PHARMACOLOGY

I. NICU Medications
II. Protocols
   A. Methadone Protocol for Neonatal Abstinence syndrome
   B. Caffeine
   C. Chronic Lung Disease Protocol
   D. Gentamicin Dosing
   E. Hyperkalemia
   F. Rapid Sequence Intubation Medications
   G. Opioids
   H. Vitamin D Supplementation to Prevent Osteopenia of Prematurity
   I. Indomethacin for IVH Prevention in ELBW

III. Appendix
    A. Antibiogram

I. NICU MEDICATIONS
   Link to Children's Neonatal Dosing Card

II. PROTOCOLS
   a. METHADONE FOR NEONATAL ABSTINENCE SYNDROME
      i. Link to Methadone Protocol
b. CAFFEINE

CAFFEINE CITRATE USE IN VLBW INFANTS
<1250 GRAMS OR <30 WEEKS

Caffeine Citrate (must specify \textit{citrate})
Load: 30 mg/kg IV or PO maintenance: 6 mg/kg/day (one dose/24 hrs)

- Apnea of Prematurity
- Facilitate Extubation
- Reduce Chronic Lung Disease

Load with caffeine citrate and start maintenance

- Significant apnea or doubtful efficacy
  - Obtain level.
  - Wait 4-5 days until steady steady obtained
  - Wide therapeutic range (8-20 mcg/ml)
  - Reload and/or increase maintenance

- Therapeutic response
  - 31-33 weeks PCA
  - and
  - no apnea or significant intervention
  - Stop caffeine
  - Goal: sub-therapeutic level by 33 wks PCA

- Significant apnea recurs
  - Consider starting Aminophylline

- Apnea resolves
  - DC Aminophylline

- Apnea persists at discharge

Discharge plan
- Stop Aminophylline
- ½ loading dose of caffeine citrate
- Enroll in infant apnea program
- Monitor training for caretakers
- Discharge with home monitor and caffeine citrate

Outpatient management
- Stop caffeine in 2 weeks if no significant events
- Document mature respiratory pattern with event recording at one month
- Stop monitor if recording mature

\textbf{Note:}
Because of its long half-life, caffeine should be discontinued at 1500 grams.

Theophylline can be prescribed if needed
C. CHRONIC LUNG DISEASE PROTOCOL

Recommendations for the use of steroids and diuretics in chronic lung disease at ≥ 34 weeks CGA

AIMS
1. Reduce incidence of chronic lung disease (as defined by supplemental $O_2$ need at 36 weeks CGA).
2. Provide consistency in diuretic and steroid use among neonatology providers in infants with CLD and relatively low oxygen requirements.

RECOMMENDATIONS
Infants at 34 weeks CGA with persistent oxygen need of an effective $FiO_2 < 0.3$ on low flow blended nasal cannula will have consideration of the following interventions in attempt to wean off oxygen. Prior to initiation, a discussion with parents regarding the speculative benefits of these treatments should occur.

1. At 34 weeks postmenstrual age: institute a trial of furosemide (Lasix) a 2 mg/kg/day po daily x 7 days.
   If trial results in reduction of oxygen need, consideration should be given to initiation of long-term chlorothiazide (Diuril) at 40 mg/kg/day (± sodium and potassium supplements).

AND/OR
2. At 34 weeks postmenstrual age for persistent supplemental oxygen need ± diuretic trial: institute prednisolone at 1 mg/kg/dose q 8 hours x 72 hours.
   Infants should be observed for rebound oxygen need for 5-7 days post steroid use.

RELATIVE CONTRAINDICATIONS
1. Lasix: hypokalemia or nephrocalcinosis
2. Prenisolone/methylprednisolone: hypertension

These clinical practice recommendations should be considered as suggested clinical practice and the choice to pursue these treatment options will remain at the discretion of rounding neonatologist or fellow.

Suggested reading:

D. GENTAMICIN DOSING

NICU GENTAMICIN DOSING \(^{1,2}\)

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1 Children's Hospitals and Clinics 09/97 – Based on data collected at St Paul 1996
E. HYPERKALEMIA

(Central Serum Potassium 6.5 mEq/l or ≥) is a medical emergency that requires close patient observation, continuous cardiac monitoring, and measurement of serum potassium levels. Treatment is indicated when serum potassium is greater than 7 mEq/l.

Etiology of Hyperkalemia in Neonates

- **Factitious (most common):** Hemolyzed blood from heel stick, thrombocytosis. Send repeat sample STAT before starting treatment, unless EKG changes indicate hyperkalemia.
- **Decreased removal of potassium:** Acute renal failure, positive potassium balance in premature infants during the first days of life, adrenal failure in CAH and medications (Captopril).
- **Increased load of potassium:** Hemolysis, IVH, hematoma, excess potassium administration.
- **Redistribution:** Elevated potassium, secondary to metabolic acidosis and sepsis, NEC, and medications (Digoxin).

Evaluation of Hyperkalemia

**Determination of etiology and management:** Electrolytes, BUN, creatinine, platelet count, blood gases, ionized calcium, total calcium, and magnesium levels. EKG changes progress with increasing potassium level: peak T-waves, prolonged PR interval, loss of P wave, widening QRS, sign wave QRST, first degree AV block, ventricular dysrhythmia and, finally, asystole.

Treatment of Hyperkalemia

Hyperkalemia with dehydration should respond to fluid resuscitation.

- Immediately change to an IV solution without potassium. If on gentamicin, hold dose, pending evaluation of renal status, and gentamicin trough levels. The effects of hyperkalemia can be worsened by hypocalcemia and hypomagnesemia.

Hyperkalemia with Cardiac Changes

- With cardiac monitoring, give 100 mg/kg/dose (1 ml/kg/dose) IV of 10% calcium gluconate or 20 mg/kg/dose (0.2 ml/kg/dose) of 10% calcium chloride over 10 minutes. This will decrease myocardial excitability and prevent cardiac arrhythmias. May repeat calcium dose in 10 minutes, if abnormal cardiac changes persist. Administration of calcium does not lower serum potassium levels.
- If patient is acidotic, give sodium bicarbonate, 1-2 mg/kg IV over 10-20 minutes. Inducing alkalosis will drive potassium into cells. Correct respiratory acidosis first before administering sodium bicarbonate.
- Give insulin to assist driving potassium into the intracellular fluid compartment. If infant is normoglycemic, administer insulin and glucose together as a bolus to prevent hypoglycemia. The ratio should be 1 unit of insulin to 4 gm of glucose given as a
bolus. 0.05 units/kg of regular insulin with 2 ml/kg of D10W 10% glucose, followed by continuous infusion of D10W at 2-4 cc/kg/hour, and regular insulin, 10 units/100 ml at 1 ml/kg/hour. Obtain initial glucose level, and follow glucose levels every 30-60 minutes until stable.

- Enhance potassium excretion. Give diuretic therapy: Lasix, 1 mg/kg IV, may increase potassium excretion by increasing flow and sodium delivery to distal tubules.
- Kayexalate, rectally (1 gm/kg at 0.5 gm/ml of normal saline) with minimum retention time of 30 minutes. The silastic feeding tube should be inserted 1-3 cm for retention enema. Follow sodium levels because patient will be at risk for hypernatremia with this exchange resin.
- Double-volume exchange with fresh whole blood (less than 24 hours old or deglycerolized) red blood cells reconstituted with fresh frozen plasma.
- Peritoneal dialysis.

**MANAGEMENT OF HYPERKALEMIA IN VLBW INFANTS**

1. Maintenance fluids: 80 – 100 cc/kg/day D5W. If blood sugar is > 100 mg%, begin regular insulin normal saline, 0.1 units/kg/hour. Titrate infusion rate to keep blood sugar 100 – 200 mg%

2. Blood sugar should be monitored every hour until stable, then every two hours. If blood sugar or if serum potassium continues to rise, increase insulin infusion rate by .05 cc/kg/hr. If blood sugar is < 100 mg%, insulin infusion should be stopped. Any changes in insulin infusion rate should be blood sugar within one hour.

3. Additional treatment for hyperkalemia:
   - Sodium bicarbonate, 1 – 3 mEq/kg IV over 3 – 5 minutes;
   - Calcium gluconate (10%), 0.2 – 0.5 cc/kg IV over 2 – 5 minutes.
   NOTE: Calcium gluconate is not compatible with sodium bicarbonate.

**F. RAPID SEQUENCE INTUBATION MEDICATIONS**

Rapid sequence intubation medications should be given as a push in the following order for all NON-EMERGENT intubations in the NICU.

1. Atropine 0.1 mg/DOSE
2. Morphine 0.1 mg/kg
3. Rocuronium 1 mg/kg

The rocuronium typically takes two minutes to go into effect, so do not give a second dose until you have waited at least two minutes to see any effect.
**G. OPIOIDS**

Individual clinical circumstances may require a change from the suggested guidelines.

**OPIOIDS for PAIN or SEDATION**

Narcotics should be prescribed for pain control according to our guidelines for postoperative analgesia and for procedures. There is no concerted effort to not treat pain, particularly post-operatively. However, we should administer analgesics according to guidelines and be mindful of the side effects of prolonged exposure to narcotics.

Narcotics should not routinely be used for sedation of infants receiving mechanical ventilation. Alternative drugs for sedation include Ativan and chloral hydrate.

Morphine may be a better choice than fentanyl because of less chance of chest wall rigidity or laryngospasm following rapid administration. One study comparing continuous infusions of morphine and fentanyl in neonates found an average 9.6-day delay in discharge of infants who received fentanyl.

Intermittent doses of narcotics are generally preferable to continuous infusions. Continuous infusions predispose an infant to more complications/side effects, including gut hypomotility, urinary retention, and addiction. Infusions may be more practical in certain conditions, such as postoperative gastroschisis where both paralysis and prolonged narcotic administration may be needed. High frequency oscillatory ventilation and congenital diaphragmatic are examples where sedation rather than pain control are important.
H. VITAMIN D SUPPLEMENTATION TO PREVENT OSTEOOPENIA OF PREMATURITY

Recommendation
All infants born at < 34 weeks gestation should be started on Vitamin D 400 IU/day PO/NG at the time of birth.

** This should be initiated regardless if the patient is otherwise NPO **

Screening Labs
Vitamin D panel should be assessed after one month of therapy, and monthly thereafter (goal 25 (OH)-D level > 50 nmol/L). Alkaline phosphatase should be assessed per NICU practice.

** Vitamin D supplementation will be discontinued if the infant is receiving > 16 ounces/day of formula, the alkaline phosphatase is < 400, or the vitamin D laboratories indicate excessive levels. **

Rationale
55% of ELBW infants and 23% of VLBW infants have low bone mineralization due to premature birth. It is reported that up to 25% of VLBW infants have overt fractures during their hospitalization. Inadequate calcium and phosphorus as well as inadequate vitamin D levels are major contributors to premature infant metabolic bone disease (rickets/osteopenia). Many pregnant mothers are vitamin D deficient. Infants receive their vitamin D supply via the mother in utero and get approximately 50 – 70% of the level of the mother.


I. INDOMETHACIN FOR IVH PREVENTION IN ELBWS

Recommendation
All infants born < 1000 gm should have indomethacin prophylaxia initiated at 3 – 6 hours of life for the prevention of intracranial hemorrhage. Dosing is indomethacin 0.1 mg/kg/dose q 24 hrs x 3 doses. First dose should be given between 3 – 6 hours of life.

** Routine echocardiogram at 72 hrs of life is no longer warranted and should be obtained only if the infant is having signs/symptoms of a patent ductus arteriosus. **

** If the infant requires hydrocortisone, dosing should be delayed by 24 hours from the most recent indomethacin dose. **
Rationale

III. APPENDIX

2011 ANTIBIOGRAM
a. [Link to Children’s Antibiotogram 2011]