

# NICU Survival Guide

## Phone numbers

NICU 3 (352) 265-0033

NICU 2 (352) 265-0352

NICU 3 fax (352) 265-0285

Neo office (352) 392-4195

## Schedule:

6:00-8:30 Pre-round

8:30-9:30 Post call and On call resident round

9:30-10:00 X-ray Rounds in Radiology

10:00-12:00 Attending Rounds

12:15-1:15 Resident Conferences

1:30-2:30 NICU Teaching Conference

\*Every morning each physician must scrub for 3 minutes before entering nursery

\*Wash hands or use hand sanitizer between babies to prevent spread of infection

\*Use stethoscopes provided at bedsides of babies

\*Check out patients to senior resident BEFORE leaving for clinic or if leaving postcall.

## Responsibilities of House Officer in NICU:

**PL-1** Be aware of all aspects of your patient's care. Become proficient in clinical assessment of the neonate, both in acute and chronic conditions, knowledgeable about basic care (fluids, HAL, common problems, CPR), proficient in common procedures, and responsible for communication with the family, referring physician, and all medical staff involved with your patient. You are the primary physician.

**PL-2/PL-3** In addition to the skills obtained as a PL-1, continue to acquire expertise in neonatal care including CPR, nutrition, cardiac/surgical problems, PPHN, sepsis, ICH, and reading x-rays. Be able to teach and supervise the PL-1s and students basic neonatal care. Familiarize yourself with all of the patients on the team and provide interns with guidance in managing their patients.

## **Admission:**

Pre-printed admission forms and orders should be filled out on every infant admitted to NICU in a timely manner.

## **Progress Notes:**

**Time and date all entries.** Every baby must have a progress note every day. Note "Rounds with Dr. X" at top of daily note (X being whoever your attending of the day is). Include pertinent physical exam in all progress notes. All progress notes should have FEN, Respiratory, cardiovascular, ID, heme, and social (including communication with parents, social services involvement if appropriate, and discharge planning/disposition). **Contact parents within 24 hours of admission, and then every 1-2 days for updates. Document communication (or attempts) in chart.** Lines/access, neuro, renal, and GI are other common problems that may be included. If you are called to see a baby for a problem, write a note indicating the problem you were called for, your assessment, and what evaluation and/or therapy was done.

### **Transfers:**

Transport checklist (available in cabinet next to transport team desk) should be completed for any baby being transported to another hospital. The following must be ready prior to transfer: parental consent, transfer paperwork, discharge summary must have been completed along with discharge paperwork and typed up by Robbie Anderson.

### **Delivery Room Resuscitation:**

Wear Gloves! Set up suction and catheter (~ 80 cm water pressure), turn warmer on, turn oxygen on (~10 LPM), check to make sure you have an appropriate sized face mask and that the ventilation bag/neopuff works. Get appropriate size ETT ready, stylet if needed. Check laryngoscope blade and light. Make sure warmed blankets are available. Prepare for the worst - designate jobs expecting a difficult resuscitation. If meconium is present and baby is depressed or has respiratory distress, intubate and suction below cords. Remember, dry baby, stabilize Airway, Breathing, and Circulation- A B C's!

**"Position, suction, stimulate, intubate!"**

If Demerol/narcotic has been given to Mom < 4 hrs prior to delivery, Narcan may be needed. Never give Narcan if mother is on chronic narcotics.

### **Apgar Scores:**

<u>Sign</u>	<u>0</u>	<u>1</u>	<u>2</u>
Heart Rate	absent	<100	>100
Resp Effort	absent	slow, irregular	good, crying
Muscle Tone	flaccid	some flexion	active motion
Reflex	irritability	no response	grimace cry
Color	blue, pale	acrocyanosis	pink

Assess at 5 minute intervals until Apgar score > 7.

### **Intubation:**

Baby's Weight	Tube size	Depth	Suction Catheter size
1 Kg	2.5	7 cm	5 Fr.
2 Kg	3.0	8 cm	6 Fr.
3 Kg	3.5	9 cm	8 Fr.

For really small infants, once you visualize cords, swing handle of scope to left of midline in order to allow room for ETT. Don't try to pass the tube along the groove of the scope.

## **IV Fluids and Nutrition**

### **IV Fluid Guidelines:**

#### **DOL # 1**

**Infants > 1000 gm:** 60-80 ml/kg/day Day 1 HAL or D<sub>10</sub>W (+ 3 gm Calcium gluconate/L for < 34 weeks)

**Infants 750 to 1000 gm:** 80-100 ml/kg/day

**Infants < 750 gm:** 100-120 ml/kg/day -follow weight and electrolytes **closely** (q6h) and adjust prn (May need up to 200 ml/kg/day) (VLBW infants may only tolerate D<sub>5</sub>W).

Infants on Indocin tx usually require **less**, as this makes them retain free water.

\*No Na<sup>+</sup> or K<sup>+</sup> needed on day 1.

\***TPN** if full feeds will not be reached by ~DOL #5, and if lytes are fairly stable:

Day 1 HAL at 60-80 cc/kg/day (D<sub>5</sub> for <1000gm; D<sub>10</sub> for >1000gm); make up remainder of fluids as clear IVF (ex D<sub>5</sub>W or D<sub>10</sub>W).

**\*Dextrose:** Term infants 6-7 mg/kg/min in term infants, <34 weeks 5-6 mg/kg/min. Increase to 10-12 mg/kg/min over a few days. **Glucose infusion rate (GIR)=mg/kg/min of dextrose: (% glucose in solution x10) x (rate of infusion)/(60 x weight Kg).** Maximum Dextrose concentration by peripheral IV = D<sub>12.5</sub>W.

**\*Protein:** Begin with 2 gm/kg/day and increase by 0.5 -1 gm/kg/day to MAX of 3.5 gm/kg/day

**\*Lipids:** Begin with 1 gm/kg/day and increase by 0.5 gm/kg/day up to 3.0 gm/kg/day (Restrict if triglycerides > 200 mg/dL).

### DOL # 2

\*Increase by 10 to 20 ml/kg/day

\*Check electrolytes at 24 hrs of life add Na<sup>+</sup> now or on Day 3. 2-3 meq/kg/day Na<sup>+</sup> is "normal".

\*Add K<sup>+</sup>: (1-2 meq/kg/day) if urine output is good.

\*HAL: For preemies, give most sodium as acetate, very little potassium, maximize calcium and phosphorus, usually will not need magnesium initially as mag will be high. For near term babies, standard neonatal and adjust lytes based on next days lab values.

### DOL # 3

\*Increase by 10 to 20 ml/kg/day

\*If under phototherapy, increase free water by 20-30 ml/kg/day. (10-20 ml/kg/day per bili light)

\*Continue to increase Total Fluid Volume (TFV) by 10-20ml/kg/day until at TFV of 150ml/kg/day

### **Starting Feeds (These are Guidelines ONLY!)**

\*Infants < 1250 gm: consider gut 'priming' starting at 2.5 ml/kg/day ÷ q6h or q12h.

\*Infants 1250-1800gm: start at 10 to 20 ml/kg/day ÷ q3h, and increase by 10 - 20 ml/kg/day.

\*If 5 min Apgar <3, consider delaying feeds. Go slower in sicker babies, or if mesenteric blood flow is compromised (PDA, Indocin, asphyxia)

\*For any babies you anticipate will need TPN for > 1 week, or who will be working up slowly on feeds, **consider a PICC line early (within first 3 days of life).** This will increase the chance of success, and save the baby needle sticks.

### Calculating Ins and Outs

Ins: HAL or IVF + drips + art line fluids + enterals (write as ml/kg/day). Do not include colloids as ins.

Outs: urine + stools (sometimes Chest tube or NG tube)

Write UOP as ml/kg/hr (should be > 1)

### Calorie/Kg/Day Calculations:

In general, preemies will need 100-120 KCal/kg/day PO or 90-110 KCal/kg/day IV to gain weight. They may require more if they have increased caloric requirements (BPD, wound healing, etc).

**Dextrose calories:** (ml/kg/day) x (3.4 KCal/mg) x concentration of Dextrose = KCal/kg/day (D<sub>10</sub> = 0.1 g/ml, D<sub>12.5</sub> = 0.125 g/ml, etc)

**Lipids calories:** 20% = 2 KCal/ml x ml/kg/day = Kcal/kg/day of lipids

**Feeds calories:**

Breastmilk: 0.67 Kcal/ml, 20 KCal/oz formula 0.67 Kcal/ml, 22 Kcal/oz formula 0.73 Kcal/ml, 24 KCal/oz 0.80 Kcal/ml

For enteral feeds: ml/kg/day x KCal/ml = KCal/kg/day

Fluid Description (solution, additive, amount of additive)														Site				
A	TPND 8.5ml/hr 0900 ↓ Hal to 7ml/hr 1400 ↑ Hal 8ml/hr													UAC 17				
B	Meds																	
C																		
D																		
E																		
F																		
G																		
H																		
I	IL 2ml/hr x 15 hrs													PIV 0610				
TIME	Blood # Narcotic # Solution #	Crystalloid										Lipids	Colloids	Oral / Enteral				
		Flush	A	B	C	D	E	F	G	H	I	Type	Amt	Type	Route	Amt	Resid	Abd Girth
07												15						
08												12						
09	↑ Acyclovir	1	12	8								Hold for med	Slow flow	Bm	PO	10	0	26cm
10												2						
11												3						
12												4						
13												5						
14												6						
8 <sup>h</sup> Total		1	3	8								6						
15												7	(1500)	Bm	NG	15	0	25cm
16	↑ Acyclovir											8						
17												9						
18												10		Bm	PO	15	1	26cm
19												11						
20	Amp											12						
21												13						
22												14						
16 <sup>h</sup> total												15						
23												16						
24												17		Bm	PO	5	0	26
01	Acyclovir											18						
02												19						
03												20		Bm	PO	15	0	26
04												21						
05												22						
06												23		Bm	NG	15	0	26
24 <sup>h</sup> total		6	132									15						
24 hour Fluid Summary		IVF	173	Colloid	0	Oral	0	Enteral	115	Urine	197	Gastric	0	Chest Tube	0	Blood	1.5	
Total Intake		308			Total Output			193.5			Net Balance			→ 114.5				

NICU Daily Flow Sheet

Weight 2010 grams

Page 5 of 8  
Rev. 10/01/2007 15-0294-4

**Example of Calculations:**

Nutrition	Volume (ml)	ml/kg/day	kcal/kg/day
HAL (blue)	172	172ml/2.010kg=86	86ml/kg/day x 0.15grams/ml x 3.4kcal/gram=44
IL (pink)	15	15ml/2.01kg=7.5	7.5ml/kg/day x 2kcal/ml=15
BM (green)	115	115ml/2.01kg=57	57ml/kg/day x 20kcal/30ml =38
Totals		150ml/kg/day	97kcal/kg/day

\*Calculations based on weight of 2.01kg and HAL with 15% dextrose

## Metabolic Problems

### Acid-Base:

Consider correction if pH < 7.2 or Base Deficit > 10. Correct by giving **Sodium Bicarb 2 meq/kg/dose** or 1/2 correction of base deficit: base deficit x 0.6 x Wt in Kg.

Must write to dilute 1:1 in sterile water. Give over 30 to 60 minutes.

*Example: Sodium Bicarb 4 meq diluted 1:1 with sterile water IV over 60 minutes.*

For every increase in PCO<sub>2</sub> of 10 torr, pH should fall by 0.08 units (If acidosis is purely respiratory).

### Hypoglycemia (glucose < 40):

1) Send Central glucose to confirm.

2) While waiting for lab results, Give **D<sub>10</sub>W bolus of 2 mL/kg** and **increase current IV rate and concentration.**

3) Repeat Glucose evaluation q1hr until stable

4) In kids with UAC's, check position; a UAC infusing glucose into the celiac axis will cause the pancreas to produce excess insulin.

### HypoCalcemia (Ionized Ca<sub>2+</sub> < 0.9):

Usually can correct in maintenance fluids by increasing daily amount. (If also hypomagnesemic, must correct magnesium first.)

To bolus, use Calcium gluconate, 10% sol'n. Each mL contains 9.8 mg of elemental Ca<sub>2+</sub>, or 0.465 mEq Ca<sub>2+</sub>. Maintenance is 200-500 mg/kg/day. Bolus dose: 100-200 mg/kg/dose (= to 1-2 mL/kg/dose).

Max infusion rate: 200 mg/kg over 10 min. Usually give bolus over 1 to 2 hours.

*Example: Calcium gluconate 200 mg diluted 1:1 with sterile water IV over 2 hours.*

### HyperKalemia (K<sub>+</sub> > 6.0):

**Delete all external sources of K<sub>+</sub>.**

**Calcium gluconate** (10%): 0.2-0.5 cc/kg over 2-5 min to correct cardiac defects. Effective for up to 1 hour.

**Sodium Bicarbonate** 1-3 mEq/kg over 15 min (lasts several hours)

**Insulin/Glucose:** Give 2 cc/kg of D<sub>10</sub>W followed by ¼ unit regular insulin. Repeat as necessary. Monitor chemsticks closely. Alternatively, add 18 units of insulin to 500 cc of D<sub>10</sub>W. Then give 4 mL/kg of this mixture (Equal to 0.15 Units of insulin/kg) over 2 minutes. Consider **starting insulin drip at 0.1 U/kg/hr in either D<sub>5</sub>W or D<sub>10</sub>W**. Follow hourly K<sub>+</sub> until normokalemic.

**Kayexalate** 1-2 gm/kg PO or PR q4-6 hours. 1 gm Kayexalate should lower K by 1 mEq/L.

Consider **Lasix** to increase renal potassium clearance.

Proceed to **dialysis** if above measures are inadequate.

### HypoKalemia (K<sub>+</sub> < 2.5):

Usually can correct in maintenance fluids by increasing daily amount.

To bolus, use potassium phosphate. Give up to max dose of 1 mEq of K<sub>+</sub>/kg/dose. Usually over 4 hrs. Dilute 1:1 in sterile water. May also use Potassium Chloride or Potassium acetate to correct hypokalemia (SLOWLY), depending on the infant's electrolyte needs. May give 1 mEq/kg infusion over 2 to 4 hours. Recheck K<sub>+</sub> in 2 hours or so.

### HypoPhosphatemia (PO<sub>4</sub> < 3.0):

May use K-Phos or Na-Phos. Infuse: 0.3 to 0.5 mMol/kg/dose (or 0.45 to 0.75 mEq of K) over 4 hours. K-Phos - 1mMol of PO<sub>4</sub> gives 1.5 mEq of K (infuse over 4-6 hours). Na-Phos - 1 mMol of PO<sub>4</sub> gives 1.3 mEq of Na (infuse over minimum of 2 hours).

If given orally, must give separate from formula (or it binds to the Ca in formula and precipitates)

**HypoMagnesemia ( $Mg^{2+} < 1.5$ ):**

Usually can correct in maintenance fluids by increasing daily amount.

MgSO<sub>4</sub>: 25-50 mg/kg/dose IV. May repeat q6hrs for 3 to 4 doses, if needed. *Example: 75 mg diluted per protocol IV over 4 hours.*

## Hematologic Issues

**Transfusions: You MUST obtain parental consent prior to administering ANY blood product!** A good time to obtain consent is when updating the family immediately after admission and stabilization.

**Packed red blood cells (PRBCs):**

All babies should get CMV negative and irradiated blood. **15 ml/kg** over 3-4 hrs is usually adequate. May need to give lasix after transfusion to prevent or treat fluid overload. Use separate IV, so glucose source is not interrupted, resulting in hypoglycemia during transfusion. Directed donor blood will be used if parents request and if it is possible, but in cases of severe symptomatic anemia, the clinician will use blood banked blood if directed donor blood availability is delayed. See guidelines for indications.

**Transfusion guidelines:**

1. Hematocrit <35% **and** patient's on positive pressure ventilation with MAP >9 and FiO<sub>2</sub> >40% or hypotension and/or capillary refill >4 sec
2. Hematocrit <28% **and** should have one of the following symptoms:
  - 1) Unexplained apnea 12 spells per day or 2 which require bag-mask resuscitation or apnea while on ventilator, 2) Unexplained heart rate >165 for 48 hours, 3) Weight gain <10 gm/day average over 1 week with adequate caloric intake, 4) Lethargy, 5) Positive pressure ventilation, 6) O<sub>2</sub> requirement of >200 cc/min (100% cannula) or FiO<sub>2</sub> >40% (hi-flow cannula)
3. Hematocrit < 20%: No symptoms required

**Platelets:** Use *CMV negative, irradiated, random donor platelets*. Each unit is prepared from 450 mL whole blood collected from *one donor*. Contains 5.0-7.0 x 10<sup>10</sup> PLT/unit in 45-65 cc/unit. Expires 4 hours after being prepared. **10-15 ml/kg** should raise the PLT count by ~100-150K.

Transfuse through **IV** (not arterial, to avoid emboli) over 25-30 min.

**Therapeutic transfusion guidelines:**

PLT count < 50,000 /  $\mu$ L *with active bleeding*

**Prophylactic transfusion guidelines: (no active bleeding)**

1. If patient is **stable**, transfuse for PLT count < 25,000 /  $\mu$ L
2. If **unstable**, transfuse for PLT count < 50,000 /  $\mu$ L

**Unstable** defined by the following: 1. Preoperative: Scheduled for surgery, 2. Postoperative: Within 5 days following surgery, 3. Cardiovascular instability: Receiving dopamine at more than 3  $\mu$ g/kg/min, or any other, catecholamine infusion at any rate, 4. Respiratory instability: Receiving > 0.4 FIO<sub>2</sub>, or a mean airway pressure of > 9 cmH<sub>2</sub>O, 5. Neurologic instability: Within 72 hours of a seizure, 6. Disseminated intravascular coagulation: Clinical diagnosis,

supported by clinical or laboratory tests at the attending neonatologist's discretion, 7. Very low birth weight: Infants with a birth weight < 1500 g, during their first week of life.

\*Special considerations: Infants who are being treated with medications known to induce platelet dysfunction (indomethacin, ibuprofen, etc) or with anticoagulants should probably maintain higher platelet counts than neonates who are not receiving these medications.

**Fresh Frozen Plasma:** Contains all clotting factors except platelets

Volume: 10-15 ml/kg

Indications: correction of coagulopathy with prolonged PT/PTT (ie.- liver failure, sepsis with DIC, etc.).

**Cryoprecipitate:** Enriched for factor VIII, vWF, and fibrinogen

Volume: 10-15 ml/kg

Indications: fibrinogen replacement, Factor VIII replacement

**IVIG: uses:**

1) Source of specific antibody, to prevent infections on patients with low antibody concentrations.

2) Means of inducing temporary nonspecific reticuloendothelial blockade, to prolong the circulation of immunoglobulin-coated blood cells

Indications: Immune hemolytic anemia nearing exchange level, severe alloimmune thrombocytopenia where HPA-1b donor platelets are not available, severe thrombocytopenia associated with maternal autoimmune thrombocytopenia, or severe neutropenia due to (presumed) sepsis.

Dose: For severe neutropenia and septic shock: single dose of 750 mg/kg IV over 2-4 hours. For immune-mediated cytopenias: 400 mg/kg/day IV for 3 to 4 days.

**G-CSF (Granulocyte-Colony Stimulating Factor):**

G-CSF is used primarily to increase granulocyte production. Neutropenia related to NEC, sepsis, and PIH rarely persist for greater than 3 days, and are generally not responsive to G-CSF.

Consider G-CSF if:

ANC < 500 for > 2-3 days

ANC 500-999 for > 5-7 days

In a patient with sepsis, NEC, or maternal PIH, consider G-CSF if ANC < 500 for > 3 days

Dose: 10 mcg/kg/day IV/SQ x 3 days, then titrate dose to keep ANC > 1000.

## Common NICU Problems

**Sepsis:** For sepsis workup at birth (or in first week of life), blood cultures and ETT aspirate (if intubated) should suffice. LP if CNS symptoms or positive blood culture. Start Ampicillin and Gentamicin per Neofax. Follow sepsis evaluation at birth guidelines posted in NICU.

After first week of life, sepsis workup includes blood culture, urine culture and U/A, ETT aspirate if intubated, and LP. Usually start Oxacillin (or Vancomycin if baby is very sick) and Ceftazidime or Tobramycin, for *Pseudomonas* coverage. If baby is corrected to > 40 weeks post-conceptual age, consider Cefepime.

Normal WBC range 5,000-30,000 cells/mm<sup>3</sup>

Negative Predictive Value of WBC for Sepsis:

WBC > 5000 91-96%

ANC > 1750 96-99%

I/T ratio < 20% 99-100%

Antibiotic therapy should be tailored based on organism, sensitivities, and clinical course.

Length of treatment:

Uncomplicated sepsis 10-14 days

Meningitis 14-21 days

UTI 7-10 days

Longer portion of ranges suggested for gram-negative infections

### **Indirect Hyperbilirubinemia:**

Order Blood type and Rh on Mom and baby, Coombs direct and indirect, HCT, Bili T/D, blood smear. (CBC w/diff, total and direct bili, neonatal evaluation on blood bank form should suffice initially)

Consider phototherapy when bili is > dotted line on bili charts for BW 1500+. For BW < 1500 gm, consider the following chart:

BW	day 1	day 2	day 3	day 4	day 5	day 6	day 7
< 1000	> 3	> 3	> 3	> 5	> 5	> 7	> 7
1000-1249	> 5	> 5	> 5	>7-8	> 8	> 10	> 12
1250-1499	> 8	> 8	> 8	> 10	> 12	> 12	> 12

Consider double volume exchange transfusion, dependent on weight and age of patient, presence of hemolysis, rate of rise of bilirubin, when bili is > .01 x wt in grams, or > 20.

Consider IVIG early for Rh disease (or ABO incompatibility if nearing exchange levels).

### **Direct Hyperbilirubinemia:**

Differential diagnosis of direct hyperbilirubinemia includes TPN cholestasis, infectious hepatitis, biliary atresia, alpha-1 antitrypsin deficiency, tyrosinemia, neonatal iron storage disease, defects in bile acids/bile acid transporters, and idiopathic neonatal hepatitis.

Workup includes LFTs, electrolytes (to exclude acidosis), urinalysis for reducing substances, serum amino acids and urine organic acids, abdominal ultrasound, rule out sepsis,  $\alpha$ -1 antitrypsin level, hepatitis panel, and rule out TORCH infections. Further along in the workup, consider PT, ferritin/transferritin, qualitative bile acid profile, GI consult and liver biopsy.

### **Ventilators:**

Pressure limited mode: Set rate, peak inspiratory pressure (minimum pressure required to inflate chest), PEEP (positive end expiratory pressure) usually to 4 or 5, inspiratory time(Ti) (usually 0.35-0.4), and FiO2. Ventilator gives mandatory breaths to the set pressure every breath.

Volume limited mode: Set tidal volume (usually ~ 10cc/kg), rate, PEEP, and FiO2. PIP and Ti are determined by compliance of baby's lungs.

Ventilator will deliver the given volume of gas no matter how much pressure it takes. Highly compliant lungs will require low pressures, but stiff lungs may require high pressures. Therefore, this ventilator gives you some information about the changes in compliance of the baby's lungs. For safety reasons, there are now pressure limits that can be set to avoid high pressures. Pressure support for spontaneous breaths can be given.

Oscillator: Used for air leak syndromes (pneumothorax, pulmonary interstitial emphysema) and CO<sub>2</sub> retention on significant conventional vent support. Good data for use in meconium aspiration and congenital diaphragmatic hernia. Set hertz at 10 for big babies, 15 for small babies; mean airway pressure at ~ 2x current MAP on conventional vent; increase amplitude until baby shakes. Adjust oxygen as needed. Get CXR about every 6 hours initially to look at expansion. Make changes slowly and be patient.

Interpretation of ABGs:

In general, things that increase the mean airway pressure increase oxygenation (PaO<sub>2</sub>). Those that increase tidal volume or minute ventilation increase ventilation (PaCO<sub>2</sub>). In pure respiratory acidosis, for every increase in PaCO<sub>2</sub> by 10, the pH is decreased by 0.08.

**Persistent Pulmonary Hypertension of the Newborn (PPHN):**

PPHN is characterized by pulmonary hypertension due to elevated pulmonary vascular resistance and altered pulmonary vascular reactivity. This leads to right-to-left extrapulmonary shunting of blood across the foramen ovale and PDA. Primary finding is respiratory distress with cyanosis. CXR may show decreased pulmonary vascular markings ("black lungs") if there is no parenchymal disease. A >5% differential between readings of pre- and post-ductal sat monitors indicates right-to-left shunting through the PDA. Need to rule out CHD, usually done as part of your "pre-ECMO" work-up when PPHN is severe.

**Typical management:** Maintain normovolemia (avoid hypotension); normalize glucose, calcium, and phosphorus; keep magnesium high-normal; minimal stimulation; sedation but NOT paralysis; pre- and post-ductal sat monitors; avoid acidosis, but don't hyperventilate or push pH up by repeated bicarb infusions. Mechanical ventilation is often required, use 100% oxygen, wean vent settings very slowly when weaning is started! Surfactant may be useful. Calculate Oxygen Index (OI).

$$OI = \frac{MAP \times FiO_2}{PaO_2}$$

**NO protocol for non-CDH Patients:**

**-Institute NO at 20 PPM if:**

- 1) PPHN documented by ECHO in hospitalized patients or by preductal saturation-postductal saturation difference of 8% in transport patients and OI > 30.
- 2) If OI does not drop by 5 after 30 min of NO, increase NO to 40 PPM.
- 3) If after 2 hours of NO (90 min at 40 PPM) OI does not drop by 5, then this is evidence of NO failure. NO should be discontinued if the patient is not an ECMO candidate. If he/she is an ECMO candidate, further use until cannulated is appropriate.
- 4) If patient has a positive response to NO as documented by a drop in OI of > 5, then after 4 hours, decrease NO concentration by 50%, then another 50% 4 hours later to 5 PPM (or 10 PPM if required 40 PPM as described above). These will serve as resting NO settings.
- 5) Every 24 hours, attempt to decrease NO by 50% to a low of 1 PPM.
- 6) When patient is stable on FiO<sub>2</sub> of 0.75, attempt to discontinue NO use.

If OI is > 30, consult Ped Surg for possible ECMO and proceed with pre-ECMO orders. Call radiology for HUS and cardiology for ECHO. Prognosis is actually very good for most term or near term infants.

**Meconium Aspiration Syndrome:**

Meconium stained fluid is evidence that the fetus passed stool *in utero*. Meconium may be aspirated if the fetus gasps from hypoxia or hypercapnea. MSF is a warning sign of fetal distress. If an infant with MSF is not vigorous or has respiratory distress, he/she should be intubated for tracheal suction immediately, then resuscitated. Risk factors for MAS include: postterm pregnancy, preeclampsia, maternal hypertension, maternal diabetes mellitus, abnormal fetal heart rate, IUGR, poor biophysical profile, oligohydramnios, maternal heavy smoking, chronic maternal respiratory or cardiovascular disease. Infants with MAS are at risk for PPHN, and are managed similarly. Surfactant has been shown to be beneficial. Watch for air leaks!

**Transient Tachypnea of the Newborn (TTN):**

TTN is a benign disease of near-term and term infants who have respiratory distress shortly after delivery that usually resolves within 3 days. Incidence is ~1-2% of all newborns. Delayed resorption of fetal lung fluid is thought to be the cause. Signs include tachypnea and retractions, which resolve (hence the name). Classic CXR finding "fluid in the fissure" (minor fissure), hyperexpansion of lungs, prominent perihilar streaking (engorgement of periarterial lymphatics). Oxyhood or NCPAP are often sufficient. PO feeding is OK if resp rate <60, otherwise OG feed. (Consider NPO if RR > 80). Rule out pneumonia, CHD, HMD, cerebral hyperventilation, metabolic disorders, polycythemia and hyperviscosity. TTN is self-limited and usually lasts 1-3 days with no risk of further pulmonary dysfunction (good prognosis).

**IVH (Intraventricular Hemorrhage):**

For infants < 1500 gm, check head ultrasound at one week, looking for IVH, looking for periventricular leukomalacia. May need to get 1st one earlier if withdrawal of support/prognosis questions arise. If first HUS is abnormal, follow more frequently (weekly or biweekly). Follow daily head circumference if IVH is present. Use prophylactic Indocin for first 3 days of life if birth weight < 1000 gm.

(Indomethacin: 0.1 mg/kg q24hr X 3 doses).

Seizures, persistent metabolic acidosis, decreased perfusion, hypoxemia, hyperglycemia, apnea, hyperkalemia, bulging fontanel, lethargy, or rapid unexplained drop in HCT may be signs/sx of IVH.

**PDA:**

Physical signs include: wide pulse pressure, bounding pulses, palmar pulses, systolic/diastolic murmur.

Different regimens of Indocin therapy exist: (most common: Indocin 0.2 mg/kg IV Q12hr X 3 doses, or 0.2 mg/kg followed by 0.1 mg/kg q12hr X 2, may extend 0.1 mg/kg/day "tail" up to 5 days if PDA persists)

Check with your attending. Make sure to check Creat and PLT count prior to starting. Side effects of Indocin include hyponatremia, decreased urine output, decreased mesenteric blood flow and increased creatinine. **Contraindications:** Renal failure, NEC, active bleeding, thrombocytopenia or coagulation defects. *Consider stopping or reducing feeds during Indocin therapy.*

**NEC:**

Physical signs and symptoms include feeding intolerance, apnea, hyperglycemia, increased abdominal girth, abdominal tenderness, guaiac positive stools, increased or decreased WBC and decreased PLT. If suspicious, check KUB, left lateral decubitus film. If pneumatosis is present, keep NPO, place red rubber catheter to low intermittent suction, sepsis work-up and start antibiotics, check serial films and pertinent labs. Don't forget to adequately fluid resuscitate these babies. Consider Peds Surg consult. Follow-up films should be LLD only looking for perforation or resolution.

**Evaluation of neonates with Thrombosis:**

Indications: any neonate with arterial, venous (eg SVC syndrome) or intracardiac thrombosis, infarction on CT or U/S (eg. brain or kidney infarct), or severe thrombotic events such as purpura fulminans, limb necrosis etc.

Lab evaluation: Basic eval includes: Antithrombin III (1.0 mL, blue top tube), Factor V Leiden, prothrombin G 20210 A variant (0.5 mL purple top tube), Protein C activity, and Protein S activity (2.7 mL blue top tube). These labs go to Dr. Kao's lab: 392-0014.

Other tests which may be helpful include: free Protein S antigen, activated Protein C resistance, Protein C antigen, antiphospholipid and anticardiolipin antibody, plasminogen, fibrinogen, homocysteine concentration.

Treatment options: 1) observation alone, 2) short term anticoagulation with heparin 10 to 14 days, 3) short term anticoagulation with low molecular weight heparin (LMWH), 10 to 14 days minimum, or until clot resolution 4) thrombolysis with urokinase or t-PA (consider consultation with 1-800-NO CLOTS), in life threatening situations, 5) long term anticoagulation.

Consult Pediatric Hematology/Oncology (responsible for long term follow up), and 1-800-NO CLOTS.

## Health Care Maintenance

**ROP:** Infants of birth weight < 1500gm, 30 weeks or less, and if 32 weeks or less with unstable clinical course require ophthalmology exams at 6 weeks to check for retinopathy of prematurity. Depending on results of 1st exam, follow up exams should be scheduled as per ophthalmology (Dr. Khuddus).

**Hearing:** All infants should be screened prior to discharge. If you are transferring a baby, and the hearing test has not been done yet, contact Sharon Bowers.

**Immunizations:** If infant is stable, first immunizations should be given at 60 days (or patient weight minimum of 2kg, whichever is later). Written consent must be obtained from parent prior to giving shots. Treat infant with antipyretic (acetaminophen or ibuprofen) x 24 hours following shots.

**Brain imaging:** Obtain head ultrasound in all babies <1500grams or 30 weeks or less to evaluate for intraventricular hemorrhage at one week of age or earlier if high index of suspicion. Obtain head MRI in same patients at 6 weeks or prior to discharge (whichever comes first).

## Procedures

**\*Write a procedure note in the chart after completion of any procedure: include procedure, indication, consent obtained, sedation, patient preparation, and complications.**

### **Intubation (If non-emergent)**

1. Assure that bag-valve-mask is set-up with the proper oxygen concentration and patient is properly monitored with HR and saturation monitors.
2. Have end-tidal CO<sub>2</sub> device in place.
3. Have naloxone or flumazenil at bedside (may be kept in crash cart).
4. **Fentanyl 1-2 mcg/kg IV, slow push Or Midazolam (Versed) 0.1 mg/kg IV**
5. Wait 3-5 minutes. If still active and not well sedated, repeat fentanyl/midazolam dose.
6. Intubate. Auscultate for bilateral breath sounds, connect to end-tidal CO<sub>2</sub> device and verify expired CO<sub>2</sub> with yellow color change.
7. If intubation unsuccessful and there is evidence of patient compromise, administer naloxone 0.1 mg/kg IV push (if used fentanyl) or flumazenil 0.01 mg/kg (if used midazolam).
8. Obtain CXR to confirm level of ETT placement (ideally at T2).

### **Rapid Sequence Induction (For intubation of larger infants in non-emergent circumstances):**

1. **Atropine 0.02 mg/kg IV** Given to block vagal response to intubation
2. **Na Thiopental 3-5 mg/kg/dose IV** Thiopental is an intravenous ultra-short-acting barbiturate. The onset of action and recovery are rapid. Thiopental provides retrograde amnesia.
3. **Vecuronium 0.1 mg/kg/dose** (neuromuscular blockade begins within 1 minute, reaches a peak in 3-5 minutes, and lasts 25-40 minutes).

### **Lines:**

#### Umbilical artery catheters:

Place UAC in infants who require multiple ABGs or lab draws per day.

**UAC (high line) = (3 × birth weight) + 9**; tip should be at T6-T9. *UAC (low line) = BW + 7; tip at L3-L4*

#### Umbilical venous catheters:

Place UVC in infants who require prolonged stable IV access, such as BW < 1000 gm, CHD dependent on PGE, infants who will be NPO requiring central HAL for extended period (ie.- ECMO, surgical babies). Try to remove UVC as soon as possible. Plan for PICC line placement early before all good IV sites have been used. D/C UVC once PICC.

**UVC = UAC(high line) + 1**; tip should be just above diaphragm but not in right atrium.

2

PICC: candidates include those with: birth weight < 1 kg, surgical/GI issues, increased dextrose requirements (> 12.5 %), prolonged antibiotic/antifungal course, any infant whose anticipated IV access requirement exceeds 10 days.

Proper placement estimated by following formulas:

PICC: if placed in upper extremity, tip should be at ~T6, NOT in right atrium. NICU PICC team or NNPs usually place PICCs (for the right price).

**You MUST obtain parental consent before placing on PICC list.**