Entry codes for doors *(for your convenience, most of them are different)*:
- Door to Mom/Baby Floor: 35011
- Door to Newborn Nursery: 3500
- Right side door to L&D: 50033 then press *
- Left side door to L&D: 15933
- NICU 3 entry from halls: 0033
- NICU 2 entry (either door): 0033
- NNP/HO call room: 3311
- Clean holding room (NICU 2): 1133
- Clean holding (NICU 3): 0033
- IV/med room (NICU 3): 0033

**Helpful phone numbers:**
- NICU 3: 265-0033 (or 50033 if using hospital phone)
- NICU 2: 265-0352 (or 50352)
- Fellow/attending cell phone: 494-3685
- Fellow/attending call room: 44115
- NICU 3 NNP office extensions: 44117, 45323, 42984
- NICU 2 NNP office: 44109

There is a typed phone list in NNP offices for other numbers

**L&D overhead codes:**
- 1-1-1: Peds team plus NICU nurse
- 1-1-1 with fellow: Peds team plus nurse plus fellow/attending
- 2-2-2: Peds team only (usually for repeat C-sections)

If rooms 1, 2 or 3 show up on L&D pager- delivery will be in L&D ORs, anything else will be in a labor room

If you think you’ll need an extra hand, ask 1st admission NICU nurse to come back with you

If you find out you need an extra hand when you’re already in the back- ask L&D team to overhead for extra nurse or NNP/attending

When in doubt, call for extra help

**Blood transfusions:** No longer necessary to use CMV negative blood as long as it is leukocyte-reduced and irradiated

Volumes:
- 15 mL/k PRBCs- infuse over 3-4 hours
- 10 mL/k FFP/plts/cryo- infuse over 1 hour

Blood products can be infused thru UVC (and UAC if necessary) but not thru PICCs

**TPN deadline:**
- 1300 daily (call 44248 to ask for extension)

Must fax form yourself (there’s a TPN button on both fax machines)
Thermoregulation practice in the Delivery Room – New protocol to help improve admission temperatures (Goal admission temperature range 36.5-37.5°C)

The OR temperature will be turned to 26° C when NICU team is called for delivery.

Infants ≤ 28 weeks GA:

- Use food grade bags to wrap infants (Ziploc side goes towards the feet, the bags will be pre-cut to fit over the head)
- Place hats earlier (within 1-2 mins if able)
- Continue to use trans-warmer mattress

Infants > 28 weeks and ≤30 weeks GA:

- Use trans-warmer mattress
- Consider using servo control in RW with temp probe

Evaluation of protocol after 3 months.
Helpful Hints for CDH- guidelines only-check with peds surgery before ordering

CDH -Hal at 100mL/kg/d - drop down to 70mL/kg/d if placed on ECMO (Call TPN room 4-4244 and ask for CDH Hal to be sent to the NICU)

No antibiotics unless clinically indicated –Abx started once on ECMO (vancomycin, ceftazidime, and prophylaxis Fluconazole)

Pre/Post sat monitors

UAC as soon as possible (No UVC), CXR after UAC done (If unable to get UAC place PAL -post ductal)

Order Cerebral/Renal Somenatics under EPIC as Perform near infrared spectroscopy-type is renal and cerebral (Usually discontinued after extubation)

Foley catheter if on ECMO

Reploge to LCS and RRR to LIS (change q 8 hours respectively)

Ventilation orders and changes per Dr Kays (starting vent if Dr Kays not here-IMV 60, delta P 18, itime 0.35, PS 15, Peep 4, 100%)

Sedation Fentanyl 0.5mcg/kg/hr and Versed 0.05mg/kg/hr

Cardiac Echo and Head ultrasound

Type and Screen (order 2 units on call for ECMO)

If not doing well may need to be cooled, ask before normothermia

If significant chance of ECMO, no Na in TPN

TPN max 2 grams of AA and @ 2 grams/kg/d IL (do not start IL on day 1)

Call DK for Pre-ductal sats less 94%. Post- ductal less than 88%.

Cerebral sats less than 60%. Renal sats less than 50%.

ABG with PaO2 less than 60, PCO2 less than 35 or greater than 55, pH less than 7.25 or greater than 7.46

Post Op

Increase Fentanyl to 2mcg/kg/hr Versed up to 0.5-.1mg/kg/hr

If using antibiotics start: Vancomycin, Ceftazidime and prophylaxis Fluconazole
New Protocol

Late Preterm Deliveries

IMPLICATIONS FOR NICU

Due to the significant health issues common for late preterm infants, the Departments of OB and Pediatrics is implementing the following new process beginning October 1st.

- PEDS 111 will be called for all deliveries <36 weeks.
- Infants <34 weeks or <2000 grams will automatically be admitted to the NICU.
- Infants ≥34 weeks and <36 weeks (35 weeks & 6 days) will be admitted to the NICU or NBN based on the following criteria:
  1. During the day (0700 – 1600) if they appear healthy, they can stay with the mother for 30 min of skin to skin bonding and then go to the newborn nursery for temperature and glucose monitoring by the Maternal Newborn Staff.
  2. At night (1600 – 0700) if they appear healthy, they can stay with the mother for 30 min of skin to skin bonding and then go to the NICU for observation and monitoring.

The pediatric team that responds to a delivery for an infant between the ages of 34 and 36 weeks will make a plan based on the stability of the infant. L&D nurses who transport Infants born in the evening or night hours to the NICU will provide the same hand-off as used in the newborn nursery; provide delivery report, verify footprint sheet, verify bands. L&D will be responsible for notifying the NICU Charge Nurse so they can have a bed ready. In some cases the Pediatric team may feel the infant needs to go to the NICU immediately.

The Labor & Delivery staff (MD's and RN's) will provide an education sheet to laboring Late Preterm families and continue to educate them on what to expect at delivery for their special newborn.

10/1/1
VLBW/ELBW admissions:
Orders and documentation

ORDERS: (specific EPIC orders are written in blue)

Open admission order set (NICU admission orders IP UF) in EPIC
ADT orders/Admit to inpatient (choose "inpatient" for patient class)
Vital signs- under comments, type .nicu, and double-click on NICU Vital

Signs

Fluids:

- "Initial TPN" is a small syringe of day 1 TPN to be infused thru a PIV until central lines can be obtained. Can choose 7.5 or 10% dextrose concentrations- 7.5% is probably the best option for most babies <1 kg, order for TFV 80 mL/kg/d
- "Maintenance TPN" is a bag of fluids to be started following central line placement, usually infused via UVC
- Order UAC fluids under "IVF"- usually we'll order sterile water with 75 meq/L Na Acetate and hep 1:1 at 0.5 mL/hr
- Lipids- start with 2 grams/k/day infused over 20-24 hours (if you want to be Joe’s best friend, start with 3g/k/day)
- Calculate fluids for approximately 80 mL/k/day to start off with (with meds/boluses, you'll end up giving far more)
- Choose appropriate dextrose concentration to provide glucose infusion rate (GIR) of approximately 4 mg/k/min
- Feeds can be ordered using Neonatal Dietary Nutrition Supplementation- UF

Meds:

- If BW <1 kg, start Indocin for IVH prophylaxis (0.1 mg/k/dose IV daily for 3 days)- write as additional order (if profoundly hypotensive on admission, hold off on Indocin as may need to start steroids)
- Infasurf- 3 mL/k/dose
o Antibiotics as necessary- start with amp/gent (substitute Claforan if suspect renal insufficiency)- we use Neofax guidelines for dosing and frequency. For ampicillin- give 100 mg/k/dose.

o When ordering antibiotics, click on Order specific weight type and enter birthweight (if you don’t, EPIC will adjust med doses every day)

o EES ointment and Vit K

**Respiratory orders:**

o Vent settings (order Mechanical ventilation as additional order- choose SIMV-PC mode (pressure controlled SIMV) for conventional ventilation

o For respiratory wean plan, enter Ventilation weaning parameters as additional order

**Labs:**

o Type and screen (Type & screen)

o CBC with differential, high sensitivity CRP, blood culture

o ABG (iSTAT ABG)

o For infants < 1 kg, we usually order q6 hour lytes to follow hydration (alternate renal batteries (lytes plus Ca/PO4/Mg) with iSTAT labs)- i.e order q12 hour NICU renal battery for 0600 and 1800 and iSTAT sodium, iSTAT potassium for 1200 and 2400.

o Start bilirubin screening at ~12 hours of age (earlier if extensive bruising)- order as Bilirubin total and/or Bilirubin direct

**X-rays:**

o CXR can be ordered by typing CXR (choose XRAY, Chest, Frontal) if need to assess ETT prior to surfactant administration

o Once lines are in, order babygram (type babygram and choose XRAY, Chest, w/Abd, ped <1 yr)

**Additional orders:**

o If BW <1 kg, start cerebral sat monitor (order as Somanetics- Perform near infrared spectroscopy- choose cerebral sat option)

o If BW < 1 kg, order humidity (enter under Nursing communication-under comments, type in “70% mist environment x 7 days”

o Under Notify Physician- “notify NNP if MAPs consistently <30”
The other types of acid have to be excreted by the renal tubules. Buffers are substances that can absorb excessive acid (H+) or base without changing pH significantly. Buffers are available to maintain the pH in normal range even though acids are being added to the body.

The norm for pH is 7.35 - 7.45

2. CO₂ - The gaseous form of carbonic acid, is the product of cellular metabolism. The lungs eliminates the carbonic acid as it combines with the CO₂. The lungs decrease the amount of carbonic acid by blowing off CO₂ and leaving water.

The norm for CO₂ is 35 - 45.

3. Bicarbonate - The major buffering system which operates in the kidneys works in conjunction with the carbonic acid mechanisms of the lungs.

The distal tubule of the kidney regulates acid-base balance by secreting hydrogen into the urine and reabsorbing bicarbonate.

The kidneys regulate bicarbonate by reabsorbing bicarbonate or regenerating new bicarbonate from CO₂ and water. This is a slower process than the elimination or retention of CO₂ in the lungs.

Changes in either system, 1) the lungs in terms of CO₂ removal or 2) the kidneys with bicarbonate regulation, has an effect on pH.

The norm for Bicarb is 20 - 26.

Another measure of base that is read out on the blood gas is the Base Excess/Base Deficit the norm -4 to +4.

Provides a picture of available base not consumed by acid (+ side) or lack of base for free acid (- side).

4. PaO₂ - The partial pressure of oxygen in arterial blood. Oxygen is transported to the blood in two forms dissolved in plasma (small amount) and bound to hemoglobin (large amount).
The alveolar/capillary membrane is ideal for oxygen diffusion because it is so thin and has such a large surface area, and the high concentration of oxygen in the alveoli allows for rapid diffusion across the alveolar/capillary membrane to the lower concentration of oxygen found in the capillary blood. As PaO2 rises, oxygen moves from the plasma into the RBCs and binds with the Hgb, until all the binding sites are filled or saturated. PaO2 provides the driving force that loads the hemoglobin with oxygen.

The norm 50 - 80 mmHg.

PaO2 relates to the amount of oxygen carried in the blood (oxygen content).
O2 content depends on:
1) Hgb
2) oxygen saturation % of blood that is bound to oxygen
3) the maximum amount of oxygen that can be transported per gram of Hgb.

5. Oxygen Saturation - the amount (percentage) of available hemoglobin that is bound with oxygen. Very important parameter that we so often discount because of the annoying alarms.

Provides an important picture of how well the infant is supplying oxygen to the cells.

Pulse oximetry is particularly helpful in monitoring low levels of oxygen, its sensitivity decreases as the PaO2 exceeds 50mmHg or when the oxygen saturation is greater than 90%. For example an infant who has a PaO2 of 33mmHg, may have a sat of 60% and that infant’s PaO2 may increase to 40mmHg and you can see a direct change in the sat up to 72%. But if this infant improves and is sitting with a sat of 100% we have less of an idea of where the baby’s PaO2 lies because regardless of if the PaO2 is 90 or 300 the baby’s saturation will continue to remain 100%. (Remember the oxyhemoglobin dissociation curve? - See diagram). This becomes very important as we manage some neonates because of the problems associated with hyperoxegenation. In the NICU, particularly when caring for the tiny preemie we do not want to keep these infants on respiratory support with saturations of 100%.

The new respiratory guidelines suggests we keep the Nelcor alarms for low and high sats at 88-98% respectively (See NICU respiratory monitoring guideline).
If mildly hypotensive with good cerebral sats/perfusion, may wish to just follow, if not, start dopamine

- Under Nursing section-glucose meter, type in .nicu in comment section and double-click on NICU bedside glucose monitoring

**DOCUMENTATION:**

1) Complete **H&P (SH IP NICU H&P)** - if fellow or attending is filling out, you don’t necessarily need to

2) Complete procedure notes for intubation, UAC and UVC (**NEO PROCEDURE UMBILICAL ARTERY CATETERIZATION, NEO PROCEDURE UMBILICAL VEIN CATETERIZATION**)

3) Complete delivery room note (if you attended delivery)- **SH IP NEWBORN DELIVERY NOTE** and billing sheet

4) Have family sign consents for blood products and NICU procedures (forms must be completed by MD)
PART I:
NEONATAL BLOOD GASES

I. Overview of Basic Concepts

Hydrogen Ion concentration must be regulated within a narrow range of normal for the body to function normally. Slight changes in amounts of hydrogen can significantly alter biologic processes in cells and tissues. Hydrogen Ion is necessary to maintain membrane integrity and speed enzymatic reactions. Most pathologic conditions disturb the acid-base balance and the degree of severity of this imbalance can be more harmful than the disease process itself.

Normal Values for Arterial Blood Gases

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.35 - 7.45</td>
</tr>
<tr>
<td>PaCO2</td>
<td>35 - 45</td>
</tr>
<tr>
<td>PO2</td>
<td>50 - 80</td>
</tr>
<tr>
<td>O2 Sat</td>
<td>90% - 95%</td>
</tr>
<tr>
<td>Bicarb</td>
<td>20 - 26</td>
</tr>
<tr>
<td>Base Excess</td>
<td>-4 - +4</td>
</tr>
</tbody>
</table>

II. Components of a blood gas

1. pH - Expresses the hydrogen ion concentration which represents a negative logarithm of hydrogen ions in solution. What this means is that as the [H+] increases the pH decreases (the more acidic the lower the pH), and as the [H+] decreases the pH increases (the less acidic the higher the pH - more alkaline).

Body acids are normally formed as an end product of cellular metabolism (breakdown/metabolism of proteins, carbohydrates, and fats).

To maintain a normal pH body acids must be neutralized or excreted. The lungs & kidneys are the major organs involved in the regulation of acid-base balance.

Carbonic acid is one of two types of acid produced by the body. Carbonic acid is a weak acid that easily dissociates into CO2 and is eliminated by ventilation.
III. Steps In Interpreting a Blood Gas
A simple review of how to interpret a blood gas includes the following steps (If anyone would like a more in depth review and practice please come see Laura Barba):

1. Evaluate pH – is there acidosis or alkalosis
2. Evaluate PaCO2 value to determine if there is a respiratory component
3. Evaluate the Bicarb or base excess to determine if there is a metabolic component
4. Evaluate the PaO2 to determine if there is hypoxia-hyperoxia

IV. Concepts of Respiratory & Metabolic Acidosis/Alkalosis -
Changes in the concentration of the hydrogen ion in the blood leads to acid-base imbalances.
Acidemia is when pH is less than 7.35.
Alkalemia is when pH is greater than 7.45.
Metabolic acidosis is when there is an abnormal decrease in bicarbonate concentration or an increase in hydrogen ion concentration (Bicarb falls & pH falls).
Metabolic alkalosis is a increase in bicarbonate concentration or an decrease in hydrogen ion concentration (Bicarb rises & pH rises).
Respiratory acidosis occurs when CO2 removal is less than CO2 production (PCO2 rises & pH falls).
Respiratory alkalosis occurs when more CO2 is removed in relation to the amount of CO2 generated (PCO2 falls pH rises).

A. Compensatory Mechanisms – The respiratory system compensates for a change in pH by increasing or decreasing ventilation and the renal system compensates by titrating acids out in the urine and by affecting Bicarb regeneration.

V. Oxygenation & Ventilation

A. Normal Physiology – Steps of 02 delivery and CO2 removal:

Oxygen Delivery: 1) Aeration to the lungs, 2) diffusion of oxygen from alveoli into capillary blood 3) perfusion of systemic capillaries with oxygenated blood 4) Diffusion of O2 (bound to Hemoglobin) from systemic capillaries into the cells.

Carbon Dioxide Removal: 1) Diffusion of CO2 from the cells into systemic capillaries, 2) perfusion of the pulmonary capillary bed by venous blood, 3) diffusion of CO2 into alveoli, 4) removal of CO2 from lung via ventilation.

Effective gas exchange depends on an approximately even distribution of gas (ventilation) and blood (perfusion) in all portions of the lungs.
VI. Blood Gas Interpretation:
Acceptable Deviations From the Norm based on Diagnosis

A. Respiratory Distress Syndrome - PaO2 50-90 mmHg, PaCO2 40-55 mmHg, Bicarb 18 - 24, and pH at least 7.25.

B. Persistent Pulmonary Hypertension of the Newborn - Two Approaches
1. Hyperventilatory Approach - Respiratory Alkalosis and hyper-oxygenated during the initial phase of the disease process. PaO2 >100, PaCO2 <40, Bicarb >24, and pH >7.5.
2. Non-hyperventilatory approach (gentle ventilation) may also be utilized in this population of infants. When this approach is utilized a PaO2 of 50-90, PaCO2 of 40-50, and 7.30-7.45 are acceptable.

C. Chronic Lung Disease/Bronchopulmonary Dysplasia - Keeping saturation 85-95%. Best method of evaluating oxygenation since obtaining gases causes these infants pain which causes the infants to drop their PaO2. Keep PaO2 50 - 80. Still need occasional gases to assess pH and CO2. Accept CO2 higher 45-60 as long as pH remains at least 7.3.

VII. Types of Blood Gases and Interpretation -
Usually only consider ABGs but we can use other types of blood gases to gain information about our patients. But we need to understand how to interpret the information we obtain.

A. Arterial Blood Gas - Provides a direct analysis of measured pH, PCO2, and PaO2, and calculated Bicarb/Base, and oxygen saturation, that is used to assess acid-base balance and oxygenation.

B. Venous Blood Gas - From UVC can provide some information regarding oxygen consumption. Can also be used to assess pH.

C. Capillary Blood Gas - controversial - some feel it provides information on pH and CO2 that is adequate to use for a spot check. More reliable than venous gas for pCO2 and pH if heel is warmed, perfused, and properly collected.
PART II
HOW SUPPLEMENTAL RESPIRATORY SUPPORT AFFECTS THE NEONATAL BLOOD GAS

Now that we have reviewed the blood gas information in this module we will now explore how we manage infants receiving supplemental respiratory support in the NICU.

I. The Ventilated Patient:

The most common method of mechanical ventilation in the neonate are time cycled, pressure limited, continuous flow devices. The general characteristics include a continuous flow of heated humidified gas (a mixture of air with oxygen) that is circulated past the infant’s airway. Advantages include the fact that the infant is able to make spontaneous respiratory efforts between ventilator breaths and this method provides for good control of respiratory pressures. Some disadvantages include the fact that tidal volume is poorly controlled, the system does not change with changes in lung compliance, and infants can breath out of phase "fighting the ventilator" and therefore receive inadequate ventilation. This type of ventilation is useful in any form of lung disease in infants weighing <10 kg. As you are aware the ventilation incorporates:

A. FiO2 - Fraction of inspired oxygen - the concentration of oxygen delivered by the ventilator. This parameter directly affects the infants PaO2. The goal is to maintain adequate oxygen delivery to the tissues.

B. IMV/Rate - Intermittent mandatory ventilation - Reflects how often a volume of gas in the system is delivered to the infant. It is expressed by breaths per minute. This directly affects the CO2 (increasing rate decreases CO2 and vice versa) and this can effect pH.

C. Peak inspiratory pressure (PIP) - reflects the maximal amount of positive pressure delivered to the infant on inspiration. This can effect both oxygenation (increasing PaO2) and ventilation (decreasing CO2). Increasing PIP can increase the risk of barotrauma, air leaks, and bronchopulmonary dysplasia.

D. Continuous Positive Airway Pressure (CPAP) is a term that used interchangeably in this institution with the term Positive End Expiratory Pressure (PEEP) - provides continuous distending pressure. This increases alveolar stability, functional residual capacity, and intrathoracic pressure. CPAP also decreases the risk of atelectasis and prevents fluids within the capillaries in the pulmonary vasculature from leaking into alveolar spaces, thereby preventing or treating pulmonary edema. CPAP can affect oxygenation (increasing PaO2). Due to the fact that tidal volume is a function of the difference between PIP and CPAP, a reduction
in CPAP may improve ventilation (CO2 removal). CPAP is usually set at 4-5cm H2O and may go as high as 8-9cm H2O. Increasing CPAP higher decreases cardiac output and may decrease tidal volume and therefore is of little benefit for most of the patients for which we care.

E. Inspiratory/expiratory ratio (I/E ratio) - reflects the time spent in inspiration and expiration. Prolonged inspiration may be associated with more efficient ventilation and optimal arterial oxygenation but also a higher risk of air leak. Prolonged expiratory times can also improve oxygenation, especially in air-trapping conditions.

F. Mean Airway Pressure (MAP) - the amount of pressure transmitted to the airway throughout an entire respiratory cycle and is reflected by the average area under the curve of a pressure waveform. Any change in ventilator settings affects the mean airway pressure. MAP is most affected by changes in CPAP, PIP, flow rate, and I/E ratio. MAP is associated with optimal oxygenation and ventilation when pressures range between 6 and 14 cm of water. Levels of MAP above 20cm H2O are associated with impeding venous return and adversely affecting cardiac output.

II. High Frequency Ventilation (HFV)

Two types used at Shands:
1) Oscillators (HFO)
2) Jet (HFJ)

These ventilators deliver extremely high rates, commonly around 10 to 15 Hertz (Hertz is a unit of frequency equal to one cycle per second). The goal is to reduce barotrauma or reduce the progression of injury in infants with pulmonary air leak syndrome (pulmonary interstitial emphysema - PIE and/or pneumothorax). HFV differs from conventional modes in that the tidal volumes delivered are much smaller (smaller than the dead space) utilizing supraphysiologic frequencies which allows for lower intrathoracic pressures. Gas flow and exchange are different than with traditional lung mechanics and are thought to be related to augmented diffusion. Barotrauma is reduced because a small pressure amplitude is utilized around the mean airway pressure in the distal airway. This mode of ventilation is very effective at CO2 removal but not very useful if oxygenation is a major problem.

Jet ventilators deliver short bursts of high flow gases directly in the proximal airway via a small cannula and have a passive exhalation cycle. Oscillators vibrate columns of air and have an active exhalation cycle.

At Shands the "Infant Star" ventilators can provide oscillation. This method of HFV has become more popular than Jet ventilation due to its ease of use (not having to change out the endotracheal tube) and because Jet ventilation has been associated with necrotizing tracheitis.
III. Synchronized Intermittent Mandatory Ventilation (SIMV) 
Mode of ventilatory support that attempts to synchronize the 
intermittent mandatory ventilatory breaths with the infant’s own 
spontaneous breaths. The ventilator is triggered by the infant’s 
own initiation of a breath and at that time a ventilator breath is 
given. The ventilator may still use a time cycled, pressure 
limited, continuous flow devices allowing only a specific number of 
ventilator breaths per minute which are synchronized with some of 
the infant’s spontaneous breaths. The infant may have additional 
spontaneous breaths around the SIMV that are not accompanied with 
the ventilator.

VII. Weaning from the Ventilator - the goal is to decrease 
ventilatory support while providing physiologic oxygen delivery and 
acid-base balance for cellular metabolism. In other words, we want 
to wean so that the infant maintains a normal (acceptable) blood 
gas.

We usually attempt to decrease barotrauma and oxygen toxicity 
by weaning PIP and FiO2 initially based on the infant’s PaO2, and 
also wean IMV as tolerated dependant on the infant’s CO2.

Weaning the infant from the ventilator is a collaborative 
effort of the respiratory therapist, physician/practitioner, and 
bedside nurse based on a written plan (See new Respiratory Wean 
Plan).

VIII. Other methods of Respiratory Support Utilized in the NICU:

A. Nasal CPAP - same principle as described earlier when 
   discussing endotracheal CPAP with conventional ventilation. 
   Provides distending pressure which improves oxygenation and reduces 
   atelectasis (see above).

B. Nasal Cannula - provides supplemental oxygen to improve 
   oxygenation. Delivery of oxygen is described in terms of flow (cc 
   & liters of oxygen) of 100% oxygen. The concentration of oxygen 
   available to the infant is dependent on the infants respiratory 
   rate, the amount of flow, and how much the oxygen is being mixed 
   with room air (Is the baby’s mouth open?).
BLOOD GAS INTERPRETATION

1. CO₂ - RESPIRATORY COMPONENT  
   < 35 ALKALOSIS  
   > 45 ACIDOSIS

2. BASE - METABOLIC COMPONENT  
   (-3 TO 3 WNL)  
   < -3 ACIDOSIS  
   > 3 ALKALOSIS

3. pH - 7.4 AS NL - TELLS WHIS WAS FIRST, THEREFORE COMPENSATED BY THE SECOND IF BOTH PRESENT  
   < 7.4 ACIDOSIS  
   > 7.4 ALKALOSIS

SODIUM BICARB DOSAGE

mEq NaHCO₃ = 1/2 (0.3 x KG x BASE DEFICIT)

HIGH-FLOW BLENDED NASAL CANNULAS

PURPOSE:  
(1) AS AN ALTERNATE MEANS OF PROVIDING CPAP WITHOUT THE TRAUMA ASSOCIATED WITH OUR PRESENT NASAL CPAP SYSTEMS  
(2) AS A BRIDGE BETWEEN MECHANICAL VENTILATION AND CONVENTIONAL NASAL CANNULAS (ESPECIALLY FOR INFANTS < 1000 GMS AND THOSE PRONE TO A/B)

PROCEDURE:

(1) EXTUBATE INITIALLY TO (1) LITRE/MINUTE NASAL CANNULA FLOW, TITRATING FIO₂ TO MAINTAIN SATS WITHIN NORMAL LIMITS

(2) OBSERVE PATIENT FOR EVIDENCE OF RESPIRATORY DISTRESS

(3) IF RESPIRATORY STATUTUR STABLE, WEAN AS FOLLOWS:

   A. TITRATE FIO₂ CONTINUOUSLY TO MAINTAIN NL SATS

   B. EVERY 3 DAYS, WEAN NC FLOW BY INCREMENTS OF 200-250 CC/MINUTE TO MINIMUM FLOW OF 200-250 CC/MINUTE

   C. IF STABLE ON 250 CC/MINUTE FLOW X 3 DAYS, CHANGE TO CONVENTIONAL (NON-BLENDED) NC AND WEAN NORMALLY

(4) IF AT ANY POINT DURING THE WEANING PROCESS, INFANT DEVELOPS RESPIRATORY DISTRESS, BACKWEAN TO PREVIOUSLY TOLERATED FLOW AND NOTIFY H.O.

PRECAUTIONS

(1) SUCTION NARES PRN

(2) (8) FR. FEEDING TUBE TO ELEVATED SYRING TO PROVIDE MEANS OF GASTRIC DECOMPRESSION

(3) ONE GTT NS TO NARES Q 8 HOURS TO LOOSEN SECRESTIONS
High-Frequency Oscillatory Ventilation (HFOV)

HFOV is a technique for maintaining effective gas exchange with lower tidal volumes and lower peak airway pressures than those usually employed with mechanical ventilation. This may reduce airway distension during tidal ventilation and potentially reduces airway injury. Basically, HFOV is a CPAP device with a special technique for removing CO2.

Complications: Include tracheal injury, pulmonary hyperinflation, and air leak. Overdistension of the lung with impairment of thoracic venous return could increase risk of IVH in preterm infant.

Indications: 1. Babies 34wk or more gest. with severe respiratory failure who are at high risk for requiring ECMO.
   2. Management of severe, acute lung disease. HFOV is recommended when conventional Vent PIP reaches or exceeds 30cm or MAP exceeds 12-14cm H2O range (10cm H2O in babies <1000g). This strategy attempts to minimize peak airway pressures applied to the lung.
   3. Babies with severe air leak syndrome producing persistent hypoxemia despite conventional fast-rate ventilation with short inspiratory time.

Initial settings: Set Hz 15 for small babies. Set Hz 10 for bigger babies MAP at approx. 2 > current MAP on conventional vent.
Increase Amp. until baby shakes.
Adj. O2 as needed.

Control of Ventilation (Pc02): Increasing the Amp. improves ventilation and lowers Pc02. If Pc02 remains excessive despite max Amp. the frequency may be reduced to 10 Hertz. If Ventilation is excessive (Pc02 too low); lower Amp.

Control of Oxygenation (P02): Oxygenation is managed by changes in mean airway pressure (Paw). Increasing MAP improves Po2. The general strategy is to recruit and maintain normal lung volume using relatively high MAP during acute phase of lung disease. MAP is weaned as the disease process improves. Average MAP is 11-19cm H2o. When adequate
oxygenation occurs, concentrate on weaning FiO2. When FiO2 falls below 60% to 70%, begin to wean MAP 1-2cm H2O decrements.

Hertz: High frequency ventilation rate (Hz= cycles per second, i.e 10Hz= 10 cycles/sec = 600 cycles/min.

Inhaled Nitric Oxide (iNO): Nitric Oxide produced primary relaxation of vascular smooth muscle. When inhaled, the gas becomes selective pulmonary vasodilator. It appears to increase PaO2 by dilating vessels in better-ventilated parts of the lung, thus allowing redistribution of blood flow from regions with low ventilation/perfusion (V/Q) ratios or a reduction in shunting. It combines with hemoglobin and is rapidly converted to methemoglobin and nitrate. As a result, there is no effect on systemic vascular resistance or blood pressure. Approx. 70% of the inhaled dose is excreted in urine as nitrate.

Indications for Use:
Term and Preterm infants: Improves oxygenation and reduce the need for ECMO in babies 34wks. or more who have disorders that produce acute hypoxic respiratory failure. Those disorders include: PPHN, PPHN secondary to MAS, neonatal pneumonia or sepsis, or RDS.

Initiation of therapy is recommend if a patient 34 or more weeks’ gest. on mechanical ventilation has an oxygen index (OI) of at least 25 on two separate measurements.

OI: MAP x FiO2 / PaO2 x 100

iNO is administered via the ventilator circuit at an initial dose of 20ppm. Response to therapy is defined as a change from baseline Pa2 of at least 10-20mmHg.

\[
OI = \frac{FiO2 \times MAP}{PaO2}
\]
Shands' Protocol:

1. Start NO 20ppm for pt with documented PPHN by ECHO for hospitalized patient or preductal sat-postductal sat diff. of 8% in transport patients and OI >30.
2. If OI does not drop by 5 after 30min. of NO, increase to 40 PPM.
3. If after 2hrs. of NO (90 min. at 40ppm) OI does not drop by 5, then this is evidence of NO failure. NO should be dc'd if the pt. is not an ECMO candidate. If he/she is an ECMO candidate, further use until cannulated is appropriate.
4. If pt. has a pos. response to NO as documented by a drop in OI of > 5, then after 4hrs., decrease NO concentration by 50%, then another 50% 4hrs. later to 5PPM (or 10PPM if required 40PPM as described above. These will serve as resting NO settings.
5. Every 24hrs., attempt to decrease NO by 50% to low of 1PPM.
6. When patient is stable on Fio2 of 75%, attempt to discontinue NO use. If OI is > 30, consult Peds surgery for possible ECMO and proceed with pre-ECMO orders. Call radiology for HUS and cardiology for ECHO.

Other weaning protocol:
If response to treatment occurs, begin weaning Fio2. When Fi02 weaned to 60% or less and pt. has been stable for 4-6hrs., attempt wean iNO Does should be reduced from 20ppm to 10 to 5ppm over 12-24hrs as tolerated. When dosage of 5ppm is reached, further reductions should occur in decrements of 1ppm every 1-2hrs. Wean with caution, even in patients exhibiting no response to iNO because precipitous deterioration in oxygenation has been reported during weaning at these levels. In infants treated for more than a few days, expect a small increase in O2 requirement when iNO is dc'd. This is not an indication for re-initiate iNO.
High frequency oscillatory ventilation (HFOV) is a type of mechanical ventilation that uses a constant distending pressure (mean airway pressure [MAP]) with pressure variations oscillating around the MAP at very high rates (up to 900 cycles per minute). This creates small tidal volumes, often less than the dead space. In conventional ventilation large pressure changes (the difference between PEEP and PIP) create physiological tidal volumes and gas exchange is dependent on bulk convection (expired gas exchanged for inspired gas). HFOV relies on alternative mechanisms of gas exchange such as molecular diffusion, Taylor dispersion, turbulence, asymmetric velocity profiles, Pendelliuf, cardiogenic mixing and collateral ventilation. 1 The large pressure changes and volumes associated with conventional ventilation have been implicated in the pathogenesis of ventilator induced lung injury (VILI) and chronic lung disease (CLD). 2 Animal studies suggest that HFOV may reduce lung injury. 3 At present HFOV is only indicated as a rescue therapy.

1 Failure of conventional ventilation in the term infant (Persistent Pulmonary Hypertension of the Newborn [PPHN], Meconium Aspiration Syndrome [MAS]). 4, 5 NB: The evidence for HFOV in term infants with severe pulmonary dysfunction is not strong. 6

2 Air leak syndromes (pneumothorax, pulmonary interstitial emphysema [PIE]) 7

3 Failure of conventional ventilation in the preterm infant (severe RDS, PIE, pulmonary hypoplasia) or to reduce barotrauma when conventional ventilator settings are high.

HFOV is not as yet proven to be of benefit in the elective or rescue treatment of preterm infants with respiratory dysfunction and may be associated with an increase in intraventricular haemorrhage. 8 Furthermore, caution is needed when HFOV is used as high airway pressures may result in impaired cardiac output causing hypotension requiring inotropic support or volume expansion. Some infants poorly tolerate the extra handling involved in switching ventilators or may not respond to HFOV. If there is no improvement with HFOV, consider reverting to conventional ventilation.

In this unit HFOV will only be delivered using the SensorMedics Oscillator.

Terminology
Frequency  
- High frequency ventilation rate (Hz = cycles per second, i.e. 10Hz = 10 cycles/sec = 600 cycles/min)

MAP  
- Mean airway pressure (cmH2O)

Amplitude  
- delta P or power is the variation around the MAP

Oxygenation  
- Oxygenation is dependent on MAP and FiO2. MAP provides a constant distending pressure equivalent to CPAP. This inflates the lung to a constant and optimal lung volume maximising the area for gas exchange and preventing alveolar collapse in the expiratory phase.

Ventilation  
- In HFOV oxygenation can be separated from ventilation as they are not dependent on each other as is the case with conventional ventilation. Ventilation or CO2 elimination is dependent on amplitude and to a lesser degree frequency.

Initial settings on HFOV

Optimal lung volume strategy  
- Set MAP 2-3 cmH2O above the MAP on conventional ventilation
- MAP in 1-2 cmH2O steps until oxygenation improves
- Set frequency to 10 Hz
- Consider recruitment manoeuvres after discussion with consultant

Low volume strategy  
- Set MAP equal to the MAP on conventional ventilation
- Set frequency to 10 Hz
- Adjust amplitude to get an adequate chest wall vibration.

Obtain an early blood gas and adjust settings as appropriate.
Obtain chest radiograph to assess inflation

Making adjustments once established on HFOV

<table>
<thead>
<tr>
<th>Poor Oxygenation</th>
<th>Over Oxygenation</th>
<th>Under Ventilation</th>
<th>Over Ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase FiO2</td>
<td>Decrease FiO2</td>
<td>Increase Amplitude</td>
<td>Decrease Amplitude</td>
</tr>
<tr>
<td>Increase MAP*</td>
<td>Decrease MAP</td>
<td>Decrease Frequency** (1-2Hz) if Amplitude Maximal</td>
<td>Increase Frequency** (1-2Hz) if Amplitude Minimal</td>
</tr>
<tr>
<td>(1-2cmH2O)</td>
<td>(1-2cmH2O)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Consider recruitment manoeuvres - discuss with consultant
** Changes in frequency should only be made in discussion with attending Neonatologist+

Chest Radiograph

- Initial chest radiograph at 1-2 hrs to determine the baseline lung volume on HFOV (aim for 8 ribs).
- A follow-up chest radiograph in 4-6 hours is recommended to assess the expansion.
- Thereafter repeat chest radiography with acute changes in patient condition.

Weaning
Weaning

Reduce FiO₂ to <40% before weaning MAP (except when over-inflation is evident). Reduce MAP when chest radiograph shows evidence of over-inflation (>9 ribs). Reduce MAP in 1-2cm H₂O increments to 8-10 cm H₂O. In air leak syndromes (low volume strategy), reducing MAP takes priority over weaning the FiO₂. Wean the amplitude in 2-4cm H₂O increments. Do not wean the frequency. Discontinue weaning when MAP 8-10 cm H₂O and Amplitude 20-25. If infant is stable, oxygenating well and blood gases are satisfactory then infant could be extubated to CPAP or switched to conventional ventilation. Discuss with consultant.

Suctioning

Suction is indicated for diminished chest wall movement (chest wobble), elevated CO₂ and/or worsening oxygenation suggesting airway or ET tube obstruction, or if there are visible/audible secretions in the airway. Avoid in the first 24 hours of HFOV, unless clinically indicated. In-line suctioning must be used (see Suction Protocol for full procedure). Press the STOP button briefly while quickly inserting and withdrawing suction catheter (PEEP is maintained).

References

NICU Nutrition Guidelines
Less than 1250gm Babies

Total Fluid Intake
- Initiate immediate IV access with Day 0 HAL
  - Switch Day 0 HAL to UAC/UVC or PICC route after placement
- Initiate: 80-100ml/kg/d
  - Can piggyback additional fluids if greater than 100ml/kg/d is needed
- Advance: 10-20ml/kg/d
- Goal: 130-150ml/kg/d

HAL
- Initiate Day 0 HAL on day of birth.
  - Less than 1000gm
    - D7.5% 9.4gm AA
    - 0.5gm Calcium Gluconate
    - No electrolytes needed on DOL 0 other then calcium gluconate
    - GIR - adjust according to blood glucose levels
      - GIR less than 4 is not recommended
  - Greater than 1000gm
    - D10% 9.4gm AA
    - 0.5gm Calcium Gluconate
    - No electrolytes needed on DOL 0 other then calcium gluconate
    - GIR – adjust according to blood glucose levels
      - GIR less than 4 is not recommended

- Dextrose
  - Initiate GIR of 6-8mg/kg/min
  - Advance GIR by 1-2mg/kg/min daily
  - Goal 10-12mg/kg/min
    - Max GIR 12mg/kg/min
      - Certain exceptions may be considered to exceed a GIR of 12mg/kg/min-i.e. refractory hypoglycemia; infant of a diabetic mother

- Amino Acid (Trophamine)
  - Initiate: 3-4gm/kg/d 
  - Goal: 3-4gm/kg/d
    - Max Amino Acid: 4gm/kg/d

- Lipids
  - Initiate: 3gm/kg/d
  - Goal: 3gm/kg/d
    - Max lipids: 3.5gm/kg/d
  - Maintain a continuous infusion of lipids over 24hours
    - May need to window lipids to provide additional medications
- If needing to window IL, run as long as possible
  - Maximum of 50% of calories should come from lipids

- **Electrolytes**
  - Range and Standard doses – **adjusted daily per lab results**

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>Day 1-2</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>2-5 mEq/kg/d</td>
<td>2-4 mEq/kg/d</td>
</tr>
<tr>
<td></td>
<td>4.6-11.5mg/kg/d</td>
<td>4.6-9.2mg/kg/d</td>
</tr>
<tr>
<td>Potassium</td>
<td>0-2 mEq/kg/d</td>
<td>2-3 mEq/kg/d</td>
</tr>
<tr>
<td></td>
<td>0-7.8mg/kg/d</td>
<td>7.8-11.7mg/kg/d</td>
</tr>
<tr>
<td>Chloride</td>
<td>2-7 mEq/kg/d</td>
<td>2-7 mEq/kg/d</td>
</tr>
<tr>
<td></td>
<td>7.1-24.85mg/kg/d</td>
<td>7.1-24.85mg/kg/d</td>
</tr>
<tr>
<td>Acetate</td>
<td>as needed</td>
<td>as needed</td>
</tr>
</tbody>
</table>

- **Minerals**

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Day 1-2</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>2-3 mEq/kg/d</td>
<td>3 mEq/kg/d</td>
</tr>
<tr>
<td></td>
<td>4-6mg/kg/d</td>
<td>4-6mg/kg/d</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>1.3-2 mM/kg/d</td>
<td>1.3-2 mM/kg/d</td>
</tr>
<tr>
<td></td>
<td>4.02-6.19mg/kg/d</td>
<td>4.02-6.19mg/kg/d</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.2-0.3 mEq/kg/d</td>
<td>0.2-0.3 mEq/kg/d</td>
</tr>
<tr>
<td></td>
<td>0.24-0.36mg/kg/d</td>
<td>0.24-0.36mg/kg/d</td>
</tr>
<tr>
<td>Iron</td>
<td>none</td>
<td>2-3 mEq/kg/d**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.6-8.4mg/kg/d**</td>
</tr>
</tbody>
</table>

  - Acetate can be administered as sodium or potassium acetate as needed, especially in the preterm infant
  - **Iron** is not typically needed to be added to TPN. However, the reference ranges are listed above if a patient is on long term TPN and labs and clinical findings indicate the need for iron supplementation.

- **Trace Elements**
  - Dosing: 0.21ml/kg/d

<table>
<thead>
<tr>
<th>Trace Elements</th>
<th>Contents per 1ml:</th>
<th>Contents per 0.21ml:</th>
<th>Target for weight:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium</td>
<td>1mcg</td>
<td>0.21ml</td>
<td>0.1mcg/kg/d</td>
</tr>
<tr>
<td>Copper</td>
<td>100mcg</td>
<td>21mcg</td>
<td>20mcg/kg/d</td>
</tr>
<tr>
<td>Manganese</td>
<td>50mcg</td>
<td>10.5mcg</td>
<td>1mcg/kg/d</td>
</tr>
<tr>
<td>Selenium</td>
<td>6mcg</td>
<td>1.26mcg</td>
<td>1.2-2mcg/kg/d¹</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.5mcg</td>
<td>105mcg</td>
<td>400mcg/kg/d</td>
</tr>
<tr>
<td>Iodine</td>
<td>5mcg</td>
<td>1.05mcg</td>
<td></td>
</tr>
</tbody>
</table>

For infants older than 28 days:
**Cholestatic TPN**
Above trace elements will be given on Mondays and Thursdays
All other days the following will be provided
Zinc 250mcg/kg/d
Chromium 0.15mcg/kg/d

- Vitamin Supplementation
  o Per current TPN sheet

<table>
<thead>
<tr>
<th>Vitamin Dosing</th>
<th>Less than or equal to 1kg</th>
<th>Less than or equal to 3kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascorbic Acid</td>
<td>32mg</td>
<td>52.8 mg</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>920 USP</td>
<td>1520 USP</td>
</tr>
<tr>
<td>Ergocalciferol</td>
<td>(Vitamin D)</td>
<td></td>
</tr>
<tr>
<td>Thiamine (B1)</td>
<td>0.48 mg</td>
<td>0.79 mg</td>
</tr>
<tr>
<td>Riboflavin (B2)</td>
<td>0.56 mg</td>
<td>0.92 mg</td>
</tr>
<tr>
<td>Pyridoxine (B6)</td>
<td>0.4 mg</td>
<td>0.66 mg</td>
</tr>
<tr>
<td>Niacinamide</td>
<td>6.8 mg</td>
<td>11.2 mg</td>
</tr>
<tr>
<td>Pantothenic Acid</td>
<td>2 mg</td>
<td>3.3 mg</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>2.8 USP</td>
<td>4.6 USP</td>
</tr>
<tr>
<td>Biotin</td>
<td>8 mcg</td>
<td>13 mcg</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>56 mcg</td>
<td>92.4 mcg</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>0.4 mcg</td>
<td>0.66 mcg</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>80 mcg</td>
<td>132 mcg</td>
</tr>
</tbody>
</table>

Enteral feeds- See algorithm
- Initiate on DOL 0, when stable, prefer within 4-6 hrs of birth
- Nursing initiates to get mom pumping within 1hr of delivery
- Prefer breastmilk
  o If not available: preterm infants: SSC/EPF; term infants: Sim/Enf 20
  o There is no evidence to support supplementing with Donor Breastmilk until mom’s milk comes in
- Assessing tolerance
  o Gastric residuals
    ▪ Greater than 50% of the 3hr feeding volume
    ▪ Marked or persistent increase from normal residual volume
    ▪ Trophic feeds- can anticipate the residual amount to be the same as the feeding volume due to gastric secretions. If residual is non-bilious, can re-feed as part of the total feeding volume
  o If clinical signs appear, such as: abdominal distention/tenderness, visible bowel loops, emesis- evaluate (see algorithm)
- Feeding Intolerance
  o Stop light Classification
    ▪ Green light: safe to feed
- Mild: clinical signs but no bloody stools and normal x-ray
  - Yellow light: Hold feeds and evaluate
  - Moderate: clinical signs, no bloody stools but non-reassuring x-ray
  - Red light: requires surgical consultation, antibiotics, and NPO status
    - Severe Clinical: clinical signs, bloody stools, abnormal x-ray with pneumatosis, gasless abdomen, fixed loops and or systemic manifestations
    - Severe Surgical: All of the above plus free intraperitoneal air or portal gas

- Minimal Enteral Nutrition Phase
  - Initiate at a rate of less than or equal to 20ml/kg/d
  - Can keep minimal enteral nutrition for up to 3-5 days without advancing, may consider slowly advancing over 5 days

- Advancing Phase:
  - Advance by up to 20ml/kg/d and as tolerated
  - As advance feeds decrease TPN/IL accordingly.
    - Discontinue lipids when enteral feeds reach 80ml/kg/d
    - Discontinue TPN when enteral feeds reach 100-120ml/kg/d

- Fine Tuning Phase
  - Fortify breastmilk with Human Milk Fortifier:
    - When TPN discontinued, fortify breastmilk to 22kcal/oz
      - Fortifying to 22kcal/oz with HMF- add 1 packet of HMF to 50ml of EBM
      - When enteral feeds reach 140-150ml/kg/d, fortify to 24kcal/oz
        - Fortifying to 24kcal/oz with HMF- add 1 packet of HMF to 25ml of EBM
  - Other products that can be used to supplement feeds:
    - Increasing concentration of formula
      - Ex SSC 24cal/oz, SSC 27cal/oz, SSC 30kcal/oz
    - Beneprotein
      - Used on case by case basis in which additional protein is needed
      - If BUN is less than 5:
        - And breastmilk is already fortified, can add additional protein to increase intake
        - If formula fed- consider increasing to a high protein formula such as SSC high protein before adding additional protein powder
      - Not to be added if a pt is on a semi-elemental or elemental formula- this will change the formulation of the formula- it will no longer be semi-elemental or elemental
- Polycose
  - Used on a case by case basis
  - Can be used to increase carbohydrate intake in patients with persistent hypoglycemia (ex. Premature infants w/ poor glucose stores)
- MCT oil
  - Used on a case by case basis
  - Adds calories from fat
  - Can be used in patients with GI issues or not wanting to increase osmolality in formula
  - Example- pt w/ high ostomy output on concentrated formula, can decrease formula concentration and add MCT oil then assess tolerance
- Corn Oil
  - Used on a case by case basis
  - Adds calorie from fat
  - Would prefer to increase concentration for a better macronutrient distribution prior to adding additional fat

  - When considering adding additional supplements to increase calories, protein or fat in a patient's formula regimen, contact the team's dietician. They will review the patient's case and determine the most appropriate way to increase calories for that particular patient.

  - Vitamin/Mineral Supplementation
    - When pt is tolerating full feeds, initiate MVI w/ iron to supplement vitamin and mineral intake
      - MVI w/ iron dosing: 2mg/kg/d or MVI 1ml/d
    - Mix into formula, split into separate doses due to high osmolarity
  - Feeding Controversies: (if the gut works, use it)
    - **Enteral feeds and indomethacin:** There is no evidence that the administration of indomethacin prevents from feeding the preterm infant. We recommend continuing feeding during indomethacin administration if there is no other contraindication. Some reports of bowel perforation with the use of indomethacin and high dose hydrocortisone.
    - **Holding feeds for gastric residuals:** There is no evidence that gastric residuals are useful or prevents any complications such as NEC. We recommend to continue feeding if the residuals are non-bilious and if there is no other manifestation of severe intolerance. See algorithm.
    - **Mode of Feeding:** Bolus vs continuous. There is no evidence that continuous feeding is superior to bolus feeding or vice-versa. But, certain patients may benefit from continuous feeding in cases of severe intolerance or severe GERD. The prefer mode of feeding is bolus because is thought to stimulate in a more physiologic way the
gastrointestinal motility as well as the secretion of intestinal hormones and enzymes.

- **Transpyloric Feeds**: The review of trials found that babies receiving transpyloric tube feeding had more adverse effects, without any evidence of any increased benefit over gastric tube feeding.
Feeding Algorithm for less than 1250g

Selection of Milk:
- Human milk is the best source of nutrient for all infants
- If human milk is not available use Preterm formula 24cal/oz
- Add human milk fortifier when tolerating 100ml/kg/d (for 22cal/oz 1 pack per 50ml 24cal/oz 1 pack per 25ml)
- Increase volume and/or concentration usually one at a time
- If poor weight gain less than 15g/d consider fortification or concentration with MCT oil, corn oil, HMF, beneprotein, polycose
  (Consult with the NICU Dietitian for best recommendation)
- If unfortified breast milk give iron 2mg/kg/d or MVI 1ml/d

Abdominal x-ray free air (portal gas, free intraperitoneal air)
  Severe Surgical
  Peds Surgery Consult
  yes

KUB x-ray or babygram (consider left lateral decubitus) if gasless/pneumatosis fixed dilated loops/fibers pattern/no free air and/or bloody stools
  Severe Clinical
  no

Hold feeds, Lab analysis as indicated (minimum CBC, CRP) gastric decompression, antibiotics for 7 to 10 days (ampicillin+gentamicin)

No bloody stools but non-reassuring x-rays with questionable pneumatosis and not free air
  no

Hold feeds and re-evaluate in the next hours to 24h
  improvement

Reinitiate feeds

Abdominal distention/emacsisis/dyscoloration/tenderness and gastric residual more than 50% of the feeding volume or bilious residual with clinical symptoms
  yes

Evaluate feeding tolerance every 3 hours

Initiate feedings with EBM or Preterm Formula within the first hours of life along with Day Zero HAL after establishing an IV access

Provide up to 20 ml/Kg/day trophic feeds via NG/OG tube in combination with parenteral nutrition support as per clinical team discretion

Keep advancing feeds no more than 20/25g/d and adjust total fluid volume from IVF or PN decrease accordingly

Normal x-ray. Keep feeding. Consider feeds over 30-50 minutes or decrease volume or continuous feeds

Mild

Moderate

No improvement

NEC Risk Levels
- Peds Surgery consultation needed. Definitive NEC.
- Clinical management. Risk of NEC
- Minimal risk for NEC. May need to change feeding strategies.

a Initiation of feedings should not be delayed more than 24-48 hours waiting only for BM availability. For parenteral nutrition see guidelines.

a,b Consider to not initiate feeds in the first 48 hours or give lower volumes in babies that had low APGARS <3 OR HIE stage 2 or 3 or hypotensive

C With trophic feeds expect residuals same amount as feeding volume. Non-bilious residuals should be re-feed as part of total feeding volume

D Metronidazole should be added if Severe Surgical
D5 = 0.17 KCal/CC
D10 = 0.34 KCal/CC
D12.5 = 0.43 KCal/CC
D15 = 0.51 KCal/CC
IL = 2 KCal/CC
MCT OIL = 8 KCal/CC
POLYCOSE = 4 KCal/GM
CORN OIL = 8.4 KCal/CC

DEXTROSE

Mg/KG/MIN = Mg/ML x CC/HR ÷ 60 ÷ Kg
(D5 = 50)

INITIATE < 6 Mg/KG/MIN/CHO
INCREASE BY 2 Mg/KG/MIN/DAY
MAXIMUM 11 - 12 Mg/KG/MIN

FATS - < 60% TOTAL CALS.

LIPIDS ML/D = GM x KG x 5
20% IL = 1 GM/5 ML

BEGIN WITH 0.5 GM/KG/D (5 - 7 DOL)
ADVANCE BY 0.5 GM/KG/D
MAINTENANCE = 3.0 GM/KG/D

** IF UNCONJUGATED BILI IS
> 1/2 EXCHANGE, LIMIT FAT
TO 1 GM/KG/DAY

PROTEIN

INITIATE = 0.5 - 1.0 GM/KG/D
INCREASE BY 0.5 GM/KG/D
MAINTENANCE = 3.0 GM/KG/DD
60 PROTEIN KCALS/KG/D AND
2.5 GM PROTEIN/KG/D
REQUIRED FOR + NITROGEN
BALANCE
80 - 85 NON-PROTEIN KCal/KG/D
AND 2.5 - 3.0 GM PROT/KG/D
ARE REQUIRED FOR NITROGEN
RETENTION AT THE FETAL RATE

NUTRITION

PARENTERAL - DOL 3
80 - 100 KCALS/KG/D
2.5 - 3.0 GMS PROTEIN/KG/D
2.0 - 3.0 GMS FAT/KG/D
(<.25 GM/KG/HR)

ENTERAL - DOL 3 - 10
120 KCAL/KG/D
3.5 - 4 GM PROTEIN/KG/D
**NECROTIZING ENTEROCOLITIS PRACTICE GUIDELINE**

**Gen Signs and Symptoms of NEC**
- Abdominal distention, residuals, bloody stools, abdominal tenderness/erythema

**Gen Symptoms Present?**
- Yes → Physical Exam
- No → Continue Feeding

**Physical Exam**

**PE Abnormal?**
- Yes → 1. Check for signs or Sx compatible with NEC 2. KUB ± LLD
- No → If symptoms warrant this, consider:
  1. Septic Work up with antibiotic therapy, pending culture results
  2. NPO for 2-3 days, with cautious refeeding.

**Systemic Signs or Sx compatible with NEC**
- Apnea, hypotonia, shock, thrombocytopenia, high or low WBC, metabolic acidosis, positive blood culture or peritoneal cultures

**Systemic Signs Present?**
- Yes → 1. Check for signs or Sx compatible with NEC 2. KUB ± LLD
- No → Observe carefully, D/C antibiotics if cultures negative (72 hrs)

**Radiographic Signs of NEC**
- Non-Specific: Distended bowel loops, ileus
- Definitive: Pneumatosis intestinais, intrahepatic portal venous gas, or free air

**Radiographic Signs of NEC**
- Abnormal X-ray?
  - Yes → Red rubber catheter to low intermittent suction: NPO for 7-10 days, antibiotics for 10-14 days, CBC, diff & pts q8-12 hrs x 24 48 hrs; check ABG or Lytes for acidosis; follow KUB and or LLD q 8-12 for 48 hours or until normal.
  - No → D/C Indocin, Consult Peds Surgery

**Deterioration**
- Yes → Consider: Adding Clindamycin, fluid boluses with LR or NS, blood products PRN.
  - Vascular access: consider PAL, reliable venous access. D/C UAC
  - Intubate if needed. Check labs and X-rays q8-8 during acute illness (48 hrs)
- No → Continue current therapy

**Indications for surgery**
- Free air, severe medical NEC, unresponsive to therapy > 24 hrs.
  - Paracentesis yielding brown fluid or bacteria on gram stain has high correlation with necrotic bowel
# Sepsis Guidelines—UF

<table>
<thead>
<tr>
<th>History/symptoms</th>
<th>Immediate Management</th>
<th>Subsequent Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signs of sepsis?</td>
<td>Yes</td>
<td>Determined by clinical response, cultures, and physician judgment.</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Repeat CBC &amp; diff, CRP at 48 hr</td>
</tr>
<tr>
<td>Maternal chorioamnionitis?</td>
<td>Yes</td>
<td>DC home if cultures (-) and labs normal at 48 hrs in healthy appearing infants</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Prolonged therapy if 48 hr labs abnormal</td>
</tr>
<tr>
<td>Maternal GBS prophylaxis indicated?</td>
<td>Yes</td>
<td>Observation in hospital for 24-48 hrs. Write orders for vital signs (Temp/HR/RR) and hands-on nursing assessment q6</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Observation in hospital for 48 hrs. Write orders for vital signs (Temp/HR/RR) and hands-on nursing assessment q6</td>
</tr>
<tr>
<td>Received penicillin, ampicillin or cefazolin ≥4 hr before delivery?</td>
<td>Yes</td>
<td>CBC with manual diff, CRP, blood cultures. Begin vital signs (Temp/HR/RR) and hands-on nursing assessment q6 If labs abnormal, Ampicillin and Gentamicin</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>CBC with manual diff, CRP, blood cultures, at 6 hrs.</td>
</tr>
<tr>
<td>≥37 weeks and ROM &lt;18 hrs? (Inadequate IAP and no risks)</td>
<td>Yes</td>
<td>CBC with manual diff, CRP, blood cultures.</td>
</tr>
<tr>
<td>Either &lt;37 weeks or ROM &gt; 18 hrs?</td>
<td>Yes</td>
<td>Determined by clinical response, cultures, and physician judgment.</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>Repeat CBC, diff CRP at 48 hr if on antibiotics</td>
</tr>
</tbody>
</table>

Adapted from MMWR Nov 19, 2010/Vol 59/No. RR-10 by David J Burchfield, MD, Medical Director of NICU and Donald J Fillipps, MD, Medical Director Newborn Nursery. Reviewed by neonatology and newborn faculty 3/1/11.
UTI Management Protocol

First Uncomplicated UTI
1. IV treatment until sensitivity known
2. May convert to oral Abx after 3-4 days IV
3. Treatment length= 7-10 days
4. Renal U/S after treatment initiated
5. VCUG ONLY if RUS abnormal
6. Late DMSA scan (>6 mo of age)
7. NO prophylaxis

Atypical/Complicated/Recurrent UTI
1. IV treatment through total course, no oral
2. Treatment length= 7-10 days
3. Renal U/S after treatment initiated
4. VCUG after treatment completed
5. Late DMSA scan (>6 mo of age)
6. Prophylaxis only if VUR grade ≥IV
   Prophylaxis- TMP/SMX if >1mo old
   Prophylaxis- Amoxil if <1 mo old
7. Referral to Nephrology as Outpt.

"Typical" Organisms
E. coli
Klebsiella spp.
Enterobacter spp.
Candida spp. in prematures

"Atypical UTI Definition"
Seriously ill- fever, sepsis
Poor UOP, elevated creatinine
Failure to respond to tx <48 hrs
Presence of "atypical" organisms

Other Pearls
No need for f/u cx after tx
Referral only if abn imaging
If VCUG, get prior to d/c
Include DMSA in D/C summ

Antibiotic Choices
Cephalosporins – risk of ESBL and fungus
Amoxicillin – risk of resistance is high
TMP/SMX – risk of bilirubin displacement
Amox/Clav – risk of diarrhea/GI disturbance
Aminoglycosides – risk of accumulation if renal dysfunction or low UOP
Nitrofurantoin – does not treat systemic or blood infections well

Other Tidbits
Antibiotic choices and length of treatment are discretionary
Keep the high rate of resistance to Amox and TMP/SMX in mind
If imaging very concerning or atypical, consider alternate prophylaxis
If using aminoglycosides, use once daily dosing and monitor levels
May use prophylaxis until VCUG obtained if atypical UTI

Created by: C. Young - 2/11
Transfusion Guidelines  
Division of Neonatology-University of Florida  
03/12/96

Purpose: The purposes of these guidelines are multiple and include:  
1) Reduction in the number of transfusions being administered.  
2) Promotion of discussion amongst the clinicians that leads to rational use of blood products.  
3) Promotion of a safe practice plan to be followed by housestaff and nurse practitioners rotating through the nursery services.  
4) Promotion of a consistent approach to transfusions which will allow more timely transfusions to those patients that meet criteria.

Background: Little is known about the optimum amount of blood needed under the various physiological and pathological circumstances encountered during the care of the neonate. The medical literature contains some studies dealing with abatement of certain symptoms with blood transfusions but also contains studies which refute the benefits. We feel that there is a certain minimum blood hemoglobin concentration required for health and this amount probably varies from individual to individual and within individuals from one pathological condition to another. Also, we feel that it is best to avoid the effects of an inadequate hematocrit because our patients may not tolerate these effects as well as older, stronger patients. For this reason, we have included some criteria that encompasses the asymptomatic patient.

Caveat: These are only guidelines, and the actual practice of transfusion may be individualized by the physicians clinical judgment based on such things as parents' desires and attitudes towards transfusions, availability of directed donor blood when requested, religious concerns, advancements in medical knowledge or other extenuating circumstances. These guidelines do not include patients with congenital heart disease or candidates for ECMO therapy.

Transfusion Practice: In general, transfusions will be performed using 15 mL/kg body weight administered over 3-4 hours. Furosemide may be administered concomitantly at the clinicians discretion. Irradiated blood will be used for all patients suspected of DiGeorge Syndrome, especially if they have congenital heart disease and an absent thymus on chest film. 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.

Transfusion Guidelines

Hematocrit <35% and  
1) Patients on positive pressure ventilation with MAP >9 and FiO₂ >40%  
or  
2) Hypotension and/or capillary refill >4 sec

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) O₂ requirement of >200 cc/min (100% cannula) or FiO₂>40% (hi-flow cannula)

Hematocrit < 20%: No symptoms required

15
BAND : POLY RATIO (B:P, I:P)

IMMATURE NEUTROPHILS
MATURE + IMMATURE NEUTROPHILS

ABSOLUTE NEUTROPHIL COUNT (ANC)

(% NEUTROPHILS + % IMMATURE NEUTROPHILS) x WBC

NORMAL RANGE IS 2,500 - 13,000
LESS THAN 1000 IS SUSPICIOUS

ABSOLUTE GRANULOCYTE COUNT (AGC)

(% BASOPHILS + % EOSINOPHILS + % TOTAL NEUTROPHILS) x WBC

LESS THAN 1000 IS SUSPICIOUS
LESS THAN 500 INDICATES AN INABILITY TO FIGHT INFECTION

CORRECTING THE WBC COUNT

TOTAL WBC x 100
NUMBER NRBC'S + 100

PLATELET INFUSION

0.10 U/PLT/KG (PACKED) WILL INCREASE THE PATELET COUNT 30,000

CORRECTING FOR BLOOD IN CSF

RBC IN BLOOD = X
WBC IN BLOOD
RBC IN CSF = Y
Y + 40 = MAX WBCs IN CSF

GRAM +
STREP A, B & D
(CHAINS)
PNEUMO COCCI
STAPH
(CLUSTERS)
AUREUS (+)
EPI (-)

GRAM -
NEISSERIA
(DIPLOID)

COCCI

RODS

LISTERIA
DIPHTHERIA

BACILLUS CEREUS
ANAEROBES
CLOSTRIDIUM

ENTEROBACTERIA
(CLUB SHAPED, PLEOMORPHIC)

KLEBSIELLA, SHIGELLA, PROTEUS
FRAGILIS

SALMONELLA
SERRATEA

CITRROBACTER
ENTEROBACTER

H. FLU
PSEUDOMONAS
Normal WBC range 5,000-30,000 cells/mm³

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 tables, page 15. For BW < 1500 gm, consider the following chart:

<table>
<thead>
<tr>
<th></th>
<th>day 1</th>
<th>day 2</th>
<th>day 3</th>
<th>day 4</th>
<th>day 5</th>
<th>day 6</th>
<th>day 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1000</td>
<td>&gt; 3</td>
<td>&gt; 3</td>
<td>&gt; 3</td>
<td>&gt; 5</td>
<td>&gt; 5</td>
<td>&gt; 7</td>
<td>&gt; 7</td>
</tr>
<tr>
<td>1000-1249</td>
<td>&gt; 5</td>
<td>&gt; 5</td>
<td>&gt; 5</td>
<td>&gt; 7-8</td>
<td>&gt; 8</td>
<td>&gt; 10</td>
<td>&gt; 12</td>
</tr>
<tr>
<td>1250-1499</td>
<td>&gt; 8</td>
<td>&gt; 8</td>
<td>&gt; 8</td>
<td>&gt; 10</td>
<td>&gt; 12</td>
<td>&gt; 12</td>
<td>&gt; 12</td>
</tr>
</tbody>
</table>

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, α-1 antitrypsin level, hepatitis panel, and rule out TORCH infections. Further along in the workup, consider PT, ferritin/transferferritin, qualitative bile acid profile, GI consult and liver biopsy.

**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. Antibiotics. Calculate Oxygen Index (OI).

$$OI = \frac{MAP \times FiO_2}{PaO_2}$$
into the subcutaneous tissue. There is some evidence that phototherapy can produce oxidative injury to cell membranes and DNA, and such injury could have a negative effect on these immature infants. In the Neonatal Research Network study, the average irradiance level was reported as 22 to 23 μW cm⁻² nm⁻¹ and the 'target irradiance level' was 15 to 40 μW cm⁻² nm⁻¹.²⁵

**Effective use of phototherapy**

Phototherapy in most infants <35 weeks of gestation is generally used in a prophylactic mode—the goal being to prevent further elevation of the TSB. The most effective irradiance is delivered by a light source (such as special blue fluorescent lamps or LED systems) that will deliver irradiance predominately in the 430 to 490 nm band.²²,²³ Detailed information on phototherapy use can be found in a recent technical report.²³ If, in spite of phototherapy, the TSB continues to rise, either the irradiance can be increased by bringing the phototherapy lamp closer to the baby (except when halogen or tungsten lights are used) or by increasing the body surface area of the infant exposed to phototherapy (by placing a light source beneath the infant and reflecting material around the incubator or radiant warmer bed). Because there is significant variation in the irradiance measurements provided by commercial radiometers, it is difficult to recommend a specific irradiance level. Nevertheless, when possible, clinician's should use the radiometer recommended by the manufacturer of the phototherapy system and provide sufficient irradiance to prevent an increase in the TSB.

Because of the reported increase in mortality in infants with birth weights 501 to 750 g,²⁵ it seems prudent, at least in infants with birth weights <750 g, to initiate phototherapy at lower irradiance levels and only to increase these levels, or to increase the surface area of the infant exposed to phototherapy, if the TSB continues to rise (see Table 1).

**Exchange transfusion**

Most reports suggest that sick, preterm infants, are more likely than term infants to experience a wide range of serious complications as well as mortality from exchange transfusion.²⁴⁻²⁶ The complications include cardio-respiratory arrest, arrhythmias, thrombosis, thrombocytopenia, hypothermia, necrotizing enterocolitis and infection, among others.²⁴⁻²⁶ Of the total of 25 sick infants who received exchange transfusions at the Children’s Hospital and University of Washington Medical Center in Seattle between 1980 to 1995, 3 (12%) had serious complications and 2 (8%) died, whereas in 81 healthy infants there were no deaths and there was one case of necrotizing enterocolitis.²⁴ Between 1992 and 2002, at two perinatal centers in Cleveland, OH, 15 infants ≤32 weeks gestation, received exchange transfusions and there was one death (7%).²⁶ This infant was a 751-g, 25-week gestation infant with hydrops fetalis, respiratory distress syndrome and pulmonary hemorrhage before the exchange. On the other hand, less serious complications such as thrombocytopenia (38 to 67%) and hypocalcemia (13 to 58%) in very low birth weight infants are quite common.²⁴,²⁶ In a recent study, there were no significant

<table>
<thead>
<tr>
<th>Gestational age (week)</th>
<th>Phototherapy</th>
<th>Exchange transfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 28 0/7</td>
<td>5–6</td>
<td>11–14</td>
</tr>
<tr>
<td>28 0/7–29 6/7</td>
<td>6–8</td>
<td>12–14</td>
</tr>
<tr>
<td>30 0/7–31 6/7</td>
<td>8–10</td>
<td>13–16</td>
</tr>
<tr>
<td>32 0/7–33 6/7</td>
<td>10–12</td>
<td>15–18</td>
</tr>
<tr>
<td>34 0/7–36 6/7</td>
<td>12–14</td>
<td>17–19</td>
</tr>
</tbody>
</table>

This table reflects the authors' recommendations for operational or therapeutic TSB thresholds—bilirubin levels at, or above which, treatment is likely to do more good than harm.²⁵ These TSB levels are not based on good evidence and are lower than those suggested in the recent UK²⁶ and Norwegian guidelines.²⁶ The wider ranges and overlapping of values in the exchange transfusion column reflect the degree of uncertainty in making these recommendations. Use the lower range of the fixed TSB levels for infants at greater risk for bilirubin toxicity; for example, (a) lower gestational age, (b) serum albumin levels <2.5 g/dl, (c) rapidly rising TSB levels, suggesting hemolytic disease and (d) those who are clinically unstable.²⁶ When a decision is being made about the initiation of phototherapy or exchange transfusion, infants are considered to be clinically unstable if they have one or more of the following conditions: (a) blood pH <7.15, (b) blood culture positive sepsis in the prior 24 h, (c) apnea and bradycardia requiring cardio-respiratory resuscitation (bagging and or intubation) during the previous 24 h, (d) hypotension requiring pressor treatment during the previous 24 h, and (e) mechanical ventilation at the time of blood sampling.²⁶

Recommendations for exchange transfusion apply to infants who are receiving intensive phototherapy to the maximal surface area but whose TSB levels continue to increase to the levels listed. For all infants, an exchange transfusion is recommended if the infant shows signs of acute bilirubin encephalopathy (hypertonia, arching, retrocollis, opisthotonus, high-pitched cry) although it is recognized that these signs rarely occur in VLBW infants. Use total bilirubin. Do not subtract direct-reacting or conjugated bilirubin from the total. For infants ≤26 weeks gestation, it is an option to use phototherapy prophylactically starting soon after birth. Use postmenstrual age for phototherapy for example, when a 29 0/7 week infant is 7 days old, use the TSB level for 30 0/7 weeks. Discontinue phototherapy when TSB is 1–2 mg/dl below the initiation level for the infant's postmenstrual age. Discontinue TSB measurements when TSB is declining and phototherapy is no longer required. Measure the serum albumin level in all infants. Measure irradiance at regular intervals with an appropriate spectroradiometer. The increased mortality observed in infants <1000 g who are receiving phototherapy¹⁴–¹⁶,¹⁷ suggests that it is prudent to use less-intensive levels of irradiance in these infants. In such infants, phototherapy is almost always prophylactic—it is used to prevent a further increase in the TSB and intensive phototherapy with high irradiance levels usually is not needed. In infants <1000 g, it is reasonable to start phototherapy at lower irradiance levels if the TSB continues to rise; additional phototherapy should be provided by increasing the surface area exposed (phototherapy above and below the infant, reflecting material around the incubator). If the TSB, nonetheless, continues to rise, the irradiance should be increased by switching to a higher intensity setting on the device or by bringing the overhead light closer to the infant. Fluorescent and LED light sources can be brought closer to the infant, but this cannot be done with halogen or tungsten lamps because of the danger of a burn.

*Journal of Perinatology*
Fig. 2. Phototherapy and exchange transfusion thresholds for preterm infants of less than 35 weeks of gestation. TSB-thresholds of phototherapy (PT) and exchange transfusion (ET) in preterm infants of 35 or less weeks of gestational age. TSB-thresholds (17.1 μmol/L = 1 mg/dl bilirubin) versus postnatal age (days). Standard or high risk is based on the presence of risk factors. All nomograms can be downloaded from http://www.babyrietgeest.nl/index.php?id=135.

specific TSB-thresholds were not used in 4 NICUs, which partially explains the large range of applied TSB-thresholds.

Our results are in agreement with previous (inter)national data and support the lack of evidence on specific TSB-thresholds and neurological outcome [1,7-9,14,15,19-23]. To the best of our knowledge, only 3 prospective studies have analyzed effects of different TSB-thresholds on biochemical, phototherapy, and/or outcome data in preterm infants (Table 3) [24-26]. In 1985, Curtis-Cohen et al. randomly assigned 22 preterm infants with a birth weight of less than 1250 g to a prophylactic or a conservative treatment. Phototherapy was initiated immediately postnatal in the prophylactic group (n = 11), whereas in the conservative group phototherapy was started above TSB concentrations of 85 μmol/L. Mean TSB concentrations at onset of phototherapy were significantly different (102 μmol/L versus 39 μmol/L, conservative versus prophylactic phototherapy, respectively, p < 0.001) and total duration of phototherapy was 48 h longer in the prophylactic group (p = 0.05), whereas maximum TSB concentrations, age at maximum TSB concentrations and rate of rise of TSB were similar [24]. Long-term neurodevelopmental outcome has been analyzed in two prospective trials on prophylactic versus conservative phototherapy in preterm infants. Jangaard et al. started prophylactic phototherapy (n = 46) 12 h after birth, and conservative phototherapy (n = 49) at a predefined TSB concentration of 150 μmol/L in newborn infants with a birth weight lower than 1500 g. Maximum TSB concentrations did not differ significantly except in a subgroup of infants weighing less than 1000 g: Maximum TSB concentrations were highest in the conservative group (171 μmol/L versus 139 μmol/L, conservative versus prophylactic phototherapy, respectively, p = 0.02). A non-significant tendency toward poor long-term neurodevelopmental outcome in conservative-treated extreme low birth weight infants was reported [25]. Recently, a randomized controlled trial investigated the effects of prophylactic phototherapy (started immediately postnatal) versus
NICU Phototherapy for VLBW

<750 gram BW begin at 5mg/dl attempt to keep below 7 mg/dl
750 gram-1000 gram begin at 7 mg/dl and attempt to keep below 10 mg/dl

Head Ultrasounds and MRI: prefer MRI prior to d/c instead of 6 week HUS, unless transferred to community then MD will decide on HUS vs. MRI outpatient.

Infants ≤ 30 weeks all

Infants 31 – 34 weeks: with unstable NICU course (proven NEC, perforation, bacterial sepsis, pressor support etc.) This is per discussion with attending MD.

Do them during week of discharge, unsedated.

Von - 30 wks or 1500 grams
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 70 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 < 1500 grams 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).

*Brain MRI at term adjusted age or prior to PICU whichever comes last.*
RETINOPATHY OF PREMATURITY (ROP) GUIDELINES FOR UNIVERITY OF FLORIDA HEALTH CARE SYSTEM*

Infants to be screened, if meeting either of the below criteria:

1. Birth weight less than 1500 g
2. Gestational age at birth less than 32 weeks

Additional screening indications:

1. Infants greater than 1499 g at birth, or infants 32 weeks or greater gestational age at birth if any there is any history of an unstable clinical course, or significant concurrent disease (examples: bronchopulmonary dysplasia, necrotizing enterocolitis, cardiac or hematologic instability); as judged by the attending neonatology or pediatric service.

Timing of initial ROP screening:

1. The following table will be used as a guide for the timing of the initial ROP screening exam. The exam will be scheduled by the NICU service and provided by the ROP screening ophthalmologist(s).

<table>
<thead>
<tr>
<th>Gestational Age at Birth (wk)</th>
<th>Gestational Age at Initial ROP Examination (wk)</th>
<th>Chronologic Age at Initial ROP Examination (wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>34-30</td>
<td>9-8</td>
</tr>
<tr>
<td>23</td>
<td>34-30</td>
<td>8-7</td>
</tr>
<tr>
<td>24</td>
<td>34-30</td>
<td>7-6</td>
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</tr>
<tr>
<td>31</td>
<td>35</td>
<td>4</td>
</tr>
<tr>
<td>32</td>
<td>36</td>
<td>4</td>
</tr>
</tbody>
</table>
HIE and cooling protocol – orders and documentation

See HIE Brain Team Notebook for other references

Cooling criteria: Infant’s must meet all of the 5 criteria.

1. Gestational age greater than or equal to 35 weeks
2. Birth weight greater than or equal to 1.8 kg
3. Less than or equal to 6 hrs since insult occurred
4. Seizures or 3 of 6 of the following:
   a. Level of consciousness – lethargic or stupor/coma
   b. Spontaneous activity – decreased activity or no activity
   c. Posture – distal flexion, complete extension or decerebrate
   d. Tone – hypotonia or flaccid
   e. Primitive reflexes
      i. Suck – weak or absent
      ii. Moro – incomplete or absent
   f. Autonomic system
      i. Pupils – constricted or deviated/dilated/non-reactive to light
      ii. Heart rate – bradycardia or variable
      iii. Respiration – Periodic or apnea
5. One or More of the following predictors of severe HIE:
   a. pH less than or equal to 7 with base deficit greater than or equal to 16 on an arterial blood gas
   b. pH 7.01-7.15 and base deficit 10-15.9 or no blood gas available and acute perinatal event (cord prolapsed, heart rate decelerations, uterine rupture) and either APGAR less than or equal to 5 at 10 min or assisted ventilation at birth required for granter than or equal to 10 min

Exclusion criteria:

a. presence of lethal chromosomal abnormalities
b. Severe IUGR
   c. Significant intracranial hemorrhage (grade III or IV)
If infant meets criteria there is an HIE order set in EPIC for cooling and re-warming:

NICU HIE Cooling – Systemic Hypothermia in Neonates with Hypoxemic-Ischemic Encephalopathy IP UF

NICU Rewarming – Systemic Hypothermia in Neonates with Hypoxemic-Ischemic Encephalopathy IP UF

There is a place to document criteria in EPIC. Once you click on the patient’s chart, click on the Newborn tab on the left side of the screen and click on HIE admission to document the criteria.

When it says to consult HIE team that means Dr. Weiss – he is involved on all infants who are cooled, whether or not he is on service.

For the continuous opiate infusion we usually use fentanyl at 0.5 mcg/kg/hr

The orders for echocardiogram and renal ultrasound are to be considered if patient is showing specific symptoms (see order). You do not have to wait to obtain Echo or renal u/s before you start cooling if the patient is not showing the specific symptoms listed in the order (it can be very difficult to obtain an Echo and/or ultrasound in the middle of the night but it shouldn’t prevent you from starting hypothermia treatment).

There are many educational guidelines listed within the order set to explain why certain tests are being done and treatment/therapy for certain abnormal test results. There is also a blue binder in the NNP office (labeled “Hypothermia”)

Sarnat exams should be done initially and every 24 hrs. Usually Dr. Weiss will do one but the NNP should also do one. It can be charted in EPIC by clicking on the Newborn tab (found on the left side of the computer screen once you are in the patient’s chart) and then click on HIE to document your exam.

All HIE infants should be placed on amplitude EEG monitoring. This should be continued through entire cooling/rewarming phases.
Shands NICU DISCHARGE INSTRUCTIONS for NAME/ Med record number

Discharge weight autopopulate

Discharge Medication Instructions:

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Route</th>
<th>Frequency</th>
<th>Next dose due:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
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<td></td>
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</tr>
<tr>
<td>Ability to add lines</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

At Risk Infant/Prematurity Needs:
[ ] Your child is premature/at risk of injury from RSV, a respiratory illness. Synagis was given on:
autopopulate synagis medicine and/or recommended: [ ] monthly during RSV season [ ] next RSV season
[ ] ROP screening Appointment Form has been given to parent by: [ ] provider.
[ ] Premature/Sick infants are at risk for developmental delay and movement disorders. Your baby’s
follow up plan is:
[ ] Developmental screen was completed prior to discharge [ ] Neonatology follow up clinic [ ] monitoring
by your child’s pediatrician [ ] OT/PT prescription has been given [ ] Referred to Early Steps [ ] Referred to
services in child’s community [ ] If you have concerns about your baby’s development call 1 (800) 334-1447.

Follow-up appointments:

<table>
<thead>
<tr>
<th>Doctor/Clinic</th>
<th>Location</th>
<th>Phone</th>
<th>Date and time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autopopulate hearing screen appt.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Able to add lines</td>
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</table>

Feeding Instructions:
[ ] Breastfeed for 20-30 minutes at least every 2-3 hours, for 8-12 feedings per day.
[ ] Supplement breastfeeding with ***
[ ] Feed ___ (ounces/)(mL) or as much as baby wants [ ] standard infant formula [ ] (formula choice box)
* other formula by { } mouth { } G-Tube every *** hours
[ ] Vent G-tube after feedings for ___ minutes before and after feeding and when fussy. Evelyn
[ ] Other: ***
[ ] Formula preparation instructions: ***

Car Safety Instructions:
[ ] Place baby in rear-facing infant car seat in the back seat of the car.
[ ] Place baby in car bed in the back seat of the car.
Special Equipment:
[ ] Your baby should receive ___ ml or fraction of liter oxygen by nasal cannula at all times
[ ] Use apnea/bradycardia monitor as instructed by the home health provider- may remove during bath while supervised. Alarm limits for discharge: High HR ___ BPM Low HR ___ BPM Apnea ___ seconds.
[ ] If G-tube falls out bring baby to emergency room.
[ ] Other ***

Newborn Screen: the state of Florida requires infants to be tested for certain diseases that may result in mental retardation if treatment is not started early in life. Your infant had the test performed on the following dates:
Dates autopopulate Each date: Check one:
[ ] testing is complete and normal result
[ ] testing is complete and result abnormal ***
[ ] testing in process results pending
[ ] A Follow up screen will need to be done ***
[ ] Hearing screen results: autopopulate and [] follow up arranged [] no further testing required.

Newborn Care Instructions:
Baby should be placed in his/her own bed
Always place baby on back for sleeping
Keep bulb syringe nearby or available
Keep umbilical cord dry, keep diaper folded down until cord falls off. Do not use alcohol on cord, may clean with soap and water if soiled and air dry.
Temperature: take baby’s temperature if he seems to hot or cold, or if he is very sleepy or fussy. If temperature is below 97 degrees or above 100.4 degrees, confirm by taking a rectal temperature and call the pediatrician.
Bathing: check one
[ ] Sponge bath only until umbilical cord falls off
[ ] Sponge bath until incisions are well healed
Do not smoke around your baby or inside your home or car.
Avoid sick people and crowded places, instruct visitors to wash hands before holding
Bring copy of your baby’s discharge summary to all doctor appointments
[ ] Circumcision: rinse area with plain water for cleaning and apply [ ] bacitracin or [ ] petroleum jelly ointment to site with each diaper change for 4 days.
Do not advertise baby’s birth by putting signs in the yard or home, don’t open door to uninvited visitors.
[ ] ***

Additional instructions:
..................................................................................
..................................................................................
Warning! Call your baby's pediatrician immediately for:
Rectal temperature 100.4 or greater
Increased sleepiness or lethargy
Blood in stool or diaper
Breathing problems (rapid or labored breathing, increased secretions, or skin color changes such as paleness/duskininess/turning blue).
Poor feeding for 3 or more feedings
No wet diapers or urine for 12 hours
Jaundice or yellow color of skin or eyes that is getting worse.
Redness, swelling, or foul odor around the umbilical cord
Frequent vomiting
Inconsolable crying
Drainage or bleeding from a wound or central venous line.

ROP Warning Form Using the standard Shands form.
Appt:

Signature line for the parent: ______________________ [ ] responsible provider