KKUH

College of Medicine

Pediatric Department

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WELCOME TO THE NEONATAL INTENSIVE CARE UNIT

This reference was designed to provide busy house officers easy access to pertinent information and tips to aid in the care of ill neonates. The information that this manual provides was not meant to supplant teaching or discussion of neonatal disease and care. Please do not hesitate to ask questions to the nurses, senior residents, fellows, or attending consultant.

Relax; take a deep breath; remember, you are not alone!

This guidebook is updated yearly. If you notice an area that could be improved or have any suggestions, please contact the head of the unit or teaching coordinator.

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1 -RESIDENT RESPONSIBILITIES

Level One (R1)

The primary goal of the two-month NICU rotations during the first year is to introduce the new house officer to the practice of clinical neonatology. The resident should use the month-long experiences to recognize the clinical presentation of a variety of common and unusual neonatal illnesses, develop clinical skills required for patient care, and understand the decision-making processes involved in the management of critically ill newborns. He should not feel uncomfortable with his/her lack of knowledge and/or clinical acumen. Senior physicians, nurses, and support staff are able to offer assistance in order to facilitate high quality patient care and an overall positive experience for the new pediatrician.

The following summary highlights the responsibilities of the first year resident:

1. **Participation in daily work rounds**

    a) Pre-round on all assigned patients prior to morning rounds.
    b) During rounds, present any overnight changes or events as well as any new admissions.
    c) Take part in discussion of management plans for each assigned patient.

2. **Clinical management of infants admitted to the NICU**- the resident is responsible for patients admitted during his/her call nights and other infants as designated by the senior resident (SAR). Responsibilities include:

    a) Review of prenatal records (or transfer notes), x-rays, and laboratory reports
    b) Admission history and physical exam (completed and placed in the infant's blue chart within 24 hours of admission).
    c) Formulation of a differential diagnosis, management, and plan, with guidance from the SR or fellow.
    d) Written orders for medical care, hyper alimentation, respiratory support, diagnostic tests, and consultations (except in an emergency, only the intern writes orders).
    e) Diagnostic and therapeutic procedures (with supervision)
    f) Daily physical examinations and progress notes on all assigned patients.
    g) Attendance at daily radiology rounds with the NICU team.
    h) Preparation of patients for transfers or discharge.

3. **Delivery room management**

    a) Attend resuscitation review (given monthly)
    b) Review Neonatal Resuscitation Program CD Ram available with the head of the unit

c) Attend high risk deliveries with resuscitation team whenever possible (nights on call, weekend days, anticipated NICU admission)- observe and gradually take part in resuscitation and stabilization of critically ill neonates.
d) Completion of Neonatal data admission papers

4. **Attendance at scheduled lectures**
    1) 1) Core lectures in Neonatology-11: 30 - 12:30 noon every Sunday at NICU conference room (schedule is posted weekly).
    2) Journal Club each Saturday 11:30 to 12:30 Prepare and presented by senior resident or neonatal fellow alternating with formal lecture by the neonatologist and a report from neonatal follow up program.
    3) Monday Morning report from 8 -8:30 am At Pediatric seminar room schedule every other Monday present short course of newly diagnosed patient or problem of chronic patient)
    4) High risk and prenatal mortality meeting-Tuesdays 12; 30 noon in the OB/Gyne conference room. Discussion of selected high-risk pregnancy cases or topics with the perinatology team. The last Tuesday of the month we discussed the statistic of prenatal and early neonatal deaths in addition to still birth
    3) 3) 5) Combine Neonatal and Pediatric mortality morbidity meeting 12:30 noon the last Monday of the month

At the end of the two months first year rotations, the resident should achieve comfort and experience with:

- **Physical examination:** achieve competence in the evaluation of infants across a full range of gestational ages; understand the presentation of a variety of medical and surgical problems (including common neonatal respiratory problem congenital heart disease, birth trauma, surgical emergencies, inborn errors of metabolism, and infectious diseases); assess gestational age and adequacy of intrauterine growth.
- **Use and interpretation of laboratory and imaging studies:** develop an understanding of the most appropriate tests, their sequence, frequency, and interpretation in a range of clinical situations; order tests in a timely manner and follow through to obtain results; begin to be selective in ordering tests, and consider issues of risk to patient.
- **Formulation of a differential diagnosis and treatment plan:** formulate a problem list and, with guidance, integrate history, physical exam, and laboratory and imaging data into a diagnosis and management plan; understand the need for frequent reevaluation of patients and plans because of the evolving nature of complex and multi-system disease processes; understand limitations in making management decisions and acknowledge the need for help.
- **Principles of newborn resuscitation**: observe and gradually participate in the delivery room resuscitation and stabilization of term and pre-term infants with a broad range of congenital and prenatal problems.
- **Performing procedures:** develop skill at common neonatal procedures (sterile gowning/aseptic preparation, phlebotomy, intubations, lumbar puncture, umbilical catheterization, bladder catheterization, suprapubic bladder aspiration); observe and participate in less common procedures as much as possible (thoracocentesis, chest

tube placement, paracentesis, exchange transfusion); recognize the level of comfort/uncertainty in performing procedures and seek assistance when needed; document all procedures; discuss procedures and obtain informed consent from parent/guardian in non-urgent situations.

- **Communication with staff and families:** maintain a courteous, caring, and professional demeanor; present data on assigned patients in an organized manner during rounds; complete documentation (admission, progress, and procedure notes) in a timely manner; write daily progress notes that are complete, current, and non-judgmental; include diagnoses and plans as well as data; communicate management plans to bedside nurse; take part in discussions with consulting physicians fro other subspecialty; respect patient and family privacy at all times; establish rapport with parents and communicate general information; attend scheduled family meetings with the neonatologist in service and begin to take part in more complex discussions.

Senior RESIDENT (R3, 4)

The SENIOR residents are responsible for cross-coverage of the NICU at day and night and backup a genior resident. This experience should allow you to strengthen your knowledge base of neonatal pediatrics and assume a more independent and supervisory role. Immediate backup will be provided by Neonatology fellow or an experienced Neonatal Nurse Practitioner (NNP).

The following summary details the responsibilities of the senior resident when covering the NICU.

1. **Day and Overnight supervision of clinical management of NICU patients:**
    1. Supervise and assist the genior resident in clinical evaluations and management decisions on NICU patients.
    2. Discuss and review admission work-ups including data base sheet for accuracy and completeness.
    3. Assist the genior resident in the formulation of differential diagnoses and plans and in writing accurate orders.
    4. Supervise the genior resident in diagnostic and therapeutic procedures, and assist if necessary.
    5. Assist the genior resident and assume a leadership role in the communication with consultants and parents,
    6. Assume responsibility for notifying the NICU fellow or attending of any admission or any significant clinical change in a NICU patient.
    7. To provide primary care of all admission when resident is busy
2. **Delivery room management of the newborn:**
    1. Carry the Delivery room beeper and respond to all calls.
    2. Assume a leadership role in the evaluation, resuscitation, and stabilization of the infant.
    3. Complete the data base sheet and determine appropriate placement of the infant (NICU or Postnatal ward).
    4. Understand the support available in case of a difficult delivery. Generally, a fellow or attending neonatologist will accompany you when you need support.

5. Allow the genior resident (whenever possible) to initiate delivery room **resuscitation and stabilization** under your supervision.
6. Observe prenatal consultations on Labor and Delivery by the Neonatologist whenever possible, and gradually assume responsibility for such consultations that occur when you are on call.

3. **Sign out of overnight events to the attending team**
    1. Inform the morning team of any changes or events, and sign out new admissions.
    2. Make every effort to arrive ON **TIME** for rounds.

At the end of the rotation, the senior resident should achieve the following:

- **Clinical assessment and management of critically ill newborns:** become more competent in the evaluation of the full range of infants admitted to the NICU; appreciate greater the appropriate use and interpretation of laboratory and imaging studies; formulate independently a diagnosis and treatment plan; develop the ability to instruct and supervise more junior residents in clinical management of critically ill patients; notify appropriately and consult with the NICU fellow or attending consultant.
- **Neonatal resuscitation and stabilization**: efficiently and effectively assess and resuscitate term and pre-term infants with a broad range of congenital and prenatal problems; use back-up resources appropriately in complex cases.
- **Procedures**: acquire increased skill and greater independence with neonatal procedures; instruct and supervise junior residents; assess a level of comfort with performing procedures and willingness to seek assistance when needed.
- **Communication with staff and families**: establish effective and courteous communication with NICU staff and consultants; become increasingly more comfortable in communicating clinical information to families, including the conveying of bad news; provide prenatal consultation to families on Labor and Delivery (after consultation with the NICU attending or fellow) to mothers with threatened preterm delivery or known prenatal problems.

SENIOR ASSISTANT And Neonatal fellows

The clinical assistant and fellows should assume the role of a team leader in the NICU. Each will be paired with two residents, supervising their clinical evaluation and management of NICU patients. This supervision is carried out in consultation with the NICU attending. Throughout the month, the/she is expected to advance in knowledge of neonatal disease processes, independence and judgment in clinical management of critically ill infants, instruction and support of genior and senior residents, and in communication skills.

The following summary highlights the role of the fellow in the NICU:

1. **Participation in daily work rounds:**
    1. Prior to rounds, assess new admissions, overnight clinical changes in established patients, and urgent situations requiring immediate attention.

    2. Lead discussions on rounds of management plans for each team patient
2. **Supervision of clinical management of NICU patients**:
    1. Discuss each admission work-up with intern, reviewing for accuracy and completeness.
    2. Assist residents in the formulation of a differential diagnosis and plan and in writing accurate, appropriate orders.
    3. Supervise and assist residents in ongoing clinical evaluations and management decisions on NICU patients;
    4. Review progress notes and provide feedback.
    5. Review plans for laboratory and imaging studies, discussing risk and cost-effectiveness
    6. Supervise residents in diagnostic and therapeutic procedures, and assist if necessary; instruct in completing procedure notes and obtaining informed consent.
    7. Participate in discussions with families and consultants; assume an increased role in complex discussions conveying bad news and prognostic information.
    8. Anticipate potential transfers and discharges; provide medical update on each team patient at weekly
    9. Multidisciplinary Discharge meeting (Wednesday 11:30am) assist residents in completing their discharge summaries
    10. If necessary, redistribute patients among residents to maintain equal workloads.
    11. Maintain close communication and consultation with the attending neonatologist on management plan; notify him/her of any admission, request for transfer, or any clinical change in a NICU patient.
3. **Delivery room management of the newborn:**
    1. Attend resuscitation review (given monthly)
    2. Review Neonatal Resuscitation Program with the newly rotating residents
    3. Carry DR beeper and attend high risk deliveries when on-call (nights and weekends)
    4. Providing and presenting monthly prenatal and neonatal mortality statistic
    5. Covering the other neonatal follow up program clinic mainly on Saturday and Tuesday. (8:30am -12 noon)
4. **Attendance at scheduled lectures:**

    Journal club each Saturday (11:30 am - 12:30)

    Pickup a recent article on the common neonatal management, distributed to all team on Wednesday morning to review and be ready to discuss it on Sunday of next week

Post Call Duties

Residents, senior registrar and fellows are allowed to take off after 12:30 noon and after completing their daily round work and clear their endorsement if permitted by consultant neonatologist in service

2- NICU ADMISSION CRITERIA FOR NEWBORNS

A. Direct Admission from Delivery Room to NICU (at least for observation)

1. Gestational age <34 weeks.
2. 5 minute Apgar score ≤ 5.
3. Birth weight < 1900gm.
4. Any newborn with persistence signs and symptoms of respiratory distress
5. Supplemental oxygen, monitoring (cardio respiratory and/or pulse oximetry), or IV therapy required.
6. Babies with or suspected to have cyanotic congenital heart disease
7. Any newborn with arrhythmia
8. Poor tone.
9. Consider with major congenital anomaly or dysmorphisms.
10. Newborn of mother with PROM and signs of chorio-amnionitis or symptomatic for sepsis

B. Transfers to NICU from Postnatal nursery

1. Medically unstable eg. Clinical signs of sepsis
2. Acute life-threatening event eg. Apnoea, bradycardia
3. Cardiopulmonary or O_2 saturation monitoring required.
4. O_2 required.
5. Respiratory distress.
6. Persistent tachypnea (>80-100) or grunting.
7. Stridor.
8. Polycythemia with Hct > 65 with symptoms who may need partial exchange
9. Seizures.
10. Hypoglycemia requiring I.V. dextrose.eg IDM
11. Babies with hyperpilirubineamia who may need exchange transfusion
12. I.V. therapy or medications required.
13. NICU procedure required; e.g. exchange transfusion.

C. Transfers from the NICU to Postnatal Nursery

1. Stable infant as determined by NICU fellow or attending.
2. *Can accommodate oral feeding and need for isolette. No I.V. fluids or medications
3. Gestational age ≥34 weeks with resolving grunting or hypothermia
4. *Infants who may need Iv antibiotic or single phototherapy for non hemolytic indirect hyperbilirubineamia and their mother still in hospital

** In over census situation with 28 admission

D. Transfer from out side Hospital

1- After getting the acceptant letter from the consultant, the transferred paper should be felled by the fellows or pediatric surgeon's/R

2- These infants will be admitted to isolation room

3- Full septic screen and surface swabs should be taken

4- we are usually accepting 2 cases with either surgical (eg. CDH, TOF) or medical condition (eg. MAS with PPHN)

ROUTINE" ADMISSION ORDERS

Vital Signs
Fluids

- NPO or Feeds
- IV Fluids:
  Dextrose Concentration
  Additives (if any)
  Rate

Labs	**Indication**
• Type & Screen (Cross match on request)	Blood typing Antibody screen/transfusion
• CBC with manual differential	Evaluation for sepsis
• Hemoglobin/Hematocrit	Anemia/polycythemia
• Blood culture	Suspected sepsis
• Urine toxicology screen	R/O maternal substance abuse
• Blood gases (CBG or ABG)	Respiratory distress; cyanosis
• Electrolytes	Usually after 12 hours of age; sooner (6-12 hours) if clinically indicated, preemies
• Blood glucose	Hyperglycemia/hypoglycemia; SGA, LGA

Medications	**Indication**
• Erythromycin ophthalmic ointment OU x 1	Prevent gonococcal/chlamydial infection
• Vitamin K 1.0 mg IM x 1 (0.5 mg for <1,000 gm)	Prevent hemorrhagic disease of the newborn
• Triple dye to umbilical cord	Prevent bacterial overgrowth

(if infant unstable and may require UAC, may wait)

- Ampicillin and Gentamicin — Suspected sepsis
- Vasselin applied to skin BID - QID — **Considered** in extremely premature newborns (<25 wk, birth weight <75 reduction of insensible water losses through immature skin
- Indomethacin 0.1 mg/kg Q 24 hr X 3 days — **Considered** in newborns (<28 weeks, birth weight <1250 gm) for prever
- Hepatitis B vaccine Universal vaccination — Given for all infants including premature infants >2kgm

Pulse ox parameters	e.g. 87-93%- dependent on disease process and maturity
Incubator humidification	<1,000 gms
Blood gas frequency	
Vent settings/O_2	Order the Mode of Ventilation SIPPV or SIMV
	adjust the Pressure PIP and PEEP
	I time and Rate

ADMISSION NOTE AND *PROBLEM LIST*

In addition to the data base admission sheet

Must be completed within 24 hours of admission By Senior resident, senior registrar or fellow and should contain the following components:

Patient ID
Date of Birth

History of Pregnancy:

Gravida
Para (full term, preterm, abortion, living children)
Due date (by LMP and US)
Prenatal care & maternal labs (blood type, Rh, rubella, other
TORCH screen

Medications, tobacco, drugs
Past Obstetrical History: Previous pregnancies, including GA and BW, as well as complications: abortions, miscarriages, premature delivery, etc.
Maternal Past Medical History and Family History

History of Delivery:

Delivery type and position
Complications
Maternal drugs (i.e., steroids, antibiotics, sedation, $MgSO_4$)
Time of rupture of membranes
Initial assessment and resuscitation
Apgar scores

Physical Exam:

Birth weight with percentiles (LGA, AGA, SGA)
Head circumference and length with percentiles
Vital signs and ventilator settings

Labs & Tests

Assessment & Plan

NOTE: Admission weight, HC, and length must be plotted on Ballard's chart for assessment of symmetrical intrauterine growth and gestational age.

Problem list ((Blue card)) should be updated by S/R or Fellow as the course of the baby dictated

3- PREMATURE CARE

GESTATIONAL AGE ASSESSMENT

1. LMP/best OB estimate (early ultrasound)
2. New Ballard score (neuromuscular/physical maturity scale)

NOTE: Best obstetrical estimates, especially with early ultrasound, are the best methods for determining gestational age in preterm and post term neonates. Postnatal estimates are less accurate than good prenatal measures.

GROWTH PARAMETERS

1. Weight- daily. Weights may be held on unstable infants.
2. Head circumference- weekly. More frequently if indicated (e.g., IVH, hydrocephalus). Use the head growth chart to plot.
3. Length- weekly.

NOTE: Admission weight, HC, and length should be plotted on Ballard's chart for assessment of intrauterine growth and gestational age. It is the intern's responsibility to plot growth parameters **weekly** on the baby's bedside growth chart. This shows the "big picture" and is an assessment of the baby's overall growth.

FLUIDS AND ELECTROLYTES

Suggested ranges for start-up fluids [rate (cc/kg/day) and type of fluid]:

	< 750 gm	750-1000 gm	1000-1500gm	1500-2500 gm	> 2500 gm
Day 1	110 -150 D5W	90 -120 D5W	80 -100 D10W	70 - 90 D10W	60 - 80 D10W
Day 2	120 -180 D5W	100 -130 D5W	100 -120 D10W	90 -110 D10W	80 - 90 D10W
Day 3	140 -190 D5W	120 -150 D5W	120 -140 D10W	100 -140 D10W	100 -110 D10W

NOTE: **Close attention to weight gain and electrolytes will allow proper adjustment of total fluid intake**.

1. A higher range of fluids may be needed if skin is very immature, secondary to greater insensible water loss. Vaseline applied to skin BID - QID may help to decrease these losses.
2. Preterm infants need about 5-8 mg/kg/min of glucose initially.
   [mg/kg/min = (% glucose x rate of infusion x 0.167)/ wt]

Suggested Electrolyte Administration:

	First 24-48 hours*	After 48-72 hours
NaCl	None, unless Na <135 with out evidence of fluid overload	***Term***: 2-3 mEq/kg/d ***Preterm***: 3-5 mEq/kg/d
KCl	Usually none required	1-2 mEq/kg/d (desired K < 4.5)

*** Electrolyte additives are appropriate only when an infant starts urinating well and thus will be having some electrolyte losses in the urine. If Na is dropping with no or poor urine output, the problem is likely fluid overload. Total fluid should be decreased rather than adding Na.**

Common Electrolyte Problems in Small Premature Infants:

Hypernatremia with Normal or deficient ECF volume

Causes

Increase renal and insensible water loss (IWL) is the major attributing factor in ELBW infant

Birth weight (gm)	Insensible water loss (ml/kg/day)@
750-1000	82
1001-1250	56
1251-1500	46
>1500	26

@ Values represent mean IWL, this values increase up to 40% by phototherapy and up to 50% by radient warmer

Diagnosis. Wt loss, tachycardia, hypotension and metabolic acidosis can developed

Therapy

Monitor Na frequently.
Increase fluids if Na >145.mmol/l

Adjust Na intake if sign of ECF depletion or excess developed.

Hypernatremia with excess ECF volume.

Causes. Excessive administration of isotonic or hypertonic fluids.

Diagnosis. Wt gain, edema, normal HR, BP and UOP

Therapy Restrict fluid administration and (or) Na intake.

Hyperkalemia (K >7.0)

No KCl usually needed <24 hours diagnosis based on serum level, EKG changes

(I.e. peaked T waves documented by rhythm strip). Remember heel-stick K is frequently hemolyzed and may be falsely elevated.

Predisposing factor

1) 1) Increase K release secondary to tissue destruction eg. IVH, asphyxia/ischemia insult,
2) 2) Decrease K clearance as seen with renal failure
3) 3) The most common cause of sudden unexpected hyperkalemia is medication error. (eg. IVF and TPN calculation)
4) 4) Blood transfusion

Important to evaluate urine output.

Treatment:

Stop all KCl infusions or supplements.
Consider dehydration and increasing fluids.
Maintain normal pH: If acidotic, consider $NaHCO_3$ (1mEq/kg) and/or maximize acetate in TPN.

(Acidosis drives K out of the cell, and alkalosis drives it into the cell).
Consider glucose and insulin infusion.
If arrhythmia developed (usually wide QRS, Brady arrhythmia), give Ca gluconate 1-2ml/kg IV (50 mg/kg). May repeat until normal rhythm.
Exchange resin retention enemas (Kayexalate) are not useful in neonates and have potentially serious side effects especially in ELBW.

Use antiarrythmia agents such as lidocain in refractory ventricular tachycardia

Hyperglycemia

Calculate the **mg/kg/min** of dextrose infused.

VLBW infants on D5-D7.5W to give approximately 6 mg/kg/min of dextrose.
Follow D stix. If trend is upward >10mmol/l, consider decreasing dextrose concentration (can not decrease < D5W because it is too hypo-osmolar).
Hyperglycemia may lead to glucosuria and an osmotic diuresis (further exacerbating fluid balance issues).

Insulin infusion can be used to control hyperglycemia. Usual starting dose is 0.05 U/kg/hr with blood glucose (BG) recheck 1 hr. after start of infusion. A frequent D stix monitoring schedule and insulin infusion sliding scale can be designed for each baby dependent on sensitivity (ex: bedside BG screen Q1-2 hr and

No insulin with BG<12mmol/l

0.05 U/kg/hr with BG 12-18mmol/l

0.1 0.1 U/kg/hr with BG 18-20mmol/l,

0.15 U/kg/hr with BG 20-24mmol/l,

0.2 0.2 U/kg/hr with BG >240).

Hypocalcaemia

Treatment is based on an ionized Ca, not total Ca
for ionized Ca <1.0, supplement with Ca gluconate (100 mg/kg q 6 hr x 4 doses) then recheck after fourth dose.

Hypoglycemia

Blood glucose (BG) must be checked on admission to the NICU using glucometer screening:
If BG >35 mg/dl:

Repeat every 1-2 hour until the infant is receiving sufficient glucose source and value has stabilized x2. Once an infant's glucose has stabilized >40 mg/dl, routine bedside monitoring is every 4-8 hours.

If BG is <35 mg/dl:

With any glucometer measurement that prompts intervention real blood glucose should be measured (in the critical care lab or plasma glucose (gray top tube) sent STAT to the chemistry lab).
IV access is a priority for an infant with BG <30 mg/dl.

Suggested therapeutic interventions (BG<35mg/dl) and monitoring (BG<40mg/dl) are as follows:

Blood Glucose	Infant on IV	No IV
35 - 40 mg/dl	Observe, monitor glucose every 1 - 2 hours	Observe, monitor glucose every 1 - 2 hours
30 - 35 mg/dl	Increase rate or concentration of glucose to 4-6 mg/kg/min*	Additional feeding by nipple or gavage. Consider continuous feeds.
25 - 30 mg/dl	Increase rate or concentration of glucose to 6-8 mg/kg/min*	Start IV with D10W at 4-6 mg/kg/min
<25 mg/dl	"Mini-bolus": 2 ml/kg D10W Increase rate or concentration of glucose to 8-10 mg/kg/min*	Start IV with "mini-bolus". Continuous glucose at 6-8 mg/kg/min

*If the patient is already receiving glucose at these rates, increase glucose infusion rate by 2 mg/kg/min.

NOTE: If BG <25 mg/dl and immediate IV access is a problem, consider glucagon 0.1 mg/kg/dose (max 1 mg) IM or SC every 30 minutes. This will give you time to secure IV access. Glucagon works by mobilizing liver glycogen stores so it may not be effective in SGA babies.

- Try to make changes gradually. Generally, changes in dextrose infusion rates should not exceed 2 mg/kg/min in a two-hour interval. Every glucose bolus may result in increased insulin excretion and subsequent risk for repeat hypoglycemia. Therefore, in infants with BG > 25 mg/dl, attempt management without bolus.
- Follow-up BG (may be glucometer screen) should be obtained after any therapeutic intervention:
- In a symptomatic infants, follow-up BG determinations should be obtained at 60 min intervals until the values are >40 mg/dl and stable.
- In symptomatic infants, follow-up BG determinations should be obtained at 30 - 60 min intervals until normal; any symptoms and the

response to restoring glucose level to normal must be documented on the flow sheet.

- At any time, the recurrence or onset of clinical manifestations (e.g. prolonged apnea, cyanotic spells, seizures, change in level of consciousness, lethargy, coma, etc.) requires a STAT blood glucose level (not just a bedside screen).
- Any bedside screen of <25 requires a STAT blood glucose (drawn before bolus is given, but don't wait for results to administer bolus).

IVH PROPHYLAXIS

Indomethacin is considered for IVH prophylaxis in some newborns (<28wks, birth weight <1250 gms). Consult fellow or attending regarding risks and benefits (Indomethacin has also been shown to blunt the cerebral vasodilatory response to hypoxia). Follow urine output, creatinine, platelet count and BP.

Dosage: 0.1 mg/kg q 24 h x 3 days.

Additionally, consider using a fentanyl or morphine drip in the early newborn period, which has been shown to minimize alterations in cerebral blood flow (which can contribute to IVH).

EXOGENOUS SURFACTANT THERAPY

Surfactant is indicated for prevention and treatment of respiratory distress syndrome. Survantaâ is used in our nursery, and is given by our respiratory therapists.

Prophylactic therapy: Indicated for babies with gestational age £26 weeks. It is administered as soon as possible (preferably within minutes of birth) in the delivery room or NICU after insuring that the infant is clinically stable and ET tube is in good position. **Surfactant is NOT a resuscitation medication.**

Rescue therapy: Indicated when the infant demonstrates clinical respiratory distress syndrome confirmed by X-rays and requiring mechanical ventilation.

Dose: Survanta 4 cc/kg/dose given via the endotracheal tube divided into 2 aliquots(or 4 aliquots if the infant is stable).

Additional doses of surfactant are considered with persistent or worsening lung disease (ex. continued mechanical ventilation with Fi02 > 0.40, worsening chest X-ray). Up to three additional doses may be given within the first 2 days of life at

intervals of no less than 6 hours. Infants on minimal ventilatory support, primarily for apnea, do not require surfactant.

Weaning after surfactant:

- Marked improvement in lung compliance may occur soon after administration of surfactant. Watch closely for **hypocapnia** and **air leak**.
- Obtain a blood gas 15-20 minutes after surfactant administration and again every 30 minutes after that (until stable) while weaning from the ventilator.
- Wean PIP aggressively as long as good chest wall movement is noted; may adjust prior to blood gas if clinically indicated.
- Do not be afraid to wean IMV and PIP at the same time.
- Aim for pCO_2 in the range of 45-50 mmHg.

4-RESPIRATORY SUPPORT

To assess adequate ventilation:

1. Look (at the chest wall movement).
2. Listen (to the breath sounds).
3. Watch (CO_2 on blood gases and oxygen saturation on pulse ox meter).

General principles:

Ventilation:

1. Alveolar minute ventilation determines CO_2 elimination.
2. Minute ventilation = tidal volume X respiratory rate.
3. Tidal volume ~ (PIP - PEEP), IT (in a pressure-limited ventilator).

Oxygenation:

1. Oxygenation is dependent on FIO_2 and ventilation/perfusion (V/Q) matching.
2. V/Q matching (in RDS) is improved by increasing mean airway pressure (MAP).
3. MAP is dependent on PIP, PEEP, IT, ET and rate.

Neuromuscular blockade:

1. May be indicated in patients whose respiratory efforts hinder ventilation, rarely indicated in preterm infants
2. Strong, "angry" infants.
3. Infants ventilated at high rates (>60/min, oscillator).
4. Infants on high pressures (>30-35 mm Hg) to avoid air leaks.

5. Agitation is NOT an indication for neuromuscular blockade unless inadequate ventilation and pain have been ruled out.
6. Always monitor gases closely when paralyzing a child.
7. Always consult with the fellow or attending prior to paralyzing a baby.
8. Chose the muscle relaxant after discussion with the attending consultant (Vacronium, atracurium or pancrunium)

(Sea Drug Booklet for indication and dose)

Choosing start-up vent settings (always discuss with the fellow or attending Consultant):

1) PIP (Peak Inspiratory Pressure)
Use the manometer to find the minimum peak pressure needed to see chest wall movement and to hear breath sounds while bagging the baby. Follow up with ABG and adjust as needed.

2) PEEP (Positive End Expiratory Pressure)
3-4 cm is considered physiologic. Certain disease states (e.g., HMD, meconium aspiration) may require more or less.

SIPPV OR SIIMV (Drager 8000 plus)
Start any mode after discussion with consultant or the fellow on the depend on the gestational age and contest of the lung pathology

FiO_2
Adjust inspired oxygen to maintain pulse oximeter in the 87-93% range until the retina is fully vascularized (at 32 – 33wks corrected)

94-98% if retinas are mature, ≥95 % if pulmonary hypertension is entertained

IT (inspiratory time)
usually between 0.3-0.5 sec. has a major impact on the mean airway pressure. Avoid reversed I: E ratio (air trapping)

Common "start-up" respiratory settings:

	<1000	1000-1500	1500-2000	>2000
PIP	14 - 16	16-18	18 - 20	20 - 25
PEEP	3 - 4	4	4	4

IMV	40	40	40	40
FiO_2	.50	.50	.50	.50

Intubation:

Some infants (especially larger infants) may require pre-medication prior to intubation. Should have reversal agents* at bedside in case of untoward effects. Pre-medication drugs include:

1. Morphine sulfate (MSO_4) 0.05-0.1 mg/kg/dose IM or IV (Caution: Respiratory depression, bradycardia, hypotension). Reversal with Naloxone 0.1 mg/kg/dose ETT/SQ/IM/IV; may need to repeat dose.
2. Fentanyl 1-2 m g/kg/dose IV (Caution: Chest wall rigidity, bradycardia, bronchoconstriction, laryngospasm). Reversal with Naloxone 0.1 mg/kg/dose ETT/SQ/IM/IV. .
3. Atropine sulfate 0.1 mg/dose, may be administered to prevent reflexive bradycardia that may sometimes occur during tube placement (Caution: tachycardia, constipation, urinary retention, hyperthermia).

*Use of reversal agents in patients with history of chronic exposure may precipitate withdrawal.

ETT Size and Placement:

Tube Size (ID mm)	Weight (g)	Gestational Age (weeks)
2.5	< 1,000	<28
3.0	1,000-2,000	28-34
3.5	2,000-3,000	34-38
4.0	>3,000	>38

Weight (kg)	Depth of Insertion (from upper lip)
1	7 cm

2	8 cm
3	9 cm
4	10 cm

Extubation:

Usually ready when:

- PIP <16 Or MAP <6
- SIMV <20 P/M
- FiO_2 <35%

May be extubated to:

- Nasal CPAP
- Nasal cannula
- Oxygen hood

Steroids:

Consult with fellow or attending before initiating. Multiple dosing protocols are available.

Example: Cummings* Protocol (42-day course)
Dexamethasone: 0.5 mg/kg/day divided q 12 x 3 days; 0.3 mg/kg/d divided q 12 x 3 days; decrease 10% q 3 days until 0.1 mg/kg/d is reached on day 34 x 3 days; 0.1 mg/kg QOD x 1 wk; then D/C.

Consider stress steroids for surgery and sepsis. (Consult with Endocrinology).

Apnea of Prematurity:

- Episodes of prolonged apnea (<20 seconds) occur in virtually all infants <28 weeks gestation; in 50% of infants 30-32 weeks; and in <7% of infants 34-35 weeks.
- Types of apnea:.

1. Central apnea: No diaphragmatic activity
2. Obstructive apnea: Upper airway obstruction with continuous diaphragmatic activity
3. Mixed apnea: A combination of upper airway obstruction preceded or followed by central apnea.

4. Pathological apnea: An abrupt increase in the frequency and/or severity of apnea; onset of apnea after the first week in a premature infant who did not have RDS; apnea in a term infant at any time.

- **Treatment of apnea of prematurity:**

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Therapy should be directed at the cause of apnea (e.g. infection, PDA, etc.). However, if the apnea is idiopathic and significant (e.g. several episodes/day that require intervention), treatment is recommended.

Methylxanthines

Aminophylline

- Actions include bronchodilation, CNS stimulation, increased GI secretions, increased diaphragm motility. Side effects: tachycardia, jitteriness, GI irritation, GE reflux.
- Follow levels (apnea: 7-12 mg/L; bronchospasm: 10-20 mg/L).
- Dosing:

Loading Dose: 4-6 mg/kg IV or p.o.
Maint. Dose: start 8-12 hrs after loading dose.
preterm: 1-2 mg/kg/dose IV or p.o. q 8-12 hrs*
term: 2-4 mg/kg/dose IV or p.o q 8-12 hrs

*Serum half-life prolonged (20-30 hrs) in the VLBW infant.

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Caffeine citrate (Not available)

- Increases CNS respiratory center output, cardiac output.
- Side effects: mild restlessness, vomiting.
- Therapeutic trough level is 10-25 mg/L. Toxic effects rarely seen below 40 mg/L.
- Dosing or caffeine citrate:

Loading Dose: 20 mg/kg IV or p.o.
Maint. Dose: 5 mg/kg/dose QD p.o or IV; start 24 hrs after load. Dose can be divided Q12hr.

Nasal CPAP

- Particularly helpful for mixed and obstructive apnea. High flow nasal canula may also be helpful in this regard.

Intubation

- Too numerous to count, constant bedside nursing, any episodes requiring bagging.

Doxapram

- Analeptic agent used for intractable apnea resistant to methylxanthines, and as a possible alternative to intubation and mechanical ventilation. It produces respiratory stimulation mediated through the peripheral carotid chemoreceptors. As the dose is increased, the central respiratory centers in the medulla are stimulated too.
- Usual side effects are: increase in BP and HR, hyperactivity, jitteriness, seizures, feeding intolerance and glucosuria. Use of
- Doxapram should be discussed with the fellow or attending. It is important to continue aminophylline or caffeine while using doxapram.
- DOSE: Continuous infusion with max. dose of 2-2.5 mg/kg/h. Therapy may be initiated in one of two ways: a dose of 0.5 mg/kg/h may be initiated and titrated upward until a therapeutic response is seen; or, a dose of 2.5 mg/kg/h may be initiated and titrated downward.

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High Frequency Oscillatory Ventilation (Sensor Medics)

HFOV delivers extremely small tidal volumes that are frequently less than the patient's dead space at supra-physiologic rates (expressed in Hertz, 1Hz=60 breaths/min.), thereby limiting barotrauma.
Tidal volumes are delivered with both an active inspiratory and expiratory phase. HFOV effectively decouples oxygenation from ventilation so that changes made to alter oxygenation have little effect on ventilation and vice versa. During HFOV a constant MAP is applied, and lung volume is established and maintained relatively constant.

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Indications for HFOV:

1. Failed conventional mechanical ventilation.
2. Pulmonary interstitial emphysema.
3. Air-leak syndrome.
4. PPHN e.g. MAS or CDH

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Initial orders/parameters:

1. MAP (reflects lung volume and alters oxygenation).
2. Power (controls amplitude (D P), affects tidal volume and CO_2 elimination).
3. Frequency (affects CO_2 elimination but less so than power).
4. Inspiratory time (usually set at 33%).
5. FiO_2.

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Initial HFOV decisions:

1. Initial settings depend on underlying pathology.
2. In general MAP is ~2-5cm higher than on conventional. The frequency is typically 10-15 Hz for preterm infants and 8-10 for term infants. The power (D P) is set to achieve chest wall vibration.
3. Initial HFOV setting should be discussed with fellow or attending consultant.

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Guide to therapeutic intervention:

The CXR is the best tool for assessing lung inflation; you will need to obtain more frequently than when on conventional ventilator.

Blood Gas Results				
PaO2	PaCO2	FiO2	MAP	D P/power
□	Ok	increase	Increase	_
okay	high			Increase
okay	low	wean	Wean	Deacrease
□	high	Increase	increase	increase

Nitric Oxide

Nitric Oxide (NO) is an endothelium-derived relaxing factor, and when inhaled it can cause selective pulmonary vasodilation. Studies have suggested that in newborns with severe PPHN, NO can increase oxygenation without causing systemic hypotension.

Potential toxicities include methemoglobinemia and lung injury due to NO_2, peroxynitrite, and hydroxyl radical formation. Monitor methemoglobin levels (monitored Q6 hr per protocol, acceptable level <5%).

Starting NO is a consultant decision

After preparing the setup and connection is adequate with pulmonox start with 20 PPM and wean down according to the response

No Flow = Desired PPM X Vent. Flow

NO cylinder Concentration

5-CARDIOVASCULAR DISEASE

Blood Pressure Ranges Expected in the **First 24 Hours**:

Gestational Age	MAP
24-28 wks	25-30
28-30 wks	30-35
30-34 wks	35-40
>34 wks	40-50

* Never treat blood pressure values alone without assessing the infant.

** Quick guide to initial mean blood pressures: Mean Blood Pressure = Gestational Age + 5

***See the Harriet Lane Handbook, 14th edition, 1996, Mosby-Year Book, Inc., for blood pressure ranges expected in the **first week** of life.

Hypotension:

Myocardial Dysfunction (secondary to asphyxia, sepsis).

- Begin pressors (dopamine, dobutamine).

Hypovolemia.

- Use volume expanders (NS or 5% albumin).
- 10 cc/kg over 30-60 minutes (given slowly, especially in VLBW infants, to prevent rapid fluid shifts).
- If no BP response, re-evaluate volume status; consider additional bolus, blood transfusion, pressors.

Suspected Congenital Heart Disease:

1. Perform basic cardiac evaluations (history, PE, CXR, EKG).

2. Perform 4 limb blood pressures (>20 mm Hg gradient between upper and lower extremities suspicious for coarctation).
3. Hyperoxia test (ABG on room air and then on 100% O_2 to R/O cyanotic heart disease).
4. Pre and postductal oxygen saturations.
5. If cyanotic CHD is suspected, start prostaglandins (PGE_1 0.05-0.1 m g/kg/min- Adverse effects: Apnea, bradycardia, hypotension, fever.

Algorithm for Diagnosing a Cynaotic Infant

I. CHEST X-RAY (AP)

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|

V

Heart size — enlarged ----> Ebstein's Anomaly

|

| normal

V

Total anom. pulmonary venous return <---- "white out" — Pulmonary vascularity — increased ----> Transposition of the great vessels

|

| nl or decreased

V

II. 12 LEAD EKG

|

|

V

Quadrant of QRS Axis

-90

|

|

|

180 ------- -+- ------- 0

|

Tetralogy of Fallot/ Pulmonary atresia | Pulmonary atresia

(No murmur)	|	(No murmur)
	|	
Tetraolgy of Fallot/ Pulmonic stenosis	|	Pulmonary stenosis
(Murmur)	90	(Murmur)

Suspected PDA (With L-->R Shunt):

85% of sick very low birth weight infants have PDA, which is a major contributor to the morbidity.

Clinical Signs and Symptoms:

- o Hyperdynamic precordium, bounding pulses, widened pulse pressure (with lowering of diastolic pressure), systolic murmur, increased O_2 requirement.
- o CXR findings with PDA can include increased pulmonary vascular markings, cardiomegaly with splaying of carinal angle.

Treatment:

- o Fluid restriction
- o Indomethacin- check with fellow or attending to decide if indomethacin should be given. Follow urine output, creatinine, and platelet count.
- o Indomethacin treatment: 3 doses Q 12 hours. Doses are as follows:
- o **Infant < 7 days of age**
- o Initial dose: 0.2 mg/kg at 0h then 0.1mg/kg at 12h and 36h
- o **Infants > 7 adys of age**
    - · 0.2 mg/kg /dose at 0h 12h and 36hs
    - · 0.25 mg/kg if 8 days old or older

- o To menimize renal side effects use renal dose of Dopamine infusion 2 – 3ugm/kg/min
- o In the event of acute pulmonary edema use high PEEP, though an effort must be made to close the ductus before complications of high PEEP
- o Surgical ligation is indicated for symptomatic PDA unresponsive to second course of Indomethacin

6-HEMATOLOGY

TRANSFUSION IN PRETERM INFANTS:

The NICU Blood Gas lab can measure hemoglobin concentration (g/dl). Hemoglobins in the range 4.0 - 21.5 g/dl correlate well with central lab values with the Htc being slightly lower. Any hemoglobin outside this range should be confirmed by a repeat sample sent to the central lab. Decisions on partial exchange transfusions should be based on a hematocrit.

Approximate conversion: Hgb [g/dl] X 3 = Hct [%]

Infants with Cardio-pulmonary Disease:

1. Consider transfusion for hematocrit <= 40% (Hgb <= 12 g/dl) in infants with moderate to severe cardiopulmonary disease.
2. Consider transfusion for hematocrit <= 35% (Hgb <= 10 g/dl) in infants with mild residual lung disease requiring any of the following:
    1. Mechanical ventilation at low settings.
    2. Hood O_2 or diuretic therapy.
    3. Bronchodilator therapy.
    4. Significant apnea or bradycardia.

NOTE: In acutely ill infants <=1000 grams a record should be kept of blood volume withdrawn. If more than 10% of their blood volume (10 cc/kg) is removed, replacement should be considered.

Table 1. Guidelines for Small-volume RBC Transfusions to Neonates

• Maintain HCT >0.40 (>40%) for *severe* cardiopulmonary disease
• Maintain HCT >0.30 (>30%) for *moderate* cardiopulmonary disease
• Maintain HCT >0.30 (>30%) for *major* surgery
• Maintain HCT >0.25 (>25%) for *symptomatic* anemia
—Unexplained breathing disorders
—Unexplained abnormal vital signs
—Unexplained poor growth
—Unexplained diminished activity

Stable Growing Infants:

1. Transfuse for heelstick hematocrit < 20% (Hgb <=6.5 g/dl).
2. Consider transfusion for hematocrit <=30% (Hgb <=10 g/dl) with the following symptoms or situations:
    1. Onset or increased severity of apneic or bradycardic spells.
    2. Sustained tachycardia (>=180) or tachypnea (>=380).
    3. Poor weight gain (<10 gm/day), for the prior 4-day period on adequate caloric intake.
    4. If having surgery.

BLOOD PRODUCTS:

- Packed red blood cells and platelets must be CMV negative and irradiated.
- Fresh frozen plasma (FFP) must be irradiated.
- Transfusion should be 10-15 cc/kg of packed red blood cells from a common donor unit. Order 10 cc extra PRBC's to fill the IV line.
- Multidose units are available for 28-35 days (dependent on anticoagulant).
- ABO, Rh and antibody, and cross match must be performed on an initial pre-transfusion sample for neonates. Additional ABO and Rh testing is not required during their first 4 months of life. Crossmatching of subsequent units during this 4 month period will only be necessary if the patient demonstrated unexpected serum antibody in the first sample. Blood Bank will alert you of this.

  Directed Donation:

  - Directed donations are possible. Please contact Blood bank for further information.
  - Directed donation **cannot** be done on an emergency basis.
  - Mothers of infants may **not** donate for six weeks after delivery.
  - Procedure:
    - For any preterm infant <1500gm, or Term infant who may require blood transfusion, provide the father with the blood bank donation request.
    - Inquire about direct transfusion if possible .

POLYCYTHEMIA:

- A hematocrit > 65% (Hgb > 21.5 g/dl) by heel stick requires a venous hematocrit for confirmation.
- Symptoms of polycythemia may include: respiratory distress, cyanosis, hypoglycemia, lethargy/poor feeding, apnea.

- Do a dilutional exchange during the first 24 hours of life when the venous hematocrit is >=70 in an a symptomatic infant and >=65 in a symptomatic infant. Decisions on dilutional exchange transfusions are based on a hematocrit.
- Dilutional exchange is done by removal of a determined volume of blood and replacement using 5% albumin or normal saline to achieve a goal hematocrit.

$$\text{VOLUME of EXCHANGE (ML)} = \frac{\text{Est. Blood volume X wt (Observe Hct - Desired Hct)}}{\text{Observed Hct}}$$

THROMBOCYTOPENIA:

- Transfuse any sick preterm infant <1500gm when platelet count <=100,000 in the first 7 days of life
- Transfuse any platelet count <=50,000 accompanied by oozing or bleeding (ex. blood in urine, stool, tracheal aspirate).
- If indomethacin therapy is required, transfuse for platelet count <=100,000.
- Need to consider etiologies; in the newborn- alloimmune, congenital infection, sepsis, preeclampsia etc., in older neonates- sepsis (especially yeast), consumption, NEC, etc..

UNCONJUGATED HYPERBILIRUBINEMIA

Guidelines have been developed for management of hyperbilirubinemia in healthy, a symptomatic, term infants ((AAP Guide line 1995)). However, the risks of adverse effects due to hyperbilirubinemia increase with the degree of prematurity and in patients who are ill, and decrease with advancing chronologic age. Risks also vary depending on etiology (ex., higher in hemolytic disease). Therefore, management decisions should depend on the individual clinical situation.

EXAMPLES OF INTERVENTIONS FOR HYPERBILIRUBINEMIA

	"Healthy"		"Sick"	
Weight	**Consider Phototherapy**	**Consider Exchange Transfusion**	**Consider Phototherapy**	**Consider Exchange Transfusion**
<1000 gm.	5 - 7	Variable	4 - 6	Variable
1000 - 1500 gm.	7 - 10	Variable	6 - 8	Variable
1501 - 2000 gm.	10 - 12	Variable	8 - 10	Variable
2001 - 2500 gm.	12 - 15	Variable	10 - 12	Variable
>2500 gm.	15 - 18	20 - 25	12 - 15	18 - 20

- Quick-guide for preemies: if indirect bilirubin > (weight * 5), start thinking about phototherapy
- Never treat **significant** hyperbilirubinemia with bili-blanket alone; always start with combination phototherapy. The goal of phototherapy is to avoid exchange transfusion. Always discuss need for exchange transfusion with fellow or attending.
- REMEMBER: Phototherapy increases insensible water losses. Infants may need a 10-20% increase in their IV fluids. Follow their hydration status closely. Fluid losses may be considerably less with the bili-blanket.

7-INFECTIOUS DISEASES

SUSPECTED SEPSIS

- Clinical Signs of Sepsis:
- Hyper- or hypothermia
- Apnea
- Respiratory distress
- Lethargy
- Irritability
- Hyper- or hypoglycemia

- Leukopenia (WBC <5,000)
- Leukocytosis (WBC >30,000)
- Thrombocytopenia
- Acidosis
- Vomiting/diarrhea
- Abdominal distention

Work-up:

- Thorough physical exam looking for potential sites of infection.
- Blood cultures- central line, peripheral site.
- Urine culture (suprapubic or cath), in infants >3 days of age.
- Culture of any draining wounds.
- Spinal tap (if stable and antibiotics are being started or if + blood culture).
- Total WBC and manual differential. Neutropenia is ominous (ANC < 2000 sepsis likely).
- Platelet count.
- Chest x-ray.
- Viral cultures as necessary particularly during known outbreaks or perinatal exposure (liver enzymes may provide a good screen).

Therapy:

- < 1 week: Ampicillin and Gentamicin (sometimes Cefotaxime if urine output a concern).
- > 1 week age or indwelling catheters: oxacillin or vancomycin and gentamicin or cefotaxime (should not use vancomycin and

gentamicin as a combination unless necessary as determined by resistance profile).

- NEC with suspected perforation: may add anaerobic coverage (metronidazole or clindamycin).
- General Length of Therapy:

    - Proven sepsis 7-14 days (depending on organism)
    - Meningitis 14-21 days
    - NEC 7-10 days

NOTE: If the infant is already on antibiotics and is not respond to these or has additional symptoms, another work-up should be done and the antibiotic status should be reviewed and discussed with the fellow or attending. Consider yeast as an etiology, especially with thrombocytopenia.

UNTREATED GC INFECTION

Infants born to mothers with active, untreated GC infection will usually not develop gonococcal ophthalmia if eye prophylaxsis is correctly given. However, there have been reported cases of both eye involvement and disseminated disease, so treatment is recommended.

Single dose ceftriaxone IV or IM (25-50 mg/kg <2500 gm., 125 mg maximum dose)

or

Single dose cefotaxime IV or IM (100 mg/kg)

Note: Ceftriaxone binds avidly to albumin binding sites normally occupied by billirubin, and has been associated with hyperbilirubinemia in neonates. Use with caution.

UNTREATED CHLAMYDIA INFECTION

Infants born to mothers with active chlamydial infection are at risk for the development of conjunctivitis and pneumonia. Prophylactic treatment has been recommended for these infants.

Erytrhromycin suspension (EES) 50 mg/kg/d ¸ TID or QID x 14 days

Treatment can be delayed to allow establishment of feeds.
Oral sulfonamide is an alternative and may be given after the immediate newborn period.

RSV PROPHYLAXSIS

Some premature infants discharged during RSV season are candidates for RSV prophylaxsis with RSV immunoglobulin. Guidelines used at JHU for the 1998-1999 season are below. RSV IG is not recommended for use in children with cardiac disease.

Premature and no CLD	<26 wk	**Respigam** or Synagis until 12 m.o.
	26-28 wk	Synagis until 12 m.o.
	29-31 wk	Synagis until 6 m.o.
	32-35 wk	Consider Synagis if other risk factors*
CLD and <2 years old	Severe	**Respigam** or Synagis
	Immunodeficient, 0_2 dependent, diuretics, chronic tachypnea, systemic steroids	
	Less Severe	**Synagis** or Respigam
	Recent 0_2 use, inhaled steroids, prior severe RSV disease	

* Smoking, daycare, multiple births, other children in the household.

IMMUNIZATIONS:

	Birth	Hepatitis B + BCG

	1 Month	Hepatitis B
	2 Months	Hemophilus Influenza B DTaP IPV
	4 Months	Hemophilus Influenza B DTaP IPV
	6 Months	Hepatitis B DTaP

Additional considerations:

Influenza–Preterm infants who develop chronic respiratory disease should be given influenza immunization in the fall once they reach 6 months of age. Only "split virus", sub virion or purified surface antigen, vaccines should be given in children less than 13 years of age. Two doses, given 1 month apart, are recommended for children receiving the vaccine for the first time. Dosing for 6-35 m.o. is generally 0.25 ml (may vary with product–check package insert).

8- NUTRITION

TPN /HYPERALIMENTATION

Indications:

- The VLBW infant
- Major GI anomalies or surgical disease
- Necrotizing enterocolitis (NEC)
- Severe respiratory disease
- Supplementation during slow advancement of enteral feeds

Caloric goals in the VLBW infant:

- 50-55 kcal/kg/Day 3
- 65-75 kcal/kg/Day 5
- 85-90 kcal/kg/Day 7

PAS Guidelines	Advancement		Goal
	≤1000 gms	>1000 gms	
Protein	1.0 1.0 gm/kg/day 40 cc/kg	1.0 gm/kg/day	2.5-3 gm/kg/day (protein should be 80 –120cc /kg
Lipid	0.5 gm/kg/day	1.0 gm/kg/day	3 gm/kg/day (IV fat should not exceed 50% of total calories)
Complications	Electrolyte and glucose disturbances, hyperlipidemia, cholestatic jaundice and cirrhosis, osteopenia, infection, as well as complications related to central lines.		

Electrolyte Requirements:

2nd day

Na: 3 - 5 mEq/kg/d

K: 1 - 2 mEq/kg/d

Cl: as indicated by labs

Acetate: as indicated by labs

Mg: 0.25 mEq/kg/d

Ca: max unless contraindicated

PO_4: max unless contraindicated

Remove copper and manganese from the trace elements in direct hyperbilirubinemia. Direct > 25% of TSB

Nutrition Laboratory Monitoring:

Initial: **Daily** Basic Metabolic Panel (BMP) until full TPN concentrations 120cc/kg.
Once stable: **Weekly** Metabolic Panel (U/E), CO_2, PO_4,Ca

Every other week: LFT and Bone profile. To bick up early cholestasis and osteopenea of prematurity

Enteral Feeding with EBM or formula:
Weekly: CBC and reticulocyte count.
Every 1-2 weeks: U/E, CO_2, PO_4.

ENTERAL FEEDS

Breast Milk vs. Formula:

Mother's own preterm breast milk is best. However, because it does **not** provide the adequate calcium and phosphorus needed by preterm infants, human milk fortifier is frequently added after full volume feeds achieved. When human milk is not available, there are two high Ca and PO_4 preterm formulas that can be used: *Similac Special Care (SSC) and Premature formula like prenan* , either formula may be used at any time if available.

Breast milk **contraindications**:

Absolute- Maternal HIV infection
Relative- Maternal drug & alcohol use

(check with clinical pharmacist)

Feeding Administration: (see feeding protocol)

Feeding may be started by nipple or gavage (bolus or continuous) depending on the condition and size of the infant. Bolus tube feedings are usually begun if the infant is >28 wks but <34 wks gestation. Continuous gastric feeds may be beneficial to very small infants, those with reflux, or those recovering from NEC or GI surgery.

Nutrition Goals:

Calories: 120 kcal/kg/day.
Protein: 3 - 3.5 gm/kg/day.

Feeding Volumes:

Infants >28 wks gestation may start on full-strength formula unless contraindicated. In general, babies will advance to full-strength formula within 48 hours. The volume of any bolus feeding should be started at 1-3 cc/kg/feeding (1 cc/kg/hr for continuous feeds). Feeding intervals will vary with birth weight and tolerance of the infant. Some very preterm infants may be placed on minimal feeds for "gut stimulation."

Size	**Interval**
<1000 grams –1500grams	q 2 hours or continuous drip
>1500 grams	q 3 hours

NOTE:

1. 1. Volume and concentration **should not** be increased at the same time.
2. 2. Advance no more than 20 cc/kg/day.
3. 3. Do not start hypercaloric formula (>20 kcal/oz) until infant is well established on full volume feeds.
4. 4. Enteral medications are not usually added until babies are on substantial enteral feeds (usually full feeds).

Weight	**Examples of timing to full feeds: [120 Kcal/kg/d]**
<750 grams	14 days
750-1000 grams	10-14 days
1000-1250 grams	7-10 days
1250-1500 grams	7 days
1500-2000 grams	5-7 days
>2000 grams	3-5 days

NOTE:

1. The nurses are astute at spotting signs of feeding intolerance or the need to advance the feeds more quickly. Their advice should be taken seriously.
2. Always examine the baby when there are signs of feeding intolerance (i.e. residuals, distention, vomiting, diarrhea, heme-positive stools). Stop or reduce feedings if these should occur. Write specific orders - never "as tolerated."

Vitamins and Iron:

1. Babies receiving Premature Similac Special Care, or breast milk with fortifier do not need multivitamin supplement.
2. When infant is on full enteral feeds, begin iron supplementation of 3 - 6 mg/kg/d usually not done before 2-3 weeks of age.

(Pediatric Clinical pharmacist is available for questions on –71500

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9-VASCULAR ACCESS

Peripheral Intravenous Line (PIV):

1. 1. May give up to 12.5% dextrose solution. Used for fluids, meds, and transfusions.

Percutaneous Central Venous Catheter (PCVC):

2. 2. Physician must get consent for line placement.
3. 3. Placed by specifically trained staff (Pead. Surgeon)
4. 4. Fellow or attending must approve need for PCVC.
5. 5. Cannot be used for blood products.
6. 6. Fluids should contain 0.5 unit heparin/cc.
7. 7. Verify placement by X-ray: tip should be between clavicles and right atrium at the junction of SVC/RA (this corresponds to 4th rib).

Umbilical Venous Catheter (UVC):

Equiſpment

1- 1- Umbilical catheter
2- 2- Normal saline
3- 3- Stopcock
4- 4- Syringe
5- 5- Knife blade
6- 6- Umbilical tape
7- 7- Hemostats

Procedure

1- Swab with N/S and betadine
2- Tie a knot at the skin umbilical junction snugly with umbilical tape
3- Cut the cord off about 1cm from tie off
4- If a significant bleeding occurs, control with a hemostat.
5- Identify the u.vein (thin at12 o,clock) and artery (thick wall, 4&8 o'clock position)

8. Catheter size 3.5 Fr for VLBW infants, otherwise 5.0 Fr may be used. Double lumen catheters are available for sicker babies. However, there may be an increased risk of thrombosis with these, so placement of a double lumen line should be discussed with fellow or attending.
9. Lines should be placed above the diaphragm in the IVC or right atrium (ideal is junction of IVC/RA which corresponds to T8-9). Verify placement by X-ray and document in procedure note.
10. . Fluids should contain 0.5 unit heparin/cc.

11. Unless approved by the fellow or attending, the line should be removed by 72 hours.
12. **Caution:** Never allow UV catheter to be "open to air" due to risk of air embolus.
13. Calculate the catheter length to be inserted:

Using the shoulder-umbilical length:

(measured in a line dropped perpendicular from the shoulder to the level of the umbilicus), determine the insertion depth using the graph below. Be sure to add the length of the remaining cord to the calculated insertion depth.
Please review Diagram from Harriet Lane Handbook, 15th Edition, 1999, Mosby-Year Book, Inc., p.54

Or

(2/3 of shoulder to umbilicus length + umbilical stump)

Umbilical Artery Catheter (UAC):

1. Catheter size 3.5 Fr for VLBW infants, otherwise a 5.0 Fr may be used.
2. Lines can be placed in low (L3 - L5) or high (T6 - T9) position. Verify placement by X-ray and document in procedure note.
3. Fluids are usually NS with 0.5 unit heparin /cc. Never run fluids <D5W or <½NS due to hypo-osmolarity.
4. Initiation of feedings after line removal should be discussed with fellow or attending. (Infants are not usually fed until 24 hours after the line is removed.)
5. Calculate the catheter length to be inserted:

Using the shoulder-umbilical length

(measured in a line dropped perpendicular from the shoulder to the level of the umbilicus), determine the insertion depth using the graph. Be sure to add the length of the remaining cord to the calculated insertion depth (high line = tip just above diaphragm, low line = tip just above bifurcation):
Please review Diagram from Harriet Lane Handbook, 15th Edition, 1999, Mosby-Yearbook, Inc., p. 52

Using the birth weight regression formula:

High line (between T6 –T10) UA catheter length (cm) = [3 X BW (kg)] + 9
Low line: UA catheter length (cm) = BW (kg) + 7

Surgical Central Lines:

1. GPS physician must get consent for line placement.
2. Fluids should contain 1 unit heparin /cc.
3. Verify placement by x-ray.
4. Need fellow or attending order to give blood products through central line.

Percutaneous Arterial Line:

1. Usually run NS with 0.5 unit heparin /cc.
2. Toes and fingers should be exposed to follow extremity perfusion.
3. Never run fluid <D5W or <½NS.

****PROCEDURE NOTES**

Procedure notes are required for: arterial lines, lumbar puncture, chest tubes, intubation, thoracentesis, pericardiocentesis, paracentesis, suprapubic tap, ventricular tap, exchange transfusions, and minor surgical procedures.

Procedure Notes Should Include:

1. Indication.
2. Consent: obtained or not (if not, explain why, i.e., "emergency").
3. Description of the procedure.
4. Complications.
5. Verification of tube/line position by X-ray.

10- **NTRACRANIAL HEMORRHAGE**

Incidence

30% of all newborns less than 32 weeks or weighing less than 1500 grams at birth. The probability of hemorrhage increases with decreasing gestational age.

Grading

Ultrasound findings are described based on CT scan data from Papile. The grade of hemorrhage for a given patient is the maximum degree of bleeding seen by 2 weeks of age.

- Grade I Subependymal (SEH) or germinal matrix hemorrhage only.
- Grade II SEH plus intraventricular hemorrhage (IVH).
- Grade III IVH resulting in ventriculomegaly.
- Grade IV Parenchymal hemorrhage with or without IVH.
- PVL Periventricular Leukomalacia - Later finding suggesting ischemic injury with necrosis of the periventricular white matter.

Recommendations for Ultrasound Diagnosis

Infants <32 weeks gestation:

- Initial sonogram within the first week and repeated the second week.
- If the initial exams are normal, repeat at 6 weeks of age, at 40 weeks corrected, or prior to discharge, whichever comes first (you're looking for PVL).
- If bleed is present, repeat at 1 week and then every 1-2 weeks until ventricles are stable.
- Additional ultrasound examinations may be done for clinical indications.

Infants >32 weeks gestation:

- Cranial ultrasound examinations are performed for clinical indications, but not on a routine basis.

NEONATAL SEIZURES

Secondary to immature cortical organization (i.e., incomplete synaptogenesis, neurite outgrowth, and myelination), neonatal seizures do not often present as well-organized, tonic-clonic activity.

"Subtle" ictal activity in the newborn may present as:

- **Ocular phenomena**: Tonic eye deviation (term), sustained eye opening with fixation (pre-term)
- **Oral/Lingual/Buccal movements:** Chewing, cry/grimace, facial "wincing".
- **Limb movements:** Stepping, "bicycling" (pedaling movement of hands and feet)
- **Autonomic abnormalities :** Tachycardia, bradycardia, tachypnea
- **Apnea** (particularly in term infants)

Neonates may also demonstrate tonic, myoclonic, or clonic activity.

Etiologies for seizure activity in our NICU population include:

- Hypoxic-ischemic injury
- Intracranial hemorrhage (IVH, subarachnoid hemorrhage, subdural hemorrhage)
- Electrolyte abnormalities (sodium, calcium, magnesium)
- Hypoglycemia
- Drug withdrawal
- Inborn errors of metabolism
- Intrauterine or perinatal infection (CMV, toxoplasmosis, herpes simplex, bacterial meningitis)
- CNS developmental defects (hydrocephalus, lissencephaly)

Work-up:

1. Clinical exam-look for evidence of birth trauma, infection, congenital anomalies in addition to seizure activity.
2. Radiography - cranial CT (preferred) or ultrasound.
3. Electrolytes/calcium/phosphorus/glucose/magnesium.
4. Urine toxicology screen
5. Inborn error studies-serum amino acids/urine organic acids/CSF lactate/serum ammonia
6. Lumbar puncture (for meningitis/metabolic disease).
7. Cultures (blood, urine, CSF, veiscle for bacterial/viral pathogens) and titers (Toxo IgM).
8. CBC/Coagulation studies (PT/PTT) in cases of intracranial hemorrhage.
9. EEG-may not detect all epileptic discharges, but is useful in correlating subtle signs with possible seizure activity, detecting seizures in paralyzed infants, and defining interictal background (valuable for prognosis).

Treatment:

1. Correct all metabolic abnormalities (IV glucose, electrolyte replacement).
2. Antibiotics/acyclovir if sepsis/meningitis/HSV is suspected.
3. Correct any abnormalities in oxygenation, ventilation, and perfusion.
4. Surgical management (if indicated).
5. Anticonvulsant therapy

- Phenobarbitol: 20 mg/kg IV loading dose over 10-15 minutes. If seizures persist, bolus of 5 mg/kg to achieve serum level of greater than 40 mcg/ml. Myocardial and

respiratory depression as well as sedation can occur even at the low end of this range, resulting in increased ventilator and inotropic support as well as an altered neurological exam. The dose of phenobarbitol administered roughly equals the serum concentration in mg/ml (i.e., 20 mg/kg bolus results in a serum level of 20 mcg/ml). However, in infants with significant liver injury (i.e., hypoxic-ischmeic encephalopathy), higher serum levels may be seen with lower dosed. Maintenance dose 3-4 mg/kg/day.

- Phosphenytoin: After continued, prolonged episodes of seizure activity on maximal phenobarbitol therapy. Load with 20 mg/kg bolus (infuse no faster than 1 mg/kg/minute, watch for cardiac arrhythmias). The maintenance dose is 5 mg/kg/day.
- Benzodiazepines: For brief, episodic events, diazepam (0.5 mg/kg/dose) or lorazepam (0.1 mg/kg/dose) may be used. In cases of status epilepticus or severe refractory seizures, a midazolam drip (therapeutic range: 0.1-0.4 mg/kg/hr) should be initiated.

Discuss with NICU fellow/attending or Peds Neurology resident/attending before beginning any anticonvulsant therapy.

ROP, HEARING SCREENING, DEVELOPMENTAL FOLLOW-UP,AND DISCHARGE PLANNING

Guidelines for Eye Exams

- Eye exams are done routinely to R/O retinopathy of prematurity (ROP) on:
    - All patients below 1600 grams even if they never required supplemental O_2.
    - Babies who received supplemental Oxygen > 50 days at any gestational age.
    - Post-ECMO babies.
- The first exam should be scheduled at 4-6 weeks of age in preterms. Judgment should be used on very small (<1000 gm) or sick infants as to when to schedule the first exam.
- Follow-up Eye Exams:
    - If the retina is incompletely vascularized and no ROP is found, a repeat exam will be done in 2 weeks.
    - If mild retinopathy is found, exam is repeated every 2 weeks until regression is unequivocal.
    - If pre-threshold ROP (Zone 1: immature or any stage; Zone 2: Stage 2 or 3), repeat within 1 week. The decision to offer laser therapy will be made on an individual basis.

NOTE: A physician order must be written for the dilating solution prior to the exam.

Example: Eye exam on _____

Cyclomydril II GTTS O.U. q 10 min ´ 2 starting at _____

- Feedings should be held around the time of the eye exam.
- Babies are usually not discharged from the NICU in less than 24 hours after eye exam or treatment.

***REMEMBER-** Observe babies closely after eye medications and eye exam for apnea and bradycardia, significant tachycardia, and feeding intolerance.

Hearing Screening

The state of Maryland has mandated universal hearing screening for newborns. In this NICU infants have Brainstem Auditory Evoked Responses (BAERs), preferably prior to discharge or transfer. This testing is can be arranged by the Case Manager (Beth Diehl, RN). Another screening tool is Transient Evoked Otoacoustic Emissions (TEOAEs) , which is easier to perform and may soon be available in our unit.

Discharge Planning and Developmental Follow-up

Discharge planning is often a long and complicated process and may take weeks to accomplish with the more difficult infants. There should be ongoing discussion with the primary nurse, fellow or attending, and social worker. Family Discharge Planning Rounds are held on Monday at 1:00 pm. (SAR's attend).

The following are needed prior to discharge:

- Before most infants go home, parental teaching of infant care, CPR, special equipment, etc. is done by the nursing staff. Adequate time has to be given for this to occur. Notify charge nurse or primary nurse.
- A pediatrician or clinic must be identified for primary care of each patient.
- **Contact the pediatrician prior to discharge** as the summary is likely to arrive after the first visit. This should make discharges go smoothly. If not otherwise arranged, this is the responsibility of the intern.

- Changes in medications or other types of care should not be done just prior to discharge. The infant must be stable with current medications and care. Prescriptions should be written in advance so parents can bring them in for teaching prior to discharge.
- All special follow-up needs (i.e., head sonograms, BAER's, repeat eye exams, etc.) should be scheduled prior to discharge.
- Home monitoring may be discussed on an individual basis.
- Immunizations, if appropriate, are usually given.
- Parents may room-in with the infant after teaching is completed.
- Developmental exams on all babies at risk (<1200 gm., Grade III-IV IVH, congenital anomalies, chromosomal anomalies and syndromes, or any other condition or history that may place the child at risk) are usually performed by Dr. Marilee Allen prior to discharge. Follow-up clinic appointments at the Kennedy Krieger Institute can be made through Beth Diehl, RN (Discharge Coordinator) or the Clinic Coordinator at 550-9142.
- An increasing number of babies cared for in our unit are being transferred back to referring hospitals, or Mt. Washington for convalescent care. Eligibility for Mt. Washington small baby program includes medical stability (non-ventilated +/- O_2 , enteral feeds, etc.) and weight of 1350 gm. Eligibility for transfer to other units depends on the level of care and services provided by the individual units.

Discharge Checklist

Name _____

DOB _____ GA _____ Birth wt. _____

Discharge criteria:

____Medically stable
____Gaining weight
____Nippling all feeds
____Temperature stable in bassinet

____Famil
y ready

Anticipate discharge 2-3 weeks in advance. Discharge as early as 34 post-conceptional age (PCA) for infants without major problems. Begin discharge planning by 32 weeks.
Calendar date for 32 weeks PCA:

Anticipating Discharge:

__Primary care pediatrician name
__20 kcal/oz formula with Fe started
__Nipple feeds started nippling all
__Weaned to bassinet
__Medication changes made for optimal home care management: started completed
__Caffeine/theophylline discontinued. Date discontinued
__Family notified and involved in discharge plan

Pre-discharge studies:

__Head sonogram ordered done
__Neurodevelopmental exam ordered done
__BAERS scheduled done
__Hct/reticulocyte count ordered done
__Head circumference measured
__ROP exam scheduled done
__Metabolic screens done dates:

Medical discharge checklist. Division of Neonatology, The Johns Hopkins Hospital

Record Keeping

Discharges:

One page discharge summary outline must be completed 24 hours prior to discharge of all babies. This summary should be given to Joy Peterson in the Neonatology office. **Please, do not place in the chart.** The summary sheet may be completed by the intern. If a weekend discharge is anticipated, the summary sheet should be completed on Friday. In the rare case of an unscheduled weekend discharge, the summary sheet should be completed by the covering intern.

PLEASE INCLUDE: The private physicians name, telephone number, fax number, and address, as well as recommendations regarding subspecialty and developmental follow-up. We are trying to fax the discharge summary to the private physician within 24 hours of discharge.

Transfers:

A **written transfer summary** should be written in the chart by the intern for all babies being transferred to another hospital including Mt. Washington. This written summary should be completed the evening before transfer since transfers are frequently done around 8:00 a.m.

A dictated discharge summary may or may not accompany the infant on the day of transfer.

Contacting the Private Pediatrician:

If there is a private pediatrician, a call should be made to the pediatrician's office within 24 hours to inform the physician that the patient has been admitted to the NICU. The social workers, Linda Cronin and Jan Collins, or Beth Diehl, can help find out the name and number of the private pediatrician. It is not necessary to talk directly to the pediatrician. This is a great time to obtain the address and fax number from the secretary.

If the infant is complicated, a periodic update should be done.

INFANT DEATH

Infant death is a sad event in any NICU. Nonetheless, the following paperwork needs to be completed in a timely and accurate manner:

Death Certificate:

- Bed Control in Admitting will complete items 2,3,4a and 4b.

- MDs are responsible for items 1 and 23-30 only. Do not fill in other information.
- All information must be printed in **BLACK** ink only.
- Item #1 requires the MD to print the deceased's First Name (if known), followed by the Middle Name and then the Last Name. If the First or Middle Name are not known, leave a large enough gap in the appropriate place, so that it can be filled in at a later point.
- Cross-outs or white-outs will **NOT** be accepted.
- Do not use abbreviations at all, including numerical or letter abbreviations for the date.
- Time intervals must be filled in.
- Item 29c must include your Maryland Physician **License Number**. All house-staff without a Maryland license must write RES-000 in this box.
- The physician declaring the death signs the death certificate.

Death note

Death information packet: It consists of the following forms:

- Release of property - cross out form and write "Not applicable"
- Items 1, 2, and 3 form:
    - Item 1 - completed by nurse
    - Item 2 - completed by physician
    - Ignore the rest of items

- Organ and tissue consent form: ignore the form
- Authorization for post mortem examination - completed by the attending physician

NOTE: There is no need to fill the death information packet out if parents do not want post or hospital disposal. Hospital disposal is offered up to 30 days. No remains are given to the family if they choose hospital disposal.

Remembrance Packet

There is a special remembrance packet (usually used for pre-viable infants) that the nurses will complete for the families. This packet contains a memory sheet (for information such as a length and birth weight and the footprints), a dress, gown and hat, and a pamphlet containing information regarding Compassionate Friends, a parent bereavement support group.