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Pediatric Advanced Life Support

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Alpine Pediatric Life Support Training Center

http://www.provinz.bz.it/se/paednotmed/
Italian PALS statistics

- 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
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

- Compensated respiratory failure
  - Decompensated respiratory failure
    - Cardiorespiratory failure
      - Cardiorespiratory arrest

- Compensated circulatory failure
  - Decompensated circulatory failure
    - Cardiorespiratory failure
      - Cardiorespiratory arrest
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 CO₂ and O₂

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

<table>
<thead>
<tr>
<th>Minute ventilation</th>
<th>Tidal volume</th>
<th>resp rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400ml/min</td>
<td>140ml</td>
<td>10/min</td>
</tr>
<tr>
<td>1400ml/min</td>
<td>70ml</td>
<td>20/min</td>
</tr>
<tr>
<td>1400ml/min</td>
<td>35ml</td>
<td>40/min</td>
</tr>
</tbody>
</table>

Respiratory failure can occur with respiration which is either too slow or too fast
Assessment of Respiratory Insufficiency

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

<table>
<thead>
<tr>
<th>Age</th>
<th>&lt;1</th>
<th>2-5</th>
<th>5-12</th>
<th>&gt;12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resp rate</td>
<td>30-40</td>
<td>20-30</td>
<td>20-24</td>
<td>12-20</td>
</tr>
</tbody>
</table>

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 $\text{FiO}_2$ 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

Assess, change, reassess
Assessment of Circulatory Failure

Relationships between variables affecting cardiac output and blood pressure

- Preload
- Afterload
- Contractility
- Stroke volume
- Cardiac Output
- Heart Rate
- Systemic Vascular Resistance
- 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

<table>
<thead>
<tr>
<th>Age</th>
<th>&gt;30 days</th>
<th>5 years</th>
<th>12 years</th>
<th>18 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR</td>
<td>30</td>
<td>20</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td>HR</td>
<td>130</td>
<td>100</td>
<td>90</td>
<td>70</td>
</tr>
</tbody>
</table>
Assessment of Circulatory Failure: Blood Pressure

Changes in systolic blood pressure with age

<table>
<thead>
<tr>
<th>Age</th>
<th>Systolic BP (normal) mmHg</th>
<th>Systolic BP (lower limit) mmHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1 month</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>1 – 12 months</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>1 – 10 years</td>
<td>90 + 2x age</td>
<td>70 + 2x age</td>
</tr>
<tr>
<td>&gt; 10 years</td>
<td>120</td>
<td>90</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th></th>
<th>HR</th>
<th>BP</th>
<th>SVR</th>
<th>Pre-load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolaemic</td>
<td>↑</td>
<td>→</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>Distributive</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Cardiogenic</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>
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 cardiorespiratory 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
- \( \text{O}_2 \) therapy (unthreatening)
- Monitoring (pulse oximetry, pulse and respiratory rate)
- IV access with topical anaesthesia
- Reassess
Decompensated Respiratory Failure

- Maintain clear airway
- 100% O₂
- 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% O₂
- Support ventilation if required
- Urgent IV/IO access, fluid bolus
- Reassess and repeat as required
- Consider inotropes
Cardiorespiratory Failure

- Airway control
- 100% O₂
- 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

- **Airway**
  - LMA, cuffed tube

- **Breathing**
  - Hyperventilation, ET CO2

- **Circulation**
  - Tracheal access
  - Adrenaline, glucose, lidocaine, vasopressin

- **Defibrillation**
  - 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
  \[ \text{diameter ETT} = \frac{\text{age (yr)}}{4} + 4 \]
  \[ \text{Depth (cm)} = \text{diameter ETT (mm)} \times 3 \]

- 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 PaCO2 : 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?
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
Unresponsive?

- Open Airway
  - Look, Listen, Feel for breathing

- Give 5 rescue breaths

- Look for signs of life

- CPR 15:2 until defibrillator/monitor attached

- Call Resuscitation team
Assess Rhythm

Shockable (VF/Pulseless VT)

1 Shock
4 J/kg
or paed attenuated AED

1 CPR 15:2 for 2 min

Non-shockable (PEA/Asystole)

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) Definitive Treatment
Classes

- Head Trauma
- Chest Trauma
- Abdominal Trauma
- MusculoSkeletal and Spine Trauma
- Burns
- Triage and Transport
- Analgesia and Sedation
# Pediatric Trauma Score

<table>
<thead>
<tr>
<th>Score</th>
<th>Consciousness</th>
<th>Airway</th>
<th>BP (pulses)</th>
<th>Open wounds</th>
<th>Fractures</th>
<th>Weight (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ 2</td>
<td>awake</td>
<td>Normal</td>
<td>CP+ / PP+</td>
<td>No</td>
<td>No</td>
<td>&gt; 20</td>
</tr>
<tr>
<td>+ 1</td>
<td>Obtunded</td>
<td>maintainable</td>
<td>CP+ / PP-</td>
<td>Minor</td>
<td>Single and closed</td>
<td>10 – 20</td>
</tr>
<tr>
<td>- 1</td>
<td>Coma</td>
<td>Un-maintainable</td>
<td>CP- / PP-</td>
<td>Major or</td>
<td>Multiple or open</td>
<td>&lt; 10</td>
</tr>
</tbody>
</table>
Conclusion

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