

Advanced Trauma Life Support

Moon Jonghwan

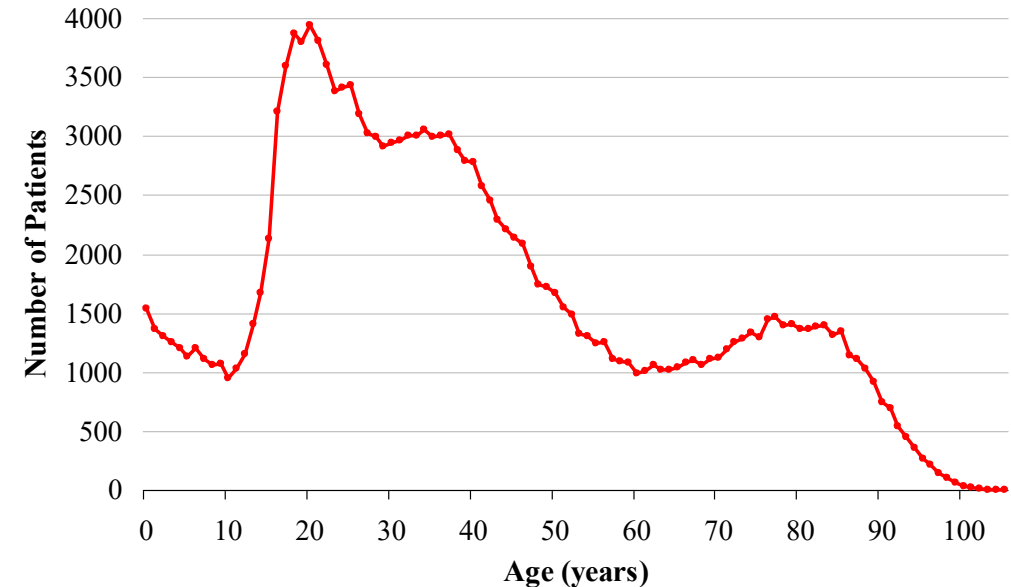
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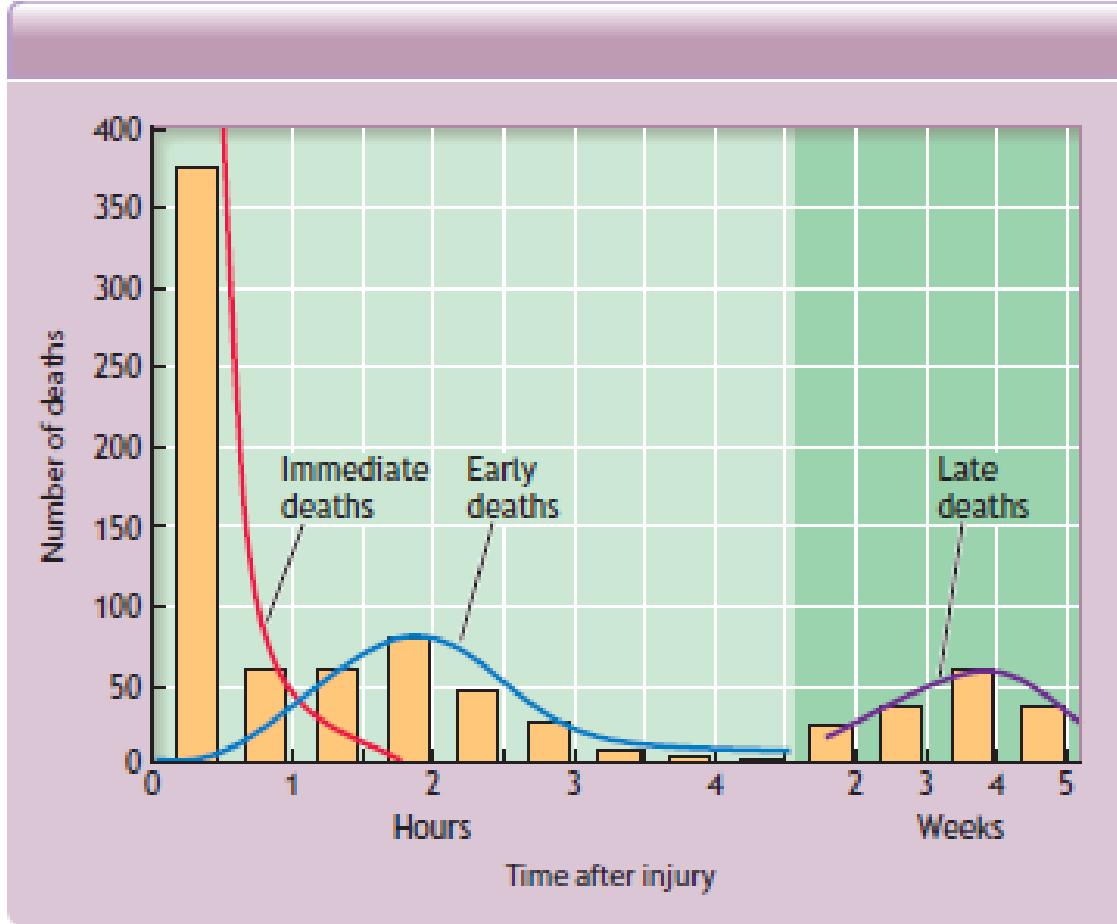
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The Burden of Injury

- The **4th leading cause of death** overall.
- **Leading cause** of death for **ages 1 – 44**
- 2020–2021: Injury deaths were 58× HIV deaths and approximately 75% of COVID-19 deaths
- More years of **productive life lost** than cardiac, cancer and stroke combined.
- Disabling conditions with long-term care and lost productivity cost.





■ **FIGURE 3** Trimodal Death Distribution.

- **Immediate deaths**

- within seconds to minutes of injury
- severe brain or high spinal cord injury or rupture of the heart, aorta, or other large blood vessels.

- **Only prevention!!**

- **Early deaths**

- within minutes to several hours following injury
- subdural and epidural hematomas, hemopneumothorax, ruptured spleen, lacerations of the liver, pelvic fractures, and/or multiple other injuries associated with significant blood loss.

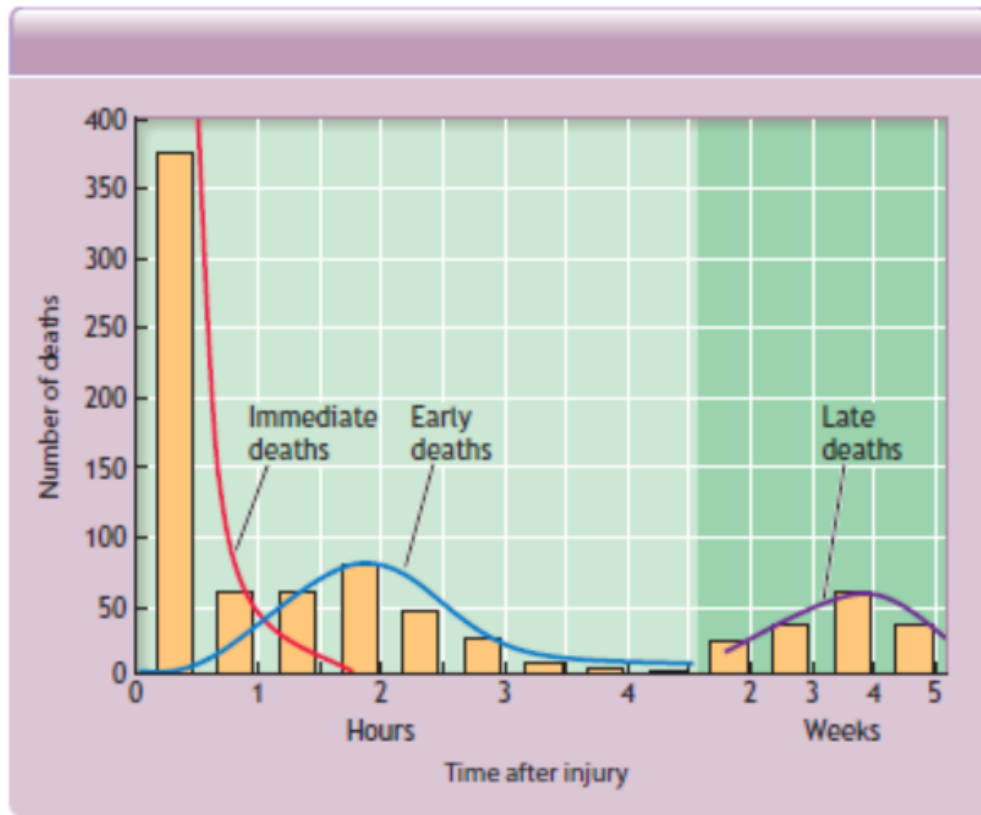
- **Rapid assessment and resuscitation(Golden hour)**

- **Late deaths**

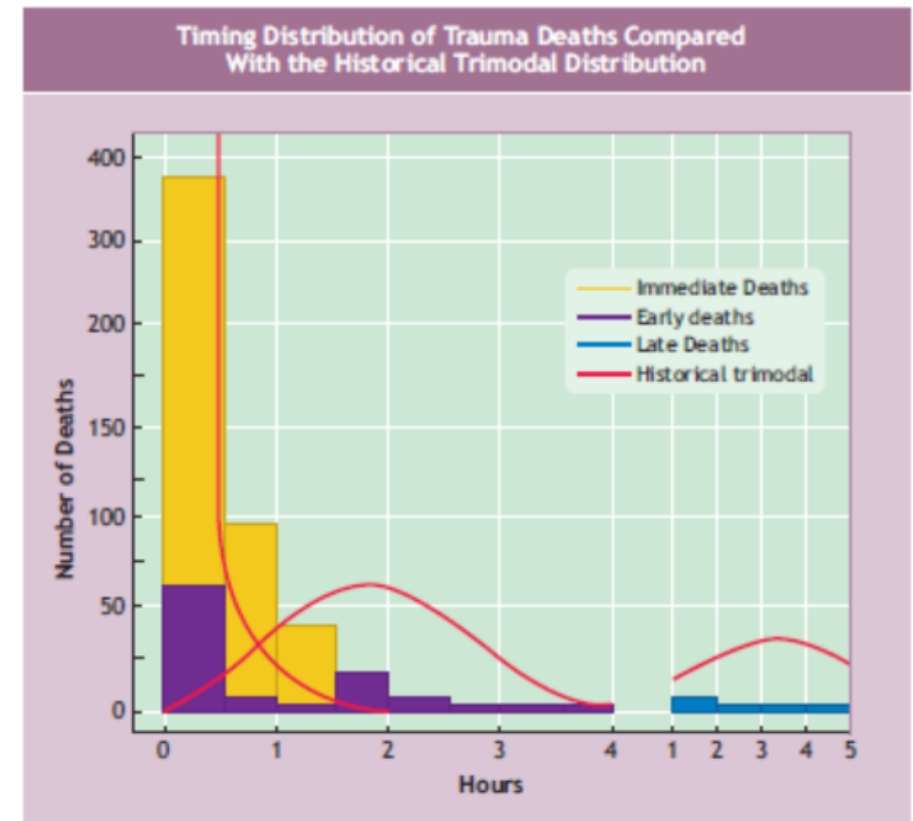
- several days to weeks after the initial injury
- sepsis and multiple organ system dysfunctions
- **Care provided during each of the preceding periods(Critical care)**

Temporal Distribution of Trauma Deaths

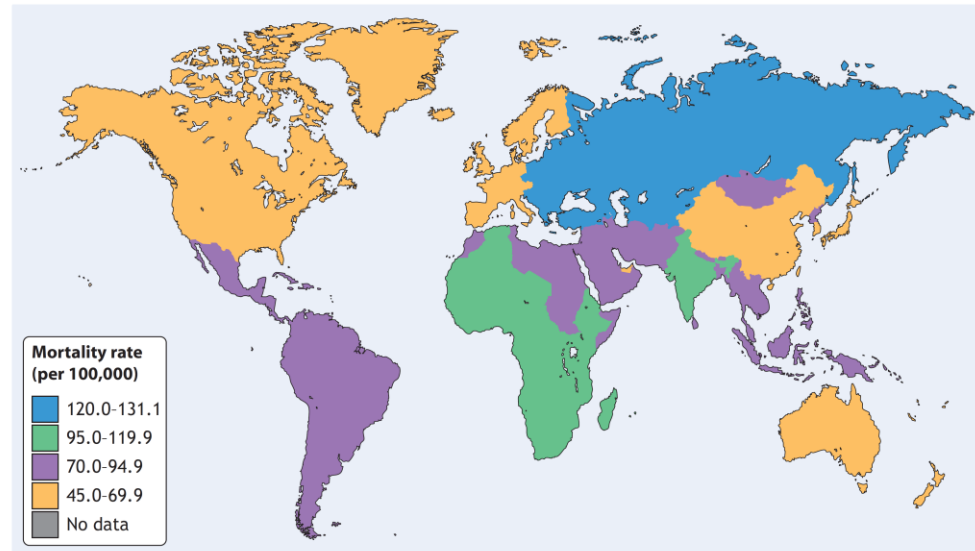
Death patterns reflect local trauma-system capabilities.



■ FIGURE 3 Trimodal Death Distribution.



Key advances: **standardized training, better prehospital care, and trauma centers with dedicated teams and established protocols.**



■ **FIGURE 1** Global Injury-Related Mortality.

Reproduced with permission from *The Injury Chart Book: a Graphical Overview of the Global Burden of Injuries*. Geneva: World Health Organization Department of Injuries and Violence Prevention. Noncommunicable Diseases and Mental Health Cluster; 2002.

Advanced Trauma Life Support



At the time of publication,
the **78 countries** were actively providing the ATLS course to their trauma providers

- M/25
- 10층 추락
- Painful response
- BP 80/50 HR 140 SPO2 60%
- 안면부 출혈, 우측 가슴 함몰, 복부 팽만, 양측 하지 다발성 개방성 골절

어디서부터 어떻게 처치해야?

Why Learn ATLS?

1 The burden of injury

A major cause of death in the young, with a rising burden in older adults

2 Urgency of initial trauma care

Recognize life threats rapidly while assessing and treating the patient

3 A systematic approach to prioritization

xABCDE guides overall patient assessment and resuscitation priorities

4 A common language for the trauma team

Teamwork and handover from initial care to definitive treatment

COMMITTEE ON TRAUMA

COURSE MANUAL | 11th Edition

**Advanced Trauma
Life Support®
(ATLS®)**

Standardized Trauma Care
When Seconds Count



History

1976 A plane crash exposed gaps in care

Orthopedic surgeon James K. Styner and his family crashed in rural Nebraska. Inadequate early care prompted him to seek change.



1978 The first ATLS course

Styner and colleagues launched the first course, combining teaching, skills practice, and simulation.

1980 Adoption by the ACS

The American College of Surgeons adopted ATLS and expanded training across the United States.



ATLS began with the need for systematic initial trauma care

“You have to train them before you blame them.”

Ronald Craig, MD

Three Core Principles of ATLS

1. **Treat the greatest threat to life first.**
2. **The lack of a definitive diagnosis should not delay the application of urgent treatment.**
3. **An initial, detailed history is not essential to begin the evaluation and treatment of a patient with acute injuries.**

- ATLS provides a defined evaluation order to support global applicability and **guide inexperienced clinicians.**
- **Experienced trauma clinicians** often use steps **as a mnemonic, not a strict sequence.**
- ✓ In trauma care, clinicians must rapidly assess injuries and start life-saving therapy.
- ✓ **Timing is critical → requires a systematic, rapid, and accurate approach.**
- ✓ Life threats should be managed immediately when identified.

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Primary survey (xABCDE) with immediate resuscitation of patients with life-threatening injuries

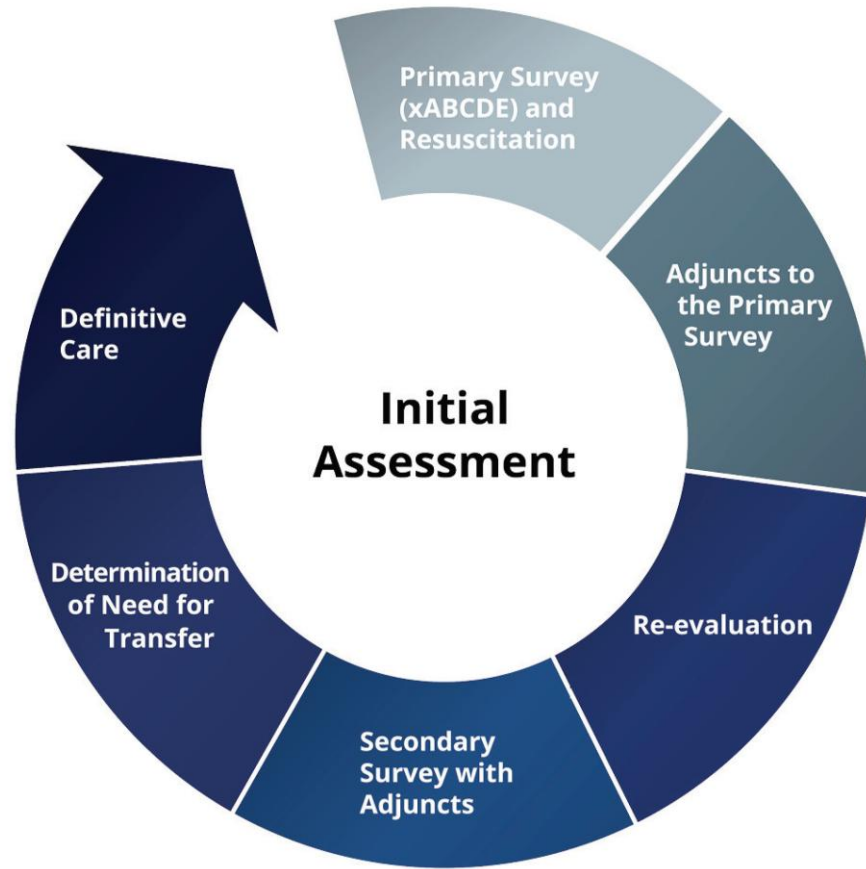
Secondary survey (head-to-toe evaluation and patient history) and adjuncts

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Preparation: In the Field

- **Standard precautions** (e.g., face mask, eye protection, water-impervious gown, and gloves)
- **Pre-arrival huddle**
- appropriate equipment.
- A protocol to summon additional medical assistance is in place, as well as a means to ensure prompt responses by laboratory and radiology personnel.





- **Primary survey (xABCDE)** with immediate resuscitation of patients with life-threatening injuries
- **Secondary survey** (head-to-toe evaluation and patient history)

The Primary Survey

& SIMULTANEOUS RESUSCITATION

		Key Causes and Issues
X	eXsanguinating eXternal hemorrhage	Massive bleeding from open extremity and other wounds
A	Airway	Inability to maintain the airway patency due to direct injury, altered mental status, shock
B	Breathing	Compromise of oxygenation and/or ventilation due to direct injury, shock
C	Circulation	1. Presence of shock from hemorrhagic, neurogenic, cardiogenic, or other sources 2. Hemorrhage control 3. Restoration and maintenance of end-organ perfusion
D	Disability	Injury to the central nervous system • Traumatic brain injury • Spinal cord injury
E	Exposure/ Environment	1. Exposure to prevent missed injuries while maintaining patient dignity 2. Maneuvers to prevent hypothermia

x: Control of eXsanguinating Hemorrhage

- Massive external hemorrhage represents an immediate threat to life.
- Stopping exsanguinating external bleeding through
 - ✓ **direct pressure,**
 - ✓ **wound packing,**
 - ✓ and/or **tourniquet application**



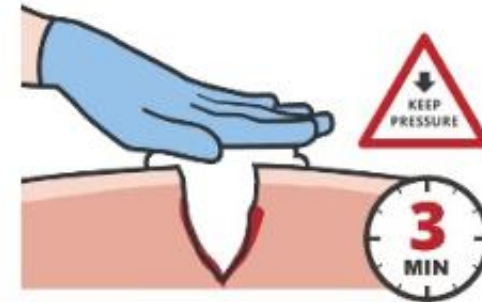
WOUND PACKING PRINCIPLES



Identify **exact source** of bleeding and **APPLY direct pressure UNTIL** dressing or gauze is placed

Pack the wound **maintaining CONSTANT** direct pressure within **90 SECONDS** to be effective

Fill and pack the wound tightly, ensuring dressing or gauze extends 1-2 inches above the skin



HOLD direct pressure for at least **3 MINS** (*this is necessary, even with the active ingredient in hemostatic dressing*)

When packing a large wound, more than one hemostatic gauze and/or **additional** gauze may be **needed**



Carefully **observe** to determine if bleeding has been **controlled**

Once you are sure the bleeding has **stopped**, apply a pressure bandage

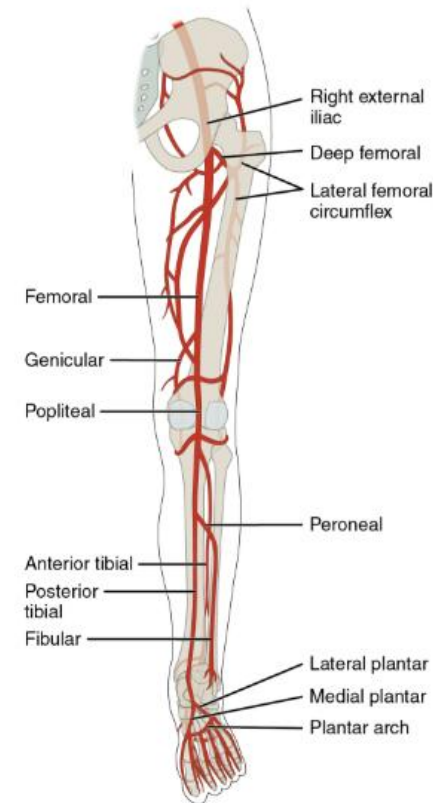
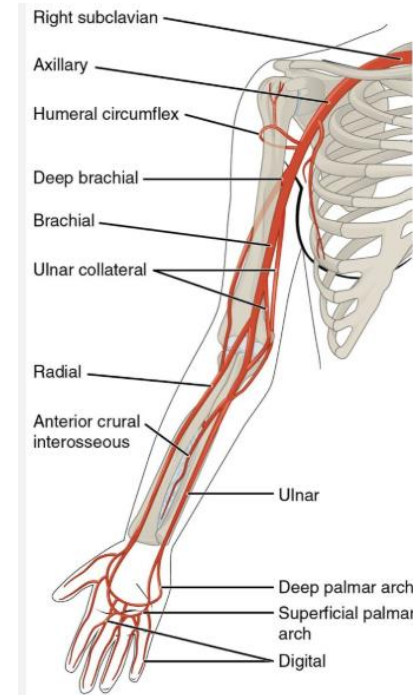
Tourniquet

- Mortality ↓
 - blood transfusion ↓
 - Tourniquet application **< 2 hours**
- Low risk of complications



Tourniquet Application – Key Steps

- Apply **2–3 in (5–8 cm) proximal** to bleeding site, **not over a joint**
- Place **directly on skin**, not over clothing
- Ensure **no distal pulse** and bleeding has stopped
- If bleeding persists → apply a **second tourniquet proximal** to the first(2-3 inches)
- If possible, apply the tourniquet proximally
→ For forearm or lower-leg wounds, place the tourniquet **on the upper arm (humerus) or thigh (femur)** — regions with a single large bone — to maximize effectiveness.



Airway maintenance with restriction of Cervical Spine motion

- Airway management is a fundamental aspect of trauma care.
- Meticulous planning and flawless execution are important to ensure **patient safety**.
- Ensuring **adequate oxygenation is a primary goal**, understanding that **not all patients benefit from immediate intubation**.

The primary physiological functions of the airway are, in order of importance in trauma management:

- ✓ To provide oxygenated air to the lungs (oxygenation)
- ✓ To remove carbon dioxide (CO₂) from the lungs (ventilation)
- ✓ To protect the lungs from foreign material, including food, fluids, secretions, and regurgitated gastric contents (protection against pulmonary aspiration)

Airway Priorities

Maintain airway patency and control bleeding.

- Facial/mandibular fractures may cause **soft-tissue collapse**.
- Obstruction may worsen when supine.
- **Allow the self-selected position** that best maintains the airway.
- Adjust the collar as needed while protecting the cervical spine.
- Monitor continuously for **bleeding and progressive edema**.

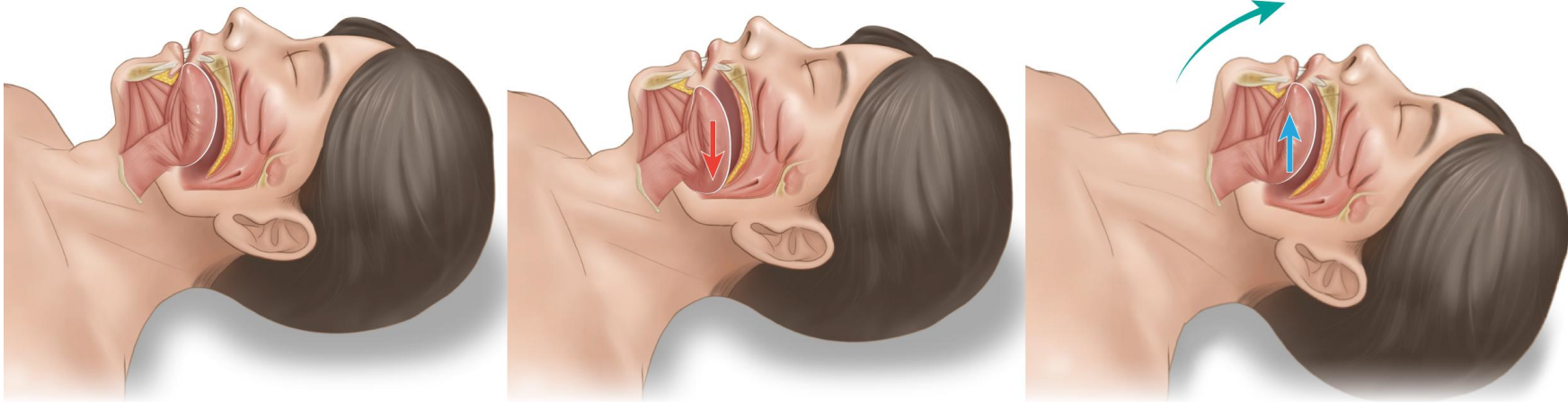
■ Table 4-1: Indications for Airway Management During the Primary Survey.

Airway	Partial or complete airway obstruction Anticipated or impending airway obstruction (e.g., direct trauma, hemorrhage, or burns)
Breathing	Severe chest injury with respiratory failure Significant hypoxia ($\text{SpO}_2 < 90\%$) despite high-flow oxygen, after exclusion of pneumothorax Hypercapnia from hypoventilation, without an immediately reversible cause (e.g. due to neurological or respiratory failure)
Circulation	Altered mental status due to shock
Disability	Severe TBI with GCS score 8 or lower
Exposure	High percentage body surface area burns

SpO_2 : Pulse oximetry. TBI: Traumatic brain injury. GCS: Glasgow coma scale



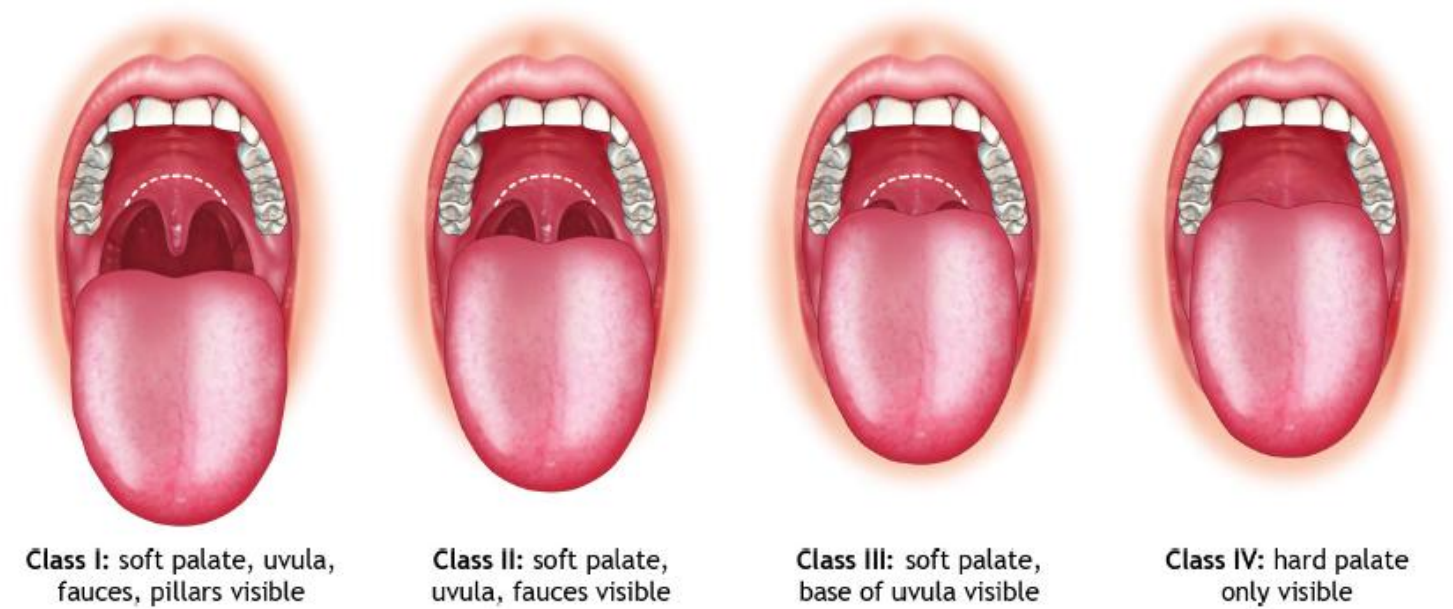
Altered level of consciousness or a GCS <9 The Reason of Airway Maintenance ?



■ **Figure 4-1: Factors Contributing to Airway Management in Trauma.** The confluence of these factors illustrates that the potential for difficulty with emergency airway management is always present.

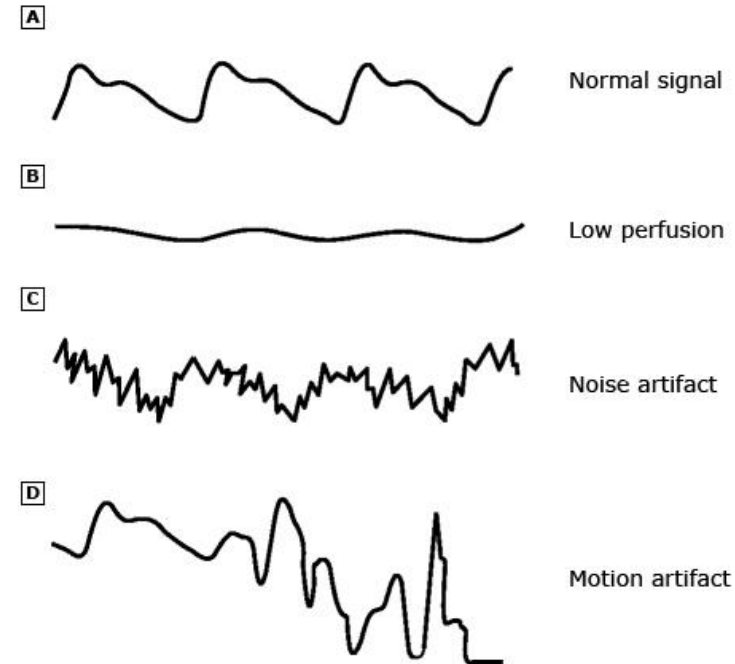
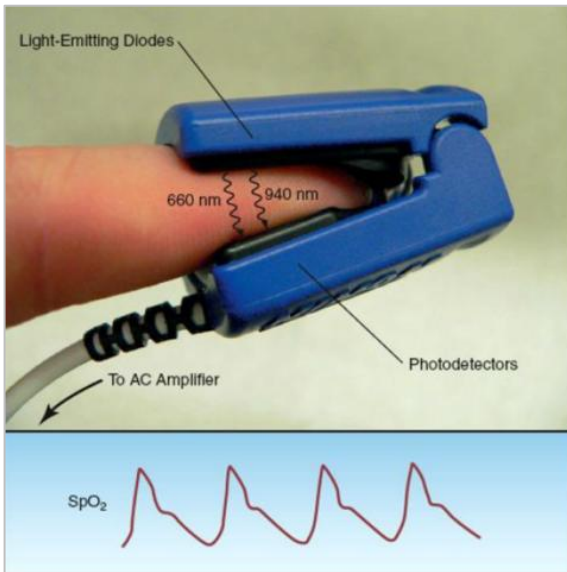


■ **Figure 4-2: The Mallampati score.** Employed in less emergent situations, this scoring system predicts airway management difficulty based on the structures visible. The patient is asked to open the mouth and protrude the tongue without phonating. **Class I:** soft palate, uvula, fauces, pillars entirely visible; **Class II:** soft palate, uvula, fauces partially visible; **Class III:** soft palate, base of uvula visible; **Class IV:** hard palate only visible.



ADJUNCTS TO ASSESSMENT

Pulse oximetry



peripheral arterial oxygen saturation (SpO₂)

Deoxyhemoglobin - 600 to 750 nm

Oxyhemoglobin - 850 to 1000 nm

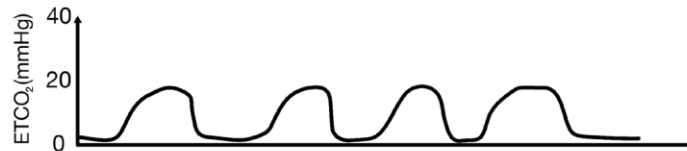


Capnography

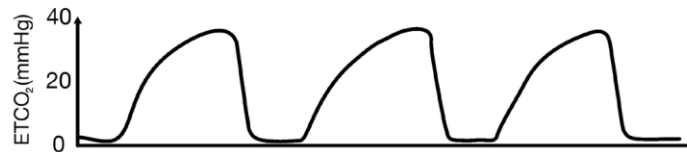
(a) Normal



(b) Partial upper airway obstruction/hypoventilation



(c) Bronchospasm



(d) Esophageal intubation



- Detects **exhaled CO₂**
- Assesses **airway patency** and ventilation
- No exhaled CO₂ → suspect airway obstruction / no ventilation
- **Sustained CO₂ for ≥7 breaths confirms successful intubation**
- ETCO₂ helps assess ventilation
- **Low ETCO₂ may suggest low cardiac output**

Factors toward *immediate* RSI

Inability to oxygenate via mask or supraglottic airway (absolute indication), or difficulty maintaining ventilation with these methods

Appropriate resuscitation and adequate hemodynamic status

Inability to maintain airway patency due to airway bleeding, regurgitation, or emesis

Lack of or prolonged delay until availability of airway specialist

Definitive airway indicated for safe transfer

Factors toward *delaying or deferring* RSI

Well-functioning upper airway device or patient maintaining airway spontaneously

Hypotension or hemodynamic abnormality

Inadequate intubation experience

Potential or suspected difficult airway and anticipated rapid arrival of expert assistance

More urgent clinical priorities

Inadequate staff available to assist

Rapid availability of airway specialist

Multi-casualty scenario

Cervical Spine Motion Restriction

Uncommon injury, potentially catastrophic consequences

Why it matters

Missed unstable injuries can cause catastrophic neurologic damage.

During initial care

Minimize neck movement during airway management, handling, and transfers.



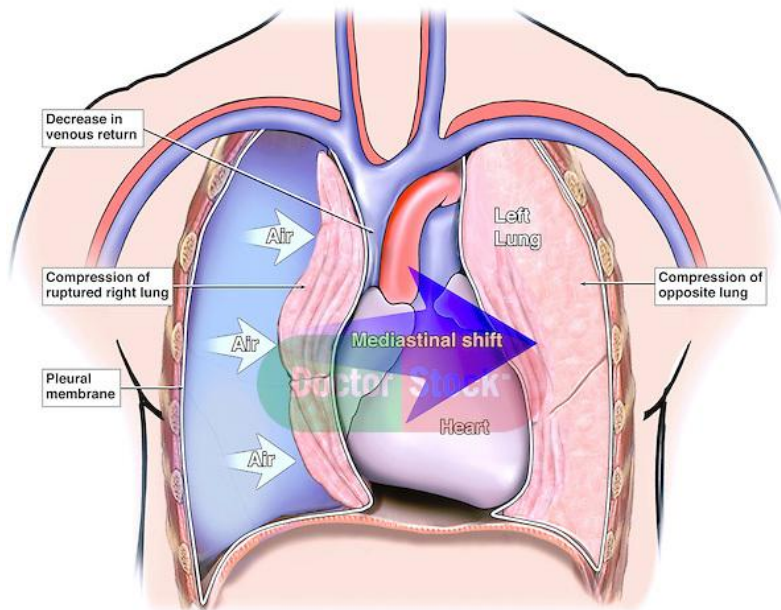
Motion restriction is essential in at-risk patients until the cervical spine is appropriately cleared.

Breathing and Ventilation Assessment and Management

➤ **Injuries that can impair ventilation in short term**

- Tension pneumothorax
- Flail chest with pulmonary contusion
- Massive hemothorax
- Open pneumothorax

Tension Pneumothorax



In a tension pneumothorax, air from a ruptured lung enters the pleural cavity without a means of escape. As air pressure builds up, the affected lung is compressed and all of the mediastinal tissues are displaced to the opposite side of the chest.



Needle Decompression



■ **FIGURE 4-2 Needle Decompression.** Tension pneumothorax may be managed initially by rapidly inserting a large-caliber needle into the second intercostal space in the midclavicular line of the affected hemithorax.

chest wall thickness

needle kinking

Due to the **variable thickness of the chest wall, kinking of the catheter, and other technical or anatomic complications,** needle decompression may not be successful.

In this case, **finger thoracostomy** is an alternative approach

Chest wall thickness and decompression failure: A systematic review and meta-analysis comparing anatomic locations in needle thoracostomy[☆]

Daniel V. Laan^a, Trang Diem N. Vu^c, Cornelius A. Thiels^a, T.K. Pandian^a, Henry J. Schiller^b, M. Hassan Murad^{c,1}, Johnathon M. Aho^{a,d,*}

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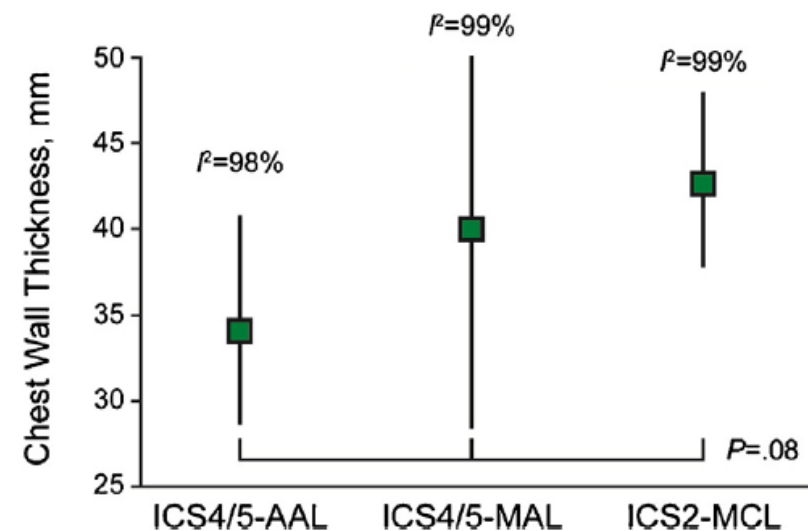
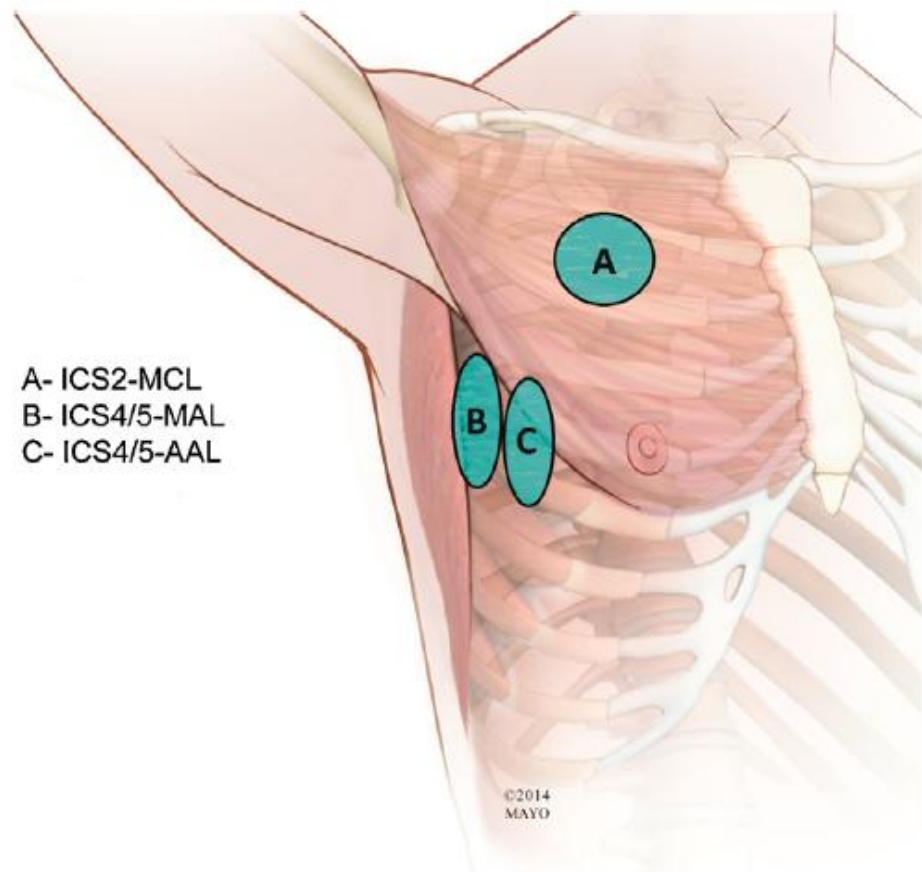


Fig. 3. Chest wall thickness by recommended anatomic location and alternative anatomic locations. Shown are the fourth and fifth intercostal spaces-anterior axillary line (ICS4/5-AAL), the fourth and fifth intercostal spaces-midaxillary line (ICS4/5-MAL), and the second intercostal space-midclavicular line (ICS2-MCL).

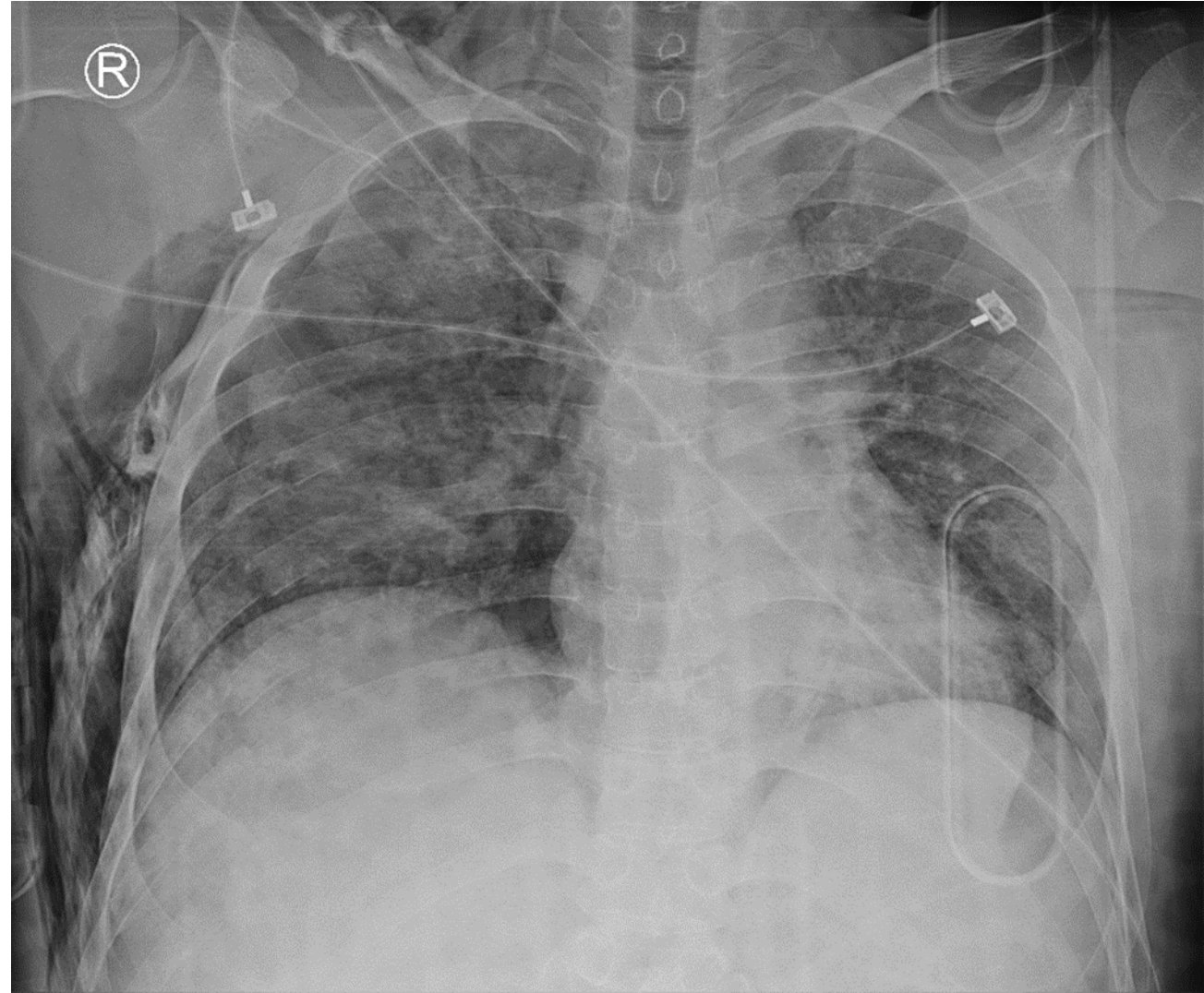
NT failure rate with 5-cm angiocatheter

Mean (95% CI) NT failure rate was 38% (24–54%) at ICS2-MCL, 31% (10–64%) at ICS4/5-MAL, and 13% (8–22%) at ICS4/5-AAL ($P = .01$). The I^2 values, representing heterogeneity of the included studies, were high (Fig. 4).

Not tension, but simple pneumothorax?

- Vital sign stable
- Risk/benefit
- Radiologic evaluation
- Pneumothorax!!

=> **Chest tube insertion ~**

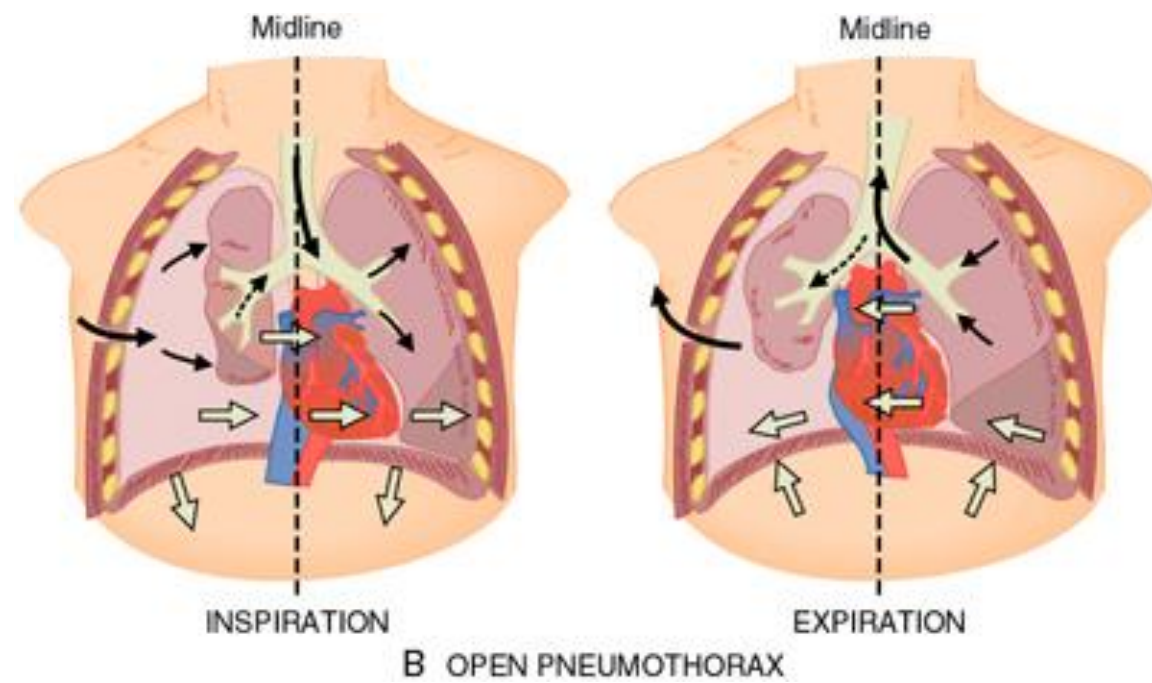


Tension pneumothorax

- Shock
- Tension pneumothorax 의심
- Arrest risk > 영상 검사 시간
- 즉각적인 decompression
- Needle decompression 시에 air가 나온다면 tension pneumothorax로 진단
=> clinical diagnosis

OPEN PNEUMOTHORAX







■ **Figure 4-4 Dressing for Treatment of Open Pneumothorax.** Promptly close the defect with a sterile occlusive dressing that is large enough to overlap the wound's edges. Tape it securely on three sides to provide a flutter-type valve effect.

- **Chest tube insertion**

- **Surgical treatment**

FLAIL CHEST

Flail Chest

- Original Definition: Paradoxical motion of the chest wall due to multiple consecutive ribs fractured in ≥ 2 places.
→ Associated with high mortality when clinically diagnosed.

- Modern Use:

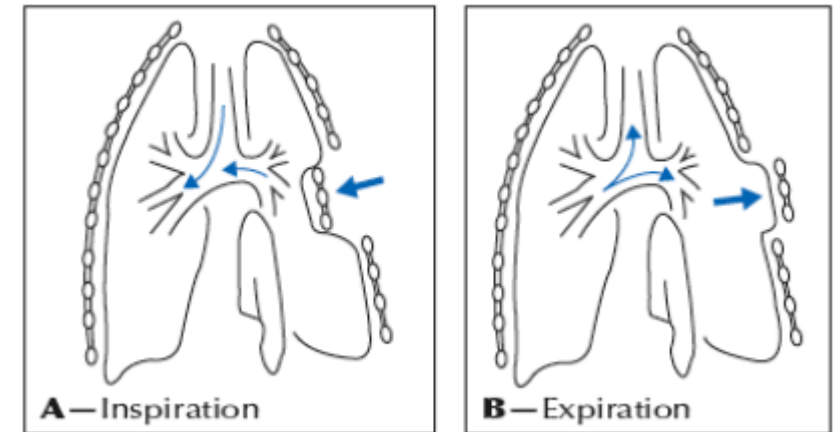
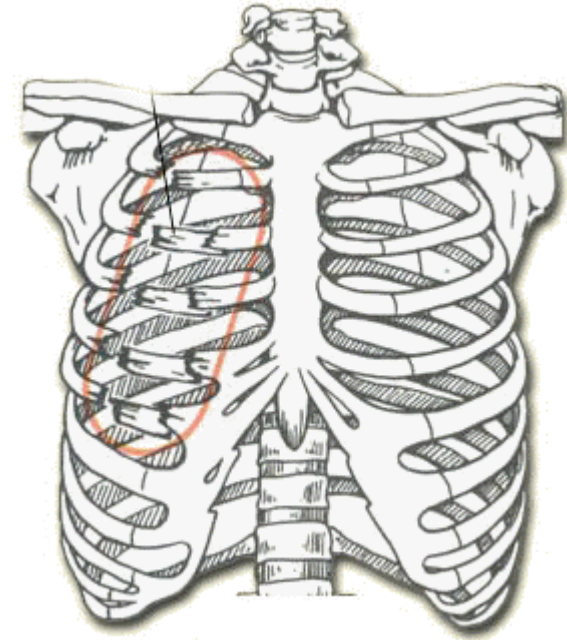
Often diagnosed radiologically on CT: ≥ 3 consecutive ribs fractured in ≥ 2 places.

→ Definition ambiguity leads to mixed patient populations and confounds research.

- Proposed Terminology (Edwards et al.):

Flail Segment: Radiologic finding of ≥ 3 ribs fractured in ≥ 2 locations.

Flail Chest: Clinical diagnosis based on visible paradoxical motion.



Treatment

- **Pain control, humidified oxygen 공급, 적절한 fluid resuscitation**
- **Pulmonary volume expansion**(incentive spirometry, cough, deep breathing)
- **Continous positive airway pressure**
 - Non-invasive ventilation(NIV)
 - intubation & mechanical ventilation support(Internal Stabilization)
- **Surgery(rib fixation)**

Hemothorax

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

✓Physiology

✓Refractory shock

✓Clearly identified injuries

May 2001

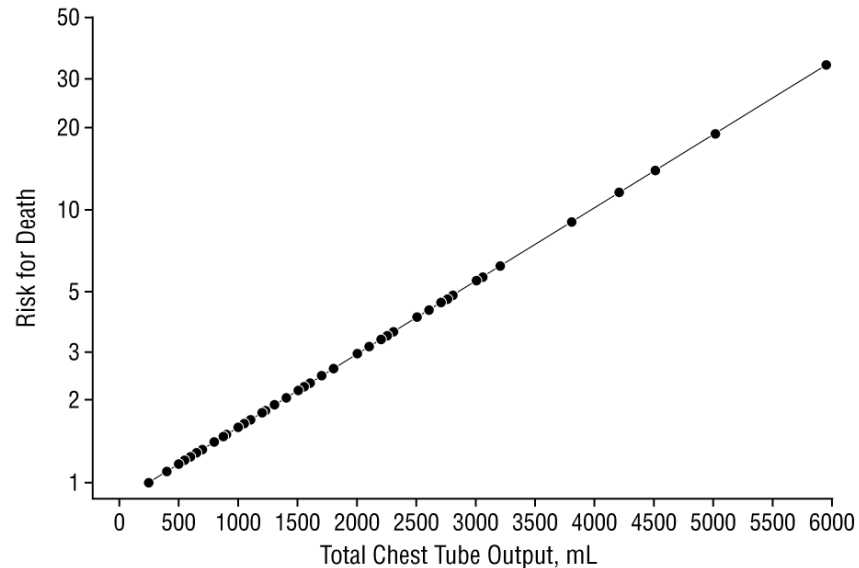
Timing of Urgent Thoracotomy for Hemorrhage After Trauma

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



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.

Traditional Criteria

- More than 1,500 mL of blood immediately evacuated by tube thoracostomy.
- Persistent bleeding from the chest, defined as 150 mL/h to 200 mL/h for 2 hours to 4 hours.
- Persistent blood transfusion is required to maintain hemodynamic stability.

CIRCULATION WITH HOMORRHAGE CONTROL

- **Hemorrhage** is the predominant cause of preventable deaths after injury.
- Once tension pneumothorax has been excluded as a cause of shock, consider that hypotension following injury is due to **blood loss until proven otherwise.**

Classification of Nonhemorrhagic Shock in Trauma Patients	
Type of Shock	Trauma Etiologies
Obstructive	Tension pneumothorax Cardiac tamponade
Cardiac	Blunt cardiac injury Myocardial infarction
Distributive	Neurogenic Septic Anaphylactic

Hemorrhagic Shock in Injured Patients

Definition of Hemorrhage

- **Hemorrhage ?**
 - Acute loss of circulating **blood volume**
- **The normal adult blood volume**
 - **7%** of body weight
 - **70-kg male** ⇒ **approximately 5 L**
 - **Obese** adults: based on their **IBW**
 - **Child:** **8-9%** of body weight (**80-90mL/kg**)

Hemorrhage is the most common cause of shock in trauma patients.

■ **Table 6-2. Changes in Clinical Parameters as Related to Hemorrhage Severity.** Response to blood loss varies based on patient factors and source control. Response to resuscitation is dependent on the presence of continued bleeding, not on a specific volume of blood loss.

	HEMORRHAGE SEVERITY 			
PARAMETER	MINOR		MODERATE	MAJOR
Heart Rate (beats/min)	Unchanged	Unchanged to Increased	Increased (>100)	Markedly Increased (>120)
Systolic Pressure (mm Hg)	Unchanged	Unchanged	Unchanged to Decreased	Markedly Decreased (<90)
Pulse Pressure	Unchanged	Decreased	Decreased	Decreased
Respiratory Rate	Unchanged	Unchanged to Increased	Increased	Increased
Level of Consciousness	Unchanged	Unchanged	Decreased	Markedly Decreased
Base Deficit (meq/L)	0 to -2	-2 to -6	-6 to -10	-10 and less
Blood Products	Unlikely	Possibly	Likely	Massive Transfusion Protocol
Response to Resuscitation	Rapid and Sustained	Fairly Rapid and Sustained	Transient	Minimal to None
Operative Hemorrhage Control	Unlikely	Possibly	Likely	Extremely Likely

- **Shock Index(SI) = Heart Rate / Systolic BP**

- ✓ $SI \leq 0.7$ normal

- ✓ **$SI \geq 0.8$**

Blood product transfusion, emergent surgical therapy, increased 24-hour and in-hospital mortality, and increased ICU and hospital lengths of stay.

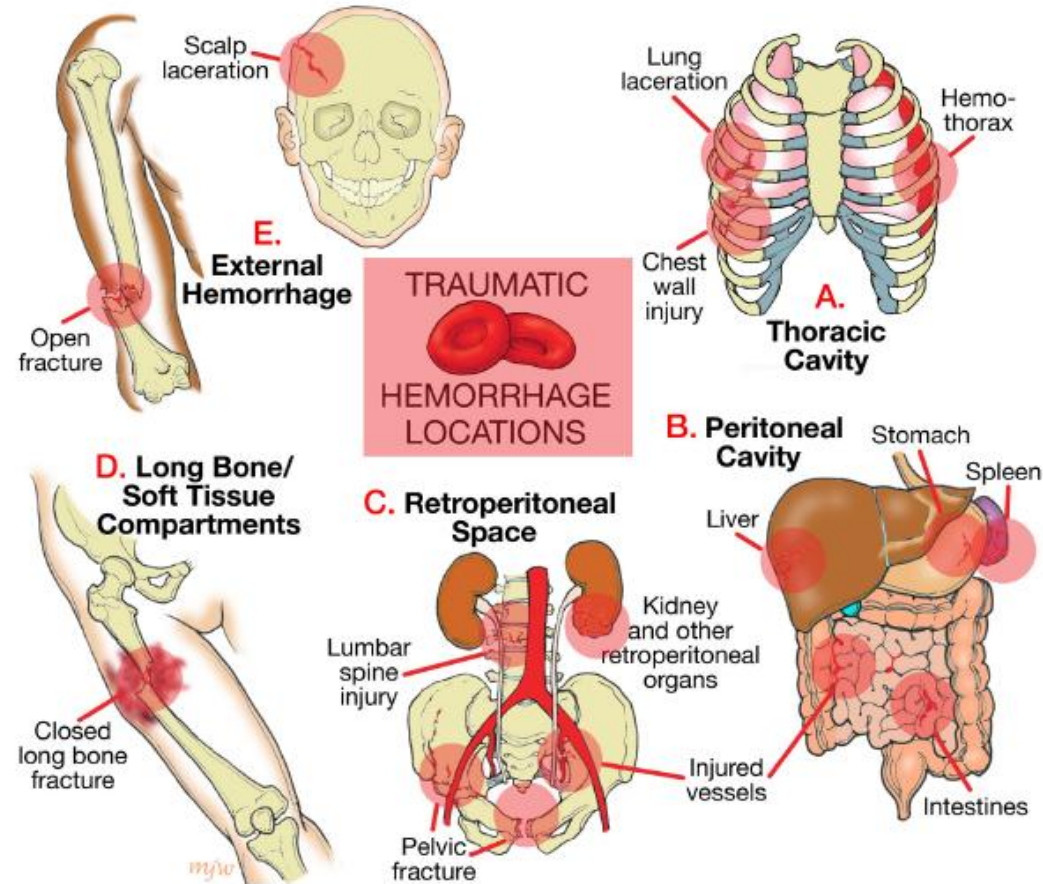
- ✓ **$SI \geq 1.0$** High mortality

- **Laboratory Values**

- ✓ Hemoglobin (a normal initial hematocrit or hemoglobin does not exclude significant hemorrhage.)

- ✓ Lactic acid, Base deficit...

■ **Figure 6-2: Potential Anatomic Locations for Blood Loss, “One on the Floor and Four More” or “Four and the Floor”.** A. Thoracic cavity. B. Peritoneal cavity. C. Pelvic and Retroperitoneal Space. D. Long bone fracture sites, muscle compartments, and subcutaneous tissue. E. External hemorrhage (“the floor”).



Find Bleeding Focus!

- **CHEST**

- **Physical Examination**
- Massive Hemothorax

- **ABDOMEN**

- **Physical Examination**
- FAST, f/u

- **PELVIS**

- **Physical Examination**
- Pelvic X-ray /pelvic binder /Pre-Peritoneal Packing

- **LONG BONES**

- **Physical Examination**
- Splinting / traction

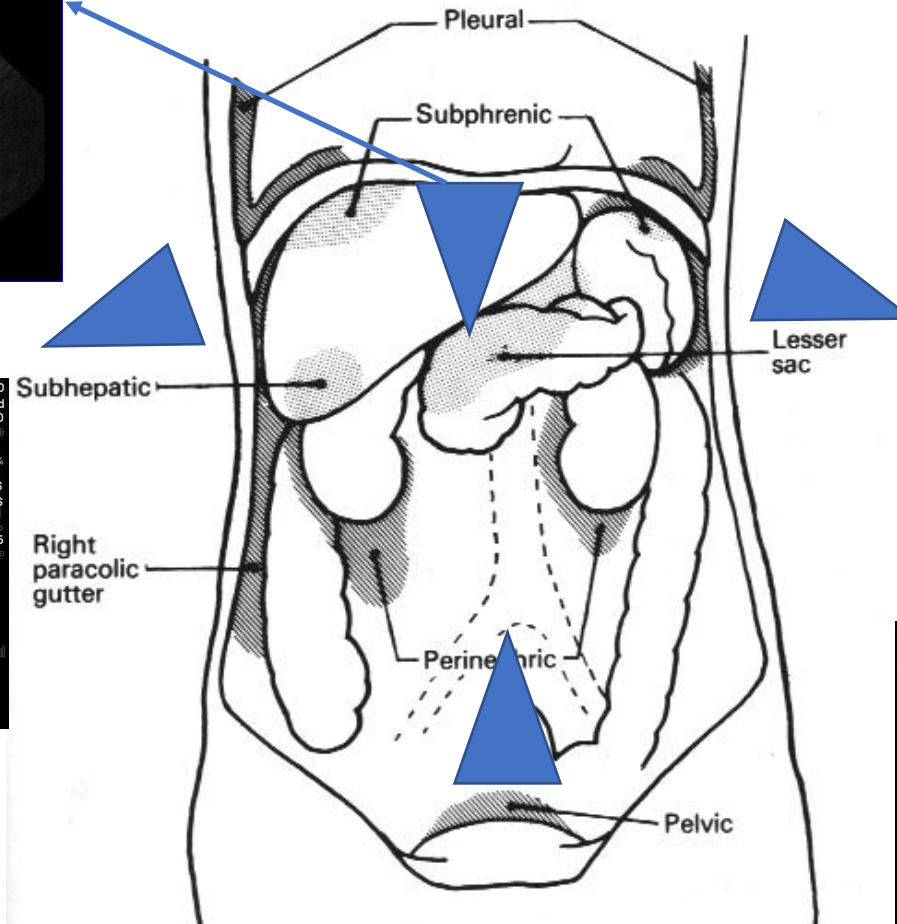
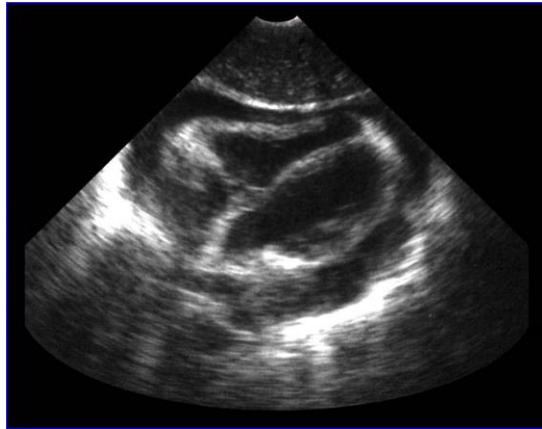
- **EXTERNAL**

- **Physical Examination**
- Direct compression/Tourniquet

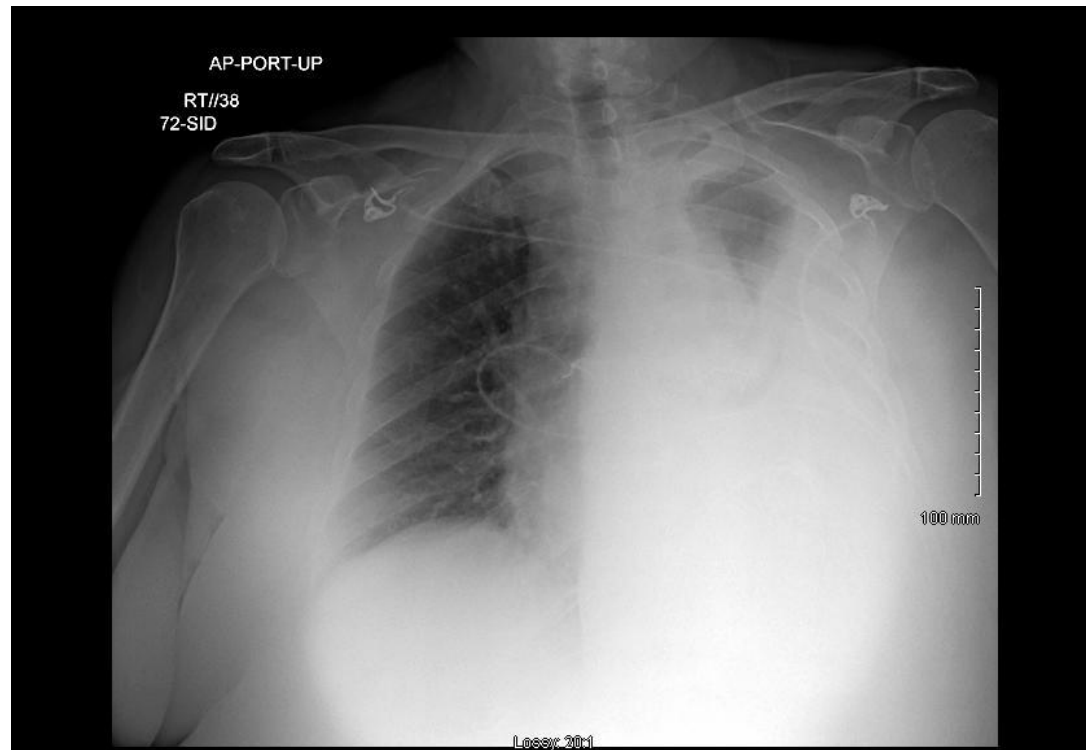
Direct compression & Tourniquet apply



Focused Assessment with Sonography for Trauma (FAST)



Chest X-ray & extended FAST

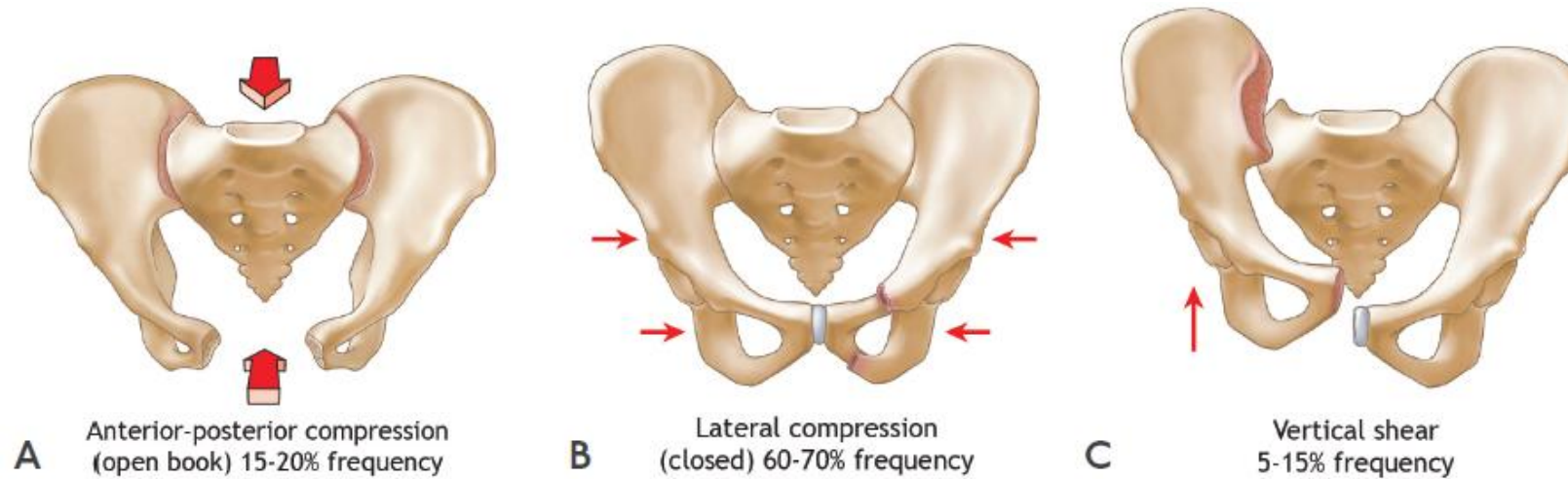


blood is lost **into the site of injury**,
particularly in cases of **major fractures**

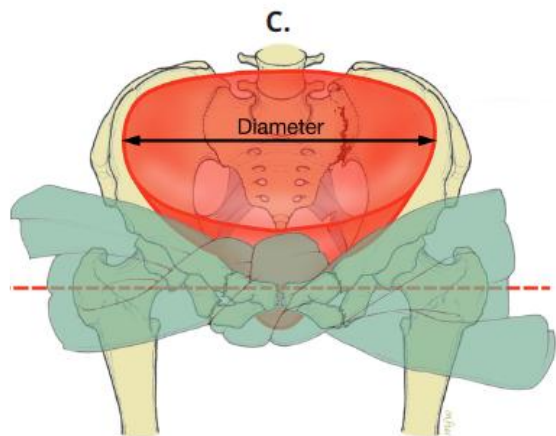
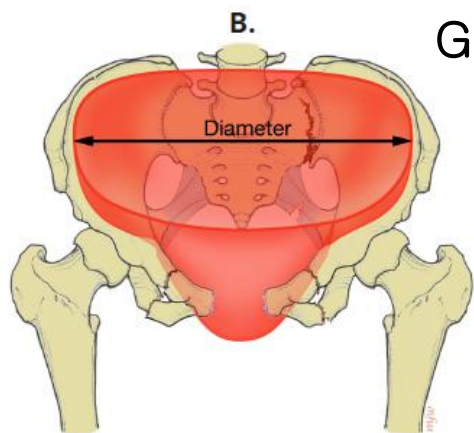
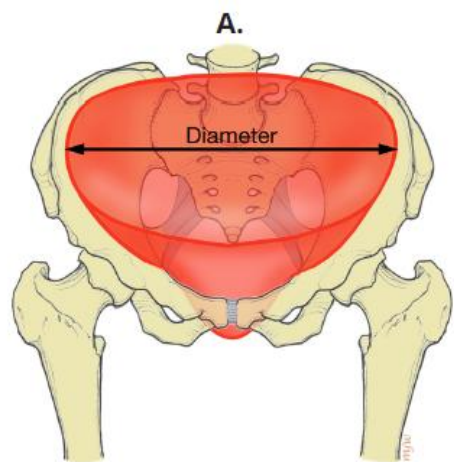
- ✓ **Tibia or Humerus** fracture = loss of **750mL** of blood
- ✓ **Femur** fracture = up to **1500mL**
- ✓ **Pelvic** fracture = **Several liters** of blood



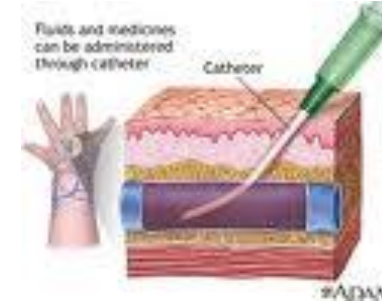
PELVIC BONE FRACTURE



■ **FIGURE 5-8** Pelvic Fractures. A. AP Compression fracture. B. Lateral compression fracture. C. Vertical shear fracture.



Initial Management of Hemorrhagic Shock



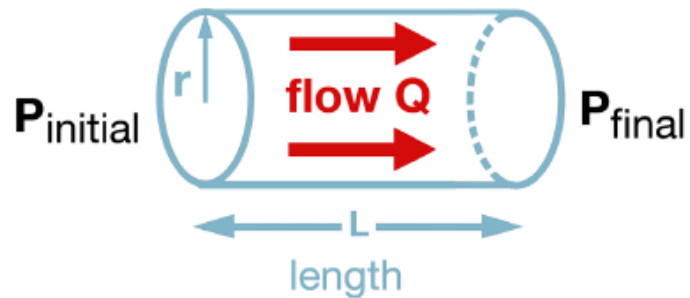
Vascular Access Lines

- ✓ This is best done by inserting two large- caliber (**minimum of 16-gauge**) peripheral intravenous catheters.

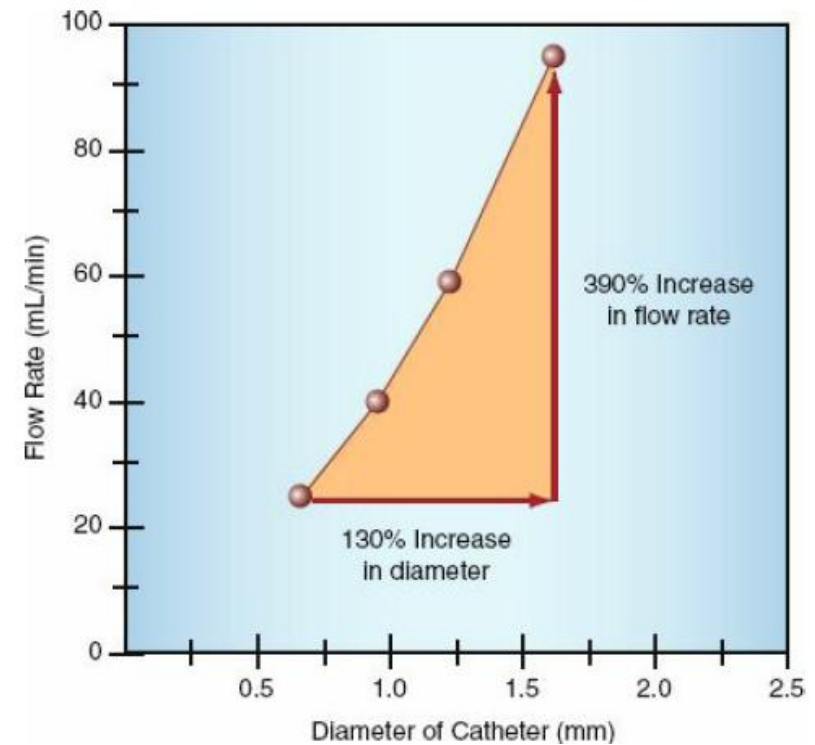


■ **Figure 6-9. Flow Rate of Vascular Access Catheters, Poiseuille's Law.** Fluid may be infused faster through wide and short catheters. Flow is directly proportional to the radius to the 4th power and inversely proportional to 8x the length.

$$Q = \frac{(P_{\text{final}} - P_{\text{initial}}) \pi r^4}{8 \eta L}$$



Gauge	Range of Actual OD (mm)	Nominal OD (mm)
24	0.65 – 0.749	0.7
22	0.75 – 0.949	0.8, 0.9
20	0.95 – 1.149	1.0, 1.1
18	1.15 – 1.349	1.2, 1.3
16	1.55 – 1.849	1.6, 1.7, 1.8
14	1.85 – 2.249	1.9, 2.0, 2.1, 2.2



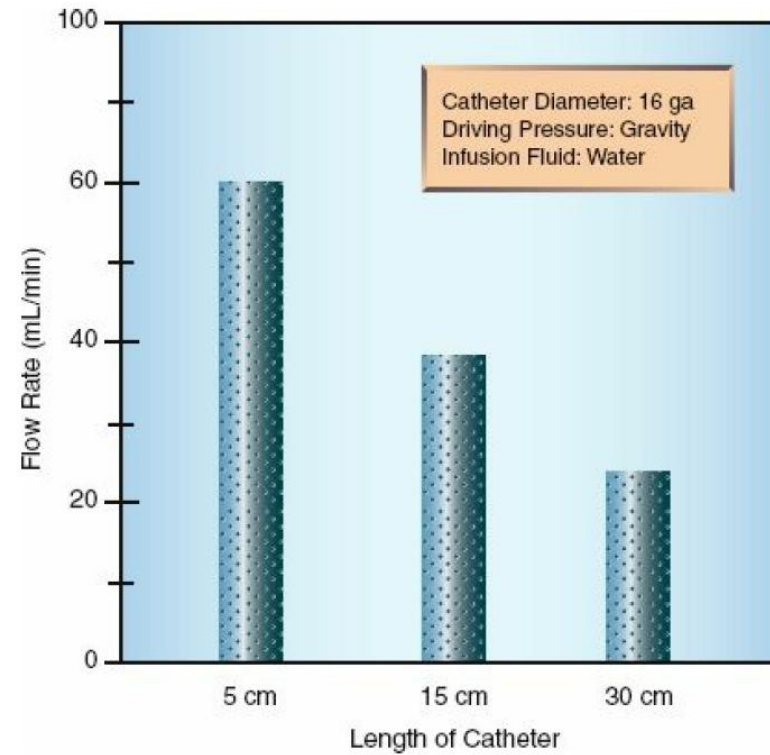


Table 1.2 Flow Characteristics in Peripheral Vascular Catheters

Gauge Size	Length	Flow Rate	
		mL/min	L/hr
16	30 mm (1.2 in)	220	13.2
18	30 mm (1.2 in)	105	6.0
	50 mm (2 in)	60	3.6
20	30 mm (1.2 in)	60	3.6

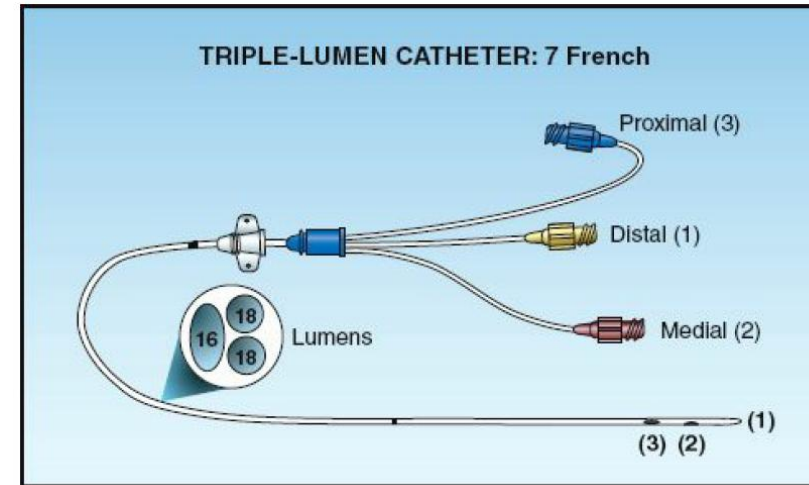
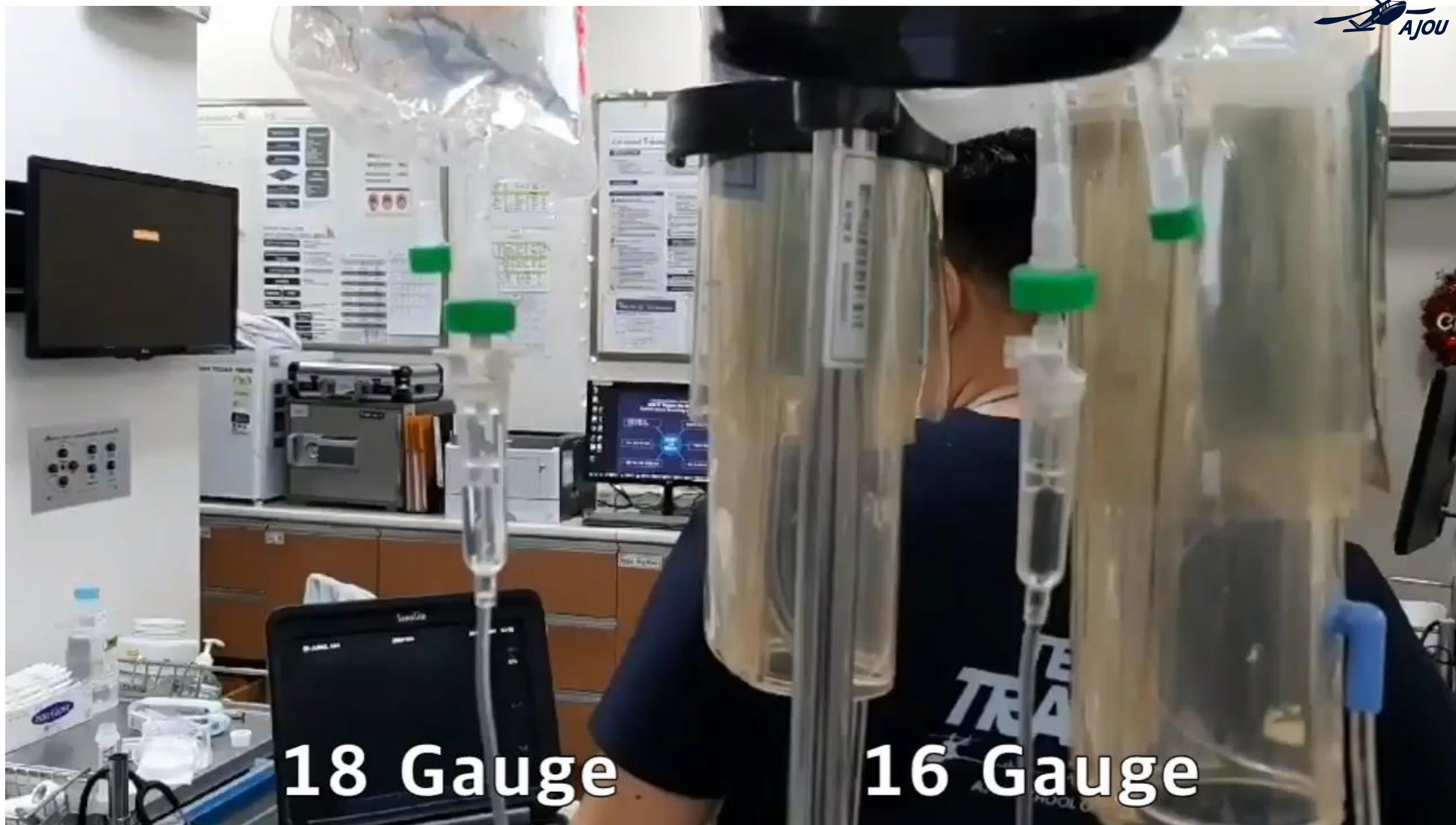


Table 1.3 Selected Features of Triple-Lumen Central Venous Catheters

Size	Length	Lumens	Lumen Size	Flow Rate (L/hr)†
7 Fr	16 cm (6 in)	Distal	16 ga	3.4
		Medial	18 ga	1.8
		Proximal	18 ga	1.9
7 Fr	20 cm (8 in)	Distal	16 ga	3.1
		Medial	18 ga	1.5
		Proximal	18 ga	1.6
7 Fr	30 cm (12 in)	Distal	16 ga	2.3
		Medial	18 ga	1.0
		Proximal	18 ga	1.1

†All flow rates are for gravity-driven flow of isotonic saline from a height of 40 inches above the catheters. Fr = French size; ga = gauge size.
From Arrow International (www.arrowintl.com); accessed 8/1/2011.

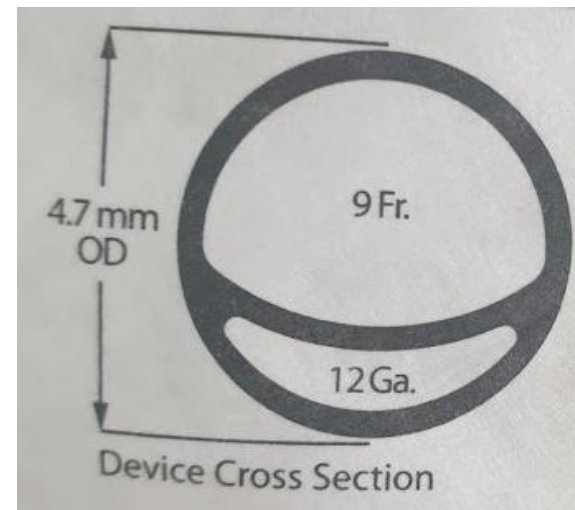


Antecubital/ Wrist / ankle 16G



In patients with injuries below the diaphragm, at least one intravenous (IV) line should be placed in a tributary of the superior vena cava, as there may be vascular disruption or obstruction of the inferior vena cava.

<MAC catheter>

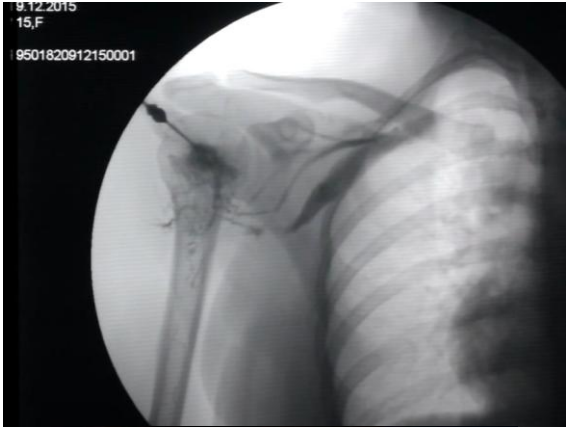
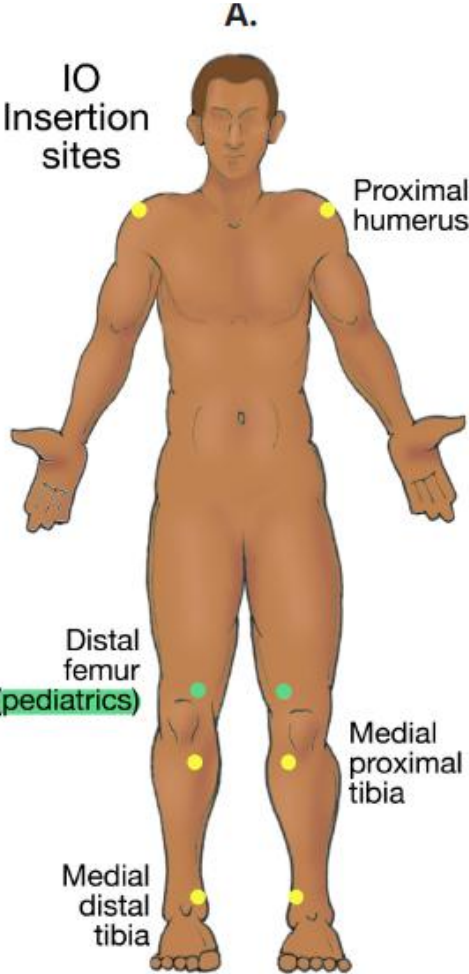
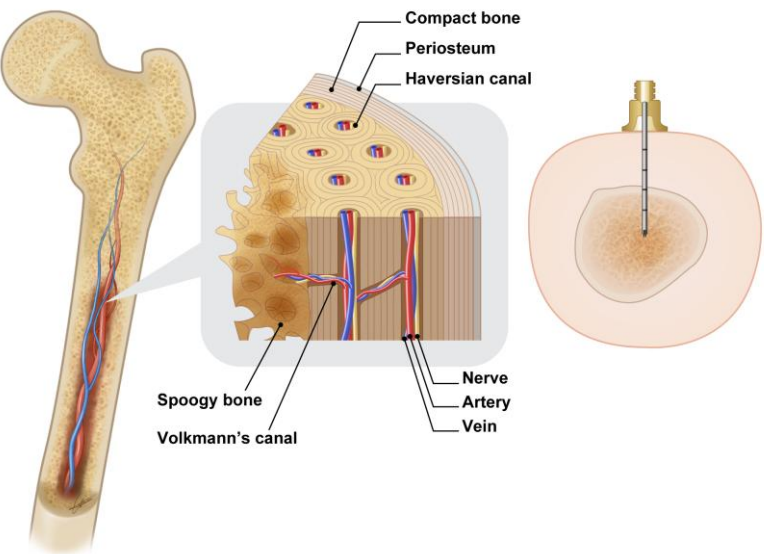


Lumen	Priming Volume* (mL)	Flow Rate† (mL/hr)
Distal (9 Fr.) no catheter	1.65	33,000
Distal (9 Fr.) with 8 Fr. catheter	0.90	10,500
Proximal (12 Ga.) no catheter	0.60	13,000

* Priming volumes are approximate and are done without the injection cap. Injection cap priming volume is 0.17 mL.

† Flow rates are done with normal saline, room temperature, 100 cm head height and represent approximate flow capabilities.

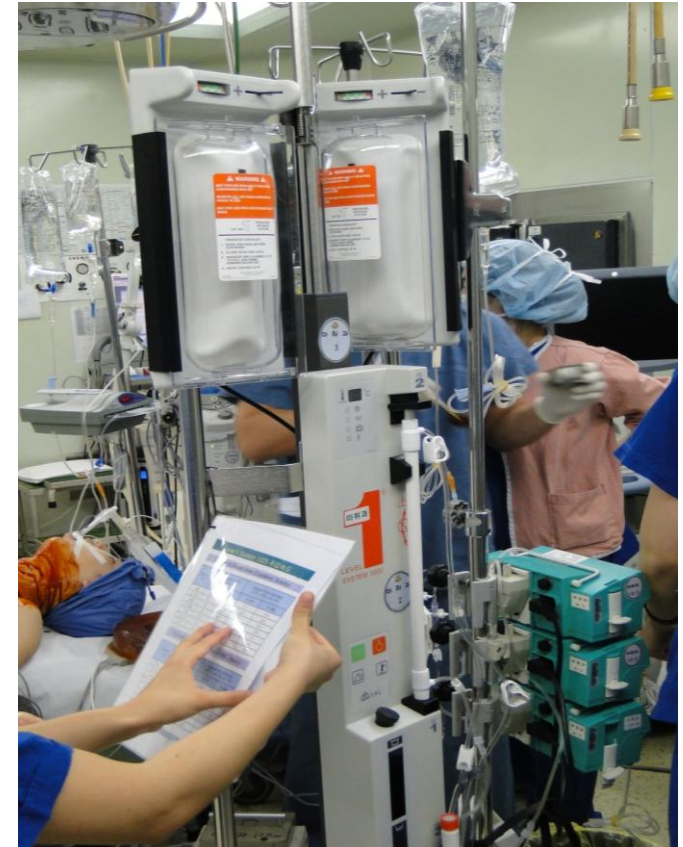
Intraosseous Access



Initial **Fluid** Therapy

- **Red cells and other blood products**, including whole blood, are the ideal resuscitative fluids.
- If these are unavailable, crystalloid may be administered.
- However, **crystalloid** resuscitation is **minimized** as much as is practical.
- Warmed (39°C) isotonic crystalloid
 - lactated Ringer's
 - normal saline(brain injury)
 - plasma solution
 - as rapidly as possible.

- A goal blood product **ratio of 1:1:1** (packed red blood cells to plasma products to platelets) is commonly practiced.
- The usual dose of crystalloids
 - For adults : **250-500mL**
 - For pediatric patients : **10mL/kg**
- **Pumping devices**



Permissive Hypotension

- Normal BP restoration may worsen bleeding
- Target SBP ~90 mmHg until bleeding is controlled
- If TBI / SCI / hypertension: target SBP ~110 mmHg
- Use as a bridge to hemostasis, not a replacement

- **Definitive control of hemorrhage and restoration of adequate circulating volume** are the goals of treating hemorrhagic shock.
- **Definitive bleeding control is essential**, along with appropriate replacement of intravascular volume.
- **Aggressive and continued volume resuscitation is not a substitute for definitive control of hemorrhage.**

Vasopressors are contraindicated as a first-line treatment of hemorrhagic shock because they worsen tissue perfusion.

Noncompressible torso bleeding: What are the options?



CAB versus ABC approach for resuscitation of patients following traumatic injury: Toward improving patient safety and survival

Tessa Breeding, B.S.^a, Brian Martinez, B.S.^a, Joshua Katz, B.S.^a, Jason Kim, B.S.^a, Will Havron, MD^{b,c}, Heather Hoops, MD^d, Adel Elkbulli, MD, MPH, MBA^{b,c,*}

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• CAB vs ABC

• ABC(삽관 먼저): 사망률 ↑, 혈압 ↓

• CAB(수혈 먼저): 생존률 ↑

• **Post Intubation Hypotension** (삽관 후 저혈압) → 치명적

Authors	Year	Design	Study Description	Reported Outcomes	Additional Comments
Ferrada	2018	Retrospective	Analysis of 229 hypotensive trauma patients who underwent RSI before blood transfusion (ABC) or blood transfusion before RSI (CAB).	Patients who underwent RSI before blood transfusion (ABC) had a significantly higher mortality rate than those who had blood transfusion initiated first (CAB) (50% vs 78% $p < 0.05$).	RSI resulted in hemodynamic deterioration in 75% of the already hypotensive patients.
Ferrada et al.	2018	Retrospective	Analysis of 440 hypotensive trauma patients, 245 (55.7%) received intravenous blood product resuscitation first (CAB), and 195 (44.3%) were intubated before any resuscitation was started (ABC).	Those intubated prior to receiving transfusion had a lower GCS than those with transfusion initiation prior to intubation (ABC: 4, CAB:9, $p = 0.005$). There was no statistically significant difference in mortality between cohorts (CAB 47% and ABC 50%).	N/A
Petrosoniak and Hicks	2018	Review	Literature review challenges the conventional ABC sequence that can at times inappropriately prioritize less urgent interventions over treatment for more critical injuries.	Authors propose the use of evidence-based methods for shock identification to apply effective trauma resuscitation, placing emphasis on prioritizing circulation in patients without critical hypoxia or dynamic airway injury.	No single indicator can predict both presence and degree of shock in trauma patients reliably
Ferrada et al.	2019	Meta-analysis	Meta-analysis including 2044 trauma and acute patients across four studies that underwent intubation and developed PIH.	Overall mortality rates were higher in trauma patients who developed PIH (mortality, n (%): PIH = 250/753 (33.2%) vs 253/1291 (19.6%), $p < 0.001$).	N/A

Abbreviations: ABC = Airway-Breathing-Circulation, CAB = Circulation-Breathing-Airway, RSI = Rapid Sequence Intubation, GCS = Glasgow Coma Scale, PIH = Post-Intubation Hypotension, NA = Not Applicable.

Management Priority in Polytrauma Patients with life-threatening injuries

- During the acute period, in addition to decompression of organ cavities, **hemorrhage control of thoracic, abdominal, pelvic and external bleedings** is essential.
- Trauma surgeons tend to take turns depending on what is perceived to be more urgent, with hemorrhage control usually taking priority.
- **Damage Control Surgery**

2nd Priority injuries

Table 3 Second-priority injuries for surgical treatment after resuscitation

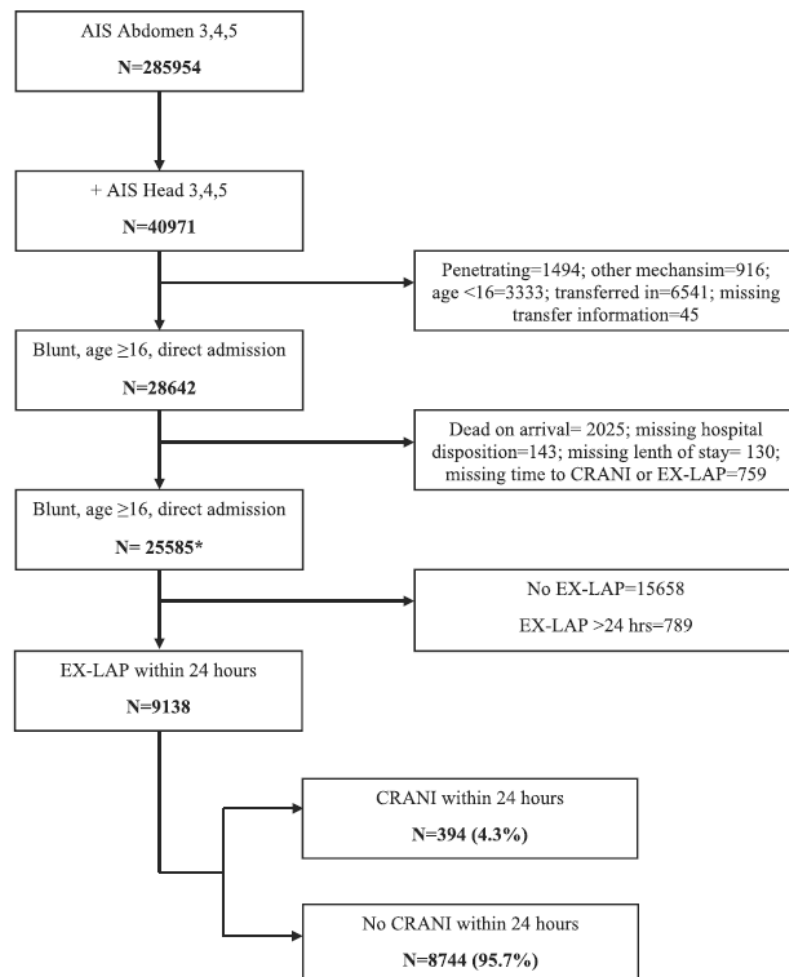
Second priority injury
Brain injuries
Eye and facial injuries
Progressive compression of the spinal cord
Visceral injuries
Musculoskeletal injuries
Fractures with injuries to major vessels
Compartment syndrome
Open soft-tissue injury
Open joint injury
Closed shaft fractures
Pelvic-ring injuries
Unstable spine fractures

Intracranial injury in the hypotensive blunt trauma patient

- **Cerebral injuries**, especially epidural and subdural hematoma have **second priority after massive hemorrhage**.
- **Prevention of secondary brain injury by maintaining adequate oxygenation and perfusion** are the main goals of initial management.

Combined head and abdominal blunt trauma in the hemodynamically unstable patient: What takes priority?

Dominik A. Jakob, MD, Elizabeth R. Benjamin, MD, PhD,
Jayun Cho, MD, and Demetrios Demetriades, MD, PhD, Los Angeles, California



Overall, 9,927 (38.8%) of the 25,585 patients with combined severe head and abdominal blunt trauma, needed a laparotomy, and 1,219 (4.8%) a craniotomy. Overall, 8,744 (34.2%) of the 25,585 patients with combined severe head and abdominal trauma needed only a laparotomy, 534 (2.1%) only a craniotomy and 394 (1.5%) required both procedures within 24 hours of admission. One hundred and seventeen patients had a craniotomy after 24 hours (median time to craniotomy, 70 hours; IQR, 38–169 hours) and were not included in the craniotomy group (Fig. 1).

laparotomy/craniotomy. Overall, 34.2% of the 25,585 patients with combined severe head and abdominal trauma needed only a laparotomy, 2.1% only a craniotomy and only 1.5% required both procedures within 24 hours of admission. Furthermore, in the subgroup of 4,667 hypotensive patients, 51.9% underwent only a laparotomy, 1.2% only a craniotomy, and 1.7% a combined procedure within 24 hours of admission. These findings reinforce the long stated standard that hypotension is related to shock and not related to head injury. In the vast majority of the

Sequence of the Primary Operation in Polytrauma Patients with life-threatening injuries

- Stopping life-threatening thoraco-abdominal hemorrhage and preventing secondary brain injury are time critical priorities.
- However, **unrecognized expansion of an acute subdural or epidural hematoma(critical mass effect)** may occur whilst a damage control surgery is being performed with deleterious effects.
- Situations arise whereby **simultaneous craniotomy and chest or abdominal surgery** is necessary to **prevent mortality or reduce severe morbidity.**

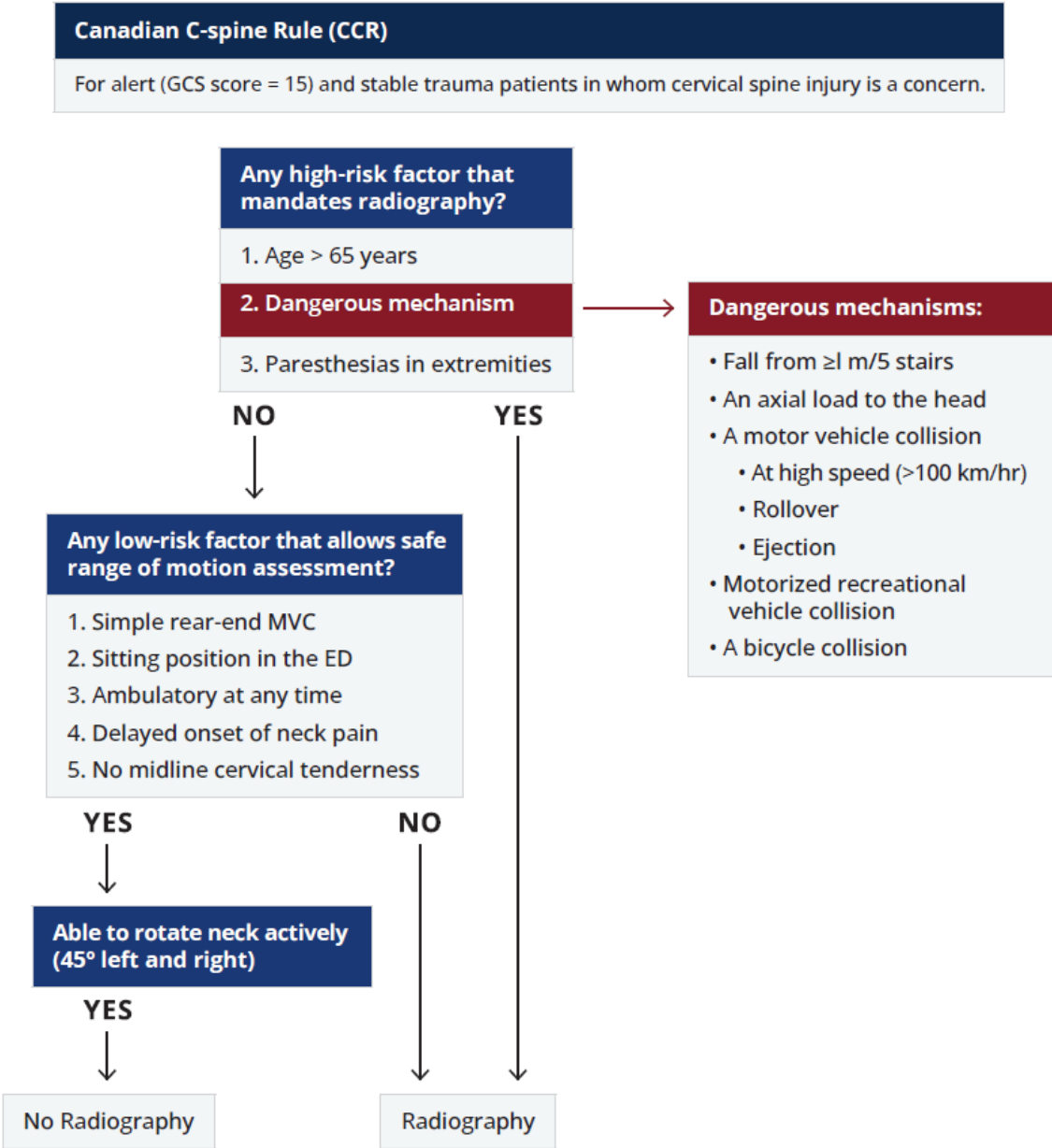
Disability (Neurologic Evaluation)

- **A rapid neurologic evaluation**
 - performed at the end of the primary survey.
 - Level of consciousness
 - Pupil size and reaction
 - Lateralizing signs
 - Spinal cord injury level
- **GCS (Glasgow Coma Scale)**

- Primary brain injury results from the structural effect of the injury to the brain.
- Prevention of secondary brain injury by maintaining **adequate oxygenation and perfusion** are the main goals of initial management.

- **Hypoglycemia, alcohol, narcotics, and other drugs** can also alter a patient's level of consciousness.
- **Until proven otherwise, always presume that changes in level of consciousness are a result of central nervous system injury.**

■ **Figure 7-17: Canadian C-Spine Rule.** A clinical decision tool for cervical spine evaluation. MVC, Motor vehicle collision; ED, Emergency department. Adapted from Stiell IG, Wells GA, Vandemheen KL, et al. The Canadian C-Spine rule of radiography in alert and stable trauma patients. *JAMA*. 2001;286:1841–1848.



Adapted with permission of *JAMA*, from The Canadian C-Spine Rule for Radiography in Alert and Stable Trauma Patients, Stiell, Ian G.; Wells, George A., 286, 2001; permission conveyed through Copyright Clearance Center, Inc.

National Emergency X-Radiography Utilization Study (NEXUS) Criteria

Meets ALL low-risk criteria?

1. No posterior midline cervical-spine tenderness and...
2. No evidence of intoxication and...
3. A normal level of alertness and...
4. No focal neurologic deficit and...
5. No painful distracting injuries

YES → **No Radiography**

NO → **Radiography**

NEXUS Mnemonic

N	Neuro deficit
E	EtOH (alcohol)/intoxication
X	eXtreme distracting injury/injuries
U	Unable to provide history (altered level of consciousness)
S	Spinal tenderness (midline)

Explanation:

These are for purposes of clarity only. There are not precise definitions for the individual NEXUS Criteria, which are subject to interpretation by individual physicians.

1. Midline posterior bony cervical spine tenderness is present if the patient complains of pain on palpation of the posterior midline neck from the nuchal ridge to the prominence of the first thoracic vertebra, or if the patient evinces pain with direct palpation of any cervical spinous process.
2. Patients should be considered intoxicated if they have either of the following:
 - A recent history by the patient or an observer of intoxication or intoxicating ingestion.
 - Evidence of intoxication on physical examination, such as odor of alcohol, slurred speech, ataxia, dysmetria or other cerebellar findings, or any behavior consistent with intoxication. Patients may also be considered to be intoxicated if tests of bodily secretions are positive for drugs (including but not limited to alcohol) that affect levels of alertness.
3. An altered level of alertness can include any of the following:
 - Glasgow Coma Scale of 14 or less
 - Disorientation to person, place, time, or events
 - Inability to remember 3 objects at 5 minutes
 - Delayed or inappropriate response to external stimuli
 - Other
4. Any focal neurologic complaint (by history) or finding (on motor or sensory examination).
5. No precise definition for distracting painful injury is possible. This includes any condition thought by the clinician to be producing pain sufficient to distract the patient from a second (neck) injury. Examples may include, but are not limited to:
 - Any long bone fracture
 - A visceral injury requiring surgical consultation
 - A large laceration, degloving injury, or crush injury
 - Large burns
 - Any other injury producing acute functional impairment

Physicians may also classify any injury as distracting if it is thought to have the potential to impair the patient's ability to appreciate other injuries.

- **Multidetector CT with coronal and sagittal reconstruction** is the preferred imaging modality for cervical and thoracolumbar spine evaluation
- Plain radiographs have limited value because of low sensitivity
- If CT is unavailable, obtain cervical spine radiographs from occiput to T1

■ **Table 7-7: Indications for Head CT.**

Indications for Head CT	
Age >16 with LOC or PTA (CDC / ACEP)	Consider CT without LOC or PTA
GCS < 15	GCS ≤15
Age greater than 60 years	Age >65
Physical evidence of trauma above the clavicle	Coagulopathy, Anticoagulant
Coagulopathy (supra-therapeutic international normalized ratio (INR) or thrombocytopenia)	Focal neurologic deficit
Headache	Severe headache
Vomiting	Vomiting
Drug or alcohol intoxication	Signs of basilar skull fracture
Short-term memory deficit	Ejection from motor vehicle
Posttraumatic seizure	Pedestrian struck by motor vehicle
Focal neurologic deficit	Fall down 5 stairs or >1 meter

CT, Computed tomography; LOC, Loss of consciousness; PTA, Post-traumatic amnesia; CDC, Centers for Disease Control; ACEP, American College of Emergency Physicians; GCS, Glasgow Coma Score.

Exposure/Environmental control

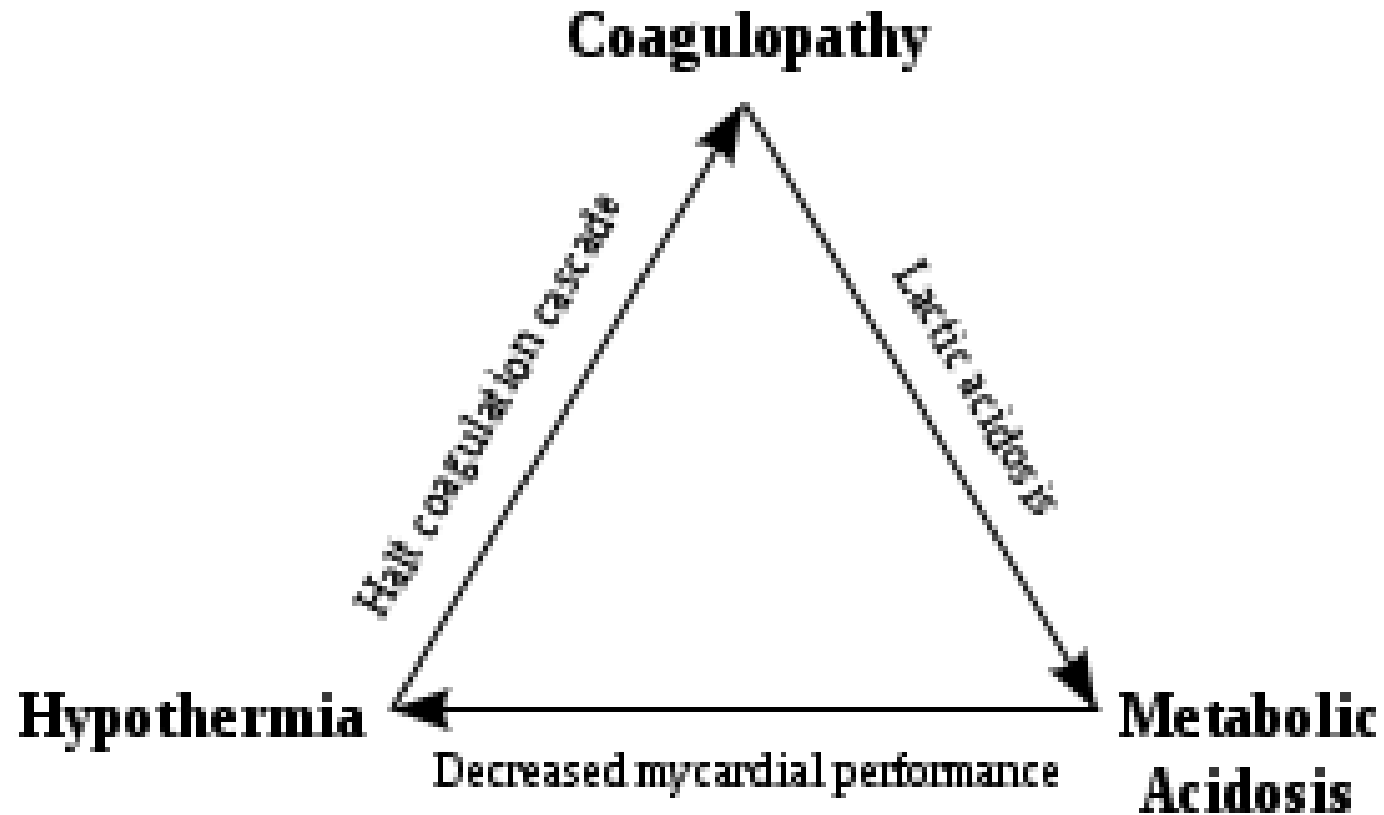
The “E” component of the primary survey has two major goals:

(1) to fully expose and inspect the patient for externally visible injuries

(2) to identify and begin treatment for any life-threatening environmental emergencies.

- Hypothermia is defined as a core temperature $< 35^{\circ}\text{C}$.
- Patients with traumatic injuries are at increased risk for hypothermia from **exposure** in the field, **administration of IV fluids**, **hemorrhage**, and in-hospital exposure.
- The incidence of hypothermia in trauma patients during resuscitation has been reported to be as high as 66%.
- **Hypothermia** in trauma patients is an **independent predictor of mortality.**

Lethal Triad



■ **Table 8-2: Stages of Hypothermia and Tiered Correction Strategies.** Hypothermia, no matter the stage, can lead to coagulation dysfunction and decreased platelet aggregation, which can in turn complicate the management of hemorrhage. Worsening hypothermia can lead to dysrhythmias and cardiac arrest.

Stage	Core Temperature	Symptoms	Interventions
I	32° — 35°C	Conscious, shivering	Warm environment and clothing, active movement, warm oral fluids
II	28° — < 32°C	Impaired consciousness, no shivering	Cardiac monitoring, cautious movements to avoid arrhythmias, full-body insulation, active external and minimally invasive rewarming techniques (chemical, electrical, or forced-air heating packs or blankets, warm IV fluids)
III	24° — < 28°C	Unconscious, vital signs are present	All the above, plus: intubation, rewarming with extracorporeal support if available
IV	< 24°C	No vital signs	All of the above plus: CPR and up to three doses of epinephrine and defibrillation, can continue if patient responds. Continue active external or internal rewarming if extracorporeal support not available

Exposure Steps

1. Remove all clothing, jewelry, and prehospital dressings (use shears as needed)
2. Identify **external signs of injury** (abrasions, contusions, bleeding, wounds, foreign bodies, burn, frostbite, etc.)
3. In patients at **risk for spinal injury**, log roll the patient while maintaining C-spine precautions to examine posterior aspect of the patient for signs of injury
4. To respect patient privacy and **reduce hypothermia**, cover the patient as much as possible during the examination and completely after the exam



Resuscitation

Airway

Breathing / Ventilation / Oxygenation

Circulation and Bleeding Control



**Simultaneous,
Multidisciplinary
approach**

Secondary Survey

The secondary survey does not begin until

the primary survey(ABCDEs) is completed, resuscitative efforts are underway, and the normalization of vital functions has been demonstrated.

History

Blunt trauma
Penetrating trauma
Thermal injury
Hazardous environment

- **A** -allergies
- **M**-medications currently used
- **P** -past illnesses/Pregnancy
- **L** -last meal
- **E** -events/environment related to the injury

Physical Examination

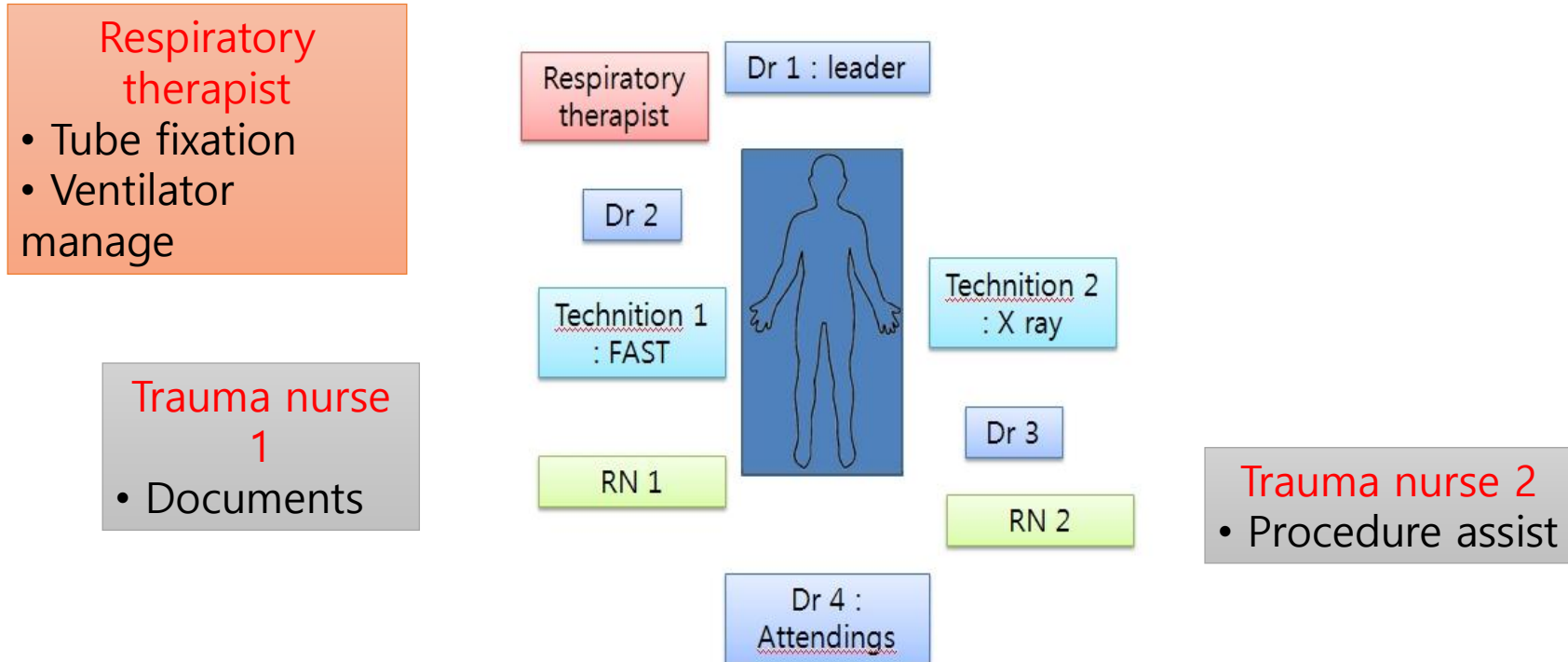
Head
Maxillofacial structures
Cervical spine and neck
Chest
Abdomen
Perineum/Rectum/Vagina
Musculoskeletal system
Neurologic

- While the primary survey identifies immediately life-threatening injuries, the comprehensive secondary survey ensures that **all other injuries are identified**.
- **Vital signs are frequently reassessed** to identify physiologic changes as rapidly as possible and facilitate rapid resuscitation.
- Imaging is an important adjunct to the physical assessment.

Transfer to Definitive Care

- The actual transfer may occur following the secondary survey, though for **patients with exsanguinating injuries**, transfer may happen even **with ongoing resuscitation**.
- When patient injuries exceed facility capabilities, **do not delay transfer for secondary survey imaging** (e.g., CT scan, extremity radiographs).

Action in a Trauma Bay





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SPORTS
LIVE

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Formula 1

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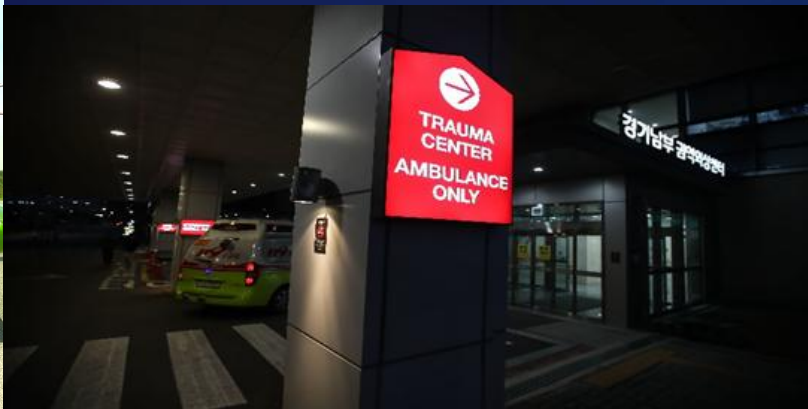
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Thank you for your attention

