thoracostomy (for reducing the risk of a clotted hemothorax)

If patient's hemodynamic status is unstable  $\rightarrow$  decision for operation



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Delayed massive hemothorax requiring surgery after blunt thoracic trauma over a 5-year period: complicating rib fracture with sharp edge associated with diaphragm injury

Sung Wook Chang, Kyoung Min Ryu, Jae-Wook Ryu







Fig. 2. Patient 5. (A) Computed tomography showing an aortic dissection without right hemothorax. (B) Followup chest radiograph after thoracic endovascular aortic repair showing massive right hemothorax. (C) Intraoperative photograph showing active bleeding on the diaphragm due to superficial injury (arrow).









Fig. 1. Chest computed tomography (CT) after blunt thoracic trauma showing a fractured rib with a sharp edge (arrows). (A) Patient 1. Delayed hemothorax and extravasation seen 93 hours after the initial CT. (B) Patient 2. CT showing only a fractured rib with no hemothorax 7 hours later. (C) Patient 3. Delayed hemothorax seen 66 hours later. (D) Patient 4. Delayed hemothorax and extravasation seen 63 hours after the initial CT. (E) Patient 5. CT showing left hemothorax and periaortic hematoma 2 hours later.

# Flail chest



- Pathophysiology
  - Two or more adjacent ribs fracture in two or more places
  - Disruption of normal chest wall movement Paradoxical movement
  - Asymmetrical and uncoordinated movement of thorax
  - Commonly associated with lung contusion  $\rightarrow$  Hypoxia
- Observation and palpation of motion/crepitus/cartilage fracture



• Tx: Adequate ventilation, Administration of humidified oxygen, Pain control Fluid resuscitation (avoid the volume overload). Prn) Operation

## Flail chest

Preop CXR

₽

Postop CXR

#### Pulmonary contusion – Intrapulmonary hemorrhage

- Young patient: occur without rib fracture/flail chest
- In adults: most commonly seen with concomitant rib fracture
- In room air, significant hypoxia ((i.e.,  $PaO_2 < 65mm$  Hg or  $SaO_2 < 90\%$ )
  - → Intubation and ventilation within the first hour after injury
- Underlying chronic obstructive disease, renal failure → Intubation need ↑
- Monitoring: Pulse oximeter, ABGA, ECG
- 24-72 hours later → ARDS

Sx: Hemoptysis Suspicion  $\rightarrow$  CT scan



## Blunt cardiac injury

- Myocardial muscle contusion, Cardiac chamber rupture, coronary artery dissection, valvular disruption
- If cardiac rupture → typically cardiac tamponade (primary survey)
  But, atrial rupture → slowly development of tamponade symptoms
- Dysrhythmia- tachycardia(m/c), atrial fibrillation, multiple PVC etc
- Hypotension, wall motion abnormality on 2D echo
- Dysrhythmia  $\rightarrow$  monitored for the first 24 hour

Blunt cardiac injury

• Myocardial contusion: occur in 16-76%



Blunt cardiac trauma may produce rupture, acute or delayed tamponade, or cardiac contusion. (Redrawn from Blaisdell FW, Trunkey DD: Trauma Management, Vol III. Cervicothoracic Trauma. New York, Thieme Medical Publishers, Inc, 1986, p 197.)



Blunt cardiac injury

#### • Myocardial contusion: occur in 16-76%



(Redrawn from Blaisdell FW, Trunkey DD: Trauma Management, Vol III. Cervicothoracic Trauma. New York, Thieme Medical Publishers, Inc, 1986, p 197.)

- True cardiac rupture
  - Direct transmission of increased intrathoracic pressure
  - Hydraulic effect form large force (RA, intraabdominal, vein etc)
  - Decelerating force between fixed and mobile areas
  - Direct force (contusion, necrosis, delayed)
  - Penetration from broken bone
  - Autopsy data: LV  $\uparrow$  but, among the survivor: RA  $\uparrow$
  - Cardiac septum rupture: m/c near the apex
  - About 25%: associated aorta injury

#### Case

- M/35
- Fall from 4<sup>th</sup> floor
- FAST: Pericardial fluid(+), V/S-stable
- Pericardiocentesis  $\rightarrow$  fresh blood
- Operation

# CyberLink PowerDirector where the st trauma

#### Traumatic aortic dissection



- Proximal descending aorta: 54-65% (m/c)
- Mechanism: Shear forces
  - Heart: relatively mobility
  - Ligamentum arteriosum: fixation







Aortic rupture

• Chest X-ray : Mediastinal widening, frequently hemothorax

	Fractures	Sternum, scapular. Multiple rib, clavicle, 1 <sup>st</sup> rib (?)
	Mediastinal clues	Obliteration/double shadow
		Widening > 8cm
		Depression of Lt. main bronchus> 140 degree from trachea
		Displacement of trachea
		Deviation of nasogasric tube
	Lateral X-ray	Anterior displacement of trachea
		Loss of aortic/pulmonary shadow
	Other findings	Apical pleural hematoma
h		Diaphragm injury, massive hemothorax

- CT scan: Gold standard
- Tx: Permissive hypotension (systolic 70-90mmHg), Beta-blocker

Non-operative management (Thoracic EndoVascular Aortic Repair, TEVAR)


- Tx: Surgical repair (Graft interposition)
- Potential complication: Paraplegia (up 2022%), stroke, brachial plexus injury

left recurrent laryngeal nerve injury...



# Traumatic diaphragm injury

- More commonly diagnosed on the left side (Right: liver)
- Left hemithorax: appearance of bowel, stomach, nasogastric tube ...
- Blunt trauma: large tear and herniation of organ
- Penetrating trauma: small and even years, to develop into hernia
- Frequently missed: diaphragm elevation, loculated hemopneumothorax...
- Pathophysiology: Increased intra-abdominal pressure
  - $\rightarrow$  intra-abdominal organs to enter the thoracic cavity

- Rupture  $\rightarrow$  intra-abdominal organs to enter the thoracic cavity:
  - Compression of the lung with reduced ventilation, Decreased venous return
  - Decreased cardiac output, Shock
  - Bowel obstruction and strangulation
  - Restriction of lung expansion
  - Hypoventilation, Hypoxia
  - Mediastinal shift
- Dx: CT scan, Thoracoscopy/Laparoscopy
- Tx: Surgical repair











### Blunt esophageal rupture

- Esophageal trauma: most commonly from penetrating injury
- More common in the neck than within the thorax due to bony protection
- Forceful ejection of gastric contents  $\rightarrow$  tear  $\rightarrow$  leakage into mediastinum
- Result in mediastinitis (mediastinum), empyema (pleural space)
- Suspicion: postemetic chest pain, mediastinal air, severe blow to epigastrium...
- Dx: Esophagogram, endoscopy, CT
- Tx: Drainage of the pleural space and repair

# Rib fracture

- Most often caused by blunt trauma: bowing effect with midshaft fracture
- Respiratory restriction as a result of pain and splinting
- Intercostal vessel injury
- Associated complications
  - First and second ribs are injured by severe trauma
  - Rupture of the aorta
  - Tracheobronchial tree injury
  - Vascular injury



### Sternum fracture

- About 20% → Cardiac contusion
- Associated injuries cause morbidity and mortality
  - Pulmonary and myocardial contusion

Flail chest

- Vascular disruption of thoracic vessels
- Intra-abdominal injuries
- Head injuries

Seriously displaced sternal fractures  $\rightarrow$  produce a flail chest.



### Case

- M/45
- In car TA (Driver), Seat belt(-)
- Rt. Leg and ant. Chest pain









### Progression

- 23:20 환자도착
- 23:40 V/S 92/43-120-36
- 00:00 s/p C-thoracostomy, 89/45 mmHg-128/min-32/min, PRC 2P T/F
- 01:35 From CT room to Resuscitation room 67/32mmHg-100/min-28/min

- Angiography and embolization HOLD
- Em-op

# OP finding

- Sternum: transverse Fx.
- ➔ Bone bleeding
- Hematoma (+)
- LIMA branch: 2 site
- → Arterial bleeding



# Subcutaneous emphysema

- Tracking of air into subcutaneous layer
- Feel spongy and crunchy to the touch
- Distorting the vocal cord arrest
  - Tx: prophylactic antibiotics
    - mild observation

severe - additional tube

high power suction, collar incision

#### Subcutaneous Emphysema Laceration of both parietal and visceral pleura and of lung by fractured rib, torn adhesion, or puncture wound (may also be secondary to mediastinal emphysema resulting from rupture of trachea or bronchus, q.v.). "Frog-face" may occur in advanced cases Crepitus Crepitus

### Case

- F/66
- Slip down, 가구 모서리에 좌측 가슴을 부딪힘
- 타병원 방문, T-pneumothorax c severe subcutaneous emphysema Dx









### Traumatic asphyxia

- Powerful compressive force → Pressure to thorax
- Upper extremities: cyanosis
  - Neck and head: Petechiae

Jugular venous distention and facial edema



## Thoracic duct injury

- Marked nutritional depletion
- C-tube: chylous material draining, milky
- Tx: NPO, devoid of long-chain fatty acid, Operation



# Unusual airway obstruction due to thoracic duct injury after whiplash injury

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#### ABSTRACT

Turkish Journal of Trauma and Emergency Surgery Ulus Travma Acil Cerrahi Derg, July 2021, Vol. 27, No. 4

Traumatic chylothorax is a rare condition following blunt trauma. Although a chyle leak resulting from direct damage to the duct may occur at any level because of an anatomical variation, an airway obstruction due to thoracic duct injury after blunt trauma has never been described. Here, we report a very unusual case with airway obstruction due to thoracic duct injury after whiplash injury. A 60-year-old man presented to the emergency department with allodynia after blunt trauma. Initial chest computed tomography (CT) showed a prevertebral hematoma and pneumomediastinum from C2 to T3 spinal level without vertebral fracture. Seven days later, repeat CT showed an increased amount of mediastinal and prevertebral fluid collection extending to the upper neck level with airway compression. He underwent an operation to drain the fluid via a neck incision and a thoracic duct ligation via right thoracotomy and was discharged without complaint. The findings suggest that if hematoma and pneumomediastinum are found in the prevertebral space at the level of the cervical and upper thoracic spine, the patient should be closely observed to exclude the complication of airway obstruction caused by thoracic duct injury.

Keywords: Airway obstruction; chylothorax; injuries, thoracic duct; trauma.

### Case

- M/60
- C/C: bleeding on forehead and nose
- 택시 조수석 TA
- V/S: 160/137 mmHg 88 /min 24/min
- GCS: E4M6V5
- PMHx: HTN(+): medication (aspirin-)









<sup>지대: 춘추시대</sup> 我听见 我忘记 (아은견 아망기) 我看见 我记住 (아간견 아기주) 我做 我了解 (아주 아료해) 들은 것은 잊어버리고 본 것은 기억하지만

◎ 공자 (BC 551~ BC 479)

이름: 구(丘), 자는 중니(仲尼)

Confucius I hear and I forget I see and I remember I do and I understand

직접 해 본 것은 이해한다

일자	연차	시간	강의제목	Damage control surgery for chest injury
06월 10일	1년차	09:30~10:00	Orientation	(1) Finger thoracostomy on Lt. hemithorax
		10:00~11:00	1.Airway workshop (intubation and tracheostomy)	
		11:00~12:00	2.Mechanical ventilation workshop	(2) Resuscitative thoracotomy via Lt. anterolateral incision
		12:00~13:00	Lunch	(3) Open pericardiotomy- cardiac tamponade model
		13:00~14:00	3.Surgical technique workshop	
		14:00~15:00	4.Hemodynamic monitoring workshop	(4) Aorta cross clamp
		15:00~16:00	5. ultrasonography workshop	
				(5) Clamshell incision
07월 08일 07월 22일	2년차 (A) 2년차 (B)	09:30~11:20	Congenital heart (VSD closure 3D printing)	(6) Primary lung repair – Rt. lung
		11:30~13:00	초음파 hands on (pig)	
		13:00~14:00	Lunch	(7) Stapled pulmonary tractotomy for penetrating injury – Lt. lung
		14:00~16:30	Trauma hands on (pig)	
		and the second	the second second second	(8) Pulmonary hilum control for destructive lung injury



hilum clamp and twist, Lt. Lung

(9) Temporary management for cardiac injury

RA, LA: laceration → Satinsky clamping and suture

RV: Skin stapling and Foley catheter

(10) Open cardiac massage

(11) Primary repair for diaphragm injury

