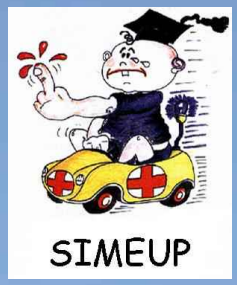
European Resuscitation Council

Italian Resuscitation Council IRC



Nanjing, China, March 2006

Pediatric Advanced Life Support

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Alpine Pediatric Life Support Training Center

http://www.provinz.bz.it/se/paednotmed/

Italian PALS statistics

- 15 courses in Trento province (1998-2000)
- 74 provider courses (2000-2006)
- 1357 providers
- 91 instructors
- 5 instructors of instructors
- 8 instructor courses
- 130 Italian PBLS Training Centers

Aims and Objectives

- Aetiology of cardiac arrest in children
- Reducing mortality and morbidity
- Recognising respiratory and circulatory failure
- Initial management plan

Aetiology of Cardiac Arrest in Children (1)

Primary Cardiac Arrest

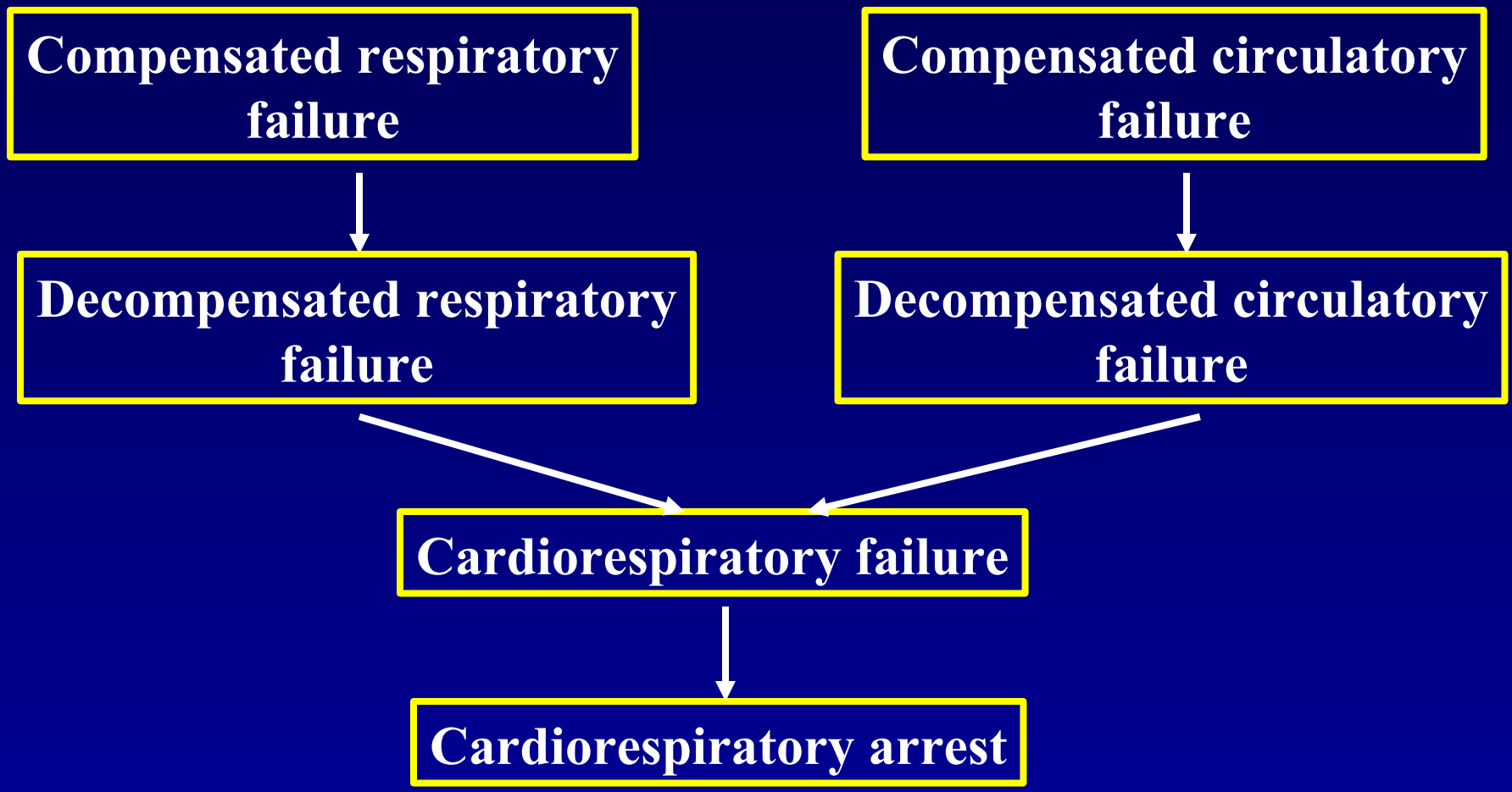
- Common in adults, less common in children
- Sudden, unpredictable onset
- Due to arrhythmia (VF or pulseless VT)
- Hypoxia and acidosis not initially present
- Outcome depends on early defibrillation

Aetiology of Cardiac Arrest in Children (2)

Secondary Cardiac Arrest

- Most common form in children
- Heart stops due to ischaemia or hypoxia secondary to another condition
- Arrest rhythm is usually bradycardia, progressing to asystole
- Hypoxia initially present
- Outcome depends on prevention or prompt resuscitation

Pathways to Cardiac Arrest in Children



Pathways to Cardiac Arrest in Children

Successful resuscitation in children depends upon early recognition of respiratory and circulatory failure and measures to prevent progression to cardiac arrest

What is wrong with these children?

Respiratory Failure:
Definitions

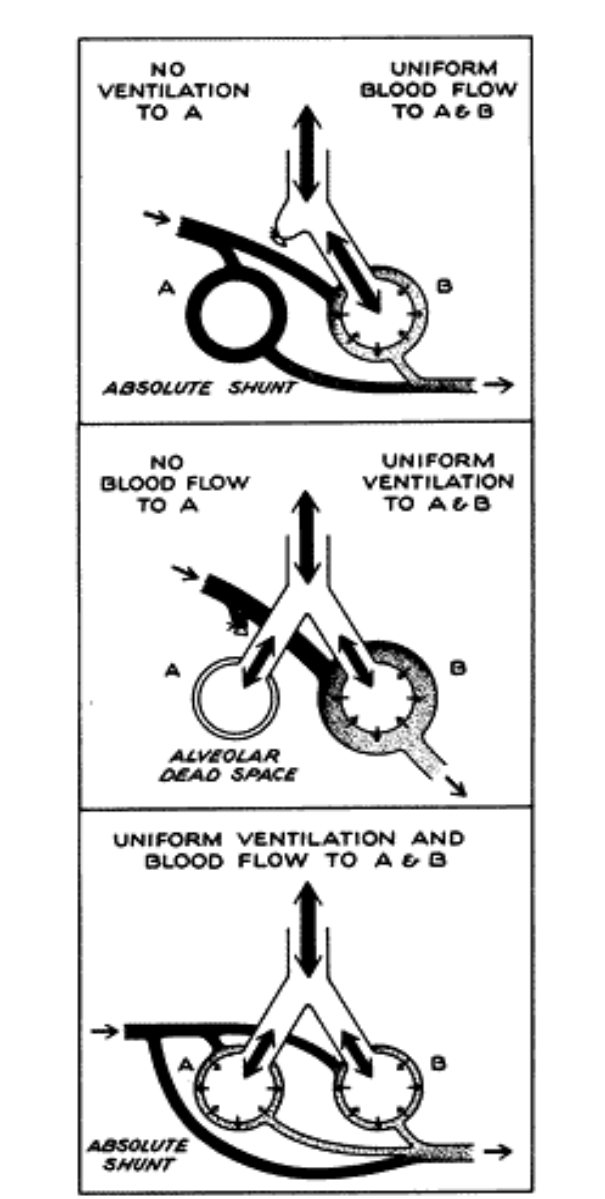
Respiratory failure

- The loss of ability of the respiratory system to maintain adequate blood levels of CO_2 and O_2

Respiratory distress

- Clinical state with increased work of breathing

Respiratory failure can exist without respiratory distress



Pathophysiology of Respiratory Failure (1)

Due to mismatch of ventilation and perfusion in lung units

Pathophysiology of Respiratory Failure (2)

Due to inadequate movement of gas in and out of the lungs

Minute ventilation = Tidal volume x resp rate

1400ml/min	140ml	10/min
1400ml/min	70ml	20/min
1400ml/min	35ml	40/min

Respiratory failure can occur with respiration which is either too slow *or* too fast

Assessment of Respiratory Insufficiency

A B C

Assess, change, reassess

Assessment of Respiratory Insufficiency: Airway

- Chest movement does not imply a clear airway
- Listen and feel for air movement and noises
- Is the airway:
- Clear and safe?
- At risk?
- Obstructed?

Assessment of Respiratory Insufficiency: Breathing

- Respiratory rate
- Tidal volume
- Work of breathing (WOB)
- Oxygenation

Assessment of Respiratory Insufficiency: Breathing

Respiratory rate:

Varies with age, fever, pain and anxiety as well as respiratory insufficiency

Age	<1	2-5	5-12	>12
Resp rate	30-40	20-30	20-24	12-20

It is more important to monitor the trend in respiratory rate than to rely on the absolute value

Assessment of Respiratory Insufficiency: Breathing

Tidal volume; look, listen, feel

- Compare one side with the other
- Subjective assessment; breath sounds should be audible in both bases
- Feel for the trachea; is it central?
- Noises!

Assessment of Respiratory Insufficiency: Breathing

Noises

- **Stridor:** Inspiratory noise; airway obstruction above the thoracic inlet
- **Wheeze:** Expiratory noise; airway obstruction below the thoracic inlet
- **Grunting:** Expiratory noise; attempt to raise the end-expiratory lung volume

Signs of Respiratory Distress
(increased WOB)

- Tachypnoea
- Head bobbing
- Anxious demeanour
- Flared nostrils
- Grunting
- Stridor or wheeze
- Exhaustion

Assessment of Respiratory Insufficiency: Oxygenation

Cyanosis is an unreliable sign of hypoxia

- Absence of cyanosis does not imply good oxygenation
- Central cyanosis does imply hypoxia
- Use a pulse oximeter
- What FiO_2 is required to maintain good saturations?

Compensated or Decompensated?

Signs of decompensation

- Increasing respiratory rate
- Respiratory rate <10 or >55
- Sudden fall in respiratory rate
- Reduced interaction with carers
- Exhaustion
- Decreasing level of consciousness

What is wrong with this child?

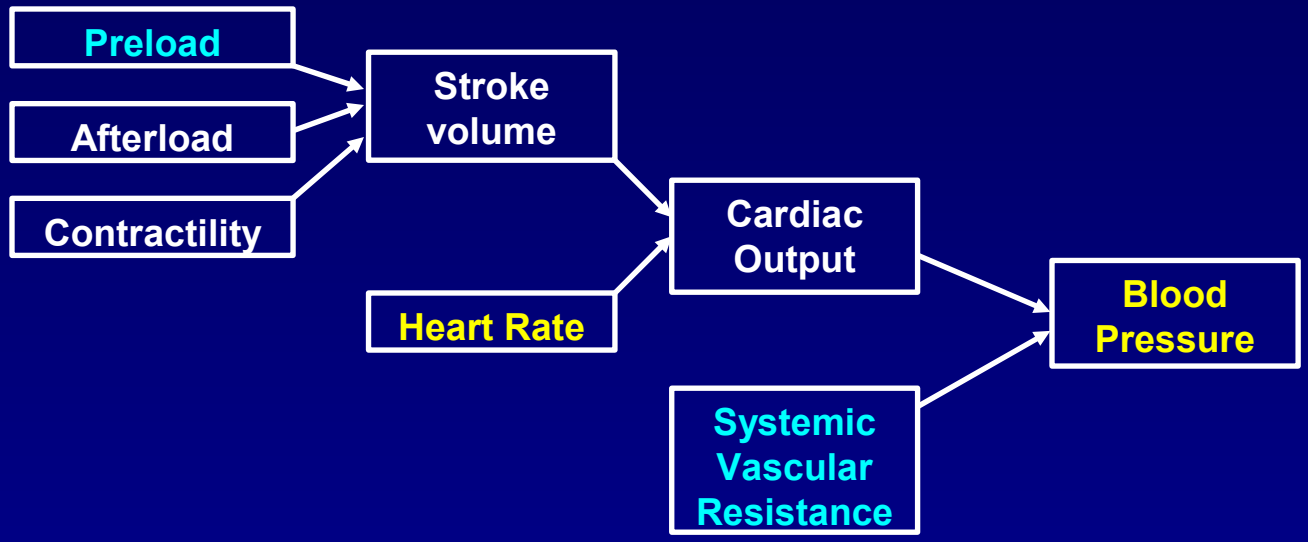
Assessment of Circulatory Failure

A B C

Assess, change, reassess

Assessment of Circulatory Failure

Relationships between variables affecting cardiac output and blood pressure



Can be objectively measured

Can be subjectively assessed

Assessment of Circulatory Failure

- Heart rate
- Blood pressure
- Systemic vascular resistance
- Pre-load

Assessment of Circulatory Failure: Heart Rate

Heart rate:

Varies with age, fever and anxiety as well as circulatory failure

Normal heart (HR) and respiratory (RR) rates by age

Age	>30 days	5 years	12 years	18 years
RR	30	20	18	14
		X5	X5	X5
HR	130	100	90	70

Assessment of Circulatory Failure: Blood Pressure

Changes in systolic blood pressure with age

Age	Systolic BP (normal) mmHg	Systolic BP (lower limit) mmHg
0 –1 month	60	50
1 – 12 months	80	70
1 – 10 years	90 + 2x age	70 + 2x age
> 10 years	120	90

Assessment of Circulatory Failure: Blood Pressure

Blood pressure is maintained by increases in SVR at the expense of perfusion of:

- Skin
- Kidneys/gut

When compensatory mechanisms fail, BP falls. Prior to cardiac arrest so dose perfusion of:

- Brain & heart

Assessment of Circulatory Failure: Skin Perfusion

Capillary refill

- Gently squeeze a finger (or toe) pulp until it blanches
- Release and observe the return of capillary blood
- > 2 seconds is abnormal

Assessment of Circulatory Failure: Skin Perfusion

- **Look** – for colour (mottling, pallor, peripheral cyanosis or rashes)
- **Feel** - for peripheral pulses, temperature and the line of demarcation between warm and cold

Assessment of Circulatory Failure: Renal Perfusion

Urine output is an index of organ perfusion

- **Nappy weights**
- **Urinary catheter?**

Assessment of Circulatory Failure: Pre-load

- Jugular venous pulsation
- Enlargement of liver
- Moist sounds in lungs
- CXR

Compensated or Decompensated?

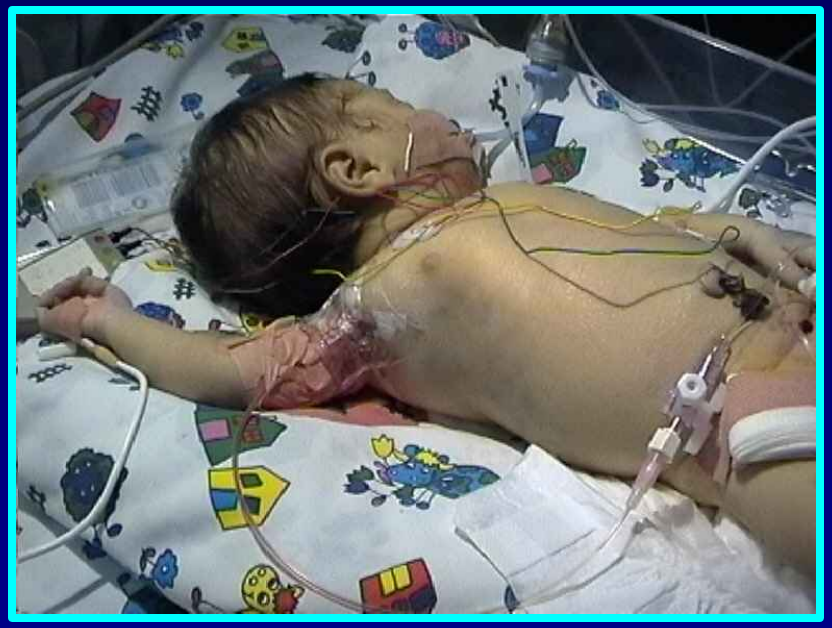
Signs of decompensation

- Increasing pulse rate
- Sudden fall in pulse rate
- Hypotension
- Oliguria
- Reduced interaction with carers
- Decreasing level of consciousness

Types of Circulatory Failure

	HR	BP	SVR	Pre-load
Hypovolaemic	↑	→	↑	↓
Distributive	↑	↓	↓	↓
Cardiogenic	↑	↓	↑ →	↑ →

Cardiorespiratory Failure



- There is always some respiratory compensation for circulatory failure and vice versa
- In severe illness it is not possible to determine which came first
- If untreated, this phase presages imminent cardio-respiratory arrest

Management, based on initial assessment

- Stable and safe
- Compensated respiratory failure
- Decompensated respiratory failure
- Compensated circulatory failure
- Decompensated circulatory failure
- Cardio-respiratory failure

Compensated Respiratory Failure

- Assess airway
- O_2 therapy (unthreatening)
- Monitoring (pulse oximetry, pulse and respiratory rate)
- IV access with topical anaesthesia
- Reassess

Decompensated Respiratory Failure

- Maintain clear airway
- 100% O_2
- Support ventilation with bag/mask system
- Consider tracheal intubation and mechanical ventilation

Compensated Circulatory Failure

- Assess airway
- O_2 therapy (unthreatening)
- Monitoring (pulse oximetry, pulse and respiratory rate, blood pressure)
- IV access
- Fluid bolus
- Reassess

Decompensated Circulatory Failure

- Airway control
- 100% O_2
- Support ventilation if required
- Urgent IV/IO access, fluid bolus
- Reassess and repeat as required
- Consider inotropes

Cardiorespiratory Failure

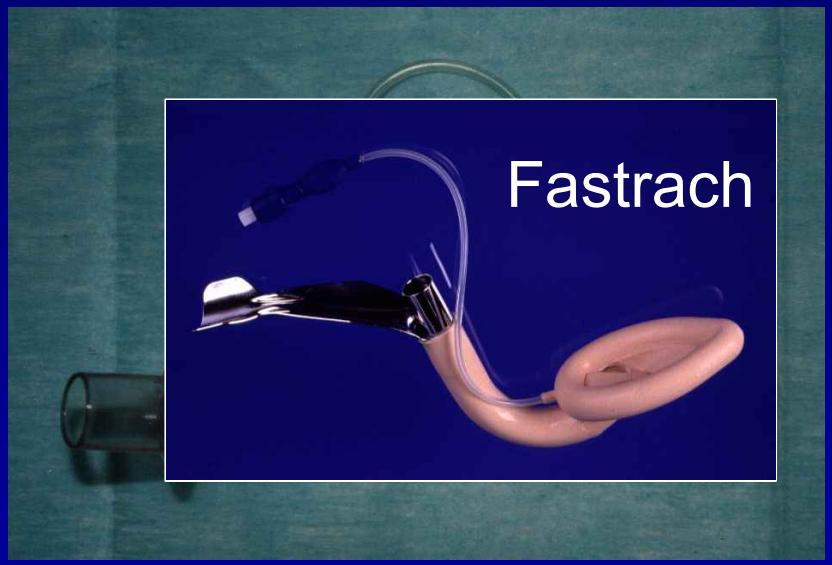
- Airway control
- 100% O_2
- Support ventilation, initially with bag/mask system
- Reassess (monitoring)
- Urgent IV/IO access; fluid boluses if required
- Reassess
- Consider inotropes

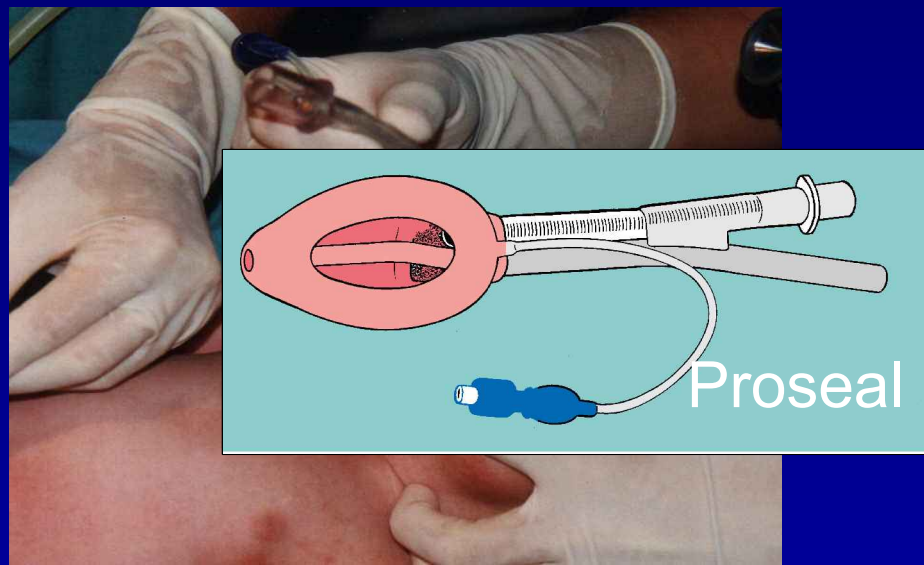
PALS procedures: what is new in 2005 Guidelines

- **A**irway
  LMA, cuffed tube
- **B**reathing
  Hyperventilation, ET CO_2
- **C**irculation
  Tracheal access
  Adrenaline, glucose, lidocaine, vasopressin
- **D**efibrillation
  Doses, biphasic, algorithm

Airway: LMA

- Not a first choice in resuscitation
- Acceptable for experienced providers in children





Airway: tracheal tube

- **Tape measurement is more accurate than formulae**

$$\text{diameter ETT} = \frac{\text{age (yr)}}{4} + 4$$

Depth (cm) = diameter ETT (mm) x 3

- **Prehospital uncuffed TT (up to 5.5)**
- **In- hospital: cuffed TT acceptable**
  - **Leak, ARDS, non-compliant lungs**
- **Monitoring of cuff pressure (20 cm H2O)**

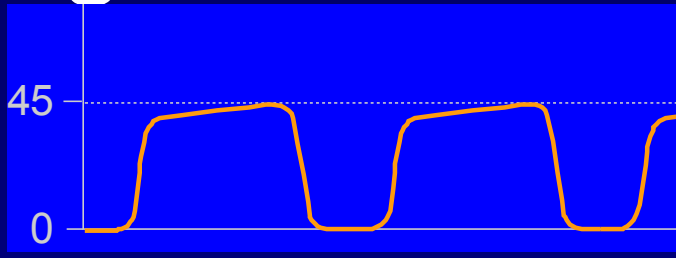
Breathing: ventilation during and after CPR

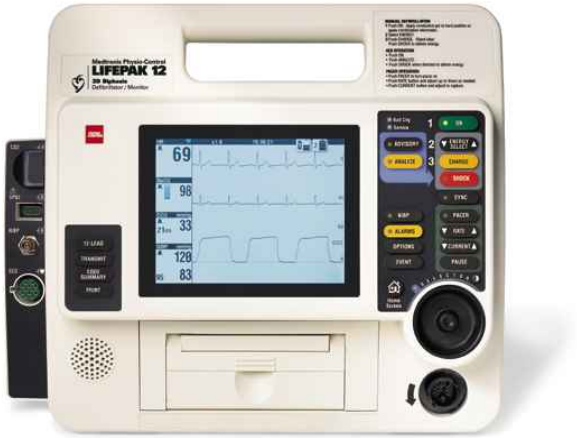
- **Hyperventilation :**
  - ⇗ **intrathoracic pressure**
  - ⇘ **cerebral & coronary perfusion**
- **Ideal tidal volume = modest chest wall rise**

Avoid hyperventilation
Maintain normal $PaCO_2$: 35-45 mm Hg

Breathing : monitoring of $EtCO_2$

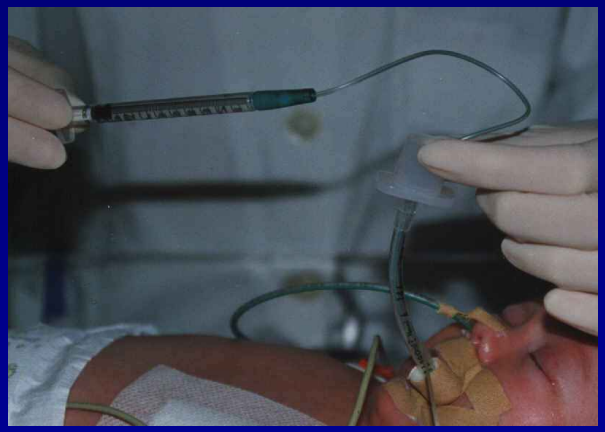
- ✓ **In pre- & in-hospital setting**
- ✓ **In any intubated child > 2 kg**
- ✓ **In any transportation**
- ✓ **Low or absent $EtCO_2$**
  - **Oesophageal intubation**
  - **Absence or low pulmonary BF (shock states or CA)**

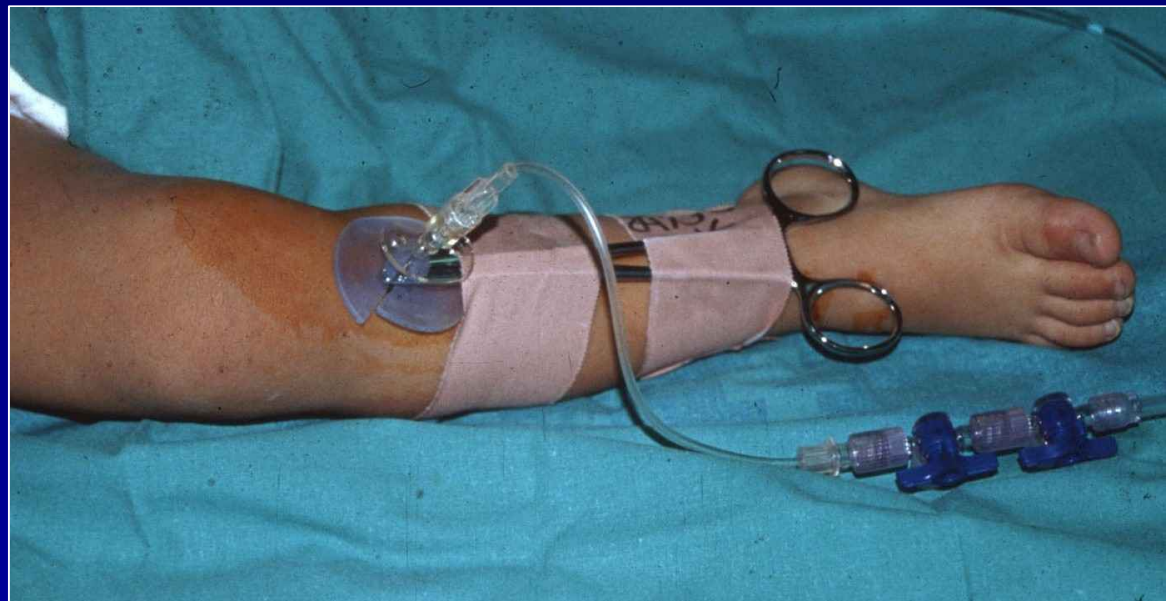




Circulation : vascular access

- ✓**IV & IO always better than ET**
- ✓**Give adrenaline only once by ET access**





Circulation : adrenaline

- ✓ **Infant and child**
  - **IV-IO : 0.01 mg/kg for every dose**
  - **ET : 0.1 mg/kg**
- ✓ **Newborn**
  - **IV-IO : 0.01-0.03 mg/kg**
  - **ET : try to avoid – if required 0.1 mg/kg**

Circulation : medications

- ✓ **No glucose containing solutions during CPR**
- ✓ **Avoid hyper-, hypoglycaemia after ROSC**
- ✓ **Lidocaine not first line treatment for VF/pulseless VT**
- ✓ **Vasopressin : insufficient data**
  - **Rescue therapy ? International protocol?**

Circulation: defibrillation

- ✓ **Optimal paddle force**
  - **3 kg for child < 10 kg**
  - **5 kg for child > 10 kg**
- ✓ **Biphasic waves (versus monophasic)**
  - **As effective**
  - **Less myocardial dysfunction**

Circulation: defibrillation doses

- ✓ **No stacked doses**
- ✓ **Dose : 4 J/kg for every single shock**
  - **Monophasic or biphasic**
- ✓ **No escalation**
- ✓ **Animal model**
  - **better results with 3-4 J/kg than with lower or adult doses**
  - **No myocardial damage with dose ≥ 9 J/kg**

Circulation: defibrillation

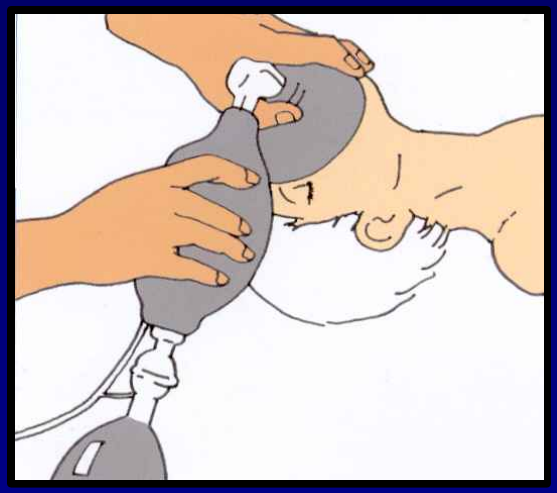
- Place gel/ pads on chest
- Select energy : 4 J/kg
- Stop chest compressions and remove high flow oxygen
- Charge the defibrillator with paddles on chest
- “STAND CLEAR”
- Check that nobody is in contact with the patient / bed
- Check monitor for VF/VT and deliver shock
- Replace paddles on the defibrillator
- Return to CPR immediately

PALS algorithm

Unresponsive ?

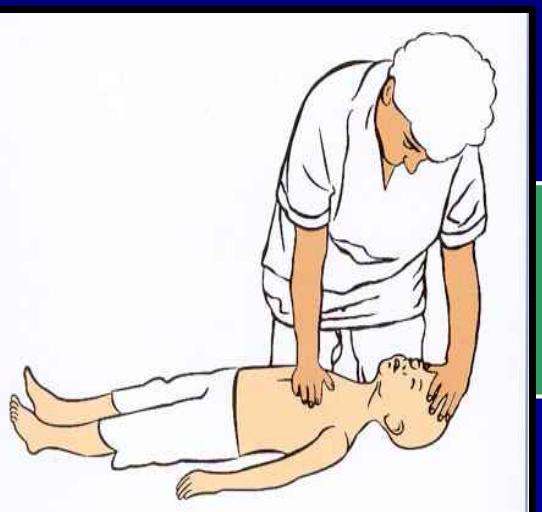
Open Airway
Look, Listen, Feel for **breathing**

Call Resuscitation team

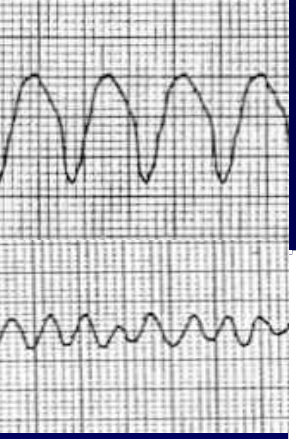


Give 5 rescue breaths

Look for **signs of life**



CPR 15:2
until **defibrillator/monitor attached**



PALS algorithm

Assess Rhythm

Shockable (VF/Pulseless VT)

1 Shock
4 J/kg
or
paed attenuated AED

CPR 15:2 for 2 min

Non-shockable (PEA/Asystole)

CPR 15:2 for 2 min

During CPR:
- Correct reversible causes*
- Check electrode position and contact
- Attempt / verify:
  i.v./i.o. access
  airway and oxygen
- Give uninterrupted compressions when airway secure
- Give adrenaline every 3-5 mins
- Consider: amiodarone, atropine, magnesium

*** Reversible Causes**

Hypoxia
Hypovolaemia
Hypo/hyperkalaemia/Metabolic
Hypothermia
Tension Pneumothorax
Tamponade, cardiac
Toxins
Thrombosis (coronary or pulmonary)

Circulation: minimise CPR interruption

Palpate briefly a pulse only if :

- **modification of the arrest rhythm**
- **non-shockable / organised rhythm**
- **In VF/VT only after 2 min CPR (except if signs of life)**
- **In doubt resume CPR**

Temperature management

For child comatose after ROSC :

- ✓ **Aggressively control hyperthermia**
- ✓ **Do not rewarm if hypothermic (if >32°C)**
- ✓ **Cooling down to 32-34°C for 12-24 hours**
- ✓ **Avoid shivering (analgesia, NM blockade)**
- ✓ **After 12-24 hours, rewarm by 0.25-0.5°C per hour**
- ✓ **Check for infection, CV instability, coagulopathy, hyperglycaemia, electrolytes abnormalities**

P-Trauma Life Support

1) Primary survey and initial CPR
(A, B, C, D, E)
2) Secondary Survey and stabilization
3) Pediatric Trauma Index
4) Destination and transport
5) Definitve Treatment

Classes

- Head Trauma
- Chest Trauma
- Abdominal Trauma
- MusculoSkelatal and Spine Trauma
- Burns
- Triage and Transport
- Analgesia and Sedation

Pediatric Trauma Score

	+ 2	+ 1	- 1
Consciousness	awake	Obtunded	Coma
Airway	Normal	maintainable	Un-maintainable
BP (pulses) (mmHg-children>8yr)	CP+ / PP+ >90	CP+ / PP- 50–90	CP- / PP- < 50
Open wounds penetrating	No	Minor	Major or
Fractures	No	Single and closed	Multiple or open
Weight (Kg)	> 20	10 – 20	< 10


SEP 10 2005

Conclusion

- Prevention of cardiac arrest is the best way of reducing mortality and morbidity
- ABC
- Assess, change, reassess

Conclusion

- ✓ **Avoid hyperventilation during CPR**
- ✓ **Prefer IV/IO to TT access**
- ✓ **New VF/VT algorithms :**
  - **Single shock**
  - **Minimise CPR interruption**
  - **No pulse palpation except if rhythm change**
  - **Adrenaline before 3rd shock, then every two loops**
  - **Amiodarone before 4th shock**