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Ajou University Medical Center

Traumatic Hemothorax : NOM or Surgical management or Embolization

Moon Jonghwan

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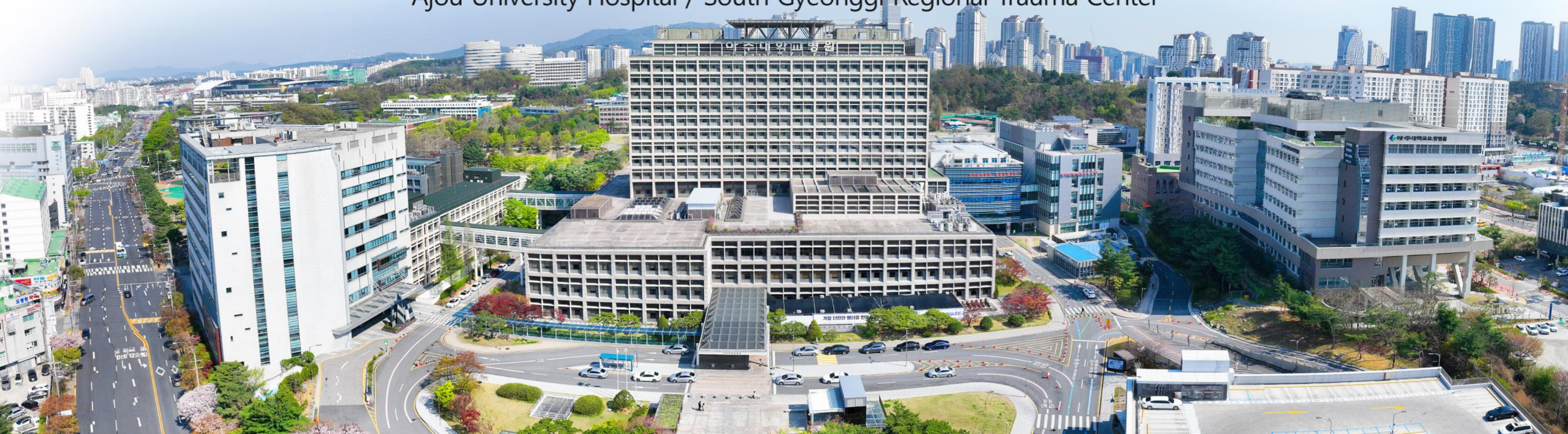
Ajou University Hospital / South Gyeonggi Regional Trauma Center



It generally has been reported that thoracotomy will be required in approximately **30%** of cases presenting after **penetrating chest injury** and in **15% after blunt chest trauma.**

KTDB in Ajou Hospital

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- 2016 ~ 2023
- bleeding으로 thoracotomy or VATS 시행

\# Thorax AIS ≥ 1

- Blunt Trauma : 146/9168(1.6%)
- Penetrating Trauma : 44/236(18.6%)

\# Thorax AIS ≥ 3

- Blunt Trauma : 133/7490(1.8%)
- Penetrating Trauma : 38/177(21.4%)

Surgical Timing

Immediate & Emergent Thoracotomy

- Traumatic Cardiac Arrest
- Shock
- In Extremis
- Emergency Room

Urgent Thoracotomy

- Newly developed life-threatening condition
- Prevent the development of deterioration, injury, or infection
- Operating Room (<48hr)

Delayed Thoracotomy

- Complications or missed injury of Thoracic trauma
- Delayed repairs of diaphragmatic injury or aortic injury
- Retained hematoma

Immediate & Emergent Thoracotomy

Emergency thoracotomy may be defined as that occurring either immediately at the site of injury, in the emergency department, or in the operating room, **as an integral part of the initial resuscitation.**

Immediate & Emergent Thoracotomy

INDICATIONS:

Salvageable postinjury cardiac arrest:

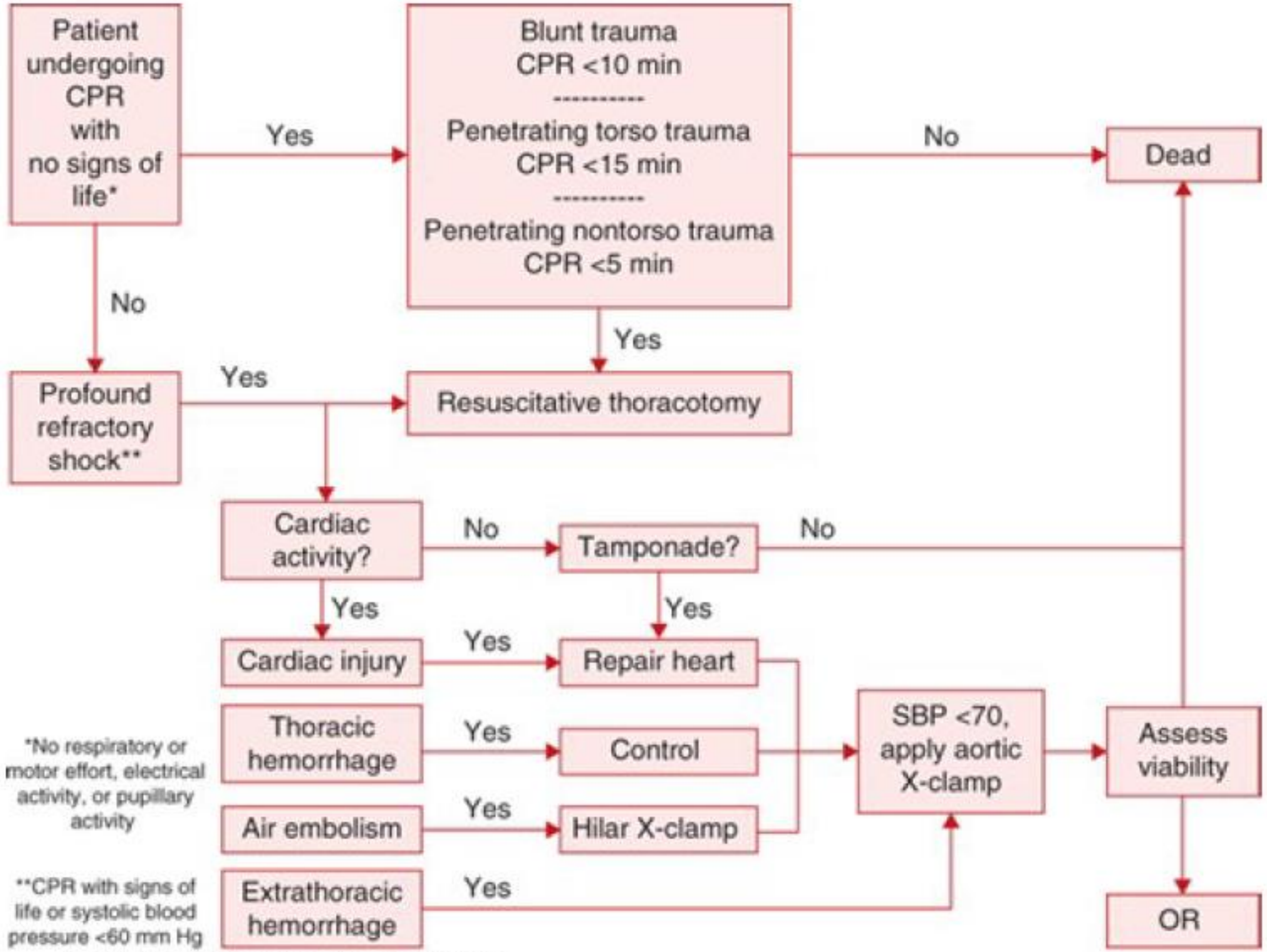
- Patients sustaining witnessed penetrating thoracic trauma with <15 min of prehospital CPR
- Patients sustaining witnessed penetrating nonthoracic trauma with <5 min of prehospital CPR.
- Patients sustaining witnessed blunt trauma with <10 min of prehospital CPR

Persistent severe postinjury hypotension (SBP < 60 mm Hg) *due to:*

- Cardiac tamponade
- Hemorrhage-intrathoracic, intra-abdominal, extremity, cervical
- Air embolism

CONTRAINDICATIONS:

- **CPR >15 min** following **penetrating injury** and no signs of life (pupillary response, respiratory effort, or motor activity)
- **CPR >10 min** following **blunt injury** and no signs of life. Asystole is the presenting rhythm and there is not pericardial tamponade



Source: David V. Feliciano, Kenneth L. Mattox, Ernest E. Moore: Trauma, Ninth Edition

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Immediate & Emergent Thoracotomy

An evidence-based approach to patient selection for emergency department thoracotomy: A practice management guideline from the Eastern Association for the Surgery of Trauma

Mark J. Seamon, MD, Elliott R. Haut, MD, PhD, Kyle Van Arendonk, MD, Ronald R. Barbosa, MD, William C. Chiu, MD, Christopher J. Dente, MD, Nicole Fox, MD, Randeep S. Jawa, MD, Kosar Khwaja, MD, J. Kayle Lee, MD, Louis J. Magnotti, MD, Julie A. Mayglothling, MD, Amy A. McDonald, MD, Susan Rowell, MD, MCR, Kathleen B. To, MD, Yngve Falck-Ytter, MD, *and* **Peter Rhee, MD, MPH,** *Philadelphia, Pennsylvania*

J Trauma Acute Care Surg. 2015;79: 159Y173.

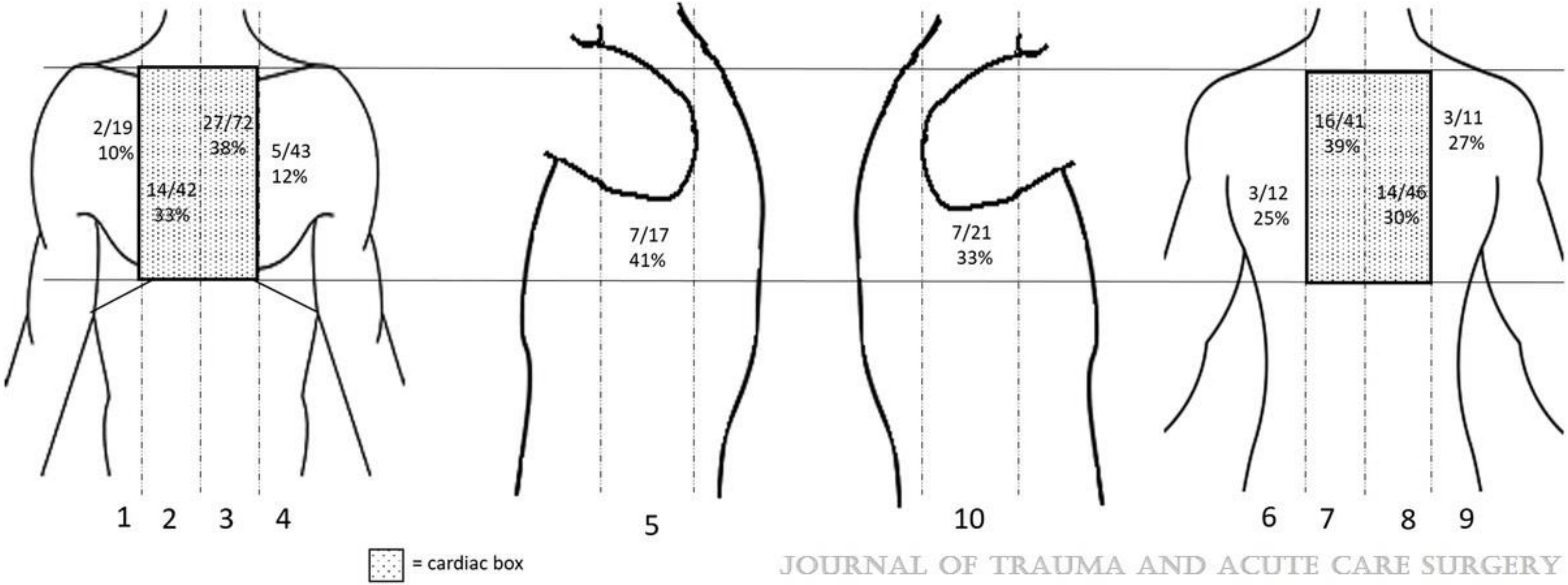
Question	Recommendation
PICO #1	In patients who present pulseless to the Emergency Department with signs of life after penetrating thoracic injury, we **strongly recommend** resuscitative Emergency Department thoracotomy. **Strong Recommendation**
PICO #2	In patients who present pulseless to the Emergency Department without signs of life after penetrating thoracic injury, we **conditionally recommend** resuscitative Emergency Department thoracotomy. **Conditional Recommendation**
PICO #3	In patients who present pulseless to the Emergency Department with signs of life after penetrating extra-thoracic injury, we **conditionally recommend** resuscitative Emergency Department thoracotomy. **Conditional Recommendation**
PICO #4	In patients who present pulseless to the Emergency Department without signs of life after penetrating extra-thoracic injury, we **conditionally recommend** resuscitative Emergency Department thoracotomy.[1] **Conditional Recommendation**
PICO #5	In patients who present pulseless to the Emergency Department with signs of life after blunt injury, we **conditionally recommend** resuscitative Emergency Department thoracotomy. **Conditional Recommendation**
PICO #6	In patients who present pulseless to the Emergency Department without signs of life after blunt injury, we **conditionally recommend against** resuscitative Emergency Department thoracotomy.[2] **Conditional Recommendation**

Direct to OR

Performance of the primary and secondary surveys and ongoing resuscitation with the ability to convert to immediate surgical or other invasive procedural interventions.

Initial assessment + Resuscitation + Surgical procedure

Cardiac Box



Journal of Trauma and Acute Care Surgery83(3):349-355, September 2017

2021 AAST Podium Paper

Direct to OR resuscitation of abdominal trauma: An NTDB propensity matched outcomes study

Theodore E. Habarth-Morales, BS, Arturo J. Rios-Diaz, MD, Stephen P. Gadomski, MD,
Tiffani Stanley, BA, Julie P. Donnelly, MSN, RN, TCRN, George J. Koenig, Jr, DO, Murray J. Cohen, MD,
and Joshua A. Marks, MD, *Philadelphia, Pennsylvania*

TABLE 1. EDOR Triage Criteria for Patients Presenting to Our ED

Penetrating injuries of the neck, chest, abdomen, or pelvis
Cardiopulmonary arrest
Profound shock
Amputation (traumatic, proximal to elbow or knee)
Impaled objects in neck, chest, abdomen, or pelvis
Open chest or abdominal wound (evisceration of abdominal contents)

Ajou Trauma Center V1.0 (2023-07-11)

DOR Protocol

적응증 혈역학적으로 불안정한 경부/체간부 관통상

선언

선언시점

- 환자 병원 도착 최소 5분 전
(한 번 선언한 DOR 여부는 ETA 5분 이내 변경 불가)

선언내용

- MTP 시행 정보
- 환자정보
  - 손상부위
  - 수술내용

이송

항공팀

- 가능한 Vascular access
(IO, Large-bore peripheral line, MAC at SCV, jugular or femoral vein등)

지상팀

- 선접수
(선접수는 환자도착 5-10분 전에 시행)
- MTP Activation
  - RIS(FMS) Setting & Priming
  - MTP 1st pack
  (T bay O RBC + AB FFP 의뢰)
- 마취과, 수술 준비실 연락

병원 도착

소생팀 리더 역할

- 의식/활력징후(ABCDE) 확인
- Airway and/or Vascular function access
- 외부 출혈 부위 지혈 상황 확인
- 마취과 당직 교수에게 인계사항
  - 수혈 관련
    - ✓ MTP 여부
    - ✓ ABO Sample 접수 상황
    - ✓ 의뢰 후 수령 대기중 혈액, FMS에 섞인 혈액, 혈액은행 불출 후 이동중인 혈액
    - ✓ 향후 수혈 계획: 언제, 어떤 혈액을 누가 의뢰
  - Intubation, A line & V line 확보 상황
  - 출혈 예상 부위 및 정도
  - 수술 관련 정보

Urgent Thoracotomy

- **An urgent thoracotomy** is one that takes place under more controlled circumstances and in the context of appropriate physiological stability and hitherto successful resuscitation.

- **An urgent thoracotomy** is performed **minutes to hours** after injury to control and **manage a potential life-threatening condition** or **prevent** the development of further deterioration, injury or infection.

Traditional Criteria

- More than 1,500 mL of blood immediately evacuated by tube thoracostomy.
- Persistent bleeding from the chest, defined as 200 mL/h for 2 hours to 4 hours.
- Persistent blood transfusion is required to maintain hemodynamic stability.
- Patient's physiologic status and whether the chest is completely evacuated of blood.

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INDICATIONS FOR THORACOTOMY FOLLOWING PENETRATING THORACIC INJURY

ROGER SIEMENS, M.D., HIRAM C. POLK, JR., M.D., LAMAN A. GRAY, JR., M.D., AND ROBERT L. FULTON, M.D.

From the Department of Surgery, and the Price Institute of Surgical Research, the University of Louisville School of Medicine, Health Sciences Center, Louisville, Kentucky

The treatment of penetrating thoracic injuries has been reviewed in both civilian and military series. Although most surgeons agree that closed thoracostomy drainage is the initial treatment of choice, the timing of early thoracotomy and perhaps cardiorrhaphy upon patients with penetrating thoracic injuries remains controversial. The purpose of this study was to determine which patients will require immediate thoracotomy or cardiorrhaphy following penetrating chest injury.

Over a two-year period 190 patients with penetrating thoracic injuries were treated. Of 53 patients who required immediate thoracotomy, 31 suffered cardiac wounds. Seventy-nine patients required laparotomy for associated intra-abdominal injuries. The mortality rate was related to exsanguinating hemorrhage or postoperative intra-abdominal sepsis. Cardiopulmonary complications were rare in the absence of intra-abdominal sepsis and could not be attributed to the thoracic injury or thoracotomy. Indications for immediate cardiorrhaphy or thoracotomy are: 1) location of the entrance wound (70% in upper mediastinum); 2) blood pressure on admission <90; 3) initial thoracostomy blood loss >800 cc; 4) radiographic evidence of retained hemothorax; and/or 5) clinical evidence of pericardial tamponade.

TABLE I
Patient Data Base

	Totals		Treatment Groups				
			Thoracostomy		Cardiorrhaphy		Thoractomy
Number of patients	190		137		31		22
Weapon:							
Gun	71%		74%		55%		77%
Knife	23%		20%		35%		14%
Shotgun	6%		6%		10%		9%
Patients with multiple wounds	42%		50%		23%		18%
Admitting blood pressure:							
less than 90 Hg	37%		26%		71%		55%
average (± S.D.)	94	(±44)	106	(±37)	61	(±48)	75 (±42)
Initial thoracostomy blood loss:							
less than 500 ml	77%		83%		74%		32%
500–1,000 ml	13%		10%		16%		23%
more than 1,000 ml	10%		7%		10%		45%
Clinical cardiac tamponade	12%		0%		70%		0%

J Thorac Cardiovasc Surg. 1979 Feb;77(2):162-8.

Original Communications

Operative management of penetrating wounds of the chest in civilian practice

Review of indications in 125 consecutive patients

Although most patients with penetrating chest wounds can be managed successfully with early tube thoracostomy, blood volume replacement, and close observation, the remainder can be saved only by an aggressive operative intervention. Between July, 1972, and June, 1977, 600 patients with penetrating chest wounds were treated at the Martin Luther King, Jr./Drew Medical Center, with an over-all mortality rate of 2.2 percent. One hundred twenty-five patients required thoracotomy. They included 110 male and 15 female subjects with an average age of 29 years. Fifty-four percent had stab wounds and 46 percent gunshot wounds. On admission 92 percent were in shock. Hemothorax was the most common x-ray finding, being significant (average 1,200 ml.) in 88 percent. Fourteen patients (11 percent) had cardiac arrest before reaching the hospital. They underwent immediate thoracotomy in the emergency room, and two survived. Eighty-five percent of the deaths were due to severe cardiac wounds. Ninety-nine patients (79 percent) underwent early thoracotomy (within 24 hours), with only one death; 92 percent were operated upon within 2 hours of admission. Persistent hemorrhage was the indication in 60 percent. There were no deaths among the 24 patients with cardiac wounds who reached the operating room alive or among the 26 patients who underwent both thoracotomy and exploratory laparotomy. Other indications for early thoracotomy included pulmonary and hilar wounds and perforations of the esophagus, trachea, and major bronchi. Late thoracotomy (after 24 hours) was required in 12 patients. The indications included significant clotted hemothorax in nine, infected hemothorax in one, and subclavian arteriovenous fistula in two patients. All survived. The over-all mortality rate was 10.4 percent, but less than 1.0 percent for the 111 patients who reached us alive. The over-all complication rate was 7 percent, and the average period of hospitalization was 11.8 days.

Sonny S. Oparah, M.D., and Ashis K. Mandal, M.D., *Los Angeles, Calif.*

Table V. *Indications for early thoracotomy in 99 patients with penetrating chest wounds*

Indications	*No. of patients*	*No. of deaths*
Persistent hemorrhage	59	1
Cardiac wounds	24	0
Axillary-subclavian arterial injury	10	0
Perforation of esophagus	3	0
Laceration of tracheobronchial tree	3	0
Totals	99	1

were operated upon within 2 hours of admission. Persistent hemorrhage was the indication for thoracotomy in 59.6 percent of the patients. The rate of bleeding considered significant was 150 ml. per hour or more, usually for 4 consecutive hours. Lacerations of the internal mammary, intercostal, and subclavian arteries as well as major pulmonary and hilar structures were re-

Hemothorax

- More than 1,500 mL of blood immediately evacuated by tube thoracostomy.
- Persistent bleeding from the chest, defined as 200 mL/h for 2 hours to 4 hours.

=> This Concept was largely derived from observations made in the early 1970s based on experience predominantly with penetrating injuries.

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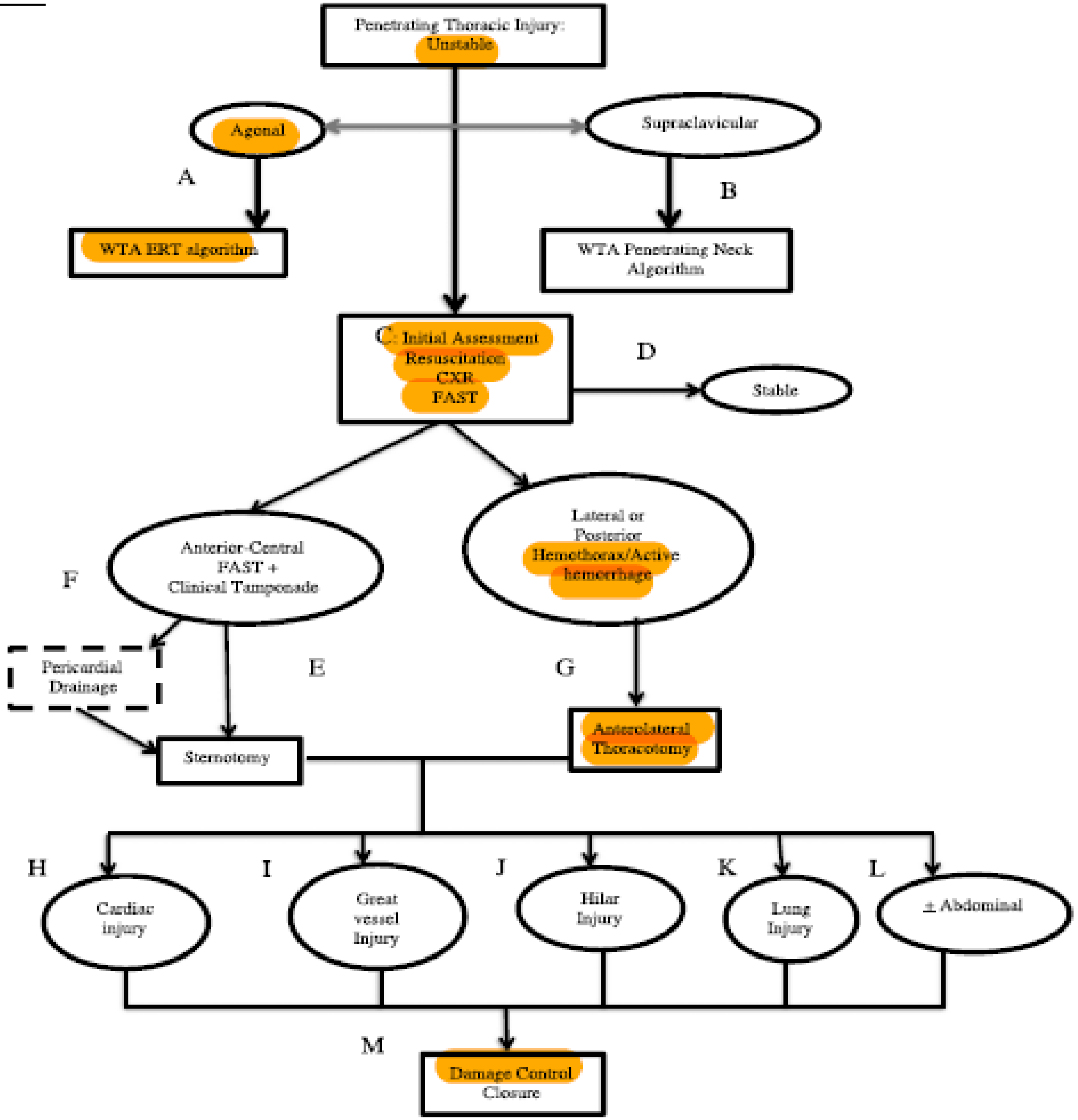
Western Trauma Association Critical Decisions in Trauma: Penetrating chest trauma

Riyad Karmy-Jones, MD, Nicholas Namias, MD, Raul Coimbra, MD, Ernest E. Moore, MD, Martin Schreiber, MD, Robert McIntyre, Jr., MD, Martin Croce, MD, David H. Livingston, MD, Jason L. Sperry, MD, Ajai K. Malhotra, MD, *and* **Walter L. Biffl, MD,** *Portland, Oregon*



J Trauma Acute Care Surg. 2014
Dec;77(6):994-1002

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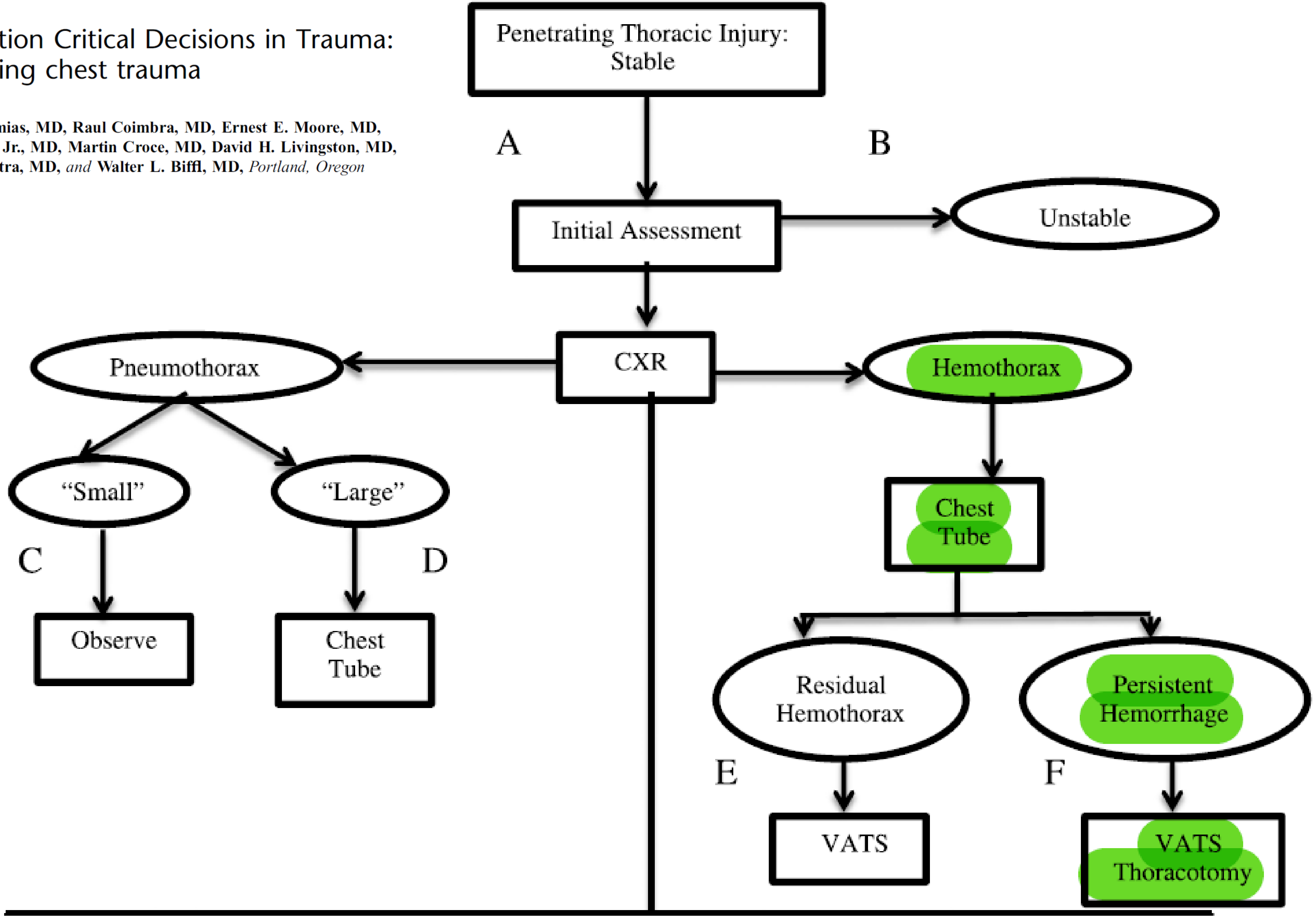


J Trauma Acute Care Surg. 2014

Blunt trauma?

Blunt ≠ Penetrating

Only chest tube drainage?

May 2001

Timing of Urgent Thoracotomy for Hemorrhage After Trauma

A Multicenter Study

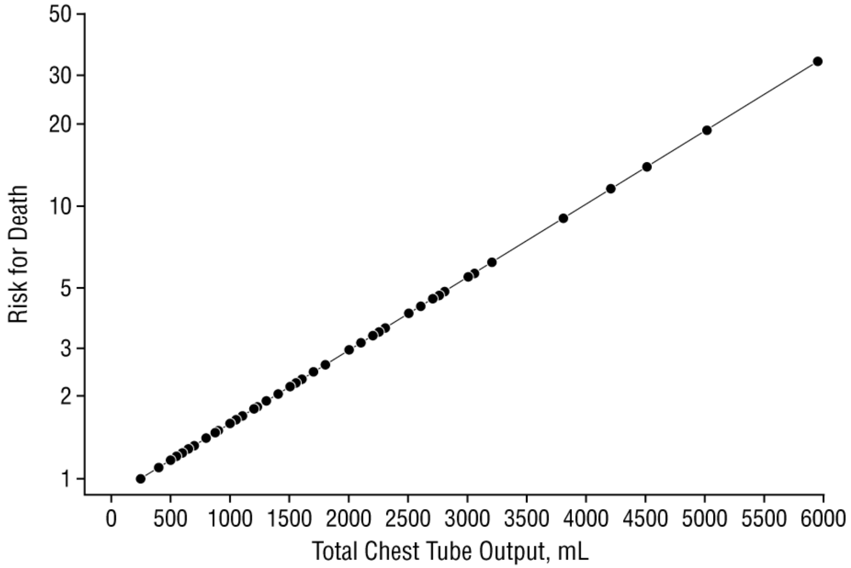
Riyad Karmy-Jones, MD; Gregory J. Jurkovich, MD; Avery B. Nathens, MD; et al

Author Affiliations | Article Information

Arch Surg. 2001;136(5):513-518. doi:10.1001/archsurg.136.5.513

Table 1. Incidence of Primary Factors That Prompted Thoracotomy Owing to Evidence of Thoracic Hemorrhage*

Injury	Massive Hemothorax on Chest x-Ray Film	Initial Chest Tube Output	Ongoing Chest Tube Output	Total
Blunt	6	13	17	**36**
Penetrating	21	61	39	**121**



The risk for death if CT–total exceeded 1500 mL before thoracotomy was 3.2 times greater than with CT–total of 500 mL or less.

Based on this increase in mortality after a CT–total of 1500 mL, it may be worthwhile to consider thoracotomy in patients who have CT–total of greater than 1500 mL in the first 24 hours of admission, even if there is no evidence of shock.

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Practice Management Guidelines for Management of Hemothorax and Occult Pneumothorax

Nathan T. Mowery, MD, Oliver L. Gunter, MD, Bryan R. Collier, DO, Jose' J. Diaz, Jr., MD, Elliott Haut, MD, Amy Hildreth, MD, Michelle Holevar, MD, John Mayberry, MD, and Erik Streib, MD

Management of Massive Hemothorax

1. Patient physiology should be the primary indications for surgical intervention rather than absolute numbers of initial or persistent output (Level 2).
2. 1500 mL via a chest tube in any 24-hour period regardless of mechanism should prompt consideration for surgical exploration (Level II).

J Trauma. 2011 Feb;70(2):510–8

Acute Medicine & Surgery 2016; **3**: 81–85 doi: 10.1002/ams2.148

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Ajou University Medical Center

Original Article

Thoracotomy for blunt chest trauma: is chest tube output a useful criterion?

Yasuaki Mizushima, Shota Nakao, Hiroaki Watanabe, and Tetsuya Matsuoka

Senshu Trauma and Critical Care Medical Center, Rinku General Medical Center, Osaka, Japan

When the source of hemorrhage was believed to be the thoracic cavity, thoracotomy was performed regardless of chest tube output.

Table 1. Patient characteristics and 1-h chest tube outputs of patients who underwent thoracotomy for hemorrhage and those who did not undergo thoracotomy

	Thoracotomy (*n* = 24)	Non-thoracotomy (*n* = 93)	*P*
Age (years)	51.3 ± 23.7	46.6 ± 20.1	NS
Sex (% male)	75%	72%	NS
Thoracic AIS	4.3 ± 0.7	4.0 ± 0.7	NS
ISS	35.2 ± 9.6	33.1 ± 13.1	NS
TRISS	0.53 ± 0.34	0.73 ± 0.31	<0.01
1-h chest tube output (mL)	708.0 ± 258.3	108.9 ± 222.9	<0.01
Mortality (%)	58.3% (*n* = 14)	14.0% (*n* = 13)	<0.01

AIS, Abbreviated Injury Scale; ISS, Injury Severity Score; NS, not significant; TRISS, Trauma-Related Severity Injury Score.

Results: Data were available for 24 patients who underwent thoracotomy for hemorrhage and 93 patients who did not undergo thoracotomy. The 1-h chest tube output between the groups was significantly different (708.0 ± 258.3 mL versus 108.9 ± 222.9 mL). Receiver operating characteristic curve analysis of the predictive value of 1-h chest tube output for thoracotomy was conducted. The area under the receiver operating characteristic curve was 0.98, and the cutoff 1-h chest tube output value for predicting thoracotomy was 404 mL (sensitivity, 87.5%; specificity, 96.8%).

Conclusions: The 1-h chest tube output of patients who underwent thoracotomy was lower than the thresholds traditionally reported as indications for urgent thoracotomy. High chest tube output as a traditional indicator for thoracotomy may not apply to patients with blunt chest trauma.

Journal of
Clinical Medicine

MDPI

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Ajou University Medical Center

Article

Blunt Chest Trauma in Polytraumatized Patients: Predictive Factors for Urgent Thoracotomy

Josef Stolberg-Stolberg [1,*], Jan Christoph Katthagen [1], Thomas Hillemeyer [2], Karsten Wiebe [3], Jeanette Koeppe [4] and Michael J. Raschke [1]

pattern, thoracotomy, and mortality were retrospectively analysed. Results: 235 polytraumatized patients were included. Patients that received urgent thoracotomy (UT, $n = 10$) showed a higher mean chest-tube output within 24 h with a median (Mdn) of 3865 (IQR 2423–5156) mL compared to the group with no additional thoracic surgery (NT, $n = 225$) with Mdn 185 (IQR 50–463) mL ($p < 0.001$). The cut-off 24-h chest-tube output value for recommended thoracotomy was 1270 mL (ROC-Curve). UT showed an initial haemoglobin of Mdn 11.7 (IQR 9.2–14.3) g/dL and an INR value of Mdn 1.27 (IQR 1.11–1.69) as opposed to Mdn 12.3 (IQR 10–13.9) g/dL and Mdn 1.13 (IQR 1.05–1.34) in NT (haemoglobin: $p = 0.786$; INR: $p = 0.215$). There was an average number of 7.1($\pm$3.4) rib fractures in UT and 6.7($\pm$4.8) in NT ($p = 0.649$). Conclusions: Chest-tube output remains the single most important predictive factor for urgent thoracotomy also after blunt chest trauma. Patients with a chest-tube output of more than 1300 mL within 24 h after trauma should be considered for transfer to a level I trauma centre with standby thoracic surgery.

J. Clin. Med. 2021, 10, 3843.

Injury 52 (2021) 225–230

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Is massive hemothorax still an absolute indication for operation in blunt trauma?

Jen-Fu Huang, Chih-Po Hsu, Chih-Yuan Fu*, Chun-Hsiang Ou Yang, Chi-Tung Cheng, Chien-Hung Liao, I-Ming Kuo, Chi-Hsun Hsieh

Division of Trauma and Emergency Surgery, Chang Gung Memorial Hospital, 5 Fu-Xing Street, Guishan District, Taoyuan City, Taiwan

The inclusion criterion was a chest tube drainage amount that met the MHT criteria.

Therapeutic operations were defined as those involving surgical haemostasis; otherwise, operations were considered non-therapeutic.

The non-therapeutic operation group included the patients who received nonoperative management.

Table 1
Comparisons between blunt trauma patients with massive haemothorax who underwent therapeutic and non-therapeutic operations.

	Therapeutic operation ($N = 27$)	Non-therapeutic operation ($N = 17$)	*p*-value
General Demographics			
Age (years)	47.0 (26.0, 55.0)	47.0 (29.5, 66.5)	0.547[d]
Sex			1.000[e]
Female	5 (19%)	3 (18%)	
Male	22 (81%)	14 (82%)	
Condition at Emergency Department			
Body Temperature (°C)	35.9 (35.0, 36.7)	36.5 (35.7, 37.0)	0.125[d]
Pulse Rate (bpm)	125.0 (111.0, 135.0)	116.0 (84.0, 121.0)	**0.013**[d]
Respiration Rate (per minute)	24.0 (19.0, 25.0)	21.0 (20.0, 22.0)	0.226[d]
SBP on Arrival (mmHg)	110.0 (78.0, 142.0)	124.0 (109.0, 143.5)	0.263[d]
SBP after Resuscitation (mmHg)	106.0 (84.0, 127.0)	121.0 (116.0, 134.0)	**0.040**[d]
SBP <90 mmHg (N)	8 (30%)	2 (12%)	0.314[e]
SBP <90 mmHg Post-resuscitation (N)	9 (33%)	0 (0%)	**0.014**[e]
Chest Tube Amount			
1500 ml STAT (N)	6 (22%)	7 (41%)	0.316[e]
200 ml/hr for 2-4 H (N)	22 (81%)	12 (71%)	0.632[e]
Laboratory Data and Exam			
Haemoglobin (mg/dl)	9.9 (7.4, 13.3)	9.6 (8.7, 11.6)	0.716[d]
INR	1.3 (1.1, 1.7)	1.2 (1.1, 1.4)	0.168[d]
pH[b]	7.2 (7.2, 7.3)	7.4 (7.3, 7.4)	**0.002**[d]
HCO_3 (mEq/L)[b]	17.8 (14.6, 21.5)	21.4 (17.0, 21.5)	**0.038**[d]
Base Excess (mEq/L)[b]	−9.1 (−13.4, −4.5)	−3.8 (−10.1, −0.7)	**0.028**[d]
Lactate (mmol/L)[c]	5.7 (3.3, 7.8)	1.8 (1.7, 2.8)	**0.002**[d]
Lactate > 2.2 mmol/L (N)[c]	20 (100%)	1 (25%)	**0.004**[e]
Blood Transfusions			
PRBC and WB (unit)	18.0 (10.0, 42.0)	6.0 (3.0, 19.0)	**0.005**[d]
FFP (unit)	10.0 (4.0, 42.0)	2.0 (0, 15.0)	**0.003**[d]
Severity and Outcomes			
ISS	29 (24, 34)	29 (13, 40)	0.437[d]
Hospital Stay (days)	16.0 (7.0, 35.0)	16.0 (10.0, 21.0)	0.807[d]
Mortality (N)	7 (26%)	1 (6%)	0.196[e]

Table 2

Subgroup analysis of blunt trauma patients with massive haemothorax with stable haemodynamics who underwent therapeutic and non-therapeutic operations. ($N = 35$).

	Therapeutic operaton ($N = 18$)	Non-therapeutic operation ($N = 17$)	*p*-value
General Demographics			
Age (years)	47.0 (24.8, 66.5)	47.0 (29.5, 66.5)	0.619[d]
Sex (N)			0.944[e]
Female	2 (11%)	3 (18%)	
Male	16 (89%)	14 (82%)	
Condition at Emergency Department			
Body Temperature (°C)	35.9 (35.0, 36.8)	36.5 (35.7, 37.0)	0.254[d]
Pulse Rate (bpm)	126.0 (115.5, 136.3)	116.0 (84.0, 121.0)	**0.007**[d]
Respiration Rate (per minute)	23.0 (19.0, 26.3)	21.0 (20.0, 22.0)	0.280[d]
SBP on Arrival (mmHg)	110.0 (73.0, 145.5)	124.0 (109.0, 143.5)	0.322[d]
SBP after Resuscitation (mmHg)	122.5 (105.0, 145.8)	121.0 (116.0, 134.0)	0.788[d]
Chest Tube Amount			
1500 ml STAT (N)	4 (22%)	7 (41%)	0.400[e]
200 ml/hr for 2-4 H (N)	15 (83%)	12 (71%)	0.622[e]
Laboratory Data and Exam			
Haemoglobin (mg/dl)	10.8 (7.9, 13.3)	9.6 (8.7, 11.6)	0.391[d]
INR	1.3 (1.1, 1.7)	1.2 (1.1, 1.4)	0.254[d]
pH[b]	7.2 (7.2, 7.4)	7.4 (7.3, 7.4)	**0.011**[d]
HCO_3 (mEq/L)[b]	17.0 (14.6, 21.7)	21.4 (17.0, 24.5)	0.099[d]
Base Excess (mEq/L)[b]	−9.9 (−13.4, −4.0)	−3.8 (−10.1, −0.7)	0.070[d]
Lactate (mmol/L)[c]	5.0 (3.0, 7.3)	1.8 (1.7, 2.8)	**0.006**[d]
Lactate $>$ 2.2 mmol/L (N)[c]	13 (100%)	1 (25%)	**0.012**[e]
Blood Transfusion			
PRBC and WB (unit)	18.0 (10.0, 36.5)	6.0 (3.0, 19.0)	**0.007**[d]
Fresh Frozen Plasma (unit)	9.0 (5.5, 27.0)	2.0 (0, 15.0)	**0.008**[d]
Severity and Outcomes			
ISS	29.0 (21.5, 32.3)	29 (13, 40)	0.863[d]
Hospital Stay (days)	14.5 (7.0, 36.5)	16.0 (10.0, 21.0)	0.877[d]
Mortality (N)	3 (17%)	1 (6%)	0.646[e]

Table 3

Subgroup analysis for patients with hourly chest tube amounts over 200 ml for 2 to 4 H and comparisons between those who underwent therapeutic and non-therapeutic operations. ($N = 34$).

	Therapeutic operation ($N = 22$)	Non-therapeutic operation ($N = 12$)	*p*-value
General Demographics			
Age (years)	46.0 (25.5, 55.0)	41.0 (22.3, 67.8)	0.676[d]
Sex			1.000[e]
Female	5 (23%)	2 (17%)	
Male	17 (77%)	10 (83%)	
Condition at Emergency Department			
Body Temperature (°C)	35.9 (35.0, 36.3)	36.6 (35.1, 37.2)	0.200[d]
Pulse Rate (bpm)	123.5 (113.0, 136.3)	116.5 (86.3, 119.8)	**0.027**[d]
Respiration Rate (per minute)	23.0 (18.8, 26.0)	21.5 (20.0, 22.0)	0.458[d]
SBP on Arrival (mmHg)	109.5 (86.3, 135.5)	121.0 (103.3, 127.5)	0.689[d]
SBP after Resuscitation (mmHg)	106.5 (84.8, 128.5)	122.0 (114.8, 136.8)	0.073[d]
SBP $<$90 mmHg on Arrival (N)	6 (27%)	2 (17%)	0.804[e]
SBP $<$90 mmHg Post-resuscitation (N)	7 (32%)	0 (0%)	0.064[e]
Laboratory Data and Exam			
Haemoglobin (mg/dl)	10.7 (7.3, 13.3)	9.5 (8.5, 12.4)	0.824[d]
INR	1.5 (1.1, 1.9)	1.3 (1.2, 1.6)	0.456[d]
pH[b]	7.2 (7.1, 7.3)	7.4 (7.3, 7.4)	**0.002**[d]
HCO_3 (mEq/L)[b]	16.1 (12.9, 19.0)	20.2 (15.3, 24.4)	0.112[d]
Base Excess (mEq/L)[b]	−10.7 (−14.3, −6.8)	−5.0 (−11.9, −1.2)	0.069[d]
Lactate (mmol/L)[c]	6.0 (3.5, 7.8)	1.8 (1.7, 2.8)	**0.002**[d]
Lactate $>$ 2.2 mmol/L (N)[c]	17 (100%)	1 (25%)	**0.006**[d]
Blood Transfusions			
PRBC and WB (unit)	19.0 (11.5, 39.0)	9.0 (4.5, 23.5)	0.075[d]
FFP (unit)	13.0 (4.0, 42.0)	3.0 (0, 18.5)	**0.032**[d]
Severity and Outcomes			
ISS	29 (24, 34)	29 (12, 45)	0.673[d]
Hospital Stay (days)	13.5 (6.0, 35.8)	16.0 (11.0, 29.5)	0.637[d]
Mortality (N)	6 (27%)	1 (8%)	0.396[e]

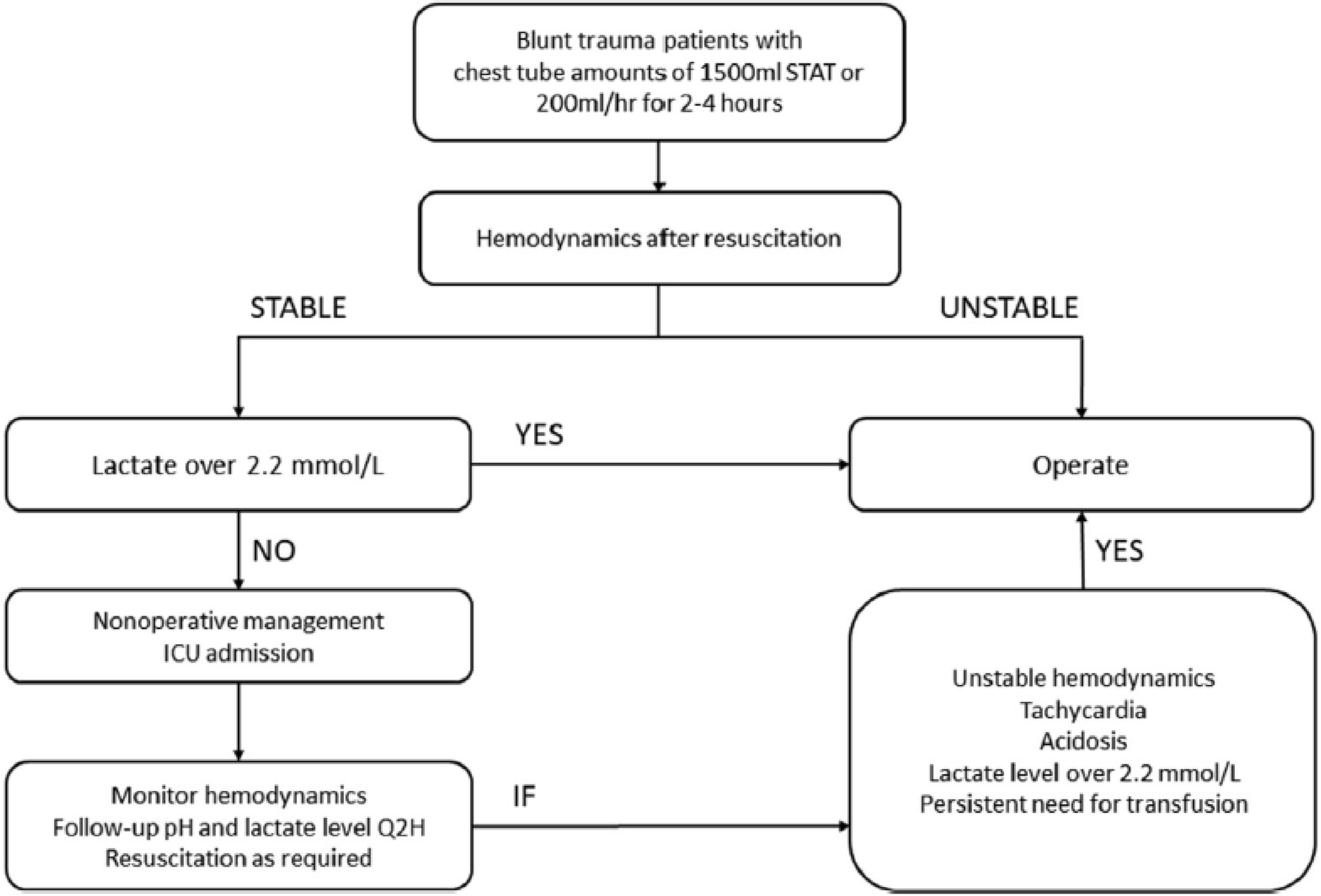


Fig. 1. Treatment algorithm for blunt trauma patients with massive hemothorax.

Blunt Chest Trauma

- Urgent thoracotomy for blunt trauma is **rarely justified on the basis of chest tube output alone.**

✓Physiology

✓Refractory shock & Coagulopathy

✓Clearly identified injuries of thorax

✓Combined injuries

Video-Assisted Thoracoscopy (VATS)

VATS is now widely accepted as a safe and effective procedure for the diagnosis and treatment of a multitude of blunt and penetrating chest injuries.

- **Diagnostic video-assisted thoracoscopic surgery**

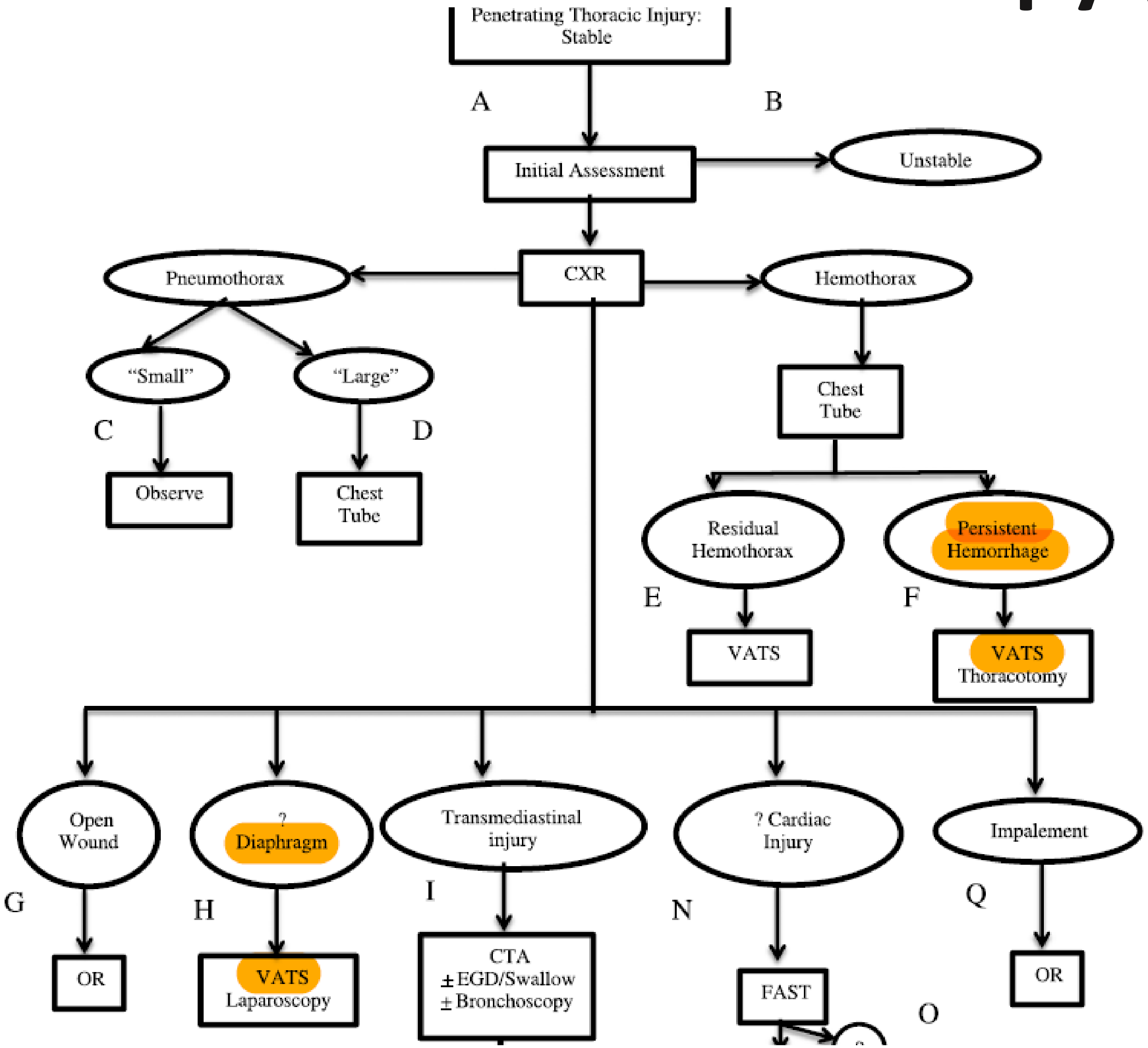
➢ Diaphragm Injury
➢ Transmediastinal and precordial injuries

- **Persistent thoracic hemorrhage**

➢ VATS is useful for patients with significant bleeding who do not meet the criteria for massive hemothorax and are hemodynamically stable.
➢ Several studies have demonstrated a success rate of up to 80% using VATS to control intrathoracic bleeding
➢ Persistent bleeding from the chest arises from intercostal vessels or lung lacerations.
➢ Hemostasis can be achieved thoracoscopically using cautery, endoclips, direct pressure or endovascular stapling devices.

Curr Opin Crit Care. 2006 Dec;12(6):584–9

Video-Assisted Thoracoscopy (VATS)



tube output can lead to an underestimation of the injury severity.[33] In stable patients in whom the blood loss seems to be "slowing," VATS may be an option. Intercostal bleeding can be controlled with clips, lung bleeding with wedge resection, and diaphragm laceration with suture repair. Thoracotomy is advisable if the bleeding is persistent or if

J Trauma Acute Care Surg. 2014 Dec;77(6):994-1002

A comparison of Video-Assisted Thoracoscopic Surgery with Open Thoracotomy for the Management of Chest Trauma: A Systematic Review and Meta-analysis

Na Wu · Long Wu · Chongying Qiu · Zubin Yu · Ying Xiang · Minghao Wang · Jun Jiang · Yafei Li

World J Surg (2015) 39:940–952

Huang[a] [48]	2012	China	Traumatic diaphragmatic hernia	Repair of diaphragmatic laceration	Cohort	VATS	Thoracotomy	23	27
Lu [43]	2013	China	Clotted hemothoraces	Evacuation of hemothorax, hemostasis of bleeders	Cohort	VATS	Thoracotomy	35	33
Hu [40]	2009	China	Hemothoraces	Evacuation of hemothorax, decortication and drainage	RCT	VATS	Thoracotomy	58	58
Liu [38]	2012	China	Pneumothorax and hemothorax	Evacuation of hemothorax, hemostasis of bleeders, repair of lung laceration, decortication of empyema	Cohort	VATS	Thoracotomy	62	62
Li [36]	2012	China	Pneumothorax and hemothorax	Evacuation of hemothorax, hemostasis of bleeders, repair of lung and diaphragmatic laceration	RCT	VAMT	Thoracotomy	30	32
Yu [45]	2012	China	Pneumothorax and hemothorax	Hemostasis of bleeders, repair of lung and diaphragmatic laceration, widen pericardial lacerations	Cohort	VATS	Thoracotomy	21	35
Xie [34]	2009	China	Lung contusion, intercostal bleeders	Evacuation of hemothorax, hemostasis of bleeders, repair of lung and diaphragmatic laceration	Cohort	VAMT	Thoracotomy	29	31
Cao [32]	2011	China	Lung contusion, intercostal bleeders, thoracoabdominal trauma	Evacuation of hemothorax, hemostasis of bleeders, repair of lung and diaphragmatic laceration	RCT	VAMT	Thoracotomy	63	63
Li [47]	2012	China	Hemothoraces	Evacuation of hemothorax, hemostasis of bleeders, control air leak	Cohort	VATS	Thoracotomy	40	40
Peng [28]	2008	China	Lung contusion, diaphragmatic laceration	Evacuation of hemothorax, hemostasis of bleeders, repair of lung and diaphragmatic laceration	RCT	VATS	Thoracotomy	38	38
Wang [44]	2011	China	Pneumothorax and hemothorax	Evacuation of hemothorax, hemostasis of bleeders, repair of lung and diaphragmatic laceration, wedge lung resection, control air leak	Cohort	VATS	Thoracotomy	105	95
Samiatina [49]	2004	Lithuania	Open chest trauma (no description in detail)	repair of diaphragmatic laceration, control air leak	Cohort	VATS	Thoracotomy	33	88
Lian [33]	2008	China	Fractured rib, lung contusion, diaphragmatic laceration, diaphragmatic hernia	Hemostasis of bleeders, repair of lung and diaphragmatic laceration	Cohort	VATS	Thoracotomy	37	33
Ben-Nun [17]	2007	Israel	Chest trauma (no description in detail)	Hemostasis of bleeders, repair of lung and diaphragmatic laceration, wedge lung resection	Cohort	VATS	Thoracotomy	37	40
Long [25]	2010	China	Lung laceration, intercostal bleeders	Hemostasis of bleeders, repair of lung laceration	RCT	VAMT	Thoracotomy	29	31
Li F [27]	2009	China	Clotted hemothorax, lung laceration, intercostal bleeders, pericardial bleeding	Repair of lung and diaphragmatic laceration, evacuation of clotted hemothorax	RCT	VATS	Thoracotomy	53	61
Liao [30]	2012	China	Chest trauma (no description in detail)	Evacuation of clotted hemothorax, hemostasis of bleeders, repair of lung and diaphragmatic laceration, fixation of fractured rib	RCT	VATS	Thoracotomy	56	57
Li[a] [29]	2008	China	Chest trauma (no description in detail)	Repair of lung laceration, wedge lung resection, hemostasis of bleeders, removal of foreign body in myocardium	RCT	VATS	Thoracotomy	40	36
Lu [42]	2011	China	Hemothoraces	Evacuation of hemothorax, hemostasis of bleeders, repair of lung and diaphragmatic laceration	Cohort	VATS	Thoracotomy	20	20
Yu [46]	2013	China	Pneumothorax and hemothorax	Hemostasis of bleeders, repair of lung laceration	Cohort	VATS	Thoracotomy	31	29
Chen [41]	2013	China	Pneumothorax and hemothorax	Hemostasis of bleeders, repair of lung and diaphragmatic laceration, wedge lung resection	RCT	VATS	Thoracotomy	38	38
Jiang[a] [26]	2010	China	Chest trauma(no description in detail)	–	RCT	VATS	Thoracotomy	40	36
Yuan [37]	2012	China	Lung laceration, fractured rib, diaphragmatic laceration	Hemostasis of bleeders, repair of lung and diaphragmatic laceration	Cohort	VAMT	Thoracotomy	32	30
Yang [39]	2012	China	Hemothorax	Evacuation of hemothorax, hemostasis of bleeders	Cohort	VATS	Thoracotomy	28	28
Hao [35]	2010	China	Hemothoraces	Hemostasis of bleeders, repair of lung laceration, wedge lung resection	RCT	VATS	Thoracotomy	39	34
Zhao [31]	2010	China	Fractured rib, lung contusion, diaphragmatic laceration, diaphragmatic hernia, thoracoabdominal trauma	Hemostasis of bleeders, repair of lung laceration	RCT	VATS	Thoracotomy	44	43

Video-Assisted Thoracoscopy (VATS)

아주대학교의료원
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A comparison of Video-Assisted Thoracoscopic Surgery with Open Thoracotomy for the Management of Chest Trauma: A Systematic Review and Meta-analysis

Na Wu · Long Wu · Chongying Qiu ·
Zubin Yu · Ying Xiang · Minghao Wang ·
Jun Jiang · Yafei Li

Results Twenty-six studies were included. Pooled analyses showed significant reductions in the incidence of postoperative complications (risk ratio [RR] [95 % confidence interval (CI)], 0.47 [0.35, 0.64]), chest tube drainage volume (mean difference [MD] [95 % CI], −146.88 ml [−196.04, −97.72]), duration of tube drainage (MD, −1.71 days; 95 % CI −2.16 to −1.26), duration of hospitalization (MD, −4.67 days; 95 % CI −5.19 to−4.14), operation time (MD, −41.18 min; 95 % CI −52.85 to −29.51), and amount of bleeding (MD, −119.10 ml; 95 % CI −147.28 to −90.92) and transfusion volume (MD, −379.51 ml; 95 % CI −521.24 to−237.77) in chest trauma patients treated with VATS compared with open thoracotomy. The perioperative mortality rate was not significantly different between patients received VATS and open thoracotomy (RR, 0.52; 95 % CI 0.22–1.21).

Conclusions Compared to open thoracotomy, VATS is an effective and even better treatment for improving perioperative outcomes of hemodynamically stable patients with chest trauma and reduce the complications. However, caution should also be exercised in certain clinical scenarios.

World J Surg (2015) 39:940–952

Transcatheter Arterial Embolization(TAE)

- Transcatheter arterial embolization (TAE) is becoming the treatment of choice for hemorrhage in traumatic splenic, hepatic, renal, and pelvic injuries.
- However, there are no guidelines and also limited reports about embolization following traumatic thoracic injury.
- The clinical success rate has been reported to range from 78.9% to 92.6%.

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Indications for Transcatheter Arterial Embolization in Persistent Hemothorax caused by Blunt Trauma

Akiyoshi Hagiwara, MD, Youichi Yanagawa, MD, Naoyuki Kaneko, MD, Akira Takasu, MD, Kousuke Hatanaka, MD, Toshihisa Sakamoto, MD, and Yoshiaki Okada, MD

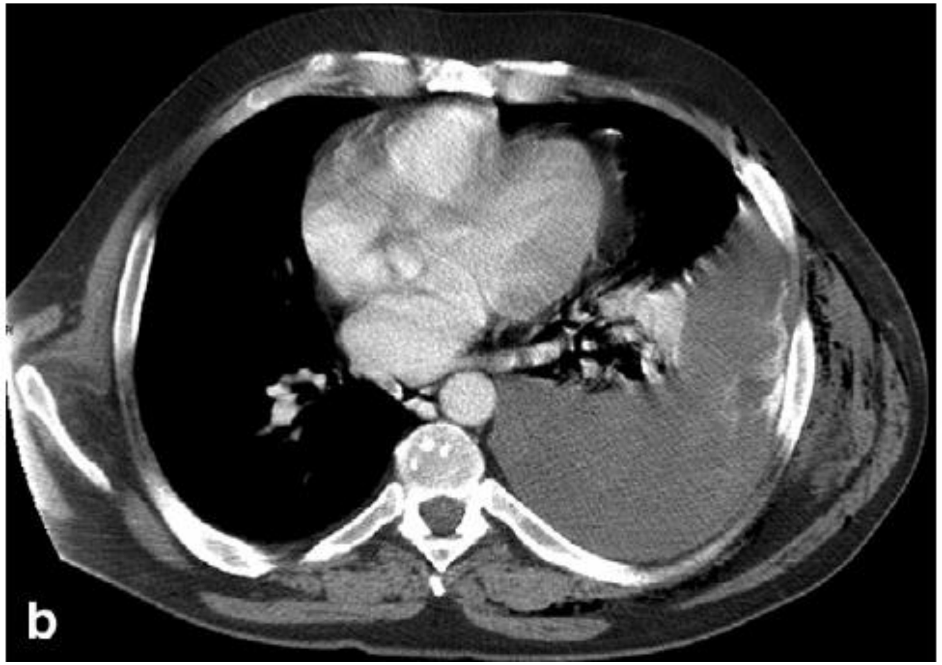

Table 2 Comparison Between Thoracic Injuries With ≥200 mL/h and <200 mL/h Blood Loss

Blood Loss	≥200 mL/h	<200 mL/h	*p*
Thoracic site (n)	6	32	
Percent volume of the lung injuries (%)	30 ± 12	29 ± 16 (n = 31)	0.75
Number of rib fractures	5.3 ± 2.8	3.9 ± 3.0	0.32
Magnitude of rib fracture displacement			
PD (mm)	20.4 ± 11.1	10.0 ± 9.2	0.03
TD (times)	1.9 ± 0.9	0.9 ± 0.8	0.02
Contrast extravasation on CECT			
Positive	5	0	
Negative	1	32	<0.01

PD, Parallel displacements; TD, Transverse displacements.

Original Article

아주대학교의료원
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Technical results, clinical efficacy and predictors of outcome of intercostal arteries embolization for hemothorax: a two-institutions' experience

Nicola Tamburini[1], Nicole Carriel[2], Giorgio Cavallesco[1], Laureano Molins[2,3], Roberto Galeotti[4], Rudith Guzmán[2], Elisabetta Salviato[4], David Sánchez-Lorente[2], Elisa Maietti[5,6], Pio Maniscalco[1], Marc Boada[2]

Table 3 Predictors of technical failure after TAE

Variable	No success (n=4)	Technical success (n=26)	P value
Age, median [IQR, range]	59.5 [44.5–71.5]	71 [64–77]	0.222
Gender M, n (%)	2 [50]	20 [77]	0.284
Cardiovascular diseases (%)	2 [50]	10 [38]	1.000
Liver impairment (%)	3 [75]	2 [8]	0.009
Renal impairment (%)	1 [25]	2 [8]	0.360
Malignancy (%)	2 [50]	6 [23]	0.284
Anticoagulant therapy (%)	1 [25]	4 [15]	0.538
Antiplatelet therapy (%)	1 [25]	8 [31]	1.000
Iatrogenic causes (%)	3 [75]	8 [31]	0.126
Extrathoracic injuries (%)	0 [0]	5 [19]	1.000
ICA embolized >1 (%)	4 [100]	10 [38]	0.037
Packed cells transfused, mL	12 [6–40]	5 [3–11]	0.128

Conclusions: ICA embolization was found to be a safe and effective method in treating hemothorax caused by active ICA haemorrhage. Careful pre-embolization evaluation may be required for patient with low haemoglobin levels and haematocrit, hepatic comorbidities and active haemorrhage from more than one artery.

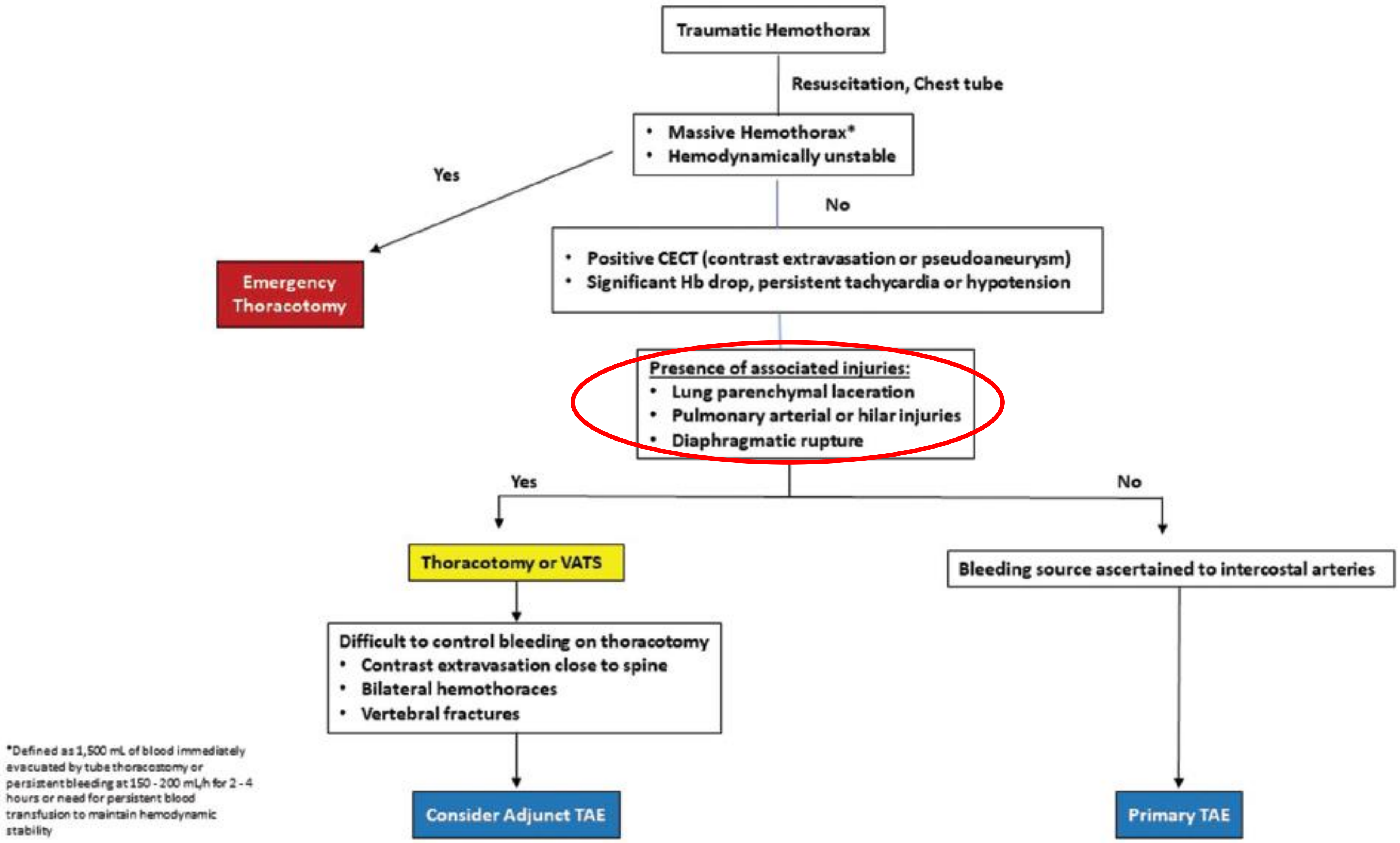

Figure 3: Previously published case reports and studies on transarterial embolization of intercostal artery(ies) for traumatic hemothorax

J Emerg Trauma Shock. 2021 Apr-Jun; 14(2): 111–116

Bleeding from thoracic spinal fractures

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Scand J Trauma Resusc Emerg Med. 2020 Sep 11;28(1):92

Table 1 Clinical characteristics of 12 cases (10 reported cases and our 2 cases)

Author/ Year	Age	Sex	Injury mechanism	Thoracic spinal fracture as the bleeding source (site/ Fx type)	Other sites of injury	Initial hemodynamic status	Side of HTX	Drained volume of Right HTX (mL)	Intervention	Hemostatic technique	Deterioration during the transfer	Spinal fixation	Prognosis
Dalvie/ 2000 [8]	28	M	Traffic accident	T4 / dislocation	NR	NR	Bilateral	NR	Right thoracotomy	spinal fixation	Yes	Performed	Survived
van Raaij/ 2000 [13]	55	F	Fall	T11 / Chance	Compression Fx (T10 & 12), chest, pelvis, limb	unstable	Right	1500	Right thoracotomy	bone wax, synthetic patch	NR	NR	Survived
Lu/ 2010 [10]	72	F	Traffic accident	T11 / burst + T12	NR	unstable	Bilateral	1300	Right thoracotomy	bone wax, gauze packing	NR	Performed	Survived
Masteller/ 2012 [11]	93	M	Fall	T10–11 / burst	chest, L1–2 Fx	NR	Right	1000	Only thoracentesis.	–	NR	Not performed	Dead
Masteller/ 2012 [11]	71	M	Transfer in OR	T11 / burst	none	unstable (CPA later)	Right	3000	Only thoracentesis.	–	NR	Not performed	Dead
Okamoto/ 2018 [12]	81	M	Fall	T7 / Chance	NR	stable (unstable later)	Right	1330	Right thoracotomy	bone wax, coagulant sheet	NR	Performed	Survived
Hirota/ 2019 [9]	74	F	Fall	T11 / Chance	none	unstable	Right	1200	Right thoracotomy	coagulant sheet	NR	Performed	Survived
Kaneko/ 2000 [14]	86	F	Unclear	T6 / dislocation	NR	unstable	Right	2000	Right thoracotomy	argon beam, iliopsoas muscle flap	NR	Not performed	Dead
Matsushita/ 2016 [16]	67	M	Hit by a lumber	T3 / dislocation	chest, T12 Fx (dislocation), limb	unstable	Bilateral	2090	Right thoracotomy	coagulant sheet	NR	Performed	Survived
Haruta/ 2016 [15]	78	F	Traffic accident	T8 / reverse Chance	TBI, chest, liver, pelvis	unstable (CPA later)	Right	1400	Left thoracotomy followed by clamshell thoracotomy	gauze packing, coagulant sheet	NR	Not performed	Dead
Our case	81	M	Traffic accident	T8 / burst	TBI, C5 Fx, chest, pelvis, limbs	unstable	Right	1500	Right thoracotomy	gauze packing	Yes	Not performed	Survived
Our case	64	M	Fall	T7 / burst	TBI, chest, L1 Fx	stable (unstable later)	Right	1300	Right thoracotomy	gauze packing, bone wax, coagulant sheet	Yes	Performed	Survived

Abbreviations: *C* cervical spine, *CPA* cardiopulmonary arrest, *F* female, *Fx* fracture, *HTX* hemothorax, *L* lumber spine, *M* male, *NR* not reported, *OR* operation room, *T* thoracic spine, *TBI* traumatic brain injury

Emerg Radiol (2009) 16:489–491
DOI 10.1007/s10140-008-0780-8

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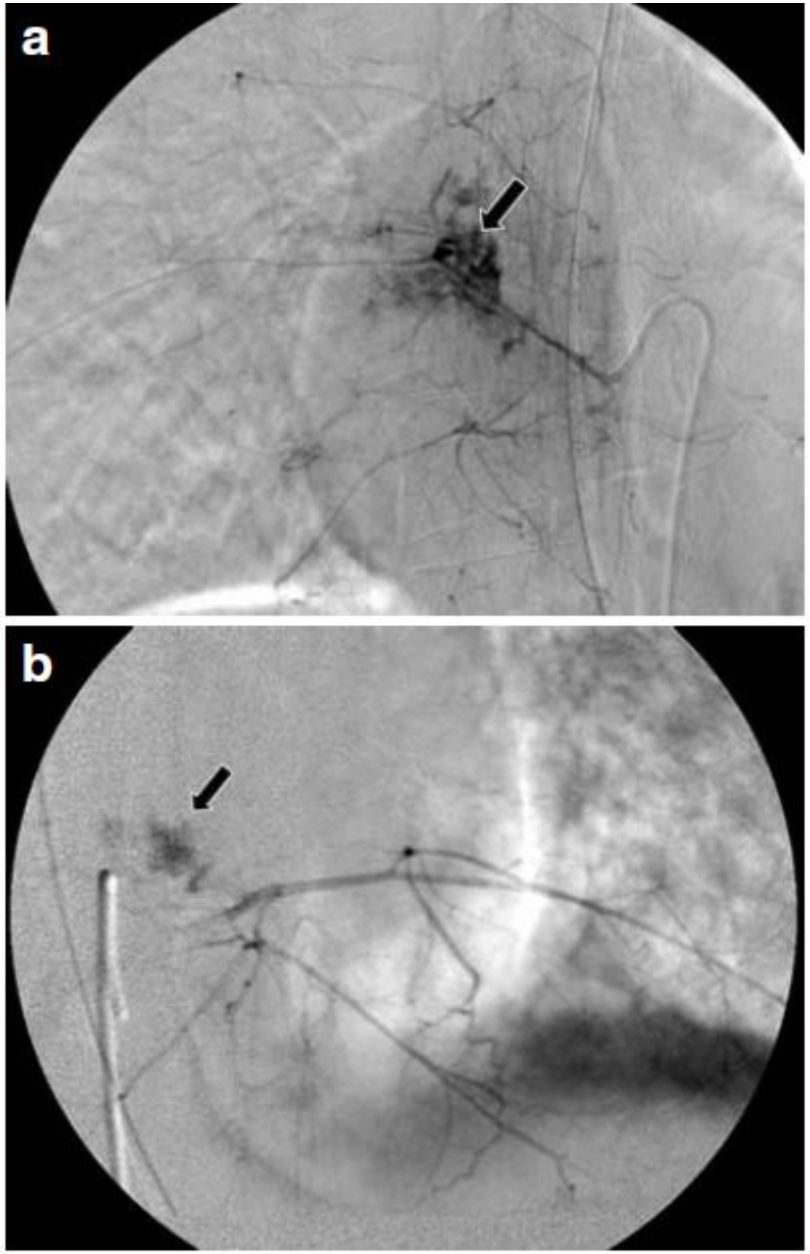
CASE REPORT

Usefulness of transcatheter arterial embolization for intercostal arterial bleeding in a patient with burst fractures of the thoracic vertebrae

Akiyoshi Hagiwara · Shinichiro Iwamoto



ORIGINAL RESEARCH Open Access

Massive hemothorax due to bleeding from thoracic spinal fractures: a case series and systematic review

Scand J Trauma Resusc Emerg Med. 2020 Sep 11;28(1):92

Kohei Ninomiya[†], Akira Kuriyama[*†] and Hayaki Uchino

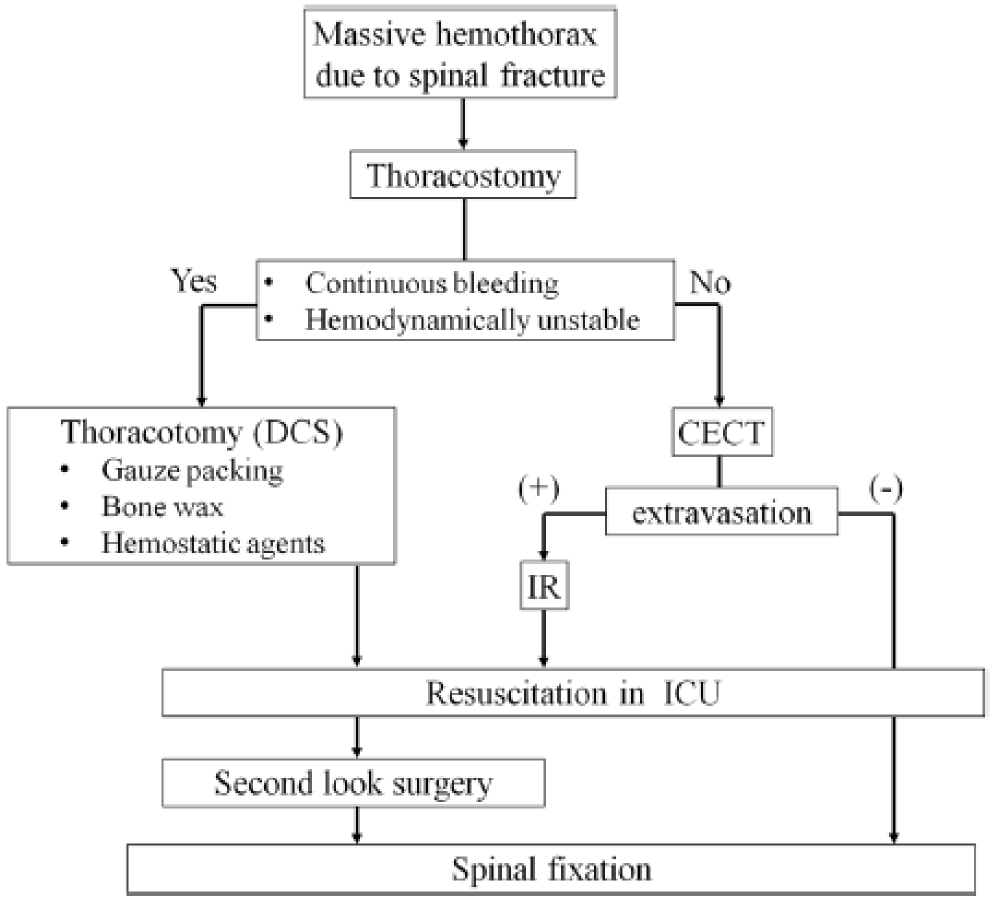


Fig. 4 Our proposed treatment algorithm for massive hemothorax due to bleeding from a fracture of the thoracic spine. Abbreviations; CECT, contrast-enhanced computed tomography; DCS, damage-control surgery; ICU, intensive care unit; IR, interventional radiology

CASE

M/22

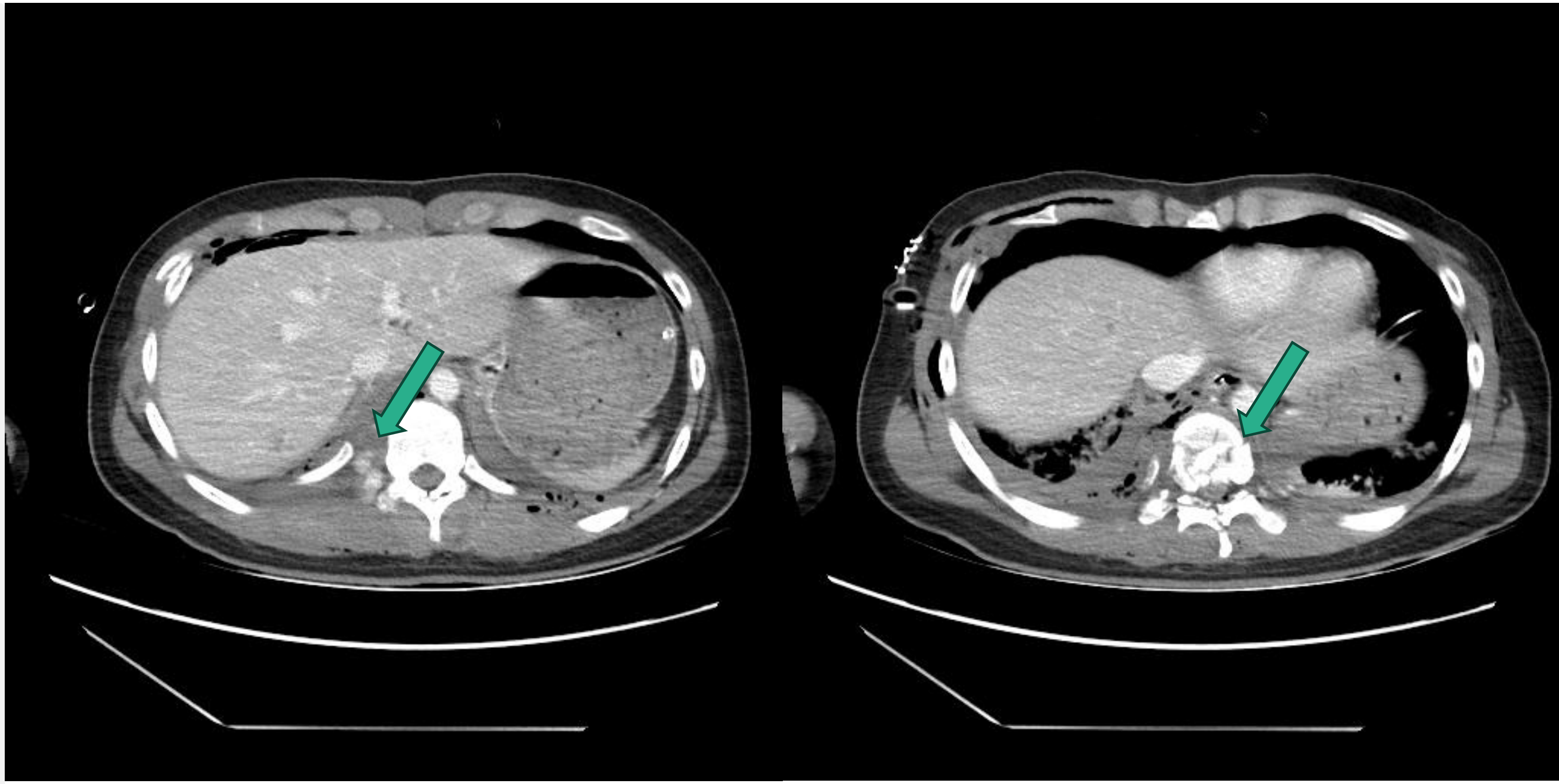
Fall from 14th floor

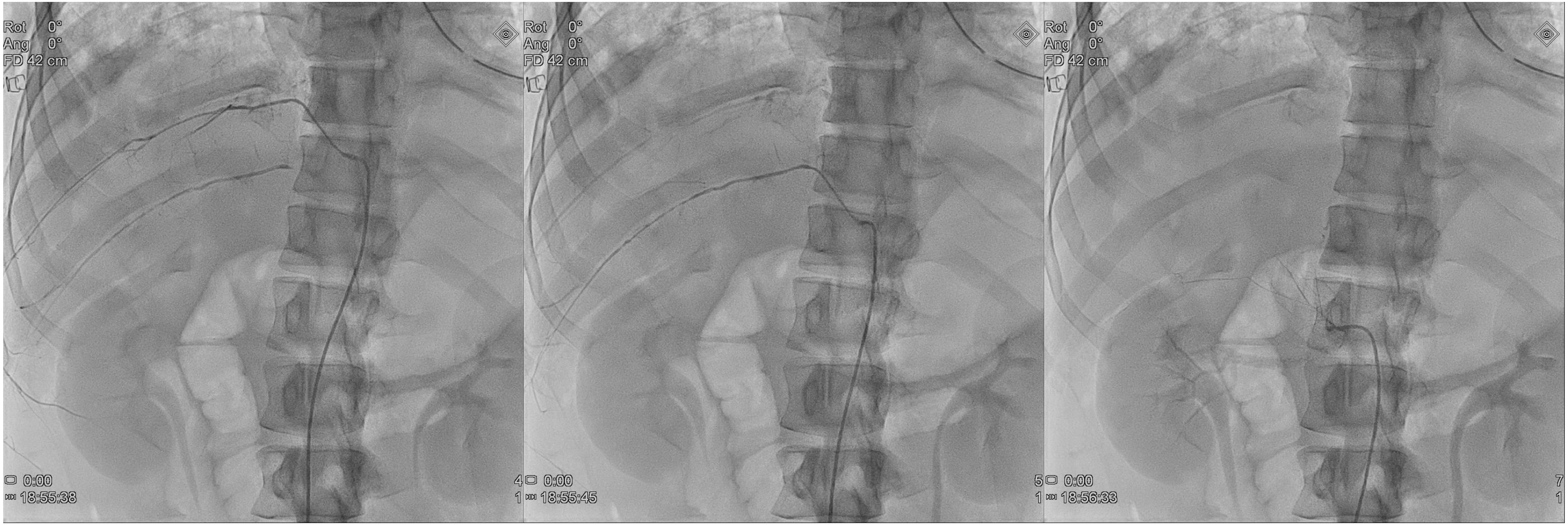
BP 94/72 HR 142

88% via 100% mask 15L

GCS 3/5/6
FAST(-)

HOD 1
Chest tube drainage 2000ml





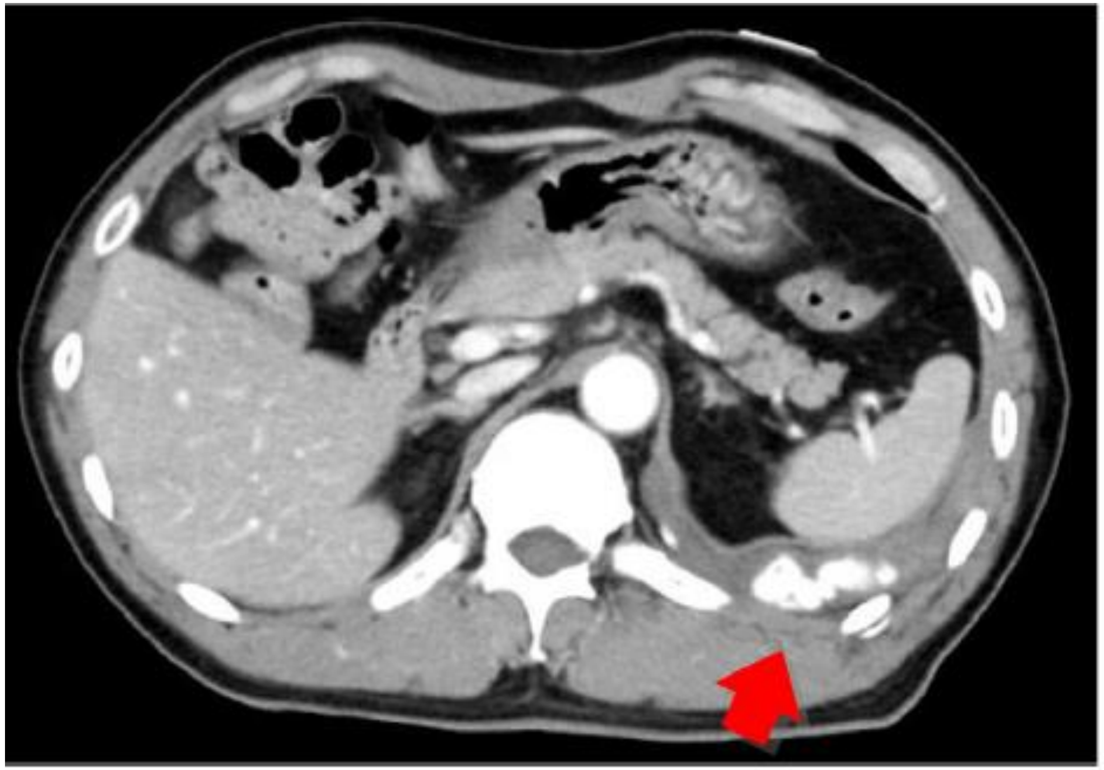
Embolization of injured lumbar arteries (two levels) using NBCA glue mixture.

HOD 2 chest tube drainage 500cc for 1 day
HOD 2 OS op for multiple spine fracture

Delayed massive hemothorax due to diaphragm injury with rib fracture: A case report

Tomohiro Muronoi*, Akihiko Kidani, Kazuyuki Oka, Madoka Konishi, Shunsuke Kuramoto, Yoshihide Shimojo, Eiji Hira, Hiroaki Watanabe

Department of Acute Care Surgery, Faculty of Medicine, Shimane University, Shimane, Japan



International Journal of Surgery Case Reports 77 (2020) 133–137

Table 1
Studies concerning delayed hemothorax due to blunt trauma requiring surgical intervention or IVR reported in the English literature (References: [4,5,9,12,18–23]).

No	Year	Author	Age/sex	Mechanisms	Time from onset	Extent rib fracture	Surgery	Cause	Outcome
1	1998	Simon	N/A	N/A	18h-6days	N/A	Thoracotomy	Intercostal artery	Survived
2	1998	Simon	N/A	N/A	18h-6days	N/A	Thoracotomy	Intercostal artery	Survived
3	2004	Misthos	N/A	N/A	2–14 days	N/A	Thoracotomy	Intercostal artery	Survived
4	2004	Misthos	N/A	N/A	2–14 days	N/A	Thoracotomy	Intercostal artery	Dead
5	2013	Masuda	56/M	Fall	30days	Left 10th	Thoracotomy	Extra pleural cavity	Survived
6	2014	Chen	60/M	Fall	6days	Right 10th-11th	VATS	Diaphragm	Survived
7	2015	Yamanashi	75/M	Motorcycle accident	24h	Right 7th-8th,10th-11th	IVR→VATS	Diaphragm	Survived
8	2015	Curfman	29/M	Assault	10days	Left 7th	Thoracotomy	Intercostal artery	Survived
9	2016	Ahn	24/F	Fall	13days	Right 11th-12th	VATS	Musculophrenic artery	Survived
10	2017	Lin	19/M	Assault	12hours	None	Thoracotomy	Diaphragm	Survived
11	2018	Chang	52/M	Fall	93h	Left 4th-10th	Thoracotomy	Diaphragm	Survived
12	2018	Chang	44/M	Slip	63h	Right 8th-10th	VATS→Thoracotomy	Diaphragm	Survived
13	2018	Chang	45/M	Motorcycle accident	66h	Left 10th-12th	Thoracotomy	Diaphragm	Survived
14	2018	Chang	59/M	Pedestrian traffic accident	63h	Right 1st-11th	Thoracotomy	Diaphragm	Survived
15	2018	Chang	31/M	Motor vehicle accident	33h	Right 3rd-8th	VATS→Thoracotomy	Diaphragm	Survived
16	2019	Igai	44/F	N/A	22days	Right 9th-12th	VATS	Diaphragm	Survived
17	2019	Igai	55/F	N/A	30days	Left 9th-11th	Thoracotomy	Diaphragm	Survived
18	2019	Igai	85/F	N/A	15days	Left 9th-11th	Thoracotomy	Diaphragm	Survived
19	2019	Igai	57/F	N/A	14h	Right 5th-12th	Thoracotomy	Diaphragm	Survived
20	2020	The present case	58/M	Fall	17h	Left 11th-12th	IVR→Thoracotomy	Diaphragm	Survived

Abbreviations: IVR, interventional radiology; N/A, no available information; VATS, video-assisted thoracic surgery.

- Arteries feeding the diaphragm comprise the pericardiophrenic artery; the musculophrenic artery, branching from the internal thoracic artery, and; the inferior phrenic artery, branching from the abdominal aorta or the celiac artery.

- The effect of embolization of the intercostal artery or the internal thoracic artery on hemostasis in the diaphragm is not clear.

- Since embolization of the inferior phrenic, pericardiophrenic, and musculophrenic arteries is not a simple procedure, a lengthy surgical intervention is required to stop bleeding in the diaphragm. If the vital signs are unstable, these arteries should not be sticked for IVR

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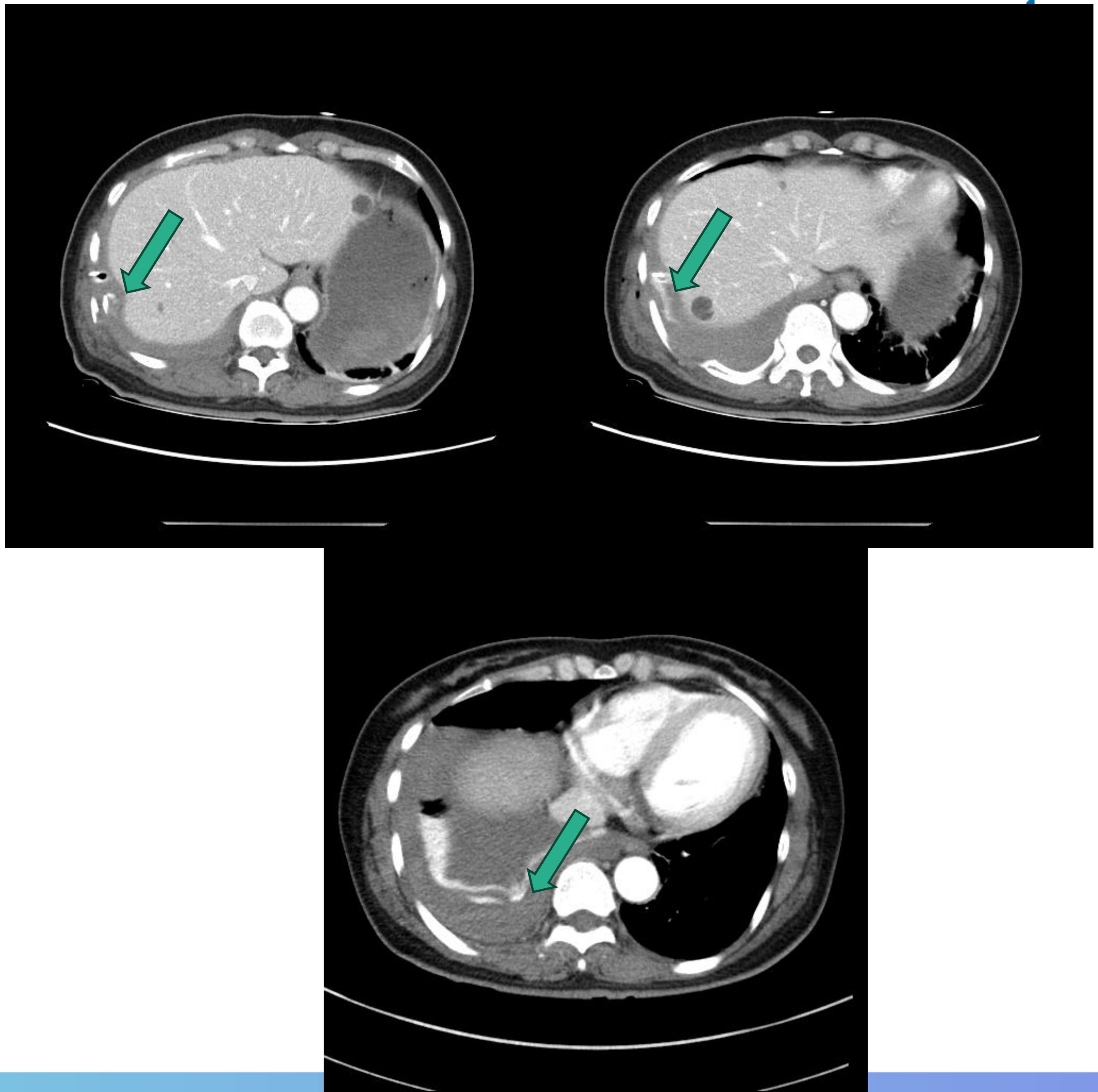
CASE

F/50
Slip down 3 days ago
BP 208/107 HR 68
100% via 100% mask 15L
GCS 4/5/6

Chest tube drainage : 1130ml in local clinic

Thoracoscopic exploration

Op finding
Lung laceration 3cm at RLL
Diaphragm laceration 5cm

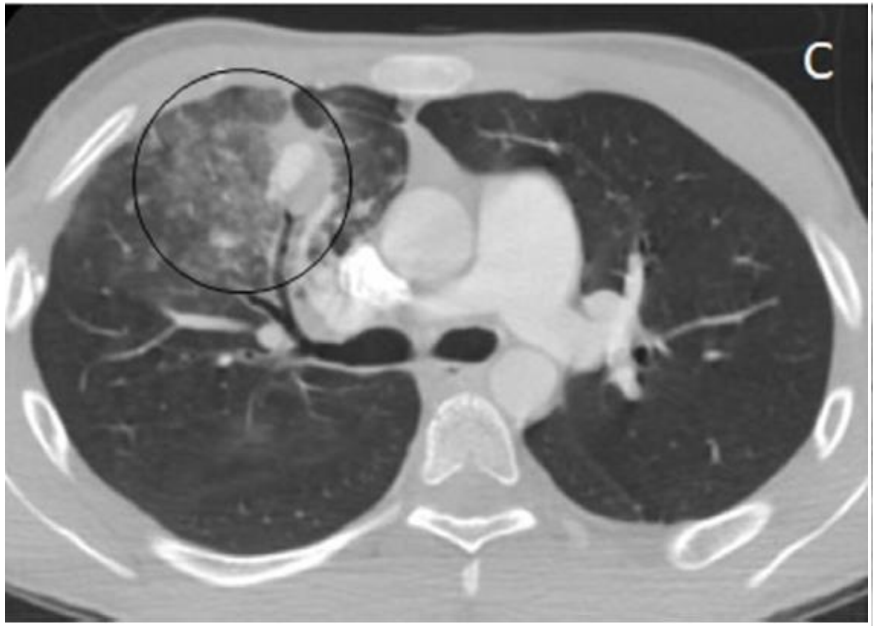


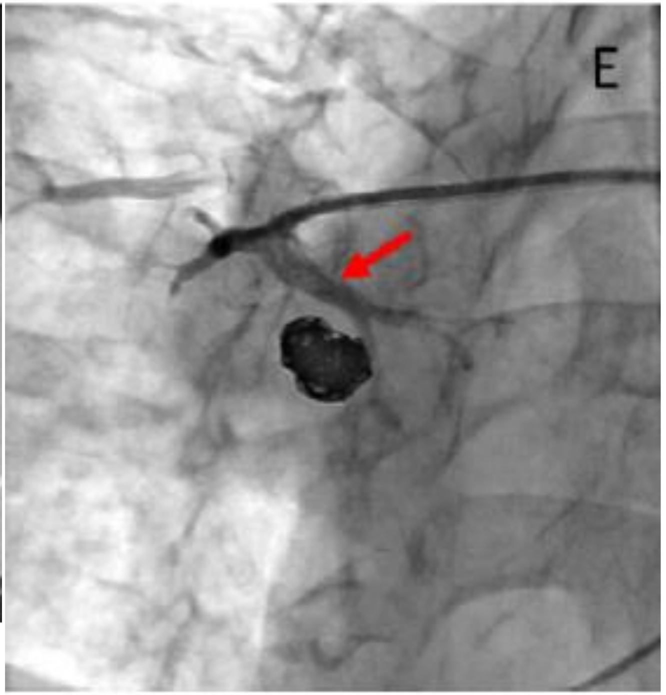
Case Report

Pseudoaneurysm and post-traumatic arteriovenous fistula in pulmonary artery branch: Case report and review of the literature ☆

Sandra Ramírez, MD[a], *Nicolás Bastidas, MS*[b,*], *Nicolás Lozano, MS*[c], *Diego Casas, MD*[d], *Michel Hernández, MD*[a]

[a] *Radiology Department, Hospital Universitario de la Samaritana, Bogotá, Colombia*
[b] *University of la Sabana, Chía, Cundinamarca, Colombia*
[c] *University of Los Andes, Bogotá, Colombia*
[d] *Radiology Faculty, University of la Sabana, Chía, Cundinamarca 110321, Colombia*





Although there are no definitive guidelines for the management of traumatic pseudoaneurysms, it is important to analyze their size, as well as patient symptoms and hemodynamic status in order to ascertain the risk of rupture and decide whether to observe the patient or to perform endovascular or surgical repair.

CASE

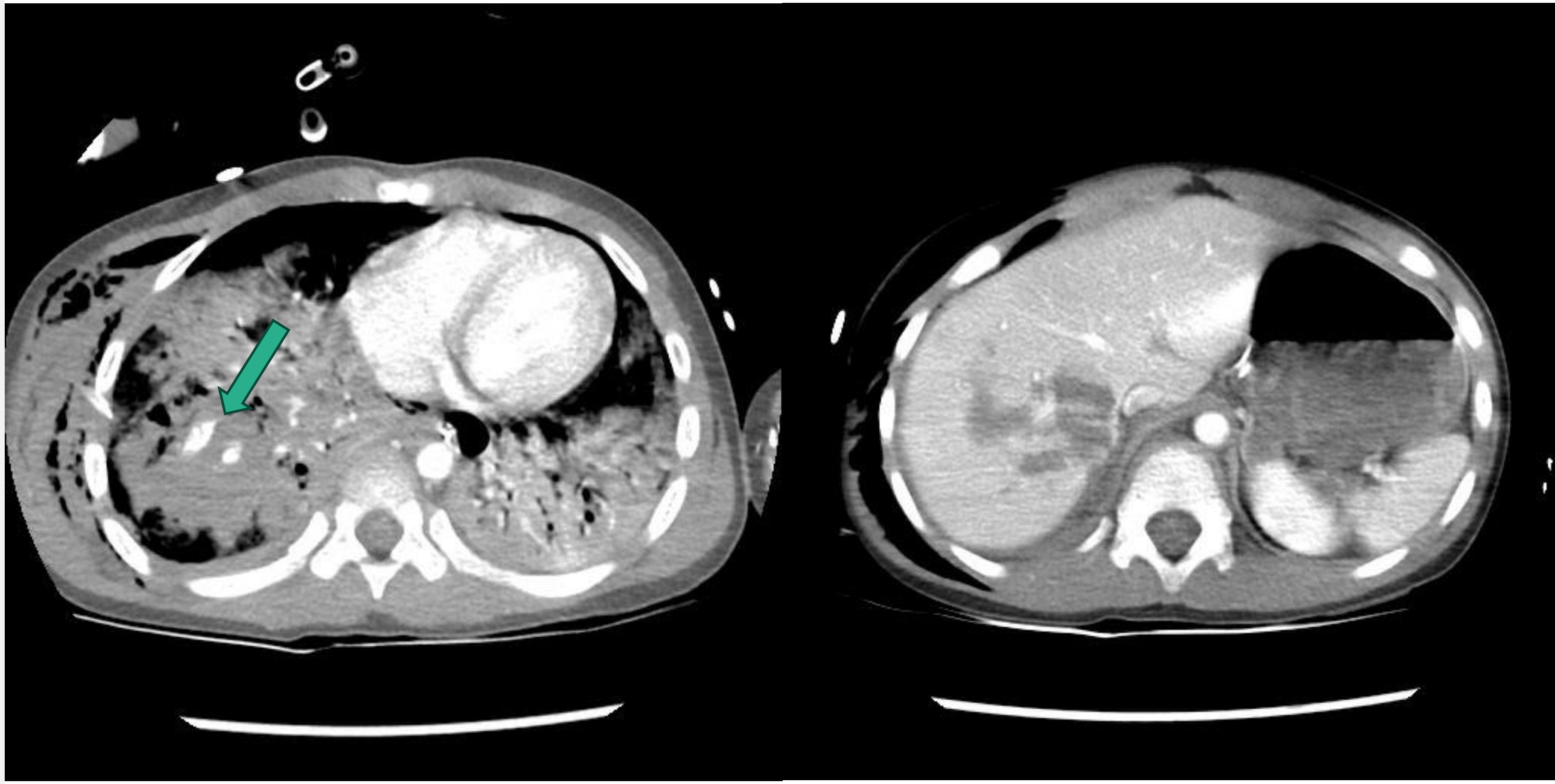
M/7

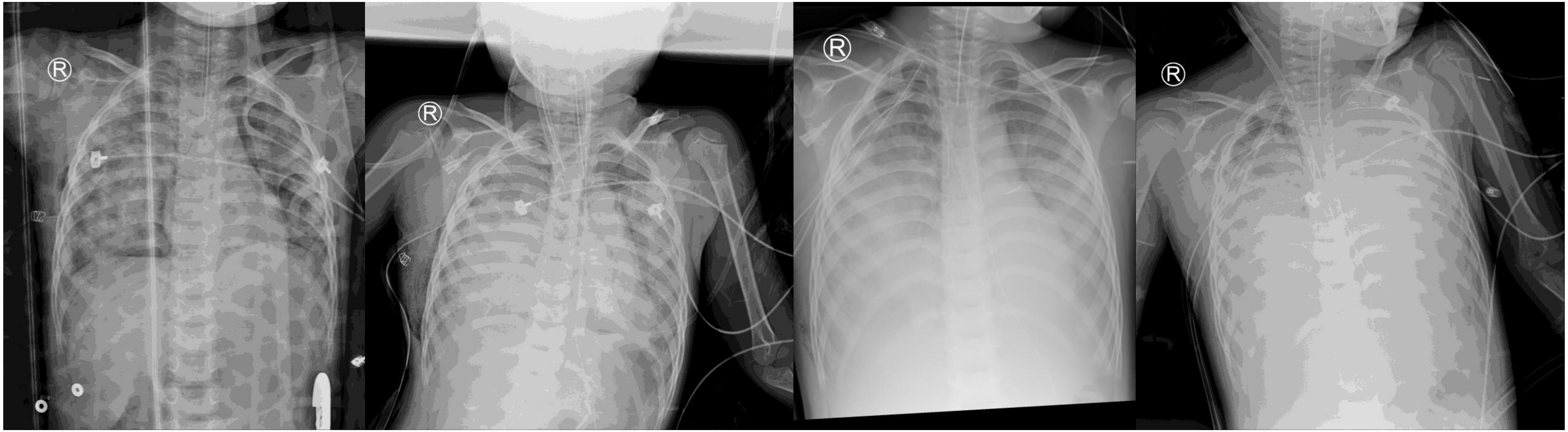
Out car TA

137/119

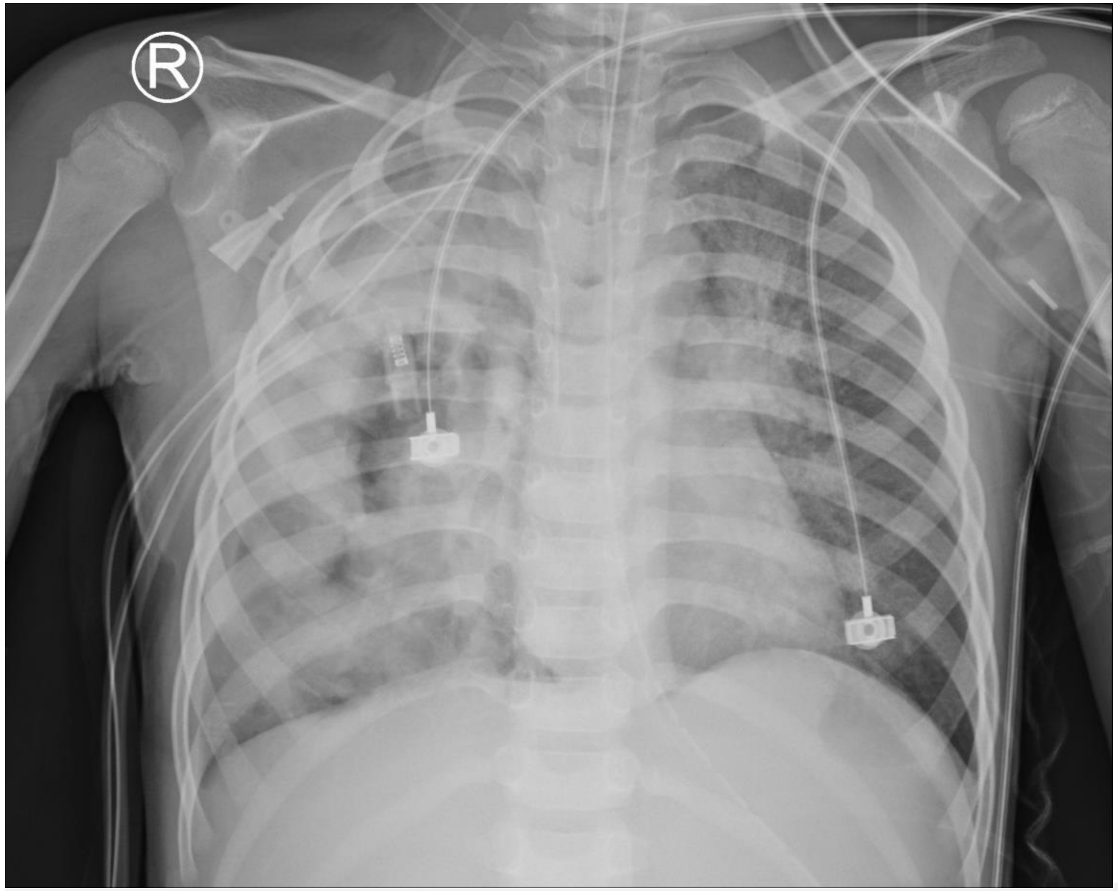
97% via 100% mask 15L

GCS 3/5/5

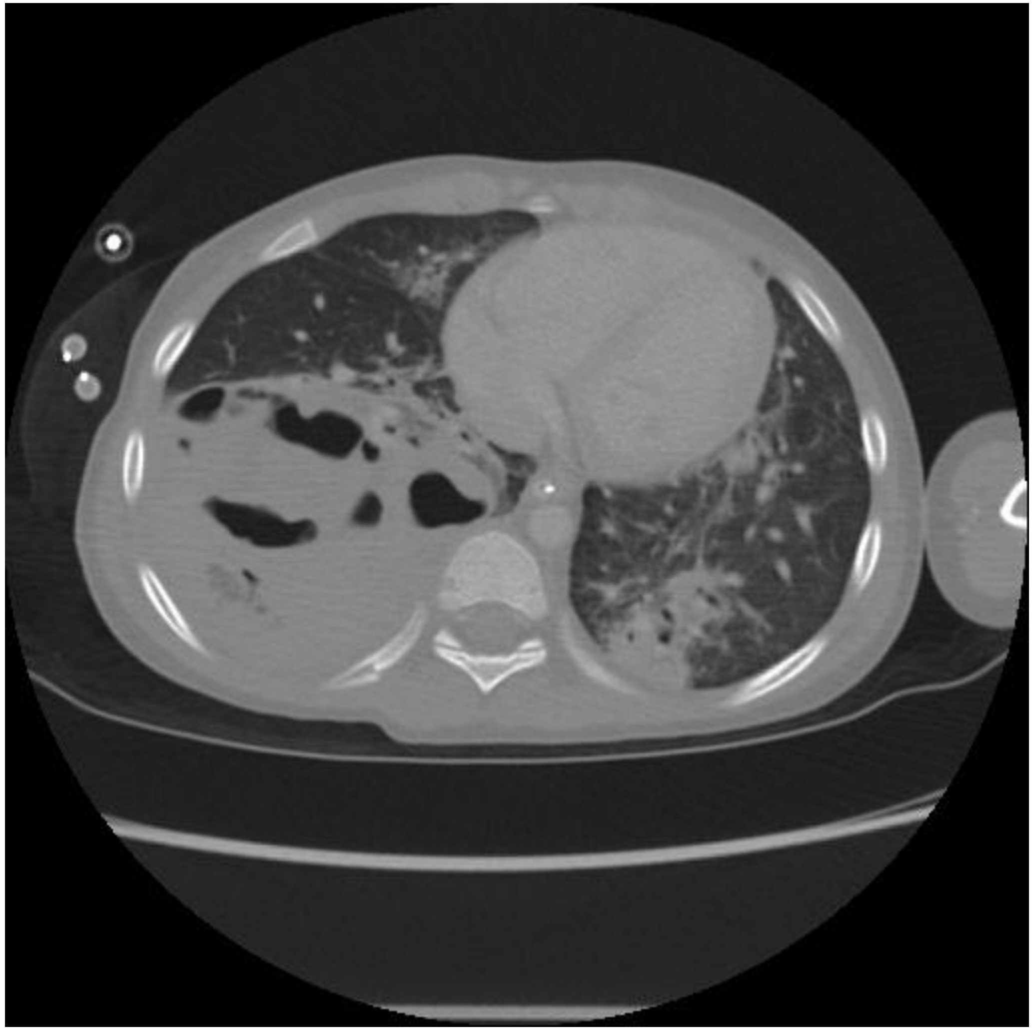


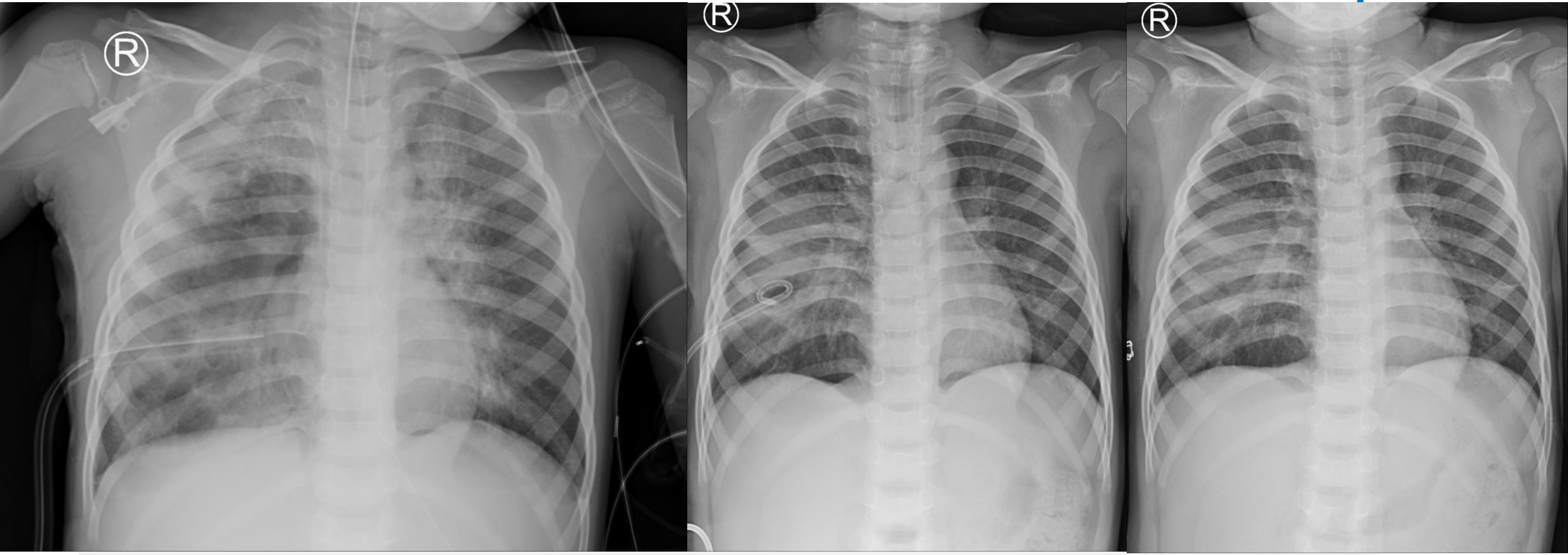


HOD 1 Chest tube drainage 600cc
HOD 2 ARDS 진행
HOD 4 ECMO support



HOD 15 ECMO weaning





Repeated abscess drainage
HOD 29 tracheostomy
HOD 32 ventilator weaning
HOD 52 tracheostomy seal off
HOD 59 discharge

CASE

F/23

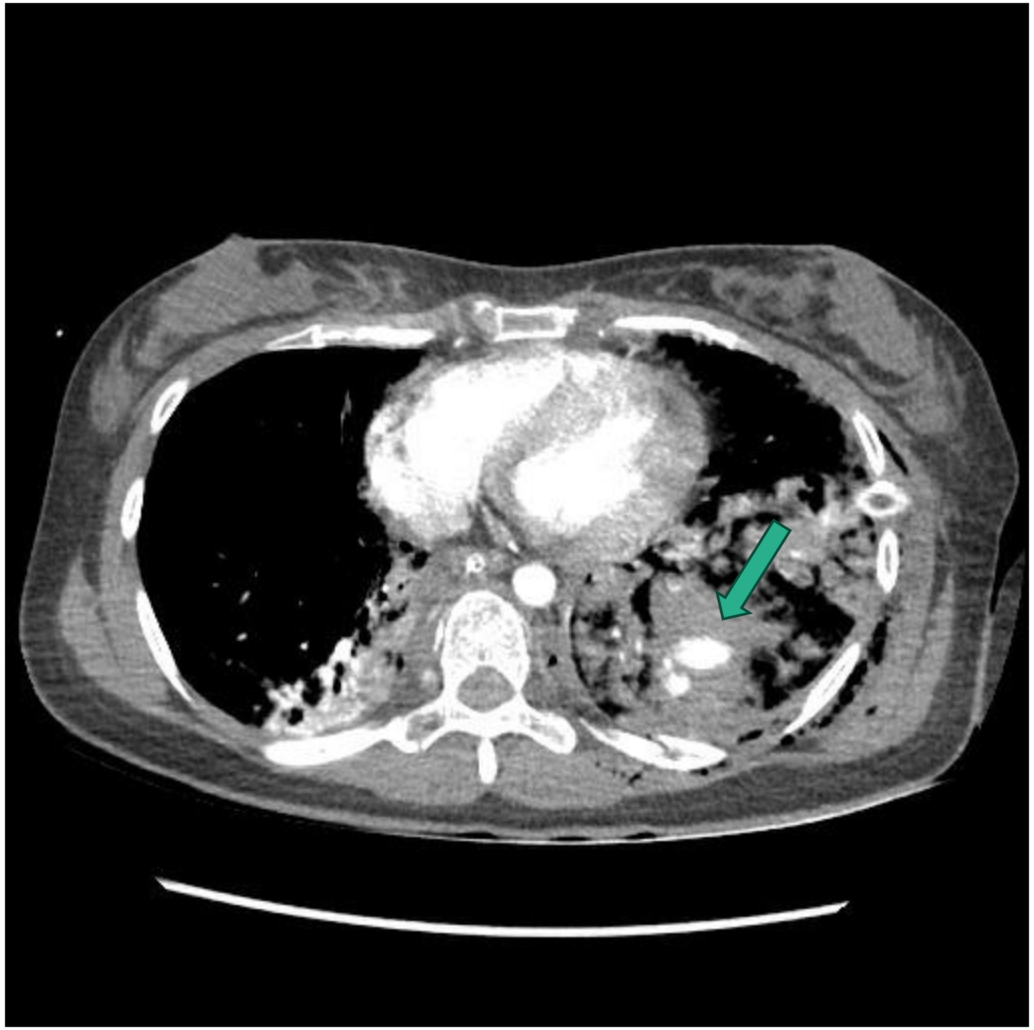
Fall from 4th floor

BP 90/20 HR 120

98% via 100% mask 15L

GCS 4/4/5

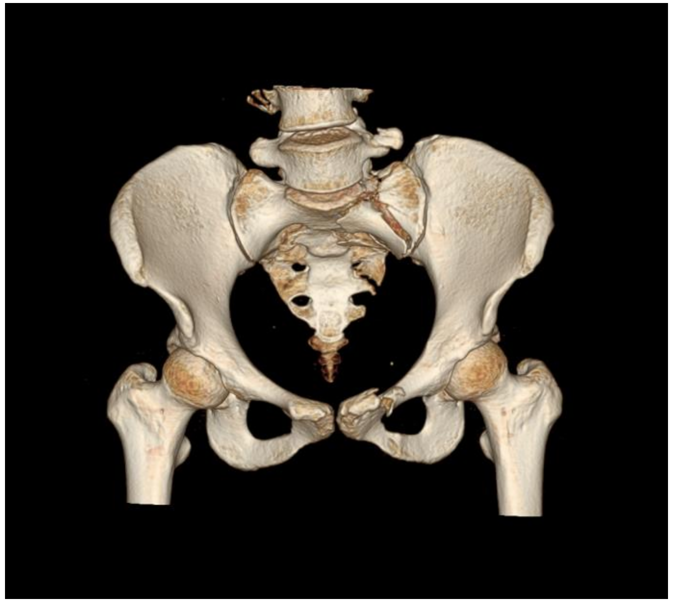
Chest tube drainage 890ml for 6 hr



CASE

1.C7 Rt. transverse process Fx.
2. Both multiple rib fx.
    Lt. hemopneumothorax (s/p chest tube insertion)
    Rt. lung contusion
5. Lt. renal injury
4. r/o Fx. unstable burst, T4
  Flexion-distraction injury, T7/8
  Flexion-distraction injury, T12/L1
  Fx. transverse process, T2-3, Lt.
  Fx. transverse process, T4, Both
  Fx. transverse process, T5-T7, Rt.
  Fx. transverse process, T8, Both.
  Fx. transverse process, T9-L3, Lt.
  Fx. transverse process, L4, Both.
  Fx. transverse process, L5, Lt.
6. Fx. sacrum (λ-type)
   Diastasis, SI joint, Rt.
   Fx. ilium, Rt.
   Fx. both rami of pubis, pelvis, Lt.
   Fx. lateral malleolus, ankle, Lt.



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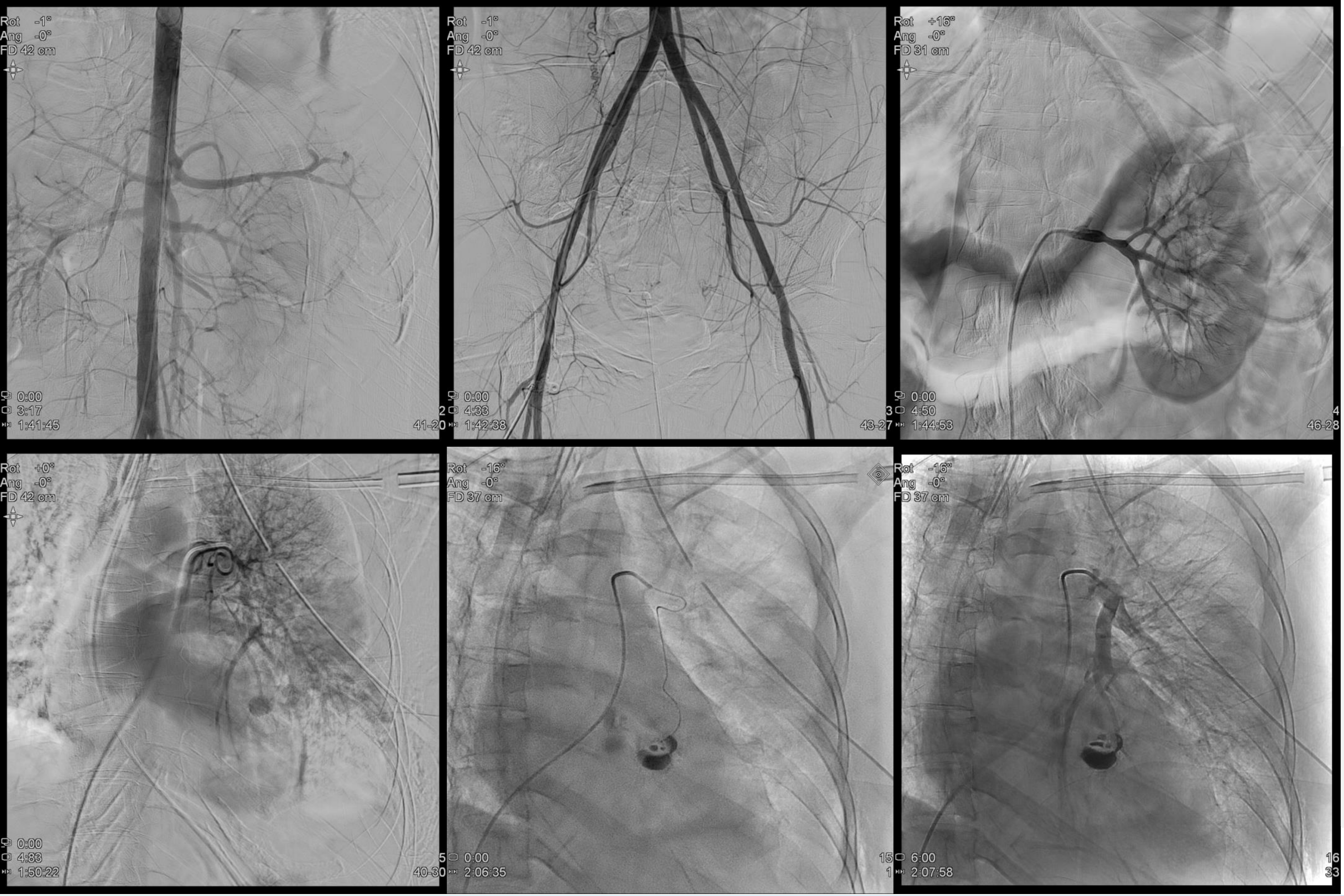
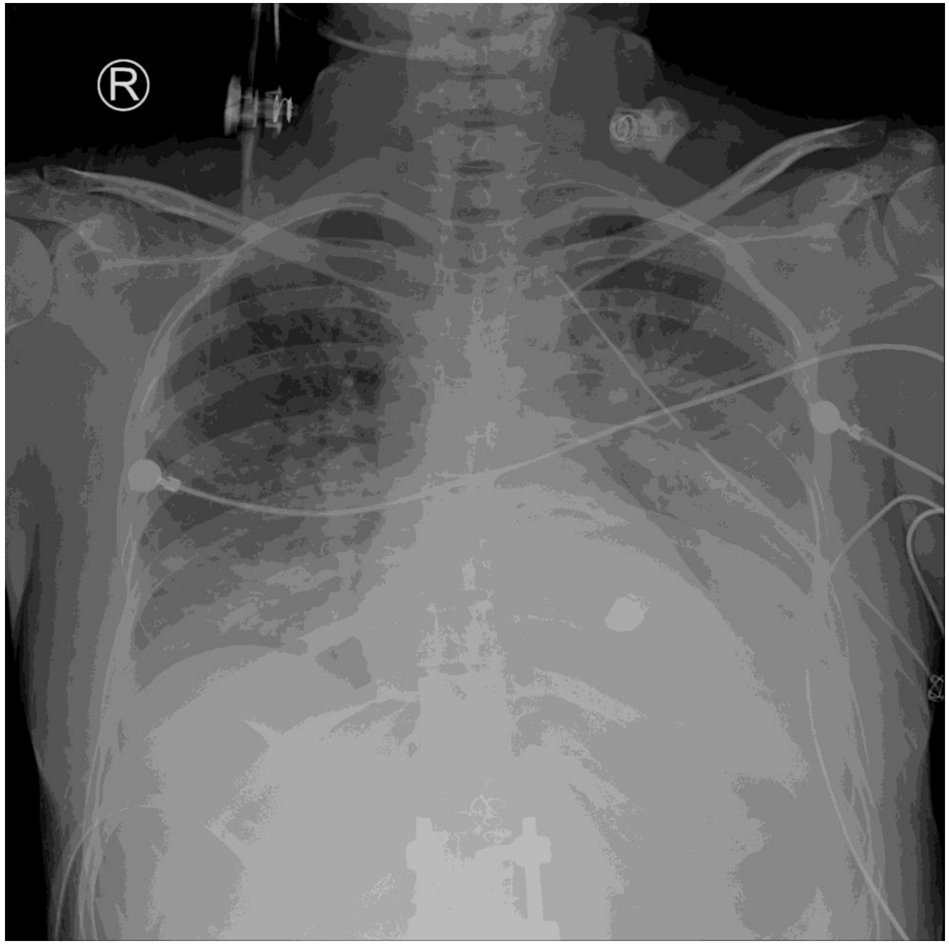


No active bleeding in the pelvis, kidney, and thoracic wall

Pseudoaneurysms in the left lower lung

Selective embolization of pseudoaneurysm and feeding branch using NBCA glue mixture



HOD 2 open reduction & posterior fusion for T-L spine
& SI screw insertion for pelvic bone fracture
HOD 6 ventilator weaning

Occult Hemothorax

SYSTEMATIC REVIEW

The management of occult hemothorax in adults with thoracic trauma: A systematic review and meta-analysis

Richard W. Gilbert, MD, MSc, Adam M. Fontebasso, MD, PhD, Lily Park, BSc, Alexandre Tran, MD, MSc, *and* **Jacinthe Lampron, MD, MPH**, *Ottawa, Canada*

- Hemothoraces seen on CT scan but not on x-ray are defined as occult hemothoraces.
- The standard trauma bay supine chest x-ray is noted to be able to detect most large volume (greater than 500 mL) hemothoraces.
- Conservative treatment of occult hemothorax fails in 23.1% of patients.
- It may be possible to safely observe patients with occult hemothoraces less than 300 mL (1.5 cm pleural stripe) secondary to blunt trauma without upfront tube thoracostomy insertion.

J Trauma Acute Care Surg. 2020 Dec;89(6):1225–1232.

Delayed Thoracotomy

In a patient with multisystem trauma, delayed repair is appropriate to allow time for **stabilization or treatment of a severe injury to the brain and intra-abdominal organs or pelvis.**

- Complications or missed injury of thoracic trauma
- Delayed repairs of diaphragmatic injury
- Retained hematoma
- Empyema

Retained Hemothorax

EAST PRACTICE MANAGEMENT GUIDELINES

Practice Management Guidelines for Management of Hemothorax and Occult Pneumothorax

Trauma. 2011 Feb;70(2):510-8.

- The presence of retained hemothorax on postplacement CXR has been shown to be an independent predictor of the development of empyema in 33% of patients
- Persistent retained hemothorax, seen on plain films, after placement of a thoracostomy tube should be treated with early VATS, not a second chest tube (Level 1).
- In a prospective randomized trial, Meyer et al. showed that patients who had retained hemothorax on plain films 72 hours after initial chest tube output benefited from early VATS instead of a second chest tube.
- Patients undergoing VATS had significantly shorter duration of chest tube drainage, fewer days in the hospital after the procedure, and lower hospital costs than putting in a second chest tube.

Management of simple and retained hemothorax: A practice management guideline from the Eastern Association for the Surgery of Trauma

Nimitt J. Patel [a,*], Linda Dultz [b], Husayn A. Ladhani [c], Daniel C. Cullinane [d], Eric Klein [e], Allison G. McNickle [f], Nikolay Bugaev [g], Douglas R. Fraser [f], Susan Kartiko [h], Chris Dodgion [i], Peter A. Pappas [j], Dennis Kim [k], Sarah Cantrell [l], John J. Como [c], George Kasotakis [m]

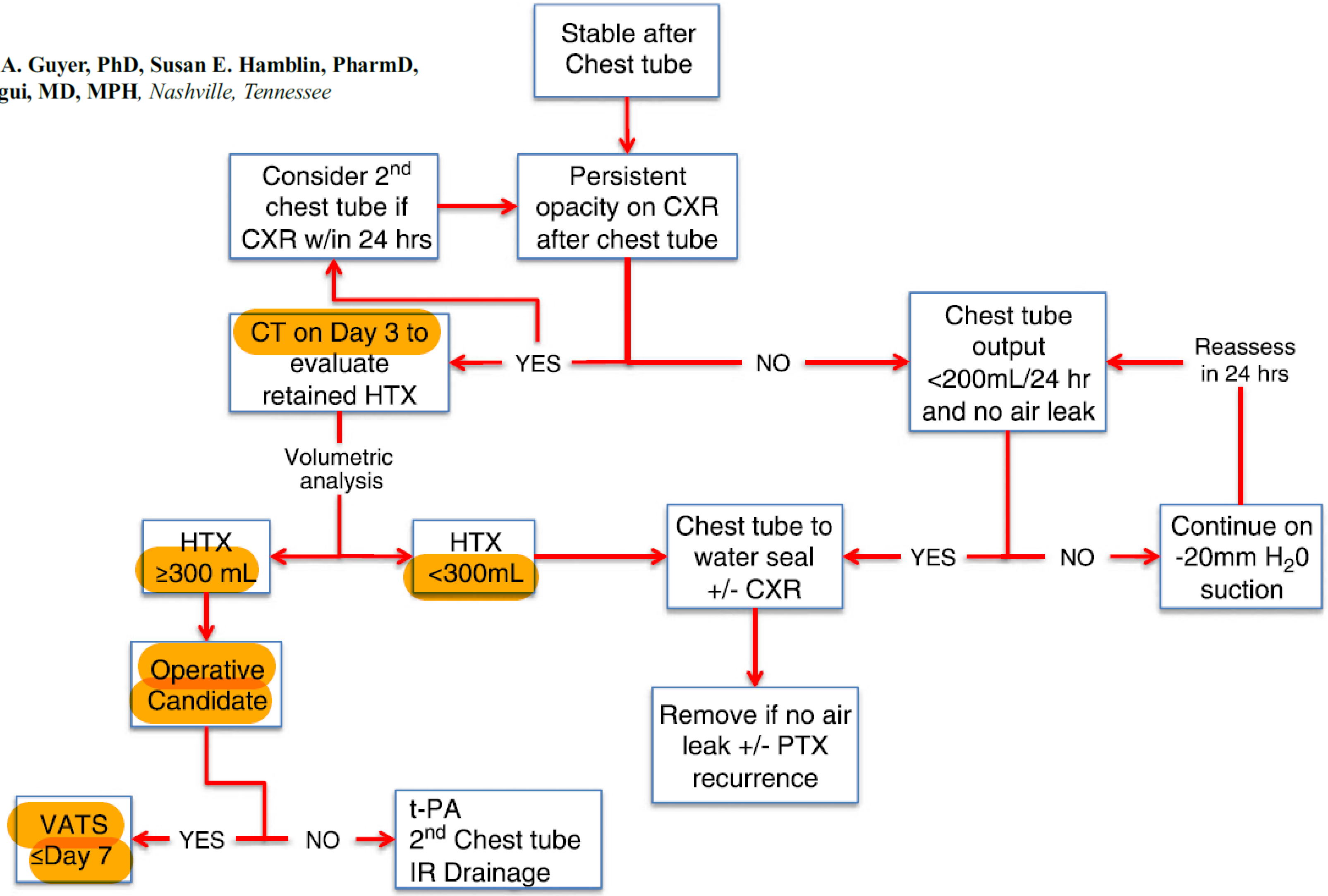
Table 2
Summary of Recommendations for PICO questions.

PICO	QUESTION	RECOMMENDATION
1	In hemodynamically stable patients with a small traumatic hemothorax (less than 500 ml) should routine tube thoracostomy vs. observation be performed to decrease need for additional procedure, rHTX and empyema?	**No Recommendation**
2	In hemodynamically stable patients with a traumatic hemothorax requiring drainage should pigtail catheter (14 Fr or smaller) vs. thoracostomy tube (20 Fr or larger) be placed to decrease need for additional procedure, rHTX and empyema?	**Conditionally Recommend pigtail catheter**
3	In hemodynamically stable patients with retained traumatic hemothorax, should intrapleural thrombolytic therapy (i.e. tPA) be attempted vs. immediate thoracoscopic assisted drainage (VATS) in order to decrease need for additional operative or non-operative procedure and empyema?	**Conditionally Recommend VATS**
4	In hemodynamically stable patients with retained traumatic hemothorax deemed to require drainage should early VATS (less than or equal to 4 days) vs. Late VATS (greater than 4 days) be performed in order to decrease need for additional procedure, conversion to open thoracotomy, empyema, and length of hospital stay?	**Recommend Early VATS**

The American Journal of Surgery 221 (2021) 873e884

Use of an evidence-based algorithm for patients with traumatic hemothorax reduces need for additional interventions

Bradley M. Dennis, MD, Stephen P. Gondek, MD, MPH, Richard A. Guyer, PhD, Susan E. Hamblin, PharmD, Oliver L. Gunter, MD, MPH, *and* **Oscar D. Guillamondegui, MD, MPH,** *Nashville, Tennessee*



Acute Care Surg. 2017;82: 728–732.

Take Home Massage

- **Thoracic trauma resulting in persistent hemodynamic instability, without another obvious source, should also prompt emergent thoracic exploration.**
- Urgent thoracotomy for blunt trauma is **rarely justified on the basis of chest tube output alone.**
- **VATS and TAE** are useful for patients with significant bleeding who are hemodynamically stable.
- Persistent retained hemothorax, seen on plain films, after placement of a thoracostomy tube should be treated with **early VATS**.

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Thank you for your attention