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## INITIAL TRAUMA MANAGEMENT AND DAMAGE CONTROL RESUSCITATION IN HUMAN MEDICINE

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## TODAY'S TOPICS



1. "Preventable Trauma Deaths" and Initial Trauma Management Guidelines

2. Damage Control Strategy and Damage Control Resuscitation

3. Treatment Strategies Using the Hybrid Emergency Room System



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# TODAY'S TOPICS



## 1. "Preventable Trauma Deaths" and Initial Trauma Management Guidelines

2. Damage Control Strategy and Damage Control Resuscitation

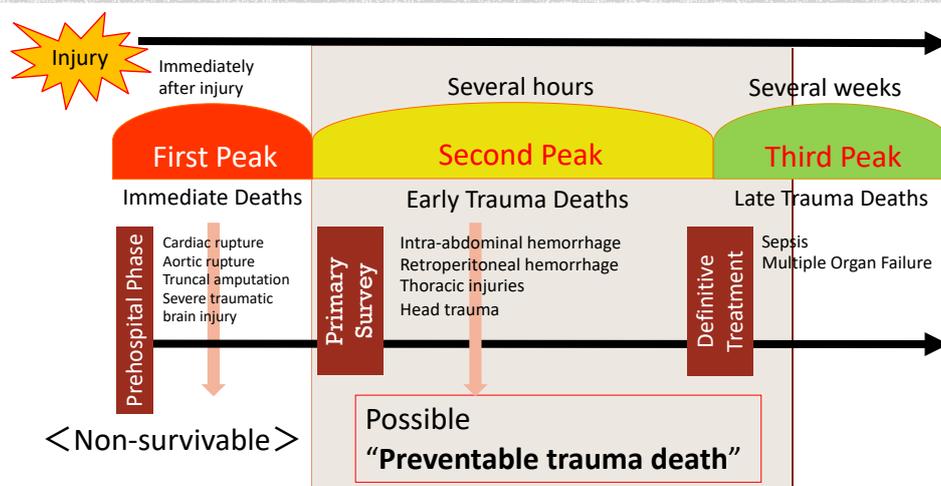
3. Treatment Strategies Using the Hybrid Emergency Room System



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# TRAUMA-RELATED DEATHS



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## PREVENTABLE TRAUMA DEATH

Predicting Survival Rate : TRISS Method

The probability of survival is calculated based on physiological severity, anatomical severity, and age.

**Unexpected mortality** the predicted rate is  $\geq 50\%$  but the patient dies.

Exclusions: Severe traumatic brain injury and patients aged  $\geq 80$  years

**Modified unexpected mortality** **38.6%** (in 2000)

appropriate interventions could have prevented some deaths

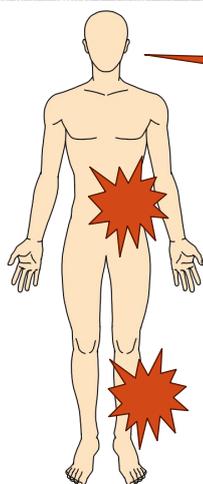
**Preventable Trauma Death (PTD)**



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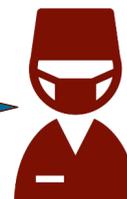
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## FOR EXAMPLE...



"My leg hurts! My leg hurts!"

"This is a severe fracture! We need to perform surgery immediately!"



During OR preparation...

Blood pressure drops, consciousness deteriorates

Actually...

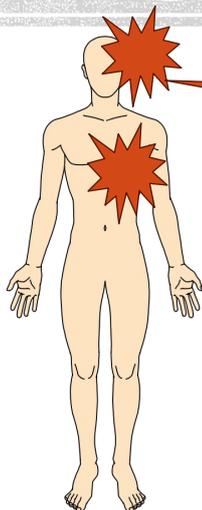
There is massive bleeding due to intra-abdominal organ damage.



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# ANOTHER EXAMPLE...



"Ugh..."

"Severe head trauma! We need a head CT immediately!"



During CT scanning...  
Breathing worsens, blood pressure drops...  
Cardiac arrest!

Actually...  
Tension pneumothorax due to chest trauma!



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# REDUCING PTD

The goal of trauma care is to reduce preventable trauma deaths



Standardization of trauma care is essential.

In 2002,

- trauma management guidelines were developed
- two-day training course was initiated

JATEC HP

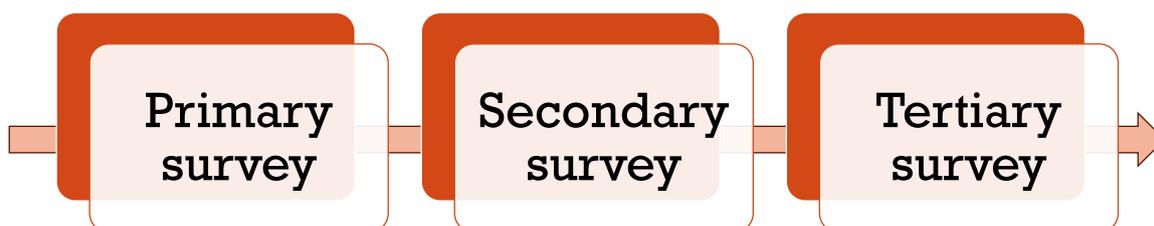


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## INITIAL TRAUMA MANAGEMENT (JATEC)

Flow of initial trauma management



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## PRIMARY SURVEY

- Primary survey

### **Physiological assessment and resuscitation**

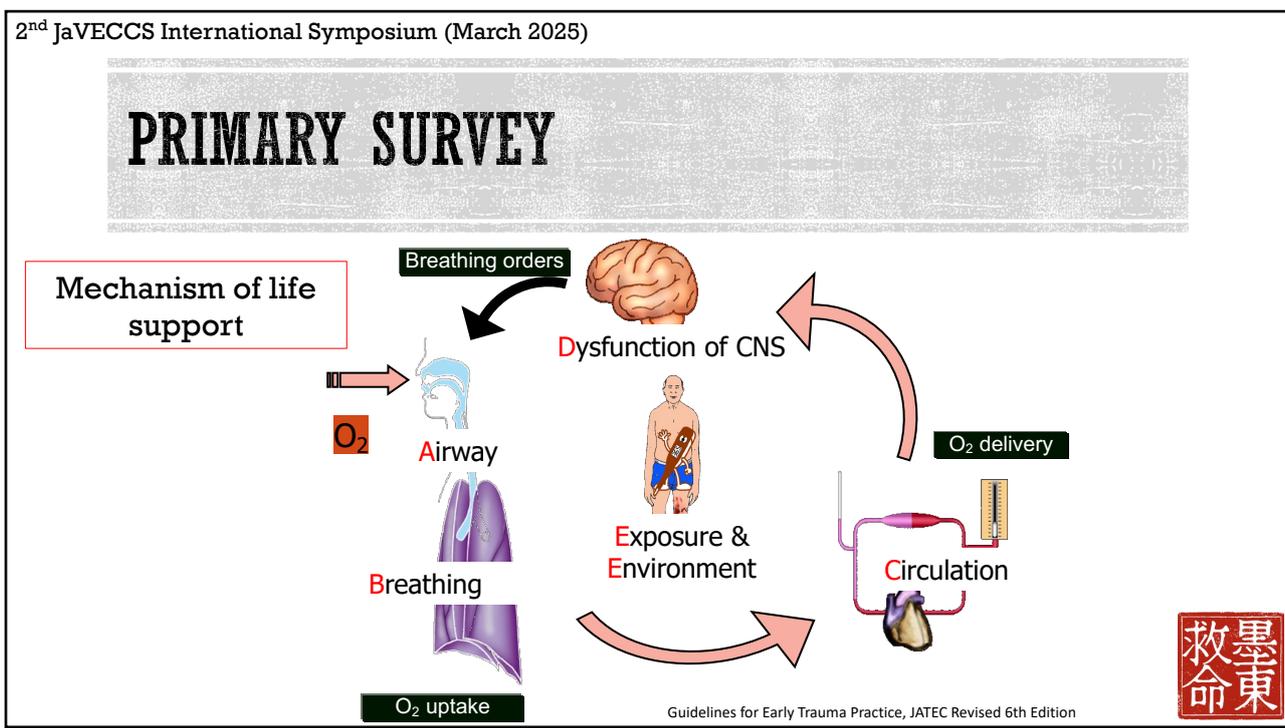
rapidly identifies and resuscitates life-threatening injuries affecting vital functions (ABCDE approach),

based on physical findings and minimal diagnostic imaging.

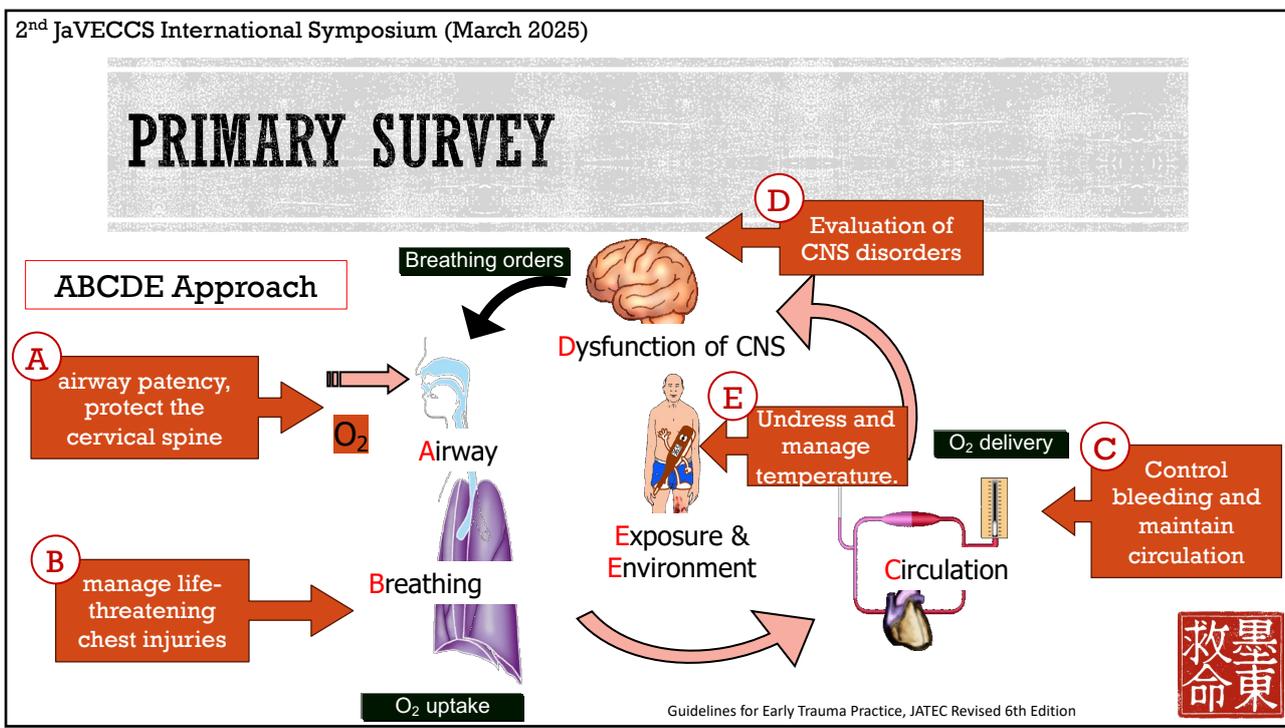
The most crucial step in saving  
a patient's life



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## KEY CONSIDERATIONS IN PS

Principal injuries/pathological conditions requiring resuscitation that may be present in PS

### TAF 3XMAP DH

|                           |          |      |
|---------------------------|----------|------|
| T : Cardiac tamponade     | 心タンポナーデ  | [C]  |
| A : Airway obstruction    | 気道閉塞     | [AB] |
| F : Flail chest           | フレイルチェスト | [B]  |
| X : Open pneumothorax     | 開放性気胸    | [B]  |
| X : Tension pneumothorax  | 緊張性気胸    | [BC] |
| X, M : Massive hemothorax | 大量血胸     | [BC] |
| A : Abdominal hemorrhage  | 腹腔内出血    | [C]  |
| P : Pelvic fracture       | 骨盤骨折     | [C]  |
| D : Dysfunction of CNS    | 切迫するD    | [D]  |
| H : Hypothermia           | 低体温      | [E]  |



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## PS A: AIRWAY

### 【Evaluation】

- Confirm airway patency
- Voice, hoarseness, paradoxical breathing
- Blood or foreign bodies in the mouth

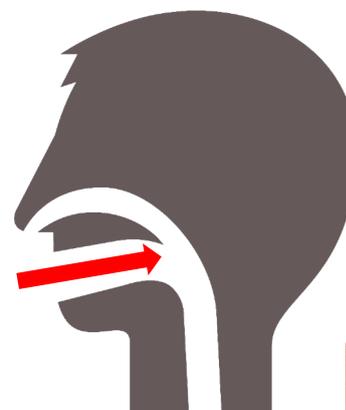
### 【Conditions requiring resuscitation】

- Upper airway obstruction

### 【Interventions】

- Jaw thrust, suction
- Oropharyngeal intubation, cricothyroidotomy.

**Simultaneously... protect the cervical spine.**



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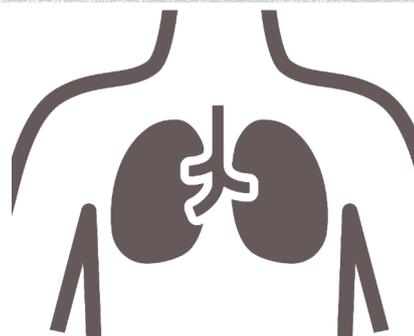
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## PS B: BREATHING

### 【Evaluation】

Respiratory and thoracic assessment

- Respiratory effort, symmetry, flail chest
- Difference in breath sounds between sides, respiratory rate, SpO<sub>2</sub>
- Crepitus or instability
- Tympany or dullness
- Observe the neck: tracheal deviation, jugular vein distension, use of accessory muscles



### 【Conditions requiring resuscitation】

- Open pneumothorax, hypoxia, Tension pneumothorax, hemothorax

### 【Interventions】

- Assisted ventilation, intubation, positive pressure ventilation, needle decompression, chest tube placement.



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## PS B: BREATHING

### Tension Pneumothorax

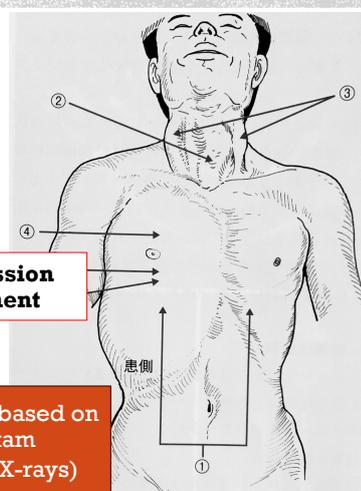
One of the **most urgent conditions** presenting as obstructive shock (**shock + respiratory failure**).

### 【Findings】

- ① Asymmetrical chest movement
- ② Tracheal deviation
- ③ Jugular vein distension
- ④ Decreased or absent breath sounds
- ⑤ Subcutaneous emphysema
- ⑥ Hyperresonance on percussion

- Needle decompression
- Chest tube placement

Rapid diagnosis based on physical exam  
(before taking X-rays)



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## PS C:CIRCULATION

### Early recognition of shock is crucial!

|                  | Class I           | Class II                           | Class III                 | Class IV                  |
|------------------|-------------------|------------------------------------|---------------------------|---------------------------|
| Bleeding (ml)    | < 750             | 750-1500                           | 1500-2000                 | > 2000                    |
| Bleeding (%)     | < 15%             | 15-30%                             | 30-40%                    | > 40%                     |
| Pulse Rate       | < 100             | > 100                              | > 120                     | > 140 or bradycardia      |
| Blood Pressure   | Unchanged         | Systolic: unchanged<br>Diastolic ↑ | Systolic ↓<br>Diastolic ↓ | Systolic ↓<br>Diastolic ↓ |
| Pulse Pressure   | Unchanged<br>or ↑ | Decreased                          | Decreased                 | Decreased                 |
| Respiratory Rate | 14-20             | 20-30                              | 30-40                     | > 40 or nothing           |
| Consciousness    | Mild anxiety      | Anxiety                            | Anxiety, unsettled        | Unsettled, lethargy       |

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## PS C:CIRCULATION

### Early recognition of shock is crucial!

#### 【Assessment】

Focus on physical exam

- S:** Skin – Cool, clammy skin
- H:** Heart Rate – Tachycardia, weak pulse
- O:** Outer bleeding – Active external bleeding
- C:** CRT >2 seconds is abnormal  
Consciousness – Cerebral perfusion, confusion, agitation
- K:** “Ketsuatsu” – Blood pressure in Japanese



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# PS C:CIRCULATION

## Types of Shock in Trauma

➤ Hypovolemic shock (Hemorrhagic shock)

Bleeding into free spaces ⇒ abdomen, thorax, retroperitoneum, external hemorrhage

Mostly hemorrhagic shock

➤ Obstructive shock

Cardiac tamponade

FAST

Chest and pelvis x-rays

Physical Exam

Physical Exam

Tension pneumothorax

➤ Distributive shock (neurogenic shock)

High spinal cord injury

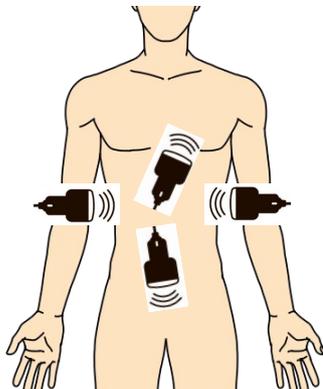
➤ Cardiogenic shock

Blunt cardiac injury



# PS C:CIRCULATION

## FAST : Focused Assessment with Sonography for Trauma



- ① Pericardial effusion (obstructive shock)
- ② Morrison's pouch and right hemithorax
- ③ Splenic area and left hemithorax
- ④ Perivesical space
- ⑤ Lungs (pneumothorax)

## E-FAST : Extended FAST

Repeated evaluation is essential!



## PS C:CIRCULATION

### Chest and Pelvis X-rays

#### Chest X-rays

- 1 Massive hemothorax
- 2 Pulmonary contusion
- 3 Multiple rib fractures with flail chest
- 4 Pneumothorax
- 5 Positioning of inserted catheters or tube



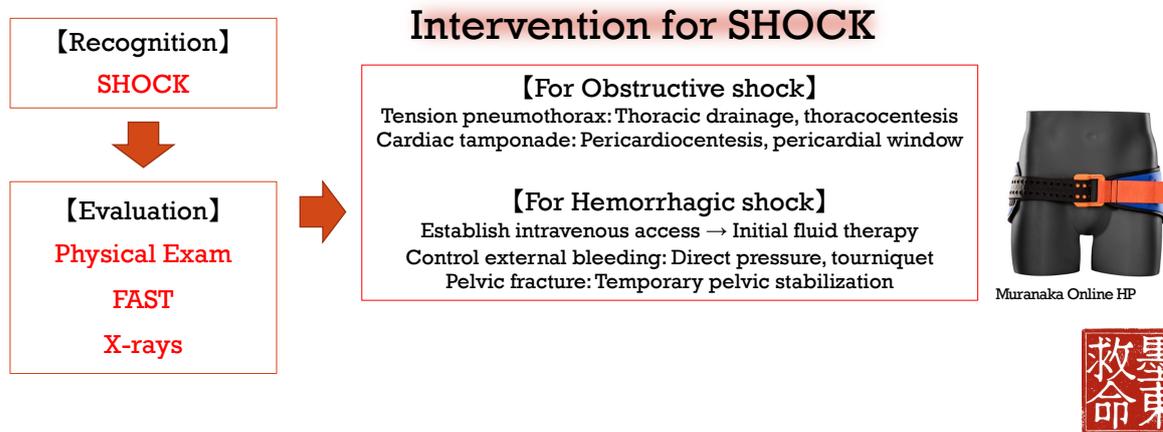
#### Pelvis X-rays

- 1 Unstable pelvic fractures  
⇒ Disruption of the pelvic ring  
(a potential cause of retroperitoneal hemorrhage)



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## PS C:CIRCULATION



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# PS C:CIRCULATION

## Fluid Resuscitation Strategy

Administer 1L of lactated Ringer's solution over 15–20 min  
Monitor response and adjust treatment



**Prioritize hemorrhage control,**  
through surgery or embolization



# PS C:CIRCULATION

## Hemorrhage Control Strategies

### Compressible bleeding

Direct pressure



Tourniquets

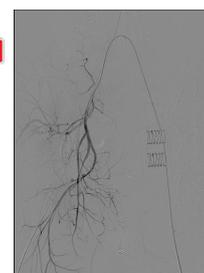


### Non-compressible bleeding

Emergency surgery



Embolization



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## PS D:DISFUNCTION OF CNS

### 【Evaluation】

Assess for signs of “D” (disfunction of CNS)

- Paralysis
- Consciousness
- Anisocoria

### 【Assessment for “D” sign】

Glasgow Coma Scal (GCS)  $\leq 8$  points (EOVOMO)

Decrease in GCS by  $\geq 2$  points during observation

Signs of brain herniation such as hemiplegia or anisocoria

### 【Management】

Call neurosurgery, perform endotracheal intubation

Ensure ABC stability and perform head CT at the start of SS

Consider decompressive surgery if indicated



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## PS E:EXPOSURE/ENVIROMENT

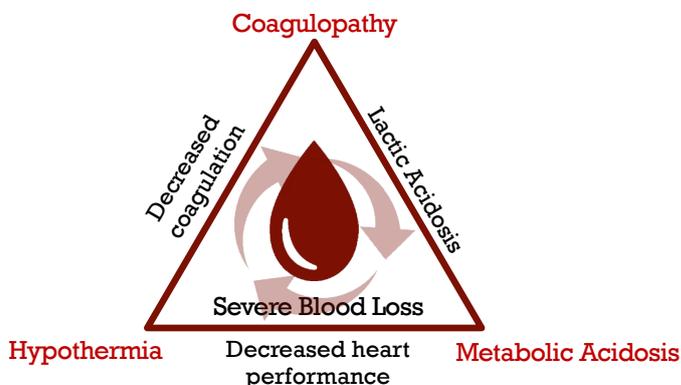
### ➤ Undressing

Perform full-body undressing to assess for injuries

### ➤ Warming

Evaluate for hypothermia and take preventive measures

### Lethal Triad



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## SECONDARY SURVEY (SS)

### ▪ Secondary survey

### **Assessment of Anatomical Abnormalities and Injuries Requiring Definitive Treatment**

Proceed to Secondary Survey (SS) Once ABCD is Stable

- If "impending D" is present, perform head CT first (pan scan can be done simultaneously).
- Conduct AMPLE history and Head-to-Toe assessment.
- Obtain necessary X-rays and CT scans (trauma pan scan).
- Implement FIXES as needed.



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## SS AMPLE

| AMPLE |                          |
|-------|--------------------------|
| A     | Allergy                  |
| M     | Medication               |
| P     | Past History & Pregnancy |
| L     | Last meal                |
| E     | Event                    |



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## SS HEAD TO TOE

- Observe **from head to toe**, including the back.
- Perform a rectal examination.
- Assess neurological findings at the end.
- The primary goal is to identify anatomical abnormalities. Follow the principle of "Look, Listen, Palpate, (Percuss)".
- **If any abnormality is found, assess vital signs.**  
If vital signs are unstable, return to A, B, C... and reassess.



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## SS HEAD TO TOE

- **Head and Face:** Check for wounds, subcutaneous hematomas, facial deformities, tenderness.. Look for raccoon eyes (periorbital ecchymosis) and other trauma signs.
- **Neck:** Assess for wounds, tracheal deviation, subcutaneous emphysema, jugular vein distension, posterior neck pain.
- **Chest:** Evaluate respiratory effort, subcutaneous emphysema, tenderness of ribs and sternum. Reassess chest X-ray and perform ECG if needed.
- **Abdomen:** Look for abdominal distension, seatbelt sign, tenderness, bowel sounds. Repeat FAST ultrasound to assess for intra-abdominal injury.
- **Pelvis:** Check for wounds, confirm pelvic X-ray findings, and perform gentle palpation.
- **Perineum:** Assess for wounds, urethral bleeding, and perform rectal examination.
- **Lower Limbs:** Check for deformities, swelling, paralysis, or other abnormalities.
- **Upper Limbs:** Assess for deformities, swelling, paralysis, or other injuries.
- **Back:** Look for wounds, spinal deformities, tenderness.
- **Neurological Examination:** Evaluate paralysis, consciousness level, pupil response.

Conduct a thorough head-to-toe and back examination.  
Identify injuries **requiring treatment or further diagnostic testing.**



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## SS REEVALUATION OF X-RAYS

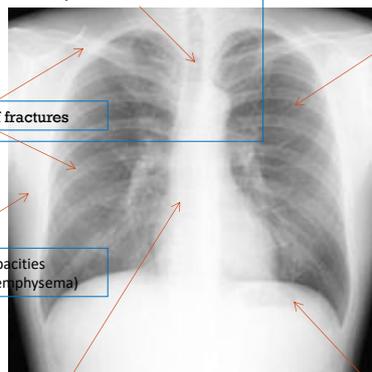
### 観察ポイント

- ① Trachea and bronchi
- ② Thoracic cavity and lung parenchyma
- ③ Mediastinum
- ④ Diaphragm
- ⑤ Bony thorax
- ⑥ Soft tissues
- ⑦ Tubes and infusion lines

① Tracheal and bronchial injuries or deviations

② thoracic cavity and lung fields  
(hemopneumothorax or pulmonary contusion)

⑤ Presence of fractures

⑥ Soft tissue opacities  
(Subcutaneous emphysema)③ Mediastinal enlargement or pneumomediastinum  
(Aortic injury, esophageal injury, tracheal injury)④ Diaphragmatic abnormalities  
(Diaphragmatic injury, pneumothorax)

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## SS FIXES

- Check **FIXES** to see what you forgot to do!

| FIXES |               |                                                        |
|-------|---------------|--------------------------------------------------------|
| F     | Finger & tube | Check all openings and tubes (e.g., urinary catheters) |
| I     | IV, IM        | Antibiotics, tetanus prophylaxis                       |
| X     | X-ray         | X-rays, CT scans                                       |
| E     | ECG           | Electrocardiogram                                      |
| S     | Splint        | Splint fixation                                        |



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## TERTIARY SURVEY

### ▪ Tertiary survey

#### Reexamination to Avoid Oversights

- **Situations Where Patients May Not Report or Cannot Express Symptoms**  
Alcohol consumption, impaired consciousness, sedation/analgesia, elderly patients, children, non-native speakers
- **Conditions That May Not Present Symptoms in the Supine Position**  
Vertebral compression fractures, non-deformed lower limb fractures, acetabular fractures (symptoms may not appear without weight-bearing)
- **Injuries That May Not Show Symptoms in the Early Stage**  
Conditions causing inflammation or ischemia, intestinal injuries, pancreatic injuries
- **Presence of Adjacent Organ Injuries That May Divert a Physician's Attention**  
Nerve, vascular, and ligament injuries associated with fractures/dislocations  
Multiple fractures in the same limb



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## SUMMARY OF INITIAL TRAUMA MANAGEMENT

### **Primary Survey (PS):**

Physiological evaluation and resuscitation (ABCDE)

### **Secondary Survey (SS):**

Anatomical evaluation and identification of injuries requiring definitive treatment

### **Tertiary Survey (TS):**

Reassessment for overlooked injuries



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## HAS THE QUALITY OF TRAUMA CARE IMPROVED?

➤ **Trauma mortality in Japan decreased post-JATEC implementation (2004-2011)**

Hondo K, Shiraishi A, Fujie S, et al. In-hospital trauma mortality has decreased in Japan possibly due to trauma education. *J Am Coll Surg* 2013;217:850-7.

➤ **10-year decline in in-hospital trauma mortality (2004-2013)**

Nagata I, Abe T, Uchida M, et al. Ten-year in hospital mortality trends for patients with trauma in Japan: A Multicentre observational study. *BMJ Open* 2018;8:e018635.

➤ **10-year decline in pediatric trauma mortality (2009-2018)**

Toida C, Muguruma T, Gakumazawa M, et al. Ten-year in-hospital mortality trends among Paediatric injured patients in Japan: A nationwide observational study. *J Clin Med* 2020;9:3273.

With advancements in Japan's trauma care system and education, in-hospital trauma mortality rates have declined.



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## NEXT STEP IN INITIAL TRAUMA MANAGEMENT?

A B **C** D E



Rapid and appropriate intervention for massive hemorrhage and hemorrhagic shock is crucial.



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# FUNDAMENTALS OF TRAUMA SURGERY

The most effective and immediate intervention 手術中  
 for abnormalities in **C**irculation  $\Rightarrow$  **T**rauma Surgery

Hemorrhage control  
 Evaluation of the injured area  
 Contamination control



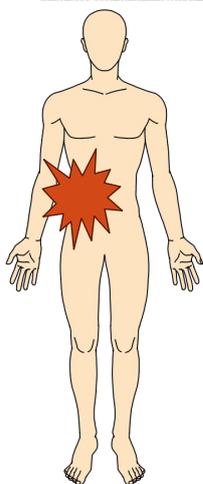
Determine if curative surgery is feasible



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## EXAMPLE CASE: ABDOMINAL HEMORRHAGE



### Primary survey

- A** Intact
- B** OK, but tachypnea
- C** Shock, FAST (+)
- D** Mild consciousness impairment, agitation
- E** BT 35.0°C

**Emergency  
 Laparotomy for  
 Intra-abdominal  
 Hemorrhage**



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## FOR EXAMPLE

Liver injury



For curative treatment, we will perform a posterior hepatic segmentectomy.

Spending a long time performing a complete posterior segmentectomy, including resection and anastomosis of the injured intestine.

- ✓ Hemorrhage control
- ✓ Contamination control

For a stable patient, this approach might have been effective.



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例えば . . . .

Liver injury



For curative treatment, we will perform a posterior hepatic segmentectomy.

Spending a long time performing a complete posterior segmentectomy, including resection and anastomosis of the injured intestine

**Despite**  
the patient being in a state of shock

- ✓ Hemorrhage control
- ✓ Contamination control

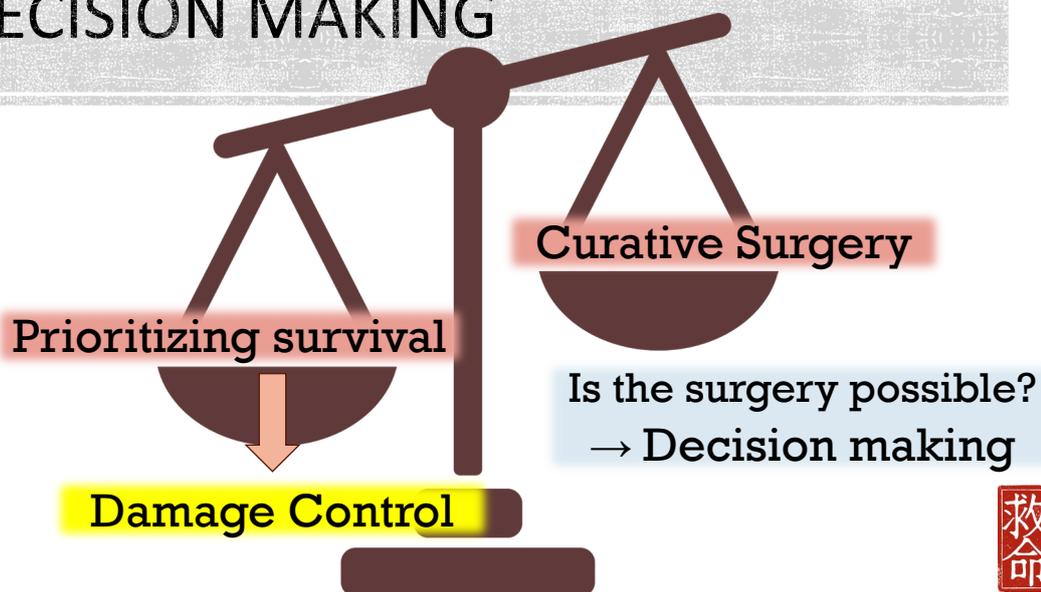
We were able to perform a **perfect curative surgery**.  
However, unfortunately, **the patient did not survive...**



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## DECISION MAKING



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## TODAY'S TOPICS



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2. **Damage Control Strategy and Damage Control Resuscitation**

3. Treatment Strategies Using the Hybrid Emergency Room System



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## WHAT IS DAMAGE CONTROL?



### Terms used in the U.S. Navy

When a warship is damaged, measures are taken to minimize the damage and allow the ship to return to port for repairs, so it can be restored to combat readiness.

This series of emergency actions is called **Damage Control.**



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## DAMAGE CONTROL STRATEGY IN TRAUMA CARE



A series of emergency interventions prioritizing patient survival.

### **Damage control strategy**

To minimize physiological deterioration and stabilize the patient in the ICU.

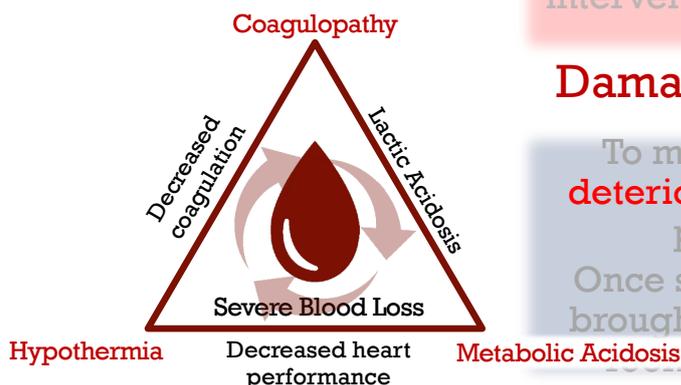
Once stabilized, the patient is brought back to the operating room for definitive repair.



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## DAMAGE CONTROL STRATEGY IN TRAUMA CARE

### Lethal Triad



A series of emergency interventions prioritizing patient survival.

### Damage control strategy

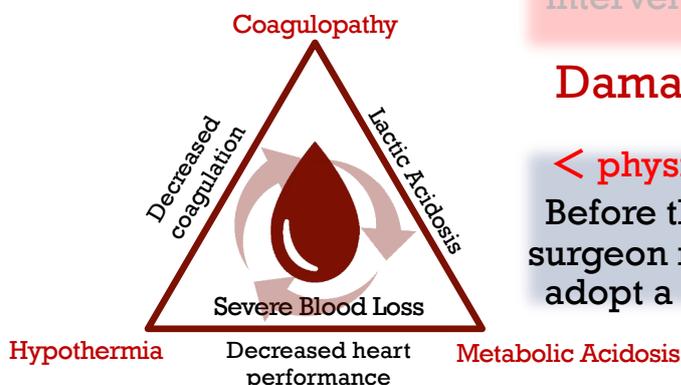
To minimize **physiological deterioration** and stabilize the patient in the ICU.

Once stabilized, the patient is brought back to the operating room for definitive repair.



## DAMAGE CONTROL STRATEGY IN TRAUMA CARE

### Lethal Triad



A series of emergency interventions prioritizing patient survival.

### Damage control strategy

< **physiological deterioration** >

Before the lethal triad sets in, the surgeon must make the decision to adopt a damage control strategy.



# DAMAGE CONTROL STRATEGY



# DAMAGE CONTROL RESUSCITATION

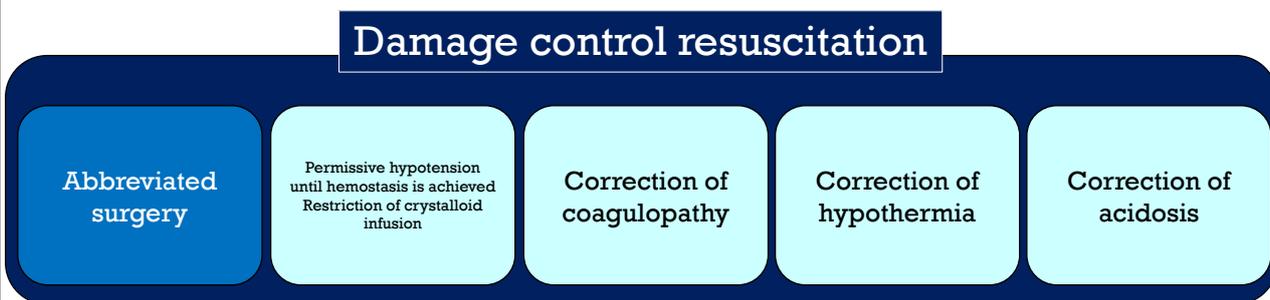
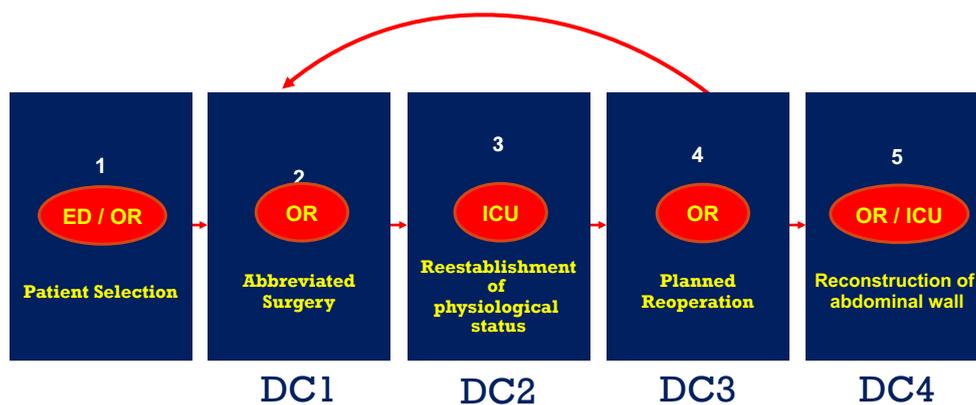


Figure 1: Concept of Damage Control Resuscitation



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## FIVE STEPS OF DAMAGE CONTROL SURGERY

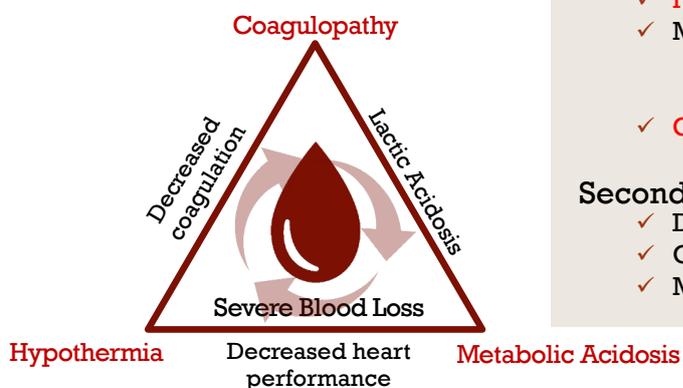


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## PATIENT SELECTION

### Lethal Triad



### Clinical indicators: The "Lethal Triad"

- ✓ Hypothermia < 34°C
- ✓ Metabolic acidosis
  - pH < 7.2
  - Lactate > 5 mmol/l
- ✓ Coagulopathy
  - Massive transfusion required

### Secondary factors

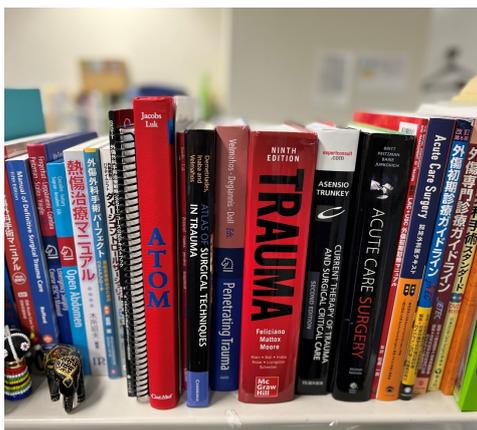
- ✓ Difficulty of definitive repair
- ✓ Operative time of >90 min
- ✓ Multiple complex injuries



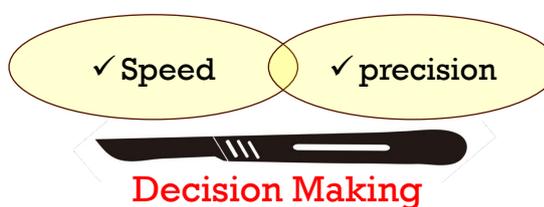
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# ABBREVIATED SURGERY



**Key principles:**  
 Rapid hemorrhage control  
 Rapid contamination control  
 Temporary abdominal closure

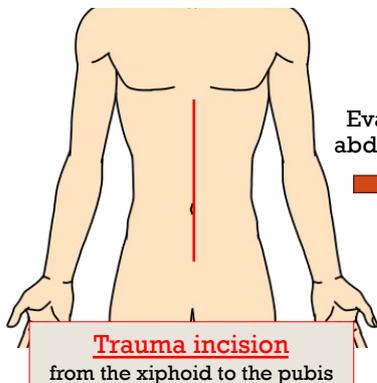


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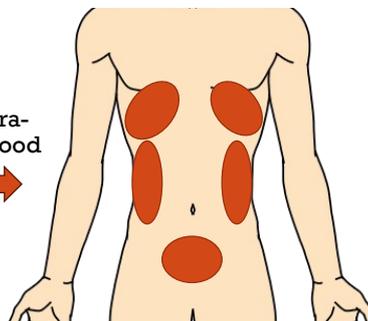
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# ABBREVIATED SURGERY

## Trauma laparotomy



Evacuate intra-abdominal blood



Remove gauze packs systematically from areas least likely to be injured first.

### Five-Point Packing

1. Right subdiaphragmatic space (around the liver)
2. Left subdiaphragmatic space (around the spleen)
3. Right paracolic gutter
4. Left paracolic gutter
5. Pelvic/rectovesical pouch



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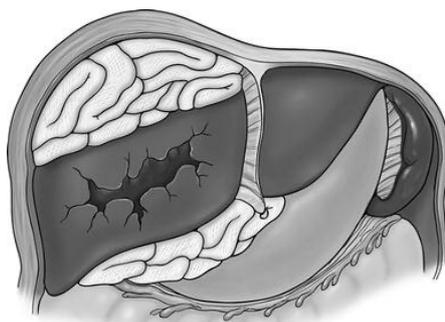
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## ABBREVIATED SURGERY

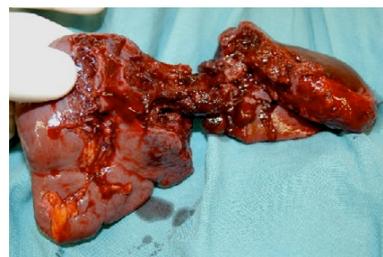
### Hemorrhage control

#### Techniques:

- Packing
- Resection
- Ligation
- Shunting



Liver injury



Splenic injury



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## ABBREVIATED SURGERY

### Contamination control

#### Techniques:

- Repair: Suturing
- Resection: Stapling
- Drainage



ATOM student manual

No bowel anastomosis is performed in this phase.



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## ABBREVIATED SURGERY

### Temporary abdominal closure

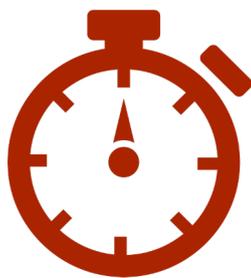


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## RESUSCITATION AND PLANNED REOPERATION

ICU resuscitation is performed, and the patient is returned to the OR for definitive repair.



Within **12–36 h** of the initial surgery

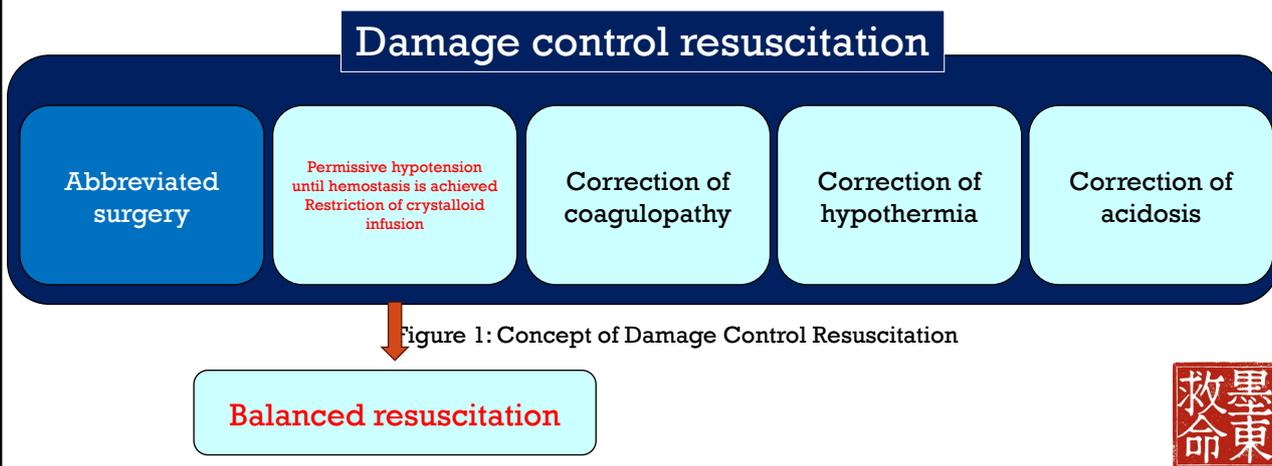
**Not too late, not too early!**

- Packing removal
- Confirm hemostasis
- Bowel anastomosis
- Fascial closure



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# DAMAGE CONTROL RESUSCITATION



# FLUID RESUSCITATION

Previous approach:

“C” abnormality  
Hemorrhagic shock = hypovolemic



Crystalloid solution for  
**Aggressive resuscitation**

However...



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## COMPLICATIONS OF AGGRESSIVE CRYSTALLOID RESUSCITATION

### ✓ Increased complications

- Cardiorespiratory complications
- Gastrointestinal dysfunction
- Progression of Coagulopathy
- Immune/inflammatory dysfunction
- Abdominal compartment syndrome
- Metabolic acidosis
- Hypothermia
- Increased mortality

### ✓ Risk of re-bleeding

- Dislodging blood clots from increased pressure in injured areas



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## BALANCED RESUSCITATION

### ✓ Permissive hypotension

Maintain **low blood pressure** until **hemorrhage is controlled**

Patients without brain injury

SBP 80–90 mmHg  
(MAP 50–60 mmHg)

Patients with severe traumatic  
brain injury (GCS ≤8)

MAP 80–90 mmHg



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## BALANCED RESUSCITATION

### ✓ Permissive hypotension

- No difference in mortality between prehospital permissive hypotension and normal blood pressure groups.  
Dutton RP, Mackenzie CF, Scalea TM. Hypotensive resuscitation during active hemorrhage: impact on in-hospital mortality. *J Trauma*. 2002;52(6):1141-1146. doi:10.1097/00005373-200206000-00020
- Permissive hypotension reduced early (24-hour) mortality. Morrison CA, Carrick MM, Norman MA, et al. Hypotensive resuscitation strategy reduces transfusion requirements and severe postoperative coagulopathy in trauma patients with hemorrhagic shock: preliminary results of a randomized controlled trial. *J Trauma*. 2011;70(3):652-663. doi:10.1097/TA.0b013e31820e77ea

Management with **hypotension until hemostasis** is a permissible strategy.



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## SYNTHETIC COLLOIDS?

Colloids (e.g., hydroxyethyl starch, albumin) **should be avoided** in trauma patients with ongoing bleeding.

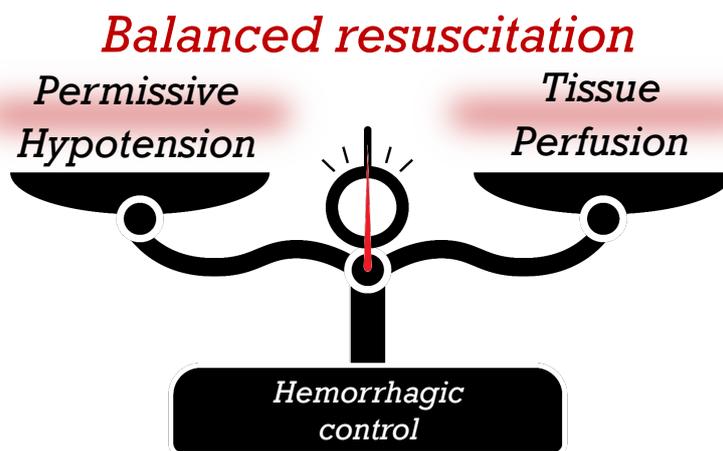
- Increased risk of acute kidney injury and multiple organ failure.  
Williams T, Parker R, The role of synthetic colloids for the volume resuscitation of critically ill adults, *Emergency Medicine Journal* 2013;30:269
- increased incidence of acute kidney injury and the need for renal replacement therapy  
Hilbert-Carius P, Schwarzkopf D, Reinhart K, et al. Synthetic colloid resuscitation in severely injured patients: analysis of a nationwide trauma registry (TraumaRegister DGU). *Sci Rep*. 2018;8(1):11567. Published 2018 Aug 1. doi:10.1038/s41598-018-30053-0



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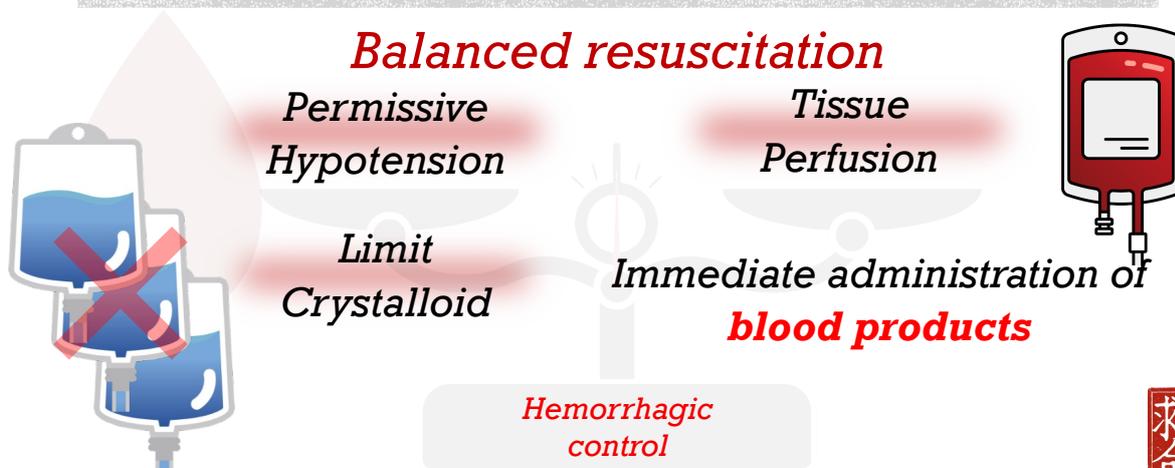
# BALANCED RESUSCITATION



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# BALANCED RESUSCITATION



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# DAMAGE CONTROL RESUSCITATION

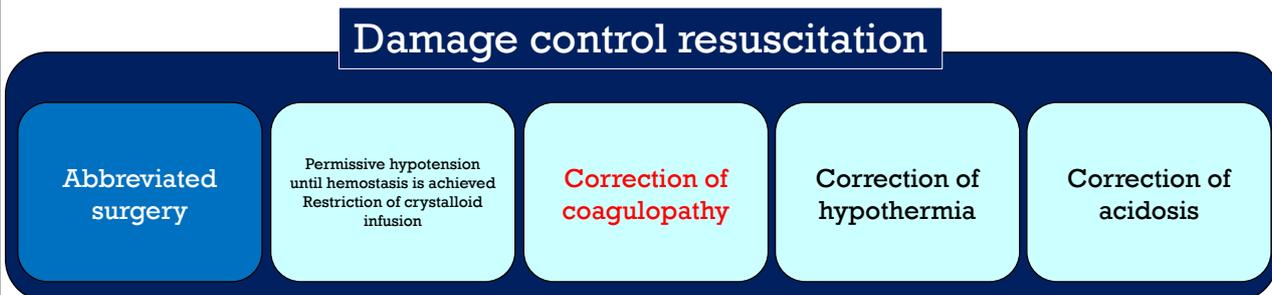
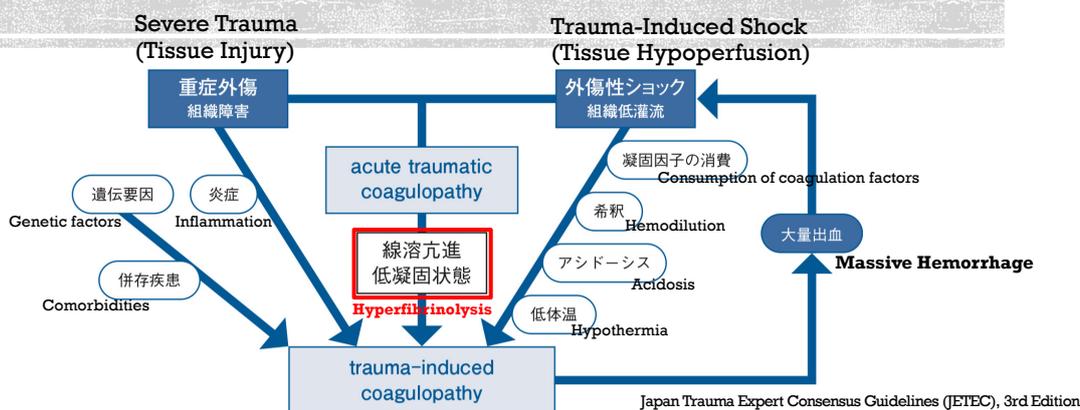


Figure 1: Concept of Damage Control Resuscitation



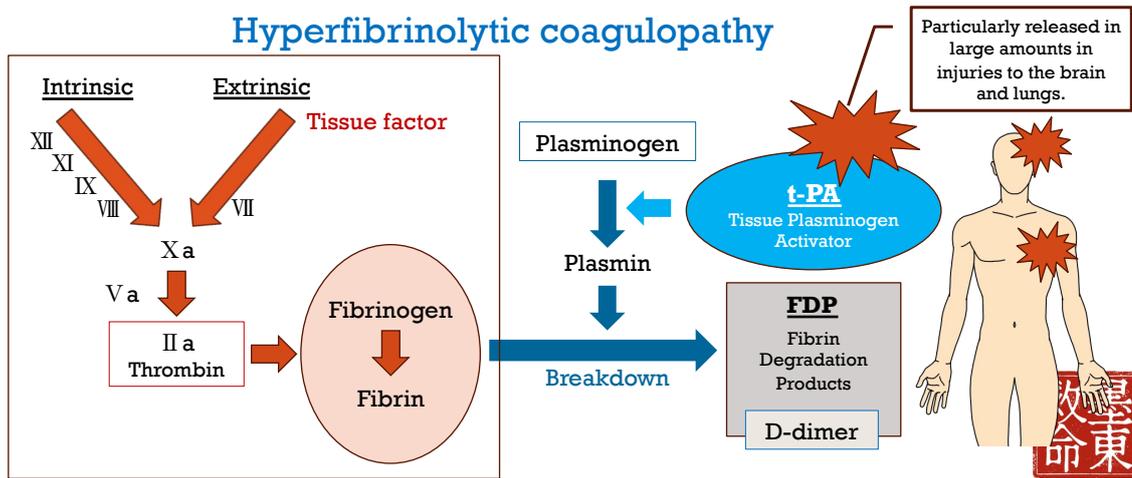
# WHAT IS TRAUMA-INDUCED COAGULOPATHY?



A complex condition involving multiple factors. In particular, "**fibrinolytic coagulopathy**"



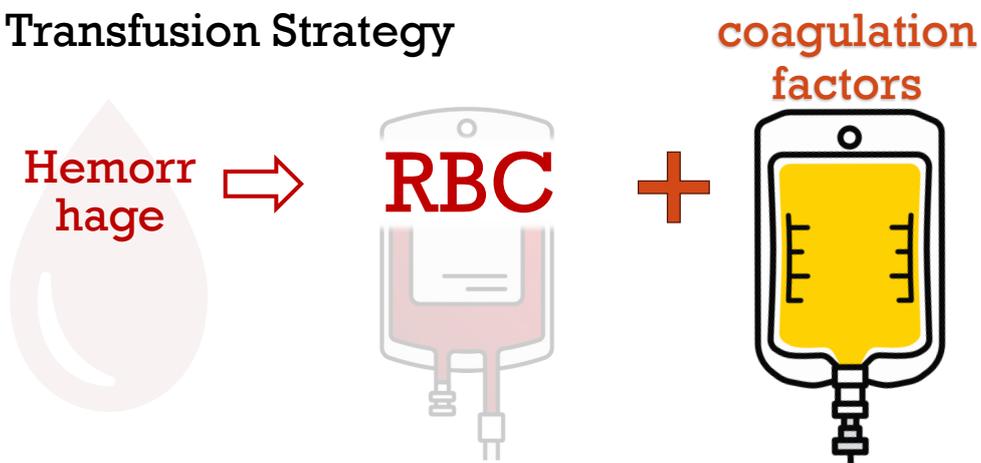
# WHAT IS TRAUMA-INDUCED COAGULOPATHY?



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# HEMOSTATIC RESUSCITATION

✓ **Transfusion Strategy**



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## HEMOSTATIC RESUSCITATION

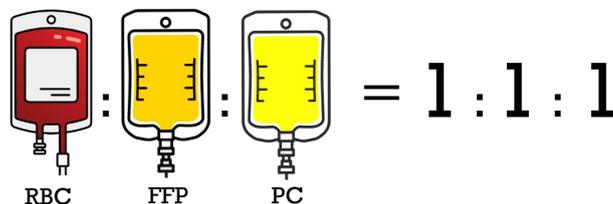
### ✓ Optimal Transfusion Ratio for Trauma Patients

- **FFP:PC:RBC = 1:1:1 vs. 1:1:2, the 1:1:1 group showed higher success rate.**

Holcomb JB, Tilley BC, Baraniuk S, et al. Transfusion of plasma, platelets, and red blood cells in a 1:1:1 vs a 1:1:2 ratio and mortality in patients with severe trauma: the PROPPR randomized clinical trial. *JAMA*. 2018;313(5):471-482. doi:10.1001/jama.2015.12

- **Administering FFP and platelets (PC) at a high ratio to RBCs. (EAST Guideline)**

Cannon JW, Khan MA, Raja AS, et al. Damage control resuscitation in patients with severe traumatic hemorrhage: A practice management guideline from the Eastern Association for the Surgery of Trauma. *J Trauma Acute Care Surg*. 2017;82(3):605-617. doi:10.1097/TA.0000000000001333

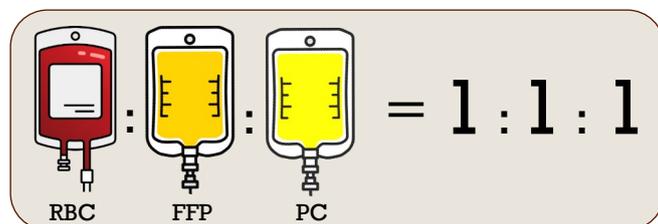


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## MASSIVE TRANSFUSION PROTOCOL (MTP)

### ✓ Massive Transfusion Protocol



× How many units?  
For how long?  
When to stop?

- **Timely delivery and administration of blood components in proper ratios is essential.**
- **Standardized hospital protocols improve patient outcomes.**

For example, once an MTP is activated, transfusions should continue at appropriate ratios until a stop order is issued.



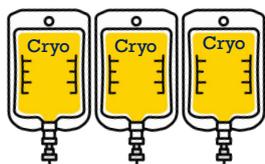
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## HEMOSTATIC RESUSCITATION

✓ **Fibrinogen** is the first to fall below critical levels.

### ① Cryoprecipitate



- Produced from 4–5 units of FFP
- It is small, quickly dissolvable, and can be administered in a shorter time than FFP.

### ② Fibrinogen concentrates



- In Japan, cryoprecipitate is not covered by insurance for trauma patients.



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## HEMOSTATIC RESUSCITATION

✓ **Whole Blood (WB) Transfusion**

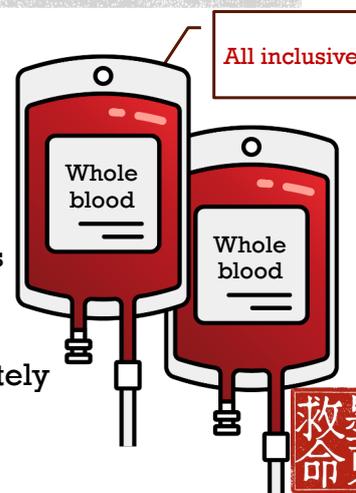
- Recently regained attention, particularly in the US; high hemostatic efficacy observed in combat settings.

**LTOWB: Low titer type O whole blood**

- Whole blood with low-titer anti-A and anti-B antibodies

**Advantages of WB:**

No need for thawing; Can be administered immediately through a single IV line; Enables rapid, balanced transfusion therapy



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## HEMOSTATIC RESUSCITATION

- ✓ Tranexamic acid :TXA – inhibits plasmin activity

**CRASH2**  
Clinical Randomisation of an Antifibrinolytic  
in Significant Haemorrhage

The CRASH-2 trial: a randomised controlled trial and economic evaluation of the effects of tranexamic acid on death, vascular occlusive events and transfusion requirement in bleeding trauma patients

- TXA administration significantly reduces in-hospital mortality in trauma patients with severe bleeding.
- Time-sensitive administration (within 3 h) is crucial.

**Administer 1g IV over 10 minutes  
Followed by 1g IV over 8 hours**



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## HEMOSTATIC RESUSCITATION

- ✓ Calcium Administration in Trauma

- Calcium is a critical cofactor for blood coagulation.
- Massive transfusion leads to hypocalcemia due to citrate in stored blood products.
- Severe hypocalcemia can cause cardiac arrhythmias and cardiac arrest.



DELTA  
DEVELOPMENT TEAM

**Maintain calcium levels within the normal  
range ( $\geq 0.9$  mmol/L).**



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## MONITORING OF COAGULATION

### ✓ Standard blood tests:

- PT, APTT, Fibrinogen, FDP, D-dimer, etc  
→ Issue: These tests take time to return results

### ✓ Point-of-care testing device

- Provides real-time fibrinogen levels  
→ Only shows current values (must be repeated frequently)



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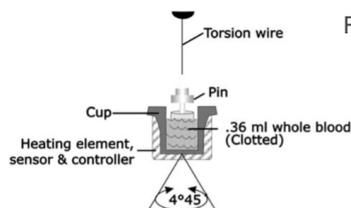
## MONITORING OF COAGULATION

### ✓ Goal-directed therapy with viscoelastic tests

- Provides detailed coagulation profiles
- TEG<sup>®</sup>, ROTEM<sup>®</sup>



Haemonetics HPより引用



American J Hematol, Volume: 89, Issue: 2, Pages: 228-232,  
First published: 03 October 2013, DOI: (10.1002/ajh.23599)



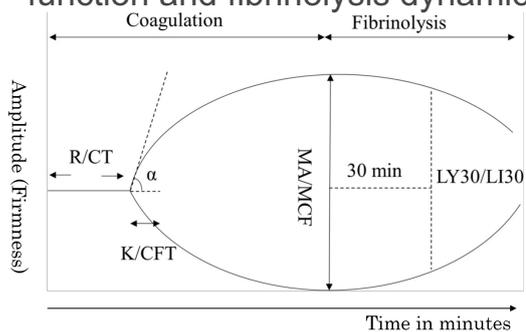
Werfen HPより引用



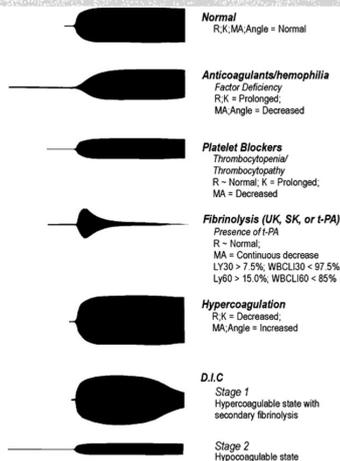
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# MONITORING OF COAGULATION

- Results are available in approx. 15 min
- Real-time assessment of coagulation function and fibrinolysis dynamics.



Zhu Z., et al. Utility of viscoelastic hemostatic assay to guide hemostatic resuscitation in trauma patients: a systematic review. World J Emerg Surg. 2022;17(1):48. CC BY 4.0より引用して改変



American J Hematol, Volume: 89, Issue: 2, Pages: 228-232, First published: 03 October 2013, DOI: (10.1002/ajh.23999)



# CELL SALVAGE (CELL SAVER®)



Trusted evidence.  
Informed decisions.  
Better health.

Cochrane review 2015

Cochrane Database of Systematic Reviews

[Intervention Review]

## Cell salvage in emergency trauma surgery

- No significant differences between the two groups (cell salvage vs. bank blood) in terms of survival, post-operative infection, or cost.
- Reduction in the amount of banked blood required for transfusion within the first 24 hours following injury among people receiving cell salvage.

**Potentially effective**

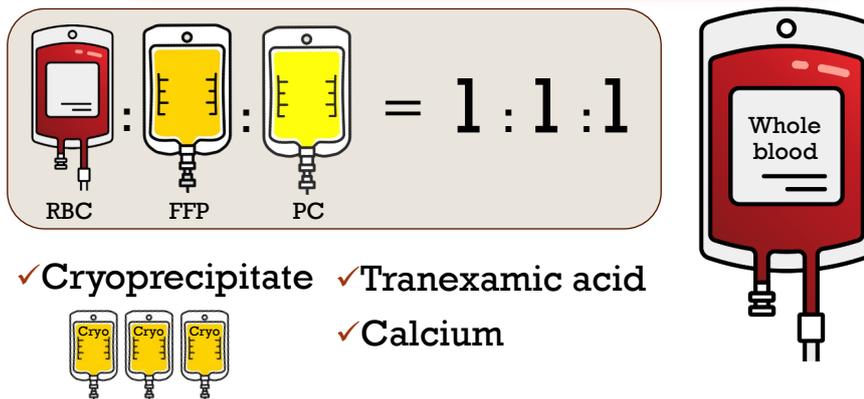


泉工医科工業株式会社HPより



# HEMOSTATIC RESUSCITATION

## Massive Transfusion Protocol



# DAMAGE CONTROL RESUSCITATION

## Damage control resuscitation

Abbreviated surgery

Permissive hypotension until hemostasis is achieved  
Restriction of crystalloid infusion

Correction of coagulopathy

Correction of hypothermia

Correction of acidosis

Rapid and precise hemostasis and transfusion



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## KEY OF TRAUMA RESUSCITATION

Primary survey focuses on **physiological assessment** and resuscitation

Trauma patients with hemorrhagic shock require **rapid hemorrhage control** and **blood transfusion strategies** (Damage Control Resuscitation).



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## 本日の内容



1. "Preventable Trauma Deaths" and Initial Trauma Management Guidelines

2. Damage Control Strategy and Damage Control Resuscitation

3. **Treatment Strategies Using the Hybrid Emergency Room System**



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## HYBRID ER SYSTEM (HERS)



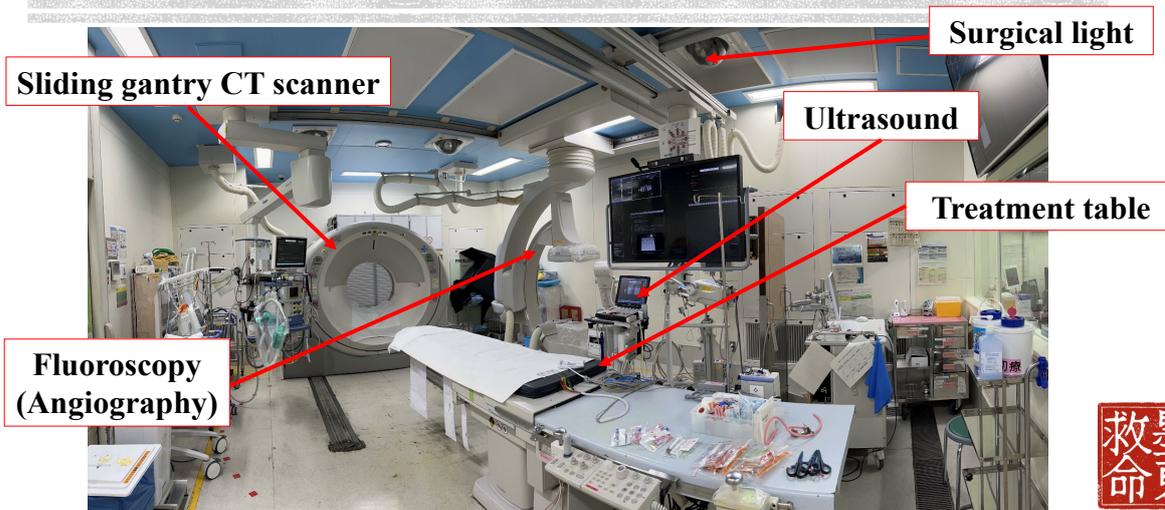
- Implemented on July 24, 2014, as the second system of its kind worldwide.
- Allows simultaneous evaluation and treatment without patient transfer.



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## HYBRID ER SYSTEM (HERS)



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## HYBRID ER SYSTEM (HERS)

Eliminates the need for room transfers, enabling:

- More detailed evaluations
- Faster resuscitation  
(improved primary survey process)
- Rapid hemorrhage control in hemorrhagic shock patients



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## HYBRID ER SYSTEM (HERS)

➤ **HERS improves trauma survival rates.**

Kinoshita T, Yamakawa K, Matsuda H, et al. The survival benefit of a novel trauma workflow that includes immediate whole-body computed tomography, surgery, and interventional radiology, all in one trauma resuscitation room: a retrospective historical control study. *Ann Surg.* 2019;269(2):370–376.

➤ **HERS enables faster angioembolization in pelvic fracture patients, improving survival in severe cases.**

Ito K, Nagao T, Tsunoyama T, et al. Hybrid emergency room system improves timeliness of angioembolization for pelvic fracture. *J Trauma Acute Care Surg.* 2020;88(2):314–319. doi:10.1097/TA.0000000000002544.

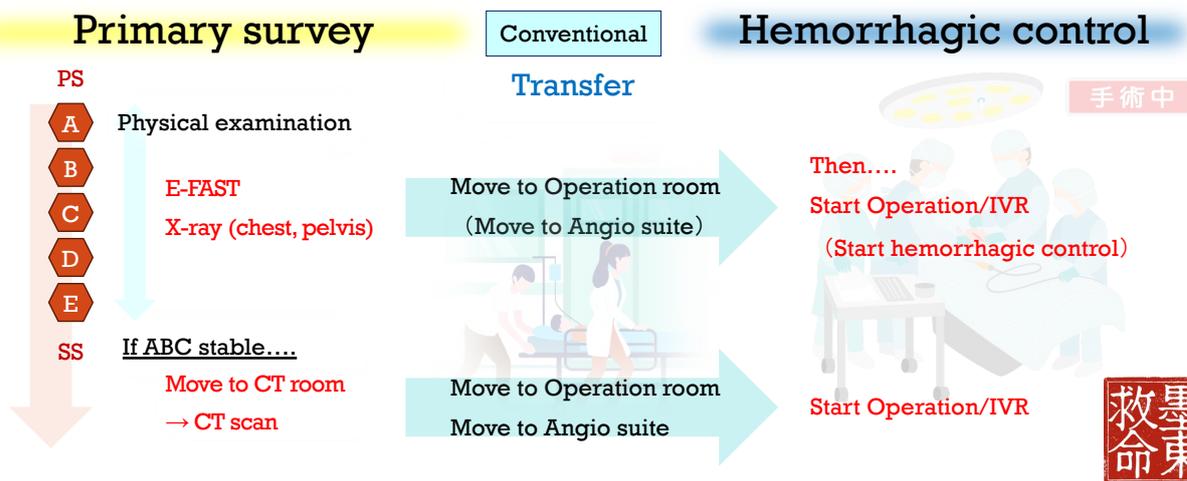
HERS may contribute to improving the survival rate of trauma patients requiring emergency hemostasis.



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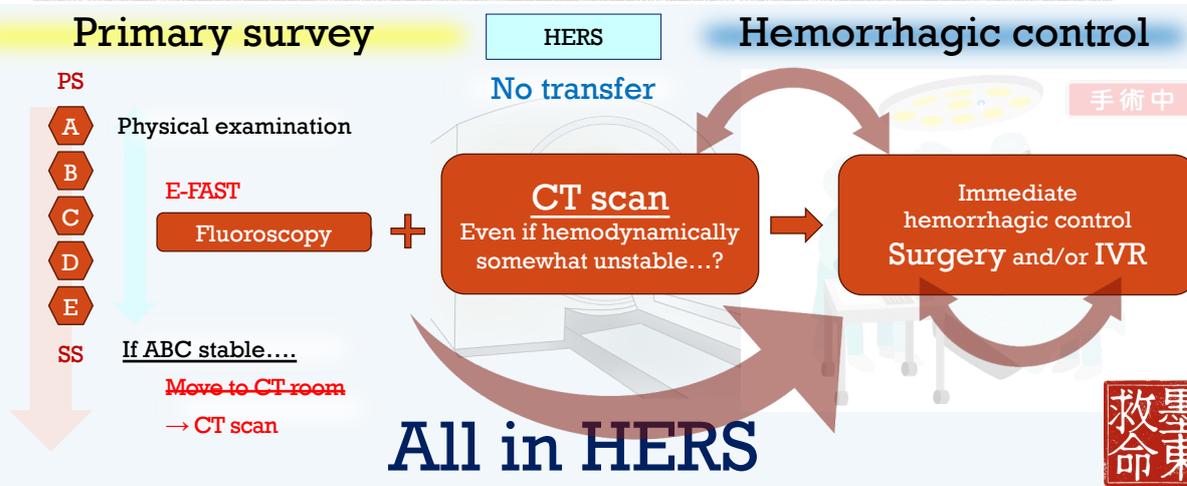
## PS/HEMORRHAGIC CONTROL IN HERS



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## PS/HEMORRHAGIC CONTROL IN HERS

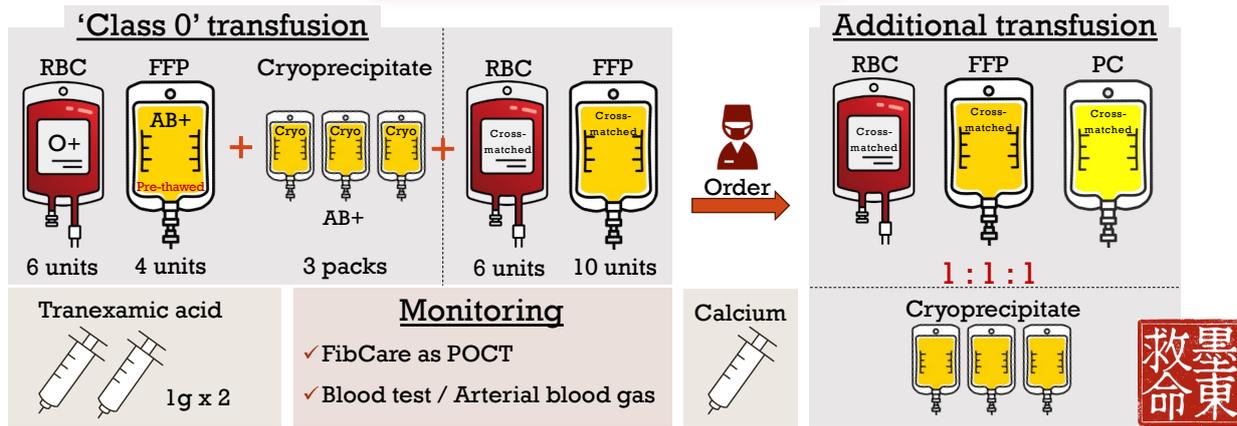


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# HEMOSTATIC RESUSCITATION IN BOKUTOH HOSPITAL

## Hemostatic resuscitation



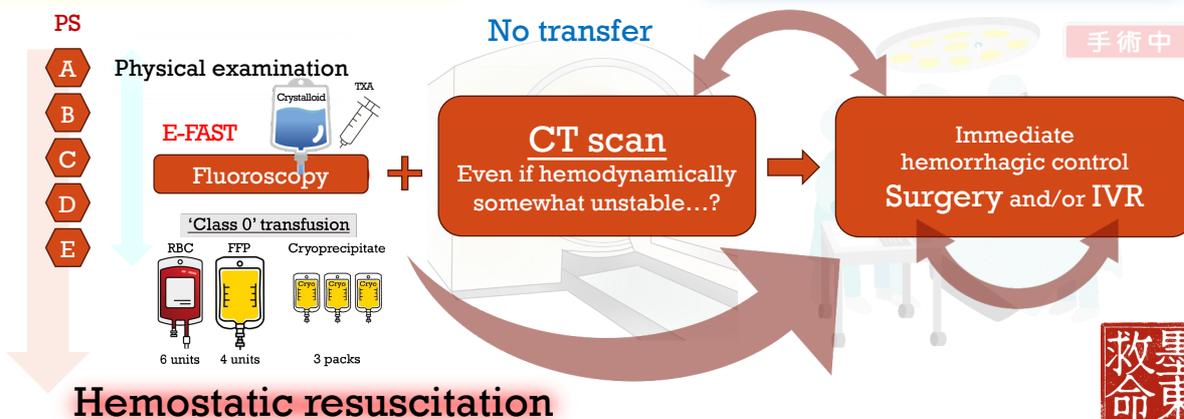
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# DCR IN BOKUTOH HOSPITAL

## Primary survey

## Hemorrhagic control



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# DCR IN HERS

**HERS**

- Primary survey
- Hemorrhagic control
- Hemostatic resuscitation

A strategic mistake is difficult to resolve with hardware alone.

Decision-making to steer the ship is the most crucial factor.

**LEADERSHIP-TEAMWORK**

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# HYBRID ER SYSTEM (HERS)

- Even with **HERS**, the **fundamental principles of trauma care** remain unchanged!

**KEEP IT SIMPLE**

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## SUMMARY

- ✓ A systematic **physiological assessment** and resuscitation are crucial in the initial trauma care.
- ✓ For severe trauma cases with hemorrhagic shock, a strategy based on the concept of **damage control resuscitation** is essential for survival.
- ✓ By establishing a trauma care system rooted in these "**fundamental principles of trauma management**," we aim to further improve survival rates.



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## QUESTION ?



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