

# Polytrauma and Critical Care

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# My Hospital



# My Football Team



# My Favourite Place



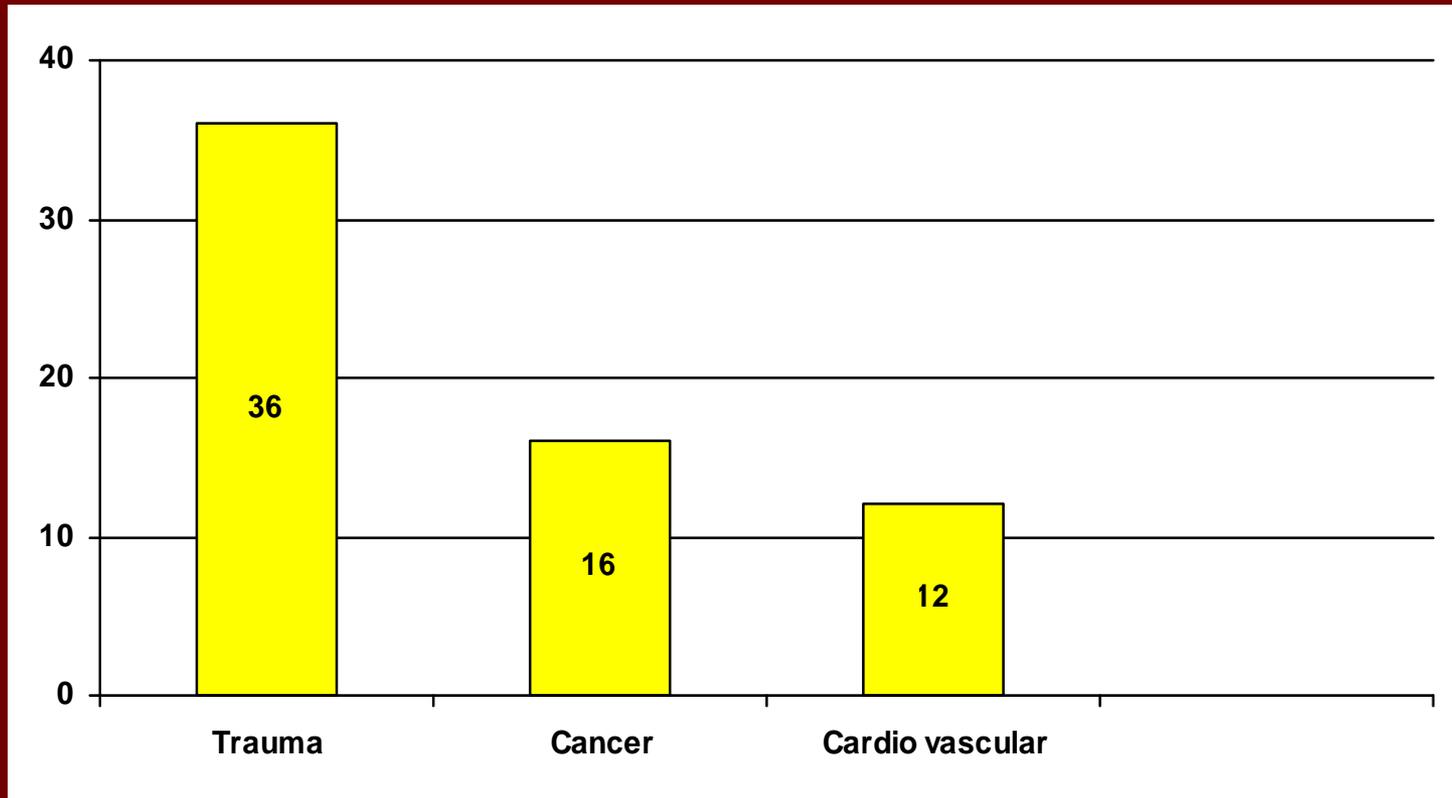
# Trauma - Introduction



# Introduction

- Trauma is the leading cause of death in the first 4 decades of life in most European countries.
- Third cause of death in all age groups (in 2020 – may be second cause of death)
- 3.8 million deaths / year worldwide
- 312 million injured / year worldwide
- 3 patients permanently disabled / death

# Lost life years



Claire Merrick et. al. Prehospital Trauma Life Support, Mosby, 2003

# Introduction

- 1 in 3 deaths occurred in hospital as a result of an injury which could have been prevented

(Royal College of Surgeons of England,  
1988)

# Motor vehicle accidents prevention

	<b>PREEVENT</b>	<b>EVENT</b>	<b>POSTEVENT</b>
<b>Host</b>			
<b>Vehicle</b>			
<b>Environment</b>			

# Motor vehicle accidents prevention

	<b>PREEVENT</b>	<b>EVENT</b>	<b>POSTEVENT</b>
<b>Host</b>	<b>Avoid alcohol consumption</b>		
<b>Vehicle</b>			
<b>Environment</b>			

# Motor vehicle accidents prevention

	<b>PREEVENT</b>	<b>EVENT</b>	<b>POSTEVENT</b>
<b>Host</b>	Avoid alcohol consumption	Use of safety belts	
<b>Vehicle</b>			
<b>Environment</b>			

# Motor vehicle accidents prevention

	<b>PREEVENT</b>	<b>EVENT</b>	<b>POSTEVENT</b>
<b>Host</b>	Avoid alcohol consumption	Use of safety belts	<b>First aid by bystanders</b>
<b>Vehicle</b>			
<b>Environment</b>			

# Motor vehicle accidents prevention

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<b>Host</b>	Avoid alcohol consumption	Use of safety belts	First aid by bystanders
<b>Vehicle</b>	Antilock brakes		
<b>Environment</b>			

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<b>Vehicle</b>	Antilock brakes	<b>Air bags deploys</b>	
<b>Environment</b>			

# Motor vehicle accidents prevention

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<b>Environment</b>	<b>Speed limits</b>		

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<b>Vehicle</b>	Antilock brakes	Air bags deploys	
<b>Environment</b>	Speed limits	<b>Impact-absorbing barriers</b>	

# Motor vehicle accidents prevention

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<b>Host</b>	Avoid alcohol consumption	Use of safety belts	First aid by bystanders
<b>Vehicle</b>	Antilock brakes	Air bags deploys	
<b>Environment</b>	Speed limits	Impact-absorbing barriers	<b>Emergency medical service (access to trauma system)</b>

# Prevention

**B B C**

**NEWS**

BBC Home > BBC News >

**TOP NEWS STORIES**

Page last updated at 10:43 GMT, Thursday, 25 September 2008 11:43 UK

## Road deaths fall to record lows

Road deaths have fallen to their lowest level since records began in 1928, according to figures published by the Department for Transport.

Last year a total of 2,946 people died - a 7% reduction on the previous year when 3,172 died.



# Introduction

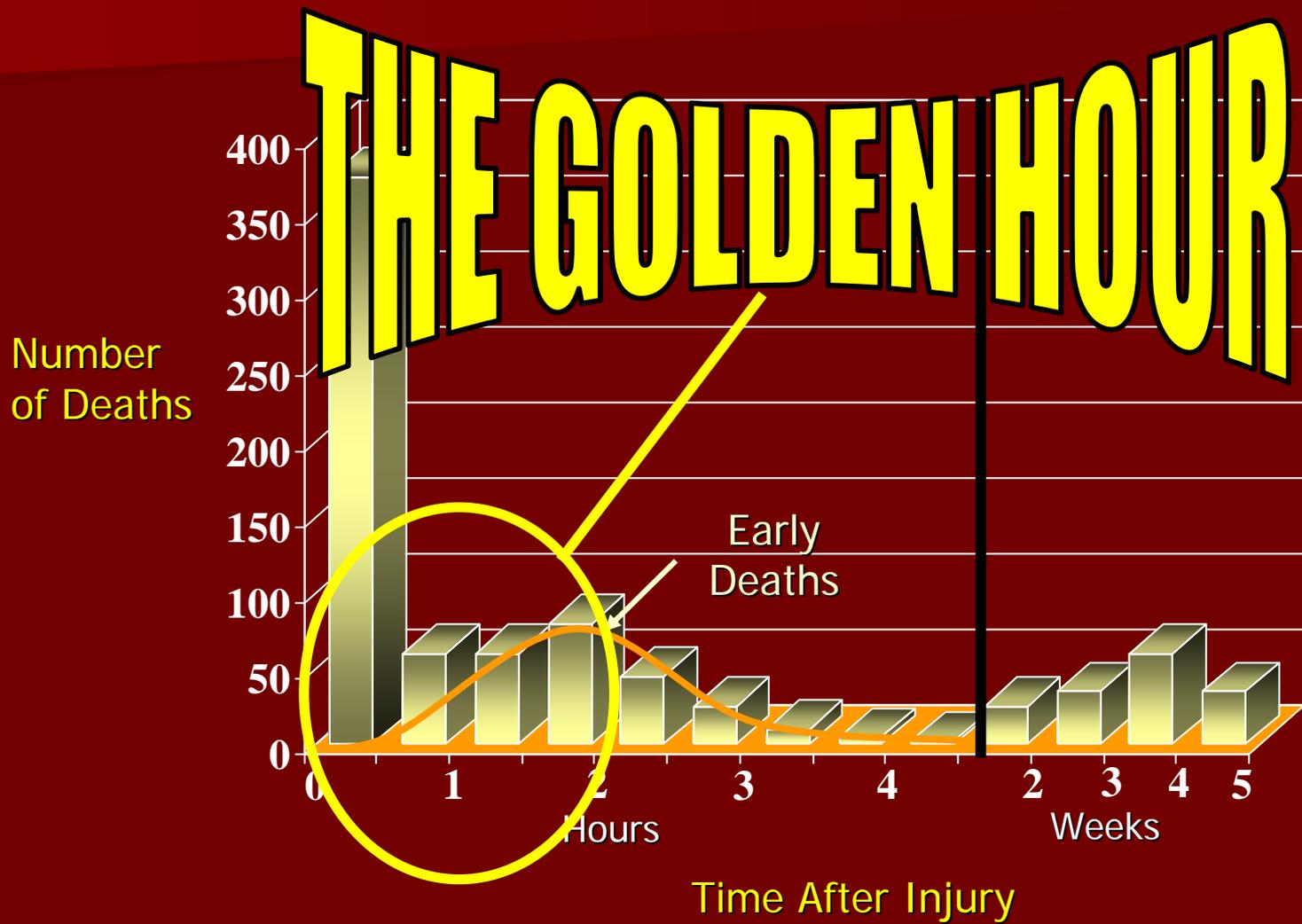
- 1 in 3 deaths occurred in hospital as a result of an injury which could have been prevented
- Deaths occur due to failure of **simple management** in the early stages ("GOLDEN HOUR"), rather than a failure of complex definitive treatment

(Royal College of surgeons of England, 1988)

# Trimodal Death Distribution



# Trimodal Death Distribution





- Plane crash in Nebraska, 1976
- 1 killed, 4 injured

“When I can provide better care in the field with limited resources than what my children and I received at the primary care facility — there is something wrong with the system and the system has to be changed.”

~ James Styner, MD, FACS ~  
1977

ATLS®



- These guidelines seek to set achievable standards for trauma treatment services which could realistically be made available to almost every injured person in the world.



World Health Organization 2004

# ATLS Concept

- ABCDE-approach to evaluation / treatment

# ATLS Concept



Airway



Breathing



Circulation



Disability



Expose

# ATLS Concept

- ABCDE-approach to evaluation / treatment
- Treat greatest threat to life first
- Definitive diagnosis not immediately important
- Time is of the essence
- Do no further harm

# ATLS® - Initial Assessment / Management

Primary Survey

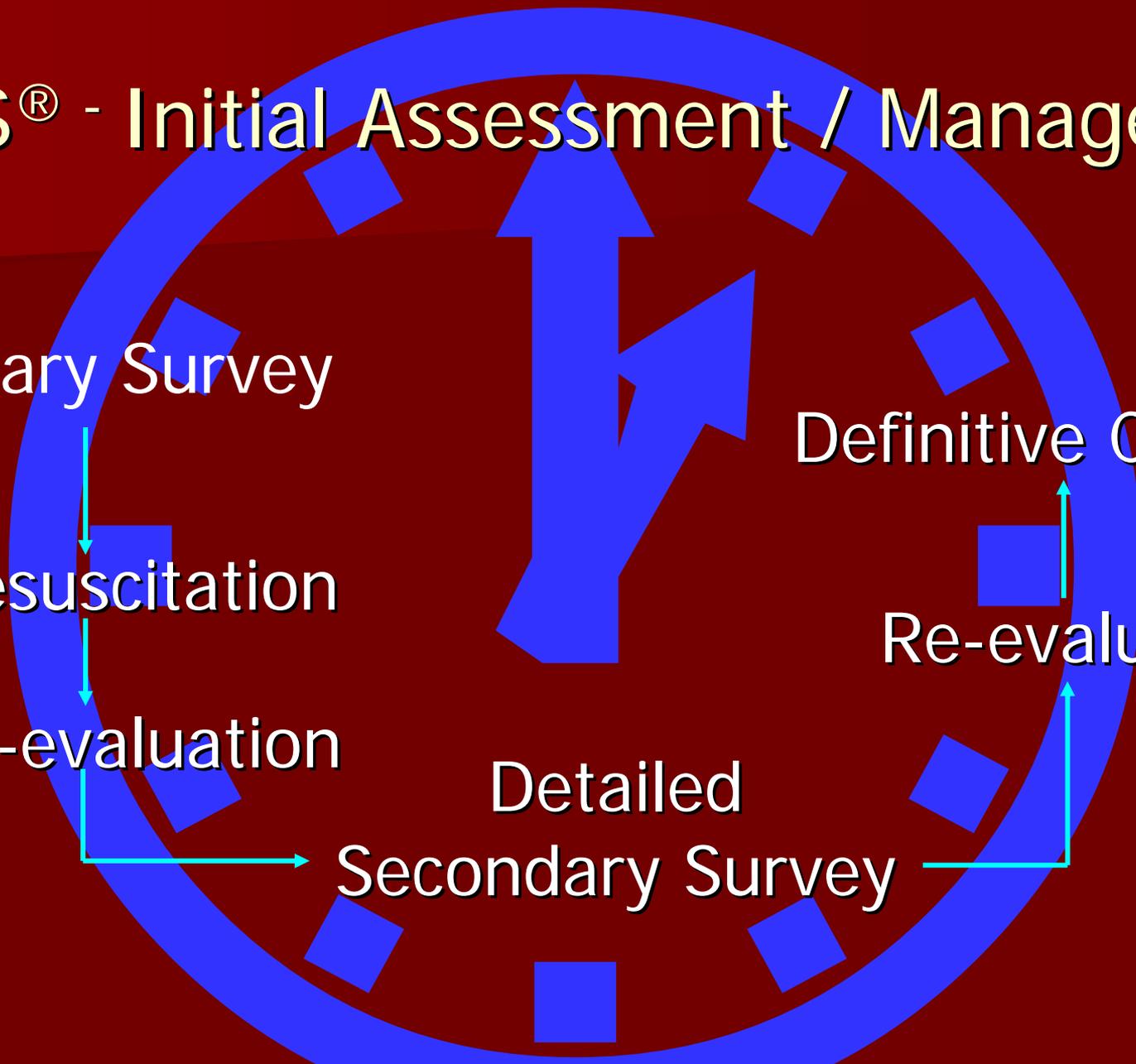
Resuscitation

Re-evaluation

Definitive Care

Re-evaluation

Detailed  
Secondary Survey



# Assessing the patient in 10 seconds

- Identify yourself
- Ask the patient his / her name
- Ask the patient what happened

# Appropriate response confirms



Patent airway



Breathing



Clear thinking

# Beware

- Continue to observe and have a “high index of suspicion”
- Especially if patient has
  - Maxillofacial injury
  - Soft-tissue injury of neck
  - Facial or neck burns
  - Hoarse voice (Laryngeal injury / tracheal burn)

If no response, proceed with  
rapid primary survey

# Primary Survey



Airway: C-spine protection



Breathing: Oxygenation



Circulation: Stop the Bleeding!



Disability: Neuro Status



Expose: Environment & Body Temp



# Airway

- Simple management manoeuvres
  - Suction
  - Chin lift
  - Jaw thrust
- Use simple equipment to help



# Airway



000#

00#

0#

1#

2#

3#

4#

5#

6#



# Airway



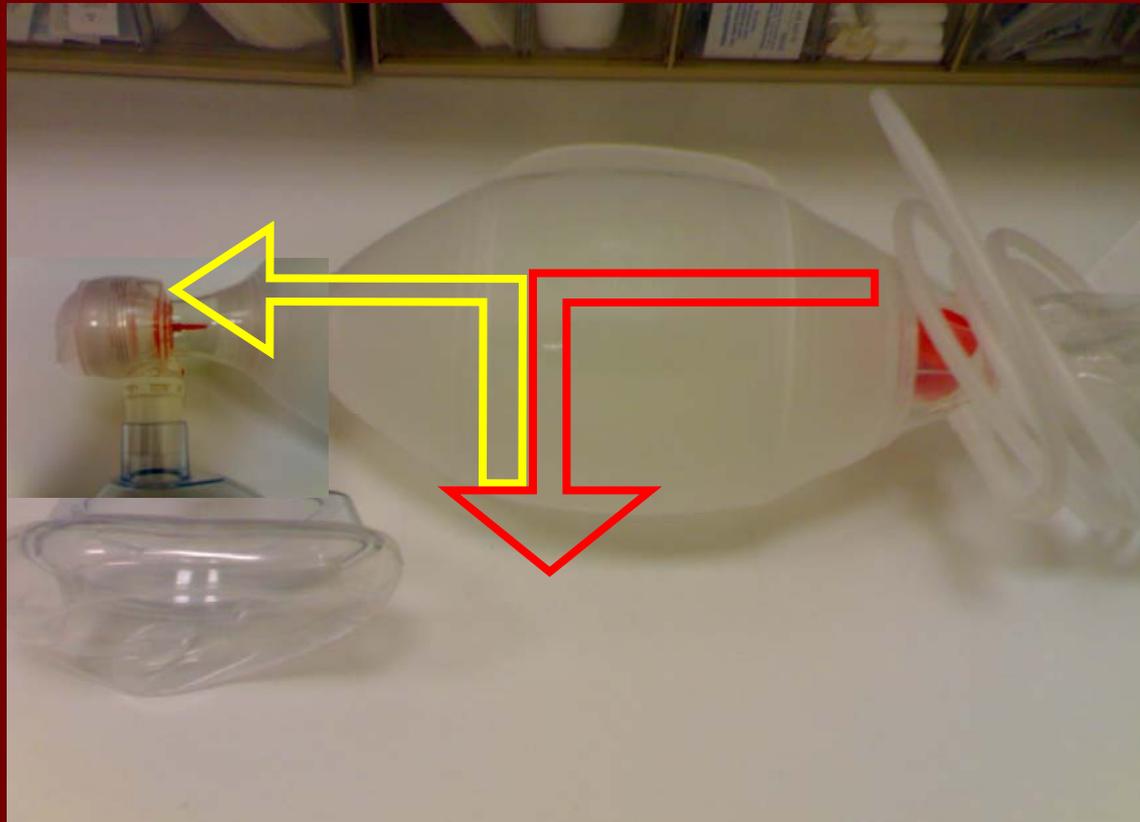
LMA



i-gel LMA



# Airway





# Airway

- Simple management manoeuvres
  - Suction
  - Chin lift
  - Jaw thrust
- "Definitive airway:" Cuffed tube in trachea



Airway (important message)

**ALWAYS THINK  
ABOUT THE  
CERVICAL SPINE**



# Airway



The reported incidence of cervical spine injury in the setting of major trauma is **1.5%–4%**.

Emerg Med J 2004;21:302–305  
Anesth Analg 1991;73:471–82.  
Can J Anaesth 1990;37:77–93.  
Arch Surg 1994;129:643–5.  
Ann Emerg Med 1998;32:461–9.

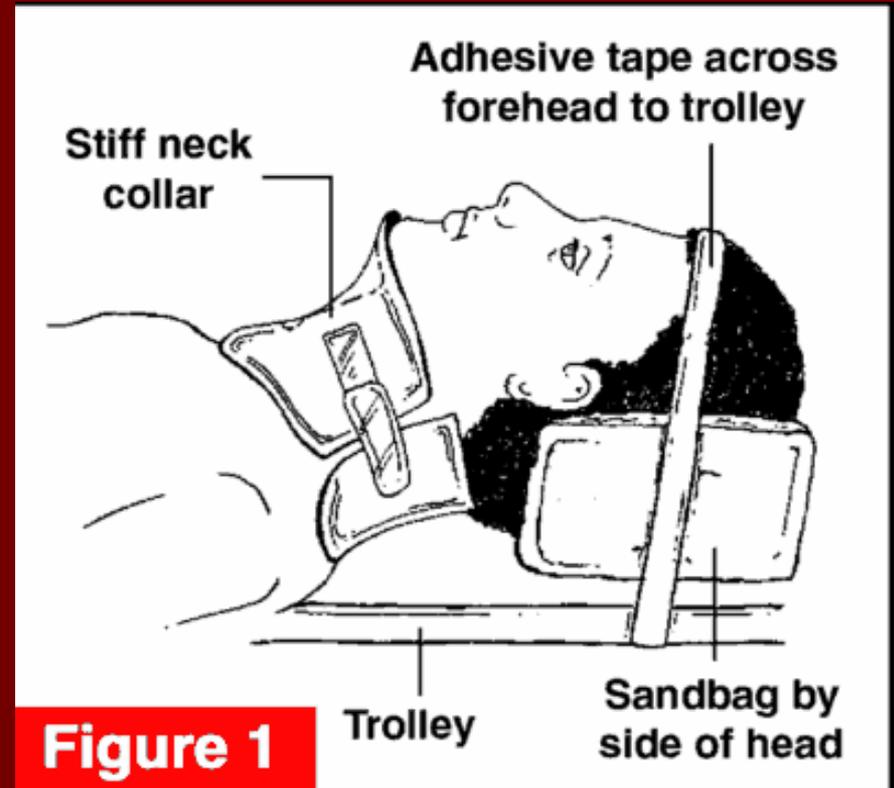
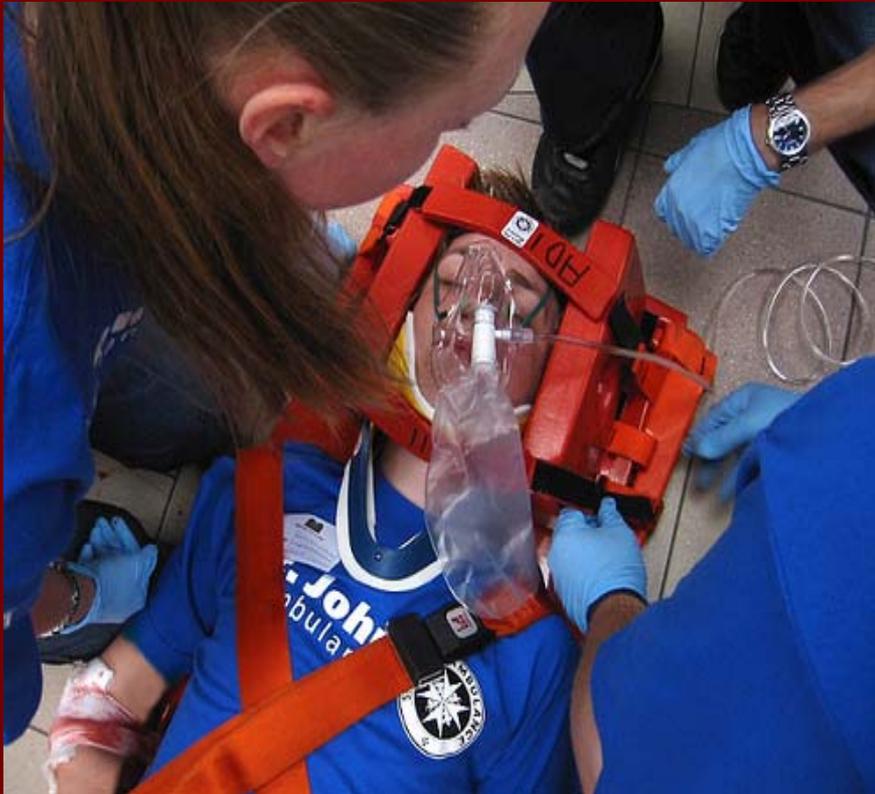
# Protecting the spine

- Immobilize entire patient on long spine board



# Protecting the spine

- Apply semirigid cervical collar/head block



**Figure 1**

## **Airway management in trauma**

Preoxygenate and BLS manoeuvres

## **Airway management in trauma**

Preoxygenate and BLS manoeuvres



RSI, cricoid pressure, MILS

# Manual in-line stabilisation (MILS)



## Airway management in trauma

Preoxygenate and BLS manoeuvres



RSI, cricoid pressure, MILS



Laryngoscopy

## Airway management in trauma

Preoxygenate and BLS manoeuvres



RSI, cricoid pressure, MILS



Laryngoscopy



Oral intubation with GEB/introducer

# Airway management in trauma

Preoxygenate and BLS manoeuvres

RSI, cricoid pressure, MILS

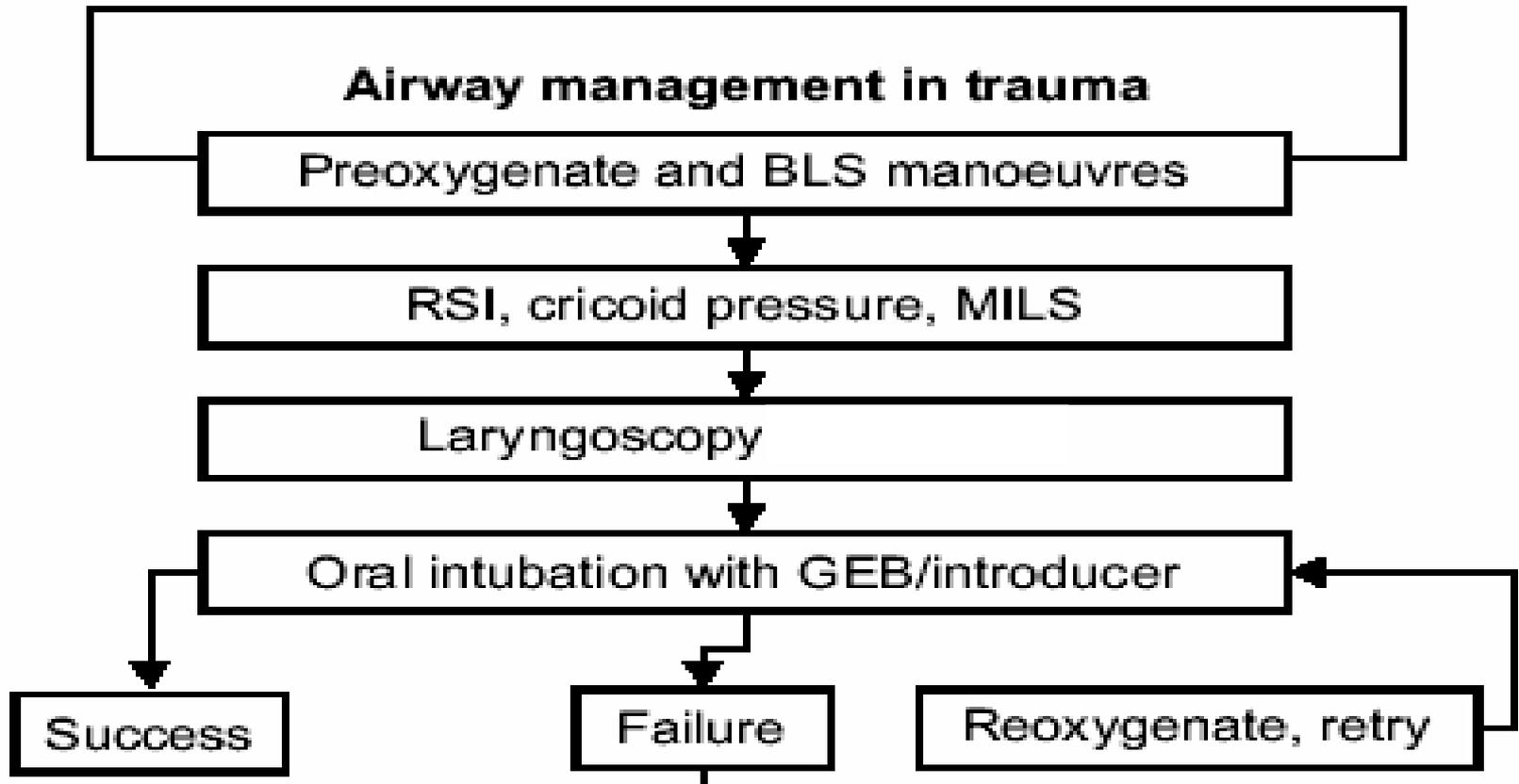
Laryngoscopy

Oral intubation with GEB/introducer

Success

Failure

Reoxygenate, retry



# Airway management in trauma

Preoxygenate and BLS manoeuvres

RSI, cricoid pressure, MILS

Laryngoscopy

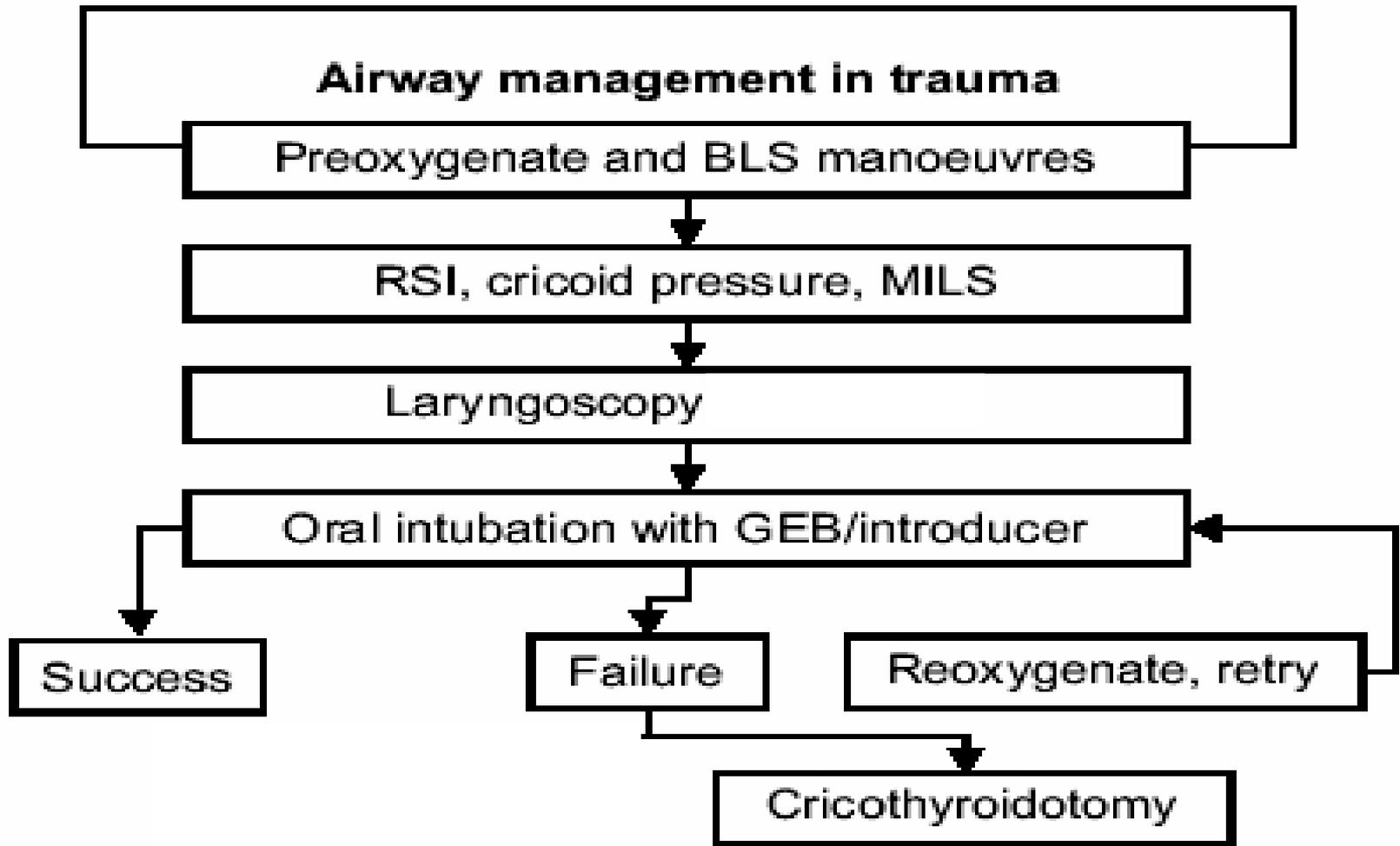
Oral intubation with GEB/introducer

Success

Failure

Reoxygenate, retry

Cricothyroidotomy



# Airway management in trauma

Preoxygenate and BLS manoeuvres

RSI, cricoid pressure, MILS

Laryngoscopy

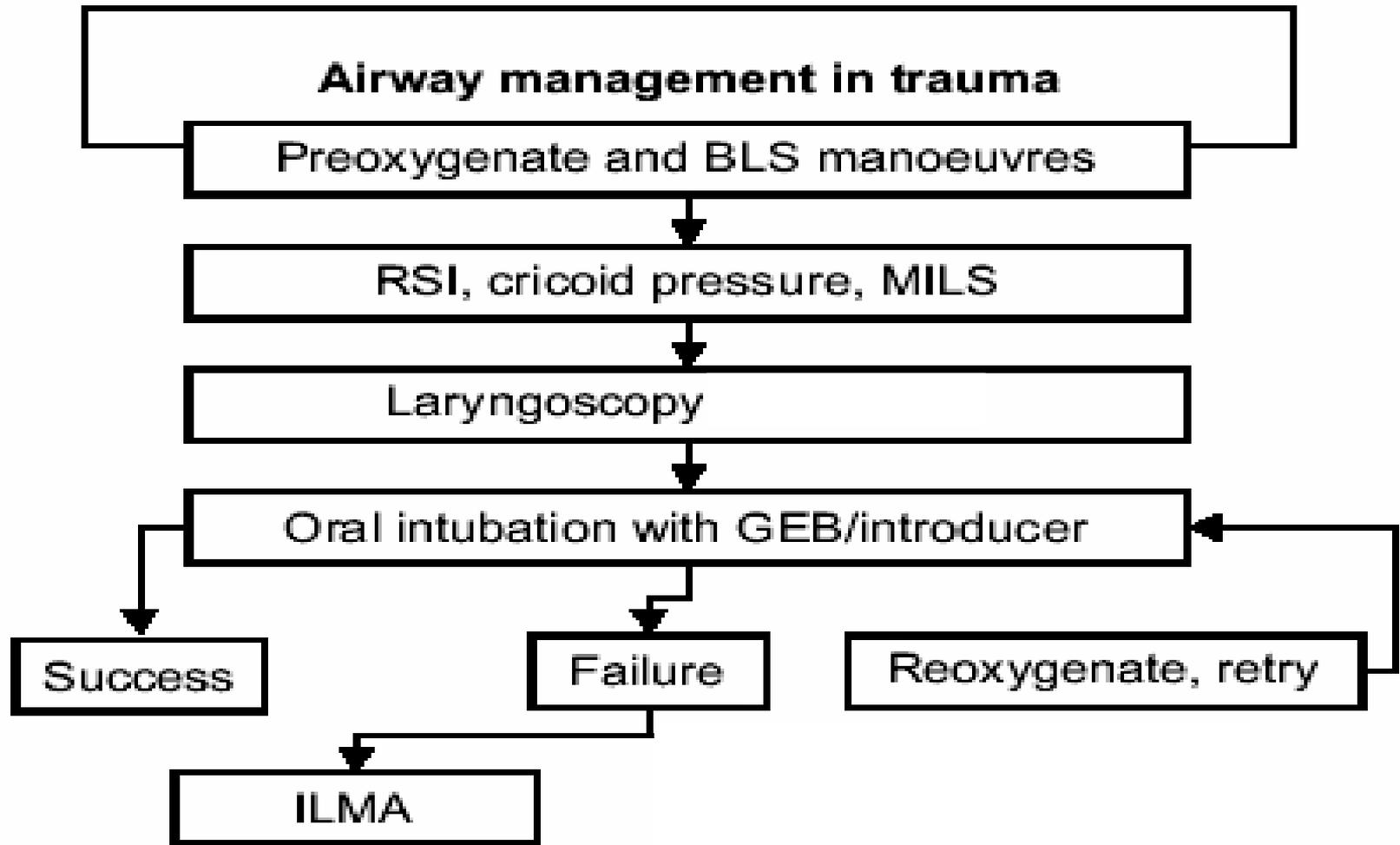
Oral intubation with GEB/introducer

Success

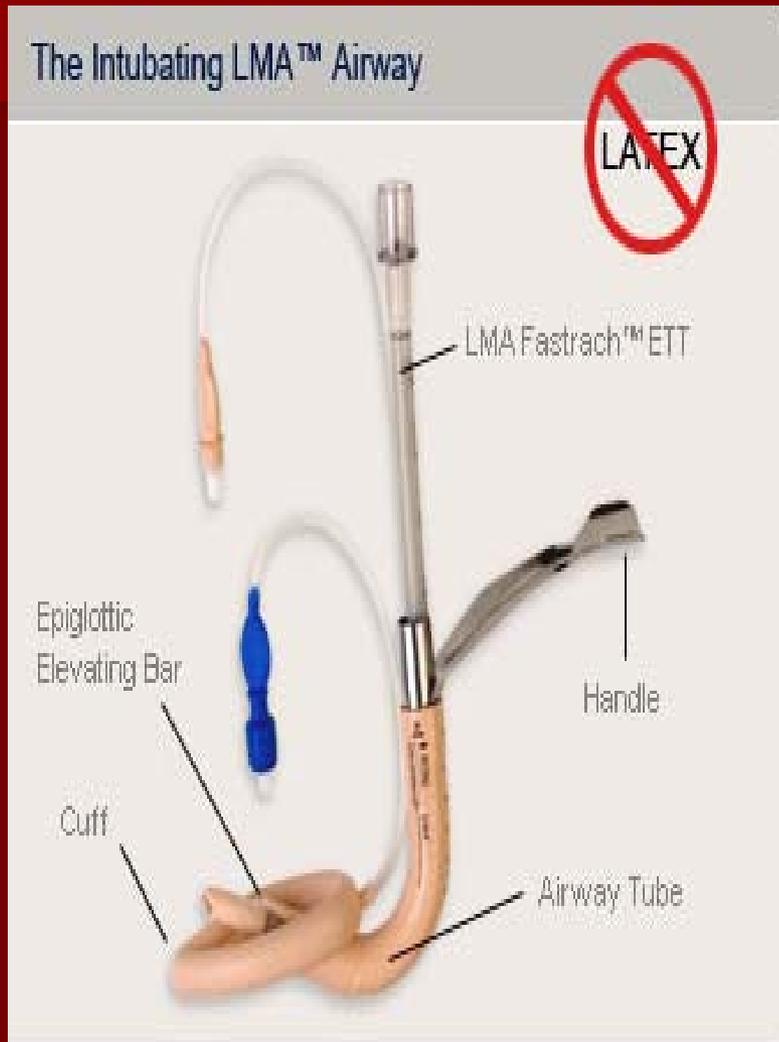
Failure

Reoxygenate, retry

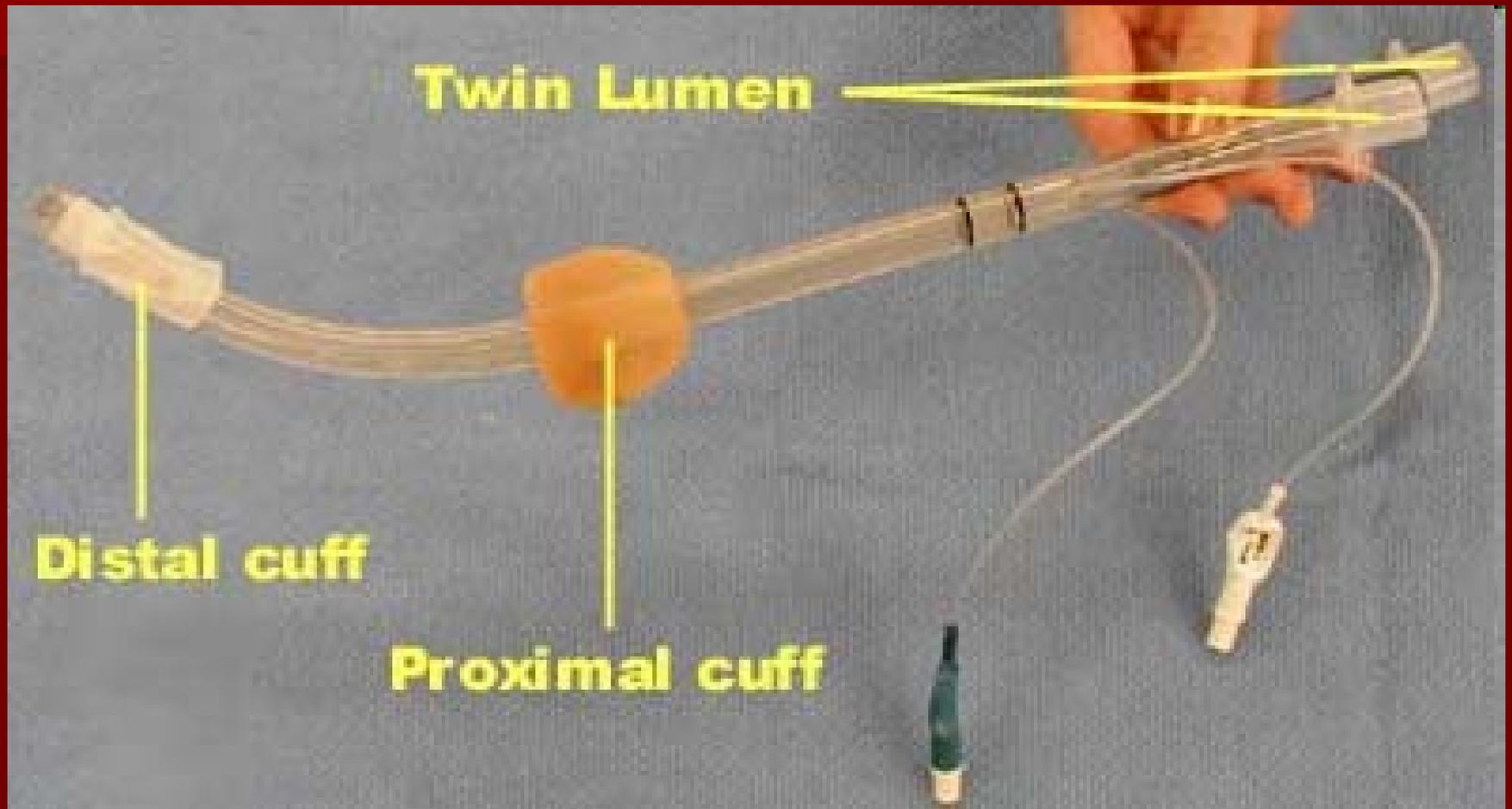
ILMA



# Intubating Laryngeal Mask Airway (IMLA)

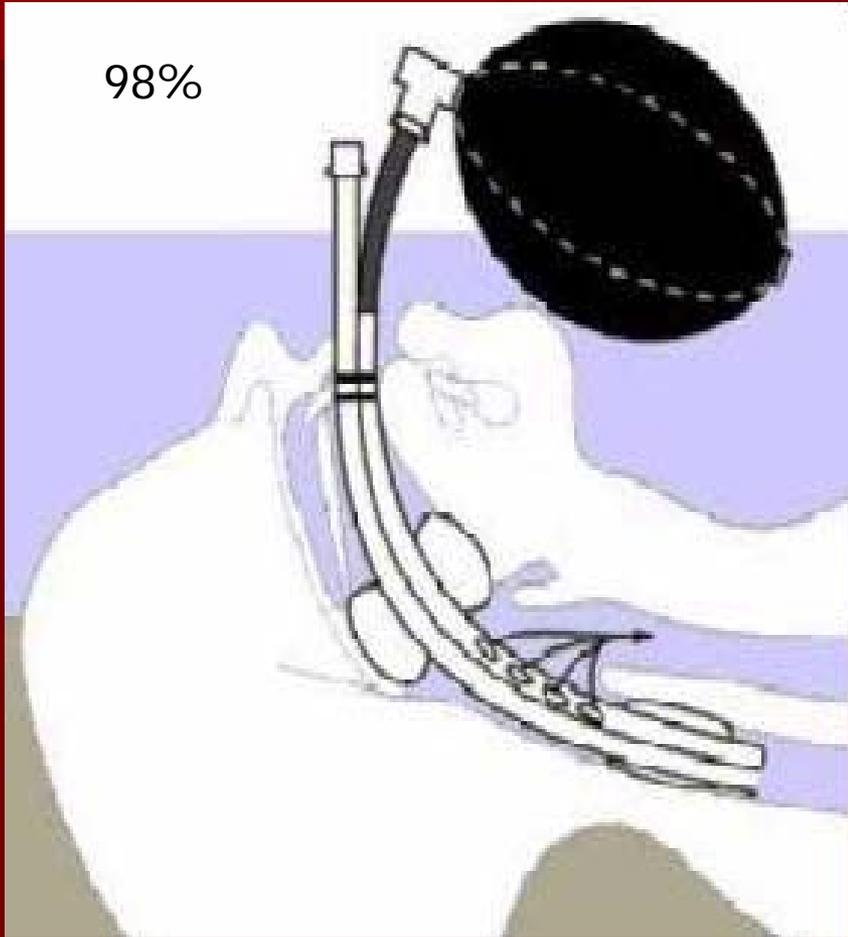


# Combitube

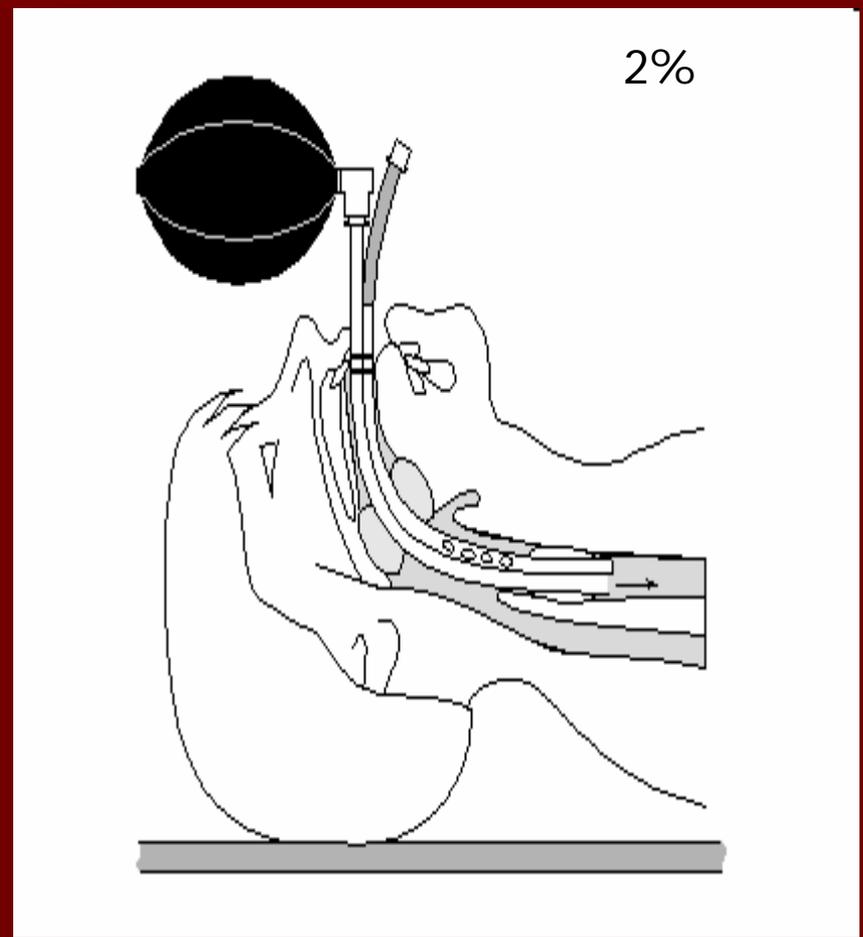


# Combitube

98%



2%



# Combitube

- Inflation of the large pharyngeal cuff of the Combitube exerts pressure against the vertebral bodies of C2, C3 and/or C4, depending on placement.

# “Gold Standard” airway management for patient with potential C-spine injury requiring immediate and/or urgent airway control

- rapid sequence induction of anaesthesia
- orotracheal intubation with
  - cricoid pressure
  - manual in-line immobilization of the head and neck
- Precise cervical spine in-line immobilization should be maintained throughout the intubation manoeuvres.

Criswell JC, Parr MJA, Nolan JP. Emergency airway management in patients with cervical spine injuries. *Anaesthesia* 1994; 49: 900-3

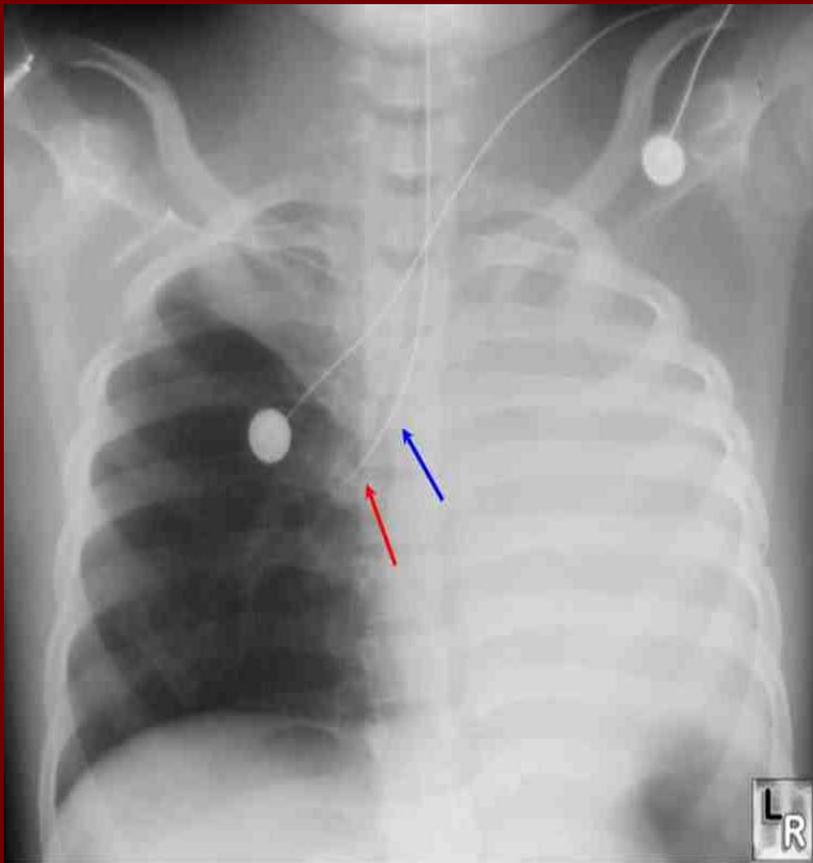


# Breathing

- Confirm ETT in the right place
  - Look at chest movements
    - Paradoxical
    - Asymmetric
  - Listen in the axillae

**B**

# Breathing



Right main bronchus  
intubation



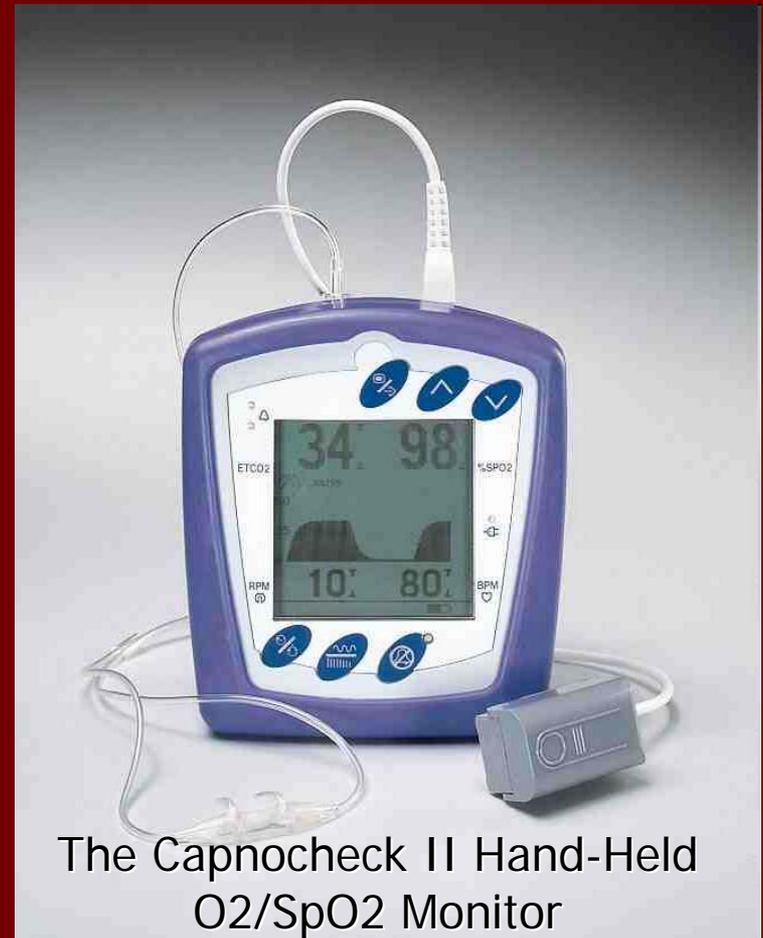
# Breathing

- Confirm ETT in the right place
  - Look at chest movements
    - Paradoxical
    - Asymmetric
  - Listen in the axillae
  - End tidal CO<sub>2</sub>
- Assess oxygenation
  - Pulse oximeter

# End Tidal CO<sub>2</sub> Monitors/Pulse Oximeters



The StatCO2™



The Capnocheck II Hand-Held  
O<sub>2</sub>/SpO<sub>2</sub> Monitor



# Breathing

- Think about
  - Pneumothorax (tension)
  - Haemothorax
  - ETT in the wrong place (if in doubt....take it out!!)

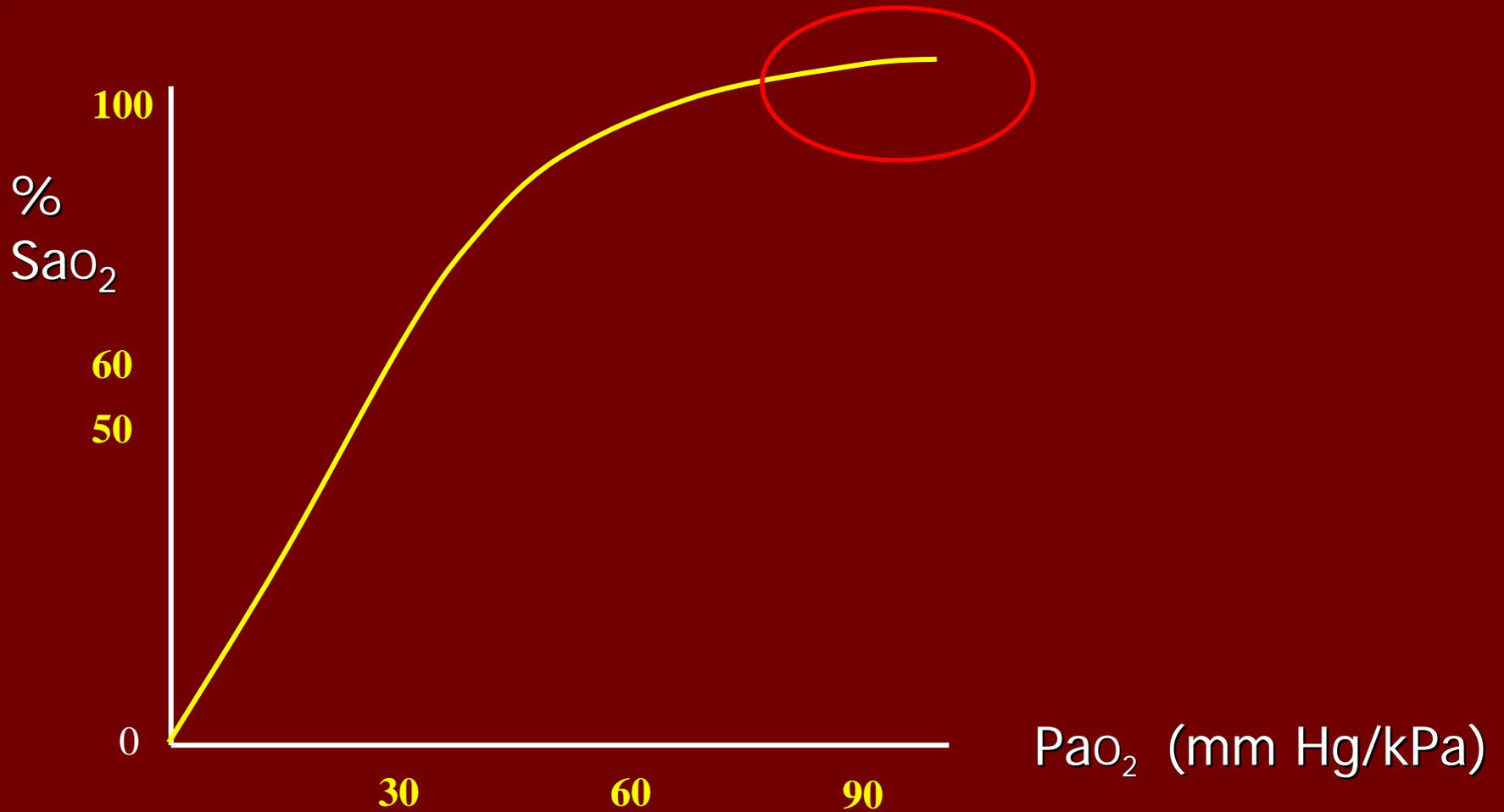


# Breathing

GIVE 100% O<sub>2</sub>



# Breathing



# Oxygen delivery ( $\dot{V}O_2$ )

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# Oxygen delivery ( $\dot{V}O_2$ )

■  $\dot{V}O_2 = [\text{Hb}] \times 1.34 \times \text{SaO}_2 \times \text{CO}$

$= 150 \text{ (g/dl)} \times 1.34 \times 100\% \times 5 \text{ (l/min)}$

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$= 1000 \text{ ml/min}$



# Circulation & Hemorrhage Control

- Shock is a generalized state of hypoperfusion causing:
  - Anaerobic metabolism
  - Lactic acid production
  - Cellular dysfunction
  - Cell death
  - MOF

# Causes of shock

## Haemorrhagic vs Nonhaemorrhagic

- Blood loss
- Tension pneumothorax
- Cardiac tamponade
- Cardiogenic
- Neurogenic
- Septic

# Treatment of shock

Direct  
pressure



**STOP  
the bleeding!**



Operation



Splint  
fractures

# Treatment of shock

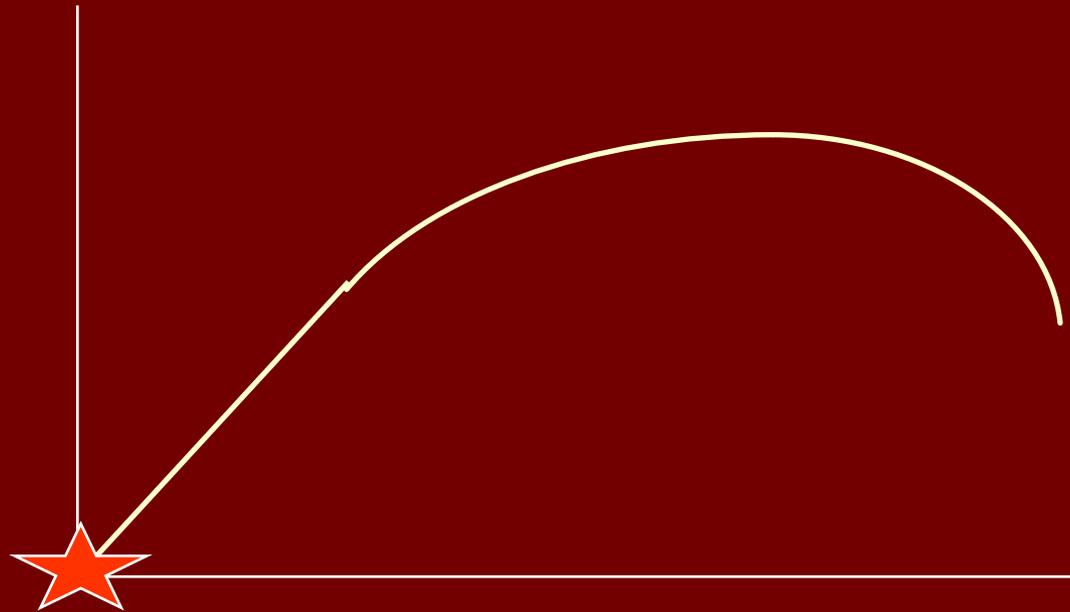
## ■ **Restore volume!**

$$CO = \text{Stroke volume (SV)} \times \text{Heart rate (HR)}$$

# Treatment of shock

## Starlings Law of the Heart

**Stroke volume**  
(BP, CO, UO)



**Initial fibre length**  
(CVP, PCWP, LVEDP)

# Oxygen delivery ( $\dot{V}O_2$ )

- $\dot{V}O_2 = [\text{Hb}] \times 1.34 \times \text{SaO}_2 \times \text{CO}$ 
  - = 150 (g/dl) x 1.34 x 100% x 5 (l/min)
  - = 1000 ml/min

# The Rule of 2's and 5's

- Give 2 mls/kg fluid stat
  - If CVP goes up by 5 stop giving fluid
  - If CVP goes up by less than 5, give 2 mls/kg fluid again
  - Keep giving 2 mls/kg fluid until CVP goes up by 5 and stays up

# Monitoring the Response

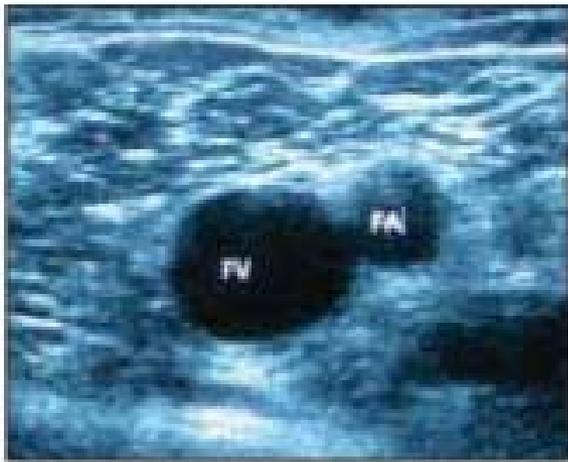
## Identify Improved Organ Function

- CNS: Improved level of consciousness
- Renal: ↑ urinary output
- Skin: Warm, capillary refill
- Respirations: Improved rate and depth
- Vital signs: Return to normal

# Treatment of shock

## ■ Restore volume!

- Vascular access



(1) The femoral vein (FV) and artery (FA) run side by side.



# Treatment of shock

## ■ Restore volume!

- Warmed fluid



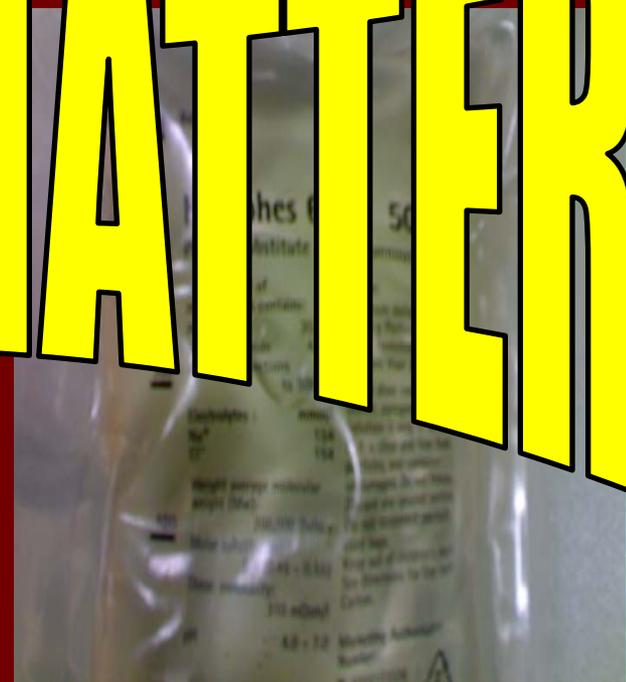
Which fluid???????

Crystalloid

v

Colloid

**DOESN'T MATTER!!**



If patient is losing blood.....

**GIVE BLOOD !!**

# Oxygen delivery ( $\dot{V}O_2$ )

■  $\dot{V}O_2 = [\text{Hb}] \times 1.34 \times \text{SaO}_2 \times \text{CO}$

$= 150 \text{ (g/dl)} \times 1.34 \times 100\% \times 5 \text{ (l/min)}$

$= 1000 \text{ ml/min}$

# Treatment of shock

**Prevent hypothermia!**



# Disability

- Baseline neurological examination
  - GCS score
  - Pupillary response
- **OBSERVE FOR DETERIORATION !!!!**



# Exposure / Environment

- Completely undress the patient
- PREVENT HYPOTHERMIA !!

# "The Golden Hour"

- **Multiple organ failure after trauma affects even long-term survival and functional status**  
*Critical Care* 2007, **11**:R95doi:10.1186/cc6111

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- MOF increased the overall risk of death 6.0 times.
- Patients with MOF were 3.9 times more likely to require personal assistance in activities of daily living.
- **Conclusion** - the presence of MOF greatly increased mortality and the risk of impaired functional status.

 ASTON VILLA | 1  
 ARSENAL | 2  
1.12.2007



Arsenal.com

# Secondary Survey

- Start only when

- ABCDE has been done and reassessed
- Vital functions are returning to normal

# Secondary Survey - Components

- History

# Secondary Survey - Components

## ■ History ..... **AMPLE**

**A**

Allergies

**M**

Medications

**P**

Past illnesses

**L**

Last meal

**E**

Events / Environment

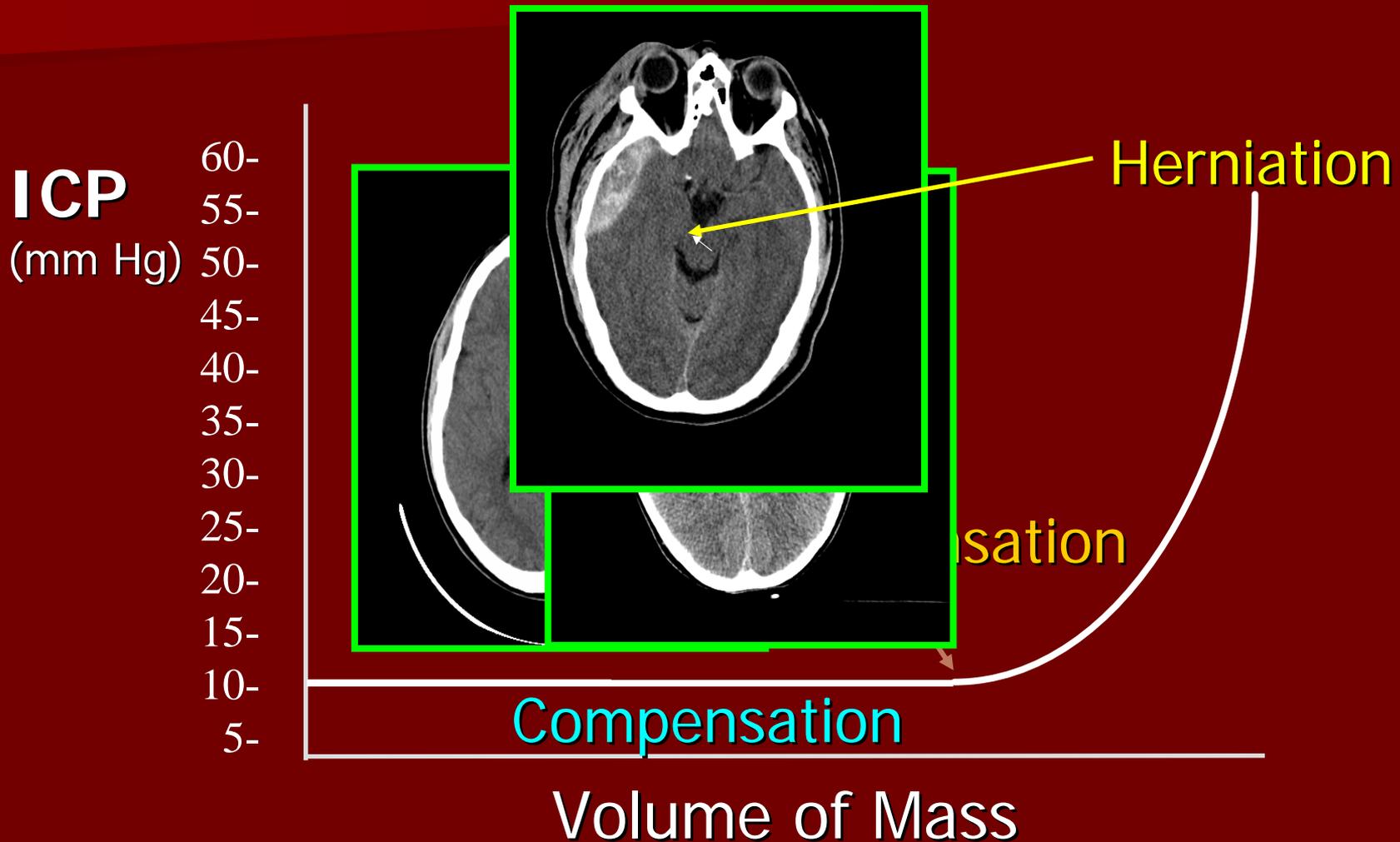
# Secondary Survey - HEAD

- GCS Score (again)
- Full neurological exam
  - Motor and sensory and reflexes
- Full eye and ear exam

# Intracranial Pressure (ICP)

- 10 mm Hg = Normal
  - > 20 mm Hg = Abnormal
  - > 40 mm Hg = Severe
- 
- Sustained  $\uparrow$  ICP leads to  $\downarrow$  brain function and outcome

# Monro-Kellie Doctrine



# Cerebral Perfusion Pressure

$$\text{MBP} - \text{ICP} = \text{CPP}$$


# Cerebral Perfusion Pressure

	<b>MBP – ICP = CPP</b>		
Normal	90	10	80

# Cerebral Perfusion Pressure

	<b>MBP – ICP = CPP</b>		
Normal	90	10	80
Cushing's Response			

# Cerebral Perfusion Pressure

	<b>MBP – ICP = CPP</b>		
Normal	90	10	80
Cushing's Response	100	20	80

# Cerebral Perfusion Pressure

	<b>MBP – ICP = CPP</b>		
Normal	90	10	80
Cushing's Response	100	20	80
Hypotension			

# Cerebral Perfusion Pressure

	<b>MBP – ICP = CPP</b>		
Normal	90	10	80
Cushing's Response	100	20	80
Hypotension	50	20	30

# Treatment

- Minimize secondary brain injury
  - ABCDE
  - Maintain CPP
    - Maintain blood pressure (systolic  $> 90$  mm Hg)
    - Reduce ICP

# Treatment

- Maintain MAP
  - Euvolaemic fluid resuscitation
  - Isotonic fluids
  - Inotropes

# Treatment

- Reduce ICP
  - Controlled ventilation
    - Goal: PaCO<sub>2</sub> at 35 mm Hg
  - Head up tilt
  - Paralysis
  - Mannitol
  - Surgery

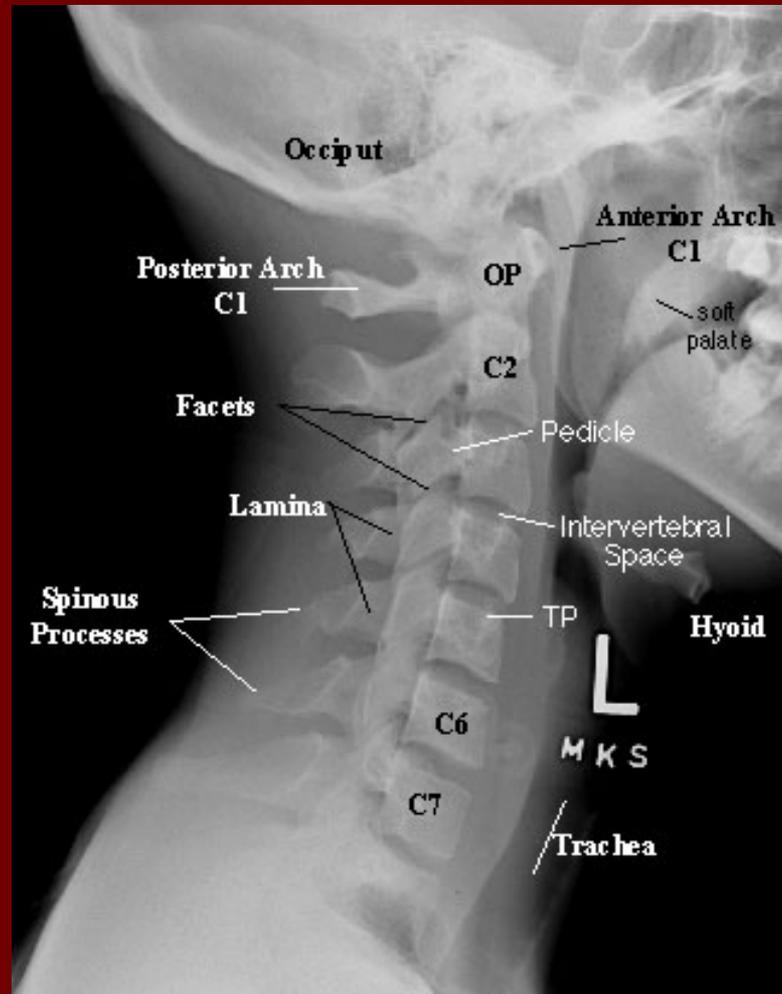
# Treatment

- Mannitol
  - Use with signs of tentorial herniation
  - Dose: 1.0 g / kg IV bolus
  - Consult with neurosurgeon first

# Secondary Survey – Cervical Spine

- Tenderness
- Complete motor and sensory exam
- Reflexes
- X-ray

# Normal C-Spine Xray



# Secondary Survey – Cervical Spine



Only 6 vertebrae seen

# Secondary Survey – Cervical Spine



Atlas fracture

# Secondary Survey – Cervical Spine



C5/6 step fracture

# Secondary Survey – Cervical Spine



Er !!!!!!!!!

# Secondary Survey – Cervical Spine



MRI of cervical  
fracture-dislocation  
with cord injury

# Neurogenic shock

- Associated with cervical / high thoracic spine injury
- Neurological (not a hemodynamic) phenomenon
- Occurs shortly after cord injury
- Variable duration
- Flaccidity and loss of reflexes
- Hypotension and slow heart rate

# Treat / prevent secondary injury

- Ensure adequate ventilation and oxygenation
- Properly immobilize entire patient
- Maintain blood pressure with fluid and inotropes
- Atropine as needed for bradycardia
- Avoid transfer delay!
- Methylprednisolone

# IV Methylprednisolone

- Blunt injury only
  - Start within 8 hours of injury
    - 30 mg/kg over 15 minutes
    - 5.4 mg/kg over next .....
    - 23 hours if started within 3 hours of injury
    - 48 hours if started within 3 to 8 hours after injury

# Secondary Survey - Neck

- Type of injury Blunt v Penetrating

# Secondary Survey - Neck



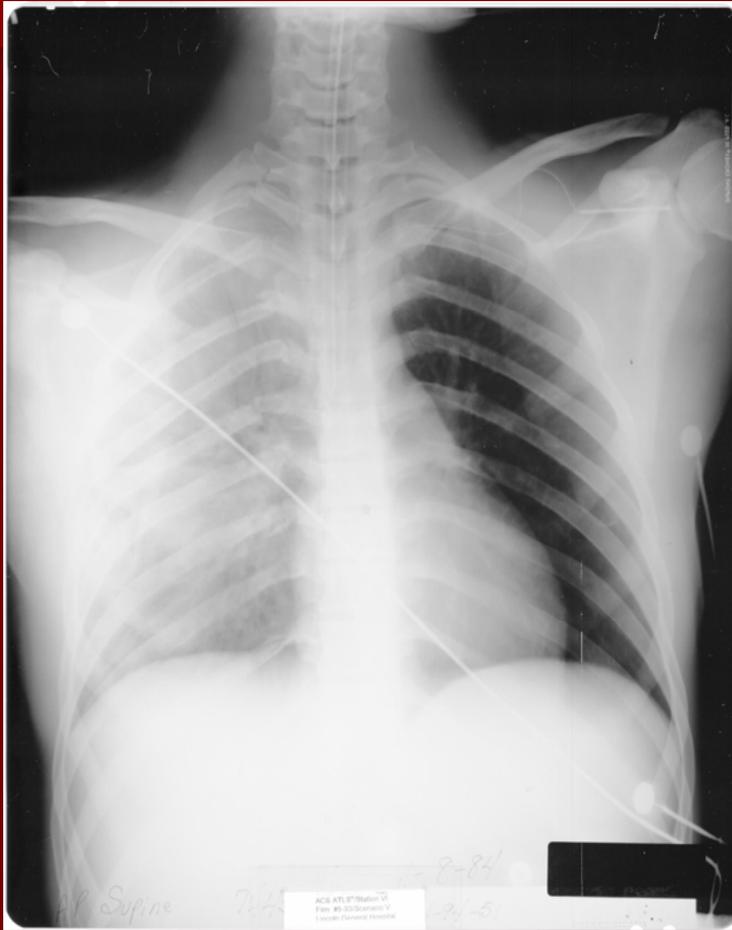
# Secondary Survey - Neck

- Type of injury Blunt v Penetrating
- Look for increasing airway obstruction, stridor or hoarseness
- **KEEP LOOKING AND LISTENING !!**

# Secondary Survey - Chest

- Inspect
- Palpate
- Percuss
- Auscultate
- X-rays

# Secondary Survey - Chest



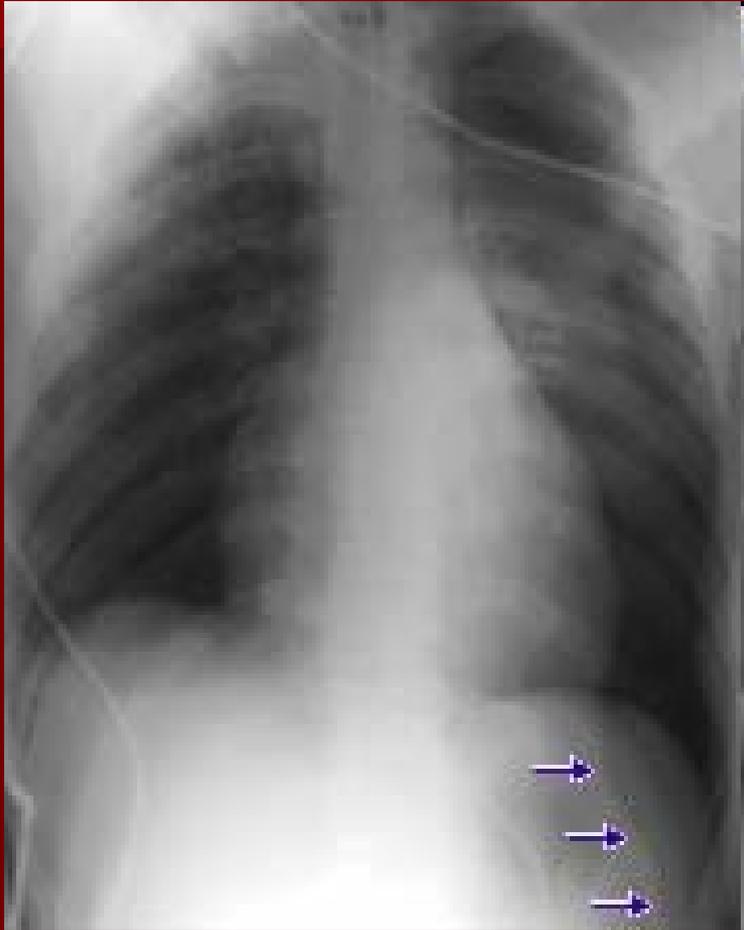
Haemothorax and flail

# Secondary Survey - Chest



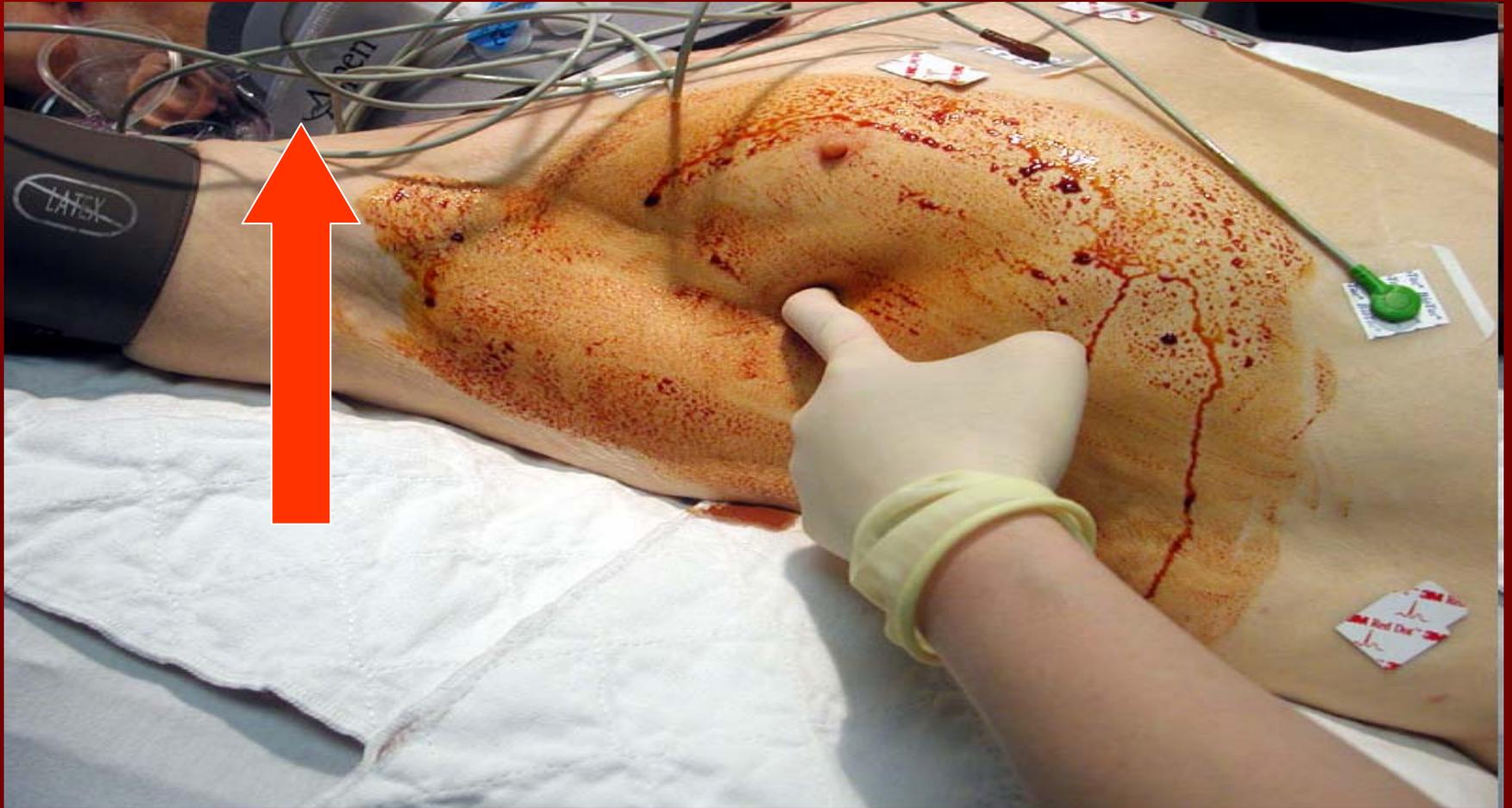
Pneumothorax

# Secondary Survey - Chest

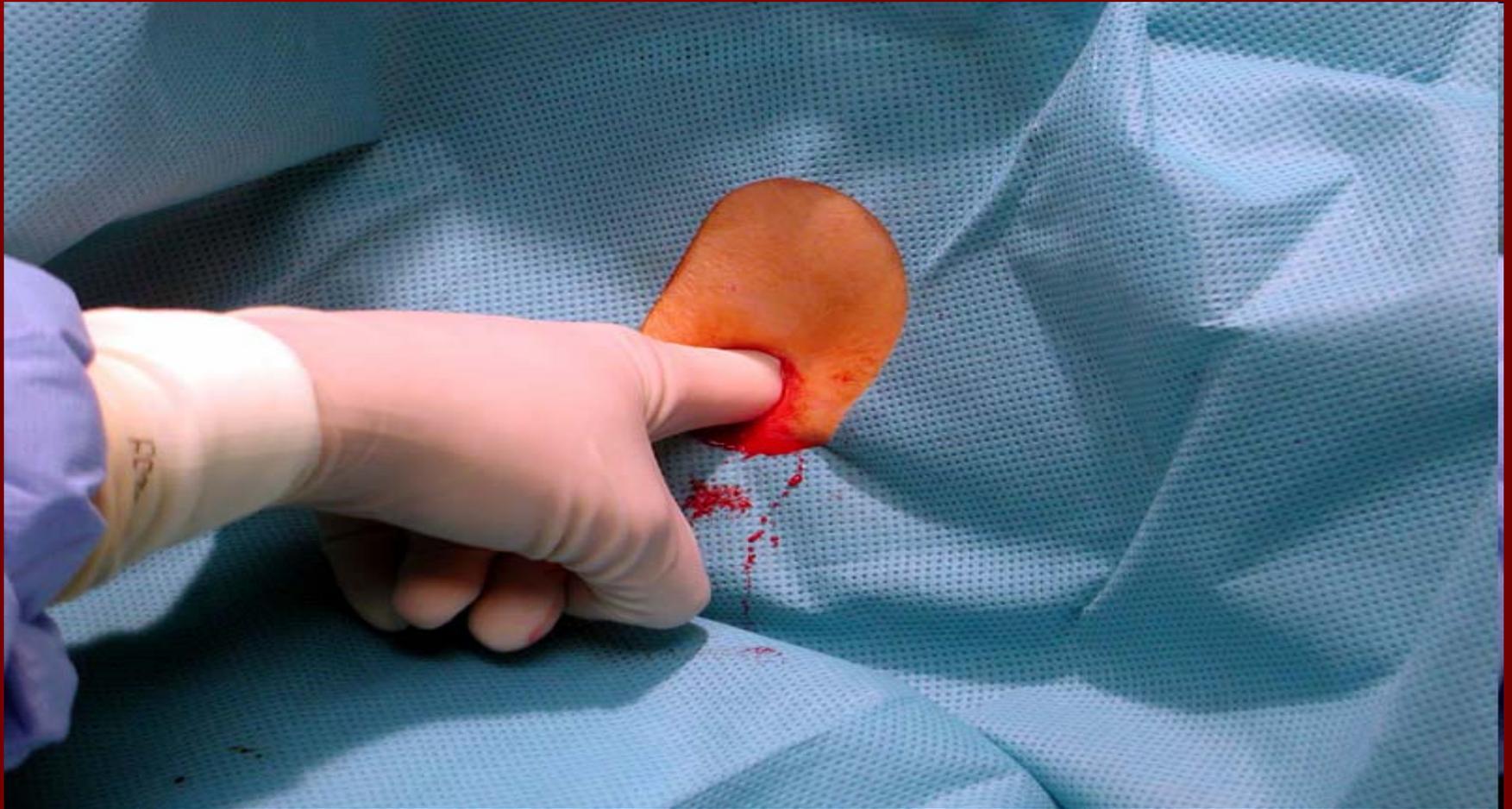


Pneumothorax  
– deep sulcus sign

# Chest Drain Insertion



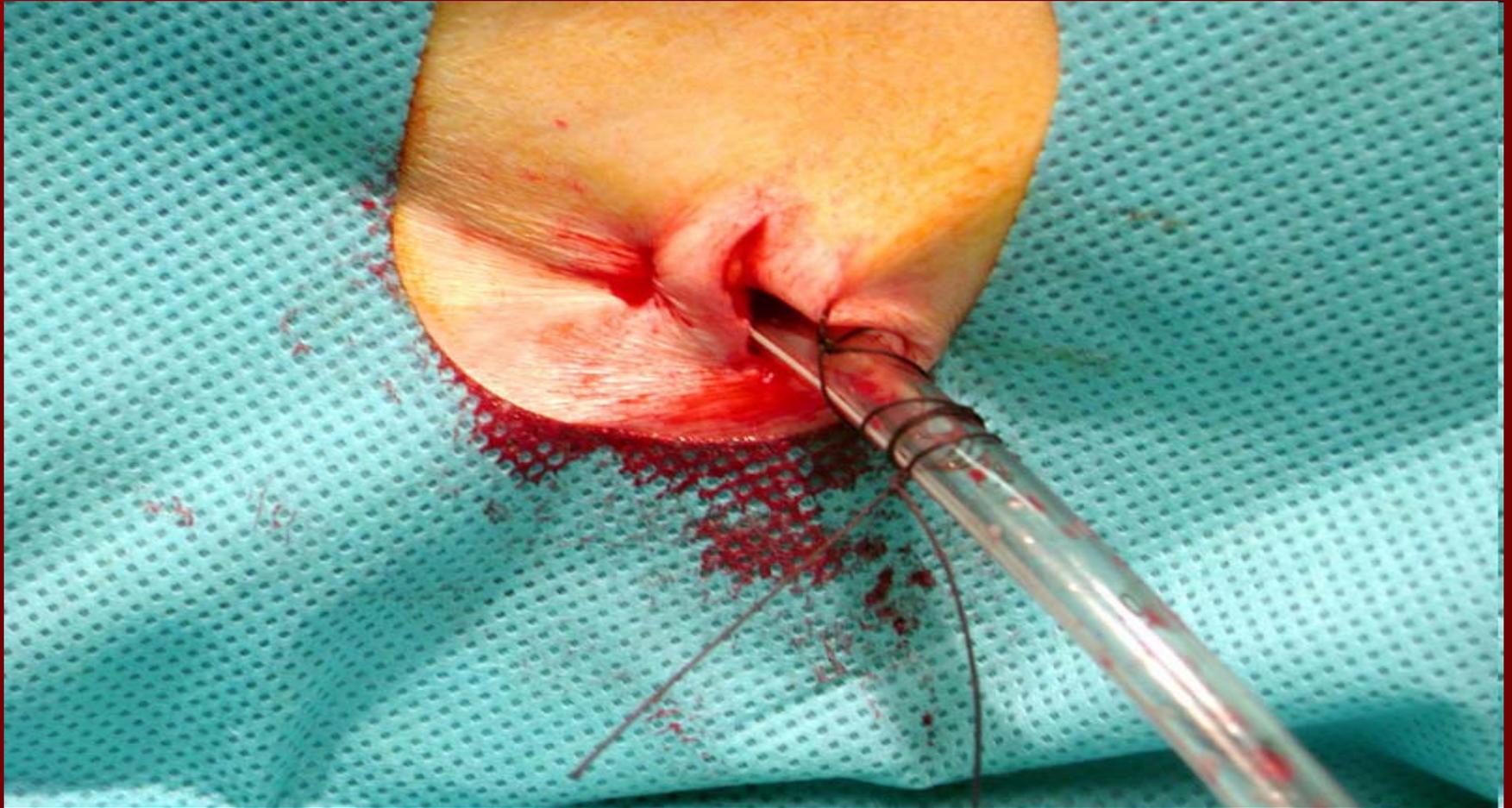
# Chest Drain Insertion



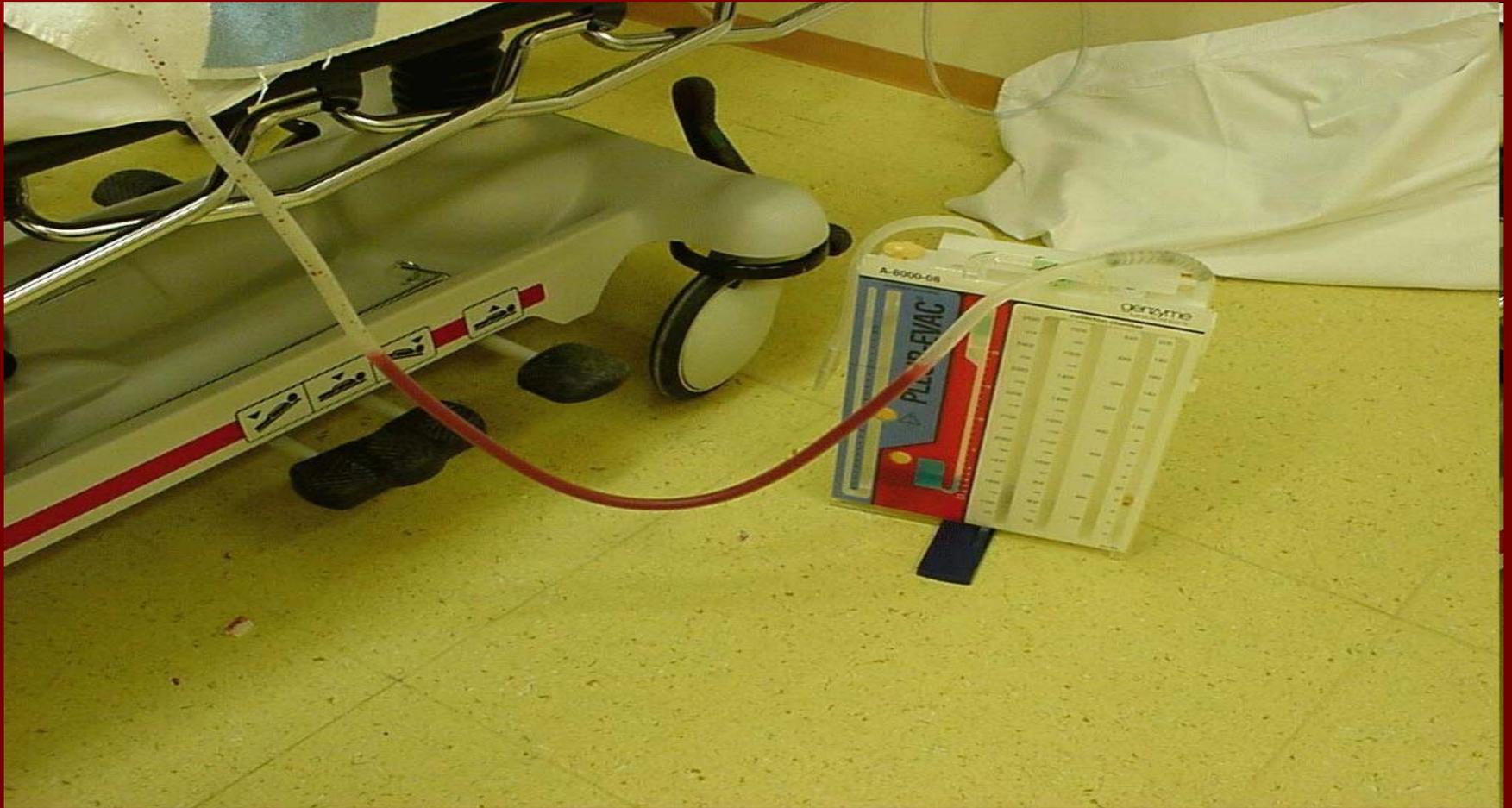
# Chest Drain Insertion



# Chest Drain Insertion



# Chest Drain Insertion



# Secondary Survey- Chest



Tension pneumothorax

This is a post mortem X-ray !!

# Tension Pneumothorax

- Respiratory distress
- Distended neck veins
- Non-central trachea
- Hypotension and tachycardia
- Hyperresonance
- Absent breath sounds

# Tension Pneumothorax - Treatment

- Immediate decompression



# Secondary Survey - Chest



Haemothorax

# Haemothorax

- At least 1500 ml blood
- Flat (not distended) neck veins
- Hypotension and tachycardia
- Absent breath sounds
- Dullness to percussion (not hyperresonance)

# Haemothorax - Treatment

- Rapid volume resuscitation
- Operation

# Haemothorax



Multiple stab wounds



Don't forget the back

# Secondary Survey – Perineum

- Urethral blood
- Rectal tone, integrity, blood
- Vaginal blood, lacerations

# Secondary Survey - Pelvis



- Pain on palpation
- Unequal leg length
- Instability
- **SIGNIFICANT BLOOD LOSS !!**

# Secondary Survey

## Musculoskeletal: Extremities

- Contusion, deformity
- Pain
- Perfusion
- Peripheral nerve status
- Potential blood loss
- Compartment syndrome
- Fat embolus

# Fat Embolism Syndrome (FES)

- Fat emboli were first noted by F.A. Zenker in 1861 in a railroad worker with a thoraco-lumbar crush injury
- Fat embolism develops in nearly all patients with fractured bones and is asymptomatic
- 1-3% chance of developing FES with single long bone fracture (increases with number of fractures)
- Mortality rate 10-20%

# FES - pathophysiology

- 2 theories:

- Mechanical theory:

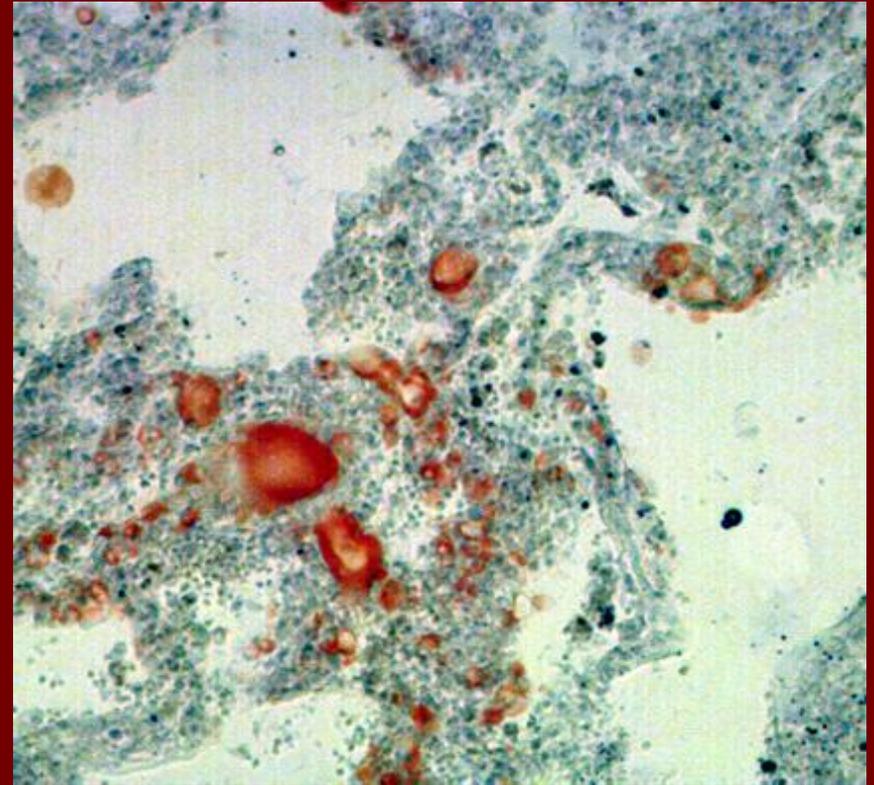
- Large fat droplets deposited in pulmonary capillary beds, and via a-v shunts to the brain. Causes local ischaemia and inflammation.

- Biochemical theory:

- Degradation of fat to free fatty acids cause vasculitis/ARDS in animals. Probably phospholipase A2 and CRP mediated.

# Pathogenesis of ARDS in FES

- Fat emboli obstructs lung vessel (20microns) platelets and fibrin adhere
- Lipase creates FFA
- Inflammatory changes->endothelial damage->ARDS



# FES – clinical signs

- Cardiopulmonary (12-72 hrs after insult)
  - Early persistent tachycardia
  - Tachypnoea, dyspnoea, and hypoxia due to V-Q mismatch
  - ½ of pts with FES require mechanical ventilation (Bulger, Archives of Surgery 1997; 132: 435-9)
  - High temperature spikes

# FES – clinical signs

- Dermatological (24-36 hrs after insult)
  - Reddish-brown nonpalpable petechiae over upper body, especially axillae
  - Occur in 20-50% of patients and resolve quickly



# FES – clinical signs

- Subconjunctival & oral hemorrhages/petechiae



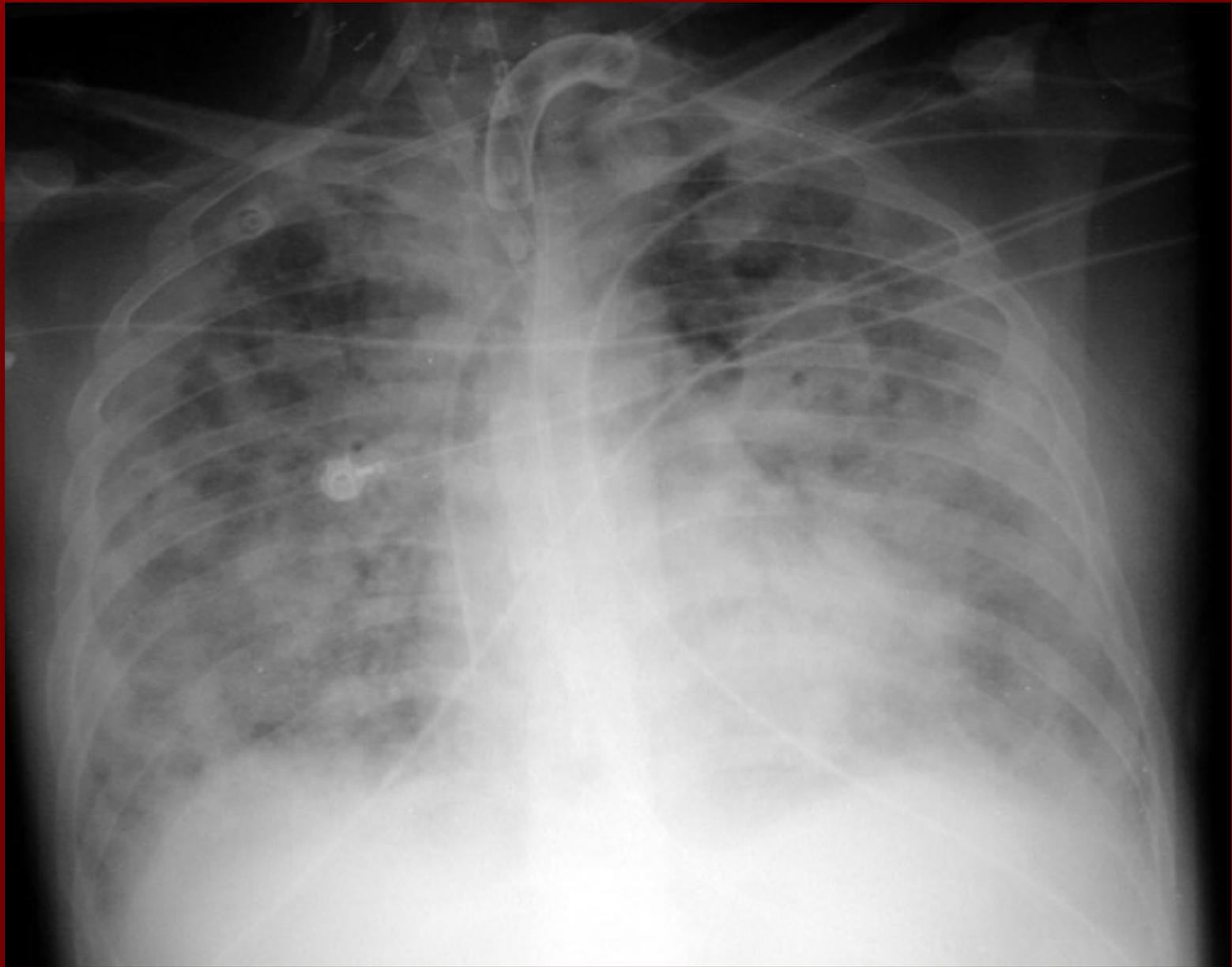
# FES – clinical signs

- Neurologic (80% of patients with FES)
  - Agitated delirium
  - Stupor, seizures, or coma
  - Retinal haemorrhages with intra-arterial fat globules visible on fundoscopy



# FES - investigations

- Blood (non-specific)
  - Thrombocytopenia
  - Anaemia
  - Hypofibrinogenaemia
  - hypocalcaemia
- Fat globules seen in urine, blood & sputum stained with Sudan or oil red
  - N.B. fat in urine common in all trauma patients
- Imaging
  - CXR-diffuse bilateral pulmonary infiltrates



# FES - investigations

- Imaging

- Head CT-nil or diffuse white matter petechial haemorrhages

- BAL-staining of alveolar macrophages for fat (controversial benefit)

# FES - treatment

- Medical care
  - Supportive in nature
  - Maintain oxygenation and ventilation
  - Stabilize haemodynamics
  - Blood products as needed
- Surgical care
  - Early stabilization of fractures to minimize bone marrow embolization

Arch Surg 1997; 132:435–439

# FES - steroids

- Steroid prophylaxis is controversial to prevent FES
- Theorized blunting of inflammatory response and complement activation
- Prospective studies suggests prophylactic steroids benefit high risk patients
- Few studies and small study size, so remains controversial
- Once FES established, steroids have not shown improved outcomes

# FES – alcohol !!!!!!!!

## ■ ABSTRACT:

In an analysis of the cases of 100 consecutive patients with diaphyseal fractures in the major bones of the lower limb, the incidence of fat embolism syndrome was 17%. The blood alcohol level was determined at the time of admission.

A raised level of alcohol in the blood was associated with a lower incidence of fat embolism.

Bone Joint Surg Am. 1977;59:878-880.  
R Myers and JJ Taljaard



Marmara earthquake – Turkey 1999

# Crush Injury

- “Crush syndrome” first recorded in bombing of London during WWII: 5 people who were crushed presented in shock with swollen extremities, dark urine.

- Later died from renal failure.



# Rhabdomyolysis - incidence

- Occurs in up to 85% of patients with traumatic injuries.
- Those with severe injury who develop rhabdomyolysis-induced renal failure have a 20% mortality rate
- Crush injury to any part of the body (e.g. hand)
- Laying on limb for long period of time

# Rhabdomyolysis - pathophysiology

- Not usually directly due to ischaemia
- Muscle sarcolemma stretch and permeability increases
- Influx of sodium, water, & extracellular calcium into the sarcoplasm
- Cells swell → reduced function → myocytic death
- Leak of intracellular metabolites into circulation
- Free radicals then cause further membrane injury

# Rhabdomyolysis – symptoms and signs

## ■ Clinical:

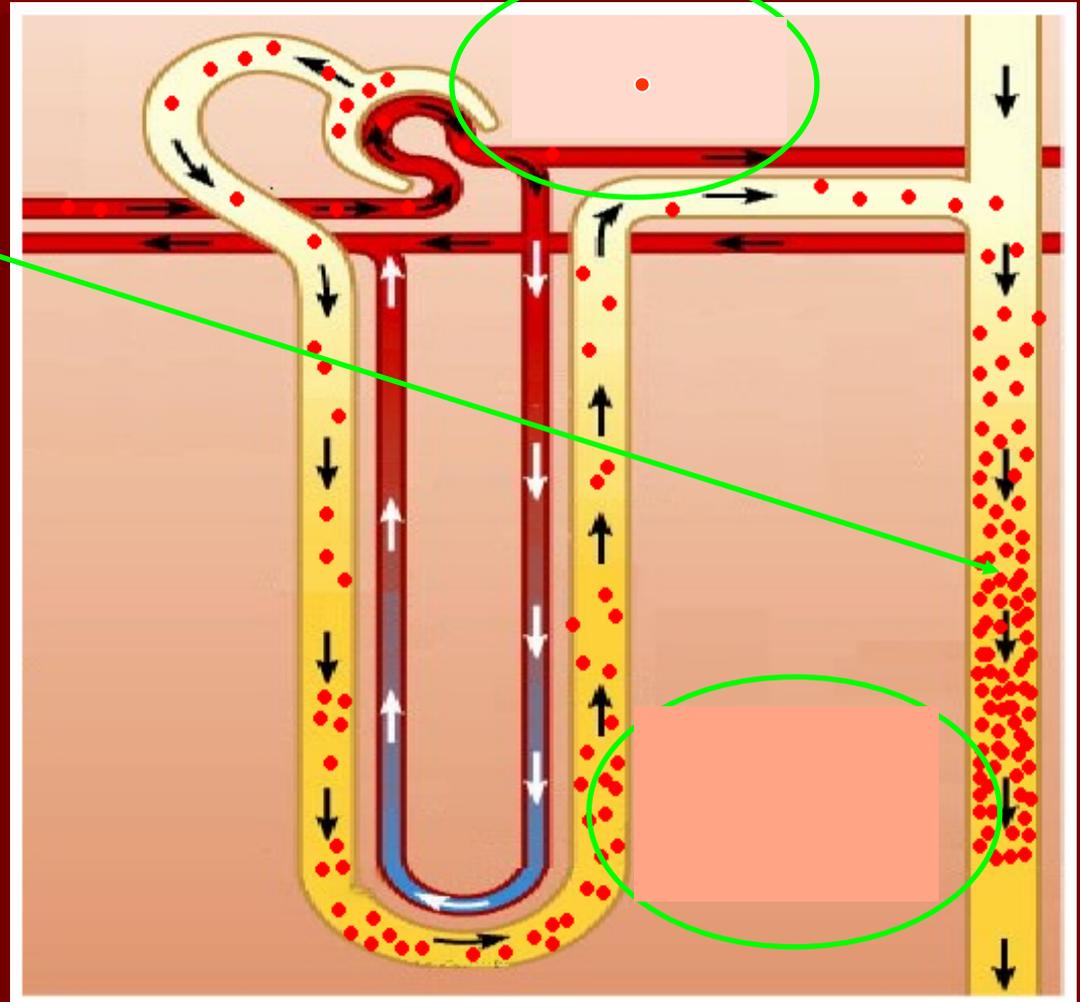
- Muscle pain & weakness
- dark urine (myoglobin)
- Hypovolaemic shock (fluid moves into damaged tissue)

## ■ Electrolyte abnormalities:

- $\uparrow K^+$  (leakage)
- $\downarrow Ca^{2+}$  (sequestered in injured tissues)
- Metabolic acidosis
- $\downarrow$  phosphate
- Myoglobinaemia/uria

# Rhabdomyolysis - ARF

- Myoglobin precipitates (particularly in hypovolemia) and obstructs renal tubules



# Rhabdomyolysis - ARF

- Myoglobin directly toxic to the renal tubular cells especially in acid urine
- At pH < 5.6, myoglobin dissociates into its 2 components
  - Globin (nontoxic)
  - Ferrihaemate (probably toxic)

# Lab tests

- **Serum Creatinine Kinase**
  - Correlates with severity of rhabdomyolysis
  - Levels peak within 24h
  - Normally 145-260 U/L
  - >5000 U/L - high correlation with renal failure
- **Serum myoglobin**
  - $t(1/2)$  2-3 h
  - Excreted in bile
- **Myoglobinuria**
  - dipstick will be (+) for haemoglobin, RBC's and myoglobin
  - Microscopy: no RBC's, brown casts, uric acid crystals



# Early Treatment

**LOTS OF  
FLUIDS**

**MAYBE  
10 l/day**



- **Begin early (on the field)**
- Ideally ½ NS with 100mmol/L bicarb
  - corrects acidosis
  - prevents tubular precipitation of myoglobin
  - reduces risk of hyperkalaemia
- 10ml/h 15% mannitol
  - renal vasodilator
  - free radical scavenger
- Forced diuresis w/in 6 hrs of admission

# Late Treatment



# In Summary

# Successful management of the trauma patient requires ....

- Teamwork
- Speed
- Efficiency
- Keeping it simple
- Using your skills
- Effective
- JUST LIKE . . . . .

# ARSENAL FIRST TEAM SQUAD 2008/09

1931

1933

1934

1935

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Thank You!

Any Questions?