



# Management of Seriously Injured child

Dr Chandima Suriyarachchi MS. FRCS

Consultant Paediatric Surgeon

Lady Ridgeway Hospital for Children

- Trauma is the greatest contributor to childhood mortality. Trauma is the leading cause of death in children aged 1 to 14 years. Major cause of disability.
- The things children do and their changing levels of maturity predispose them to different patterns of injury from adults.
- Children are rarely involved in industrial accidents and are less likely to be involved in motor vehicle accidents than their parents.

# Mechanism of injury cont.

- Instead, they fall from playground equipment, suffer sporting and playground accidents and are generally more at risk in home accidents.
- Adolescents consciously engage in risk-taking behaviours, while toddlers do not have the information or judgement to recognise and avoid imminent danger.

# APLS

- provides the information necessary to assess and manage critically ill or injured children during the first hours in the emergency department.
- course goes beyond basic resuscitation and is designed to meet the advanced skills and knowledge levels of the physician dealing with serious pediatric diseases and problems in an emergency setting.

# APLS



- Provides a detailed survey on the evaluation and management of pediatric medical and surgical emergencies.
- It is an educational "tool kit" that has helped thousands of emergency physicians and pediatricians to improve the quality of care they provide to infants and children with emergency conditions.

# What's different about children?



- **Physically** –
- Small body size/ large surface area; mass:area
- relatively large head:body mass ratio
- Compliant elastic skeleton
  
- **Physiologically**-vital signs vary with age
  
- **Psychologically**- fear and denial
- Encourage parents to be present if possible
- Be calm and quiet & gentle

- Protective equipment and clothing is more problematic for children than adults.
- The varying and constantly changing sizes of growing children make correct sizing of helmets, car restraints etc difficult and expensive for families.
- The small child hit by a car will often sustain abdominal injuries, while adults are more likely to fracture the long bones of the legs because of their greater height.



# Structured approach

- **Immediate**
  - Primary survey
  - Resuscitation
- **Focused**
  - Secondary survey
  - Emergency treatment
- **Detailed review**
  - Reassessment
  - Continuing stabilization & definitive care



# Primary survey



- Airway with cervical spine control
- Breathing with ventilator support
- Circulation with haemorrhage control
- Disability with prevention of secondary insult
- Exposure with temperature control
- NETS ; Newborn & paediatric Emergency Transport Service

# Airway & cervical spine

Check airway by

- Look chest movements
- Listen breath sounds
- Feel exhaled air

Ⓢ Cervical spine injury should be suspected & due care given unless, the mechanism of injury excludes the possibility of cervical spine injury.

# Airway



- **Paediatric airway is smaller**  
greater risk of airway obstruction.
- Children with loose deciduous teeth may have one dislodged into the airway.
- **Larger tongue and smaller oral cavity**
- **Infants have a relatively larger occiput**

The large occiput of the infant flexes the head forward when he/ she is placed prone on a flat surface.

# Airway



- **Infants are nose breathers**

Care must be taken to ensure that the nares are patent in cases of infant trauma.

- **Trachea is more cartilaginous and soft**  
makes it more subject to collapse.

- **Larynx is higher and more anterior. C 2/3**  
makes its visualisation in the paediatric airway more difficult than in the adult.

- **The trachea is short**

increases the risk of dislodgement of the ET tube.

# Breathing

The adequacy of breathing ;

- Effort of breathing
- Efficacy of breathing
- Effects of inadequate respiration

# Assessment of the adequacy of breathing

## *Effort of breathing*

Recession

Respiratory rate

Inspiratory or expiratory noises

Grunting

Accessory muscle use

Flaring of the alae nasi

## *Efficacy of breathing*

Breath sounds

Chest expansion

Abdominal excursion

## *Effects of inadequate respiration*

Heart rate

Skin colour

Mental status

# Physiological parameters in children

Age (years)	Respiratory rate (breaths/min)	Systolic BP (mmHg)	Pulse (beats/min)
<1	30-40	70-90	110-160
1-2	25-35	80-95	100-150
2-5	25-30	80-100	95-140
5-12	20-25	90-110	80-120
>12	15-20	100-200	60-100

# Circulation

- Heart rate & rhythm
- Pulse volume
- Peripheral perfusion (colour, temperature & capillary return)
- Evidence of external haemorrhage



# Circulation



- Blood volume is relatively larger, but absolute volume is smaller  
80-90ml/kg v's 65-70ml/kg.
- Relatively small volumes of blood will constitute significant blood loss in small children  
ie: a 100ml haemorrhage experienced by a 5 kg child represents the loss of approximately 10% of their total blood volume.

# Recognition of clinical signs indicating blood loss requiring urgent treatment

## Signs

Heart rate

Marked or increasing tachycardia

Systolic BP

Falling

Capillary refill time (Normal < 2 sec)

Increased to > 4-5 sec

Respiratory rate

Tachypnoea unrelated to thoracic problem

Mental status

Altered conscious level unrelated to head injury

# Disability

- During Primary Survey

- Brief neurological examination to assess level of consciousness by AVPU method

A	Alert
V	Responds to <b>V</b> oice
P	Responds only to <b>P</b> ain
U	Unresponsive to all stimuli

- Pupil's size and reactivity

Tachycardia is earliest response to hypovolaemia

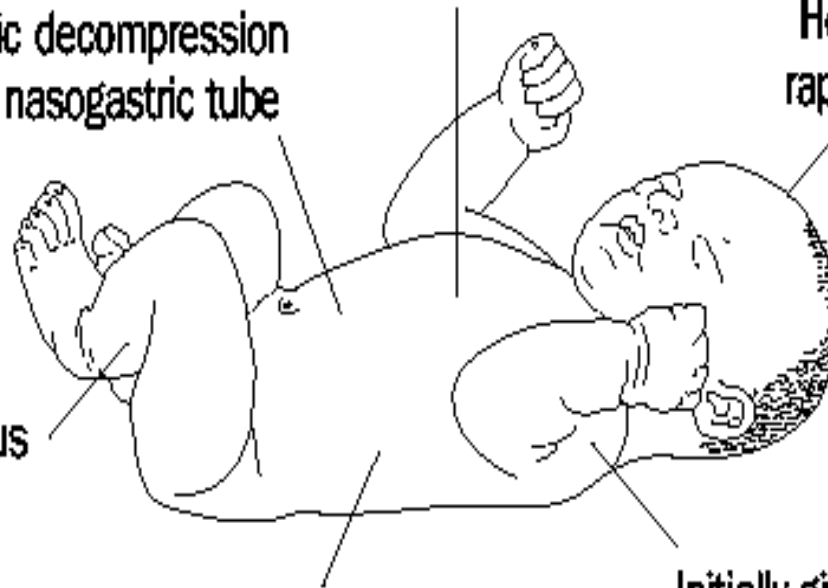
Gastric decompression via a nasogastric tube

Heat loss occurs rapidly; keep warm

Consider intraosseous route

Blood volume is 80 ml/kg in the child and 85-90 ml/kg in the neonate

Initially give 20 ml/kg of crystalloid replacement fluid if signs of hypovolaemia



# Exposure



During primary survey, exposure is necessary but the duration should be minimized to prevent the child being embarrassed and also to prevent him from getting cold.

Don't forget to keep the child  
warm, sweet and pink.

# Conditions identified at the end of primary survey

- Airway obstruction
- Tension pneumothorax
- Open pneumothorax
- Massive haemothorax
- Flail chest
- Shock (haemorrhagic or otherwise)
- Decompensating head injury

# Adjuncts to Primary survey

- Establish monitoring
- Send blood for cross-matching and tests
- Cervical spine, chest and pelvic X-Rays
- Consider ultrasound of the abdomen and chest
- Consider gastric and bladder catheters

# Resuscitation

Life-threatening problems to be treated as they are detected in primary survey

## Airway & cervical spine

**Airway** - Maybe compromised by

1. material in the lumen
2. damage to the structure of the wall
3. the wall being distorted from outside

# Airway management sequence

- **Jaw thrust**, elbows same level



- Suction 10Fr/removal of foreign body under direct vision
- **Face mask**; clear, good fit

- **Oro/nasopharyngeal airways;**

- \* < 8yr concave side down, using tongue depr.
- \* > 8yr concave side up, adult size



# Airway mgt. cont.

- **Tracheal intubation**
- Unresponsive to pain GCS <8
- Respiratory burn injury
  
- In trauma, oral intubation is always used.
- Cuffed tubes are not used in children < 8yr
  
- Surgical airway

## Airway & cervical spine (conti.)



### Cervical spine Immobilisation CSI

- The head & neck should be immobilized by manual-in-line stabilization followed by using a hard collar.
- Semi rigid collar-Lateral support with sand bags or head blocks for additional support.
- Large head; towels under the trunk to allow the head to rest in a neutral position.

# Breathing

- If breathing is inadequate, ventilation must be commenced. Initially bag-mask ventilation.
- A child requiring bag-mask ventilation initially will need intubation.

# Indications for intubation & ventilation

- **Persistent** airway obstruction
- **Predicted** airway obstruction  
eg:- inhalation burn
- Inadequate ventilatory effort or increasing fatigue
- Disrupted ventilatory mechanism  
eg:- severe flail chest
- Persistent hypoxia despite supplemental oxygen
- **Controlled hyperventilation** required to prevent secondary brain injury

- If breath sounds are unequal,
  - pneumothorax
  - haemo- pneumothorax
  - misplaced tracheal tube
  - blocked main bronchus
  - pulmonary collapse
  - diaphragmatic rupture
  - pulmonary contusion

# Circulation

- Need vascular access urgently.
  1. Direct cannulation of the external jugular vein
  2. Indirect cannulation of the femoral vein using the Seldinger technique
  3. Intraosseous cannulation
  4. Cut-down onto the cephalic or saphenous

Tachycardia is earliest response to hypovolaemia

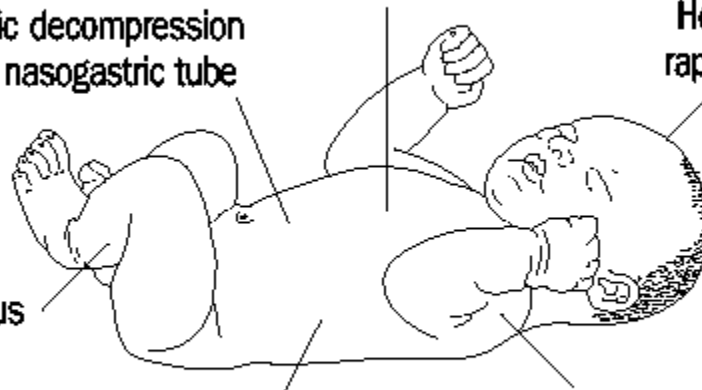
Gastric decompression via a nasogastric tube

Heat loss occurs rapidly; keep warm

Consider intraosseous route

Blood volume is 80 ml/kg in the child and 85–90 ml/kg in the neonate

Initially give 20 ml/kg of crystalloid replacement fluid if signs of hypovolaemia



# Circulation

Assess –carotid/brachial/femoral pulse.

Commence External cardiac compression

pulse is not palpable

pulse <80 /mt in an infant

<60/mt in a young child

<40/mt in an a older child

Chest compression

Infant : 1 finger breath below inter nipple line

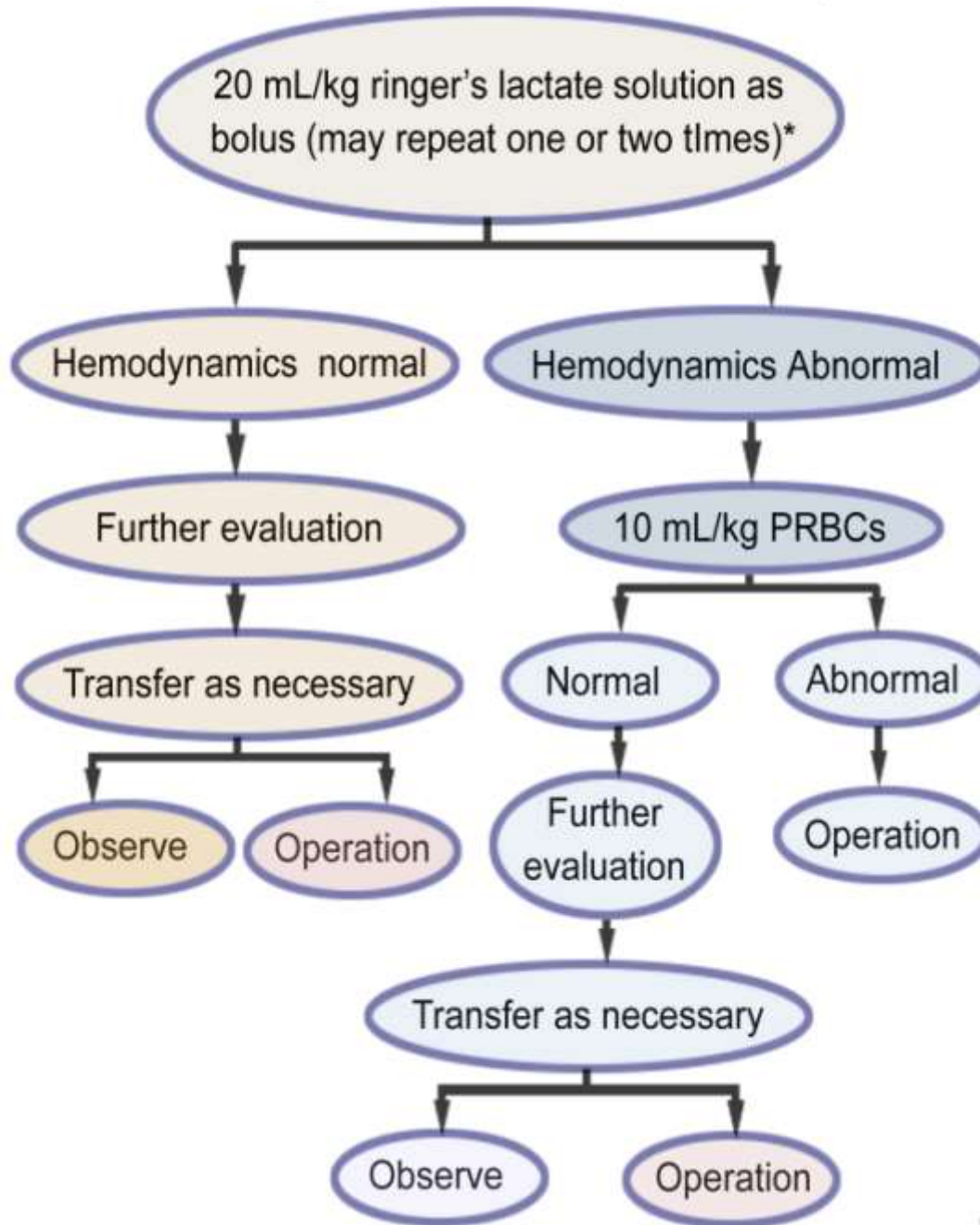
1 to 8 yrs : 1 finger breath above xiphisternum

>8yrs : 2 fingerbreadths above xiphisternum

# Guidelines for fluid therapy in children

- Rapid increase in blood pressure may cause further bleeding
- Head injury requires that the blood pressure is maintained so the perfusion to brain is maintained
- When a bolus of fluid is required, it is given as 20ml/kg of crystalloid
- If  $> 40\text{ml/Kg}$  of crystalloid does not stabilize, blood should be considered
- If  $>20\text{ml/Kg}$  of crystalloid does not stabilize, the surgical team has to be informed urgently

Volume management algorithm for the pediatric trauma patient



# Circulation

- Check the **blood glucose** frequently and give **glucose** if necessary;

Low stores of glycogen

high metabolic rate

**Children with head injury ; don't overload with intravenous crystalloids**

# Disability

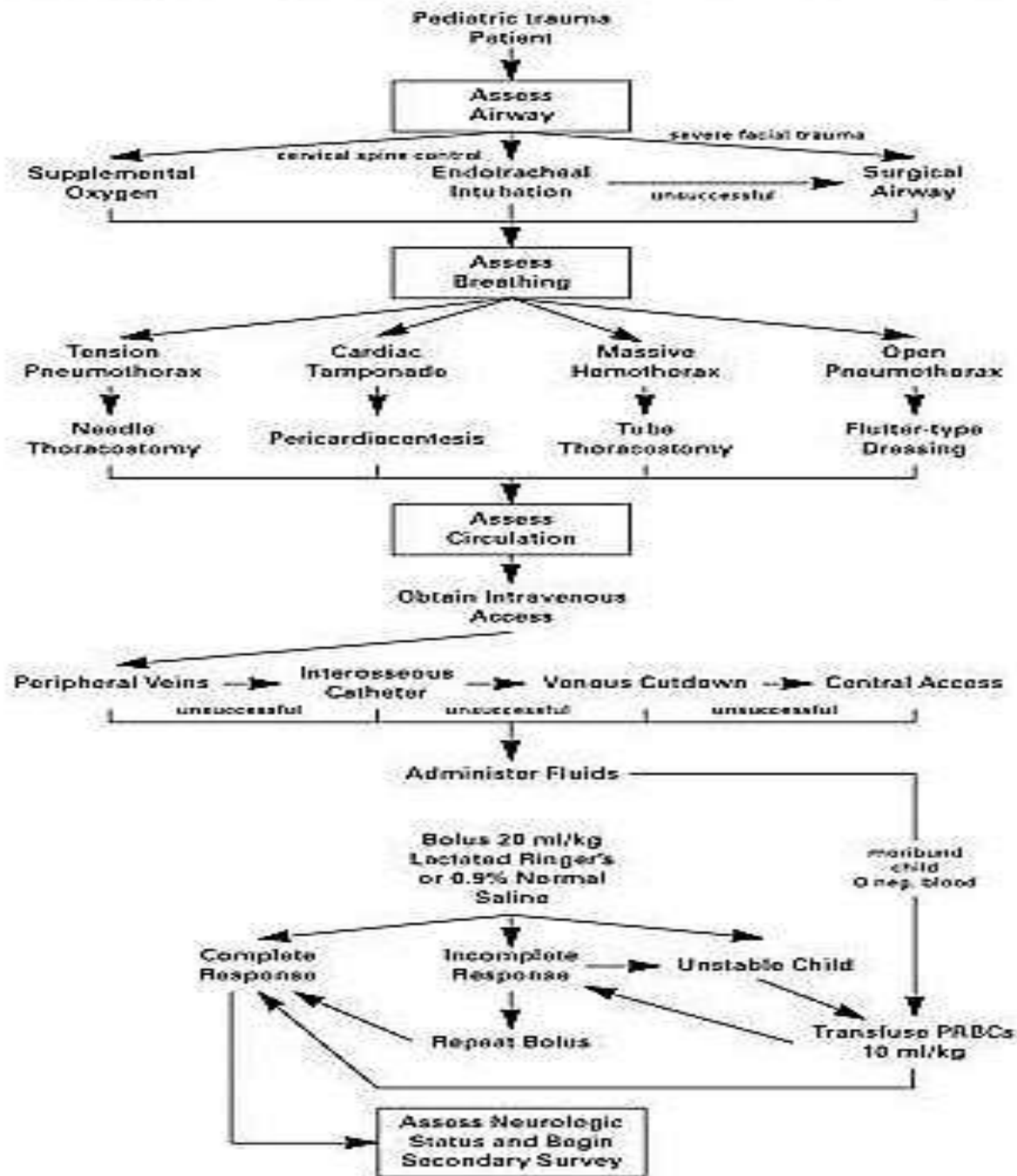
## After primary survey

1. De-compensating head injury -  
neurological resuscitation
2. GCS < 8 & pupil inequalities -  
immediate intervention
3. Lesser degree of unconsciousness or focal sign-  
urgent action

**Table 1. Glasgow Coma Scale Modified For Pediatric Patients<sup>50</sup>**

<b>Eye Opening Response</b>	<b>&lt; 1 year</b>
4	Spontaneous
3	To shout
2	To pain
1	None
<b>Verbal Response</b>	<b>0 to 2 years</b>
5	Babbles, coos appropriately
4	Cries but is inconsolable
3	Persistent crying or screaming in pain
2	Grunts or moans to pain
1	None
<b>Motor Response</b>	<b>&lt; 1 year</b>
6	Spontaneous
5	Localizes pain
4	Withdraws to pain
3	Abnormal flexion to pain (decerebrate)
2	Abnormal extension to pain (decorticate)
1	None

**ALGORITHM: INITIAL MANAGEMENT OF PEDIATRIC TRAUMA PATIENT**



# Secondary survey & looking for key features

Focused care to identify injuries

- History
- Past medical history (Haemophilia)
- Allergies
- Medication

# Secondary survey (conti.)

- Surface (head to toe, front & back)
- Orifice (mouth, nose, ears, orbits: rectum, genitals)
- Cavity (chest, abdomen, pelvic cavity, retroperitoneum)
- Extremity (upper limbs including shoulders; lower limbs including pelvic girdle)

## Secondary survey (conti.)

- Head - bruising, h'age, deformity, pupillary reflex, GCS
- Face - bruising, laceration, loose teeth
- Neck - keep collar, bruising, swelling, radio graphs (lateral, AP, Odontoid, CT, MRI)
- Chest - tracheal deviation, ECG, chest x-ray, CT
- Abdomen - bruising, laceration, tenderness, US scan, CT
- Pelvis – blood at meatus
- Spine – log-rolling, assess neurological function,
- Extremities - bruising, laceration, tenderness

# Emergency treatment

- Potentially life threatening conditions
- Potentially limb threatening conditions

Less urgent than resuscitation phase

# Reassessment

- Respiration (blood gas etc)
- Circulation (haemodynamics, haemoglobin, haemostasis)
- Nervous system (pupils, GCS)
- Metabolism (Electrolytes, Fluid balance, Gut, Hormones)
- Host defenses

# Continuing stabilization

- Note taking
- Referral
- Transfer

# Template for note taking

## History

- Mechanism of injury
- Past history

## Primary survey & resuscitative interventions

- A
- B
- C
- D

## Secondary survey & emergency treatment of injuries

- Head
- Face
- Neck
- Chest
- Abdomen
- Pelvis
- Spine
- Extremities

## Continuing stabilization

- Respiration
- Circulation
- Nervous system
- Metabolism
- Host defence

# Summary

The structured approach to initial assessment & management allows the clinician to care for the seriously injured child in a logical, effective way.

Assessment of vital functions (airway, breathing, circulation & disability) is carried out first & resuscitation for any problems found is instituted immediately.

- Primary survey

- Resuscitation

A complete head-to-toe examination is then carried out, adjunct investigations are performed & emergency treatment is instituted:

- Secondary survey & the search for key features

- Emergency treatment

Finally, a detailed review is undertaken & definitive care is provided.

- Reassessment & physiological system control

- Continuing stabilization & definitive care

# ■ Suggested Reading List

- **Advanced Paediatric Life Support.** 3rd ed. London: BMJ Books 2001. Chapters 4 (Basic life support); 5 (Advanced support of the airway and ventilation); 22 (Practical procedures: airway and breathing).
- Taussig L, Landau L, Le Souef P; Martinez F; Morgan W; Sly P (eds) (2nd edition) **Pediatric Respiratory Medicine.** St Louis: Mosby 2007. Chapters 1 (Assisted ventilatory support and oxygen treatment) and 27 (Lung trauma: toxin inhalation and ARDS).
- Fleisher G, Ludwig S (eds): **Textbook of Pediatric Emergency Medicine (4th ed).** Philadelphia: Lippincott 2000. Chapters 1 (Resuscitation: pediatric basic and advanced life support); 5 (Emergency airway management: rapid sequence induction); 104 (Major trauma); 106 (Neck trauma); 107 (Thoracic trauma); 112 (Otolaryngologic trauma); 114 (Burns).
- Bersten A, Soni N (eds): **Oh's Intensive Care Manual (5th ed)** London: Butterworth Heinemann 2003. Chapters a (The critically ill child); b Upper airway obstruction in children; c (Acute respiratory failure in children; d (Paediatric trauma).
- Macnab a, Macrae D, Henning R (eds): **Care of the critically ill child.** London: Churchill Livingstone 1999. Chapters 2.6 (Trauma: cranial, spinal and multiple); 4.2 (Smoke inhalation); 4.4 (Trauma of individual systems); 6.2 (Intubation); 6.3 (Securing the airway); 6.4 (Assisted ventilation).



Thank you