M01: Pediatrics - Cardiac Emergencies

Brian Thornburn

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Reviewed:

Introduction

Cardiac emergencies are not uncommon in pediatric patients. Primary cardiac emergencies, defined as originating from the cardiovascular system, are somewhat less common; most conditions that affect heart function have their origins elsewhere in the body. In most cases, management principles address the underlying problem.

Essentials

- Prepare, in advance, any calculations that may be necessary to provide care for pediatric patients. A Broselow tape, the BCEHS Handbook, and many other tools are available that can simplify this process.
- Recognize that in the majority of cases, respiratory failure is the primary cause of cardiac dysfunction. Focus on adequate oxygenation and ventilation.
- Be aware that these are some of the most stressful types of prehospital events. Pre-arrival planning, and effective crew resource management, are essential for ensuring an organized approach.
- High quality CPR, appropriate ventilation, timely vascular access, and a moderate scene time are proven elements that improve survival from cardiac arrest with good outcomes.
- Even transient, apparently resolved events require assessment in-hospital, as they may be a sign of an underlying condition.
- Resuscitation and cardiac emergencies for neonates (<28 days of age) differ in approach than that for older patients. See CPG M11 and CPG M13 for additional information.

Additional Treatment Information

- The most important intervention in pediatric bradycardia is ensuring adequate oxygenation and ventilation; the practitioner must search for and correct the cause of the hypoxia as well as treating the symptoms
- Avoid excessive vagal stimulation (e.g. suctioning)
- Start chest compressions at any point where, despite oxygenation and ventilation, the heart rate is less than 60 bpm with signs of cardiopulmonary compromise.
- Vagal maneuvers: in patients with SVT, vagal stimulation may convert the rhythm by slowing the conduction of the impulse through the AV node
  - Older children can be asked to cough, hold their breath, or attempt the Valsalva maneuver by telling them to "bear down hard, as though you are going to the bathroom"
  - Options for younger children include applying ice or a cold pack to the entire face
  - Ensure that the ECG is being recorded while the patient attempts the maneuver
- Synchronized cardioversion and defibrillation: pads should be pediatric sized, as the AED will attenuate the energy delivered based on type of pad
  - Pads used with the manual defibrillator should also be pediatric sized and placed anteroposterior for all energy therapy
  - Cardiovert at 1 J/kg If unable to select exact joules on the monitor, round up to the next closest selection. This may be repeated at 2 J/kg.
  - Ensure the defibrillator is set to synchronize and that it recognizes and marks each QRS complex; adjust the QRS size or switch to another ECG lead if the QRS complexes are not being recognized.
  - Unsynchronized shocks deliver the energy as soon as the operator presses the shock button; these shocks should use higher energy levels than synchronized cardioversion.
  - Deliver unsynchronized shocks in unstable polymorphic VT as it may be difficult for the monitor to recognize the QRS complexes; this may cause an unacceptable delay in energy delivery.
- Transcutaneous pacing: pacing is not helpful in children who are hypoxic, have ischemic myocardial insult or respiratory failure.
  - In selected cases of bradycardia caused by complete heart block or abnormal function of the sinus node,

pacing may be lifesaving; contact CliniCall if the bradycardia is refractory to all other therapies.

General Information

- Sinus arrhythmia is a normal variant seen in children and is described as a variation in heart rate over time without symptoms. The variation coincides with breathing. Typically, the rate increases during inhalation and decreases during exhalation. There is no concern if this is the lone finding.
- Tachycardia is a sustained increased heart rate. A heart rate greater than 180 beats per minute in a child, or greater than 220 beats per minute in an infant, is unlikely to be rapid sinus tachycardia and more likely to be an arrhythmia.
- Narrow complex tachycardia (QRS< 0.09 seconds = < 2 standard boxes on the rhythm strip) with visible p-waves should be considered to be sinus tachycardia and a primary cause should be determined. No specific cardiac management of sinus tachycardia is needed. Treat the underlying cause (ie pain, fever, hypovolemia, hypoxia or anemia) as appropriate.
  - Narrow complex tachycardia with no visible p-waves with a rate greater than 180 in children and 220 in infants with abrupt onset or termination, and no change with activity is considered to be SVT. Stable patients with no previous history, and no hemodynamic compromise, require support with oxygen, continuous cardiac monitoring, and transport to ED, with equipment for electrical cardioversion immediately available. Symptomatic patients should be treated with a vagal maneuver or adenosine/cardioversion if unstable.
  - A child with wide (QRS> 0.08 seconds) complex tachycardia who is conscious with adequate perfusion and a heart rate > 150 beats/minute is probably in stable ventricular tachycardia and requires support with oxygen, continuous cardiac monitoring, and transport to ED, with equipment for electrical cardioversion immediately available.
  - Wide (QRS> 0.08seconds) complex unstable tachycardia in a child with poor perfusion should be considered ventricular tachycardia and be treated rapidly with synchronized cardioversion with sedation if readily available.
  - In refractory cases or situations where appropriate treatment options are unclear contact Clinicall.
- Bradycardia is a sustained decreased heart rate. In the pediatric populations bradycardia is usually secondary to a different pathology and treatment focuses on the underlying cause.
  - As hypoxia may be a contributor, ensure optimized oxygenation and ventilation including BVM if needed
  - Consider a 20cc/kg crystalloid bolus to address hypotension for patient weight and size
  - In a pediatric patient with a HR <60 coupled with poor perfusion, CPR is indicated. Ensure maximal oxygenation and BVM ventilation is provided and if HR remains <60 begin chest compressions. Signs of poor perfusion include cyanosis, mottling, decreased LOC and lethargy.
  - Epinephrine 0.01 mg/kg IV/IO is indicated for bradycardia unresolved by oxygenation, ventilation, and chest compressions
  - Atropine is only indicated when increased vagal tone or primary AV block is the suspected etiology of the bradycardia; with all other causes epinephrine is preferred
  - Bradycardia with complete heart block or with a history of congenital or acquired heart disease pacing may be indicated
- BRUE (Brief Resolved Unexplained Event) and ALTE (Apparent Life Threatening Event) are not specific disorders but terms for a group of alarming symptoms that can occur in infants. They involve the sudden appearance of respiratory symptoms (such as apnea), change in color or muscle tone, and/or altered responsiveness. Events typically occur in children < 1 year with peak incidence at 10 to 12 weeks. Some of these events are unexplained (and designated BRUEs), but others result from numerous possible causes including digestive, neurologic, respiratory, infectious, cardiac, metabolic, or traumatic (eg, resulting from abuse) disorders.

Interventions

First Responder

- Keep the patient at rest
- Position the patient: if symptoms suggest hypotension, lay flat
- Provide supplemental oxygen as appropriate

- → A07: Oxygen and Medication Administration

Emergency Medical Responder – All FR interventions, plus:

- Provide supplemental oxygen to maintain SpO2 ≥ 96%
  - → A07: Oxygen and Medication Administration
- Investigate for underlying causes
- If unstable or symptomatic:
  - Maximize oxygenation, rapid transport and hospital notification
  - If HR <60 with signs of poor perfusion provide 100% oxygen and BVM ventilation. If no improvement, begin CPR
    - → PR06: High Performance CPR
- Rapid transport

Primary Care Paramedic – All FR and EMR interventions, plus:

- Obtain vascular access after consulting CliniCall for fluid requirements
  - → D03: Vascular Access

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

Tachycardia

- Asymptomatic: no treatment required
  - Consider crystalloid bolus if no cardiac history
- Unstable wide complex tachycardia
  - Vagal maneuver
  - Synchronized cardioversion 0.5 – 1 J/kg, repeat at 2 J/kg
    - → PR20: Synchronized Cardioversion
- Unstable narrow complex tachycardia
  - Vagal maneuver
    - Adenosine
      - Do not use adenosine if the patient is taking carbamazepine or dipyridamole.
    - Synchronized cardioversion 1 J/kg, repeat at 2 J/kg
      - For sedation prior to cardioversion, consider:
        - MIDAZOLam
          - MIDAZOLam may depress respiratory rate and blood pressure.
        - KetAMINE
          - KetAMINE should be used with caution where the shock index is greater than 1 – have push dose EPINEPHrine readily available in these cases.
      - Contact Clinicall for refractory cases or where treatment options are unclear

Bradycardia

- Asymptomatic: no treatment required
  - Consider crystalloid bolus if no cardiac history
- Unstable bradycardia
  - EPINEPHrine
  - Atropine – if increased vagal tone suspected
    - Consult Clinicall to repeat Q 3-5 min to a maximum total dose of 0.4 mg/kg or 1 mg, whichever is less
  - Transcutaneous pacing: contact CliniCall
    - → PR19: Transcutaneous Pacing

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

Tachyarrhythmias

- Amiodarone

- Lidocaine
- Digoxin has many drug incompatibilities and administration should be done in consultation with BC Children's Cardiology

Algorithm

Evidence Based Practice

Pediatric Bradycardia

Pediatric Tachycardia

M02: Pediatrics - Circulatory Emergencies

Brian Thornburn

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Introduction

The initial signs of shock may be subtle in children and infants as their compensatory mechanisms are very effective. As long as the compensatory mechanisms are able to maintain a systolic BP within an age-appropriate normal range, the shock is considered compensated. When the compensatory mechanisms fail, the child progresses quickly to decompensated shock where the "classic" signs and symptoms of shock are present, such as tachycardia, pallor, cold extremities, and altered levels of consciousness. When this happens, cardiopulmonary arrest may be imminent.

Children are capable of compensation for long periods of time after which they quickly decompensate. Recovery from decompensated shock is less likely. Caution must be always used when assessing children with special needs or chronic health conditions as they are more difficult to assess for what is "normal."

Essentials

- Know and be familiar with normal vital signs for given ages. Use a reference tool (either app or pocket card) before patient contact. Do not rely on memory.
- Assess patients early and from a distance
- Early recognition and intervention are the keys to survival
- Treatments must be targeted to the underlying cause. Vascular access is critical, but not all problems are responsive to fluid.
- Maintain normal oxygen saturation
- Classic systems-based shock categories are septic, hypovolemic, anaphylactic, cardiogenic, obstructive, and spinal

Additional Treatment Information

- In addition to oxygen, vascular access and patient positioning, type-specific priorities are:
  - Septic shock: 10-20 mL/kg crystalloid bolus, early antibiotics, pressors, steroids, and blood products
  - Anaphylactic shock: EPINEPHrine 0.01 mg/kg, 10 mL/kg crystalloid bolus (repeated as necessary), vasopressors, and steroids
  - Hypovolemic: 20 mL/kg crystalloid bolus, packed red blood cells, platelets, and plasma
  - Cardiogenic: 5-10 mL/kg crystalloid bolus (Clinicall/TA consult), arterial line monitoring, pressors, inotropes, and chronotropes
  - Obstructive: Identify and treat cause
  - Spinal: 10 mL/kg fluid bolus (may repeat as necessary), pressors, and inotropes

Referral Information

All patients demonstrating signs and symptoms of shock require rapid transport to the most appropriate hospital depending on resources.

General Information

- The recognition of shock relies on careful assessment of the child while at rest. Stimulation – from handling, blood work, vital sign measurements – may agitate the child producing tachycardia, tachypnea, and color changes.
- The initial assessment should follow the pediatric assessment triangle:
  - Appearance: Restlessness or inconsolability, decreased interactivity, decreased motor activity, lethargy and

listlessness, decreased consciousness, weak cry, and poor eye contact
    - Respiratory: Increased work of breathing, primarily tachypnea
    - Circulation: Poor skin perfusion, cool periphery, delayed capillary refill, pallor, tachycardia, and weak pulses
- Further assessment will reveal objective findings. These should be broken down into systems:
    - CNS: GCS less than 15, hypotonia or hyporeflexia, seizures (late and ominous)
    - Cardiovascular: tachycardia (early) or bradycardia (late and ominous), weak or absent pulses (may be bounding in cardiogenic or "warm" septic shock), ECG changes, elevated lactate, metabolic acidosis, absent or muffled heart sounds
    - Respiratory: tachypnea, accessory muscle use, hypoxemia, pneumothorax
    - GI/GU: decreased or concentrated urine output, flank pain, incontinence (spinal shock)
    - Integumentary: reduced turgor, rash, mottling, delayed capillary refill

Interventions

First Responder

- Position the patient
    - If symptoms suggest hypotension: lay flat if this does not increase symptoms
    - If no suggestion of hypotension: position of comfort
- Provide warmth
- Support oxygenation and ventilation as needed
    - → A07: Oxygenation and Medication Administration
    - → B01: Airway Management

Emergency Medical Responder – All FR interventions, plus:

- Expedite transport
- Assess for treatable cause of shock
- Consider ACP intercept

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider vascular access while en route; depending on suspected pathology, consider volume replacement
    - → D03: Vascular Access

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

Depending on pathology:

- 10 mL/kg PRBC bolus over 1hr (Hgb target 70 g/L)
- Platelets 10 mL/kg (max 4 units/1 pool)
- Frozen plasma
- Vitamin K
- Pressors
- Inotropes
- Chronotropes
- Arterial line
- Central line

Evidence Based Practice

Hypovolemic Shock

Pediatric Anaphylaxis

Septic Shock

M03: Pediatrics - Respiratory Emergencies

Wes Bihlmayr

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Introduction

Respiratory conditions in children can be categorized into upper airway obstructions, lower airway obstructions, lower airway restrictive pathology, and disordered control of breathing.

Upper airway obstructions occur when there is an increased work of breathing due to an obstruction above the thorax. This can consist of a foreign body, tissue swelling, subglottic stenosis from previous intubation trauma, and the development of a tumour. Lower airway obstructions, by contrast, result from obstructive problems below the thorax: foreign bodies, or bronchial swelling or constriction.

Restrictions in the lower airways are a result of "stiffening" of lung tissue, caused by increased fluid accumulation from pulmonary edema, toxic exposure, allergic reactions, infiltration, and inflammation. Abdominal structures can also push on lung tissue, creating a restrictive condition.

Dysfunction within the respiratory center of the brain is responsible for the development of disordered breathing. These are more properly neurological problems with respiratory effects, and can include problems such as increased intracranial pressure, neuromuscular disease, and some poisonings and overdoses.

Essentials

- Upper airway obstruction can be an uncomfortable call to attend as the majority of patients may look ill but require just comfort levels for treatment.
  - See → B04: Croup and Epiglottitis for additional information on the management of upper airway obstructions.
- Lower airway obstruction results in an inability for the patient to get air out of the chest. This is usually due to excessive swelling of bronchospasm.
- Lower airway restrictive pathologies consist of numerous conditions that result in decreasing lung compliance or stiffening of the lung. The general management of these conditions concern correcting oxygenation and ventilation utilizing an escalation pathway of increasing FiO_2 via nasal cannula, face mask, heated HiFlow nasal cannula (2 lpm/kg to a max of 60 lpm), NIV therapy and then intubation. Bronchospasm can be treated with a B_2 agonist.
- Disordered Control of Breathing are a series of conditions affecting the respiratory control center in the brain or neuromuscular diseases.

General Information

- Continuous salbutamol can decrease serum potassium
- Ventilating the lower airway restrictive disease patient may require high peak inspired pressure of up to 32 cmH_2O and high PEEP of up to 10-15 cmH_2O. Diligent monitoring for the development of a pneumothorax is required.
- Succinylcholine should be avoided in the patient with neuromuscular disease due to the possibility of triggering hyperkalemia or malignant hyperthermia

Interventions

First Responder

- Prevent heat loss but do not overheat the patient.
- Provide supplemental oxygen as required
  - → A07: Oxygen and Medication Administration
- Manual airway maneuvers as required
  - → B01: Airway Management

- Positive pressure ventilation with BVM
  - → B01: Airway Management

Emergency Medical Responder – All FR interventions, plus:

- Provide supplemental oxygen to maintain SpO_2 ≥ 94%
  - → A07: Oxygen and Medication Administration
- Transport with notification
- Consider ACP intercept

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider vascular access and fluid administration
  - → D03: Vascular Access
- Consider supraglottic airway to maintain airway patency
  - → PR08: Supraglottic Airway
- For bronchospasm, reactive airway disease, and asthma:
  - Salbutamol
  - Consider intramuscular EPINEPHrine
  - See → B03: Asthma and Bronchospasm for additional information.
- For croup, epiglottitis, and stridor:
  - Consider nebulized or intramuscular EPINEPHrine
  - See → B04: Croup and Epiglottitis for additional information.

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Consider addition of ipratropium to supplement salbutamol.
- Consider magnesium sulfate for significant and protracted bronchospasm.
- Consider intraosseous cannulation if peripheral access is unavailable.
  - → PR12: Intraosseous Cannulation
- Consider procedural sedation to facilitate airway management.
  - → PR17: Procedural Sedation
- Consider intubation in patients whose airways cannot be managed through less invasive means:
  - → PR18: Anesthesia Induction
- Decompress suspected tension pneumothorax
  - → PR21: Needle Thoracentesis

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Mechanical ventilation (NIV and invasive)
- Chest tube maintenance
- Osmotic agents
- 3% Saline
- Infusion medication
- Antibiotic therapy
- Steroid therapy
- Nonselective adenosine receptor antagonist and phosphodiesterase inhibitor

References

Pediatric Wheeze/Bronchospasm

Pediatric Stridor

M04: Pediatrics - Neurological Emergencies

Brian Thornburn

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Introduction

An altered level of consciousness is an abnormal neurological state where a child is less alert and responsive than would be appropriate for their age. Signs of an altered level of consciousness range from mild confusion, to coma.

Hypoglycemia is a common, and easily treated, cause of altered levels of consciousness. Seizures can have complex origins, and produce a variety of signs and symptoms. Although uncommon, strokes can occur in children, particularly those with congenital malformations.

Syncope is common in children and adolescents. Most are neurological in nature, caused by breath holding and vasovagal stimulation. Life threatening cardiac causes can be present in up to 6% of cases. A small, but significant, type of pediatric emergency are spinal conditions, either congenital, neoplastic or trauma related.

Essentials

- Plan for early and rapid transport
- Ensure the airway is protected, and that oxygenation and ventilation are supported as necessary
- Search for signs of trauma and impaired circulation
- Check blood glucose and correct hypoglycaemia
- If there is any reason to suspect a head injury with rising intracranial pressure, transport urgently and discuss specific management with CliniCall
- Consider maltreatment and follow reporting procedures if suspect

Additional Treatment Information

- As with adults, assessments of patients with an altered level of consciousness should focus on airway protection, oxygenation, ventilation, and an evaluation of blood glucose
- Febrile seizures are generally benign, do not require treatment if of short duration. Treating fever does not prevent recurrence of seizures
- Assessment and treatment priorities of stroke are primarily maintaining ABCs and vascular access if it does not interfere with rapid transport to a tertiary facility
- If not associated with a primary cause that requires intervention (such as trauma), headaches can be treated with support, positions of comfort, and a calm dark environment
- Treatment in spinal emergencies is supportive and prioritization of transport to a tertiary centre
- Syncope is frequently benign, but should not necessarily prompt a decision to not transport. In cases where a patient has a cardiovascular history, careful monitoring of the ECG and vital signs is important.

Referral Information

All patients exhibiting signs and symptoms of altered LOC and neurological disorder require evaluation in hospital, even if transient. Remember that all pediatric non-transport referrals must by discussed via Clinicall.

General Information

- Seizures are very common prehospital emergencies. They typically resolve spontaneously, and generally only require airway protection and supplemental oxygen. Many of these seizures are caused by a high fever in a young child (between six months and five years). Status epilepticus is defined in children as it is in adults – a series of two or more seizures without a recovery of consciousness, or a seizure lasting longer than five minutes. Patients who continue to seize on arrival of paramedics should generally be considered as being in status epilepticus.

- Increased intracranial pressure can manifest with a decreased level of consciousness and impaired respirations. Maintain oxygenation using appropriate basic and advanced airway techniques; promote cerebral drainage by elevating the head of the bed, removing cervical collars if in place.
- Pain from headaches can be acute or chronic, generalized or localized and can range from mild to severe. The common types of headache include vascular (migraine), tension characterized by a dull, achy pain, or organic caused by tumours, infection, or other diseases of the brain. Never disregard or minimize the emergent nature of a headache. Diagnosis of the cause of the pain cannot be performed in the prehospital setting.
- Be aware of malignant causes of headache:
  - Hemorrhagic strokes: onset of a sudden and severe headache.
  - Meningitis: continuous throbbing headache (usually in occiput) with sudden onset of fever, nausea, vomiting, confusion, and stiff neck. Frequently associated with a rash which may be maculopapular petechial or urticarial
- Apparent life-threatening events (ALTE) and brief, resolved, unexplained events (BRUE) are not specific disorders, but are terms for a group of alarming symptoms that can occur in infants. They both involve the sudden appearance of respiratory symptoms, such as apnea, a change in color or muscle tone, or altered responsiveness. These events are most common in children under 1 year, with a peak incidence between 10 and 12 weeks of age. Some of these events are unexplained (and hence are referred to as BRUEs), but there are many other potential causes.

Interventions

First Responder

- Position the patient
- Provide supplemental oxygen as required
  - → A07: Oxygen and Medication Administration
- Provide positive pressure ventilation if respirations are inadequate (consider use of oropharyngeal airway)
  - → B01: Airway Management
- Correct hypoglycemia: Glucogel
- Correct suspected narcotic intoxication (focus on oxygenation and ventilation)
  - → J12: Opioids (but do not give naloxone to neonates)

Emergency Medical Responder – All FR interventions, plus:

- Provide supplemental oxygen to maintain SpO2 > 94%
  - → A07: Oxygen and Medication Administration
- Obtain capillary blood sample
- Transport urgently
- Consider ACP intercept

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider use of nasopharyngeal airway if unsuitable for oropharyngeal airway
  - → PR07: Nasopharyngeal Airway
- Consider use of supraglottic airway in obtunded patients
  - → PR08: Supraglottic Airway
- Correct documented hypoglycemia
  - → E01: Hypoglycemia and Hyperglycemia
- Consider vascular access and fluid administration
  - → D03: Vascular Access
- Consider need for analgesia:
  - → E08: Pain Management
    - Ibuprofen
    - Acetaminophen
    - KetAMINE

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Advanced airway management as required
  - → PR18: Anesthesia Induction
- Monitor for cardiac dysrhythmia
- Control seizures where required.
  - → F02: Seizures
  - MIDAZOLam
- If trauma suspected and asymmetric pupils consider hyperventilation with CliniCall consult
- Analgesia
  - FentaNYL
  - KetAMINE
  - Contact CliniCall if additional analgesia is required
  - Unlike with adults, pre-treatment with ondansetron significantly decreases ketamine induced vomiting. Consider ondansetron whenever using ketamine in children aged 12-18

Evidence Based Practice

Pediatric Altered Mental Status (NYD)

References

1. Conicella E, et al. The child with headache in a pediatric emergency department. 2008. [Link]
2. Konstantinidis T. Febrile seizures: Don't Forget the Bubbles. 2014. [Link]
3. Müller MJ, et al. Syncope in children and adolescents. 2018. [Link]
4. Raab CP, et al. ALTE and BRUE (Brief Resolved Unexplained Event). In Merck Manual Professional Version. 2019. [Link]

M05: Pediatrics - Trauma

Alex Kuzmin

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Introduction

Trauma is the leading cause of death in children, and is responsible for more deaths and potential years of life lost than all other causes combined. Blunt injury accounts for 90% of these trauma cases, with 10% attributable to penetrating injury. The recognition of hidden injuries and rapid stabilization and transport of critically injured patients are the foundations of trauma care in all patients, including children.

Essentials

- In general, trauma patients cannot be stabilized in the field. They will continue to deteriorate until they receive definitive surgical care.
- Paramedics should maintain a high index of suspicion when confronted with what appear to be minor injuries associated with a significant mechanism.
- Children are at higher risk for cervical spine injury because of their larger, heavier heads, and weakly developed spine and neck muscles.
- Early deaths in hospital are most commonly due to uncontrolled shock or head injury.
- Due to their relatively healthy cardiovascular systems, children are known to be able to compensate well for blood loss. Heart rate is a more useful guide to resuscitation than blood pressure.

Additional Treatment Information

- The only interventions that should be carried out prior to transport are:
  - Identification and control of hemorrhage
  - Basic C-spine stabilization when required. C-spine stabilization should not delay ABC management and rapid transport of patients with head injury or shock.
  - Airway management and ventilatory support
  - Relief of tension pneumothorax
  - Simple stabilization of long bone and pelvic fractures. Use a pelvic binder for suspected open book fractures.
- Except for very long transports, the value of an IV and fluids, even for a patient in moderate shock, is controversial and certainly does not warrant any delay
- Radical deformities should be pulled gently to normal anatomical positioning for packaging
- Flush grossly contaminated wounds with saline prior to sterile dressing
- If adequate airway protection and ventilatory support can be achieved through the use of a bag-valve mask and pharyngeal airway, consideration should be given to not intubating in order to minimize delay at the scene

General Information

- Pediatric airway specific considerations:
  - Due to disproportion between size of cranium and midface, consider passive c-spine flexion consider padding under shoulders
  - Relatively large, soft tissues
  - Funnel-shaped larynx, more cephalad and anterior epiglottis
  - Short trachea
- Failure to ensure appropriate ventilation is the most common preventable cause of death in injured children; under-recognized and under-treated hypovolemic shock is the second.
- Opiates and/or Ketamine are the preferred choice of pain control in pediatric population. Nitrous oxide is less effective but can also be used unless contraindications exist.
- Unlike adults, children rarely die from isolated pelvic fractures. If hemodynamic instability exists in what appears

to be an isolated pelvic fracture, look for other causes of blood loss.

- Most major pediatric intra-abdominal trauma is now managed non-operatively. Bleeding is usually self-limiting even with significant lacerations of the liver, kidney or spleen.
- Major trauma criteria define patients who clearly have a high risk of death. They include but are not limited to:
  - Pediatric Trauma Score ≤ 8
  - Altered level of consciousness GCS ≤ 13 or focal neurologic deficit
  - Respiratory distress – change in RR from normal
  - Change in HR from normal
  - Signs of hypo-perfusion – ↓SBP by 5 mmHg from normal [80 + (2x age)]
  - Penetrating injury
  - Long bone fractures – 2 or more
  - Flail chest or open chest wound
  - Major amputation of extremity – proximal to wrist/ankle
  - Airway compromised with significant 2° or 3° burns.

Interventions

First Responder

- Assess wakefulness and perfusion
- Provide basic airway management and supplemental oxygen to maintain SpO2 > 94%
  - → B01: Airway Management
  - → A07: Oxygen and Medication Administration
- Control life threatening bleeding
  - → D02: Bleeding
- Cover open chest wounds with semi-occlusive dressing
- Apply spinal motion restriction as required

Emergency Medical Responder – All FR interventions, plus:

- Provide supplemental oxygen to maintain SpO_2 > 94%
  - → A07: Oxygen and Medication Administration
- Facilitate transport with early hospital notification
- Consider ACP intercept

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider vascular access once en route to hospital:
  - → D03: Vascular Access
  - PCPS MUST COMPLETE SPECIFIC TRAINING BEFORE STARTING IVS ON CHILDREN < 12 YEARS OF AGE. REQUIRES CLINICALL CONSULTATION (1-833-829-4099). MAXIMUM OF 2 ATTEMPTS PER CREW.
  - Target BP = values by age below
    - < 28 days < 60 mmHg
    - 1-12 months < 70 mmHg
    - 1-10 years < 70 mmHg + (2x age in years)
    - 10 years to adulthood < 90 mmHg
- Pelvic binding if patient is >50 lbs (20 kg)
  - → PR02: Pelvic Binders
- Wound packing
  - → PR04: Wound Packing
- Consider need for analgesia
  - → E08: Pain Management
- Correct blood glucose

- → E01: Hypoglycemia and Hyperglycemia
- Assessment and correction of the blood glucose level is mandatory for all patients with a head injury that presents with altered level of consciousness (GCS <15)

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Advanced airway management as required.
  - → PR18: Anesthesia Induction
- Tranexamic acid
- Assess for tension pneumothorax
  - → PR21: Needle Thoracentesis

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Advanced airway interventions
- Advanced diagnostics: US, CT, Angio, Xray
- Central IV access
- Blood
- CBC, type & crossmatch, PT/PTT, electrolytes etc.

Evidence Based Practice

Pediatric General Trauma Care

M06: Pediatrics - Cardiac Arrest

Brian Thornburn

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Introduction

Pediatric cardiac arrest is a rare event. Most pediatric cardiac arrests occur in children younger than one year of age, and 90% occur secondary to hypoxia due to respiratory failure. There are many rare causes of pediatric cardiac arrest including sudden infant death syndrome (SIDS), submersion or drowning, trauma, and sepsis. In contrast to cardiac arrest in adults, cardiopulmonary arrest in infants and children is rarely a sudden event, and does not often result from a primary cardiac cause. In cases of sudden collapse in older pediatric patients and patients with congenital heart disease, a primary cardiac cause should be considered.

Essentials

- Prepare, in advance, any calculations that may be necessary to provide care for pediatric patients. A Broselow tape, the BCEHS Handbook, and many other tools are available that can simplify this process.
- Recognize that in the majority of cases, respiratory failure is the primary cause of cardiac dysfunction. Focus on adequate oxygenation and ventilation.
- Be aware that these are some of the most stressful types of prehospital events. Pre-arrival planning, and effective crew resource management, are essential for ensuring an organized approach and high quality CPR.
- High quality CPR, appropriate ventilation, timely vascular access, and a moderate scene time (10 to 35 minutes) are proven elements that improve survival from cardiac arrest with good outcomes.
- Resuscitation and cardiac emergencies for neonates (<28 days of age) differ in approach than that for older patients. See CPG M11 and CPG M13 for additional information.
- When an infant or child is found without a pulse, treatment should first be directed towards adequate ventilation and oxygenation, and maintenance of circulation by chest compression.
- Commotio cordis (cardiac concussion) refers to blunt, non-penetrating, precordial chest impact that causes arrhythmia or sudden death without evidence of cardiac injury. It is from low-impact trauma, and significant signs of trauma are usually not found.

Additional Treatment Information

- Once oxygenation and high quality CPR have been established all infants and children in cardiac arrest should have a defibrillator attached to determine if a shockable rhythm is present. If there is a history of blunt trauma to the chest, electrocution, or the patient has a cardiac history, oxygen and CPR are still the priority, but paramedics should apply the AED with greater urgency as these patients may be more likely to demonstrate a shockable rhythm.
- If ventricular fibrillation is demonstrated, defibrillation should be attempted as soon as possible.
- Rhythm analysis and defibrillation are appropriate for all pediatric cardiac arrests regardless of age. A manual defibrillator is preferred for infants less than 1 year of age however if not available an AED with a pediatric attenuator is appropriate.
- An AED with a pediatric attenuator is preferred for children less than 8 years of age. If neither a manual defibrillator nor an AED with pediatric attenuator is available, an AED without a dose attenuator may be used for any pediatric cardiac arrest.
- AEDs that deliver relatively high energy doses have been used in infants with minimal myocardial damage and good neurological outcomes
- For pulseless ventricular tachycardia, or ventricular fibrillation, an initial dose of 2 J/kg is indicated when using manual defibrillators. If the initial shock fails and the patient is not hypothermic perform defibrillation at 4 J/kg.
- Drugs and advanced airways do not affect outcomes of pediatric cardiac arrest. While still indicated, time and priorities should focus on high quality CPR, ventilation and defibrillation if indicated. Do not stay on scene to justify intubating or providing drugs.
- For patients whose cardiac arrest is a result of traumatic injuries, rapid transport to a trauma center is the most important treatment. En route management and early notification to a receiving facility are the major prehospital

contributors to patient survival. In penetrating trauma, particularly penetrating chest trauma, a small percentage of patients can survive a cardiac arrest with early emergency thoracotomy. These are almost always patients who have demonstrated at least some signs of life in the prehospital setting.

- Needle decompression: in the setting of blunt traumatic cardiac arrest, bilateral needle decompression is appropriate any time the patient is in pulseless electrical activity.
  - Bilateral decompression is used because of the unreliable clinical examination in this patient subset
  - Assume a tension pneumothorax is present in all cases of cardiac arrest with penetrating chest trauma

Referral Information

All pediatric cardiac arrest patients with ROSC require emergency transport to hospital. Pediatric patients with a prolonged pulseless condition should be discussed with CliniCall. Non-viable or futile cases should also be discussed with CliniCall.

General Information

- Bystander CPR plus early defibrillation can more than double the rate of survival from out of hospital cardiac arrest. As such, paramedics should perform full resuscitation in settings where first responder or bystander CPR has been initiated unless obvious signs of death are present.
- Although survival from asystole or pulseless electrical activity is rare, patients who receive immediate, high quality CPR occasionally survive.
- Asystole in cardiac arrest is usually an ominous prognostic sign indicating prolonged hypoperfusion and myocardial ischemia with deterioration to asystole from more treatable dysrhythmias. Asystole must be confirmed in two or more leads.
- Pulseless electrical activity is evidence of organized electrical activity on the ECG without effective myocardial contraction. Patients with wide complex PEA rhythms usually have poor survival and there are often indications of severe malfunction of the myocardium or cardiac conduction system. There are numerous possible causes of PEA, some of which are amenable to pre-hospital treatment. Paramedics should follow a step-wise approach to identifying and treating reversible causes of PEA.
- Special consideration must be given to hypothermic patients without a pulse. As hypothermia progresses, the patient's respiratory and heart rate slow significantly. For this reason, breathing and pulse checks must be sufficiently long (60 seconds) to register very slow rates.
  - "Circum-rescue collapse" is a term that describes a death that occurs shortly before, during, or soon after rescue from exposure to a cold environment, usually cold water immersion. It often presents as an apparently stable, conscious patient who suffers ventricular fibrillation and cardiac arrest shortly thereafter.
  - A patient with a core body temperature below 30°C will most likely develop arrhythmias with progression to ventricular fibrillation.
  - Medications are more slowly metabolized in hypothermic patients; toxic levels of medications may accumulate if normal dosing regimens are used, therefore, prolong repeat times to twice the normal interval and limit vasopressors to a maximum of 3 doses.
- The most common causes of traumatic cardiac arrest include:
  - Hypoxemia from airway obstruction and hypoventilation
  - Obstructive shock resulting from cardiac tamponade or pneumothorax
  - Hemorrhagic shock, from any source of major hemorrhage
  - Myocardial contusions cause dysrhythmias, perforation, valve rupture
  - Electrical shock produces a fall; ventricular fibrillation may also be present

Interventions

First Responder

- Ensure high performance CPR and appropriate ventilation
  - → PR06: High Performance CPR
  - → B01: Airway Management
    - Most pediatric airways can be effectively managed with proper positioning and an OPA/NPA and BVM

and will not require further airway interventions. The gold standard for airway management is a self-maintained airway. Bag-valve mask is the preferred technique for airway management in pediatric resuscitation, and is reasonable compared with advanced airway interventions (endotracheal intubation or supraglottic airway) in the management of children during cardiac arrest in the out-of-hospital setting.

- → A07: Oxygen and Medication Administration

- Apply AED and follow prompts
- Communicate clinical scenario to follow-on personnel

Emergency Medical Responder – All FR interventions, plus:

- Investigate for precipitating cause
- Ensure scene time is no less than 10 minutes and no greater than 35 minutes
- Contact CliniCall for guidance
- Seek ACP/CCP assistance
- Low mechanism blunt trauma: CPR according to medical guidelines
- Penetrating trauma or high mechanism blunt trauma:
  - Immediately prepare for rapid transport and CPR
  - Control life threatening bleeding while facilitating transport
  - Direct pressure to sites of obvious ongoing blood loss
  - Rapid application of tight tourniquet for catastrophic extremity injury with ongoing large volume blood loss

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider vascular access for reversible causes
  - → D03: Vascular Access
    - All IV starts on a child < 12 years requires prior pediatric IV training and CliniCall consult

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Attach monitor and evaluate rhythm
- Establish vascular access
  - → PR12: Intraosseous Cannulation
- Ventricular fibrillation or ventricular tachycardia
  - Defibrillate 2 J/kg, repeat at 4 J/kg
  - EPINEPHrine
  - Amiodarone
  - Lidocaine
- Pulseless electrical activity or asystole:
  - EPINEPHrine
  - Consider treatable causes
- Bradycardia:
  - Bradycardia with poor cardiac output requires chest compressions if the heart rate is less than 60 and signs of poor perfusion are present. Signs of poor perfusion include cyanosis, mottling, decreased level of consciousness, and lethargy.
  - Consider normal saline bolus 20 mL/kg IV/IO
  - Consider EPINEPHrine
  - Consider pacing (Requires CliniCall consult)
    - → PR19: Transcutaneous Pacing
- Hyperkalemia, Torsades de Pointes, or suspected acidosis:
  - Sodium bicarbonate
  - Hypoglycemia
    - → E01: Hypoglycemia and Hyperglycemia
  - Narcotic overdose:

        - → J12: Opioids
    - Assess for pneumothorax
        - → PR21: Needle Thoracentesis

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Aggressive fluid replacement including blood products for suspected hemorrhagic shock
- Aggressive re-warming if hypothermia present and suspected to be primary cause of presentation
- Ultranosonography to assess pneumothorax, tamponade and cardiac contractility
- Post-return of spontaneous circulation care:
    - Advanced airway
    - Crystalloid bolus 20 ml/kg IV/IO
    - EPINEPHrine infusion

Evidence Based Practice

General Cardiac Arrest Care

PEA / Asystole

Post-Cardiac Arrest Care

VF/VT-Pulseless (Shock Advised)

References

1. Alberta Health Services. AHS Medical Control Protocols. 2020. [Link]
2. Heart & Stroke. 2019 Focused Updates to AHA Guidelines for CPR and ECC: Frequently Asked Questions. 2019. [Link]
3. Tijssen JA, et al. Time on the scene and interventions are associated with improved survival in pediatric out-of-hospital cardiac arrest. 2015. [Link]

M07: Neonatal Seizures

Wes Bihlmayr

Updated: December 07, 2020
Reviewed:

Introduction

- Identification of seizures in neonates and children can be difficult. Signs of seizures can include rhythmic lip smacking, blinking, or "bicycle" movement of the legs. Paramedics should treat ongoing seizures while considering reversible causes.
- The primary concern in neonatal seizures is hypoglycemia, which should be identified and corrected with a 2 mL/kg D10W bolus until the blood glucose is greater than 2.6 mmol/L. If IV access cannot be obtained, glucagon can be given intramuscularly (0.03 mg/kg).
- The preferred first line medication for control of a seizure lasting longer than 5 minutes, or multiple seizures without improving level of consciousness is a benzodiazepine. Midazolam can be administered via the intranasal (IN), intravenous (IV) or intramuscular (IM) route.
  - IN 0.2 mg/kg
  - IV 0.15 mg/kg
  - IM 0.2 mg/kg

Additional Treatment Information

- If intractable seizure despite primary and secondary pharmacological treatment, critical care paramedics may consult with the transport advisor to consider:
  - a loading dose of midazolam 50 mcg/kg followed by an infusion beginning at 120 mcg/kg/hr and titrating to effect
  - a trial of Pyridoxine 50-100 mg over 1-2 minutes

General Information

- Patients requiring multiple sedatives or anti-convulsants have a high probability of requiring an advanced airway intervention and/or hemodynamic instability

Interventions

First Responder

- Prevent heat loss

Emergency Medical Responder – All FR interventions, plus:

- Provide on-going care as per neonatal resuscitation guidelines
  - → M09: Neonatal Resuscitation
- Transport urgently to closest facility

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider use of supraglottic airway if unable to oxygenate or ventilate with bag-valve mask
  - → PR08: Supraglottic Airway
- Consider need for vascular access based on clinical scenario
  - → D03: Vascular Access
  - REQUIRES SPECIFIC TRAINING AND CLINICALL CONSULTATION (1-833-829-4099)
- Correct hypoglycemia:
  - → E01: Hypoglycemia and Hyperglycemia
  - Glucagon

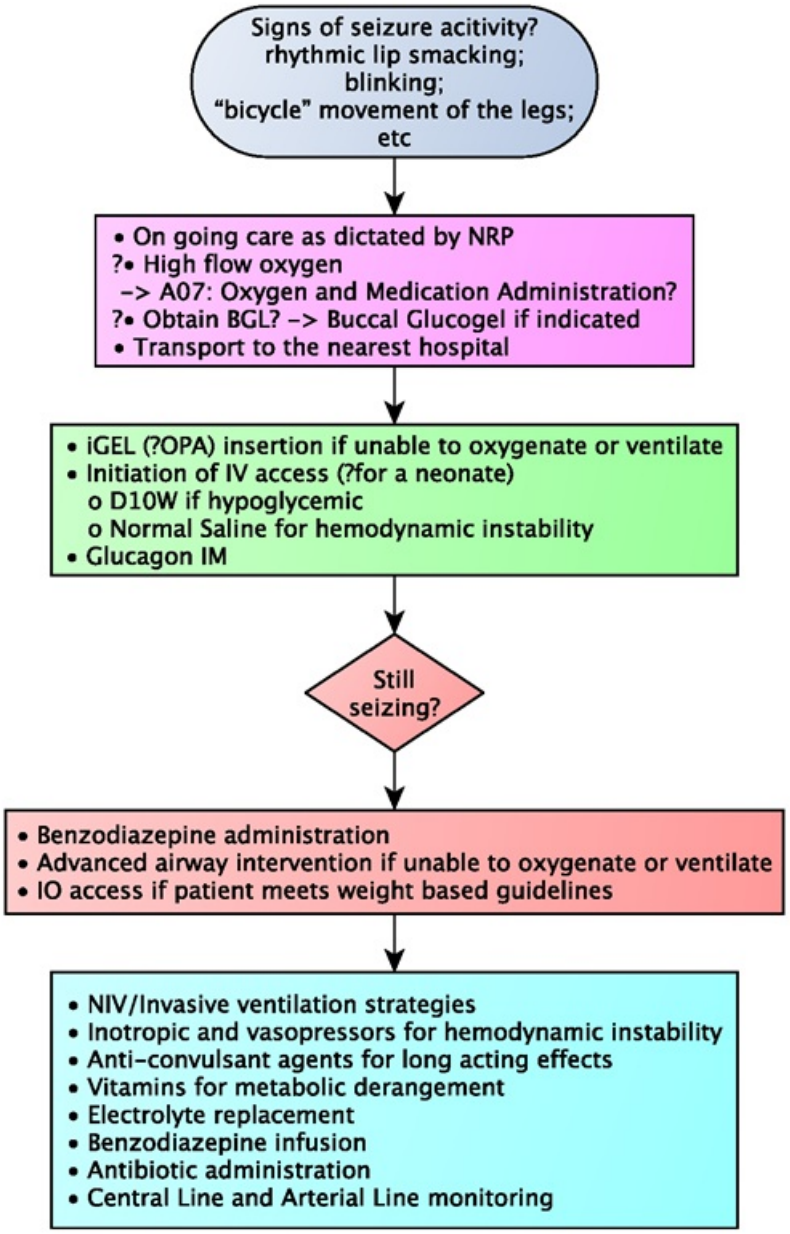
Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Advanced airway intervention if unable to oxygenate or ventilate
- MIDAZOLam for seizure control
- Consider intraosseous access
  - → PR12: Intraosseous Cannulation

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- NIV/Invasive ventilation strategies
- Inotropic and vasopressors for hemodynamic instability
- Anti-convulsant agents for long acting effects
- Vitamins for metabolic derangement
- Electrolyte replacement
- Benzodiazepine infusion
- Antibiotic administration
- Central Line and Arterial Line monitoring

Algorithm



Evidence Based Practice

Pediatric Seizure

M08: Neonatal Thermoregulation

Wes Bihlmayr

Updated: November 27, 2020
Reviewed:

Introduction

Neonates have a high body surface to weight ratio making them more prone to the four mechanisms of heat loss: convection, conduction, radiation, and evaporation. Paramedic management of neonatal thermoregulation involves these four mechanisms.

- Convection: Decrease the wind or drafts in a room.
- Conduction: Heat is lost from a warm to a cooler surface.
- Radiation: Heat is lost to the environment when the environment is cooler than the body.
- Evaporation: Moisture on the body can accelerate the loss of heat from the other modes of heat loss.

Essentials

- In addition to preparing an area for resuscitation during the delivery of a neonate it is important to think about preparing the environment for the neonate. Environmental preparation revolves around the 4 mechanisms of heat loss:
  - Convection: Warm the room, eliminate any cold drafts
  - Conduction: Warm towels and warm surface
  - Radiation: Warm the room
  - Evaporation: Dry the baby off and place a toque on the baby's head
- The ideal temperature range for a neonate is 36.3 - 37.2°C
- Encouraging "kangaroo care" for some time following delivery develops strong bonding between the neonate and mother which promotes family centered care. Kangaroo care is performed by placing the neonate on the mother's chest while maintaining the principles of heat loss. In the stable neonate this can be performed while you await the delivery of the placenta.

Additional Treatment Information

- Unless there are indicators of hypoglycemia a blood sugar is not required until a few hours after birth.

Referral Information

Neonates with no system specific problem that are maintaining a normal temperature can be left in the care of a midwife or other health professional. If no medical professional is on scene, the baby should be transported for an initial assessment.

M09: Neonatal Resuscitation

Wes Bihlmayr

Updated: December 07, 2020
Reviewed:

Introduction

Neonatal resuscitation focuses on the respiratory system and transitioning from fetal circulation to neonatal circulation. These two factors are interrelated; a functioning respiratory system is necessary to deliver oxygen to produce pulmonary vasodilation, thus lowering the pulmonary vascular resistance. When combined with increasing systemic vascular resistance, this allows fetal shunts to close and lung perfusion to progress.

Paramedic management in the resuscitation of the neonate focuses on stabilizing the respiratory system in a systemic manner from least invasive to most invasive.

Essentials

- The Neonatal Resuscitation Program (NRP) has a clearly defined algorithm for all neonatal resuscitation events. Each step in the algorithm requires 30 seconds of effective intervention prior to moving on to the next step.
  - During the first 30 seconds, begin by assessing the neonate's tone. Are they term, breathing or crying?
    - Tone: a neonate should be active with flexed extremities. If the neonate is flaccid with extended extremities resuscitation will be required.
    - Term: if the neonate is less than 37 weeks gestation, they require an initial assessment as they are more likely to require assistance either immediately or soon after delivery.
    - Breathing or crying: a strong cry is a sign of a strong respiratory system. If the neonate is not crying, then a respiratory assessment for work of breathing is required and possible movement down the resuscitation chart.
  - In the next 30 seconds, dry, stimulate, keep the neonate warm, and reassess the respiratory system and take a heart rate.
  - Following the first minute, a decision is required: does the neonate require respiratory support (blow by oxygen, CPAP) or respiratory assistance (positive pressure ventilation - PPV)?
  - If the patient requires PPV then 30 seconds of effective ventilation is initiated. Effective ventilation is described as adequate chest expansion with all breaths. If all breaths are not effective, then the acronym MR SOPA should be reviewed:
    - M – Mask: Is there adequate seal
    - R – Reposition: reposition the head, consider shoulder roll.
    - S – Suction: use a 10 fr suction catheter and suction the oropharynx
    - O – Open: open the neonate's mouth
    - P – Pressure: If possible, increase the pressure being delivered. Initial pressure is 20 mmHg to 25 mmHg to 30 mmHg. This can be accomplished with a flow inflating bag or Neopuff.
    - A – Alternate Airway: Consider intubation or supraglottic airway if weight permits.
  - Continue down the PPV path until effective ventilation is maintained. Adjust the FiO_2 to meet preductal target saturations (SpO_2 probe must be on the right hand).
  - If the HR remains in the 60-100 range with effective ventilation, then PPV must be maintained. If the HR increases to greater than 100 then PPV can be discontinued.
  - If the HR drops to below 60 with effective ventilation, then chest compression must be initiated at a rate of 3 compressions to 1 ventilation. FiO_2 should be at 100% at this point.
  - If the HR remains below 60 EPINEPHrine should be administered. The dose is 10 mcg/kg.
  - If there is a clinical history of blood loss and signs of poor perfusion a volume expander should be administered: either 10 ml/kg of normal saline or "O-negative" PRBC.

Additional Treatment Information

- Throughout a newborn resuscitation it is important to keep the neonate warm. Once a neonate becomes

hypothermic, they become more susceptible to increased pulmonary vascular resistance; this in turn affects the oxygenation and ventilation of the neonate, and may reverse the transitioning back to fetal circulation, which is not compatible with life.

- EPINEPHrine can be administered via the endotracheal tube at a dose 10 times the IV dose - 100 mcg/kg.
- IV access can be via a peripheral IV or emergency UV
- IO can be considered but is weight dependent
- Uncuffed endotracheal tubes should be utilized to prevent the possibility of developing subglottic damage producing stenosis as the child grows
- All pre-term neonates of less than or equal to 32 weeks gestation should be placed in a food grade polyethylene bag up to the neck to prevent insensible fluid loss and maintain thermoneutrality
- A neonate delivered through thick meconium is at risk for developing increased work of breathing. If the child is vigorous, monitoring is suggested. If the neonate is not vigorous then suctioning of the oropharynx is required, followed by movement down the treatment path. The past practice of suctioning below the vocal cords is no longer recommended.

Referral Information

All neonates requiring resuscitation should be transported to hospital for further work up.

General Information

- ECG monitoring should be performed during the resuscitation.
- SpO_2 monitoring must be via the pre-ductal right appendage for accurate measurements. A pre and post ductal (all other appendages) SpO_2 can be monitored to detect the presence of shunts within the cardiovascular system.
- It is common for a neonate who experienced a precipitous delivery to develop increased work of breathing requiring respiratory support.

Interventions

Emergency Medical Responder – All FR interventions, plus:

- Ongoing care as dictated by NRP: follow algorithm
  - Neonatal Resuscitation Algorithm
- Transport to the nearest hospital
- Seek additional resources or ACP intercept

Primary Care Paramedic – All FR and EMR interventions, plus:

- iGEL insertion if unable to oxygenate or ventilate
  - → PR08: Supraglottic Airway
- Consider obtaining vascular access and providing fluid for hemodynamic compromise
  - → D03: Vascular Access
- Correct hypoglycemia
  - → E01: Hypoglycemia and Hyperglycemia

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

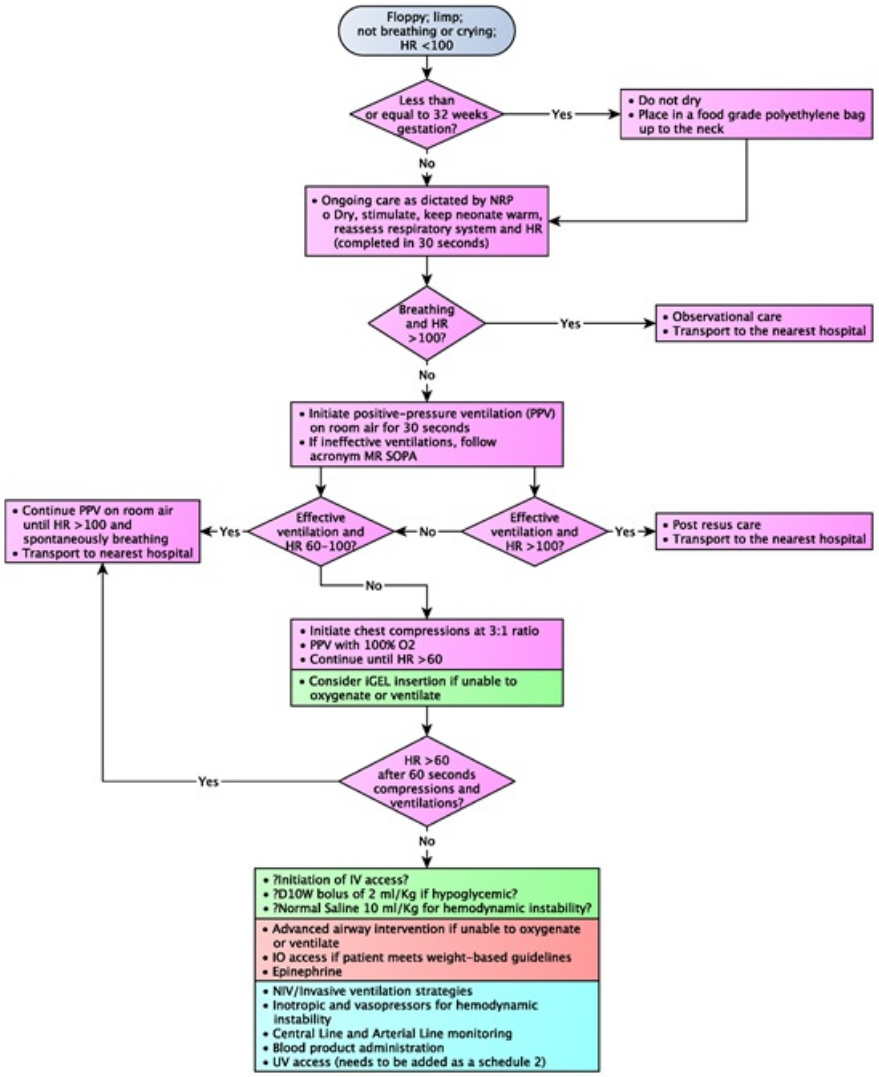
- Advanced airway intervention if unable to oxygenate or ventilate
- Obtain IO access if patient meets weight-based guidelines
  - → PR12: Intraosseous Cannulation
- EPINEPHrine

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- NIV/Invasive ventilation strategies

- Inotropic and vasopressors for hemodynamic instability
- Central Line and Arterial Line monitoring
- Blood product administration
- UV access (needs to be added as a schedule 2)

Algorithm



Evidence Based Practice

Neonatal Resuscitation

M10: Neonatal Respiratory

Wes Bihlmayr

Updated: December 06, 2020
Reviewed:

Introduction

Respiratory distress in the newborn is defined as an impairment of the lungs to exchange gas at the alveolar level. Multiple pathophysiologic processes can produce respiratory distress in the neonatal period and careful monitoring of the trend of disease progression can assist in identifying the cause.

Paramedic management of the neonate in respiratory distress should focus on maintaining appropriate oxygenation and ventilation based on gestational age and days/hours of life. Differential diagnoses to consider in the just born neonate differ than the differential diagnoses for a neonate on day of life 2 or more.

In neonates the differential diagnoses can be:

- Respiratory distress syndrome (RDS): Primarily a surfactant deficiency that will progressively worsen until 72 hours of life and then slowly get better if no treatment is initiated. Normal in the preterm infant and higher risk of in the neonate born to a mother with poorly controlled diabetes.
- Transient tachypnea of the newborn (TTN): Fluid retention in the lungs that will gradually resolve over 24-72 hours. Common in C-section and precipitous deliveries.
- Congenital pneumonia/sepsis: Similar physical presentation to RDS but with differing radiological evidence and can progress to sepsis quickly if not recognized.
- Pneumothorax: The neonate requires an opening pressure of up to 50 cmH_2O to push out the fluid filling the lung and can cause spontaneous pneumothoraxes.

The term neonate with an uncomplicated antenatal history that develops respiratory complications is unlikely to be RDS, and is most likely to have an infection or undiagnosed congenital problems.

Essentials

- The Neonatal respiratory assessment consists of lung auscultation, evidence of nasal flaring, grunting of the neonate, accessory muscle use (begins in the subcostal and works up the chest as severity increases) and symmetry of the chest. A chest x-ray and blood gas should be performed to gauge severity and initiate a baseline for trend monitoring.
- Establish ABCs and support ventilations if required.
- Support of the neonate's respirations follows staged approach. The FiO_2 is titrated to maintain a preductal SpO_2 of 88-95% in the preterm neonate and 92-95% in the term neonate. Escalation along the respiratory treatment pathway is based on clinical assessment, radiological evidence and blood gas analysis.
- Pre-ductal SpO_2 is performed on the right hand and post-ductal on a lower appendage (right or left foot). A pre-ductal less than 90% or a difference greater than 3% should prompt more investigations.
- Increased work of breathing with associated decreased air entry should be investigated for pneumothorax.

Additional Treatment Information

- Options for supporting neonatal respirations include:
  - Blow by oxygen: titrate to patient's SpO_2 if no increased work of breathing.
  - High flow O_2: 2-3 lpm/kg of heated humidified gas. Titrate FiO_2 to appropriate SpO_2.
  - nCPAP: 5 cmH20-8 cmH20. Titrate FiO_2 to appropriate SpO_2.
  - Bi-Level Support (non-triggered BiPAP): initial setting of 9/6 (delta P can be as large as 10 mmHg) Ti 0.5-1.0 RR 30. Titrate FiO_2 to appropriate SpO_2.
  - Intubation and mechanical ventilation
- Once a neonate is intubated, bLES should be considered. If the FiO_2 is greater than 30% and there is radiological evidence of surfactant deficiency, bLES is administered (5 ml/kg administered via a 6 fr OG tube down the ET

tube).

- If patient is showing signs of tension pneumothorax – tracheal deviation, increased work of breathing, absent air entry, hemodynamic compromise – needle decompression should be performed while equipment is gathered for a chest tube insertion.
  - In a neonate a 26-gauge butterfly needle attached to a 3 way stop cock and 10 cc syringe is used to access the 2nd intercostal space mid-clavicular line to aspirate air. In an older neonate, a 20 gauge needle connected to a 3-way stop cock and 10 cc syringe may be required
- Due to the rapid progression of sepsis in the neonatal period all neonates with signs of respiratory distress will have a blood culture done and be started on antibiotics: Ampicillin (50 mg/Kg) and Gentamycin
  - Gentamycin:
    - DOL 0-7: < 30 weeks gestation 5 mg/kg
    - 30-34 weeks gestation 4 mg/kg q 36 hrs
    - > 35 weeks gestation 4 mg/kg q 24 hrs
    - DOL > 7: < 30 weeks gestation 5 mg/kg
    - > 30 weeks gestation 4 mg/kg q 24 hours
- Common initial ventilation settings are RR 50 Ti 0.4 TV 4-5.5 ml/kg FiO_2 as required, PEEP 5 cmH_2O. Neonates require I:E ratios approaching 1:1. The normal range of Ti is 0.35-0.5 with most patients requiring 0.35-0.4. If a large tube leak is detected, then PCV ventilation should be considered (starting settings may be 20/5 and then are titrated to effect).
- Neonates require an uncuffed ET tube due to the possibility of subglottic damage from an ET cuff and prolonged intubation, resulting in subglottic stenosis as the neonate grows.
- Sedation in the neonate should only be initiated if there are signs of pain or discomfort based on the BIIP scale as there is evidence of increased morbidity and mortality when sedation is given to neonates with no signs of pain or discomfort. If sedation is to be initiated the preferred analgesics are:
  - Morphine: 50 mcg/kg bolus with an infusion of 10-20 mcg/kg/hr
  - Fentanyl: 1-2 mcg/kg bolus with an infusion of 0.5-2 mcg/kg/hr
  - Midazolam: 50 mcg/kg as a bolus for the labile neonate.
- Maintenance fluids for the first 24 hours should be D10W and after 24 hours D10W with NaCl (20 mmol/L)
  - DOL 0 – 60-80 ml/kg/day
  - DOL 1 – 80-100 ml/kg/day
  - DOL 2 – 100-120 ml/kg/day
  - DOL 3 – 120-140 ml/kg/day
  - DOL 4 – 140-150 ml/kg/day
  - DOL 5 – 150 ml/kg/day

General Information

- Neonates that have been in the community are at an increased risk of an infective origin to their increased work of breathing and need to be considered during the differential diagnosis.
  - Bronchiolitis
  - Pneumonia
  - Croup
  - Pertussis

Interventions

First Responder

- Maintain thermal stability
- Provide supplemental oxygen as required
  - → A07: Oxygen and Medication Administration
- Manual airway maneuvers
- Positive pressure ventilation via bag-valve mask

- → B01: Airway Management

Emergency Medical Responder – All FR interventions, plus:

- Transport to closest facility with notification
- Consider ACP intercept

M11: Neonatal Cardiovascular

Wes Bihlmayr

Updated: November 27, 2020
Reviewed:

Introduction

Neonatal cardiovascular conditions range from vascular problems to congenital cardiac problems. Neonatal vascular conditions can be separated into the pulmonary vasculature and systemic vasculature; congenital cardiac conditions can be further separated into structural problems (congenital heart disease, or CHD) and intrinsic (arrhythmia).

Paramedics must diligently investigate complaints to isolate and identify the underlying problem, while at the same time providing appropriate supportive care. Differentiation between vascular and cardiac problems begins with the antenatal history.

The time of onset of symptoms varies with the severity of the lesion for cardiac and vascular conditions. Acute, non-cyanosis-producing conditions are usually associated with the complete closure of the ductus arteriosus, which normally occurs around day 2 or 3 of life, followed by a brief symptomatic period. These conditions either result in added strain on the myocardium, and signs of congestive heart failure, or signs of inadequate tissue perfusion. Acute cyanotic lesions will usually develop soon after birth, and can progressively deteriorate as the ductus arteriosus closes. Arrhythmias can be well tolerated by neonates, and take days to months before they are noticed.

Increased pulmonary vascular resistance in the neonatal period is usually the result of inadequate transition to extra-uterine life, and begins immediately to a few hours after birth and can vary in intensity. Decreased systemic vascular resistance is usually a byproduct of sepsis.

The clinical picture of the cardiac problem varies from progressive deterioration with subtle signs to the acute conditions with obvious signs. In order to determine the precipitating cause a multisystem approach involving the respiratory and cardiovascular systems is required.

Essentials

- The cardiovascular system assessment entails assessing the patient's perfusion, four limb blood pressure, assessing the pulse pressure, heart sounds, signs of hepatomegaly, pre/post ductal SpO_2 measurements and radiological testing (U/S and x-ray).
- Pre-ductal SpO_2 is performed on the right hand and post-ductal on a lower appendage (right or left foot). A pre-ductal less than 90% or a difference greater than 3% should prompt more investigations.

Additional Treatment Information

- Cyanotic CHD present as the classic "blue baby," that is tachypneic with at times no sign of increased work of breathing. These patients may have an oxygen challenge to assist in determine a cardiac origin. These conditions can continually deteriorate until either pharmacological or surgical intervention is performed.
  - An oxygen challenge consists of either monitoring the SpO_2 on the right-hand during room air and then 100% oxygen administration. A difference of greater than 10% is usually pulmonary in nature
- Non-cyanotic CHD presentation can vary from the asymptomatic neonate with pre/post ductal SpO_2 difference greater than 3% to an initially asymptomatic neonate that has an acute deterioration around 3 days of life that begins with poor perfusion and leads to cardiogenic shock and respiratory compromise. The asymptomatic neonate requires further investigation by a cardiologist. The symptomatic neonate may require pharmacological treatment to bridge the gap before surgical treatment.
  - Pharmacological treatment consists of administering Alprostadil which is a vasodilator (Prostaglandin E1) at an initial dose of 0.02 mcg/kg/hr then gradual tailoring dose to 0.005-0.1 mcg/kg/hr (usually requires cardiac echo to tailor). Consultation with BCCH PICU and/or BCCH cardiology required to increase dose.
    - Side effects include: apnea, hypotension, bradycardia, hyperthermia and cutaneous flushing.
  - Bradycardia in a neonate is defined as a heart rate less than 100. The asymptomatic patient requires monitoring and transport to the hospital. The symptomatic patient is defined as having poor perfusion

(hypotension, decreased mentation, signs of shock).
- If HR less than 60 bpm with adequate oxygenation and ventilation, then start CPR
- Medication: 0.01 mg/kg of epinephrine IV/IO
  - 02 mg/kg of Atropine if increased vagal tone or primary AV block
- Consider transthoracic pacing

- Tachycardia in a neonate can be classified as either:
  - Narrow complex – rate greater than 220 with a QRS less than 0.09 mm
  - Wide complex – variable rate (can be normal) with a QRS greater than 0.09 mm
- In the well perfused neonate with a tachyarrhythmia, paramedics have more time to investigate the cause while preparing a treatment plan. In the poorly perfused neonate (hypotension, altered mental state, signs of shock), initiate an emergent treatment plan while investigating causative factors.
- Treatment of tachyarrhythmias moves from lowest risk to highest risk to the patient

Intervention	Narrow Complex Tachyarrhythmia	Wide Complex Tachyarrhythmia
Vagal Maneuvers	Bag of ice and water applied to the upper portion of the neonate's head, not to occlude the mouth and nose, for 20 seconds	Bag of ice and water applied to the upper portion of the neonate's head, not to occlude the mouth and nose, for 20 seconds
Medication	Adenosine: 0.1 mg/kg to a max dose of 6 mg. If no success, then 0.2 mg/kg to a max dose of 12 mg Amiodarone **or** Procainamide only after consultation with transport advisor. Amiodarone 5 mg/kg over 20-60 minutes Procainamide 15 mg/kg over 30-60 minutes	Adenosine: If WCT is thought to be due to an abnormal intraventricular conduction. 0.1 mg/kg to a max dose of 6 mg. If no success, then 0.2 mg/kg to a max dose of 12 mg Amiodarone **or** Procainamide only after consultation with transport advisor. Amiodarone 5 mg/kg over 20-60 minutes Procainamide 15 mg/kg over 30-60 minutes Magnesium for Torsades de pointes. 25-50 mg/kg administered over 60 minutes. Diluted to 10 mg/ml.
Synchronized cardioversion	Consult transport advisor. 0.5-1 J/Kg, may increase to 2 J/Kg if not successful Sedate before cardioversion	Consult transport advisor. 0.5-1 J/Kg, may increase to 2 J/Kg if not successful Sedate before cardioversion

- Increased pulmonary vascular resistance (PVR) or persistent pulmonary hypertension (PPHN) can result from a difficult transitional period from fetal to neonatal circulation. Oxygen is required to decrease the pulmonary vascular resistance in the first minutes of life allowing the pulmonary vasculature resistance to drop below the systemic vascular resistance closing the anatomical shunts of fetal circulation; supplemental oxygen is the first intervention required in these cases. If there is a delay in oxygenation or episode of poor oxygenation in the first hours of life the PVR can increase reverting neonatal circulation back to fetal circulation.
- The treatment of PPHN revolves around returning the circulation back to the PVR being lower than the SVR
  - Give supplemental oxygen
  - Assess patient fluid status and fluid resuscitate if required (10 ml/kg boluses NS to a max of 30 ml/kg)
  - iNO – inhaled nitric oxide is a potent pulmonary vasodilator. This can assist in decreasing the PVR. The initial dose is 20 ppm.
  - Increasing the SVR with inotropes and vasopressors:
    - Epinephrine: 0.05 - 1 mcg/kg/min (0.05-0.1 primarily B1 and B2 effects so increased inotropy/chronotropy and vasodilation. Doses greater than 0.1 also stimulate the alpha receptors resulting in vasoconstriction and increased SVR)
    - Dobutamine: 2-20 mcg/kg/min (primarily B1 effects increasing myocardial contractility)
    - Norepinephrine: 0.02-0.1 mcg/kg/min (strong alpha effects increasing SVR). Normally only used as an addition to another inotrope in neonates.
    - Vasopressin: 0.1 milliunits/kg/min, increase by 0.1 every hour to a max of 1.2 (systemic vasopressor and

pulmonary vasodilator at low doses)
- Dopamine: 5-20 mcg/kg/hr (5-10 mcg/kg/hr primarily B1 effects and > 10 mcg/kg/hr alpha effects)

- While treating the cardiovascular condition you may be concurrently treating a respiratory distress condition as a result of the cardiovascular condition. See Respiratory CPG for respiratory escalation of care.
- Treatable causes of bradycardia:
  - Hypoxia
  - H+ acidosis – Correct ventilation, in extreme metabolic acidosis consider sodium bicarbonate (1 mmol/kg)
  - Hyperkalemia
  - Heart Block
  - Toxins – See cardiac arrest CPG
  - Trauma – Cushing's triad of increased ICP. 3% saline at 2.0-5 ml/kg over 10 minutes or Mannitol at 0.25-1.0 grams/kg over 5 minutes.
- Treatable causes of tachycardia
  - If potentially a Sinus Tachycardia (HR less than 220, P-waves, rate varies with stimulation, history):
    - Fluid bolus for the dehydrated patient (10 ml/kg NS)
    - Antipyretic for the febrile patient
      - Acetaminophen: 15 mg/kg PO or PR
      - Ibuprofen: 10 mg/kg PO
    - Analgesia for pain
      - Acetaminophen: 15 mg/kg PO or PR
      - Morphine: 0.05-0.1 mg/kg IV
      - Fentanyl: 1-2 mcg/kg IV /IN/IM
      - Ketamine: 0.5 mg/kg IV/IN
    - Electrolyte disturbances (due to the variability of disturbance consult transport advisor for development of electrolyte correction timeframe)
      - Hyperkalemia
      - Hypocalcemia
      - Hypomagnesemia
    - Drug Toxicity – unlikely in the neonatal period but should be considered. Examples include: TCA, Cocaine, methamphetamines.
  - Risk factors associated with PPHN:
    - Hypothermia
    - SSRI during pregnancy
    - Meconium Aspiration Syndrome
    - Congenital pulmonary hypoplasia, congenital diaphragmatic hernia
  - Patients with CVS emergencies are at risk of developing coagulopathies from profound metabolic/respiratory acidosis. CBC and Coags should be monitored to direct care with respect to blood product administration.
  - Refractory hypotension in the neonate may require a hydrocortisone challenge. Discussion with Transport advisor as to a hypotensive dose (1 mg/kg) or actual cortisol challenge (1-2 mg/kg).

General Information

Amiodarone may cause hypotension if administered too quickly. The risk to the patient must be considered when administering at a quicker rate.

Interventions

First Responder

- Maintain thermal stability
- Provide supplemental oxygen as required
  - → A07: Oxygen and Medication Administration

- Manual airway maneuvers
- Positive pressure ventilation via bag-valve mask
  - → B01: Airway Management

Emergency Medical Responder – All FR interventions, plus:

- Transport to closest facility with notification
- Consider ACP intercept

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider vascular access and fluid administration if hemodynamically unstable
  - → D03: Vascular Access
  - REQUIRES CLINICALL CONSULTATION (1-833-829-4099)

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Obtain vascular access and consider fluid administration
  - → PR12: Intraosseous Cannulation
- Consider EPINEPHrine for bradycardia
  - → PR19: Transcutaneous Pacing
- For tachydysrhythmia, consider:
  - CONSULTAITON WITH CLINICALL (1-833-829-4099) REQUIRED FOR THESE THERAPIES.
  - Adenosine
  - Amiodarone
  - PR20: Synchronized Cardioversion

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- NIV/Invasive ventilation strategies
- Inotropic and vasopressors for hemodynamic instability
- Vitamins for metabolic derangement
- Electrolyte replacement
- Benzodiazepine infusion
- Antibiotic administration
- Inhaled vasodilator
- Point of care testing
- Blood product administration
- Central Line and Arterial Line monitoring
- Initiation of umbilical lines

M12: Neonatal Neurological

Wes Bihlmayr

Updated: November 27, 2020
Reviewed:

Introduction

Neonatal neurological emergencies encompass a large variety of conditions varying from cerebral vascular accident, developmental conditions, space-occupying lesions to infectious encephalopathies. The majority of these conditions require advanced imaging to diagnose, and will need long-term therapy.

Paramedic management of the neonatal neurological emergency involves determining the time of onset of condition, and management of symptoms created by the condition, including seizures, hypotonia, apnea or variations in respiratory pattern, and absent or delayed primitive reflexes.

Essentials

- Neurological emergencies in the neonate generally present through altered mental status. This may be the result of
  - Seizures
  - Hypoglycemia
  - Infection
  - Trauma
- Neonates may present with respiratory compromise from repeated seizures, or central apnea.
- The primary treatment is management of symptoms and supportive care in accordance with the appropriate clinical practice guideline. In particular, seizures should be treated if paramedics feel confident in their diagnosis, remembering that seizures can be subtle in neonates (lip smacking, blinking, and bicycle movement of the legs are common signs).

Additional Treatment Information

- The majority of neonates who experience respiratory compromise secondary to a neurological condition are treated as though they have an infectious encephalopathy, until blood and cerebrospinal fluid cultures have been completed.
- Patients should be transported to a hospital with appropriate pediatric resources, if there are multiple hospitals to choose from.
- Patients experiencing multiple apneic events may require placement of an advanced airway in order to oxygenation and ventilate effectively.

Interventions

First Responder

- Prevent heat loss
- Provide supplemental oxygen as required
  - → A07: Oxygen and Drug Administration
- Provide on-going care as per neonatal resuscitation guidelines
  - → M09: Neonatal Resuscitation

Emergency Medical Responder – All FR interventions, plus:

- Transport urgently to closest facility

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider use of supraglottic airway if unable to oxygenate or ventilate with bag-valve mask alone

- → PR08: Supraglottic Airway

- Consider need for vascular access based on clinical scenario
  - → D03: Vascular Access
  - REQUIRES SPECIFIC TRAINING AND CLINICALL CONSULTATION (1-833-829-4099)
- Correct documented hypoglycemia:
  - → E01: Hypoglycemia and Hyperglycemia

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Advanced airway intervention if unable to oxygenate or ventilate
- MIDAZOLam for seizure control
- Consider intraosseous access
  - → PR12: Intraosseous Cannulation

M13: Neonatal Fluid and Glucose Management

Wes Bihlmayr

Updated: November 27, 2020
Reviewed:

Introduction

Neonatal fluid and glucose management may involve a wide range of requirements, from general maintenance all the way to complete electrolyte replacement. The neonatal renal system does not reliably regulate electrolytes until sometime after the first 24 hours of life. During that time, fluid maintenance is primarily based on glucose replacement to meet the high metabolic demands of the infant.

Essentials

- Neonatal blood glucose levels can be corrected with feeding or intravenous glucose.
  - Attempt to correct blood glucose using oral glucose first. Be cautious with volumes, and protect the airway to the maximal extent possible.
  - If the neonate is asymptomatic: a blood glucose of greater than 2.6 mmol/L requires ad lib feeds. If the blood glucose is between 1.8-2.6 mmol/L, then a prescribed volume of feed every 2 hours is required.
  - If the neonate is symptomatic or has a blood glucose less than 1.8 mmol/l an IV is required and an infusion of glucose initiated. The normal starting solution is D10W at a rate of 3 ml/kg/hr if asymptomatic and 4 ml/kg/hr if symptomatic with an additional consideration of a 2 ml/Kg D10W bolus.
  - Once a neonate maxes out on fluid/glucose volumes the next step is to give glucagon, 0.5 mg IM/IV/SC.
- Maintenance fluids for the first 24 hours should be D10W and after 24 hours D10W with NaCl (20 mmol/L)
  - DOL 0 – 60-80 ml/kg/day
  - DOL 1 – 80-100 ml/kg/day
  - DOL 2 – 100-120 ml/kg/day
  - DOL 3 – 120-140 ml/kg/day
  - DOL 4 – 140-150 ml/kg/day
  - DOL 5 – 150 ml/kg/day

Additional Treatment Information

- Prehospital fluid management of the neonate should focus on glucose intake. D10W should be the fluid of choice. The fluid to use in a poor perfusion state is D10W with slow boluses of normal saline (10 ml/Kg).
- In general, the prehospital neonate should only receive intravenous fluid if there are signs of poor perfusion or a symptomatic blood glucose level.

Interventions

Emergency Medical Responder – All FR interventions, plus:

- Ongoing care as dictated by NRP
  - → M09: Neonatal Resuscitation
- Buccal Glucogel
- Transport to the nearest hospital

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider use of supraglottic airway if unable to oxygenate or ventilate with bag-valve mask alone
  - → PR08: Supraglottic Airway
- Consider need for vascular access based on clinical scenario
  - → D03: Vascular Access
  - REQUIRES SPECIFIC TRAINING AND CLINICALL CONSULTATION (1-833-829-4099)

- Correct documented hypoglycemia:
  - → E01: Hypoglycemia and Hyperglycemia
  - Glucagon

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Consider intraosseous access
  - → PR12: Intraosseous Cannulation

Pediatrics: Overview (For Consideration)

Michelle Haig

Updated: November 27, 2020
Reviewed:

Introduction

For clinical consideration within BCEHS, pediatric patients are those who are **≤12 years of age,** whereas adults are defined as >12 years of age or showing signs of puberty. There is widespread variation on this across Canada. This does not apply to matters of consent.

See BCEHS Pediatric Drug Dosages for age specific guidelines, vital signs and equipment sizes.

The Pedimate should be used during transport of pediatric patients between 10-40 lb (4.5-18 kg).

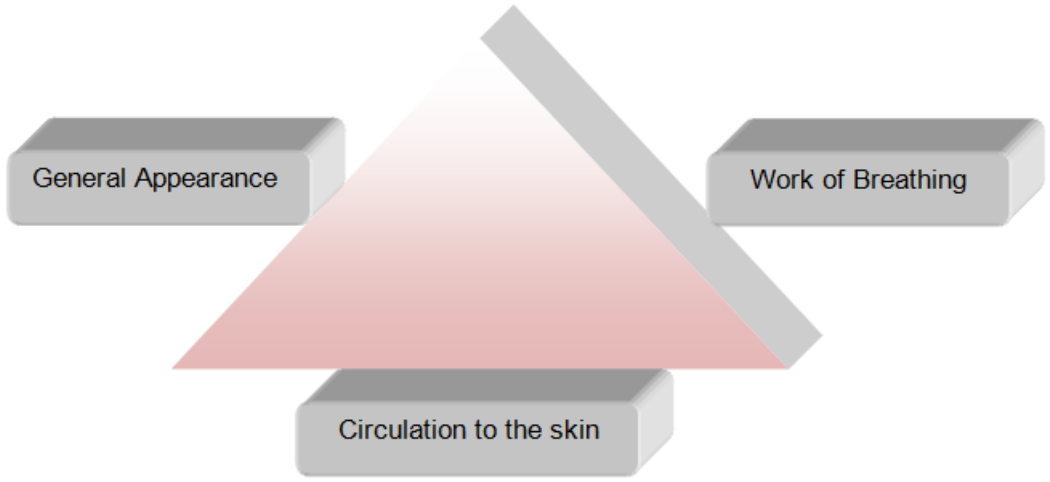
General Information

Pediatric Assessment

Children need to be treated differently from adults.

A child's anatomy, physiology and response to illness and injury varies with age, and the spectrum of emergencies involving children is different to that of the adult population. Children's vital signs, communication style, most likely diagnosis and treatment needs are age dependent, and many of their symptoms and all your equipment choices for diagnosis and care are size related. It is particularly important to always look for early signs of failure of respiratory, cardiovascular and nervous system function by assessing the work of breathing, circulation to the skin and appearance. The Pediatric Assessment Triangle (PAT) should be used to do this.

Pediatric Assessment Triangle



The PAT also enables the care giver to identify a child who is potentially unstable, and assess whether his/her condition is stable, improving or worsening over time. Clinical signs of progressive respiratory difficulty warn of impending respiratory arrest. In most instances in children, respiratory is the precipitating cause of cardiac arrest. Consequently, assessment and support of respiratory function is essential and the principal care entity and resuscitation measure required during pre-hospital care of infants and children.

Normal vital signs vary with age. Note that a younger child has a faster heart and respiratory rate and lower blood pressure. After about 12 years of age, normal vital signs approach adult values. Normal vital signs vary with age. Note that the younger the child, the faster the normal heart rate and the lower the normal blood pressure. After about 12 years of age, normal vital signs approach adult levels.

Age	Weight	Heart Rate	Respiratory	Systolic BP

	(kg)	(bpm)	Rate (bpm)	(mmHg)
Neonate	< 3	100-160	40-60	Difficult to measure
3 Months	2 - 3	100-180	30-45	65-100
6 Months	3 - 4	100-180	25-35	70-110
12 Months	10	100-180	25-35	70-110
2 Years	12	80-160	20-30	70-110
3-4 Years	14-16	70-130	18-30	75-110
5-6 Years	18-20	70-110	18-24	80-110
7-8 Years	22-24	70-110	18-22	80-110
9-10 Years	26-28	70-110	18-22	80-110
11-12 Years	30-32	70-110	16-20	90-120

- Mean systolic BP can also be estimated by:
  - 80 + (2 x Age) in years
- Lower limits of systolic BP can also be estimated by:
  - 70 + (2 x Age) in years
- Weight can be approximated from the Broselow TM tape or:
  - (Age (yr) x 2) + 8 = Wt (kg)
- Pounds/kilogram conversion:
  - Wt (lb)/ 2.2 = Wt (kg)

Pediatric Respiratory Distress

Pediatric respiratory distress may look just like respiratory distress in adults, but may also present as:

- Rapid or slow respirations
- Nasal flaring
- Retractions

- Accessory muscle use
- Pale appearance
- Decreased breath sounds
- Mottled skin
- Grunting
- Stridor
- Wheezing
- Cyanosis
- Bradycardia

Pediatric Shock

Signs of shock or other serious illness may mimic those in adults, but may also include:

- Tachycardia/bradycardia
- Pale/cool/mottled skin
- Capillary refill>2 seconds
- Narrowing pulse pressure
- Tachypnea
- Relative flaccidity
- Change in level of consciousness (LOC) – especially failure to recognize / respond to parents

Pediatric Principles

Hypotension, a late and ominous sign of shock, means that cardio-respiratory arrest is imminent. A child may lose 25% of his/her circulating blood volume before becoming hypotensive. The signs and symptoms of shock listed above are much more sensitive than blood pressure.

A Broselow™ Pediatric Emergency tape is highly recommended as an aid to determining the patient's weight and proper drug does and equipment sizes.

ET tube size can also be estimated by comparison to the size of the child's nostril (nare), or the size of the child's little finger, or by using the formula (age/4) + 4 = ET tube size. However, when a cuffed tube is to be used, calculate the tube size using the formula (age/4) +3. Children less than 1 year of age usually need a #1 straight laryngoscope blade, children 1-4 usually need a #2 blade and children >4 years usually need a #3 blade.

Abnormal Pediatric Vital Signs From the Pediatric Advanced Life Support Guidelines (PALS):

Hypotension is defined as follows:

For Term Neonates (0-28 days)	SBP <60 mm Hg
For Infants (1 month to 12 months)	SBP <70 mm Hg
For Children (>1 year to 10 years)	SBP <70 + (2 x age in years) mm Hg
For Adolescents (>10 years)	SBP <90 mm Hg

These figures overlap with the lower values for BP of 5% of the pediatric population who normally have low blood

pressure. In assessing a child for the presence of shock it is important to consider the other clinical evidence such as a history suggestive of fluid or blood loss, sepsis, or major trauma, and clinical findings such as tachycardia, pallor cold extremities, altered mental state and increased work of breathing. Hypotension, especially with bradycardia, may signal impending arrest.