



Anesthesia in trauma and battlefield

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Content

- Tactical combat casualty care (TCCC)
- Triage
- Shock
- Anesthesia in trauma & battlefield
- Field medical services



Concept of battlefield medical service

“Good medicine in bad places”

Spectrum of Military Operations



Tactical combat casualty care (TCCC)

- Care under fire
- Tactical field care
- Tactical evacuation care



Management during tactical combat casualty care



A : Airway

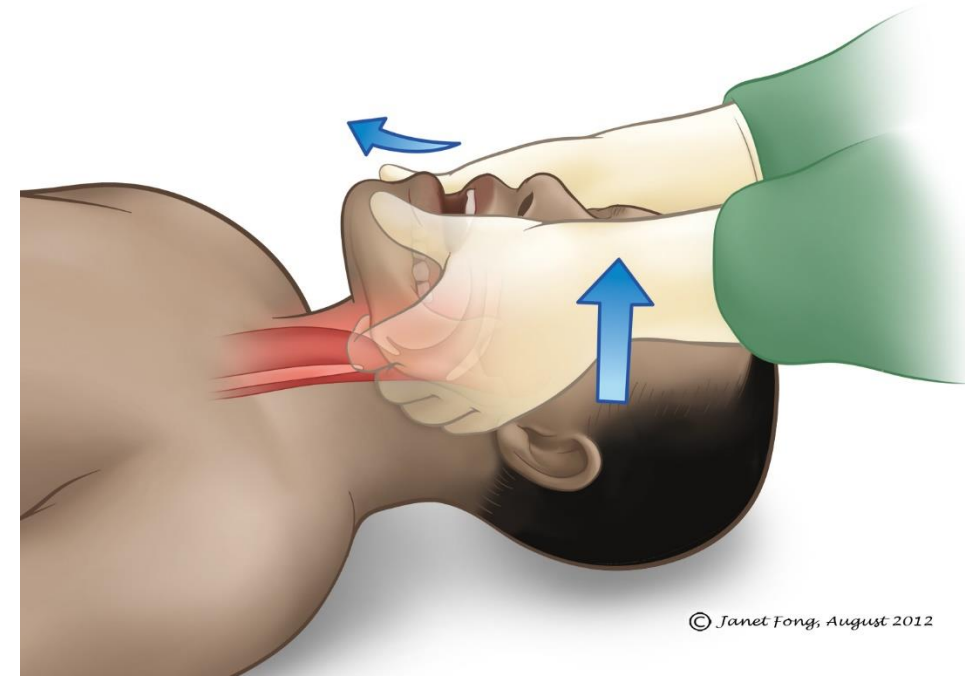
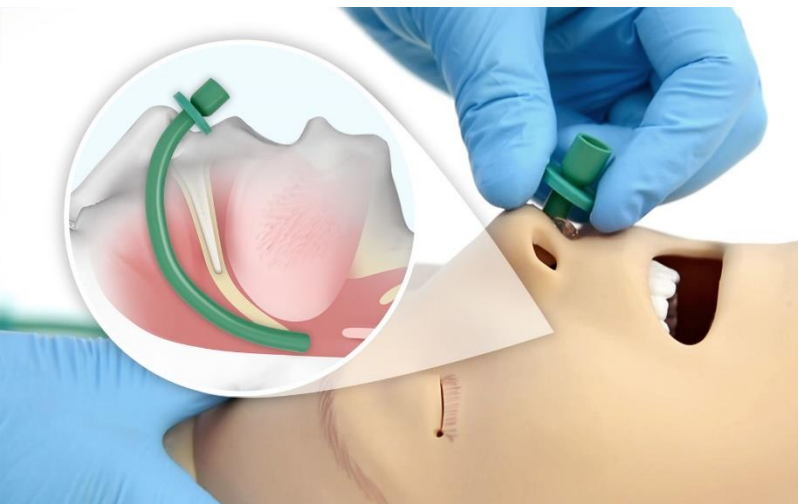
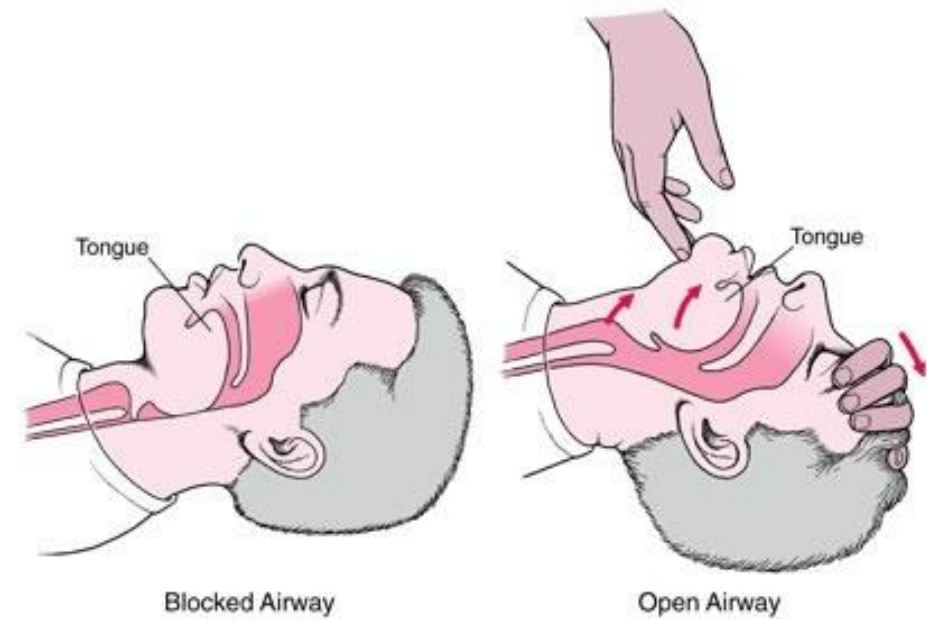
B : Breathing

C : Circulation

D : Disability

Open airway maneuver

- Head-tilt / Chin-lift
- Jaw thrust
- Nasopharyngeal airway





Triage

Triage

Objective

- Treatment
- Send back

Principle

- Effective use of resource
- Return troop to duty fast as possible
- Continue and re-triage
- Quickly move patients
- Planning, preparing, training

Triage

Immediate

(Life threatening condition, need immediate treatment)

Delayed

(After initial treatment, they can wait for hours for definite treatment)

Minimal

(Need for treatment but can wait for days, they can help themselves)

Expectant

(Unlikely survival, use more medical resource but less effective)

Immediate

- Airway obstruction,
- Uncontrolled bleeding,
- Shock
- Critical area burn

Delayed

- Large muscle wounded
- Fracture
- Abdominal wound
- Burn > 20% without critical area

Minimal

- Minor laceration
- Abrasion
- Tendinitis
- Myofascial pain
- Minimal burn

Expectant

- Penetrating head injury
- High spinal cord injury
- Burn > 85%

Triage

“Triage is a fluid process at all levels, with altered situations and resources requiring a change in category at any time and in any setting.”

Factor affect triage

- External factor
 - Situation and mission
 - Medical re-supply
 - Time
- Internal factor
 - Medical supplies
 - Space/Capability
 - Personnel



Triage decision making

Walking → NONEMERGENT

Emergency airway management

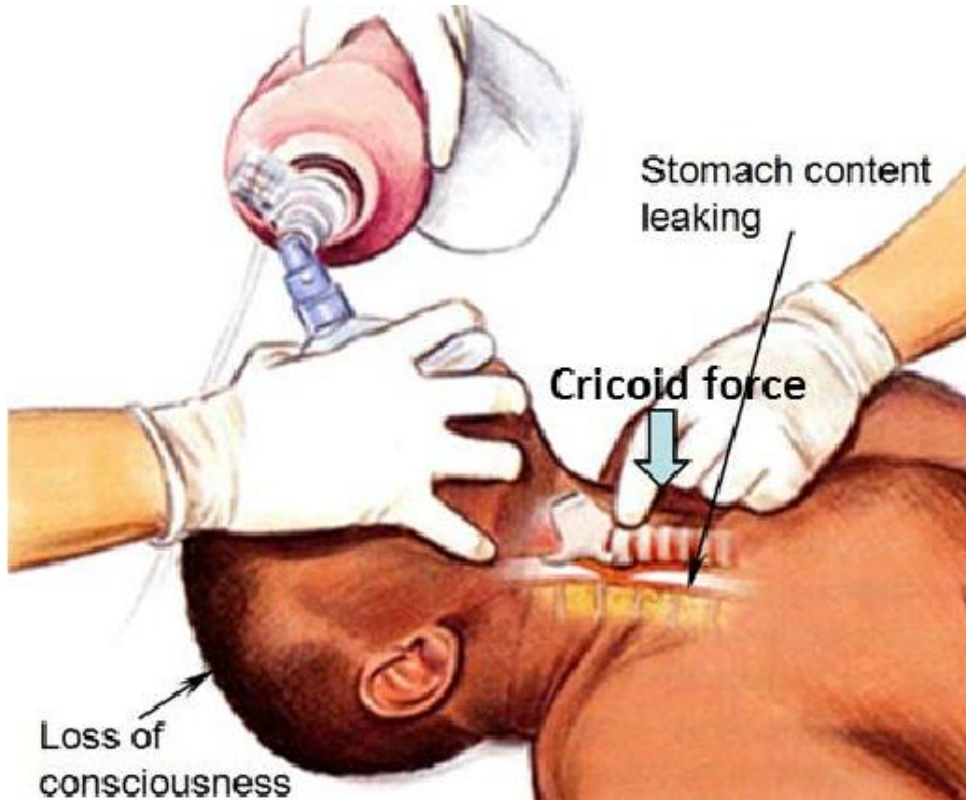
Indication

- Cardiac or respiratory arrest
- Respiratory insufficiency
- Airway protection
- Need for deep sedation or general anesthesia
- Ventilation management of patients with IICP
- Delivery of a 100% fraction of inspired oxygen (FiO_2)
- Facilitation of the diagnostic workup in uncooperative patients

Endotracheal intubation

- Aspiration prophylaxis
- Protection cervical spine
- Personnel
- Adjunct to endotracheal intubation
- Facial and pharyngeal trauma

Aspiration prophylaxis



- Cause
 - Ingestion food, fluid, blood
 - Delay gastric emptying time
- Cricoid pressure
 - Recommended
 - Worsen laryngoscopic view
 - Low pressure ventilation if needed

Protection cervical spine

- Manual-in-line stabilization during intubation
- Awake FOB intubation
- Indirect video laryngoscope



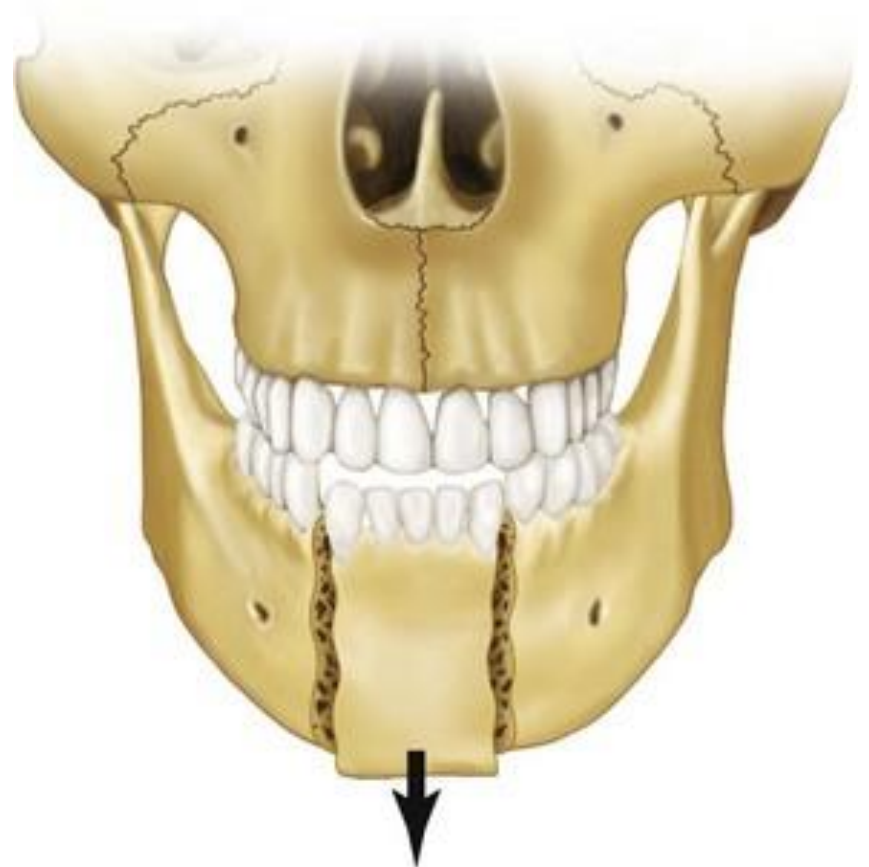
Adjunct endotracheal intubation

- Supraglottic airway
- Gum elastic bougie
- Video-laryngoscopy
- Equipment for surgical airway management



Facial or pharyngeal trauma

- Airway obstruction – soft tissue hematoma and swelling
- Sign of early intubation
 - Intraoral hemorrhage
 - Pharyngeal erythema
 - Change in voice
- Facial fracture
 - Mandibular : intubation easier
 - Trismus : improve with NMB



Shock



Shock

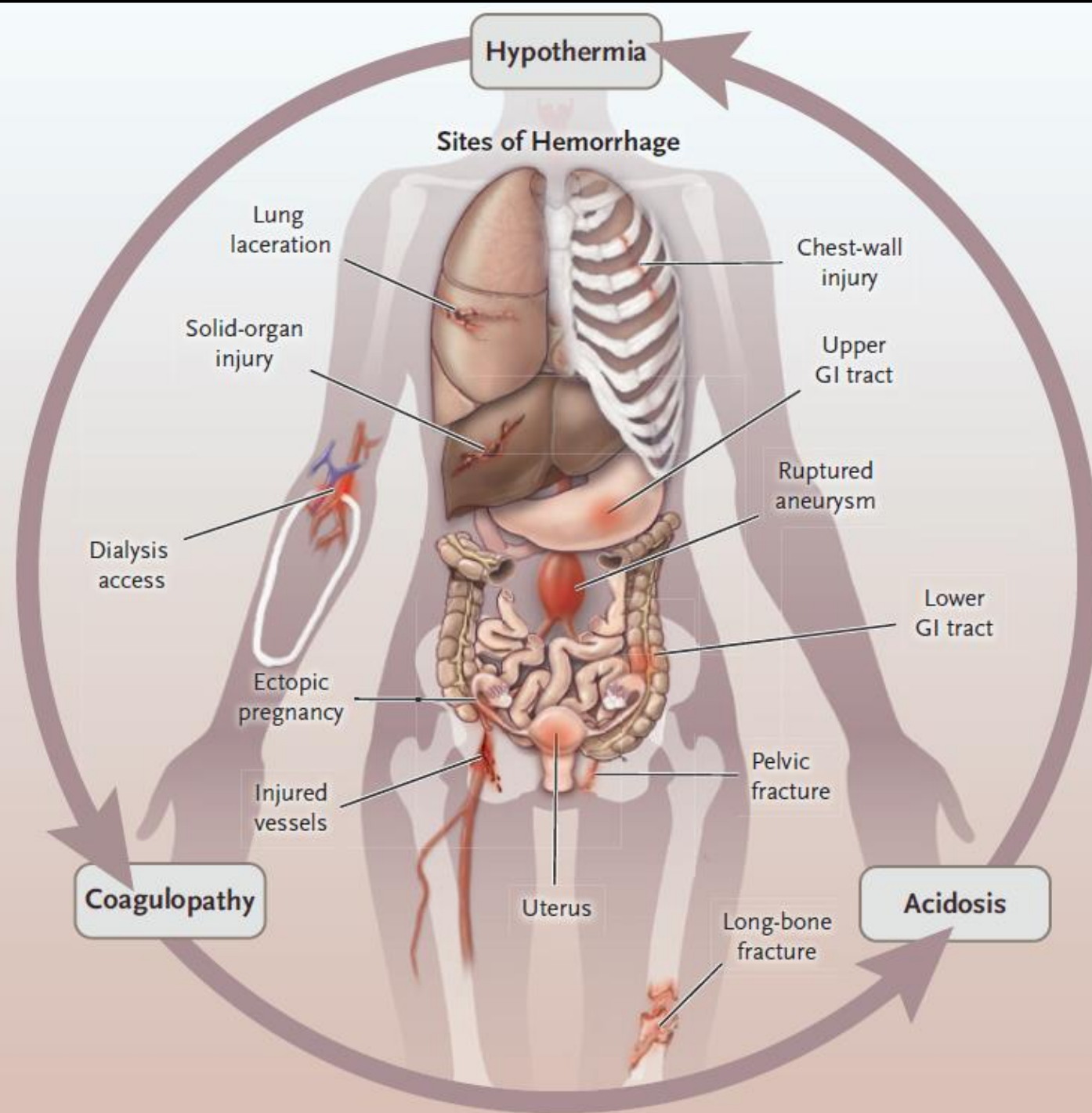
- Hypovolemic shock
- Cardiogenic shock
- Distributive / Septic shock
- Other type of shock



Shock = Poor tissue perfusion

$$BP = CO \times SVR$$

$$CO = SV \times HR$$



Treatment of Hemorrhagic Shock

- Prehospital level
- Hospital level

Exsanguinating hemorrhage is the cause of most preventable deaths during war

Prehospital intervention

- Hemorrhagic identification and control
 - Compressible site
 - Junctional site
 - Non-compressible site
- Limited resuscitation
- Hypothermia prevention
- Rapid transport



Hospital intervention



- Rapid identification of blood loss
 - Hx and PE
 - Laboratory as need
 - Immediate resuscitation
 - Massive blood transfusion protocol
- Definite hemostasis
- Posthemostasis

Table 2. Classification of Hemorrhagic Shock.*

Shock Class	Blood Loss† <i>ml (%)</i>	Heart Rate <i>beats/min</i>	Blood Pressure	Pulse Pressure	Respiratory Rate <i>breaths/min</i>	Mental Status
I	<750 (15)	<100	Normal	Normal	14–20	Slightly anxious
II	750–1500 (15–30)	100–120	Normal	Narrowed	20–30	Mildly anxious
III	1500–2000 (30–40)	120–140	Decreased	Narrowed	30–40	Anxious, confused
IV	>2000 (>40)	>140	Decreased	Narrowed	>35	Confused, lethargic

* Data are from the American College of Surgeons Committee on Trauma.⁴²

† Blood-loss volume and percentage of total blood volume are for a male patient with a body weight of 70 kg.

Damage-Control Resuscitation

- Avoid or correct hypothermia
- Apply direct pressure or a tourniquet proximal to sites of hemorrhage
- Delay fluid administration until the time of definitive hemostasis
- Minimize crystalloid infusions (<3 liters in the first 6 hr)
- Use a massive-transfusion protocol
- Avoid delays in definitive hemostasis
- Minimize imbalances in plasma, platelet, and red-cell transfusions
- Obtain functional laboratory
- Selectively administer pharmacologic adjunct

Phase of resuscitation

- **Phase 1**
Uncontrolled Hemorrhage
- **Phase 2**
Controlled Hemorrhage
- **Phase 3**
Restoration of Physiology

Phase of resuscitation

- **Phase 1**
Uncontrolled Hemorrhage

- Ongoing active bleeding
- Focus on damage control
- Pragmatic resuscitation

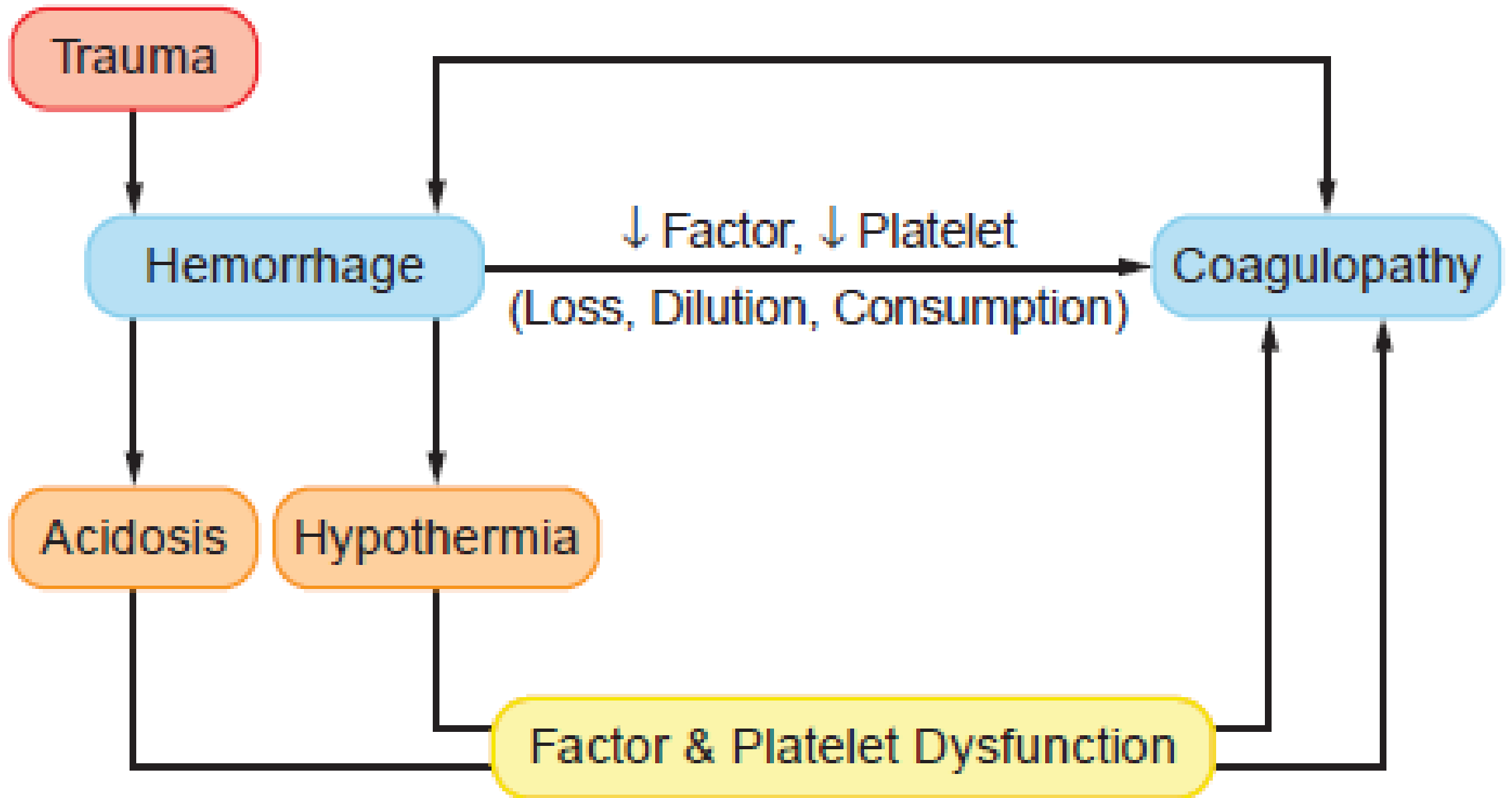
- **Phase 2**
Controlled Hemorrhage

- **Phase 3**
Restoration of Physiology

Special consideration

- Permissive hypotension
 - Controversial
 - SBP 70-100, MAP 50-60
 - Avoid in elderly, brain injury
- Hemostasis resuscitation
 - Bloody vicious cycle : hypothermia, acidosis, coagulopathy
 - PRBC : FFP : PLT = 1 : 1 : 1

“Bloody Vicious Cycle” or “Lethal Triad”



Medication for resuscitation

- Procoagulant
 - Tranexamic acid : antifibrinolytic 1 gm in 3 hour
 - Activated recombinant factor VII
 - Prothrombin complex concentrate
 - Fibrinogen concentrate
- Hydrocortisone : potent mineralocorticoid 100 mg
- Calcium : for massive blood transfusion
- Vasopressor
 - Reduce blood product & fluid requirement
 - Associated higher mortality

Phase of resuscitation

- Phase 1
Uncontrolled Hemorrhage

- **Phase 2**
Controlled Hemorrhage

- Phase 3
Restoration of Physiology

- Major bleeding sources under control
- Focus on goal-directed
- Tailored management of coagulopathy and resuscitation

Phase of resuscitation

- **Phase 1**
Uncontrolled Hemorrhage

- **Phase 2**
Controlled Hemorrhage

- **Phase 3**
Restoration of Physiology

- Hemorrhage has been fully controlled
- Focus on end-organ perfusion
- Optimization of physiologic state

TABLE 66.2 Phases of Major Traumatic Resuscitation

	Phase 1	Phase 2	Phase 3
Clinical status	<ul style="list-style-type: none"> ■ Life-threatening uncontrolled hemorrhage 	<ul style="list-style-type: none"> ■ Ongoing hemorrhage—not immediately life-threatening—partial surgical control 	<ul style="list-style-type: none"> ■ Hemorrhage controlled
Clinical priorities	<ul style="list-style-type: none"> ■ STOP THE BLEEDING ■ Call for HELP ■ Control airway, FiO₂ 1.0 ■ Damage control resuscitation <ul style="list-style-type: none"> ■ SBP <100 mm Hg ■ MAP 50-60 mm Hg ■ Consider modifications if TBI, carotid stenosis, CAD 	<ul style="list-style-type: none"> ■ TAILORED RESUSCITATION ■ Place supportive lines (arterial/CVC) ■ Prevent hypothermia <ul style="list-style-type: none"> ■ Esophageal temperature probe ■ Warmed fluids ■ Warming blankets (upper/lower) ■ Increase room temperature 	<ul style="list-style-type: none"> ■ RESTORE PHYSIOLOGY ■ Rapid intravascular filling ■ Stepwise deepening of anesthesia <ul style="list-style-type: none"> ■ Fentanyl boluses ■ Increased volatile anesthetics ■ Additional lines (urinary catheter, nasogastric tube) ■ Communicate with all team members and ICU
Blood products	<ul style="list-style-type: none"> ■ Activate MTP ■ Consider emergency (uncrossmatched blood products) ■ Early use ■ Empiric 1:1:1 ratio (PRBC:FFP:platelets) 	<ul style="list-style-type: none"> ■ Viscoelastic monitoring to guide coagulation products ■ Hb to guide red blood cell transfusion 	<ul style="list-style-type: none"> ■ Only as required on testing ■ Deactivate MTP when appropriate
Crystalloids/colloids	<ul style="list-style-type: none"> ■ Cautious use 	<ul style="list-style-type: none"> ■ Use for hypovolemia with normal coagulation/Hb ■ User serial lactate/BD to guide fluid requirements 	<ul style="list-style-type: none"> ■ Attempt to normalize lactate/BD
Special points	<ul style="list-style-type: none"> ■ Consider CaCl₂ 1 g for every three PRBC ■ Large bore IV access (>16 G) or CVC ■ Rapid infusing system ■ Avoid vasoconstrictors 	<ul style="list-style-type: none"> ■ Consider cell salvage if appropriate ■ Aim to repeat viscoelastic testing every 30 min ■ Consider TEE for difficult cases 	<ul style="list-style-type: none"> ■ Consider vasoactive infusions if appropriate/necessary

Goal of early resuscitation

Maintain

- SBP = 80 to 100 mm Hg
- Hct = 25% to 30%
- PT and PTT in normal ranges
- Plt > 50,000 /HPF
- Normal serum Ca
- Core BT > 35° C
- Function of pulse oximeter

Prevent

- Increase in serum lactate
- Acidosis

Achieve

- Adequate anesthesia and analgesia

Goal of late resuscitation

Maintain and normalize

- SBP > 100 mmHg
- Hct > transfusion threshold
- Coagulation status
- Electrolyte balance
- Body temperature

Restore and maximize

- Normal urine output
- Cardiac output

Reverse and decrease

- Systemic acidosis
- Lactate to normal

Resuscitation end point



- No evidence of ongoing hemorrhage
- Corrected symptomatic anemia
- Normalize intravascular volume
- Oxygen therapy as need
- Corrected coagulopathy
- Corrected electrolyte derangement
- Normal lactate and base excess



Anesthesia in trauma and battlefield

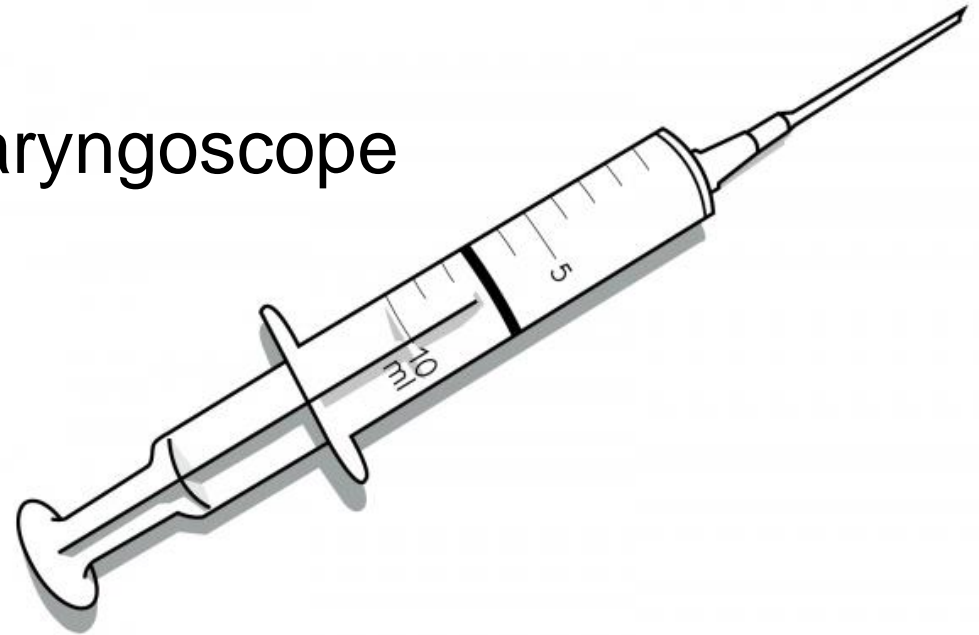
Pre-induction period



- Prevent hypothermia
 - Warm OR
 - Warm IV fluid
 - Force air warmer
- Standard check
- Establish massive transfusion protocol
- Damage control resuscitation

Induction of anesthesia

- Verify functioning vascular access
- Placement monitoring devices
- Not delay induction for invasive monitoring
- Preoxygenation : 4 VC
- Rapid sequence induction with direct laryngoscope



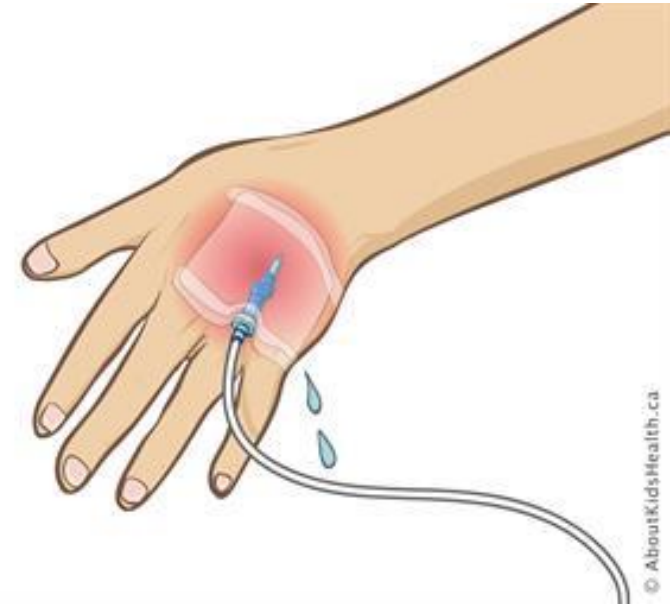
Induction of anesthesia : Medication



- Reduce induction dosage
 - Ketamine 1 mg/kg
 - Propofol 0.5-1 mg/kg (reduce SVR)
- Neuromuscular blockade
 - Succinylcholine standard dose 1 mg/kg
 - Rocuronium 1-1.2 mg/kg (in case Sch contraindicated)

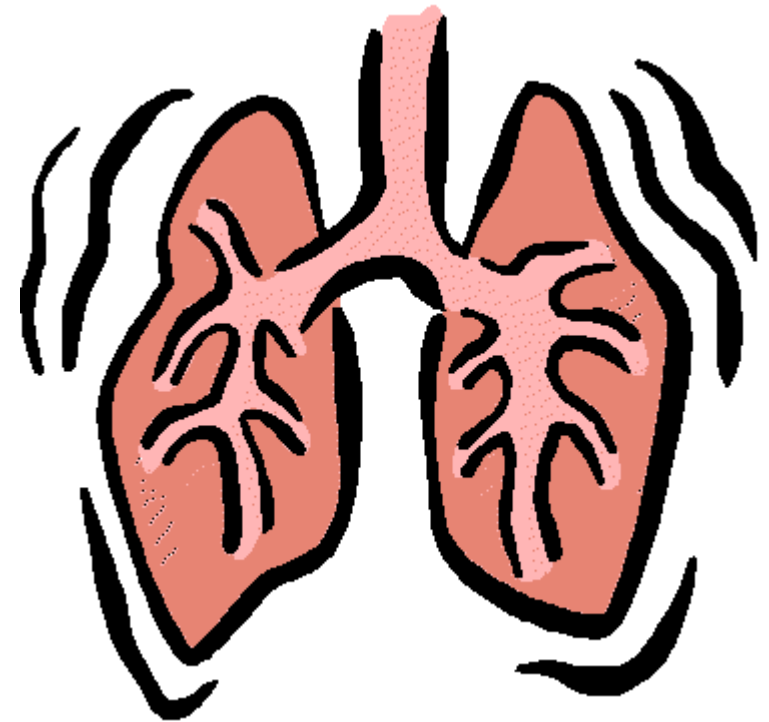
Maintenance of anesthesia

- Carefully titrate
 - Hypnotic/sedative : Inhalation or IV anesthesia
 - Analgesia : narcotic
- Reassure or placement adequate IV access
- Placement arterial line
- Baseline set of lab
- Maintain MAP ≥ 55 mmHg (facilitate end-organ perfusion)
- TBI : maintain SBP > 90 mmHg



Postoperative and emergence

- Adequacy of resuscitation
- Rapid termination of GA
- Assess neurologic function
- Not early extubation
- Confirm successful resuscitation 12-24 hr



BOX 66.12 Criteria for Operating Room or Postanesthesia Care Unit Extubation of the Trachea in a Trauma Patient

Mental Status

Resolution of intoxication
Able to follow commands
Noncombative
Pain adequately controlled

Airway Anatomy and Reflexes

Appropriate cough and gag
Ability to protect airway from aspiration
No excessive airway edema or instability

Respiratory Mechanics

Adequate tidal volume and respiratory rate
Normal motor strength
Required fraction of inspired oxygen (FIO₂) less than 0.50

Systemic Stability

Adequately resuscitated (see earlier)
Small likelihood of urgent return to the operating room
Normothermic, without signs of sepsis

Acute pain management

- Trauma patients frequently undertreat
- Vary in requirement of pain medication
- Comprehensive emotional support system
- Medication requirement influence by physical therapy
- Neuropathic pain if nerve involvement
- Regional anesthesia if benefit



Field medical services

Field medical services

Mission

To conserve the fighting strength



Function

- Preventive medicine
- Hospitalization
- Evacuation
- Medical supply
- Other medical services



Primary field medical services

การบริการแพทย์ระดับหน่วย

- Triage
- Patients gathering
- Emergency life threatening care
- Preventive medicine
- Decontamination
- Combat fatigue
- Medical evacuation
(send back / return)



Secondary field medical services

การบริการแพทย์ระดับกองพล



- Same as primary care
- Life-threatening surgery
- Limited medical treatment
- Admitted time < 72 hrs
- Limited lab, X-ray, dental care
- Medical evacuation

Tertiary medical field services

การบริการแพทย์ระดับกองทัพ

- Field hospital (medical and surgical care)
- Field surgical unit
- Postoperative care
- 30 days admit



Quaternary medical services

การบริการแพทย์เขตหลัง/เขตภายใน

- Military hospital
- Government hospital
- Private hospital



Field surgical unit (ชุดศัลยกรรมสนาม)

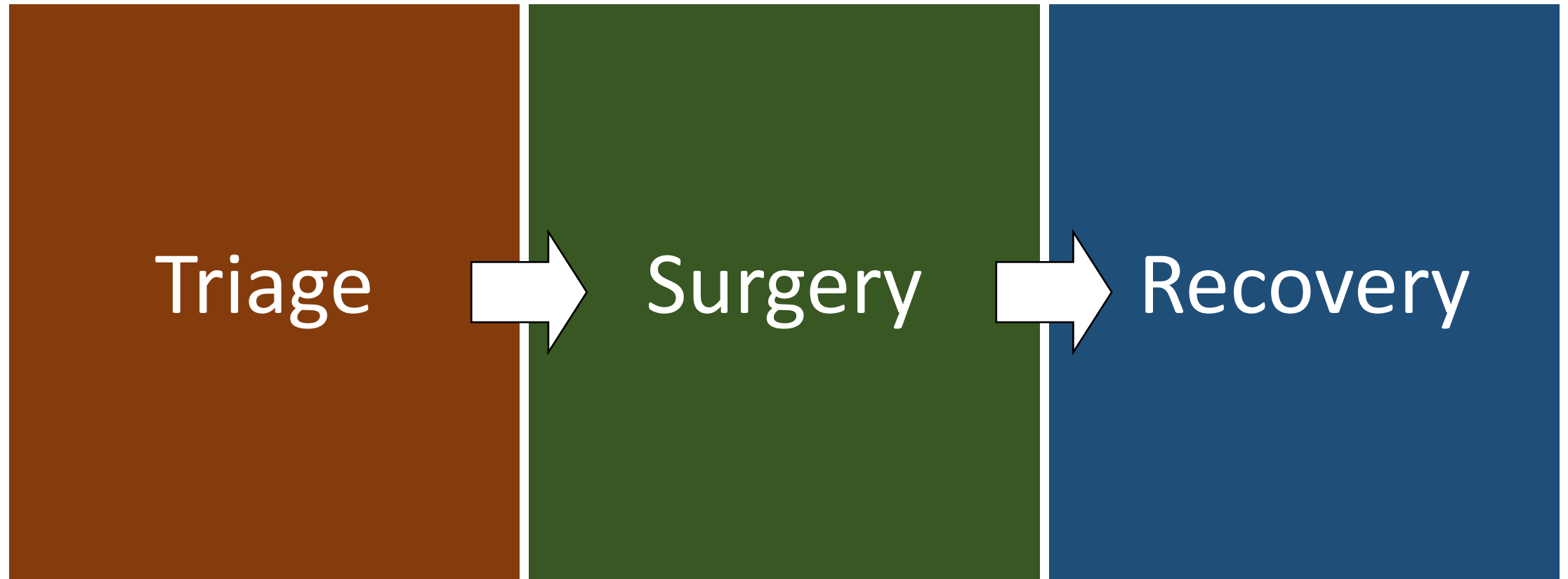
- หัวหน้าชุด 1 นาย
- ศัลยแพทย์ 2 นาย
- วิสัญญีแพทย์ 1 นาย
- พยาบาลวิสัญญี 1 นาย
- พยาบาลห้องผ่าตัด 2 นาย
- พยาบาล 2 นาย
- น.พยาบาล 1 นาย
- ส.ประจำชุด 1 นาย
- ส.ห้องผ่าตัด 1 นาย
- ส.รังสีกรรม 1 นาย
- ส.พยาบาล 1 นาย
- ส. สื่อสาร 1 นาย
- พล.เสนารักษ์ 4 นาย

Surgical team clinical planning

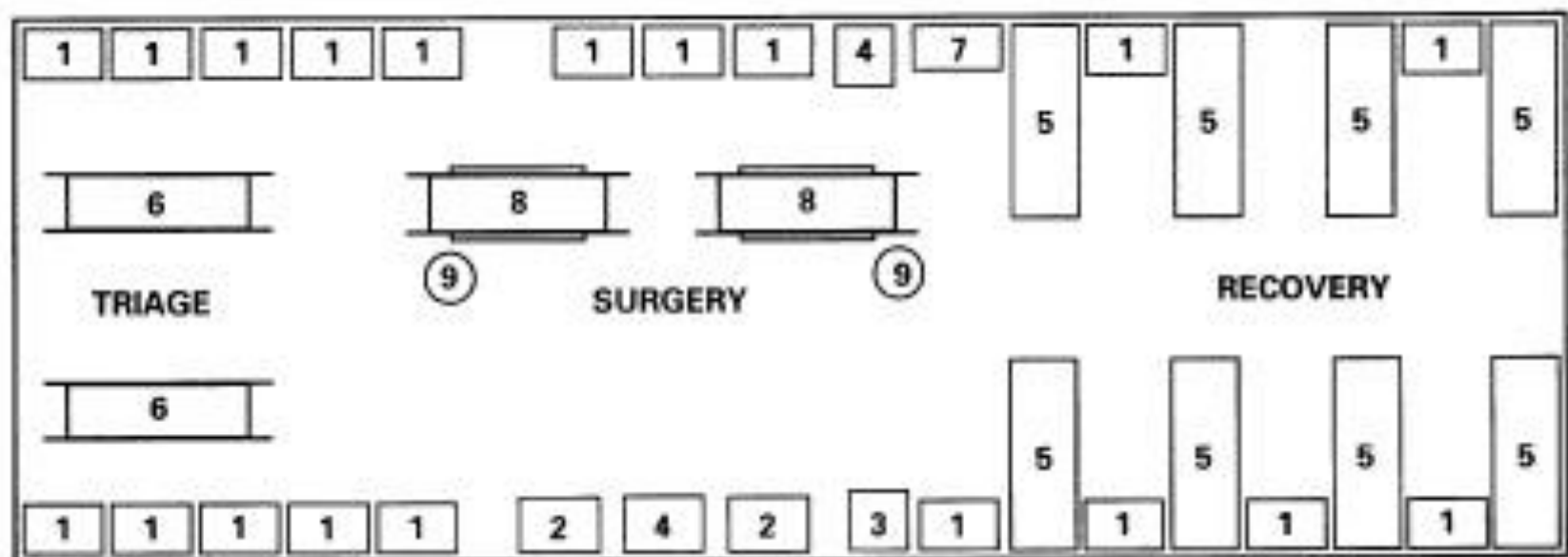
- ใช้เวลาจัดตั้ง อย่างน้อย 1.5 ชม.
- ไม่มีการผ่าตัด ถ้าไม่มีเวลาพอสำหรับการผ่าตัด และ การดูแลหลังผ่าตัด
- 2 เติ่งผ่าตัด ต่อ 1 ทีม
- ใช้เวลาไม่เกิน 135 นาทีต่อคน
- ไม่ควรเกิน 10 เคส ใน 24 ชม.
- ดูแลหลังผ่าตัดได้ถึง 6 ชม. สูงสุด 8 ราย
- ควรย้ายใน 72 ชม.



Simple layout of field surgical unit



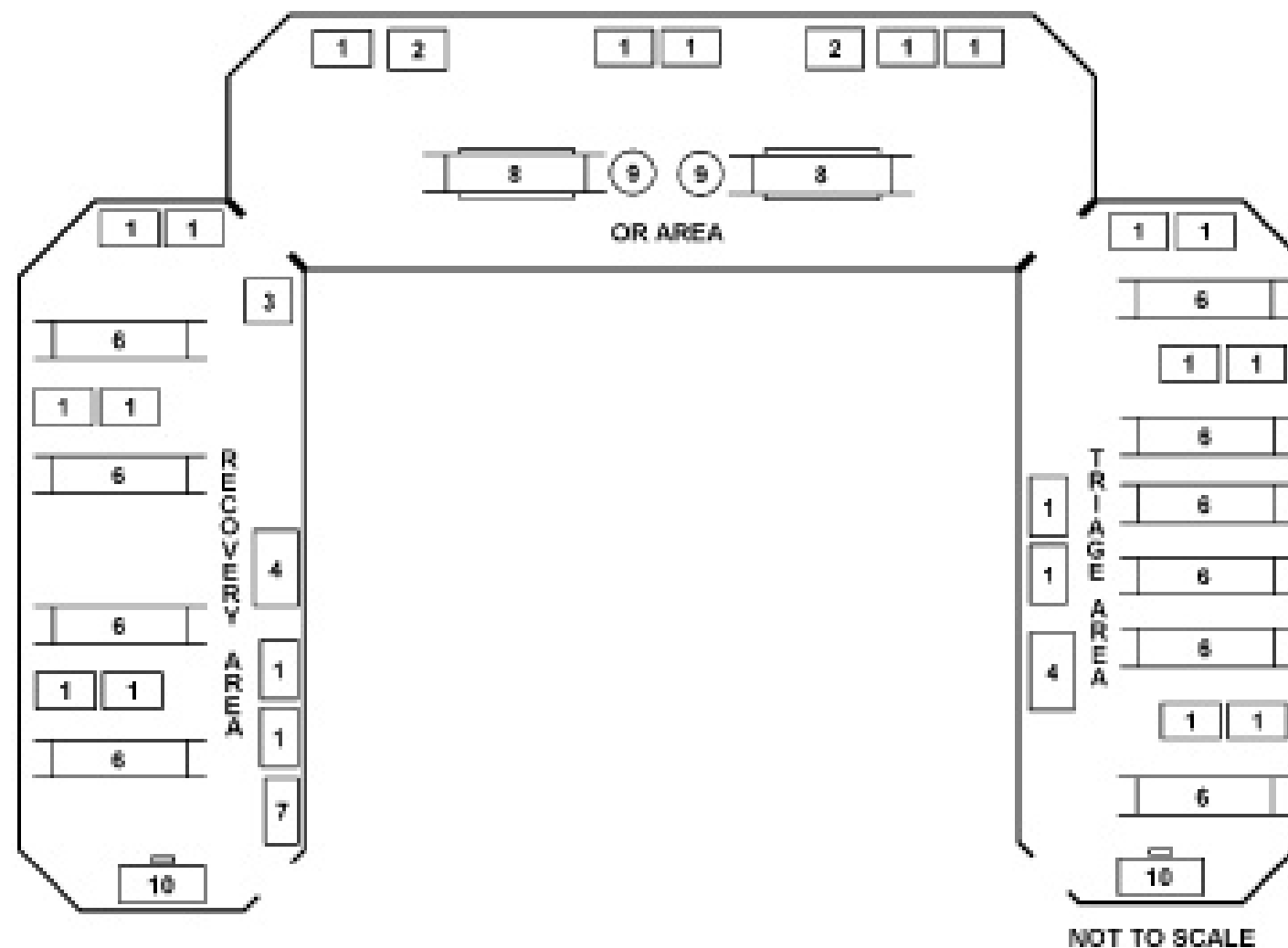
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NOT TO SCALE

LEGEND:

- | | |
|----------------|---------------------|
| 1 #3 CHEST | 6 LITTER W/STAND |
| 2 IMPACT CHEST | 7 MEDICAL CHEST |
| 3 REFRIGERATOR | 8 OR TABLE W/LITTER |
| 4 SINK | 9 SURGICAL LAMP |
| 5 RECOVERY COT | |



LEGEND:

- | | |
|------------------|---|
| 1 #3 CHEST | 7 MEDICAL CHEST |
| 2 IMPACT CHEST | 8 OR TABLE W/LITTER |
| 3 REFRIGERATOR | 9 ANESTHESIA |
| 4 SINK | 10 FIELD TABLE W/TA-312 TELEPHONE AND FOLDING CHAIR |
| 6 LITTER W/STAND | |

Figure 4-3. Sample layout in three DRASH tents.





Key message



- Triage : immediate, delay, minimal, expectant
- Shock in trauma mostly hypovolemic shock
- Hemorrhagic shock treatment : damage control resuscitation
- Anesthetic management
 - Prevent hypothermia
 - Resuscitate of shock
- Anesthetist is important in battlefield



Thank you