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[The Neonatal Handbook can be found online: www.ttuhs.edu/fostersom/pediatrics/neonatology/presentations.aspx need to verify this site]
INTRODUCTION:

Welcome to the El Paso Children’s Hospital Neonatal Intensive Care Nursery (NICU). The NICU is regarded as one of the most challenging rotations in the pediatric residency. While you develop your understanding of newborn physiology and pathophysiology, you will also learn to be an active, assertive and effective team member. You are supported by pediatric/neonatology faculty in house 24 hours, neonatal nurse practitioners, senior residents, highly skilled nurses, respiratory therapists, case managers, social workers and physical medicine specialists. This manual cannot and is not intended to take the place of recognized textbooks. It is presently still a work in progress so any suggestions for its progressive growth and improvement are welcome. Your ongoing education should include reference to one or more of the listed reference texts. You will be given a suggested reading schedule from Workbook in Practical Neonatology, Fourth Edition, by Polin and Yoder. You should have completed the text by the end of your 2nd year. Good care requires astute observation and clear educated thinking. The main thrust of this rotation is problem solving. Each infant’s problems should be considered on an individual basis. This is an area where knowledge acquisition is applied to problem-solving and effectively communicated.

El Paso Children’s Hospital strives to delivery family centered care. This mission involves including the parents as part of the medical team. In this process, it is important for mothers and families to know and trust the physician. Since this may be the first time to interface with a family introduce yourself. Your TTUHSC name tag should be readily visible on your blue scrubs. Please give the mother the prepared handout with all the physician’s pictures. Circle your name and tell the parents that you are supervised by a faculty neonatologist. Circle their name as well on the paper if you know who it is. Please speak with the mother on a daily basis even if by telephone. Please record that you spoke with the mother/family in the progress notes and place the actual date (no “will talk to the parents or talked to the parents today”).

Nurseries:
University Medical Center has approximately 3,500 deliveries a year. The infants requiring move than level I newborn care are transferred to El Paso Children’s Hospital NICU which delivers level II care in the 26 bed intermediate care nursery (IMCN) and level III care in the 24 bed intensive care nursery (ICN).

Admissions policies the ICN: (1:2-1:3 nursing to patient ratio)
- Infants < 1,500 grams
- All postoperative patients
- Most preoperative patients requiring intensive care
- Infants intubated in the delivery room other than just for meconium
- Any infant requiring over 30% O2 or NC flow greater than 500ml/min
- Respiratory distress not improving with CO2 > 55-60
- Unstable meningitis, sepsis, or necrotizing enterocolitis
- Asphyxiated infants at risk for Hypoxic Ischemic Encephalopathy
- Unstable Seizures
- Severe or Multiple Congenital Anomalies
- Suspected or known congenital heart disease requiring intensive care

Admission Policies to the IMCN: (1:4 -1:5 nurse to patient ratio):
- GA < 35 wks
- Wgt < 2,250 grams
- Suspected Sepsis
- Any infant requiring O2
- Any infant with glucoses < 30 mg%
- Persistent glucoses < 40 mg%
- Any infant requiring monitoring:
  - Stable suspected apnea or seizures
  - Any infant requiring Naloxone in the immediate newborn period
  - Symptomatic polycythemia
  - Infants requiring IV fluids
  - Tachypnea
  - Congenital anomalies requiring monitoring
- If there is any question about admission, please call the attending Neonatologist.
Pediatric Resident NICU Rotation and Educational Experience

The overall goal for the pediatric or family practice resident in the special care nursery rotation is to obtain experience in recognition, assessment and care of high-risk, low-birth-weight, preterm and term neonates who require intensive or intermediate care, surgery or evaluation by other pediatric specialists. Initially the interns care will be introduced to ill term or near term newborns and during each additional rotation will increase the experience of caring for more ill newborns.

Contacts
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Teaching Faculty: Tess Ambat, MD, Merle Ipson, MD, Angela Flores, MD, and Sadhana Chheda, MD.
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Maria Garcia Secretary Division of Neonatology
Social Services: Herlinda Gutierrez
Case Management: In-patient Mary Beth Sales RN and Out-patient Norma Garcia RN
Rehabilitation: Olivia Hernandez
Dietary: Dietary Chief Paola Llerena RD and Amanda Zimmerman, RD NICU Dietician
Pharmacy: Erika Estrada, PharmD.
Lab Director: Jane Sanchez MT MBA (242-8358)

A. First Year Pediatric Residents

The following first year goals are focused on the special learning needs of the pediatric or family practice intern. These should allow the resident to gain experience in the care of ill intermediate care infants during the first rotation and experience with the sicker ICN neonate in the second rotation. The expectation of a first year resident is medical knowledge and comprehension of the newborn pathophysiology. The first year residents are expected to develop their own differential diagnoses and it is anticipated they will need some guidance in the formulation of management plans.

COMPETENCIES

Competency 1- Patient Care: Provide family-centered patient care that is compassionate and effective for the treatment of health problems and the promotion of health in the sick or preterm newborn. The resident should use a logical and appropriate approach to the assessment and daily management of seriously ill neonates and their families, under the guidance of a neonatologist. They should use evidence-base decision-making and problems solving skills. They should provide emotional, social and culturally sensitive support to families of the SCN infants.

Goals/Competencies the residents are expected to obtain:

A. Goal: gathering data by physical examination. Perform an appropriate physical exam, demonstrating technical proficiency and sensitivity to the needs of the infant and family, as well as the clinical situation.

Learning Objectives:
1) Perform physical examination of the preterm, term, and sick neonate of all post-conceptual ages. Recognize how these exams differ from older infants and children.
2) Assess the estimated gestational age using the Ballard exam on all newborns admitted under your care and know the limitations of the Ballard exam.
3) Demonstrate examination strategies for evaluating the critically ill neonate e.g., the accurate examination of an infant with an acute abdomen.

B. Goal: obtaining a thorough family and maternal history. This includes pertinent information regarding prior pregnancies, current pregnancy and events related to labor and delivery.

Learning Objectives:
1) Identify pertinent maternal prenatal labs and conditions and document this information in the SOC EMR and verbally on rounds.
2) Recount the events of the delivery in an accurate, concise/organized manner in the EMR and verbally on rounds. The intern should demonstrate an understanding of the consequences of perinatal events.

C. Goal: using diagnostic studies. This includes procedures or laboratory data such radiological procedures, surgical diagnostic procedures and laboratory procedures to assess patients and monitor treatment while understanding the potential invasiveness,
Learning Objectives:

1) Obtain diagnostic studies at an appropriate time and in an appropriate sequence.
2) Select invasive or painful methods only when necessary.
3) Interpret common test results in terms of underlying pathophysiology, disease severity and clinical context of specific patient.
4) Recognize the need for phototherapy, monitor bilirubin levels appropriately.
5) Know or be able to locate age appropriate normal values for common tests.
6) Explain medical tests and procedures to the parents in terms they can understand, including indications, contraindications, potential complications, and results; provide information in a supportive manner that enables them to participate actively in care plans.

D. **Goal: using and understanding how to use the physiologic monitoring.** This includes special technology and therapeutic modalities used commonly in the care of the fetus and newborn.

Learning objectives:

1) Demonstrate appropriate use and interpretation of data from the following monitoring and therapeutic techniques in the NICU: physiologic monitoring of temperature, pulse, respiration, blood pressure, pulse oximetry, neonatal pain and drug withdrawal scales.

E. **Goal: Under the supervision of a neonatologist, order and understand the indications for, limitations of, and interpretation of laboratory and imaging studies unique to the NICU setting.**

Learning Objectives:

1) Appropriately interpret the following studies:
   1. Serologic and other studies for transplacental infection
   2. Direct and indirect Coombs tests
   3. Neonatal drug screening
   4. Cranial ultrasound for intraventricular hemorrhage
   5. Abdominal X-rays for placement of umbilical catheter
   6. C XR for endotracheal tube placement, air leak, heart, size, and pulmonary vascularity

2) Use appropriately (for age) the following laboratory tests when indicated for patients in the neonatal intensive care setting:
   1. CBC with differential, platelet count, RBC indices
   2. Blood chemistries: electrolytes, glucose, calcium, magnesium, phosphate
   3. Renal function tests
   4. Test of hepatic function (PT, albumin) and damage (liver enzymes, bilirubin)
   5. Serologic tests for infection (e.g., hepatitis, HIV)
   6. Therapeutic drug concentrations
   7. Coagulation studies: platelets, PT/PPTT, fibrinogen, fibrin split products, D-dimers, DIC screen
   8. Arterial, capillary, any venous blood gases and limitations of each source
   9. Detection of bacterial, viral, and fungal pathogens
   10. Urinalysis
   11. CSF analysis
   12. Gram stain
   13. Stool studies
   14. Toxicology screens/drug levels
   15. Other fluid studies (e.g., pleural fluid, joint fluid)
   16. Newborn screening tests

F. **Goal: using therapeutics and medications safely and effectively, applying sound principles of medical practice and professional ethics.** Effectively use common therapies within the scope of neonatology, including a variety of prescription and non-prescription medications, intravenous fluids, and inhalation treatments, as well as special diets and nutritional supplements.

Learning Objectives:

1) Use up-to-date resources, (including our NICU pharmacist), for information on drug selection, dosing, side effects and contraindications, recognizing advantages and limitations of different resources (e.g., pharmacologists, pharmacists, professional colleagues, information from pharmaceutical companies, text books, newsletters and websites).
2) Recognize common causes of medication error, adhere to policies and guidelines established to ensure safe medication use, and participate in efforts to reduce error through systems improvement.
3) Explain the appropriate indications for and potential risks of various blood products (e.g., red blood cell products, platelets concentrates, coagulation factors).
G. **Goal:** Prescribing and performing competently all medical procedures considered essential for the scope of a PL1; be familiar with those procedures commonly used by neonatologists.

**Learning Objectives:**
1) Demonstrate appropriate use of oxygen administration by hood, CPAP assisted ventilation, nasal cannula and high flow nasal cannula, including when to wean.
2) Demonstrate skills necessary to perform endotracheal intubation in the ICN under supervision, including correct head positioning, handling of the laryngoscope.
3) Demonstrate proficiency in basic ventilator management, respond to blood gasses appropriately.
4) Participate in umbilical arterial and venous catheterization.
5) Recognize when an infant needs TPN, and demonstrate competence in ordering central and peripheral TPN.
6) Identify the necessary procedures, equipment, and calculations required for a partial exchange reduction and exchange transfusions.

H. **Goal:** Developing skills in family/patient education and counseling by promoting a therapeutic alliance with families by providing counseling, guidance, and patient education in areas important to child health and disease.

**Learning Objectives:**
1) Counsel families in the presence of the attending, in a supportive manner so they can understand their illness or injury and its treatment, share in decision-making, make informed consent and participate actively in the care plan.
2) Provide effective preventive health care and anticipatory guidance to families.
3) Explain common medical procedures and medical test results to parents.

**Competency 2 - Medical Knowledge:** Understand the scope of established and evolving biomedical, clinical, epidemiological and social-behavioral knowledge needed by a pediatrician; demonstrate the ability to acquire, critically interpret and apply this knowledge in patient care.

**Goals/Competencies the resident are expected to obtain.**

A. **Goal:** Demonstrate the knowledge base expected of general pediatricians caring for seriously ill neonates under the guidance of a neonatologist.

**Learning Objectives:**
1. Demonstrate the ability to access medical information efficiently, evaluate it critically, and apply it appropriately to the care of ill newborns.
2. Demonstrate effective strategies to access the information needed for effective patient care.

B. **Goal:** Common signs and symptoms (NICU). Identify and comprehend under the supervision of a neonatologist, common signs and symptoms of disease in premature and ill newborns.

**Learning Objectives:**
1. Recognize and manage the following general signs and symptoms: feeding problems, history of maternal infection or exposure, hyperthermia, hypothermia, intrauterine growth failure, irritability, jitteriness, large for gestational age, lethargy, poor postnatal weight gain, prematurity (various gestational ages) and formulate a management plan.
2. Demonstrate an understanding of, and attempt to manage the following cardiorespiratory signs and symptoms: apnea, bradycardia, cyanosis, dehydration, heart murmur, hypertension, hypotension, hypovolemia, poor pulses, respiratory distress (flaring, grunting, tachypnea), shock.
3. Exhibit basic recognition of the following dermatologic signs: birthmarks, common skin rashes/conditions, discharge and/or inflammation of the umbilicus, hyper and hypopigmented lesions, proper skin care for extreme prematures.
4. Demonstrate effective strategies to respond appropriately to the following GI/surgical signs and symptoms: abdominal mass, bloody stools, diarrhea, distended abdomen, failure to pass stool, gastric retention or reflux, hepatosplenomegaly, vomiting.
5. Identify the features associated with the following genetic/metabolic signs and symptoms: apparent congenital defect or dysmorphic syndrome, metabolic derangements (glucose, calcium, acid-base, urea, amino acids, etc.).
6. Demonstrate knowledge of the pathophysiology behind and propose treatment plans for the following hematologic signs and symptoms: abnormal bleeding, anemia, jaundice in a premature or seriously ill neonate, neutropenia, petechiae, polycythemia, thrombocytopenia.
7. Identify the following musculoskeletal signs and symptoms when present: birth defects and deformities, birth trauma and related fractures and soft tissue injuries, dislocations.
8. Recognize the presence of the following neurologic signs and symptoms: birth trauma related nerve damage, early signs of neurologic impairment, hypotonia, macrocephaly, microcephaly, seizures, spina bifida.
10. Identify the following renal/urologic signs and symptoms when present on exam: abnormal genitalia, edema, hematuria, oliguria, proteinurea, renal mass.
C. **GOAL: Working with Consultants.** Use consultations and referrals effectively in a variety of settings. Recognize the limits of one’s knowledge and expertise by seeking information needed to answer clinical questions and using consultants and referrals appropriately. Use this process to guide life-long learning plans.

**Learning Objectives:**
1. Demonstrate appropriate use and selection of specialists/consultants.
2. Demonstrate an ability to construct clear questions directed towards the consultant, as well as providing sufficient background information (history, lab reports, etc.) to enable the consultation to be as effective and efficient as possible.
3. Demonstrate the ability to assess, critique and integrate recommendations of the consultant and use them as appropriate in the care of your patient.

**COMPETENCY 3 – Communication Skills:** Demonstrate interpersonal and communication skills that result in information exchange and partnering with patients, their families and professional associates.

Goals/competencies the resident is expected to obtain.

A. **GOAL: Core communication skills.** Effectively and empathetically communicate with children and families.

**Learning Objectives:**
1. Demonstrate effective communication with families to create and sustain a therapeutic relationship across the broad range of socioeconomic and cultural backgrounds.
2. Explain patient care plans and prognoses using words that are easy for the family to understand and avoid medical jargon. Check for mutual understanding of treatment plan and ask if the family has any questions.

B. **GOAL: Professional Communication and Collaboration.** Communicate and collaborate effectively as part of a functional team with physicians, other health professionals, staff, and students.

**Learning Objectives:**
1. Demonstrate the ability to communicate and work in an effective and collaborative manner with:
   - Members of an interdisciplinary health care team.
   - Other healthcare professionals, including those in the community and complementary and alternative medicine providers who are treating the patient.
   - Specialists (when functioning as the referring physician), referring physicians and primary care providers (when functioning as a specialist in the care of children).
   - Support and administrative staff
   - Medical students.
2. Demonstrate the knowledge of the various roles of team members and utilize their skills appropriately.
3. Demonstrate effective interactions with team members by establishing mutually agreed upon goals, roles and procedures (decision making, role and goal negotiation, addressing team differences and conflicts).
4. Demonstrate skill in avoiding and reducing interpersonal conflict.
5. Demonstrate respect, sensitivity and responsiveness to colleagues’ gender, age, ethnicity, culture, religion/spirituality, disabilities, and sexual orientation. Demonstrate thoughtfulness, kindness, honesty, integrity, humility, and fairness in working with peers, other professionals, and staff.
6. Communicate effectively in the following contexts:
   - Brief oral case presentations (e.g., at morning report/check-in, inpatient work rounds, clinic visits; phone contacts with primary provider or consultants).
   - Written, dictated, and computerized medical records (accurate, complete, timely, legal).
   - Oral presentations to healthcare professionals.

C. **GOAL: Medical records.** Maintain accurate, legible, timely, and legally appropriate medical records when caring for patients.

**Learning Objectives:**
1. Demonstrate maintenance of accurate, legible, timely, and legally appropriate medical records including:
   - History, including past medical, family, social history (including use of complementary and alternative therapies), review of systems, and risk assessment.
   - Physical examination appropriate for the conditions.
   - Problem list or working, differential, and final diagnosis.
   - Initial and updated plans.
   - Detailed procedure notes for procedures performed.
   - Accurate, timed record of all medications and fluids given.
   - Results of all studies ordered.
• Condition of patient at the time of office visit, or hospital admission, observation, or discharge.
• Where appropriate, written discharge instructions to the caretakers in a form understandable to them.
• Written documentation of patient education techniques used during the course of treatment.

2. Document in writing in a consistent manner in a fashion that complies with Medicaid/Medicare and HIPAA standards and other legal requirements.

COMPETENCY 4 - Practice-based learning and improvement: Demonstrate knowledge, skills and attitudes needed for continuous self-assessment, using scientific methods and evidence to investigate, evaluate, and improve one’s patient care practice.

A. **Goal: Habit of Life-long Learning.** Develop knowledge, skills and attitudes needed for life-long learning and self-assessment, and recognize key issues about continuing education and recertification processes for pediatricians.

Learning Objective:
1. Demonstrate effective approaches to acquiring new information.
2. Assess one’s own strengths and weaknesses with respect to professional knowledge and skills, and identify a process to remediate or make allowance for them in information gathering, decision-making, and professional development.
3. Identify one’s knowledge gaps in the course of providing patient care, and cultivate the habit of continuous inquiry to expand one’s knowledge of medical advances.
4. Seek and incorporate feedback and self-assessment into a plan for professional growth as well as provide constructive feedback to others.

COMPETENCY 5 - Professionalism: Demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to diversity.

A. **Goal: Work Habits and Professional Responsibility.** Develop responsible and productive work habits encompassing the broad responsibilities of a competent pediatrician.

Learning Objectives:
1. Demonstrate appropriate level of responsibility of patient care decisions and duties.
2. Demonstrate maintenance of responsibility for patient care when going off duty until suitable coverage is secured.
3. Transfer information for patient care, responsibly and effectively at the time of sign out and change of service.
4. Perform duties such as completing charts, returning calls, and making referrals in a timely manner.
5. Demonstrate recognition, consequences, and actions for appropriate responsible response towards professional errors.
6. Demonstrate organization of work with resultant effective time management.
7. Demonstrate a positive attitude in dealing with work-related problems.
8. Delegate patient care duties to other members of the healthcare team appropriately and work collaboratively to ensure that the patient’s needs are met.
9. Demonstrate honesty and integrity in professional duties.
10. Demonstrate consistent use of compassion and empathy in interactions with families and team members.
11. Demonstrate effective coping and limit-setting, maintenance of professional boundaries in interactions with patients, family, staff, and professional colleagues.
12. Demonstrate behavior that indicates prioritization of patient and family needs over those that are self-directed.
13. Identifies strategies to promote a healthy lifestyle, fostering behaviors that help balance personal goals and professional responsibilities.
14. Recognize and respond to personal stress and fatigue that might interfere with professional duties by asking for support and guidance when indicated.

B. **Goal: Cultural, Ethnic, and Community Sensitivity.** Understand and appreciate cultural diversity in patients and recognize the health-related implications of cultural and religious beliefs and practices of groups represented in a community.

Learning Objectives:
1. Offer and provide language assistance services (including bilingual staff and interpreter services) in a timely manner to each patient and family with limited English proficiency.
2. Demonstrate ease and competence in the use of a trained medical interpreter by telephone and in person.
3. Assist families in accessing religious support systems in the context of their own faith when they are in unfamiliar medical settings.

COMPENTENCY 6- Systems-Based Practice: Understand how to practice quality health care and advocate for patients within the context of the health care system.

A. **Goal: Medical Errors and Patient Safety.** Understand the importance of error reduction in medical practice.

Learning Objectives:
1. Discuss the importance of reducing pharmacy errors in pediatric practice and identify mechanisms for reducing these errors.

2. Honestly acknowledge an error when it has occurred, and assess the circumstances that led to it. When a preventable medical error occurs, demonstrate the following responses:
   - Explore error without assigning blame.
   - Differentiate between individual-based errors (e.g., lack of knowledge or skill, stress, fatigue) from system-based errors (e.g., inadequate information systems, poor staff management, patient’s lack of medical home).
   - Identify latent conditions that may result in errors and propose interventions to reduce or eliminate such risks. Identify how and to whom they should be reported.
   - Describe methods used in evaluating errors (e.g., sentinel event reporting, root-cause analysis, fish-bone diagrams).

Second Year Pediatric Resident

The rotation as a first year resident through the Neonatal Intensive Care Nursery introduces the intern to the borderline preterm and sick term infant as well as understanding normal pathophysiology. During the first year, the intern learned the care of sick infants without major complications and developed the ability to recognize an ill infant requiring intervention. In the second year the first rotation is directed toward understanding the physiology and pathophysiology of the neonate during various aspects of a disease process at a deeper level. The majority of your time will be spent taking care of infants in the intensive care nursery and caring for them during their recovery in intermediate care nursery. You will also improve your evaluation and resuscitation skills in labor and delivery and expand your knowledge of diseases during pregnancy that affect the newborn.

COMPETENCIES

**Competency 1 - Patient Care:** Provide family-centered patient care that is developmentally age appropriate, compassionate, and effective for the treatment of health problems and the promotion of health. Use a logical and appropriate approach to the assessment and daily management of seriously ill neonates and their families, under the guidance of a neonatologist, using evidence-based decision making and problem-solving skills. Provide emotional, social, and culturally sensitive support to families of critically ill infants.

**Goals/Competencies the second year residents are expected to obtain:**

A. **GOAL: Diagnostic Studies, Procedures and Laboratory Data.** Use diagnostic studies such as laboratory, radiologic exams, and procedures to assess patients and monitor treatment, understanding the potential risk of invasiveness and cost of tests ordered.

**Learning Objectives:**
1. Identify risks and benefits for common diagnostic studies and procedures. Be able to defend your choice of any invasive, painful, or expensive diagnostic test or procedure in terms of risk and benefits to patients.
2. Discuss general cost of diagnostic tests and procedures and consider cost when selecting these tests/procedures.

B. **GOAL: Decision-making and Clinical Judgment.** Make informed diagnostic and therapeutic decisions based on patient information, current scientific evidence and clinical judgment, using clinical problem-solving skills, recognizing the limits of one’s knowledge and expertise, gathering appropriate information and using colleagues and consultants appropriately.

**Learning Objectives:**
1. Demonstrate the ability to use up-to-date scientific evidence critically to develop sound, evidence-based patient care plans.
2. Interpret the pathophysiologic processes of a disease and its treatment, especially when faced with new and unexpected clinical situations.
3. Recognize clinical situations in which it is appropriate to accept uncertainty; prioritize the needs of patients.
4. Recognize when immediate treatment is needed or when it is appropriate to simply observe, or change treatment plans.

C. **GOAL: Develop and carry out patient care plans, using principles of evidence-based decision-making and appropriate prioritization, and taking into account the needs, beliefs and resources of patient and family.**

**Learning Objectives:**
1. Formulate patient care plans; cite rationale the reasoning behind the care plan on rounds.
2. Apply evidence-based medicine in designing patient care plans.
3. Prioritize labs, and diagnostic procedures according to the patient’s condition.

D. **GOAL: Prescribe and perform competently all medical procedures considered essential for the scope of general pediatric practice; be familiar** with those procedures commonly used by neonatologists.

**Learning Objectives:**
1. Demonstrate appropriate use of oxygen administration by good, CPAP or assisted ventilation including when to wean.
2. Perform endotracheal intubation in the ICN and in the delivery room, troubleshoot difficulties in performance.
3. Demonstrate proficiency in complex ventilator management, including conventional mechanical ventilation and high-
frequency oscillation.
4. Apply phototherapy appropriately, recognize the need for IVIG and exchange transfusions when phototherapy fails.
5. Perform umbilical arterial and venous catheterization.
6. Participate in surfactant administration.
7. Discriminate the need for analgesia, sedation, and paralysis.
8. Manage continuous, vasoactive medication administration.
9. Perform arterial puncture when appropriate.
10. Participate in chest tube placement.
11. Perform a suprapubic bladder aspiration.
12. Manage central line care and be knowledgeable of central line care bundles.
13. Apply the principles of the Neonatal Resuscitation Program (NRP) appropriately.
14. Perform Lumbar puncture

E. **GOAL:** Patient Education and Counseling. Develops skills in promoting a therapeutic alliance with patients and families by providing counseling, guidance, and patient education in areas important to child health and disease.

Learning Objectives: (In the presence of an Attending Physician)
1. Provide effective education via written, visual, and hands-on techniques (e.g., demonstrations, models, handouts, videotapes, and group learning sessions), selecting an educational method that is directed to the patient’s or family’s learning style, language limitation, knowledge level, cultural background, and emotional state.
2. Summarize the key topics or issues at the end of the session, and verify that the patient or parent understands the information presented.
3. Demonstrate an ability to sensitively assess the patient’s and family’s concerns and fears, and discuss these in a sympathetic and constructive fashion.

F. **GOAL:** Managing and Advocating for the Whole Patient. Provide humane care that is compassionate, altruistic, and respectful in addressing the needs of the whole patient.

Learning Objectives:
1. Demonstrate commitment to appropriately inform and communicate with families, taking into account their perspective, their needs, and their socioeconomic status, cultural context, and religious and spiritual beliefs.
2. Demonstrate efficient and organized work habits that allow time for regular face-to-face or telephone communication with families.

G. **GOAL:** Death, Acute Illness/Injury and Terminal Illness. Provide skillful medical care and empathic support to the acutely ill, injured or terminally ill neonate and his/her family.

Learning Objectives:
1. Demonstrate an understanding of the goals of treatment, including relevant medical, legal, and psychosocial issues such as: Involving parents in decision-making processes; Redirection of the goals of care; “Do Not Resuscitate” orders and termination of life support; Concepts of futility, withdrawal, and withholding of care. Actively participate in decision making by asking questions and contributing to discussions on rounds.
2. Describe the stages of the normal grieving process.

**COMPETENCY 2 - Medical Knowledge:** Understand the scope of established and evolving biomedical, clinical epidemiological and social-behavioral knowledge needed by a pediatrician; demonstrate the ability to acquire, critically interpret and apply this knowledge in patient care.

A. **GOAL:** Common Conditions in the NICU. Recognize and manage, under the supervision of a neonatologist, the common conditions in patients encountered in the NICU.

Learning Objectives:
1. Recognize, diagnose, and manage congenital malformations.
2. Formulate a management plan for various cardiovascular conditions: cardiomyopathy, congenital heart disease (cyanotic and acyanotic, e.g., common disorders such as patent ductus arteriosus, ventricular septal defect, tetralogy of Fallot, transposition of the great arteries), congestive heart failure, arrhythmias (e.g., supraventricular tachyarrhythmia, complete heart block), pericarditis.
3. Detect and verify the following genetic and endocrine disorders: abnormalities discovered from neonatal screening programs as they affect the premature infant, common chromosomal anomalies, (trisomy 13, 18, 21, Turner’s), inborn errors of metabolism, infant of a diabetic mother, infant of a mother with thyroid disease (e.g. maternal Graves Disease), uncommon conditions such as congenital adrenal hyperplasia, hypothyroidism, hyperthyroidism.
4. Recognize and manage these GI/nutrition issues: biliary atresia, breast feeding support for mothers and infants with special needs (high risk premature, maternal illness, multiple birth, etc.), complications of umbilical catheterization, gastroesophageal
reflux, growth retardations, hepatitis, hyperbilirubinemia, meconium plug, necrotizing enterocolitis, nutritional management of high risk neonates or those with special needs (cleft lip/palate, other facial anomalies, etc.).

5. Describe the pathophysiology and management of these hematologic conditions: coagulopathy of the newborn, erythroblastosis fetalis, hemophilia, hydrops fetalis, hyperbilirubinemia, splenomegaly.

6. Assess and justify the plan for managing the following infectious disease conditions: central line infections, Group B Streptococcal infections, hepatitis, herpes simplex, immunization of the premature neonate, infant of a mother with HIV, intrauterine viral infection, neonatal sepsis and meningitis, nosocomial infection in the NICU, syphilis, ureaplasma, varicella exposure.

7. Evaluate and manage these neurologic disorders: central apnea, CNS malformations (e.g., encephalocele, proencephaly, holoprosencephaly), drug withdrawal, hearing loss in high risk newborns (prevention and screening), hydrocephalus, hypoxic-ischemic encephalopathy, intraventricular hemorrhage, retinopathy of prematurity, seizures, spina bifida.

8. Troubleshoot and manage the following pulmonary disorders: atelectasis, bronchopulmonary dysplasia, meconium aspiration, persistent pulmonary hypertension of the newborn, pneumonia, pneumothorax, respiratory distress syndrome, transient tachypnea of the newborn.

9. Recognize and manage these renal disorders: acute and chronic renal failure, hematuria, hydronephrosis, oliguria, and proteinuria.

10. Evaluate and manage surgical issues [assess and participate in management under supervision of a pediatric surgeon or cardiac surgeon]: congenital heart disease, (cyanotic, patent ductus arteriosus, obstructive left-sided cardiac lesions, pre and post-operative care), diaphragmatic hernia, esophageal or gut atresia, gastrochisis, omphalocele, intestinal obstruction, necrotizing enterocolitis, perforated viscus, Pierre Robin syndrome, volvulus.


Learning Objectives:

1. Explain and perform steps in resuscitation and stabilization, particularly airway management, vascular access, volume resuscitation, indications for and techniques of chest compressions, resuscitative pharmacology and management of meconium deliveries.

2. Describe the common causes of acute deterioration in previously stable NICU patients.

3. Participate in codes and neonatal resuscitations as part of the NICU team.

COMPETENCY 3 - Practice-Based Learning and Improvement: Residents must demonstrate the ability to investigate and evaluate their care of patients, to appraise and assimilate scientific evidence, and to continuously improve patient care based on constant self-evaluation and life-long learning. (See first year pediatric resident goals and objectives).

A. GOAL: Use scientific methods and evidence to investigate, evaluate, and improve one’s patient care practice in the NICU setting.

Learning Objectives:

1. Demonstrate an ability to use scientific methods and evidence to investigate, evaluate and improve one’s own patient care practice; continually strive to integrate best evidence into one’s daily practice of medicine.

B. GOAL: Habit of Life-long Learning. Develop knowledge, skills and attitudes needed for life-long learning and self-assessment, and recognize key issues about continuing education and recertification process for pediatricians.

Learning Objectives:

1. Demonstrate a habit of critical thinking, evidence-based decision-making and continuous, quality improvement.

2. Describe one’s own style of learning, gathering and storing information, decision-making, and translate this understanding into an approach to professional development. Identify resources for up-to-date information related to general pediatrics (e.g., journals, texts, tapes, computer databases, continuing education courses, online resources, etc.) and discuss the specific utility of each for the general pediatrician.

3. Demonstrate the use of information technology to optimize life-long learning (e.g., use PDAs, online information resources, curriculum guides, self-assessment tools and tracking systems).

4. Alter one’s practice of medicine over time in response to new discoveries and advances in epidemiology and clinical care.

5. Seek and incorporate feedback and self-assessment into a plan for professional growth and practice improvement (e.g., use evaluations provided by patients, peers, superiors and other medical team members to improve patient care).

COMPETENCY 4-Systems-Based Practice: Understand how to practice quality health care and advocate for patients within the context of the health care system.

A. GOAL: Identify key aspects of health care systems, cost control and mechanisms for payment in the NICU setting.

Learning Objectives:

1. Advocate for patients/families in ones’ practice by helping them with system complexities and identifying resources to meet their needs.

2. Work with health care managers and providers to assess, coordinate, and improve patient care, consistently advocating for
COMPETENCY 5 - Professionalism: Residents must demonstrate a commitment to carrying out professional responsibilities and adherence to ethical principles.

A. GOAL: Cultural, Ethnic, and Community Sensitivity. Understand and appreciate cultural diversity in patients and recognize the health-related implication of cultural and religious beliefs and practices of groups represented in a community.

Learning Objectives:
1. Demonstrate the effort to offer and provide language assistance services (including bilingual staff and interpreter services) in a timely manner to each patient and family with limited English proficiency. Demonstrate ease and competence in the use of a trained medical interpreter by telephone and in person.
2. Assist families in accessing religious support systems in the context of their own faith when they are in unfamiliar medical settings.

COMPETENCY 6 - Interpersonal and Communication Skills: The second year resident must demonstrate interpersonal and communication skills that result in the effective exchange of information and teaming with patients, their families, and professional associate.


Learning Objectives:
1. Communicate effectively with families to create and sustain a therapeutic relationship across the broad range of socioeconomic and cultural backgrounds.
2. Share information with the family in a way that enhances their understanding of the problem and management plan, and include them in decision-making to the extent that they desire.
3. Respect the physician-patient relationship as a partnership, and respect families’ participation in decision-making.
4. In explanations, use words that are easy for the family to understand, and avoid medical jargon. Check for mutual understanding of treatment plan, and ask if parent has any questions.
5. Demonstrate an effort to include parent in choices and decisions to the extent they desire.

B. GOAL: Maintain comprehensive, timely, and legible medical records.

Learning Objectives:
1. Learn to organize documentation in a system based problem oriented manner.
2. Know importance of grammatically accurate documentation.

View documentation as a report to anyone assuming care of the patient either inpatient or outpatient with full succinct information concerning the infants medical history.

Teams: There are 2 of the neonatologists (Drs. Rubin, Levin, Ipson, Ambat, Flores and Chheda) in the NICU each weekday and one on the weekends. Patient coverage is divided into two teams (green and blue) headed by one neonatologist for each team:

Teams consist of the following:
- 1 second year pediatric resident and/or a neonatal nurse practitioner
- 1-2 first year pediatric and/or family practice residents
- Some months a IV year medical student
- 1-3 third year medical students

Rounds: SCN nursery rounds start each day at 0830-0900. Residents present their patients. Teaching will be primarily done by the SCN attending. Available resident or NNP on the team will place orders on rounds (if not done before rounds) on the patient being presented to facilitate orders.

The patient’s resident is responsible to double check that all additional orders discussed on rounds are placed and the patients nurse notified if not on rounds with the team.

Clinics: Special Care Clinic is held each Monday 1300-1700. This clinic allows us to follow our at-risk infants, infants on monitors, and/or O² during their 1-3 years of life. Attendance is mandatory unless the resident is post-call.

Conferences: NICU resident lectures each Friday (except for the Friday of Morbidity and Mortality) at 1200-1300. These are 45-50 minute interactive/didactic case conferences or reviews of pertinent topics in the nursery presented by residents and faculty. Each resident will deliver 1 case or topic per month as assigned by Dr. Ambat at the beginning of the academic year.

Morbidity and Mortality Conference: (M&M): is a shared conference with OB and OB anesthesiology when pertinent.
During this conference statistics and evaluations of deaths including autopsies and pathology is discussed as well as a shared case reviews with OB. This conference is given by the involved residents with the help of the attending responsible for M&M that month. It is held every other second Friday of each month (except July) from 1200-1300 usually in the Texas Tech Auditorium or Room 3500A in the clinic building.

**Prenatal Update:** is a shared conference with the perinatologists and the antepartum/high risk OB residents to discuss the pending high risk maternal and fetal problems. This meeting is Thursday at UMC – L&D Conference Room from 1200–1300. All free SCN residents and NNP’s should attend. OB High Risk resident sends e-mail updates weekly.

**Nutrition Rounds:** This is an educational/patient centered meeting each Thursday at 0830 sharp to learn to gather, organize and present important nutritional information and discuss ways to maximize growth and nutrition in those critically ill infants in the NICU. There will be assigned reading before each meeting so prepare in advance as you will be questioned.

**Radiology Rounds:** Yet to be set up. *When ordering X-ray studies please write the reason in your orders.* Report the results in the Site of Care event and include the date and time of the study.

**Labor and Delivery Coverage:**

**Deliveries:** *The Neonatal Response Team* is composed of an attending neonatologist/pediatrician, a PL-III/PL-II or NNP and (as much as possible) a PL-I. Other important team members are UMC newborn admission nurses for low risk deliveries and an ICN nurse and respiratory therapist for high risk deliveries. There is a schedule as to who answers L&D calls after 1200-1700 (senior residents and NNP’s). Interns must attend L&D calls with their seniors/NNP after 1200. NNP’s cover L&D calls every Monday and Wednesday afternoon to allow SCN seniors and interns to attend Monday High Risk Clinic and Wednesday lectures. *All attempts should be made to have the attending at deliveries of infants less than or equal to 30 weeks or less than 1500 grams.* This is done by informing the Neonatologist of an impending delivery.

**Paper Work:** When the physician attends the delivery, an attendance at delivery record/consult form should be filled out (two page triplicate form). The top white copy always stays at UMC for the infant’s chart irregardless if the infant is transferred to EPCH hospital or not. The yellow copy goes into Martha Trevizo’s box in the breakroom near the call rooms. For EPCH transfers from the ED, NBN or L&D, an order needs to be written/signed on a pink order sheet and the patient transfer form needs to be filled out and signed by the mother. The memorandum of transfer (MOT) will be signed by the attending.

**Infants for which the low risk team is to respond:**
- All normal spontaneous vaginal deliveries

**The following will have pediatrics attend as per OB:**
- Repeat cesarean sections with pediatrics.
- Breech cesarean sections with pediatrics
- Oligohydramnios
- Magnesium sulfate therapy
- Cesarean section – failure to progress with pediatrics
- Well-controlled diabetes

**Infants for which the High Risk Team is to respond:**
- All life threatening anomalies or known chromosomal anomalies
- Stat cesarean sections
- Meconium stained amniotic fluid or bloody fluid noted prior to delivery
- Breech vaginal deliveries
- Fetal distress
- Multiple gestations
- Infants less than or equal to 35 weeks gestation
- Shoulder dystocia
- Vacuum or forceps deliveries
- Placenta previa
- Abruptio placenta
- Poorly controlled diabetes
- Any delivery in triage
- Any other indication as determined by the obstetrician or nurse midwife
- Any suspicion or observation of a depressed infant by a nurse or obstetrician

**Infants for which the High Risk Team is to receive EMS in ED:**
- All infants born at the midwifery centers and transported via EMS.

**Infants for which the High Risk Team is to respond to the ED:**
- Infants from zero to 28 days of age born at a lay midwifery center
• Infants from zero to 28 days with problems related to the newborn period.
• Any birth in the ED (vaginal or cesarean section) or ambulance

OUTBORN infants 14 days or less may be admitted to the SCN if there is no evidence of a community acquired infection. --
OUTBORN infants older than 14 days will need to be admitted to pediatrics.

Infants for which the High Risk Team is to respond in Mother/Baby:
  - Infants with signs and symptoms of severe cardiopulmonary distress or hemodynamic instability.

Consults: The float, night PL-II/III and/or NNP covering L&D may be called with the attending to consult on a maternal case in L&D
deemed to be high risk for maternal or newborn complications requiring pediatric intervention or evaluation at or soon after birth. The
resident should attend the consult with the neonatal/pediatric attending. All three copies of the consult should remain intact until
reviewed/and commented on by the attending and then the white copy goes to the mother’s chart, the yellow copy into the resident
communication file with the signed permit for UAC/UVC, blood and blood product transfusion, PICC line, phototherapy, and lumbar
puncture. The pink copy (or most legible) goes to the attending if the attending was involved directly. There is a pre-written consult
sheet that may be used to discuss the imminent delivery of preterm infants.

FIRST YEAR PEDIATRIC AND FAMILY PRACTICE RESIDENTS:

DUTIES AND RESPONSIBILITIES: Complete a detailed check-out with the on-call team (post-call intern and senior) at
0700 every morning on current patients and new admissions. Rounds with attending are at 0830 and must be complete by 1130. High
Risk Clinic starts at 1300 hrs every Monday. We advise you to practice time management to complete your tasks. Residents are
responsible for full patient care of the 6-8 IMCN newborns assigned to them including the initial complete history and physical exam as
well as the ongoing daily assessment, plan of care, daily documentation, follow-up of all exams and tests ordered and extensive
discharge planning and documentation of each individual patient. During this period residents should rotate carrying the resuscitation
phone with other PL-II residents to attend high risk resuscitations and get initial exposure to newborn resuscitations after their NRP
course is complete. During the second month of their first year the pediatric residents will start taking care of 1-2 ICN infants with the
expectation of getting more experience in the area of ventilator management, cardiovascular problems as well as the care of infants less
than 1,500 grams. The first year residents are responsible for supervising the education and patient care of 3rd and 4th year medical
students rotating through the nursery. All residents are expected to read on newborn care and their infant’s problems daily allowing
yourselves to knowledgably participate in discussions about your infants.

PL-II RESPONSIBILITIES: The PL-II’s are pediatric residents who have completed their first year of pediatric residency and
are prepared to learn advanced resuscitation, and the care and management of acutely and critically ill newborns. The PL-II’s
responsibilities are those of the intern as well as the orientation of new 3rd year medical students and Family Practice Residents. They
will be responsible for 6-8 infants in the ICN/IMCN and will be available to assist the second rotation PL-I with the care of their ICN
patients and problems with their IMCN patients. They are both responsible for assigning patients that have been admitted in the
previous 24 hours, assigning patients to the blue or green team, maintaining the assignment board and checking that the board census
matches the Cerner census. They are also responsible for placing the blue or green dots on the assigned infants name tags attached to
the isolette, warmer or crib.

NEONATAL NURSE PRACTITIONER RESPONSIBILITIES: Advanced trained masters prepared neonatal nurses
who have completed training in an accredited Neonatal Nurse Practitioner program, recognized and licensed by the state. They have the
knowledge and clinical skills to assume the same responsibilities as the second and third year pediatric residents. They will be assuming
coverage of L&D and cover patient care during Special Care Clinic and resident conferences. They will be available to assist in the
education of residents. Please ask them for medical guidance as they have years of experience.

FLOATER (Rover): This is a PL-I-II assigned (on the days a NNP is not available) from 0700-1200 to cover the delivery room
and admit new patients during rounds.

NIGHT CALL RESPONSIBILITIES: PL-I’s: The PL-I should arrive to the nursery at 2230 for check-out. They are
expected to evaluate new problems arising with infants in the IMCN and Well Baby Nursery. They are responsible for admission
H&P’s on infants admitted to NBN from 1900-0700 only if there are problems requiring evaluation and all infants admitted to the
IMCN during their call 2230-0700. They are to follow up on lab tests, evaluations and labs checked out to them by the other physicians
caring for infants in the IMCN. They are also expected to attend all high risk deliveries with the PL-II/III or NNP to gain more
experience in this area. The PL-I is also responsible for assisting in the clinical education of the MS-III and IV on call.

PL-II/PL-III and NNP’s: The PL II/III or NNP should arrive at 1630 for check-out. They are responsible for physical coverage
in the NICU. They are responsible for answering all consults and resuscitations of infants requiring the HR team in labor and delivery,
nursery and UMC or EPCH ED. They are to supervise the PL-I and MSIII/IV when needed and attend labor and delivery TEAM
STEPPS report with the obstetric team at approximately 2200 and 1000 hrs. They also should round with the faculty in ICN between
2100-2400.
PROCEDURES:
All residents are responsible for keeping a log of all of the procedures that they perform. This log is part of your residency training requirement. You are to be observed by the faculty on certain procedures (marked with *) before doing these on your own. You will be exposed to the following procedures:
- Lumbar punctures*
- Peripheral blood draws; both venipuncture and arterial punctures*.
- Phototherapy
- Well baby exam
- Umbilical artery and vein catheterization*
- Exchange reduction or transfusion*
- Neonatal resuscitation*
- Endotracheal Intubation*
- Thoracentesis and chest tube insertion*
- Ventilator management: Conventional and HFOV*
- Family Counseling

All procedures need to be entered in the Site of Care computer programs as an event. There is a template for each procedure in Site of Care under that particular event. Please fill in the blanks in the procedure note and then print it out, have the attending sign and place it in Martha Trevizo’s box in the kitchen near the call rooms. Please enter your name and time in the procedure note so that a record of the number and type of procedure will be made. This is important especially when documenting how many procedures have been performed by the individual resident.

SUGGESTED READING SCHEDULE:

This is a general suggested reading schedule. The primary book being used is Care of the High Risk Neonate, 6th edition by Klaus and Fanaroff. This can be checked out from Maria Garcia and must be checked back in the last day of your rotation so it can be given out to the upcoming residents. If you keep to the below reading schedule you will finish the book by the end of your second rotation as a PG-II. You may at times find it handy to have a physiology text available for certain parts of this book. We recommend that you read additional articles for individual patient issues as Polin and Fox is a general Neonatology textbook and may not have the most recent diagnostic tools or therapy. Your NICU handbook is not a reference text.

FIRST YEAR FIRST MONTH ROTATION:
- First week – Chapters 5&6
- Second week – Chapters 8&13
- Third week – Chapter 10&14
Fourth week – catch up.

FIRST YEAR SECOND MONTH NICU ROTATION:
- First week – Chapter 7
- Second week – Chapters 3&14
- Third week – Chapters 2&20
- Fourth week (catch up) &1

SECOND YEAR FIRST MONTH NICU ROTATION:
- First week – Chapters 4&11
- Second week – Chapter 12&15
- Third week – Chapters 19
- Fourth week (catch up)

We strongly feel that at this level you are ready to read more pulmonary physiology than is in Polin and Yoder, so we advise reading Chapter 2 on Pulmonary Physiology Principles in Goldsmith and Karotkin’s Assisted Ventilation of the Neonate 5th edition or pertinent chapters in Donn & Sinha’s Neonatal Respiratory Care, 2nd edition.

Second years residents should take their NRP handbook when on call for review. Go over a section or two each night. Review them after a resuscitation. Knowing the suggested guidelines well will help you feel more comfortable in the delivery room.

SECOND YEAR SECOND MONTH NICU ROTATION:
- First week – Chapter 16
- Second week – Chapter17
- Third week – Chapter 18 and any remaining.
- Fourth week – Review anything you want to but highly recommend Neoreviews available via the TTUHSC PLFSOM library.
**References**

**Textbooks:**
- Polin and Fox: *Fetal and Neonatal Physiology*, 4th edition.

**Websites:**
- Neonatology on the Web.com
- MD consult
- Pub-Med
- [www.ttuhsc.edu/elpaso/som/pediatrics/neonatology](http://www.ttuhsc.edu/elpaso/som/pediatrics/neonatology)

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**SPECIAL CARE NURSERY**

**Monthly Reminders for House Officers and Students**

**Infection Control:**

*Wash hands one minute each morning at sink before coming into the nursery and before and after patient exams.* Please take off prior to washing and do not wear in the nursery any rings, watches and/or wrist jewelry. Wear gloves while examining and touching all infants. No long sleeves while evaluating babies in the nurseries. Wipe down your stethoscope with alcohol between assessments. As you go to other areas please wear your lab jacket out of the nursery. Wear a gown upon entering the isolated cohorted areas. In the NICU use that infant’s bedside stethoscope, not yours and wash your hands in the room after examining the infant. See those infants last if you can.

**Notes/consults:** Please use black ink for all written documentation.

Follow accepted abbreviations and don’t short cut with unaccepted abbreviations even in your EMR H&P’s, progress notes, addendums and or discharges.

**DO NOT USE DC (USE DISCHARGE OR DISCONTINUE)**

**QD or any terminology with “q”**

When a mistake has been made draw a line through it once, write error above it and initial. Do not scribble out or use white out.

All patient identifying information should never be lying about and should never be placed in the regular trash. There are special containers for patient identifying information that needs to be discarded.

**Patient Care:** Upon admission after completing the H&P and orders, start the appropriate Cerner growth chart. Observe growth and head circumference each Wednesday on the Cerner growth chart. Each Thursday when discussing nutrition and growth if not already done order a nutrition consult on any infant admitted to the ICN. Consider the need for a Lactation consult if < 1,800 grams, and a PT/OT consult with speech if < 1,500 grams.

*IF YOU DO TRANSFER AN INFANT FROM NBN TO SCN PLEASE WRITE A NOTE IN THE PHYSICIANS PROGRESS NOTES IN THE MATERNAL CHART NOTIFYING OB WHY YOU ARE TRANSFERRING THE INFANT AND THAT YOU HAVE SPOKEN TO MOM.*

Please order TPN by noon.

**Maternal Labs:** Not all maternal lab results will be available upon admission of the baby to the nursery. It is mandatory that the infectious labs (HIV, HBsAg, RPR and Rubella) are drawn from the mom PTD or soon after. If the infant is out-born and these labs are not available they must be drawn from the infant upon admission if the mom is not immediately available and the lab results are not available from the transferring institution. If the results are not in the H&P this problem should be carried over into the progress note or an addendum note. The Hepatitis B results should be known by 12 hours after birth or the infant should receive intervention (see Hepatitis B policy) and the HIV should be known by 6 hours after birth (see HIV policy). All of the other labs should be documented 24 hours after birth.

**Education:** Keep up with the reading schedule. There will be a new one assigned each rotation in the nursery. There will be mini talks.
after rounds and presentations once a week. The weekly talks will be assigned by Dr. Ambat. These will be lectures on Power Point with references.

**Social:** Remember HIPPA.

Speak to your patients’ families daily. Don’t wait for the parents to come looking for you. Put yourself in the parents place. What would you want to know about your infant? Be aware of the nursery’s visitation policies. When first introducing yourself to the parents please give them the sheet with all our pictures as well as your card so they will be able to recognize you and your team.

**Night Call:** The night call person will round with OB around 2200 for Team STEPPS. Make this a priority. It is your responsibility to ensure the delivery rooms are prepared so get them ready before the delivery.

You will be asked to do many consults: Please talk to the OB resident or attending personally. Review the mom’s antenatal and hospital chart then talk with the mom. There will be a consult sheet and permits to fill out. The attending should be present or notified of all consults. After completing the consult with the attending remove copies and leave them in the consult notebook at the SCN nurses station. Please check out pending deliveries with your relief. For each delivery you attend please fill out the L&D sheet.

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**Patient Admission and Hospital Course Worksheet (sample)**

<table>
<thead>
<tr>
<th>Blood Group / RH</th>
<th>Ab / Coombs</th>
<th>RPR / VDRL</th>
<th>Rubella</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</thead>
<tbody>
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</tbody>
</table>

**Admitted From:** L & D ____ Transition ____ Mother / Baby ____ ER ____ Transport ____ Maternity Center ________

(specify hospital / center name) __________________________

**CC:** This _______ gram, _______ week, _______ days old S/A/L GA (by LMP / ultrasound / Ballard _______) Female / Male Multiple Gestation # ______

Infant was born to a _______ year old G _______ P _______ Ab _______ LC _______ mother by NSVD / low or outlet forceps / vacuum assisted or extracted / stat or planned C-section secondary to

__________

Apgars _______ / _______ / _______. Admitted to ICN / IMCN secondary to

__________

**Symptoms:**

________________________________________________________________________________________

________________________________________________________________________________________

**ANTENATAL HISTORY:** Prenatal Care at _______ clinic with (number) _______ visits

beginning in _______ trimester. Prenatal vitamins Y / N. Mother gained / lost _______ pounds during the pregnancy.

Medications taken during pregnancy (include all prescription and OTC meds and indication for use)

________________________________________________________________________________________

Complications: Bleeding, UTI’s, Infections, HTN, PIH, Preeclampsia, Hospitalizations (if positive pertinent provide details)

________________________________________________________________________________________

Antenatal (Cont.) Past Medical History: DM _______ HTN _______ Seizures _______ TB _______ Other _______

(if positive pertinent provide details)

________________________________________________________________________________________

Smoking _______ ETOH _______ Illicit drug use

**GYN HISTORY:** (include STD’s)

________________________________________________________________________________________

________________________________________________________________________________________

**PRENATAL LABS:**

**OBSTETRICAL HISTORY:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Sex</th>
<th>Weight</th>
<th>Delivery</th>
<th>Complications</th>
<th>Location/City</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
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<tr>
<td>3.</td>
<td></td>
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<tr>
<td>4.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FAMILY HISTORY:

Mother is a _____ year old, ____________________________________________________ Hispanic/Non-Hispanic (ethnicity/race).

Father is a ________ year old, ____________________________________________________ Hispanic/Non-Hispanic (ethnicity/race)

Health / Medical Problems: ________________________________________________________

Smokes ______________ ETOH _____________ Illicit Drugs ________________________________

Siblings: Health/Medical Problems __________________________________________________

Other Family Members: (include grandparents, aunts, uncles, siblings and if pertinent i.e. genetic disorder great grandparents. If positive (fully investigate and provide pertinent details): DM, DTN, Kidney or Heart disease, Seizures, Hypothyroidism, Congenital disorders, Mental Retardation, Bleeding disorders, Chromosomal Anomalies.

SOCIAL HISTORY:

Married / Divorced / Separated / Living together / Not Involved/ Common Law

The pregnancy was / was not planned. Wanted / not wanted by both / mother / father / neither.

This is / is not the same father of the other children. The father does / does not live with the family.

The baby will live with the ___________________ in the city of ___________________ in a(n) apartment / house / trailer. Bedrooms _____ Bathrooms _____ # of Adults in the home _____ # of children in home ______

AID: None _______ WIC _______ Medicaid _______ Food Stamps _______ Insurance _______ Other _______

Employment: Mother____________________________  Father__________________________________________

Highest level of education:  Mother_________________ Father_______________________________________

NATAL HISTORY: The mother presented to L & D on (date / time) _______________ for ROM/labor/induction __________________. AROM /SROM ________ hours prior to delivery. Fluid color: clear/meconium (light/moderate/thick), bloody_________________. Fluid: did / did not have a foul odor. Fluid amount: none / minimal / normal / excessive__________________________

Monitors were / were not placed. Fetal Heart rate tracing was reassuring / non-reassuring. (if non-reassuring provide details) _________________________________________________________________

Medications prior to delivery: (# of hours PTD and indication). _________________________________________

________________________________________________________________________________________________

ANCS ____________________ Chorioamnionitis (highest temp) ___________________________________________

The baby was born by NSVD / low or outlet forceps / vacuum assisted or extracted / C-section Secondary to _______________________________.

Presentation was vertex / transverse / breech-footling / frank. Pediatrics in attendance Y / N. Peds in attendance secondary to _______________________________.

NOTE: If Apgars < 8 explain in detail if Peds were present, type of resuscitation, complications –
______________________________________________________________________________________________________________________________________________________________________________

RESUSCITATION:

<table>
<thead>
<tr>
<th></th>
<th>Time Started</th>
<th>Time Stopped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen (%________)</td>
<td>YES / NO</td>
<td>Satuations (________, ________)</td>
</tr>
<tr>
<td>Face Mask Vent</td>
<td>YES / NO</td>
<td></td>
</tr>
<tr>
<td>ETT (Size ________)</td>
<td>YES / NO</td>
<td># of Attempts ________</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>YES / NO</td>
<td>#Doses________ Dose Concentration ___________</td>
</tr>
<tr>
<td>Cardiac Compressions</td>
<td>YES / NO</td>
<td></td>
</tr>
<tr>
<td>NCPAP/Neopuff</td>
<td>YES / NO</td>
<td></td>
</tr>
</tbody>
</table>

Surfactant: Delivery Room / NICU (time/date) ____________________________________________________________

PHYSICAL EXAM:

<table>
<thead>
<tr>
<th>Weight</th>
<th>Grams</th>
<th>Percentiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Circumference</td>
<td>cm. (nearest 10&quot;)</td>
<td>Percentile</td>
</tr>
<tr>
<td>Length</td>
<td>cm.</td>
<td>Percentile</td>
</tr>
</tbody>
</table>

Vital Signs : DR temp _ Admit temp (Ax) _ (Rectal) _ HR _ RR _ BP _ Pulse Ox ____________

GENERAL: Quality of Cry __________ signs of distress __________

Major Birth Defects __________________________

SKIN: ____________________________________________

**Include indication for C-sections and detail of abortions**
<table>
<thead>
<tr>
<th>Pallor</th>
<th>Plathora</th>
<th>Cyanosis</th>
<th>Jaundice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peeling</td>
<td>Mongolian Spot</td>
<td>Ecchymosis</td>
<td></td>
</tr>
<tr>
<td>Foul Order</td>
<td>Edema</td>
<td>Rash</td>
<td>Vernix</td>
</tr>
<tr>
<td>Hemangioma</td>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pallor**

**Plethora**

**Cyanosis**

**Jaundice**

**Peeling**

**Mongolian Spot**

**Ecchymosis**

**Edema**

**Rash**

**Vernix**

**Hemangioma**

**Other**

**HEAD:**

AF open ______ x ______ cm. Sunken / Flat / Bulging. PF closed/ open fingertip or ______ x ______ cm.

Sutures – spread / approximated / overriding. Molding ______ Caput ______ Cephalohematoma ______ Others ________________

**EENT:**

Ear and nasal passages patent and clear

Nasal flaring __________________________

Red reflex ____________________________

Eye discharge _________________________

Conjunctivitis ________________________

**NECK:**

Normal ____________________________

Masses _____________________________

CTAB ______________________

Retractions ______________________

Grunting _________________________

Barreled chest _____________________

Crackles __________________________

Rhonchi __________________________

Decreased air exchange ______________

Tachypnea _________________________

**CHEST:**

RRR _____________________________

Murmur _________________________

Perfusion (capillary refill in seconds) __________________________

Pulses __________________________

Arrhythmia ______________________

Other __________________________

**CVS:**

RRR _____________________________

Murmur _________________________

Perfusion (capillary refill in seconds) __________________________

Pulses __________________________

Arrhythmia ______________________

Other __________________________

**ABDOMEN:**

Bowel sounds normal / hyperactive / hypoactive

Soft ______ Firm ______ Distention ______ Tender ______

Loops of Bowel ______ Organomegaly ______ 3-vessel cord ______

Other __________________________

**G/U:**

Anus patent ______________________

Normal female / male genitalia ______

Testes Descended ______

Tags ______________________

Other ________________________

**Ext:**

Deformities ______________________

Symmetrical ______________________

ROM __________________________

Other __________________________

**Neuro:**

Tone – Normal / Hypotonic / Hypertonic

Arm / Leg Recoil __________________

Suck ______ Swallow _______ Cry _______ Gag _______ Moro ______ Other ________________

**ASSESSMENT:**

1. 

2. 

3. 

4. 

5. 

**PLAN:**

1. Admit to (ICN/IMCN)

2. Environment: radiant warmer/humidified isolette/isolette/open crib.

3. Labs:
   a. Hematologic:
      i. Hct _____%, CBC >-----< S B L M E Meta Myelos NRBC’s (serial CBC & CRP as clinically indicated)
      ii. J-meter q 12 hours unless bilirubin indicated.
      iii. Total bilirubin ______mg%, direct bilirubin ______mg%, highest bilirubin during hospitalization ______mg%.
   c. Cultures (as clinically indicated):
      i. Blood x 2
      ii. Tracheal aspirate culture and gram stain
      iii. Urine cultures and gram stain
      iv. CSF studies by tube: #1 glucose and protein, #2 cell count, #3 cultures, #4 special studies
4. Diets: IV Fluids __________________________ Human Milk or Formula________________________ NPO ________________

5. Strict I&O, daily weight.

6. Ventilation:
   a. Oxygen highest%_______ (date & time started_______ stopped_______)
   b. Conventional SIMV Ventilation: Pressure Control PIP _____ PEEP _____ Volume Guarantee ______ml/kg, Pressure Support_____, Inspiratory Time _______ seconds, rate _______. (highest MAP & PIP used_____ date & time started______ stopped______)
   c. Nasal Cannula:_______ml/min (date & time started______ stopped______)

---

Revised 7/11/2013
d. VT (HFNC) ____ ml/min (highest VT ______ date & time started____ stopped____)

e. NCPAP:_______ (highest NCPAP _______ date & time started____ stopped____)

f. HFOV: MAP_______ Ampplitude____ Frequency____ (highest MAP used____ date & time started_____stopped____)

g. iNO (highest PPM):___________ (date & time started____stopped___)

h. Initial ABG/CBG/VBG then frequency of ABG/CBG q _________ hours & PRN.

i. Document umbilical cord gases: arterial _________________________ venous __________________________________

7. UA/UVC (dates placed and discontinued):_____________________________________________________________________________________

8. PICC placement (where and dates placed and discontinued):_____________________________________________________________________________

9. CXR AP/Lateral (lateral only if indicated) __________________________________________________________________________________________

10. Antibiotics after 2 blood cultures _________________________________________________________________________________________________

11. Indomethacin – Reason: IVH _________________________ PDA __________________________

12. __________________________________________________________________________________________

13. __________________________________________________________________________________________

14. __________________________________________________________________________________________

15. __________________________________________________________________________________________

16. __________________________________________________________________________________________

THE FOLLOWING ARE HELPFUL TOOLS AND TIPS PUT TOGETHER BY PL II DAVID CHUNG

NICU For Dummies
(Revised – May, 30 2012)

PGY-1 David Chanwook Chung

**A Blank Form Template**

Baby can be discharged home with mother if;
- Condition Stable
- Diet: Similac Advance ad lib, minimum amount of ___ every 3 hours.
- Newborn screen #1 done, Please F/U results.
- Newborn screen #2 to be done within 2 weeks
- ALGO II Hearing Screen passed bilaterally
- Medications:
  - Please call the Pediatric hotline 915-532-KIDS for any questions or concerns
  - **Signs of concern:** baby not feeding well, not active, fever, vomiting, seizures

**NICU Admission Templates**

**Site of Care**

Site of care. What more is there to say? It will become you best friend and your worst enemy. Here are some pointers to help you navigate your way through the jungle that is Site of Care.

**Tips**

1. It used to be that all computers that have the Red Cross tag can access Site of Care, now most of them can. Just look at the desk top to see if there is a “Site of Care” icon. As well, the portable “enovate” computers with the white base can access “Site of Care.”

2. If you search for baby “Von” using the “find” button at the bottom of the screen, you will get baby “Von, Female Child-Perfect” this is a sample baby you can look at to get an idea of how to do things.

**Log In Process**

1. Click on Site of Care
   *for the white “enovate” portable computers first click on “Remote desktop” icon and login with your cerner
password and id. That will open up a virtual desktop where you can access Site of Care.

2. Click on “More Choices>>” at the bottom of the on the “4D network Component” window that pops up. Then choose “A4-MIS-SoC.” Then click “OK” (Note: this is also the server you need to access if you want to log on to the system from your iPad).

3. Enter id and password. Most likely your last name followed by first letter of first name. Password will be the same. You will get you password from Martha.

4. Click on the “Patients” menu and select “Baby Roster” -> This will give you a list of all the babies that are in the NICU.

5. From here you can click on the baby that you want.

6. Or you want to select multiple babies you can select the check box for the babies that you want then click on “Show Subset” at the bottom. Note that sometimes you can’t deselect a checked baby. That means someone else higher up is working on it.

7. If you want to see all the babies, click on “Show Current” at the bottom.

**Printing**

➢ There are 4 printers. C6-ICN-P01 is the the central work deck in the IMCN. This is the main printer. Most of the computers are set for here by default (and can’t be changed). The call room printer prints to here. There is a printer next to the HUC. C6-ICN-P02. And there are two more printers in the work stations in the IMCN and ICN. Their numbers are C6-ICN-P06, C6-ICN-P05 respectively. Plus there is the ‘script printer next to the HUC it is RX-C6-ICN-P02 (Just a note all the printer names follow the same format “C” for Children’s Hospital followed by the floor number, then the location (ICN in this case) the “P” for printer, then the individual printer number. The ‘script printers all have an “RX” in front of the name.

➢ Blue paper is really annoying to look at.

**Progress Notes - Print them up every day give a copy to the HUC.**

1. Log in
2. Select your babies and click on “Show Subset”
3. Click “Reports” at the bottom of the screen
4. Double click “ICN Progress Note”
5. If you want you can click on the “Special” tab and change the date if you want (for example if you want to print out yesterday’s notes). As well you can click on the “Print” tab to change the number of copies.
6. If you are working on a progress note, you can print it up from within the page you are working on. Just open up the desired note and press “Print Note” on the left hand side of the screen.

**Discharge Summaries - It’s pretty much the same as Progress notes.**

At discharge Print 2 copies and give them to the nurse.

1. Open or select the patient(s) you want.
2. Do the same as above but select “Discharge Summary (Problem Oriented)”

**Admission Notes**

1. Open or select the patient(s) you want.
2. Do the same as above but select “Admission History & Physical”

**Worklist**

This is good for checkout. This is the form with all the boxes on it.

It’s not detailed enough to round with

1. Open or select the patient(s) you want.
2. Do the same as above but select “Detailed Worklist Custom 0525b”

**Face Sheet**

This is good for entering patients in the ACGME log.

This will give you all the information you need as well as ICD-9 codes.

1. Open or select the patient(s) you want.
2. In the Reports list, click on the “Context” tab
3. Scroll down until you see “Face Sheet (ICD-9)”
4. Double click on it and click “Ok”
Progress Notes

*"Copy Last Note"* this will be you best friend in the whole world. Use it, but don’t abuse it. It can be taken away. Just don’t forget to update ALL relevant information. And make your own plan.

1. Click on the baby that you want
2. The first thing to do is to fill in the “Attending” box
   - the first three letters of the last name of the attending followed by a slash then “ns” for not signed
   - e.g. IPS/NS or lev/ns
3. Click on the “Add Note” button

-The “General” tab-

4. The date and time are filled in automatically, but you can change it if you want.
5. “Examined by” and “Neo co-sign” enter the first three letters of your last name and the last name of the rounding attending. This will open a dialog box to select the full name.
6. “Interim History” This is where you report on the general condition of your baby and everything that happened since your last note. If you use copy last note, you can end up with a lot of old outdated information. Put all that stuff in your discharge summary and erase it from your progress notes. If you write a good thorough note, this is all you may have to look at when you round.
7. “Social Comment” be sure to update the parents’ everyday and make note of it here. Write down what you told them. Also make note of any contact the attending may have had with the patient.
8. “Care complexity” will usually be “Low” to “Moderate” if not sure, just ask you senior.
9. “Location” will always be IMCN for your first rotation.
10. “Thermal environment” – just choose the appropriate one from the menu.
11. “Env. Temp.” They usually keep the IMCN in the 70’s
12. Fill in the Weight. If the nurses have updated the length and HC data, then fill that in as well.
13. “Physical Exam’ button. Most people don’t fill this part out everyday, but you should make an effort to. At minimum do the Lung&chest, Hear&pulse and abdomen sections.
14. Fill in the “Vital Signs” get the data from Cerner. It is easier to look at if you use the “group” view in cerner.
15. Assessment. Start out with location, GA, Size (e.g. IMCN, late preterm, SGA) then list all active/relevant diagnosis. Just as in the “interim history” part, record all the old diagnosis in the discharge summary and erase it from here.
16. Plan. This is where you put your comprehensive plan. Each section has a separate plan, but this in the master plan.

-The “Fluid/GI” Page-

17. First “Copy Last Note” otherwise it may change thing after you have entered them.
18. Next, click on “I/O Details” as you fill this out, this will fill up most of the boxes automatically.
19. “IV route” click the “+” to get the pop up box with all the options. Double click all that apply, you may choose more than one. Then click “ok”
20. “Line Necessity” I don’t know what this is. I just leave it blank
21. “IV Solution” This will fill in automatically as you choose “IV intake”
22. “Feeding route” click the “+” to get the pop up box with all the options. Double click all that apply you may choose more that one. Then click “ok”
23. “Feeding type” This will fill in automatically as you choose “Oral intake”
24. IV intake (Fill in the white boxes, the grey boxes fill in automatically)
   - Choose the appropriate fluid/fluids from the drop down boxes. Use as many or as few as you need. Fill in the volumes you can get from cerner. Be sure to use the 24hour totals and not just the shift totals.
   - Do the same with oral feeds and other.
25. “Stools” click the “+” to get the pop up box with all the options. Double click the one that applies. Then click “ok”. You can free text the number of stool directly in the box. (e.g Normal x1) To get the number of stools, go to cerner. Click on your baby. GO to “Interactive View/I&O” then click on “Intake and Output” scroll down to the bottom. There will be a “Stool Count” line. If there is just a number there that means that they had just that number of stools for that time period. If there is a number followed by another number in brackets, that means that there is more that one entry. You have to right click on that box then move your cursor to “modify” on the pop up menu. That will show you all the stool counts. Just add up the numbers for the total stool count.
26. “Voids” click the “+” to get the pop up box with all the options. Double click the one that applies. Then click “ok”
27. Fill in the outputs (Urine/chest tube etc) you get from cerner.
28. Click “Save”
29. To enter the labs, click the “Labs” button
   - Choose the lab type you want (chemistry/Hematology/Gases/Micro/Other)
   - If there are any labs to pull over it will show up when you click the “From Interface” button. If by default “Reference” is selected, that means there are no labs available.
   - Click on the lab you want to print then click the “<” (arrow) to move the lab over. Choose all the labs you want. Click “ok”
30. Add any x-ray findings (Hint: include the date)
31. “Comments”. This is where you state what you are thinking. You can list your assessment, but also comment about what and why you are thinking that.
32. “Plans’ This is to write your plans, but only for feeding and GI. If you main plan is good enough, just copy and paste.
   - “Pending” this is where you put any pending labs or events.

- The “Resp” Page
33. “Respiratory Support” click the “+” to get the pop up box with all the options. Double click the one that applies. Then click “ok”. (most likely ‘Room air’)
34. Oxygen% leave blank if you baby is on room air
35. “Blood Gasses” Click on “Labs” and add the gasses as explained above
36. “Oxygen %” “TeO2” “TeCO2” If you did the vitals before, these fill in automatically.
37. “Apnea” click the “+” to get the pop up box with all the options. Double click the one that applies. Then click “ok”.
38. “Vent Settings” if you are seeing only IMCN babies, this won’t apply to you.
39. “Chest xray” fill in any xray findings. Don’t forget the date
40. “Comments” and “Plan” “Pending” same as above

- The “Heme” page
*This is not for infection labs. It is for stuff like jaundice and anemia (CBC and CRP go into the ID section)
41. First fill in “Mom blood type” “Baby Type” “Rh” info if it is not already filled in.
   - “DAT” is for the Coombs results. Choose the appropriate choice from the pull down menu.
   - “#transfusions” is just that, the number of transfusions the baby got. I am not sure if this is for that day or if it is cumulative.
42. “Latest HCT” “Latest total bili” should auto fill
43. Fill in “Hematology labs” as is explained above
   - “TC bili results” This is for the percutaneous bili meter. As well as the “Date” and “Time” of that reading. “Age at time of TCB” put in the number of hours of life at the time of the reading.
44. “Comments” and “Plan” “Pending” same as above

- The “ID” page
45. Fill in “Hematology” and “Microbiology” labs (I usually just free text them in to the “comments” part) (CBC, CRP’s go here)
46. “Cultures” don’t forget date and site
47. “Comments” and “Plan” “Pending” same as above

- The “Cardiac” page
48. BP’s will fill in automatically if you fill in the vitals
49. - Click “4limb Pressures” (if you have data for that) and see the picture of the cute (?) baby. Nurses don’t do them everyday.
50. “Cardiac testing” enter it if you have it
51 “ Comments” as above
52. “Plan” as above
53. “Pending” as above

- The “Neuro” Page
54. “Neurologic exam” ” click the “+” to get the pop up box with all the choices. Double click the ones that apply. Then click “ok”.
55. “Neurologic testing” click the “+” to get the pop up box with all the choices. Double click the ones that apply. Then click “ok”. Free text enter the results.
56. “Nuerologic Tracking” not exactly sure what this one is for.
57. “Head Scan Results” Enter Brain Ultrasound results and date of exam
58. “Eye exam status” Enter ROP exam results and date of exam and date of next follow up
59. “Other Results” enter all that apply
60. “Hearing test status” Enter ALGO exam results
61. “Plans” as above

- The “Other” Page
62. “Renal Comments” click the “+” to get the pop up box with all the choices. Double click the ones that apply. Then click “ok”. I usually also add the Urine output as mL/kg/hr
63. “Musculoskeletal Comments” click the “+” to get the pop up box with all the choices. Double click the ones that apply. Then click “ok”.
64. “Genetics/Endocrine Comments” I usually add a comment about the status of the Neonate screen test, either done or pending
65. “Other Comments” as above
66. “Other Comments” as above
67. Additional Plans” “Pending” as above
68. Click on the “Save Note” button (or you may live to regret it)

Discharge

*UNDER THE “PLANS” TAB, DON’T ENTER THE DISCHARGE DATE – EVER

(Martha will do that - This will discharge the baby and the notes will all disappear.)

*Make a discharge note ahead of time and update it every day. This will make your life easier, as well as the next person who had to discharge you baby who had been admitted for 98 days.
*If you try to save it a box pops up saying you have to enter a follow pediatrician. It says you can enter UNK for unknown. But you cannot. You can put in “TTU” for the Texas tech clinic, SCC for high risk clinic or “JUA” for Juarez pediatrician. Just remember to change this later.
*Fill in the “Attending” box
 - the first three letters of the last name of the attending followed by a slash then instead of “NS” fill in “DC” for discharge
 - e.g. IPS/DS or lev/ds

1. Click on the baby that you want
2. Click on the “Discharge Baby” tab on the right bottom corner. This will create a discharge note

-In the “General” tab-
3. Change the Date of Note to 00/00/00. This will put it at the bottom of the list.
4. Leave the “Examined by” and “Neo co-sign” boxes blank as you may no be the one to discharge. (or fill it in if you want)
5. Interim History - Fill this part in every day.
   Start with GA, size and sex.
   (e.g. “Term AGA male” or “Preterm SGA female 32wks”)
   Then go by system/problem and give a brief summary of what happened
   #1 Infection R/O sepsis. Amp/Gen were given for 7 days due to blah blah blah
   #2 Respiratory RDS. Patient had significant retractions yadda yadda yadda
   #3. etc…etc…
6. ‘Care complexity’ should be filled in from the admission note.
7. Enter the “Home Phone” if you know it.
8. “Social Comment” add anything in the social history that is relevant
8. <under “labs”>
9. “Blood type” and “location” should be filled in from the admission note
10. Any relevant labs should go here (mostly labs done right before discharge, you don’t need to put in all the labs). You can pull some of them from cerner. I usually left this part blank and added the labs in with the interim
history.

11. Make note of any pending labs

-The “Examination” tab-

12. Self explanatory. This should be the examination done before discharge, and not the initial examination.
13. Be sure to fill in the Discharge weight/Length and HC.
14. Don’t forget the “Vital Signs” button on the right side (I overlook this on a lot of my babies)

-The “Diagnoses” tab

15. If you have been updating the “Events” then there should be nothing to do.
16. All events need to be closed out.
   -Click on an open event (in red).
   -Enter a brief description
   -Fill in the end date, or use the “Today” button for any open events left at discharge.
   -Click “Save”
17. At this time if there are any “Events” that need to be added you can add them now.
   Don’t forget to add “Algoll” as an event, as this will be done on almost all of the babies. As well always check “Autocode” and double click to add anything that comes up
18. Click on the “Look up” button to look for events. A window with all the matching events will pop up. Double click on the one you want.

-The “Plans” tab-

19. Select the appropriate “Discharged to” option (Mostly “home”)
20. DON’T ENTER THE DISCHARGE DATE.
21. Enter Feeding instructions (e.g. Sim20/Breast milk/EBM Ad lib with minimum intake of 55 ml every 3hr)
22. Then fill in the appropriate follow up information.
23. Be sure to include any “Additional Appointments” as necessary.
24. “Follow up testing needed” is usually “newborn screen #2” and any labs to be done at OPD visit.
25. “Medications” and “Instructions to parents” is mostly covered in the Cerner Depart process so I usually just left this blank.
26. Save note
27. A bunch of dialog boxes will pop up. I just cancel all of them.
28. Print 2 copies. Give one to the nurse, one in the wooden file box behind the HUC.

-Admission Notes

1. Click on the “Admit Baby” button on the bottom of the screen.
2. Click on “Transport Baby” All newborns are “Transferred” from UMC to EPCH.
3. Enter the last name of the mother in the first box. If you get a match on the bottom you can click on it to select it.
   -If there is no match, then you can enter the mom’s first name in the next box.
   -If there is still no match, then you can enter the mom’s DOB in the last box. At this point, if there is no match, you can click on ”Add New Mom and Baby” to create a new entry.
4. Add baby demographic.

-The “General” Tab-

5. Enter the date. This should fill automatically as you make the note. If you feel that you need to change it feel free.
6. Enter “Examined by” as the first three letters of you last name. Select the correct choice if necessary. “co-signed by” is the attending on duty.
7. “Where baby was born” is usually UMC, but choose otherwise if on outside birth.
8. “Delivery date” and “Admit” date are usually the same. Be sure to correct it if it is not. However, the Delivery “Time” and the Admit “Time” are never the same. It can take 10-20 minutes even longer to get the baby stable and sent to the NICU for admission. It may be even a bigger delay if they are being transferred from the Nursery or the Mother Baby unit
9. “Admit from” – select the proper choice from the menu.
10. “Referring Hosp Med. Record Number” wont be relevant unless coming from another hospital.
11. The “Baby” information should have filled out automatically. If not, fill in as appropriate. Don’t forget the birth weight.

12. “Medical Record #” and “Baby account #” should fill in automatically. If not, add it. Don’t forget the MR number has five zeroes at the front. If you don’t add these, it may cause problems.

13. “House Service” Is this like room service? If so, check that bad boy off and order me some pancakes.

14. “Location” Select the appropriate choice from the menu. Most likely it will be IMCN.

15. “Care Complexity” ICN is usually “Critical” “Intensive, <5000gms” or “High. I usually choose “Moderate” for IMCN, but it could be “High” as well, I guess.

16. The “Mom” data should be there, enter it if it is not. Enter “Telephone number” if you have it.

17. “Maternal transport” enter the first three letters of where the mom was transferred from. Most often “UMC”

18. “Prenatal care provider” enter the first three letters of the name of the provider or name of the clinic where the mom received prenatal care.

19. Fill in the medical care team is the next boxes as appropriate and as you know it. “Perinatologist” “Delivery Obstetrician” “Attending Pediatrician” “Follow-Up Pediatrician” (be sure you ask the mom, you will need to know when you get ready to discharge and make follow up appointments) “Neonatologist”

-Prenatal-

20. “Mom birth date” “Age” gravida should fill automatically, otherwise fill it in.

21. “Best EDD(Expected delivery date)” and “Gest age” auto fill for wach other. If you fill one in, it will fill in the other.

22. “Prenatal Care” choose the correct option.

23. Choose the correct “Blood Type” and “Rh” you can find it in cerner.

24. “Antibodies” I am not exactly sure which ones they are talking about.

25. “HbsAG” “Rubella” “RPR” and “HIV” are required to be done by law. The results are in cerner. Sometimes you may have to check the chart for results of labs done outside.

26. ”Glucose testing.” If done choose the appropriate selection from the menu.

27. “Highest temp labor” is for chorioamionitis. Get the results from cerner.

28. “Group B Streptococcus” results are in cerner. “Antibiotics given” can be seen on the yellow sheet.

29. “Gonococcus”, “Chlamydia” are not always done. If you have it, fill it in.

30. “Prenatal Narrative” You can follow the template that is provided above, or make your own more detailed one. You will have to get the details as you take a history from the mom/dad/relative/whoever is there.

31. “Maternal Diagnoses” Fill them in as much as you know.

-The “Delivery” page

32. “Labor description” Choose the appropriate one from the menu. Most likely “Spontaneous”

33. “Delivery Analgesia” Will be on the yellow sheet if they got any. Most often blank

34. “ROM (rupture of membrane) date” “Time” Will be on the yellow sheet. This will automatically fill in “Duration of ruptured membranes”

35. “Method of delivery” Choose the appropriate one from the menu.

36. “Primary Operative Delivery Indication” Choose the appropriate one from the menu. I usually put “cephalic, spontaneous assisted” or “low trans C/S”

37. “Outcome” will most likely be “Live birth admitted to ICN” but choose the appropriate one from the menu.

38. “Recuscitator” Enter you name or name of Senior or NUR if it was Maggie or Leighann.

39. “How caller to DR” usually will be phone or choose the appropriate one from the menu.

40. “Did you wait for delivery (standby)” Well, did you?

41. “Why resus at delivery” What ever the reason for resuscitation (e.g. prematurity, vacuum delivery, macrosomia)

42. Enter Apgar scores.

43. “Respirations at Birth” usually “spontaneous” but choose the appropriate one from the menu.

44. “Resuscitation” check all that apply, but most of the time they will all be blank

45. “Infant suctioned at birth” usually “bulb” but choose the appropriate one from the menu.

46. “Meconium intubated” choose the appropriate one from the menu. If there was no meconium, I just left it blank.

47. “Narcan given” check the box if it was given

48. “Cord gasses” enter them if sent

50. “Narrative comments on delivery and resuscitation.” If a routine birth, you can use the template given above. If it was a complicated delivery, you will probably have to make one from scratch.

[The following is the example from the Von baby]
Infant delivered with vacuum assist. Initially, infant was hypotonic, cyanotic, and had delayed RR. BVM administered with 5 LPM of O2 for 30 seconds until cry taken (around 45 seconds of life). Infant responded well, began to pink up and continued to have regular RR during transitional period. HR 80-100 bpm during BVM but also increased after spontaneous RR continued. No supplemental O2 needed after BVM. Tone improved. Infant was transferred to IMCN for prematurity, LGA (IDM) and suspected sepsis. Apgars 5/8 (-1 HR, -1 RR, -1 tone, -2 color for 1 minute, -1 tone, -1 color for 5 minutes). Prematurity, LGA (IDM) and suspected sepsis. Apgars 5/8 (-1 HR, -1 RR, -1 tone, -2 color for 1 minute, -1 tone, -1 color for 5 minutes).

-The “ICN” page
51. “Additional history” Use the template above.
52. “Social Comment” Use the template above.
53. “Infant Transport” Ifill in as much as known
54. “Transport date” will usually be admit date
55. “Transport time” will usually be birth time and admit time.
56. “Hospital admitted from” UMC
57. “Transport team” is the people you went to the delivery with.
58. “Transported to” IMCN
59. “Transport Carrier” other (usually a crib)
60. The rest I leave blank

-The “Exam” page
61. “Admit wt (weight), length, HC” and “Birth wt, length, HC” will be the same for most of the babies. If it is different (i.e. they were admitted a day or more after birth) then be sure to make note of it.
62. “Temp <1 hr of NICU Admit” this is asking if the initial temperature was taken within 1 hour of admission. This will usually be checked.
63. “Admit temp” from cerner
64. “GA at birth” this should fill in automatically. Again, change it if it is different.
65. “A/S/LGA” (Average/Small/Large for gestation age) choose the appropriate one from the menu.
66. Physical exam. Fill this in as appropriate.
67. Click “Vital Signs” button on right. Fill in as appropriate. Get data from cerner.

-The “Plans” page
68. “Glucose Check” you probably won’t have had time to get more than one reading (if that) by the time you write this note. Just fill it is what you can.
69. “Chemistry” “Hematology” as mentioned above you probably won’t have had time to get any results, but fill in what you have.
70. “Blood gasses” for IMCN babies, you probably won’t have any gasses. If you do, fill them in.
71. “Xray” again, as mentioned above you probably won’t have had time to get any results, but fill in what you have
72. “Assessment” term, sex, diagnosis (e.g. TLGA preterm male, 37 wk, IDM, Suspected sepsis 2nd to PROM and prematurity, RD 2nd to TTN, Neonatal Depression
73. “Plan” this is you plan. If you list and number them, it is easier to edit them later as you go on. “Pending” is what is pending.
74. “Synagis” I believe this is for babies who are eligible for synagis. Check it if they are eligible. The indications are found in the NICU handbook.
75. The three buttons at the bottom of the page are good to help you add events. Just click on each one and add all the events that are appropriate.
76. Print and put a copy in the Box behind the HUC.

That’s it for Site of care. There is more, but this should get you through the first day or two.

CERNER
Lots of stuff that you need to know. Most of it you will learn from Carmen. Here are some of the basics to get you through the first day or so.

There are some facts about placing orders that you need to know.
*For labs under “Frequency” the “Daily” options means 04:00 the next morning, no matter what. The “Daily” supersedes any other comments. Even if you enter a “collection date and time” the “Daily” order will cancel that out and it will be collected at 04:00 the next morning.
* For labs that need to be done at a certain time, use “Timed Study” under “Collection Priority” then enter the date and time. (“Stat” means Stat)
*Under details T;N means “Today:Now”
  T+1 means tomorrow (Today +1 or 24 hours from now)
*Feeding orders can’t be changed. You can right click on the feeding order then “Cancel and Reorder” you can put in the new details.
*Fluid rate changes should be done as “Communication Orders” do NOT cancel the fluid order and reorder. Leave the original order and add a communication order. (you only cancel the fluid order when you change the type of fluid e.g. D10 to D10+1/4Saline)
*ICN labs should be done “nurse collect” IMCN are not “nurse collect”
*There are 4 printers. C6-ICN-P01 is the the central work deck in the IMCN. This is the main printer. Most of the computers are set for here by default (and can’t be changed) The call room printer prints to here. There is a printer next to the HUC. C6-ICN-P02. And there are two more printers in the work stations in the IMCN and ICN. Their numbers are C6-ICN-P06, C6-ICN-P05 respectively. Plus there is the ‘script printer next to the HUC it is RX-C6-ICN-P02 (Just a note all the printer names follow the same format “C” for Children’s Hospital followed by the floor number, then the location (ICN in this case) the “P” for printer, then the individual printer number. The ‘script printers all have an “RX” in front of the name.

**Power Plans**

*You can get to these Power plans by clicking on the “+add” button in the order window
  Then click ONCE on “Medical Power Plan” then click on “NICU”
*This is a brief explanation of some of the different power plans available
*If you click on the Notepad icon in front of the power plan it will give you some more information about that plan

The following have all the orders necessary for admission in them
- NICU ICN admission (Admission power plan for babies that are >1500g)
- NICU IMCN Admission (You will be using this one the most)
- NICU VLBW Admission (for babies <1500g. This is a separate plan because the really small babies usually have a whole separate set of problems associated with them, and this cover most of the more common problems)
- NICU Postoperative care (This is for babies that are post op and coming back to the NICU. This is necessary because when patients change from one level of care (e.g. thr OR) to another level of care (e.g. the NICU) all the old orders need to be discontinued and all new orders need to be written. Hence the “Postoperative orders” have all the admission orders in them)
- NICU Transfer non VLBW (the same concept as above but for transfer to IMCN from ICN)
- NICU Transfer VLBW (same as above but for small babies)
*The rest of the powerplans need to be ordered in the appropriate situation but with a separate admission powerplan.
- NICU Neonatal Hypothermia
- NICU Neonatal Nitric Oxide
- NICU Partial exchange

Etc…

**Subphase**

- There are mini powerplans that are embedded within a main powerplan.
- They are indicated by the double “pizza box” icon,
- To access them you need to double click on them to open them. To get back to the main powerplan, click on the “Return to NICU IMCN Admission” button.
- Most of these also can be selected as a stand alone powerplan from the “Medical Powerplans” folder

**NICU Transfusion of Blood Products**

**Under “Patient Care”**

When you select the following options
  Transfer Red blood cells
Transfuse Platelets
Transfuse FFP
Transfuse Cryoprecipitate

You need to right click and select “Modify Planned Order” then in the “Blood product modification” box control+click to select all four of the available options (CMV negative, Irridation, Leuko reduced and washed packed RBC).
The total volume = 27 mL.

**Under “Laboratory”**
Neonate type and screen (only need to do once) leave unchecked for subsequent tf’s
You need to check “Red Blood Cell Crossmatch”
  - Number of units =1
  - Volume = 27mL
  - Hold or Transfuse = choose appropriate one
  - Order comments = “please send additional 10mL for tubing”

**NICU Respiratory Common Orders**
(T;N means today, now)
  - CBG (we no longer do CBG with lytes, glucose or lactate
  - Oxygen Therapy (this is the one to use for nasal canula)
  - Warm Humidified High Flow Oxygem (Warm Humidified Hi Flow O2)-> this is Vapotherm
    - Right click to “Modify Order” then set “L/min” “Frequency RT =
    - Continuous (don’t change start date and time)
  - Most Respiratory meds are here (e.g. caffeine)
  - “Multichannel event recording” is here

**NICU Ventilator Care**
  - Note: Venticaltor order need to be “Discontinue and Reorder” to change settings
  - Under “Respiratory care”
    - “Ventilator Care” Right click and Modify order to set initial settings
      - CPAP is here
      - Extubation is here

**NICU IV Solutions**
  - Early Parenteral nutrition soln 200mL
    - Just remember it takes time for TPN to get here-> order a D10 at the desired rate until TPN arrives. To do this right click the order and select “Modify Order”
    - *Also remember when changinf fluid rates, don’t discontinue and reorder the original fluid order. Use a communication order. (Feeding orders are changed by “Discontinue and reorder”

**NICU Common Orders**
  - When you click on “+add” or “+add to phase” you can access the “NICU Common Orders” folder, that has in it, of all things, common orders that are used in the NICU.
  - The “NICU Common Meds” is, as of today 12/21/11, empty. Carmen, please rectify this situation, please!
  - Most of these folders are self explanatory. Here are just a few tips in using the orders.
    - NICU Chemistry: This has CMP, BMP, lytes, iCa, TG etc. You will notice that they are all listed twice. The first group is for ICN (i.e. they are set as nurse collect by default) the second group is for the IMNC (i.e. they are set at lab collect by default.
    - NICU Phototherapy Labs: This has Total Bili and Direct bili
    - NICU Sepsis: CBC, CRP, Plt, Blood Culture (Blood culture are always Nurse collect)

**Discharge**
First off Depart process is essentially the same as in the well baby. Just a few differences.
AA_blank_DI template is different. You can use the one that is given above. Fill it out as appropriate.

* The diagnosis can’t be just “Term birth of newborn male/female” you need to include the reason for the IMCN admission (i.e. sepsis, hyperbilirubinemia) the more you put in the better.

1. Click on the "Depart" icon in the tool bar at the top
2. In the next screen click on the note pad icon to start each section
3. Click on the blue circle to indicate that each part is finished
4. Discharge process
   A. Diagnosis (same as in admission except the "Type" is "Discharge" instead of "Admission")
   B. Meds Rec
      i. If this is empty just click "Reconcile and Sign"
      ii. If you do have meds, fill out the forms. Going into any more detail about this is beyond the scope of this orientation. Ask the senior.
      iii. Print and Sign the 'script (the printer is RX-C6-ICN-P04) the printer is at the HUC station
   C. Follow up
      i. Chose the appropriate provider.
      ii. If none available send them to Texas Tech Clinic Central or send them to yourself
      iii. Follow up usually in 2-3 days but ask your attending.
      iv. Add appropriate comments as you see fit (labs, results that need checking, etc)
   D. Patient Education
      i. Click once on "AA Blank DI"
      ii. Double click on it again
      iii. Use the template given above (just copy and paste). Don’t forget to check Algo results and fill out the form appropriately.
      iv. If you type "Newborn" in the search box, it will give you some information that you may want to add
      v. Be sure to check the appropriate language
      vi. Click "Ok"
   E. Orders
      i. Type "Discharge" in the search box
      ii. Click once on "Discharge Patient"
      iii. Select "T;N, Home" then click "OK" and "Done"
      iv. Click sign
      v. If you want to send the patient home later, you can change the time here
   F. Click "Save" and you are done

-Addendum for Discharge
Sodium Chloride does not show up in med rec. You have to add it manually

1. In the med rec page. Select “Do Not Continue” for sodium Chloride.
2. Click “+add” at the top of the page
3. Search for “Misc”
4. Select “Miscellaneous Prescriptions”
5. Click “ok” on the warning box that pops up, then click “Done” at the bottom of the page.
6. “Drug name” is “Sodium Chloride”
7. “Indication” is “Sodium Supplementation”
8. Click the Dose Calculator icon (it looks like a red and yellow pill with a calculator under it)
9. Enter target dose and units (e.g. 2.5 then select mEq/kg from the drop down menu in the next box)
10. Round the “Final Dose” box and click “apply dose”
11. Route of administration is “PO”
12. Frequency is “q6hr” or what ever you need.
13. Duration is 30 days
14. Dispense 1 bottle
15. Give 1 refill
16. click “Done”
Again this is going to be similar to the well baby nursery except you will use the NICU power plans

1. Open the baby chart in Cerner
2. Click on "Interactive View / I&O" in the menu list on the left side of the screen. It helps to pin it open as you will be going through a lot of them
   A. Click on "Measurements HAF"
   B. Right click on "Weight Dosing" enter the baby's weight
   C. Right click on "Height/Length Dosing" enter the baby's length
   D. Click on the green arrow at the top of the window to enter the amounts
3. Click on "Allergies" in the menu list
   A. Click on the "No Known Allergies" button
   B. When the window pops up click on "history"
   C. Enter your name in the box
4. Click on "Diagnosis& Problems" in the menu list
   A. Click on the "+Add" button
   B. Type "Term" the hit the search button
   C. Click on "Term birth of newborn male/female"
   D. Clinical service = Neonatal intensive care (you can find it after you click "more..." then type “nn” and it will come up
      E. Type = admitting
      F. Confirmation = confirmed
      G. Classification = Medical
      H. Ranking = Primary
      I. Click "Ok"
   J. Repeat with any other admitting diagnoses (e.g. sepsis, hyperbilirubemia, respiratory distress). You need to add at least one diagnosis that warrants admission to the NICU. But add as many as possible.
5. Click on "Orders" in the menu list
   A. Click on the "+Add" button
   B. Click on “Medical Power Plans”
   C. Click NICU
   D. Click (once) on the power plan that you want
      i. For admission you will use “NICU IMCN Admission’ or NICU ICN Admission” the most
      ii. Click done
      iii. The first order in the power plan will be the admit/placement order.
         (This is different from the nursery. In the nursery you had to do it as a separate order)
            a. Right click on the admit/placement order and select “modify planned order”
            b. Open the details tab and in the next window select "ICN" or "IMCN" in the "Unit" box.
            c. Type the attendings name in the "Admitting Physician" and "Attending Physician" box
               - Just type the first three letters of the last name is sufficient
               - If you are an intern and you are reading this, YOU are NOT the admitting physician
            d. Select "Inpatient" in the "Admit/Place" box
            e. Close the details box.
   iii. Now you need to go through line by line and check the boxes that you need.
Most of the items needed are selected. But the following are some important ones.
   a. Antibiotics
      *The doses for ampi and gent are given to you within the powerplan. You don’t have to look them up. (Just look for the line with the yellow notepad and pencil graphic)
      *For Gentamicin it is either 4.5mg/kg/day q 36 hr for preme or 4mg/kg/day q 24 hr for term. It is listed right there with the cut off weeks. When you go to select the actual order, you have to click on the arrow and choose the right one. The 4.5mg/kg/day q 36 hr order for premature infants is the one selected by default. Change it to the other one if necessary.
Ampi is the same. All the doses are listed right there, just make sure you choose the right one in the actual order. Click the arrow and select the one you want.

*select the proper dropdown dose before you click on the check box. That way it will auto-calculate the correct dose.

b. Labs

*When you choose labs, check the time. CBC and CRP are already set up for 24/48 hr collections. Change what you need to but don’t change what you don’t.
*Blood cultures need to be ordered one minute apart. Just order one now, then after you are done filling in the orders and sign- go back and order the second culture.

iv. When you are done click the "Initiate" button, then "Orders for Signature" then "Sign" then "Sign" then “refresh”

6. Click on the "Document Medication by Hx" tab at the top of the window
   A. Check the box that says "No Known Home Medication" (and hope to God that is true)
   B. click on "Done"

7. Click on "Reconciliation" and choose "Admission"
   A. Click on the "Continue" circle for the three meds that should be there
   B. Then click on "Reconcile and Sign"
   C. If you forgot to do this at admission and are doing it later, click on the "Do Not Continue“ circles

-Orders for Rounds

Just a few hints for entering orders during rounds
Check the Power plan first

*When adding orders, a lot of them are already in the power plan. On the left hand side of the “Orders” window is the “View” box. (it looks something like this…)

```
Views

Orders for signature
+Plans
  +Interdisciplinary
  +Medical
    -NICU IMCN Admission (Initiated)
+Suggested Plans
-Orders
…
```

Click on the active power plan. (Here listed as “NICU IMCN Admission (initiated)” Then in the main orders window a new tool bar should appear at the top of the orders Window (It should have a badminton shuttlecock, a double light bulb, blue circle with bar and and “+add to phase” button. Click on the double light bulb... This will bring up all the available orders (ordered and not already ordered) you can just scroll down and check the box next to the wanted order.

*You are adding a new order. If at all possible, add it to the power plan. Again, on the left hand side menu, click on the active power plan then click on the “+add to phase” button and then add an order as usual. (this is helpful for when you need to transfer a patient.

*When changing fluid rates, “Cancel and Reorder” your last communication order. This way you don’t have a lot of old orders sitting around.

-Transfer Level of Care

1. Before you transfer the patient print a “Rounds Report” from cerner to get a list of all the medications and doses Go to MAR and check the start date an times and the time of the last dose and the dosing interval so you know when to order the next dose. (in the MAR list, the dark blue box shows the time of the next scheduled dose)
2. Click “+add” and place the transfer order.
3. Right click on “NICU ICN Admission” in the left hand “View” list screen and discontinue the powerplan
4. Next go through each of the Categories in the Orders section
   o Condition
   o Vital Signs
Discontinue any remaining orders (these are the ones that don’t have a “pizza box” icon in front of them. (It is a good idea t write down all the labs before you discontinue them so you don’t get confused on what to order when you readmit your patient in the IMCN)

*NOTE: Don’t discontinue the Hepatitis B Vaccination order.
Also keep the 24 and 48 hour CBC and CRP labs.

5. Next you have to readmit your patient to the IMCN (or wherever). Be sure to correctly re enter all the old medications and labs that you so thoughtfully wrote down beforehand.

-Growth Charts

Needed for all Premature. Helpful for all Term
1. Click to open the baby you want to chart
2. Click “Growth Chart” on the menu on the left side of the screen
3. Select the appropriate “Fenton” curve (not CDC)
4. Click on “Ad Hoc” from the menu bar at the top
5. Select “General Assessment”
6. Check the box for “Preterm Growth Chart” (for premature babied) or “Pediatric Growth Chart” (for term babies)
7. Click “Ok”
8. On the next screen enter the time and date of birth at the top in the “Performed On” box
9. Enter the appropriate Height, Weight, HC
10. Click on the green checkmark at the top to enter the data

NOTE: from now on you don’t have to enter it again. Whenever the nurses update the daily measurements the graph is automatically updated.

Other Stuff You Might Want to Know

* You can get a copy of the latest NICU guidelines from the Department home page. Go to www.ttushc.edu/elpaso. Click on Departments and choose Pediatrics. Click on subspecialties from the menu on the right hand side. Choose Neonatology then Educational Presentations. Click on the first link “SCN Resident Neonatal Handbook”

*You can print up the consent forms from the Thomason Hospital home page at http://www.thomasoncares.org/thomason/applications.nsf/main. Click “Consent Forms” then in the new page click “NICU” from the menu then choose the appropriate consent that you want. Then you can choose if you want it in Spanish or English. Click on the appropriate one and print. The blood transfusion consent form is listed separately under “Blood Transfusion and Refusal.” The consent forms are already printed up. You can find them near the central desk in the IMCN. They are in the bottom left drawer on the wall unit.

*Most of the paper forms that we still need to use will be in the overhead cabinets behind the HUC desk.

*Two teams. Blue/Green. Each team rounds with a different attending in the morning.

*When you are post call, you answer call until 7AM. But if the rover or the Nurse practitioner is late, you have to take the calls until they get there. So be sure someone is there to take calls before you decide to ignore the phone.

What to do on the first day:
1. Come in a couple of days earlier and become familiar with the patients and how to use cerner and site of care.
2. I usually come in at 6AM. But the first day you might want to come in even earlier (5 or 5:30 depending on how slow you are. This will usually give you enough time to get all your work done and make it to morning report.
3. Check the board for the patient distribution. (It doesn’t hurt to check frequently during the morning, there are times when the board will have a habit of mysteriously changing)
4. Round on your patients. Do your physical exam. Ask the nurses how the patient was doing (sometimes it
is a good idea to ask the day nurse again how the baby was doing because sometimes you get different
information).
5. Fill in Site of Care. The more you do in the morning, the less you will have to do in the afternoon. But
technically, you don’t have to have Site of care done before rounds. Just do as much as you can and finish it
after rounds.
6. Go to Morning report. (if applicable)
7. Get ready to round. Get a portable computer. Put stickers (blue or green depending on what team you are
on) on all your patients (they go on the chart, and on the two name tags that are on the crib/incubator.
Especially, for the open crib put the sticker on the card (which is on the back side of the plexiglass) and not
on the crib. Print or get your notes ready. Wait near the central work desk in the IMCN. You can wait in
the call room; the attending will usually just knock on the door to get you.
8. The attending usually rounds around 9AM. Rounds are done for post-call first. They can take a long
time…so be prepared.
9. When rounds are done put the computers back and PLUG THEM IN or they won’t have a charge left for
the next day.
10. After rounds, do discharges and TPN if you have them (TPN slips need to be in by twelve, two o clock at
the very very latest)
11. Eat lunch
12. Update you site of care notes based on what happened during rounds. (Print them and put them and give
them to the HUC)
13. Wait for calls.

STUDENTS:

MS IV NICU CRITICAL CARE CLERKSHIP:
Prerequisites: Pediatric junior clerkship and interview with arrangements 30 days in advance.
When offered: Each month except July and December (1 student per month).
Location: TTUHSC PLFSOM at El Paso
Faculty: Drs. Rubin, Levin, Ipson, Ambat, Flores and Chheda.

This is a 4 week rotation in the Neonatal Intensive Care Unit of Children’s Hospital of El Paso. It meets the fourth year
critical care requirement at the PLFSOM. Students will spend an average of 8-10 hours per day participating in the care of
patients admitted to this unit. You are also required to attend the didactic critical care lectures each Monday from 1200-
1300.

Clerkship Objectives
During the 4 week rotation, the medical student will be exposed to a variety of neonatal patients with complex medical
conditions requiring extensive intervention and management.

The neonatal intensive care objectives were adapted internally based on those competencies required for pediatric training
by ACGME and using Neonatal Intensive Care pediatric intern curriculum as a guide in the formulation of these objectives.

COURSE GOALS:

Patient Care

- Goal: Students, together with supervising faculty must be able to provide patient care that is compassionate and
effective for the treatment of problems associated with the critically ill newborn. The student should be responsible
for gathering essential and accurate information about their patients and follow and understand his or her patients’
medical conditions throughout the rotation.

Objectives:

• Follow a minimum of 2 critically ill patients in the level III nursery daily, writing daily notes and presenting his or
her patients during rounds each day. When the patients are transferred to the level II nursery for convalescence
they should continue to follow them until discharge while acquiring additional level III patients.
• Participate in the call cycle with the team’s senior resident, attending high risk deliveries during this call and
staying to present her or his patients on rounds, (average 7 calls per month).
• Learn to obtain a complete maternal/family history, perform a physical examination on preterm and at-risk term neonates, and assessing the pattern of fetal growth, nutritional status and well-being of the preterm and term neonate after birth.
• Make informed recommendations about diagnostic and therapeutic interventions based on physical examination, physiologic monitors, laboratory data, best medical evidence, and clinical judgment. Examples: Neonates with perinatal asphyxia, complications of prematurity.
• Together with the attending, communicate plan of care to the parents. Example: Plan of care for mechanical ventilation.
• Work with health care professionals, including those from other disciplines, to provide patient-focused care, develop and carry out patient management plans. Examples: Obstetric team, respiratory care, nutritionists, pharmacology, nursing, social services and rehabilitation.

Medical Knowledge

Goal: Students must demonstrate knowledge about established biomedical and clinical sciences and the application of this knowledge to the care their patients. They must understand the approach to establishing a differential diagnosis in the sick neonate.

Objectives:
• Demonstrate understanding of the normal transition process occurring at birth, and how these are modified in preterm and ill term birth and how these changes in the term or preterm neonate results in specific disease processes.
  o Learn pulmonary transition in the normal term infants versus preterm infant and the effect of disease on this transition.
  o Learn cardiovascular transition immediately after birth and short term in the normal term infant versus the preterm and the effect of sepsis or asphyxia on the immediate and short term transition.
  o Learn to evaluate and manage fluid and electrolytes in the preterm and ill term neonate during the first 72 hours of life.
• Understand the principles of neonatal resuscitation and stabilization including the ethical dilemmas in decision making in the delivery room and the role of prenatal counseling at prior to birth.
  o Become skilled at bag and mask ventilation in the term and preterm infant via simulation.
• Understand the varying patterns of fetal growth, postnatal problems associated with abnormal fetal growth (SGA, IUGR and LGA), and how to meet the nutritional needs of the preterm neonate in order to promote postnatal growth.
• Understand the role and purpose of intensive care for the neonate, the short and long-term ethical, societal and philosophical concerns, and the reason to obtain and assess ongoing data of outcome.

Practice-Based Learning and Improvement

Goal: Students must be able to assimilate scientific evidence and improve their patient care practices.

Objectives:
• Find and study evidence from scientific studies related to their patient’s medical problems. Example: Randomized controlled trials of therapy for Hypoxic Ischemic Encephalopathy.
• Use information technology to manage information, access on-line medical information; and support each students own education.

Interpersonal and Communication Skills

Goals: Students will be able to demonstrate interpersonal and communication skills that result in effective information exchange with Neonatal Intensive Care, Newborn Nursery, and Labor and Delivery team members and patient families.

Objectives:
• Give clear, concise, well-organized presentations on rounds, exchange patient information effectively with members of the care team and participate in rounds during other patient presentations.
• Learn to transfer care
• Explain critically ill patient’s problems and treatments in lay person’s terms to parents, ensuring their
comprehension of their infant’s illness.

**Professionalism**

Goals: Students must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population. This includes timely arrival for each students own patient evaluation and preparation prior to presentation for rounds and arriving to participate on rounds, remaining attentive to all patient presentations by the other team members and participating in discussions about patient care.

**Objectives:**
- Demonstrate respect, compassion, and integrity; a responsiveness to the needs of patients and their families that supersedes self-interest; accountability to patients and the profession, and a commitment to excellence and on-going professional development. Example; willingness to seek additional patients for evaluation.
- Demonstrate a commitment to ethical principles pertaining to provision or withholding of clinical care and confidentiality of patient information.
- Demonstrate sensitivity and responsiveness to patients’ and/or their family’s culture, age, gender and disabilities.

**Systems-Based Practice**

Goals: Students must demonstrate how to practice quality health care and learn to become advocates for their patients within the Neonatal Intensive Care environment.

**Objectives:**
- Understand the criteria for attending high risk deliveries and criteria for admission to the neonatal intensive care nursery.
- Discuss the importance of reducing errors and infections in the critical care area and identify mechanisms for reducing errors and nosocomial infections.
- Learn the importance of initiating early discharge planning and participate in the discharge planning of at least one of his or her patients.

The Department of Pediatrics’ Neonatology faculty was involved in the creation and development of the curriculum. The clinical setting for this rotation is dictated by the nature of the rotation ad limited to the aforementioned critical care setting. The acquisition of medical skills will be assessed weekly via clinical and simulation experience conducted and/or observed by the neonatology faculty. The students will be expected to attend high-risk deliveries whenever possible and learn the basics of neonatal resuscitation and stabilization. They will attend parents counseling sessions with the neonatologist covering that rotation as the L&D attending in order to learn more about this aspect of care of the high-risk pregnancy.

The students will attend the following scheduled conferences:
- Neonatology lectures/Journal club/case presentations – 1st, 3rd & 4th Friday at 12:00-13:00
- OB/Pediatrics Morbidity and Mortality Conference – 2nd Friday 12:00-13:00
- Pediatric Didactic Lectures – Wednesday afternoons from 12:30-16:30
- Pediatric Grand Rounds – 1st Wednesday of each month 0800-0900.
- Pediatric Morning Report – Monday and Thursday at 0800-0830 (when patient assignment allows).
- Discharge Planning Rounds – Every Tuesday at 1130-1200.
- High Risk Conference with Perinatology – 2nd & 4th Tuesday at 1200-1300.

The NICU clerkship director/and faculty attending are responsible for ensuring that each student is being exposed to appropriate clinical experiences. The clerkship director will meet with the student at the beginning of the rotation to review the selective syllabus and to discuss expectations and procedures. The clerkship director and/faculty attending will also meet with the student at the beginning of each succeeding week to review their patient care experiences. In rare circumstances it may be necessary to assign students computerized cases, simulations, or special readings to achieve objectives that are not being met through actual patient care.

**Preparation for Teaching**

Attending faculty and residents (see below) will be oriented to the experience by the NICU clerkship director and provided copies of the syllabus and evaluation form that they will use to assess student performance.
Residents will be required, as part of their training and orientation, to function as teachers. All residents are required to participate in a “Residents as Teachers” program that is administered by the Office of Graduate Medical Education. In addition, each resident will be provided copies of the Medical Student NICU syllabus with particular emphasis on goals, objectives, and assessment methods and criteria.

At present all instruction and clinical activity occurs in the Children’s Hospital of El Paso, University Medical Center Newborn Nursery and University Medical Center Labor and Delivery. Each faculty member will receive copies of the curriculum, goals and objective. The neonatal intensive care clerkship director will meet with participating faculty to review program expectations before the start of each student’s rotation.

### Apgar Score

<table>
<thead>
<tr>
<th>Appearance (color)</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue, pale</td>
<td>Body pink; hands &amp; feet blue</td>
<td>Completely pink</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pulse (heart rate)</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Slow (below 100)</td>
<td>Over 100</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gracie (response to stimulation)</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No response</td>
<td>Cry with some motion</td>
<td>Vigorous cry</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity (muscle tone)</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaccid</td>
<td>Some flexion of extremities</td>
<td>Active motion, Well flexed</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Respiration (respiratory rate)</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Slow, irregular, hypventilation</td>
<td>Good</td>
<td>Crying lustily</td>
</tr>
</tbody>
</table>

Apgars of ≤ 5 at the 5 minute Apgar is indicative of impaired transition or potential problems with long term outcome so a careful assessment of Apgars at this time and each 5 minutes for the first 20 minutes can help measure the infant’s response to resuscitation. The following article is strongly suggested as a review. The Apgar Score. *Pediatrics* 2006; 117; 1444-1447.

### Initial Management of the ELBW Infant (<1,000 g):

The ELBW infant is a group whose initial care in L&D and immediately after birth can impact outcome. At all times consider minimally handling these fragile infants.

**Thermoregulation:** All attempts should be made to keep the infant less than 30 weeks and 1500 grams warm as survival improves if excess heat loss is prevented. All cold stressed term and preterm infants transition very poorly and mortality increases for hypothermic ELBW infants. The normal infant temperature is 35.5-37.5°C with a +/- 0.5°C diurnal variation. A wet infant in a cold room has heat loss two to three times higher than heat production and if born into an environment of 25°C with low humidity drops their temperature 0.2-1.0°C/min.

**Preparing the delivery room:**

The radiant warmer needs to be on and temperature maximized to 100%

- Ensure the transport warmer is on
- Delivery room or OR to be at 73°C
- For extended resuscitation (>10 minutes) a probe should be placed
- Sides of the radiant warmer should be up to prevent radiant losses
- Warm cap
- Dry warm linen under port-a-warmer

- 1 gallon plastic bag or wrap (port-a-warmer bag used) to immediately wrap infant without drying
- Neopuff or anesthesia bag (flow at 5-10 LPM) face mask CPAP in the room
- Size 2.5 or 3.0 ETT ready or nearby
- Curosurf and administration equipment in case infant intubated
- Suction working with adequate sized suction catheter (6-8Fr)
- O2 sat probe (attach to monitor only after attaching to infant)

**Handling Infant (minimally and gently):**

- Immediately place infant in the port-a-warmer bag or a 1 gallon polyethylene bag
DO NOT DRY OR RUB
• Place a saturation probe to the right hand to wean O₂ to keep sats < 94%
• Oxygen use will be initially started at 30% on a blender
• Place a warm hat ASAP
• If the infant is not stable or the room is cold weigh the infant in the ICN

DO NOT ALLOW RESUSCITATION TO INTERFERE WITH TEMPERATURE CONTROL

Cardiovascular Resuscitation:
Avoid volume pushes unless documented or strongly suspected volume loss
Volume for hypotension works for very limited periods
Pushes change CBF/MAP putting infants at risk for IVH
Deliver volume as 10-20ml/kg over 30 minutes to an hour
50% for mean BP in ELBW gestational age + 5
25 week infant’s MAP should be 30 mmHg or greater
To increase the blood pressure if there is no hypovolemia
Dopamine or Dobutamine at 3-5 mcg/kg/min
Discuss with the attending before initiating
Use judgement. If mean BP is 30 mmHg or at the 5% but perfusion is good-relax!

Ventilation:
BPD or CLD (multifactorial and ventilator induced lung injury)
Lung injury develops rapidly with first breath and oxygen administration
• Can easily over-stretch and over-ventilate lung, especially if tidal volume and PEEP are ignored

If intubation is needed (not all infants < 1.0 Kg need intubation)
• Gently and rapidly intubate with a 2.5 ETT (stylet optional – use it if helps)
• Prophylactic (Curosurf 2.5 ml/kg) if ≤ 30 weeks requiring intubation

Ask respiratory therapy to set up Neo-Puff (which can delivery controlled pressure and PEEP) or NCCPAP
• Limit PIP and use rate with short inspiratory times
• Do not bag unless connected to a manometer
• Use PEEP as early as possible (first breath on)
• If O₂ used keep saturation < 94% and do not use color as an indicator of O₂ need.
• When setting up initial vent settings use adequate PEEP (usually not less than 3-4 cm in infant with RDS < than 1,000 grams)
• Place on SIMV (sensitivity must be set)
• Tidal volumes of 4-6 cm/kg
• Inspiratory times of 0.3 or less
• Avoid too much oxygen
  O₂ saturation 88 to 92%
• Avoid over-ventilation.
  CO₂ less than 35 needs to be addressed immediately (prolonged hypocarbia promotes PVL)
  Attempt to keep initial CO₂ 45-55, pH > 7.27
• Avoid sedation as unusual for ELBW infants
  (not routine so discuss with attending first),
  Morphine 0.05-0.1 mg/kg/dose IV q 3-4 hours
  Fentanyl 1-2 micrograms/kg/dose IV q 2-3 hours
  Avoid benzodiazepines as the sedation may cause movements that are mistaken for seizure like activity

Skin care: Infants < 1,000grams have insensible water loss as high as 7-9ml/kg/hour. The infants at highest risk for increased fluid losses are those under a radiant warmer with no protection and did not receive antenatal steroids. The infant has very thin immature friable skin with a large surface area. Topical medications are readily absorbed and the infant can easily develop toxicity.
• Use a Giraffe Omni-bed with humidity as per unit protocol
• Avoid adhesives
• Minimal use of topical medications as irritating, easily toxic
  (especially if have preservatives)
• Use baggie or plastic wrap if needed to avoid evaporative losses additional losses if under radiant warmer
OUTLINE FOR INITIAL ORDERS FOR ELBW

Dx: ELBW infant
Respiratory insufficiency with HMD/RDS
Suspect Sepsis due to immaturity and respiratory distress

Condition: Critical

Activity: Giraffe Isolette (Nursing protocol)

Diet: NPO – NG/OG tube open to air/gravity
   strongly consider trophic feeds at 1-2 days of age
   preferably human milk at 5-10 ml/kg/day by bolus or continuous gtt

IVF: D5% W at 80–100ml/kg/day until early TPN available
   Add heparin 0.5 unit/ml to all fluids in central lines
   Early TPN with D5% glucose may be started in first 1-2 hours when warmed if glucoses are 100-119 mg% or higher and D7.5% glucose if glucoses are < 100 mg%.
   UAC fluid ¼ NS with 0.5 unit heparin/ml to run at 0.5ml/hr

Medications:
   Ampicillin 100-200 mg/kg/day divided IV every 12 hours
   Write Gentamicin dose as per protocol (gestational age dependent)
   Erythromycin ophthalmic ointment
   Vitamin K 0.5 mg IM

Initial ventilator settings if incubated:
   TCPL Pressure control or TC VG
   MODE IN SIMV (sensitivity must be set)
   PIP 16-22 cm H2O if has lung disease, 10-14 cm H2O if none
   deliver Tidal Volumes no higher than 4-7 ml/kg
   PEEP 4 cm H2O
   3 cm H2O if no lung disease
   Short inspiratory times of 0.25-0.3 seconds, 0.25 if RR > 40
   Respiratory rate of 30-40
   Wean FIO2 to keep saturations 88-92%
   CXR and KUB for line and ETT placement as well as evaluation of lung disease then every AM until stable.

Skin care:
   Minimize adhesives
   Cover with plastic wrap if intubated and under a radiant warmer
   Humidified isolette

LABS:
   Initial spun Hct.
   CBC with diff at birth then 24 and 48 hours
   CRP at 24 and 48 hours
   Lytes every 12 hours the first 24 hours
   At 24 hours BMP for BUN/creatinine/Ca++ (preferably ionized)
   Total and direct bilirubin at 24 hours then total bilirubin as indicated
   Bilirubin at 12 hours if significant bruising, early jaundiced or evidence of hemolysis
   Phototherapy (blanket) if bilirubin ≥ 5 mg% or prophylactically if bruised

CNS:
   Neurosonogram DOL 7 unless clinically indicated to obtain sooner.

Social:
   Social Service consult ASAP.

Other:
   Rehabilitation Services and Nutrition consults (to be done on all admissions ≤ 1,500 grams.)
INITIATION OF MECHANICAL VENTILATION:

Respiratory distress
Remember respiratory distress (RD) is a symptom, not a disease. RD is not the same as RDS.

Causes of Respiratory distress:
Transitional
- Retained fetal lung fluid
- Hypoperfusion/metabolic acidosis after labor
- Alveolar hypoventilation due to maternal sedation or magnesium administration PTD
- Cold stress
- Hypovolemia

Meconium aspiration
Pneumonia
Air leaks

PPHN – may be present with all of the above or present with no lung disease.

Respiratory Distress Syndrome (RDS), also known as Surfactant Deficiency Syndrome/Hyaline Membrane Disease (HMD)

Pulmonary Insufficiency of Prematurity: Evolving lung disease that may result in BPD. Infant’s initial lung disease may have been very minor. Result of the following: immature lungs, immature immune system, bacterial colonization with inflammation, insufficient surfactant, early oxygen exposure, positive pressure ventilation, and limited nutrition.

Bronchopulmonary dysplasia (BPD; formerly Chronic Lung Disease of Infancy) is a chronic lung disorder that is most common among children who were born prematurely, with low birthweights and who received prolonged mechanical ventilation to treat respiratory distress syndrome. A new definition, which categorizes the severity of BPD, is shown in Table 1.

<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>&lt;32 wks</th>
<th>&gt;32 wks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time point of assessment</td>
<td>36 wks PCA or Discharge</td>
<td>29-55 DOL or Discharge</td>
</tr>
<tr>
<td>Treatment with O2</td>
<td>&gt;21% for at least 28d+</td>
<td></td>
</tr>
<tr>
<td>Mild BPD</td>
<td>Breathing RA</td>
<td>Breathing RA</td>
</tr>
<tr>
<td>Moderate BPD</td>
<td>Need for &lt;30% O2</td>
<td>Need for &lt;30% O2</td>
</tr>
<tr>
<td>Severe BPD</td>
<td>Need for ≥30% O2 and or PPV or NCPAP</td>
<td>Need for ≥30% O2 and or PPV or NCPAP</td>
</tr>
</tbody>
</table>

Congenital malformations: Airway obstruction, Diaphragmatic hernia, Congenital lobar emphysema, Congenital Cystic adenomatoid malformation (CCAM), Bronchopulmonary sequestration, Pulmonary hypoplasia etc.

All of the above may result in respiratory failure with increasing dyspnea requiring intubation and mechanical ventilation.

NON-INVASIVE STRATEGIES OF RESPIRATORY SUPPORT OF THE NEWBORN

Available in our NICU: 1. Nasal continuous positive airway pressure (CPAP), 2. High-flow nasal cannulas (HFNC) – Vapotherm, and 3. “Assisted” CPAP, which uses nonsynchronized or synchronized ventilator-delivered breaths (NIPPV)

Indications: initial stabilization of breathing after birth, management of the primary respiratory disease, facilitation of extubation, and, for chronic management of evolving bronchopulmonary dysplasia (BPD)

High Flow Nasal Cannula (HFNC) - description for using nasal cannula flow rates which are greater than convention. In the neonatal literature, high-flow nasal cannula therapy typically denotes flow rates greater than 1 L/min.

Heated, humidified, high-flow nasal cannula (HHHFNC) with flow rates greater than 2 L/min in preterm infants.

Five reasons why HHHFNC was beneficial over low-flow nasal cannula: (1) washout of nasopharyngeal dead space leads to improved CO2 clearance and increased FiO2 in alveolar regions of the lungs; (2) reduction in inspiratory resistance; (3) improved lung compliance with warmed and humidified gas; (4) decreased metabolic cost of gas conditioning; and (5) provision of distending pressure. Whereas pressure will develop in the delivery of HFT, mechanistic studies suggest that pressure is not the primary mechanism of action responsible for observed physiologic outcomes.

HHHFNC has been used in preterm infants as an initial mode of respiratory support, to reduce apnea events, or to help in weaning from mechanical ventilation.

- Vapotherm - delivers high-flow, thermally-controlled, humidification systems for respiratory therapy. Indicated for use in adding warm moisture to breathing gases to infant and approved for delivery by nasal cannula at flow rates of up to 8 lpm in infants, providing what is known as high flow therapy (HFT).
NICU Policy

- All O2 must be on a blender to allow weaning oxygen concentration without decreasing flow to keep saturations 88-92% unless ordered otherwise.

Continuous Positive Airway Pressure (CPAP) – positive pressure applied to the airways of spontaneously breathing baby throughout the respiratory cycle.

- Indications: Mild HMD, apnea, transitional mode following extubation

Delivered by: ventilator-derived CPAP (AVEA), Bubble CPAP

- With bubble CPAP, blended gas flows to the infant after being heated and humidified. Typically, nasal prong cannulae are secured in the infant's nares. The distal end of the expiratory tubing is immersed under sterile water to a specific depth to provide the approximate level of CPAP desired.

- How CPAP Improves Respiratory Function: 1. maintains positive pressure in airways during spontaneous breathing, 2. Improves oxygenation or alveoli, 3. Increases FRC, 4. Decreases airway resistance and improves lung compliance, 5. Decreases work or breathing, 6. Improves gas exchange by preventing atelectasis during expiration and 7. Reduces the chance of upper airway occlusion and decreases upper airway resistance by mechanically splinting it open.

- Which levels of CPAP or PEEP can be used:
  1. Level of CPAP/PEEP required needs to be individualized. If infant has stiff lungs or a low lung volume, increasing CPAP/PEEP improves oxygenation. (If pressure too high, overdistention occurs and oxygenation may be compromised).
  2. Increasing CPAP/PEEP may increase PaCO2 if pressure is too high when the lung compliance is also high.

Weaning from CPAP

1. No magic guidelines as to when the child can be weaned off. Assess the baby's oxygen saturation levels, occurrence of apnea and/or bradycardia, and work of breathing.
2. In general, infants who require an FiO2 greater than 0.40 or are clinically unstable are unlikely to be successfully weaned off NCPAP.
3. Generally, we decrease pressures down to a relatively low level (≤5 cm H2O). Once the CPAP is at this level without increased work of breathing and the baby does not have substantial apnea, bradycardia, or oxygen desaturations, attempt to discontinue NCPAP.
4. Infants without oxygen requirement may be trialed off NCPAP with no additional support. Infants still requiring oxygen may require a nasal cannula. The baby's subsequent clinical findings and oxygen requirement will guide the clinician.

Nasal Intermittent Positive Pressure Ventilation (NIPPV)

- Description: Addition of breaths to nasal CPAP. NIPPV is typically performed using nasal prongs with any of the ventilators currently available in the NICU.
- Indications: May be a useful method to enhance benefits of nasal CPAP in preterm infants with frequent or severe apnea.
- Outcomes: Initial data suggests NIPPV more effective in reducing apnea than nasal CPAP, but further research is required to confirm effectiveness and safety.
- The table outlines suggested starting ventilator settings for NIPPV for the management of RDS and for extubation from conventional mechanical ventilation. Ventilator settings then are adjusted based on clinical response.

<table>
<thead>
<tr>
<th>Ventilator Variable</th>
<th>Treatment of RDS</th>
<th>Support of Extubation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate – breaths/min</td>
<td>40</td>
<td>10-25</td>
</tr>
<tr>
<td>PIP – cmH2O</td>
<td>2-4 &gt; PIP on manual PPV</td>
<td>2-4 &gt; PIP on mechanical ventilation</td>
</tr>
<tr>
<td>PEEP – cmH2O</td>
<td>4-6</td>
<td>≤5</td>
</tr>
<tr>
<td>IT - s</td>
<td>0.4-0.45</td>
<td>0.3-0.5</td>
</tr>
<tr>
<td>Flow rate – L/min</td>
<td>8-10</td>
<td>8-10</td>
</tr>
</tbody>
</table>

MECHANICAL VENTILATION

Common Indications for Neonatal Mechanical Ventilation

Clinical Criteria
- Respiratory distress - severe retractions (intercostal, subcostal, and suprasternal); grunting, tachypnea (RR > 60-70/min)
- Central cyanosis - cyanosis of oral mucosa on O2 by nasal cannula/hood or CPAP at FiO2 > 40-70%
- Refractory apnea - apnea unresponsive to medical management (e.g. theophylline, caffeine or CPAP)
- Extreme prematurity

Laboratory Criteria
- Severe hypercapnea - PaCO2 > 55-60mmHg and pH <7.2
- Severe hypoxemia - PaO2 < 40-50mmHg or oxygen saturation < 85% on O2 by hood or CPAP at FiO2 of > 40-70%
- Adequate methylxanthine levels
VENTILATOR PARAMETERS:

Please keep in mind that ventilatory management takes many years of practice and that there are many different styles of ventilation. It will take time to be comfortable with each ventilator. Please be patient with yourself. Practice decision-making with each blood gas you receive.

**Oxygenation**
- The primary determinants of oxygenation are the FIO₂ and the mean airway pressure (MAP).
- Increasing the amount of O₂ delivered to the alveoli → overcome diffusion gradients → improve delivery of oxygen to the capillary blood.
- Raising MAP recruits collapsed alveoli → increase pulmonary surface area available for gas exchange.
- Several ways to increase MAP: ↑ PEEP > ↑ PIP > ↑ IT > ↑ rate > ↑ flow

**Ventilation**
- Refers to the removal of CO₂.
- During CMV can be calculated as the product of the frequency and the delivered volume of gas (RR x TV)
- Maneuvers that increase ventilator rate or tidal volume → increase CO₂ removal.
- TV is reflected by the difference between PIP and PEEP (amplitude or ΔP). Amplitude may be increased by raising PIP, lowering PEEP or doing both.

**Oxygen concentration**
- The fraction of inspired oxygen (FIO₂) refers to the percentage of oxygen in the gas delivered to the patient. It ranges from 21% (room air) to 100% (pure oxygen).
- A blender is used to adjust the concentration. Oxygen is warmed and humidified before it reaches the airway.
- In our nursery, blended oxygen is provided to keep O₂ saturations between 88-92% unless ordered otherwise. See the EPCH NICU Oxygen Policy.

**PIP (Peak Inspiratory Pressure)**
- Refers to the highest pressure delivered during inspiration. It is set during pressure-targeted ventilation and is variable during volume-targeted ventilation.
- PIP needed in each infant varies based on gestational age and lung disease.
  - Preterm < 1 Kg with no lung disease may need only 10-12 PIP
  - Term with MAP may need pressures as high as 26-30 to give appropriate tidal volume (TV)
- Initial PIP is assessed by bagging with manometer noting pressure used to move the chest.
- Adjustments are made after placing infant on the vent and observing the TV provided.

**PEEP (Positive End Expiratory Pressure)**
- The baseline pressure is the lowest pressure reached during expiration, and if it’s above zero, it is referred to as positive end-expiratory pressure.
- Positive end-expiratory pressure (PEEP) - positive pressure applied during the expiratory phase of respiration to a mechanically ventilated neonate.
- Infants ≤ 1,500g with minimal/no lung disease is started on PEEP of +3.
- 1,500g infant with HMD/pneumonia may need +4 to +5 PEEP
- Older infants, start on PEEP of +4 → ↑ +5-6 with significant lung disease
  - Use of PEEP above these recommendations should be discussed with the attending.

**Volume**
- Tidal volume is set during volume targeted ventilation and pressure is allowed to vary.
- During pressure-targeted ventilation, tidal volume is displayed on machines capable of measuring it, and some devices display inspired and expired tidal volumes and calculate minute ventilation.
- Range we use is 4-8 ml/kg no matter what the disease process.
  - Remember if compliance changes either after surfactant treatment (↑ compliance) or prior to the next dose (↓ compliance)
    - the PIP needs to be adjusted to avoid delivering too little (atelectasis) or too much tidal volume (volutrauma) contributing to BPD.

**Flow**
- Time rate of volume delivery.
- Flow rate is usually set by the respiratory therapist. It should be high enough so that the desired PIP is reached during inspiration but not so high that it might cause turbulence, inadvertent PEEP and gas trapping.
- If it is set too low, it may result in air hunger and increased work of breathing for the patient.

**Rate**
- The ventilator frequency (or rate) in part determines minute ventilation and thus CO₂ elimination.
- For IMV and SIMV, the clinician chooses the frequency of mandatory breaths to be delivered to the patient.

**Inspiratory time (IT)**
- Amount of time delegated to inspiration or the length of time in seconds to deliver the set PIP.
• Start all infants on an IT of 0.3 seconds.
• Adjust as needed based on the disease process. The attending can guide you on this.
• To increase MAP and improve oxygenation IT may be increased.
• Do not increase IT > 0.4 seconds without talking to an attending
• For some ELBW's with hyperexpansion or little lung disease, use shorter IT's (0.25 seconds).

### Mechanical Ventilator Settings used to Adjust Arterial Blood Gas

<table>
<thead>
<tr>
<th>PaCO2</th>
<th>PaO2</th>
<th>Respiratory acidosis (low pH)</th>
<th>Metabolic acidosis (low pH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rate and PIP (determine minute ventilation; ↑rate or PIP will ↓PaCO2)</td>
<td>1. FIO2 (↑O2 will ↑PaO2)</td>
<td>1. Same controls as PaCO2</td>
<td>1. Volume expansion or sodium bicarbonate</td>
</tr>
<tr>
<td>2. I:E ratio (determines the duration of inspiration and expiration; longer expiration will ↓PaCO2)</td>
<td>2. PEEP (↑PEEP will ↑PaO2)</td>
<td>2. May correct with improved oxygenation and ventilation as perfusion improves</td>
<td></td>
</tr>
<tr>
<td>3. PEEP (if too high or too low, may ↑PaCO2)</td>
<td>3. T1 or I:E ratio (↑T1 will ↑paO2; ↓T1 will ↓PaO2 in general)</td>
<td>3. Caution: High PEEP may result in metabolic acidosis due to impaired venous return</td>
<td></td>
</tr>
</tbody>
</table>

### Benefits and Risks of Adjusting Ventilator Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Benefits</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase PEEP</td>
<td>Maintains FRC, prevents alveolar collapse</td>
<td>Air leak, increase PIE, ↓ TV if no change in PIP CO2 retention (associated with ↓ TV) Can obstruct venous return Shift to stiffer compliance curve</td>
</tr>
<tr>
<td>Increase PIP</td>
<td>↑ MAP (improves oxygenation) Prevents atelectasis</td>
<td>Can obstruct venous return Barotrauma → air leak, CLD</td>
</tr>
<tr>
<td>Increase rate</td>
<td>↑ MAP (improves oxygenation) ↓ PIP requirement</td>
<td>Inadvertent PEEP (inadequate emptying time → air trapping) May lead to inadequate TV</td>
</tr>
<tr>
<td>Increase IT</td>
<td>↑ MAP (improves oxygenation)</td>
<td>Can obstruct venous return Inadequate emptying time leading to PIE Slower rates, ↑PIP requirement, ↑ barotrauma</td>
</tr>
<tr>
<td>Increase flow</td>
<td>↑ MAP (improves oxygenation)</td>
<td>↑ barotrauma,↑ resistance</td>
</tr>
</tbody>
</table>

### Conventional Ventilation

- Conventional ventilator used in this nursery for ventilation - AVEA ventilator system

#### Classifications

**Trigger mechanism:** What initiates the ventilator breath? Examples: time, pressure, flow, chest impedance, abdominal movement

**Limits:** What is controlled and what is variable? Examples: pressure-limited (pressure is controlled, volume is variable) and volume-limited (volume is controlled, pressure is variable)

**Cycle:** What causes the ventilator breath to end? How does the change from inspiration to expiration occur? Examples: time, volume, pressure, flow (assist/control, pressure support)

### Modes of Conventional Ventilation:

<table>
<thead>
<tr>
<th>Mode of Ventilation</th>
<th>Description</th>
<th>Benefits/Limitations</th>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent mandatory ventilation (IMV)</td>
<td>Preset ventilator breaths are delivered at a set frequency and interval Ventilator breaths are independent from infant’s spontaneous breaths</td>
<td>Benefits: indicated if infants with inadequate effort or undetectable breaths Limitations: asynchrony between infant and ventilator, variable tidal volumes based on lung compliance</td>
<td>Volume or pressure: either one is fixed and other is variable Trigger: none Ventilator rate: fixed I time: fixed</td>
</tr>
<tr>
<td>Synchronized intermittent mandatory ventilation (SIMV)</td>
<td>Mandatory ventilator breaths that are synchronized with infant’s inspiratory effort Spontaneous patient breaths between mechanically</td>
<td>Benefits: improves synchrony between infant and ventilator Limitations: ventilator is not</td>
<td>Volume or pressure: either one is fixed and other is variable; usually pressure is controlled Trigger: yes Ventilator rate: fixed</td>
</tr>
</tbody>
</table>
Assisted breaths are supported by baseline pressure only unless pressure support is started.

Supplemented

I time: fixed

Sensitivity needs to be set for synchronization to occur. For term infants set at 0.4 - 0.6 and preterm infants set at 0.2.

Assist-control (AC) = time cycled, pressure control

Each spontaneous breath of infant is assisted with a preset inspiratory pressure

Benefits: reduces infant’s inspiratory muscle workload

Limitations: may lead to overventilation if spontaneous respiratory rate is high, variable TV (depends on the infants’ airway resistance and lung compliance)

Time cycled

Volume or pressure: P is fixed and volume is variable

Trigger: yes

Ventilator rate: determined by infant; back up rate is required

I time: fixed

Pressure support (PS) = flow-cycled pressure control

Each spontaneous breath of infant is assisted with a preset inspiratory pressure

Pressure support (PS) calculated as (PIP + PEEP x 0.75) = PS in cm H2O. 10 cm H2O is a relative upper limit.

Benefits: reduces infant’s inspiratory muscle workload

Limitations: may lead to overventilation if spontaneous respiratory rate is high, variable TV (depends on the infants’ airway resistance and lung compliance)

Flow cycled

Volume or pressure: P is fixed and volume is variable

Trigger: yes

Ventilator rate: determined by infant; I time: variable, limited by the mechanics of the infants lungs and thus determined by infant

Volume guarantee

Targets delivery of a set tidal volume

Adjusts PIP based on previous breath to target preset TV (need to set maximal PIP); thus, the targeted volume is “guaranteed”

Benefits: can use with DIMV, A/C and PS modes on some ventilators

Guarantees TV, independent from infant’s pulmonary mechanics

Limitations: cannot increase pressures higher than set pressure limit, pressures are variable and difficult to control, to guarantee volume, requires a pressure plateau for which longer IT and or higher flows may be needed

Time-cycled

Volume or pressure: V targeted, P varies

High Frequency Oscillatory ventilation (HFOV)

- Sensormedic 3100 for high frequency oscillatory ventilation (HFOV)
- Delivers high MAP using rapid rates, small tidal volumes (often less than anatomical dead space, attempts to limit barotraumas).
- Mechanisms not well understood with gas transport occurring by:
  - Bulk convention (bulk axial flow of gas)
  - Pendulluft (gas moves between neighboring alveoli due to different time constants)
  - Asymmetric velocity (alternating velocities of gas during inspiration and expiration)
  - Taylor dispersion (parabolic movement of inspired gas with the highest velocity in the middle; provides an increased area for diffusion to occur)
  - Molecular diffusion (diffusion gradient leads to transport of gases across alveoli)
- Uses a piston-driven diaphragm which delivers gas to the airways and also actively withdraws it (active exhalation).

- Determinants of ventilation: \( \Delta P \) (amplitude) and frequency (Hz), (1 Hz=60 cycles/min.)
  Increasing the \( \Delta P \) and decreasing the frequency (Hz) \( \rightarrow \) increase delivered tidal volume and lower PaCO2.
  Decreasing \( \Delta P \) and increasing frequency (Hz) \( \rightarrow \) reduce delivered tidal volume and allow PaCO2 to rise.
- Determinants of oxygenation: The main determinant of oxygenation during HFOV is the MAP. Secondarily by FIO2.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>CV</th>
<th>HFOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Rate</td>
<td>0-60 breaths/minute</td>
<td>120-900 breaths/minute</td>
</tr>
<tr>
<td>Tidal Volume</td>
<td>4-6 cm H2O</td>
<td>0.1-1.5 cm H2O (not set by operator)</td>
</tr>
<tr>
<td>Alveolar Pressure Swing</td>
<td>5-50</td>
<td>0.1-5</td>
</tr>
<tr>
<td>Gas Flow</td>
<td>Low 5-8 L rarely 10</td>
<td>High 10-20 L (try lowest possible flow)</td>
</tr>
<tr>
<td>Temperature</td>
<td>37 C</td>
<td>37-39 C</td>
</tr>
</tbody>
</table>

Comparision of Basic Parameters of CV and HFOV

- **Advantages:** 1. Improves ventilation at lower pressure and volume swings in the lung. 2. Safe way of using super PEEP. The lung can be inflated to higher mean volumes without having to use high peak airway pressures to maintain ventilation. 3. More uniform lung inflation. 4. Reduces air leak.
- **Disadvantages:** 1. Potential for gas trapping \( \rightarrow \) inadvertent PEEP. 2. Difficulty defining optimal lung volume. If increased lung
volume → decreased venous return → compromise cardiac output. If decreased lung volume → underinflation → collapsed lung difficult to recruit.

- **Indications:** 1. Homegenous lung disease (in contrast to heterogenous disease that responds better to lower frequency) 2. Persistent air leak (PIE, bronchopleural fistula) 3. Persistent hypoxemia (PPHN) or hypercarbia not responsive to CV.

### Initial HFOV settings

- **FiO2:** Usually set at 100% after the transition to HFOV, and then tapered using oximetry guidance to maintain SpO2 at 88-92%.
- **MAP:** Generally initiated at 2-3 cmH2O higher than the MAP noted during conventional ventilation.
  - For hemodynamically unstable patients and those with air leaks: may be started on a MAP equal to or 1 cmH2O above MAP during conventional ventilation.
  - If the SpO2 (or PaO2) has not improved enough to allow weaning of FiO2%, the MAP is raised in 1-2 cm H2O increments. Increasing MAP can be done q 2-5 minutes. (but you must remain at the bedside to observe improvements or deterioration)

### Amplitude

- ΔP is generally initiated at a value where the patient’s chest vibrations are seen down to their mid-thigh.
  - Alternatively, initial ΔP may be set to observe adequate “chest wall vibration” Nurses and RT will help you with this.

### Hertz (Hz)

- Hz or frequency determines the volume delivered. The lower the Hz, the greater the TV delivered and vice versa.
  - ↓Hz keeping the I time constant ↑’s TV and changes I:E ratio
  - Decreasing the Hz is also an alternative to decrease the pCO2 (>65) early on in the disease process if amplitude is double the MAP and pH is still in the abnormal range.
  - Severe meconium aspiration with large areas of thick meconium or meconium atelectasis rarely may need Hz of 6-8 early in the disease in order to remove secretions. “BUT” Hz is to be increased back to 10 as the first weaning strategy before decreasing the amplitude.
  - Remember-the lower the Hz, the greater the tidal volume.

### Summary of Gas Exchange and Ventilator Adjustments During High Frequency Ventilation

<table>
<thead>
<tr>
<th>Problem</th>
<th>HFOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate oxygenation with atelectasis/poor lung expansion on x-ray</td>
<td>Increase MAP by 1-2 cm H2O, then decrease after improvement</td>
</tr>
<tr>
<td>Inadequate oxygenation with lung overexpansion on x-ray ± hypercarbia</td>
<td>Decrease MAP by 1-2 cm H2O, Repeat CXR</td>
</tr>
<tr>
<td>Hypercarbia with normal lung volumes on CXR</td>
<td>Increase amplitude/power or decrease frequency</td>
</tr>
<tr>
<td>Hypocarbia</td>
<td>Decrease amplitude/power or increase frequency</td>
</tr>
<tr>
<td>Hyperoxia</td>
<td>Decrease FiO2 to 0.3 to 0.4 or less then MAP</td>
</tr>
</tbody>
</table>

### Follow-up/Monitoring:

- **Monitoring CXR**
  - Obtain CXR 1 hour after HFOV is begun.
  - Check lung expansion. Target is 8-9 ribs; no intercostal bulging, no flattened diaphragm. Identify PIE early. Rule out volume loss or over-distention. Ensure adequate ETT placement.
  - The following are **suggested** actions depending on chest expansion.
    - CXR < 8 ribs and on > 30% O2 increase MAP by 1
    - CXR > 9 ribs and on < 30% O2 decrease MAP by 1
    - CXR > 9 ribs and on > 30% consider volume or repeat surfactant
    - If the CXR shows over-distention wean MAP by 1 every 2-4 hours until FiO2 needs begin to increase if clinically possible.
  - Ordering CXR: this may be modified by the situation or attending.
    - One hour after HFOV initiated → every 6-8 hours and PRN x 24 hours → every 8-12 hours and PRN x 48 hours → every 24 hours and PRN
    - Stat CXR ordered in any on the following circumstances: 1. Any sudden unexplained decrease in saturation, 2. Gradual or sudden decrease in blood pressure, 3. Oxygen requirement increases more than 10%, 4. Blood gases showing a big change in O2 and or PaCO2.

### Blood Pressure Monitoring

- Goals: Maintain mean BP at the 50% for gestational age.
Avoid BP mean < 30 mmHg in infants < 1,200 grams. Inability to autoregulate cerebral blood flow (CBF) < 30 mmHg → ↑ intraventricular hemorrhage (IVH)/periventricular leukomalacia (PVL)

Occasionally, patients will develop hypotension shortly following transfer to HFOV or as MAP is raised. This usually implies relative hypovolemia and responds to intravenous fluid boluses.

If hypotension persists, we add vasopressors (e.g. dopamine, dobutamine) and reconsider the differential diagnosis of the hypotension.

Two methods to determine 50% for mean arterial blood pressure:

1. Gestational age rule is gestational age plus 5 = the 50% for mean BP.
2. By weight

<table>
<thead>
<tr>
<th>Weight</th>
<th>50% for Mean Blood Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 grams</td>
<td>30 mmHg + 5 = 35 mmHg</td>
</tr>
<tr>
<td>900 grams</td>
<td>29 mmHg + 5 = 34 mmHg</td>
</tr>
<tr>
<td>800 grams</td>
<td>28 mmHg + 5 = 33 mmHg</td>
</tr>
<tr>
<td>700 grams</td>
<td>27 mmHg + 5 = 32 mmHg</td>
</tr>
<tr>
<td>600 grams</td>
<td>26 mmHg + 5 = 31 mmHg</td>
</tr>
<tr>
<td>500 grams</td>
<td>25 mmHg + 5 = 30 mmHg</td>
</tr>
</tbody>
</table>

pCO₂ monitoring:

- Target CO₂ is 40-55 with pH above 7.25-7.28 unless discussed otherwise. Permissive hypercarbia allowed and sometimes desirable.
- Adequate chest expansion and lung recruitment assists with adequate ventilation.

Causes of CO₂ retention

1. Under-ventilation and over ventilation:
   - pCO₂’s 40-55 help avoid over-ventilation. Less over-ventilation → the better the long term outcome.
   - CO₂ retention due to under-ventilation or over-expansion due to over-ventilation.
   - Evaluate all increasing CO₂ retention with CXR
     - Determines over-expansion vs. under-expansion as cause for ↑ CO₂
     - Over-expansion due to over ventilation is frequently not evaluated
     - Tendency is to ↑ amplitude further, wrongly assuming infant is under-ventilated → further increasing hyper-expansion and worsening the CO₂ retention. One cannot ventilate a lung without adequate lung expansion.

2. Air leaks
   - Pneumothorax
   - Pulmonary interstitial emphysema (PIE) – interstitial air trapped around the alveoli → widens the diffusion space for gases → interferes with ventilation and perfusion.
   - Both causes of CO₂ retention not related to under or over-ventilation.

3. ETT improperly placed
   - Malpositions: ETT too high or low (frequently in right main stem bronchus). Against airway wall acting as one-way valve not allowing exhalation of gases.
   - Evaluation: Check where ETT is taped or the position of the ETT on CXR Evaluate chest wiggle with repositioning the infant.

Weaning From High Frequency Oscillatory Ventilation

- When patients respond with improved oxygenation, the first weaning maneuver is to reduce the FiO₂ before any reduction is considered in MAP.
  - Attempt reduction of FiO₂ to 40% with a target SpO₂ > 90% before attempting reductions in MAP.
  - If the patient can maintain a SpO₂ > 90% on FiO₂ 40%, start a gradual reduction of MAP.
  - When the MAP is decreased and no change in O₂ requirements, continue decreasing MAP. (e.g. Decrease MAP by 1 q 4 in 1st 24 hours → Q 2 hours in the second 24 hours)
  - It is important not to decrease MAP too rapidly in an attempt to get the patient off HFOV. If the lung derecruits and desaturation occurs, it can take many hours to regain the lost volume.
  - If O₂ needs increase > 40% go back the previous MAP, check CXR to rule out loss of lung volume, stop weaning until sats, O₂ need, and BP are stable for 2-3 hours.

- Wean amplitude to maintain pCO₂ in the target range. Avoid at all times pCO₂ less than 35 mmHg as this contributes to PVL.

- The following are suggested actions:
  - CO₂ < 35 → decrease amplitude by 3-5 → repeat gas in 15 minutes
  - CO₂ 35-45 → wean amplitude by 1 q 4-6 hours.
  - CO₂ 40-50 → no change needed → repeat 2 gases 2 hours apart
  - CO₂ 50-55 → increase amplitude by 1-2 → repeat gas in 1-2 hours
  - CO₂ 55-65 → increase amplitude by 3 → repeat gas in 30 minutes to 1 hour → If no improvement obtain a CXR and evaluate the infant.
Other Supportive Issues During HFOV

- Consider sedation and neuromuscular paralysis as indicated. Not usually needed for infants <1000G
- Tracheal suctioning should be done prior to initiation of HFOV. During the early hours and days of HFOV, limit interruption of HFOV to perform suctioning unless there are gross secretions in the airway or evidence of atelectasis on chest radiograph.
  - Tracheal suction lowers carinal pressures and may allow alveolar derecruitment to occur - usually manifested as a lower SpO2 or requirement for a higher FiO2.

THERAPEUTIC AGENTS IN RESPIRATORY DISEASES

1. METHYLXANTHINES

<table>
<thead>
<tr>
<th></th>
<th>Caffeine</th>
<th>Theophylline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loading</strong></td>
<td>20-40mg/kg/dose IV/PO</td>
<td>4-8mg/kg per dose IV/PO</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td>5-8mg/kg/dose IV/PO caffeine citrate</td>
<td>1.5-3mg/kg/dose IV/PO</td>
</tr>
<tr>
<td><strong>Plasma t ½ (h)</strong></td>
<td>40-230 (mean 103)</td>
<td>12-64 (mean 30)</td>
</tr>
<tr>
<td><strong>Therapeutic level (mcg/mL)</strong></td>
<td>5-25</td>
<td>7-12</td>
</tr>
<tr>
<td><strong>Toxic level (mcg/mL)</strong></td>
<td>&gt;40</td>
<td>&gt;20</td>
</tr>
<tr>
<td><strong>Signs of toxicity</strong></td>
<td>Sinus tachycardia, hypertonia, sweating, cardiac failure, pulmo edema, metabolic disturbances</td>
<td>Sinus tachycardia, agitation, electrolyte abnormalities, significant diuresis, gastrointestinal bleeding, ventricular tachycardia, seizure</td>
</tr>
<tr>
<td><strong>CSF distribution</strong></td>
<td>Similar to plasma concentrations (reported correlation coefficients of 0.77)</td>
<td>Crosses into the CSF (reported correlation coefficients of 0.54)</td>
</tr>
<tr>
<td><strong>Metabolism</strong></td>
<td>Excreted unchanged or CYP P450 (CYP1A2) liver-methyltransferase pathway</td>
<td>Excreted unchanged or CY P450 (CYP1A2) metabolism</td>
</tr>
<tr>
<td><strong>Interconversion between the 2</strong></td>
<td>3% to 8% converted to theophylline via CYP1A2</td>
<td>25% converted to caffeine via methylation</td>
</tr>
<tr>
<td><strong>Elimination</strong></td>
<td>Neonates younger than 1 month of age excrete 86% unchanged in urine; first-order elimination</td>
<td>Neonates excrete ~ 50% of the dose unchanged in urine; first-order kinetics; at high concentrations (&gt;20 mg/L), the drug elimination mechanism becomes saturated, resulting in concentration-dependent elimination (zero-order kinetics)</td>
</tr>
</tbody>
</table>

2. NITRIC OXIDE (NO) (To be used under direction of Neonatologist)

- Endogenous NO is formed from L-arginine by nitric oxide synthase (NOS) in endothelial cells lining the blood vessel walls
- Some NO diffuses into adjacent vascular smooth muscle cell and activates guanylyl cyclase → ↑cGMP → vascular smooth muscle relaxation → ↓vascular tone
- Remaining NO diffuses into intravascular space → binds with Hb → oxidized to NO2 and NO3 → inactivation
- Exogenous NO has the same effect as endogenous NO; when given in the inhaled form → NO reaches the alveoli → diffuses into adjacent vascular smooth muscle and endothelial cells

- Effects of Inhaled NO
  - Exogenous NO ↓ pulmonary vascular resistance
  - Selectively dilates pulmonary blood vessels that are ventilated → improving ventilation/perfusion matching → effective pulmonary vasodilation
  - Does not cause peripheral vasodilation
  - By ↓ intrapulmonary shunting, ↑ arterial O2 and ↓ ventilation/perfusion mismatching → enables ventilation to occur at lower MAP → improving tissue oxygenation and ↓ FiO2

- Indications
- Pulmonary hypertension associated with lung disease, sepsis
  - Side effects
    - Methemoglobinemia
    - Increased oxidants (nitrogen dioxide, peroxynitrite) → pulmonary injury
    - Uncertain long term effects
    - Uncertain if NO affects bleeding time or platelet function in neonates
- **Criteria for iNO eligibility at our NICU** (see El Paso Children’s Hospital practice guideline order sheet for complete recommendations)
  - Severe hypoxic respiratory failure /PPHN in newborn infants ≥ 34 weeks gestation and postnatal age < 14 days.
  - No evidence of structural heart disease with ductal dependent R → L shunting or pulmonary venous obstruction (excluding PDA and atrial level shunting).
  - Oxygenation index: PT 34-36 wks: OI ≥ 10, FT ≥37 wks: OI ≥ 10-15. (OI on 2 consecutive blood gases at least 15 minutes apart and after other therapies have been utilized and optimized)
    - Calculation of Oxygenation Index (OI): \[\frac{(MAP \times FiO_2)}{PaO_2} \times 100\]

### 3. SURFACTANT
- Saturated phosphatidylcholine species, surfactant protein B, and surfactant protein C - major components that confer the unique ability of surfactant to lower the surface tension on an air-water interface to very low values
- Role of surfactant in maintaining alveolar distention is explained by Laplace’s law: \[P = \frac{2T}{r}\]
  - \(P\) = pressure needed to resist alveolar collapse, \(T\) = surface tension, \(r\) = alveolar radius
- Surfactant provides a stabilizing effect by decreasing surface tension and thus decreases the pressure needed to keep alveoli open
- Indications: At present, RDS is the only FDA-approved indication for the use of exogenous surfactant. New indications (meconium aspiration, congenital diaphragmatic hernia, BPD, bronchiolitis, genetic disorder of surfactant system, pulmonary hemorrhage) need to undergo the same rigorous testing as did RDS.
- The table summarizes the description of Curosurf - the surfactant used in our unit.

<table>
<thead>
<tr>
<th>Surfactant</th>
<th>Synthetic or Natural</th>
<th>Protein-Containing</th>
<th>Suggested Dose</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poractant Alpha</td>
<td>Natural (minced</td>
<td>Yes, total 1%</td>
<td>2.5 mL/kg initial dose;</td>
<td>Contains only polar lipids; highest concentration of lipids of commercial surfactants</td>
</tr>
<tr>
<td>(Curosurf)</td>
<td>porcine lung extract)</td>
<td>hydrophobic proteins;</td>
<td>1.25 mL/kg subsequent dose(s); delivers 100–200 mg/kg phospholipid</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.3–0.45 mg/mL SP-B;</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>5.0–11.6 mcg SP-C /microM PL</td>
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</tr>
</tbody>
</table>
SCN OXYGEN ADMINISTRATION POLICY:

- The nurse or respiratory therapist will ensure that blended oxygen is set up and administered as per the physician/NNP’s order.
- In an emergency, the nurse will provide blended oxygen to keep O2 saturations between 88-92% unless ordered otherwise previously and have the physician or NNP notified immediately. As a general rule-high O2 saturations are harmful to living tissues. If O2 saturation monitoring is not in place it should be placed immediately upon the use of oxygen therapy.

| Effective respiratory effort but cyanotic nares | Blow-by blended oxygen at 5 liters to keep saturations 88-92%. |
| Questionable ventilation with cyanosis | Blow-by to nares. If no response, then blended oxygen at 5 liters per minute via bag and mask/ETT at 40-60 breaths per minute. Support as necessary to keep saturations @ 88-92%. |
| Respiratory failure | 5 liters blended oxygen via resuscitation bag & mask ventilation keeping oxygen saturations @ 88-92% until recovered, intubated and/or placed on a ventilator. |

- Blended oxygen administered will be humidified by approved means.
- Nursing Associates will document the blended oxygen concentration and flow rate every hour. Further, Nursing Associates will verify oxygen saturation alarm limits every shift.
- Respiratory Therapy and Nursing Associates will perform adjustments in blended oxygen concentration based upon patient oxygen saturation monitoring device.
- One of the detrimental factors contributing to retinopathy of prematurity (ROP) is frequent changes in oxygen administration as well.
- Oxygenation status will be monitored closely to maintain constant levels during procedures (i.e. positioning, suctioning, feeding and medical interventions) and post-procedure blended oxygen will be adjusted/weaned to pre-procedure status keeping saturations between 88-92%.
- A blended oxygen source and resuscitation bag will be available at all times to each patient to deliver blended oxygen in the event of an emergency, with the ability to place saturations monitoring at the onset of oxygen therapy.

PROCEDURE

A. Equipment
1. Oxygen tubing
2. Flow meter with blender (oxygen)
3. Resuscitation bag and mask
4. 100 ml reservoir
5. Devices supplied by Respiratory Therapy
   a. Nasal cannula
   b. Oxyhood
   c. Ventilator
   d. Manometer
   e. Blender
   f. Vapotherm
6. Intubation equipment available in yellow box in ICN
7. Cardiorespiratory monitor
8. Pulse oximeter or appropriate monitoring device with low saturation and high saturation alarm limits set.

B. Equipment preparation
1. Connect oxygen flow meter to source with the blender and set at 5 liters.
2. Place connecting tubing to flow meter and resuscitation bag.
3. Apply a pressure manometer to the resuscitation bag via oxygen tubing for new admissions, infants on ventilators or code arrests.
4. Check to ensure all connections of the resuscitation bag are tight and operational by covering the mask or patient outlet tightly with the palm of the hand and applying pressure to the bag. All parts must function as though on an infant.
5. Respiratory Therapy Associates will set up the blender, oxyhood, ventilators, nasal cannulas and vapotherm.

C. Method
1. Move any infant in distress to an open warmer and provide blended oxygen with/without bag & mask ventilation to re-establish life signs, keeping oxygen saturations between 88-92%.
2. If the infant is breathing, blow-by blended oxygen to the nares at 5 liters is acceptable. Cupping the hand around the face may be necessary to optimize delivery of Oxygen to keep saturations 88-92%.
3. If the infant shows no respiratory effort or ineffective effort, ventilate by resuscitation bag with flow meter at 5 liters per minute.
   a. Apply the mask securely over the nose and mouth forming a seal. Do not apply excessive pressure to the head or neck.
   b. Place the head in a sniffing position, neither hyp nor hyperextended, and ventilate at a rate of 40-60 breaths per minute (variable according to infant).
   c. Apply the pressure needed to cause the chest to rise and fall gently. Apply the pulse oximeter, manometer or appropriate monitoring device if not already in use.
   d. Ventilate the patient until additional support is supplied as ordered by the physician/neonatal nurse practitioner, or until the patient is maintaining adequate oxygenation and ventilation. Provide blow-by blended oxygen as needed to prevent hypoxia (any infant ventilated with a resuscitation bag greater than two minutes will require decompression of the stomach by nasogastric tube).

4. Humidity/temperature should be 35°F for ventilator and 30°F for oxyhood.

5. Infants who have chronic oxygen needs will require orders for the provision of blended oxygen during the performance of activities of daily living (when in oxyhood and nipple feeding, the infant may need a nasal cannula during feeding to provide a continuous, uninterrupted source of blended oxygen).

6. Increase and decrease the blended oxygen concentration delivered based on the oxygen saturation monitoring device.
   Standard Protocol:
   a. Saturation > 92% ↓ oxygen
   b. Saturation < 85% ↑ oxygen

7. Oxygen saturation alarms must be set and on while the infant is on blended oxygen therapy.
   a. High Saturation ≥ 94%
   b. Low Saturation ≤ 80%

8. Oxygen saturation and concentration may vary based on the infant’s diagnosis or the physician’s/neonatal nurse practitioner’s orders.

9. Blood gases will be monitored per policy and procedure NC-SN-15 Blood Sampling, Arterial/Venous, Assisting With.

D. Documentation
   1. In emergency, chart interventions taken to sustain life in detail. Chart the physician/neonatal nurse practitioner called and the time so that medical supervision of the emergency is noted.
   2. Place on the Patient Care Plan the method to determine the amount of blended oxygen needed during those times when interruptions of standard delivery methods are necessary (i.e. nasal cannula for feeding or interventions).
   3. Chart oxygen concentration hourly, along with the method of delivery.
   4. Document alarm limits on each shift.

E. Special Instructions
   This policy will not apply when specific orders are written for exceptional infants.
   A patient who has orders for comfort measures only (CMO) on the chart may have oxygen adjusted according to the patient-monitoring device or a blood gas if the hypoxia is iatrogenic in nature (i.e. procedure). The blended oxygen will be weaned back to pre-procedure status as soon as possible. Other changes in the method of respiratory support will be ordered by the physician/neonatal nurse practitioner.

References:
   Biology of The Neonate 2005; 87:27-34.
   Neonatology 2008; 94:176-182.

Neonatal Resuscitation Check List

Nursing/Physician/NNP
   ☐ Radiant Warmer on High & OR Temperature and L&D Thermostat Set at 73°F
   ☐ Turn bed off if anticipating an asphyxiated term infant
   ☐ Plastic Bag & Port-A-Warmer if ≤ 30 Wks and /OR 1.5 Kg
   ☐ Suction & Catheter connected to With Suction at 100 mmHg
     8 FR for Preterm and 10 FR for Term
     Meconium Aspirator Attached If MEC Stained Fluid

Respiratory Therapist/Physician/NNP
   ☐ Working Laryngoscope and Appropriate Sized Blade & ET Tube
     (2.5 < 1.0 Kg/3.0 < 2.0 Kg/3.5 < 3.0 Kg/4.0 > 4.0 Kg)
   ☐ Attached and Infant Bag with Appropriate Sized Masks
   ☐ Oxygen Source Attached To Blender Set On 30% FIO2
   ☐ O2 Pox Sensor Attached To Right Hand on Preterm OR any Term Infant Requiring Resuscitation
   ☐ 00 Miller blade for infants <1500 G. 0 Miller blade for infants > 1500 G. 1 Miller blade for Infants > 3Kg
L&D Oxygen Delivery Guidelines by Gestational Age
(RT to place POx Sensor and Wean FIO2)

Remember infants are BLUE in-utero. Do not be frightened by initial cyanosis. Heart rate is initially a more sensitive indicator of successful oxygenation.

**Preterm Infant ≤ 32 Weeks:**
- Place POx Sensor on Right Hand After Birth
- Start 30% FIO2 @ 5L Flow via Blender adjust O2 To Keep Saturations
  - 70-75% First 2 Minutes
  - 80-85% First 2-5 Minutes
  - 5 Minutes 85-92%

**Infants > 32 Weeks:**
- Place POx Sensor On Right Hand **If Starting Resuscitation**
- Start 21% FIO2 @ 5L Flow via Blender
- Adjust to Keep Sats Same as Preterm Once O2 Initiated
  - 70-75% First 2 Minutes
  - 80-85% First 2-5 Minutes
  - 5 Minutes 85-92%

**NUTRITION:**
- Caloric needs for the preterm vary individually but are around 120–140 cal/kg/day for enteral feeds and 100 cal/kg/day if given IV. The goal is a weight gain of 1- 2% of the present weight per day or 15 gm/kg/day (mimicking intrauterine weight gain).
- Caloric needs at term are less at 100-120 cal/kg/day enterally and 80-100 cal/kg/day IV.
- To follow growth rate in the SCN a growth chart adapted from known intrauterine growth rate needs to be followed weekly. The best time is the same day of nutrition labs on Wednesday. The process for this is noted at the end of the nutrition section and should be adhered to.

**SUGGESTED GUIDELINES FOR THE INITIATION OF PARENTERAL NUTRITION:**
- TPN (parenteral nutrition) should be initiated ASAP postnatally (**Early TPN stock solution**) in infants less than 1,500 g.
- Infants > 1,500 gms can start TPN the day after birth.
- Cycling TPN is used with infants requiring prolonged TPN and will be handled on a case by case basis.

**EARLY AMINO ACID INFUSION FOR VLBW INFANTS:**
Postnatal growth of ELBW infants remains poor and does not come close to approximating rates of in utero growth. There is good evidence that early deficiencies in protein may be an important contributor to the poor growth and neurologic outcomes observed in this population. Providing intravenous amino acids to sick premature infants in early postnatal life can improve protein balance and can increase protein accretion, even at low caloric intakes.

Several controlled studies have demonstrated the efficacy and safety of amino acids initiated within the first 24 hours after birth. No recognizable metabolic derangements, including hyperammonemia, metabolic acidosis or abnormal aminograms, were observed.

Early parenteral nutrition with amino acids minimizes the abrupt postnatal deprivation of amino acid supply and meets the following goals:
1. Prevention of protein catabolism
2. Prevention of a decrease in growth-regulating factors such as insulin and down-regulation of glucose transporters
3. Prevention of hyperglycemia and hyperkalemia

Based on available evidence, providing ELBW with 2.5 to 3.5g/k/day of intravenous amino acid as soon as possible after birth is a reasonable recommendation.

**EL PASO CHILDREN’S HOSPITAL EARLY PN SOLUTION PROTOCOL**
The hospital pharmacy will prepare a “stock” amino acid and dextrose solution that will be readily available for use 24 hours a day.

This solution will consist of either 7.5% dextrose, 4% amino acids, 200mg Ca gluconate/100mL and 0.5units/mL heparin or 5%
dextrose, 4% amino acids, 200mg Ca gluconate/100mL and 0.5units/mL heparin.

The early PN solution will be initiated within the first hours of life in critically ill VLBW (≤1500g) newborns at a maximum rate of 60ml/kg/day to deliver 2.4g/kg/day amino acids.

Other fluids can be co-infused with the stock solution to meet the changing individual needs for glucose homeostasis, electrolyte balance and total fluid requirements.

If the solution is not immediately available, start D5W or D10W at a rate of 80-100ml/k/day or higher depending on patient requirement. Early PN solution will then be started as soon as available at a maximum rate of 60ml/k/day with proper rate adjustment of the other IV fluid to make up for the remainder of the total fluid requirement for the day.

Precautionary measures to prevent hyperglycemia:
1. Do not start early PN solution if serum glucoses are 120mg/dL and higher.
2. If serum glucoses are between 100-119 mg/dL, use D5 Early PN solution.
3. If D7.5 Early PN is used, decreased rate to ~30ml/kg/day and give the rest of the fluid requirement as D5W. Gradually increase Early PN rate to goal of 60ml/kg/day if serum glucoses are 100mg/dL and lower.

Please allow time to warm the solution before starting infusion.

Type “Early TPN” in Cerner and choose the appropriate early PN. It is advisable to inform Pharmacy ahead of time if the delivery of a VLBW infant is anticipated. Early PN should commence no later than 4 hours after delivery.

The tables provide essential calculations of calorie and protein intake depending on administration rate.

<table>
<thead>
<tr>
<th>Glucose concentration</th>
<th>Rate (ml/k/day)</th>
<th>Non-protein calories (kcal/kg/day)</th>
<th>Gram protein/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5%</td>
<td>40</td>
<td>10.2</td>
<td>1.6</td>
</tr>
<tr>
<td>7.5%</td>
<td>60</td>
<td>15.3</td>
<td>2.4</td>
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<tr>
<td>7.5%</td>
<td>80</td>
<td>20.4</td>
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<tr>
<td>7.5%</td>
<td>100</td>
<td>25.5</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Glucose concentration</th>
<th>Rate (ml/k/day)</th>
<th>Non-protein calories (kcal/kg/day)</th>
<th>Gram protein/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>40</td>
<td>6.8</td>
<td>1.6</td>
</tr>
<tr>
<td>5%</td>
<td>60</td>
<td>10.2</td>
<td>2.4</td>
</tr>
<tr>
<td>5%</td>
<td>80</td>
<td>13.6</td>
<td>3.2</td>
</tr>
<tr>
<td>5%</td>
<td>100</td>
<td>17.0</td>
<td>4</td>
</tr>
</tbody>
</table>

Please make sure to document Early PN solution in the Site of Care note as an event.

References:

TPN COMPOSITION:

Carbohydrate
- Major source of energy during parenteral nutrition and should provide 35-55% of the total caloric intake.
  - 1 gram CHO provides 4 kcal.
- Source used in PN is mostly glucose. Dextrose is a form of glucose.
  - 1 gram of glucose provides only 3.4 kcal because glucose crystals are weighed in the hydrated state.
Infants < 1,000g have ↑ glucose needs but may not handle glucose well.

Initial glucose infusion rates (GIR) is based on endogenous production of glucose.
  - Term newborns: 3 – 5 mg/kg/min
  - Extremely premature infants: 8 to 9 mg/kg/min
    - However, ELBW infants are susceptible to hyperglycemia in the first few days of life. Suggested initial glucose delivery rates are 6-8 mg/kg/minute initially and gradually advance to maximum of 12 mg/kg/min.
  - D5W-D7.5W at 80-120 ml/kg/day usually meets this need.
    - Glucose delivery should not increase greater than 2 mg/kg/minute per day.
  - Goal is a glucose range of 50-120 mg/dl, treating glucose > 150 mg/dl.
  - Do not exceed 18 gm/kg/day glucose.
    - Excessive glucose ≥ 18 g/kg/day or ≥ 13 mg/kg/min or 60 kcal/kg/day as glucose may interfere with respiratory gas exchange and induce lipogenesis, which increases energy expenditure.

Goal is to maximize protein, intralipid and carbohydrate delivery to provide 105-115 kcal/kg/day (including at least 3.5 gram/kg/day of protein) or weight gain of 1-2% per day.

Calculate GIR as follows:

\[
\text{GIR} = \frac{\text{Dextrose (grams)}}{\text{Volume (ml/kg)}} \times \frac{60 \text{ min}}{1440 \text{ min}} \times 1000
\]

For example: A patient receiving TPN with D10 at a volume of 100 ml/kg/day will have a GIR of (0.1 x 100) divided by 1.44 = 6.9 mg/kg/min.

There are several ways to calculate GIR. In the Glucose Metabolism Section you will find another method of calculating GIR.

**Protein**

- The rationale for routine administration of amino acids during parenteral nutrition is to provide nitrogen for protein synthesis and growth.
- Amino acids can also be oxidized as substrate for energy source and should provide 7-15% of total kilocalories.
- **1 gram protein provides 4 kcal.**
- Use specially formulated amino acid solution for neonates (Trophamine®) that contains a larger percentage of total nitrogen as essential amino acids and branched chain amino acids, and have a balanced amount of non-essential amino acids instead of a single amino acid concentration
- Use of Trophamine® results in plasma amino acid levels that are similar to breastfed infant and improve weight gain and nitrogen balance
- Recommended intakes of IV amino acids vary with gestational age.
  - FT infants: 2.5g/kg/day. PT infants: 3-4 g/kg/day.
- Amino acids should be provided as soon after birth as possible at a minimum of 1.5 g/kg/day. Infants not receiving amino acids during first days lose 1% of endogenous protein stores or 1 gm/kg/day.
- Our practice is to begin Early PN immediately after birth for VLBW infants (<1500g) using a standard solution of D5W or D2.5W and 4% AA.
  - When infused at maximum of 60ml/kg/day, 2.4 g/kg/day of AA is provided.
  - After the first 24 hours, an individualized TPN solution is ordered with an initial AA concentration of 2-2.5g/kg/day.
  - AA intake is advanced to 3-3.5g/kg/day within the first few days of life.
- For infants with BW >1500g, AA is initiated at 2g/kg/day and advanced to 3g/kg/day the following day.
- If concerns regarding significant renal ischemia or dysfunction exist, a less aggressive approach is used.
- Daily lytes or BMP’s (if clinically indicated) should be followed in VLBW (those infants less than 1,500 g) while advancing TPN.

**Intralipids**

• Fats should provide 30-50% of total daily calories.
• 1g Fat provides 9 kcal for 20% intralipid solution: 1mL = 2 kcals
• Lipid emulsions consist of vegetable oil triglycerides, emulsified with egg yolk phospholipid and glycerol to achieve isotonicity.
• We use 20% intralipid in this nursery.
  o It contains reduced content of phospholipids per gram triglyceride compared to 10% lipid solution → improved lipid clearance.
  o More energy dense → allows for smaller infusion volume → prevents fluid overload.
• Intralipid (IL) can be added approximately 1-2 days after birth - helps stabilize serum glucose in certain instances.
• Initial starting rate is 0.5 gm/kg/day → advancing by 0.5 gm/kg/day daily (max 3.0 g/kg/day)
• Triglyceride levels should be checked the morning after initiating intralipid → then after each two increases of 0.5 gm lipid each day
  o Preterm infants have a limited ability to hydrolyze triglycerides (TG)
  o Elevated serum TG levels are more frequently observed with decreasing GA, infection, surgical stress, malnutrition, and SGA infants
• Reasons to decrease or stop IL infusion:
  o Triglyceride > 150 mg/dL or evidence of IL intolerance
  o Suspected clinical sepsis or documented bacteremia
    ▪ Discuss with attending about IL infusion during this period
    ▪ Until infection controlled some attending’s stop or ↓ the infusion rate
  o Serum bilirubin rising quickly or close to exchange levels
    ▪ Lower infusion to 1.0 g/kg/day or less until bilirubin controlled.
    ▪ Please discuss this with your attending.
  o Evidence of cholestasis
    ▪ An elevated direct bilirubin (DB) is early evidence of PN-associated hepatocellular damage
      ▪ DB > 1.5 – 2.0 mg/dl or,
      ▪ DB that is 40% of the total bilirubin concentration
    ▪ Alkaline phosphatase and gammaglutamyl transferase (GGT) levels may be elevated but are less specific compared to DB

Calcium (Ca) and Phosphorus (P)
• TPN amounts are often lower than recommended levels.
• Difficult to administer both at high concentrations because of the increased risk of precipitation.
• Because of insufficient amounts → risk of decreased bone mineralization with prolonged parenteral nutrition.
• Goal is to maximize amount of Ca/Phos in TPN (avoiding precipitation) at ratio allowing max retention of both minerals. Ratio of 1.3:1 to 1.7:1 Ca to P by milligram weight or a 1:1 molar ratio should be obtained.
• Conversion table

<table>
<thead>
<tr>
<th>Element</th>
<th>mEq/dL</th>
<th>mmol/dL</th>
<th>mg/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>1</td>
<td>0.5</td>
<td>20</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>-</td>
<td>1</td>
<td>31</td>
</tr>
</tbody>
</table>

Maximum safe Ca/Phos delivery
• >120 ml/kg/day TPN: 90 mg/kg/day (4.5 meq/kg/day) Ca & 60 mg/kg/day (2 mM/kg/day) of P if on 2-3 mg/kg/day protein and 40 mg/day cysteine
• This quantity of protein with the cysteine ↓ the pH ↑ the solubility of these minerals in solution.
• 100-120ml/day TPN: decrease the Ca to 60 mg/kg/day (3 meq/kg/day) and P to 45 mg/kg/day (1.5 mM/kg/day)
• < 100ml/kg/day limit Ca to 40 mg/kg (2 meq/kg) and P to 31 mg/kg/day (1 mM/kg) until TPN no longer used.
• Do not deliver > 3 meq/kg/day of Ca peripherally. Higher concentrations should be administered via central line (PICC, Broviac, CL or UVC) only.

<table>
<thead>
<tr>
<th>TF (ml/kg/day)</th>
<th>Ca</th>
<th>P</th>
<th>Ratio (by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 120</td>
<td>90 mg/kg/day</td>
<td>60 mg/kg/day</td>
<td>1.5:1</td>
</tr>
<tr>
<td></td>
<td>4.5 mEq/kg/day</td>
<td>2 mEq/kg/day</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2 mM/kg/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100-120</td>
<td>60 mg/kg/day</td>
<td>45 mg/kg/day</td>
<td>1.3:1</td>
</tr>
<tr>
<td></td>
<td>3 mEq/kg/day</td>
<td>1.5 mM/kg/day</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.5 mM/kg/day</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cysteine
- Unstable in solution and easily oxidized to the insoluble form cystine
  - Most commercially available AA solutions contain very low or no cysteine
- Cysteine supplementation in PN is provided in the form of cysteine hydrochloride
  - Also improves delivery of soluble Ca and P by lowering pH of PN solution
  - Metabolic acidosis can occur due to the hydrochloride provided from the cysteine salt. Each mmol of cysteine (175 mg) provides 1 mEq chloride and 1 mEq of hydrogen ion.
  - Maximum dose: 100-120 mg/kg/day
- **Dose: 30-40 mg/ gram of protein**

Carnitine
- Plays an essential role in the oxidation of fatty acids for energy
  - Facilitates transfer of long-chain fatty acid (LCFA) across the mitochondrial matrix for oxidation
- Evidence for its use in PN remains unclear. However, most neonatologist would consider adding carnitine to PN if an infant requires prolonged TPN > 10-14 days
- Dose: 10-20 mg/kg/day (< 34 weeks = 10 mg/kg/day)

Other Electrolytes
- Individualize need for each patient.
  - **Sodium**
    - Usually added on day 2 of life
    - Diuretic therapy may require more sodium
    - For premature infants < 1000 g: calculate total Na load from all sources
      - i.e. TPN, IV infusion via UAC, flushes
      - Under NO circumstances can the sodium content of TPN exceed 154 mEq/L. If the patient requires more sodium, it should be through a separate infusion.
  - **Potassium**
    - Do not add potassium to TPN until urine output has been established
    - Conditions that require less potassium
      - Oliguria or anuria (i.e. renal disease, cardiogenic shock)
      - Hyperkalemia (i.e. adrenal insufficiency)
      - Patients receiving a lot if insulin
      - Refeeding syndrome
    - Diuretic therapy may warrant more potassium
    - Under NO circumstances can potassium exceed 80 mEq/L of TPN for central line and 40 mEq/L for peripheral line
  - **Magnesium**
  - **Recommended daily requirements**

<table>
<thead>
<tr>
<th>Element</th>
<th>mEq/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Potassium</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.25 – 0.5</td>
</tr>
</tbody>
</table>

Vitamins
- Manufactured as a multi-ingredient solution (MVI)
- Essential component of a patients daily PN regimen because they are necessary for normal metabolism and cellular function
- TPN vitamin D in the vitamin additives is adequate.
- Fat-soluble vitamins can be absorbed into the storage bag (~80% of Vitamin A is lost).
- Amounts can vary with light (Vitamin A is light sensitive), O2 and heat. (TPNs are dispensed from pharmacy in opaque bags)
- Dose according to weight:
  - < 1 kg: 30% (1.5 ml) of a single full dose (5 ml). Do not exceed this daily dose.
  - 1-3 kg: 65% (3.25 ml) of a single full dose (5 ml)
  - ≥ 3 kg: 5 ml/day added to TPN or ≥ 100 ml of appropriate solution
**Trace elements**

- Manufactured as a multi-ingredient solution
- Often present: zinc, copper, manganese, chromium, selenium
- Cofactors essential for the proper functioning of several enzyme systems
- Dose: 0.2 ml/kg (max: 4 ml)
- Certain conditions predispose to trace element toxicity due to impaired ability to excrete these substances. Administration in PN should therefore be limited.
  - **Cholestasis:** DB ≥ 2 mg/dL
    - Delete or limit copper (Cu) and manganese (Mn)
    - Add trace elements to TPN only 2x/week
    - Provide zinc (Zn) daily
  - **Renal insufficiency**
    - Delete or limit selenium (Se), chromium (Ch), molybdenum (Mo)
- Condition that require additional supplement of Zn
  - **Ostomy losses**
  - Trace element solution dosed at 0.2 ml/kg/day provides 300 mcg/kg/day of zinc.
- Recommend daily requirements *(mcg/kg/day)*

<table>
<thead>
<tr>
<th>MINERAL</th>
<th>PRETERM</th>
<th>TERM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>400</td>
<td>250 &lt; 3 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 &gt; 3 months</td>
</tr>
<tr>
<td>Copper</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Selenium</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Chromium</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Manganese</td>
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<td>1</td>
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<tr>
<td>Molybdenum</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Iodide</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Osmolarity**

- Maximum osmolarity in PN solution is determined by the type of vascular access
  - **Peripheral line:**
    - Neonates: 900 mOsm/L (max: 1000 mOsm/L)
    - Pediatric: 1100 mOsm/L
  - **Central line:**
    - No limit
- It is important to inform Pharmacy what type of vascular access the patient has (select either “peripheral” or “central” during TPN order entry.

**TPN Pearls:**

- NICU Clinical Pharmacist and Registered Dietitian are available during day time hours for questions and/or help regarding TPNs.
- TPN is costly and is associated with complications. If the gut works, use it.
- Usual TPN volumes: 80 – 140 ml/kg/day.
- Avoid TPN volumes < 50 ml/kg/day as they are likely to be “super concentrated”. Let TPN expire and use IV fluids until full feeds are achieved.
- If TPN is turned off, it must be weaned to avoid hypoglycemia. Decrease infusion rate by half for 30 minutes and then by half again for 30 minutes then discontinue.
- Limits:
  - PIV: D12.5 W KCl = 40 mEq/L Ca 13.5 mEq/L or 2.4 mEq/kg Osmolality 900 mOsm/L
  - Central: D25,30 W KCl = 80 mEq/L
- **TPN Weaning Guidelines:**

<table>
<thead>
<tr>
<th>PN COMPOSITION</th>
<th>TOTAL TPN VOLUME (ML/KG/DAY)</th>
<th>ENTERAL FEED VOLUME (ML/KG/DAY)</th>
<th>ERM/FORMULA CONCENTRATION (KCAL/OZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIR (MG/KG/MIN)</td>
<td>PROTEIN (GM/KG/DAY)</td>
<td>LIPIDS (GM/KG/DAY)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>3.5</td>
<td>3</td>
<td>100-140</td>
</tr>
<tr>
<td>10</td>
<td>2.5</td>
<td>2</td>
<td>70-90</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>1.5</td>
<td>55-65</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>1</td>
<td>55</td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td>N/A</td>
<td>None</td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td>N/A</td>
<td>None</td>
</tr>
</tbody>
</table>
• ALL TPN ORDERS ARE DUE BY 1300
  o Make sure you add patient’s MRN number on the TPN form
  o Sign and print your name and the date on the order form
  o Select the correct line type – central vs peripheral
• Sources of calories in PN

<table>
<thead>
<tr>
<th>Sugar (Dextrose)</th>
<th>3.4 kcal/gram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lipids (20% Intralipid)</td>
<td>10 kcal/gram</td>
</tr>
<tr>
<td></td>
<td>(Fat: 9 kcal, glycerol: 1 kcal)</td>
</tr>
<tr>
<td>Protein</td>
<td>4 kcal/gram</td>
</tr>
</tbody>
</table>

Cycling TPN (“Cyclic TPN”)

• Cycling TPN refers to providing parenteral nutrition over less than 24 hours. While the TPN is off, the central line is heparin-locked or infused with a cycling fluid. Intermittent administration of TPN can help minimize the long-term adverse effects of chronic TPN, such as liver complications. The exact etiology of parenteral nutrition associated liver disease (PNALD) is unknown, but likely multifactorial. Infants who receive TPN >60 days have an 80% likelihood of developing cholestasis. Dextrose, amino acids, and lipids may all contribute to PNALD. Cycling TPN gives the liver a “break” from continuously metabolizing macronutrients. Cycling TPN is not without risk, especially risk of hypoglycemia due to limited glycogen stores and high requisite glucose needs. To reduce the risk of hypoglycemia, the TPN rate must be “ramped up” and “ramped down.” This allows the pancreas time to respond to the change in glucose load and alter the endogenous production of insulin.

• Cyclic TPN should be used for:
  o TPN induced hepatic dysfunction/failure that is imminent or already present
  o Chronic TPN patient to allow period of time off an infusion pump

• Cycling TPN is not appropriate for:
  o Patients on short term TPN (<2 weeks)
  o Patients who have an unstable hemodynamic or metabolic status
  o Patients requiring exogenous insulin
  o Patients who have poor weight gain
  o Patients that do not have central venous access

• Cyclic TPN is not recommended for patients who are septic or immediately post-op
  o If a patient becomes septic, hemodynamically or metabolically unstable, cyclic TPN should be discontinued until the patient is stable
  o Cyclic TPN should be temporarily stopped when a patient has surgery and resumed a few days post-op

• TPN must be tapered off prior to the end of the TPN time and change of lines
  o Decrease hourly rate by 50% x 60 minutes, THEN by another 50% x 30 minutes, THEN off
  o TPN must be tapered on after a new bag is started
  o Increase hourly rate by 25% x 60 mins, THEN by another 25% x 60 mins, THEN to full hourly rate

• Maximum time off TPN for neonate = 4 hours (start with 1 hour and advance by 1 hour until reach max of 4 hours). Time off TPN may be > 4 hours if cycling fluid is infused when the TPN is off
• Check blood glucose 30 minutes after TPN is stopped and again 2 hours has elapsed since TPN was stopped. Glucoses should be checked until the patient has had 2 weeks of stable glucoses during cyclic TPN

References:
General Nutrition Labs For Infants BW <1500g and other infants on prolonged TPN

<table>
<thead>
<tr>
<th>Glucose</th>
<th>Routinely done on all infants while on IVF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolytes</td>
<td><strong>≤ 1000g:</strong> Follow q12 hours until stable then q24 hours until TPN fully advanced and infant stable.</td>
</tr>
<tr>
<td></td>
<td><strong>&gt; 1000g:</strong> Follow q24 hours until stable.</td>
</tr>
<tr>
<td>BMP</td>
<td><strong>&lt;1500g/&lt;34 wks:</strong> Consider BMP or CBG to follow CO2 at &gt;72 hours.</td>
</tr>
<tr>
<td></td>
<td>• HCO3 loss in the urine with high FENa due to renal immaturity.</td>
</tr>
<tr>
<td></td>
<td>• Suspect if excess weight loss/poor weight gain despite adequate calories in the 1st week of life.</td>
</tr>
<tr>
<td></td>
<td>Some recommend BMP qWed/Sat or weekly until &gt; 1500g</td>
</tr>
<tr>
<td></td>
<td>• In the growing preterm a BUN &lt; 10 mg% may indicate need for a higher protein intake in the form of the high protein preterm formula or fortification of human milk with Beneprotein.</td>
</tr>
<tr>
<td>Ca, Mg, P</td>
<td><strong>&lt;1250g:</strong> iCa should be monitored q24 hours until stable, then Q Wednesday while on TPN.</td>
</tr>
<tr>
<td></td>
<td><strong>All other infants:</strong> Every Wednesday while on TPN.</td>
</tr>
<tr>
<td>T&amp;D bili</td>
<td><strong>&lt;1500g and other infants on prolonged TPN</strong></td>
</tr>
<tr>
<td></td>
<td>Every Wednesday while on TPN.</td>
</tr>
<tr>
<td></td>
<td>• DB is the first lab to become elevated in TPN cholestasis.</td>
</tr>
<tr>
<td></td>
<td>• If elevated ➔ LFTs + GGT need to be followed every other week.</td>
</tr>
<tr>
<td></td>
<td>• If cholestasis identified ➔ follow direct bili even off TPN until &lt; 2 mg/dL</td>
</tr>
<tr>
<td>Alkaline phosphatase</td>
<td><strong>&lt;1500g and other infants on prolonged TPN</strong></td>
</tr>
<tr>
<td></td>
<td>Every other Wednesday starting 2nd week of life.</td>
</tr>
<tr>
<td></td>
<td>• Markedly elevated before changes noted on x-ray in osteopenia.</td>
</tr>
<tr>
<td></td>
<td>• Abnormal if &gt; 500 U/L.</td>
</tr>
<tr>
<td></td>
<td>• Follow every other Wednesday until &lt;350 U/L on preterm formula.</td>
</tr>
<tr>
<td>Spun HCT/retics</td>
<td>Every Wednesday. Order reticulocyte count Q Wednesday after 3 weeks of age.</td>
</tr>
<tr>
<td>Triglyceride</td>
<td>After the first 24 hours on intralipid ➔ 24 hours after each total increase of 1 g/kg/day until stable on 3g/kg/day.</td>
</tr>
<tr>
<td>Other considerations</td>
<td>Fluid delivery should be based on Na and weight changes.</td>
</tr>
<tr>
<td></td>
<td>Urine output in the preterm infant is not a good indicator of hydration status</td>
</tr>
<tr>
<td></td>
<td>• &lt; 1,250 g will continue to have brisk urine output despite significant fluid losses.</td>
</tr>
</tbody>
</table>

Monitoring Growth in SCN

- The nurses document the head circumference and weight daily and the length every Wednesday. Board lengths are available so make sure it is being used to measure lengths.
- Please enter these measurements into the Site of Care notes.
- Infants who stay in SCN longer than one week should have a growth chart plotted. Cerner will plot growth curves if the initial anthropometrics measurements are saved. Follow these steps in Cerner: Ad Hoc ➔ General Assessment ➔ Choose the applicable growth chart: Term or preterm ➔ enter the values and gestational age ➔ click the “save” icon ➔ refresh.
  - This should be done each Wednesday as nutrition labs are done that day.
  - Nutrition rounds are done every Thursday at 8:30 AM. Residents and intern are expected to calculate weekly weight gain, nonprotein and protein calories for the NICU patients.
- Adjusted age should be calculated by the post menstrual age (Site of Care does this).

Documentation of nutrition

- Caloric intake and source should be well documented daily in Site of Care ➔ allows data analysis for quality improvement and research purposes
- Caloric intake from TPN and enteral feeds should be documented individually.
- Quantity of TPN in ml/kg/day, Glucose, Protein and IL in g/kg/day should be entered daily in Site of Care.
INITIATION OF ENTERAL FEEDS:

Important concepts
- Even under the best circumstances, it takes a substantial amount of time to achieve full enteral feeds in premature neonates.
- Based on currently available evidence, providing minimal volume feeds for some period of time seems reasonable.
- Minimal enteral feeds, also known as trophic feeds, are typically defined as low-volume feeds that do not provide sufficient calories for growth but rather help promote the maturation of the structure and function of the premature intestinal tract.

BW 500-1000g or GA < 28 weeks
- May start feeds as bolus or drip.
- Full strength human milk preferable but preterm 20 cal formula with iron can be used.
- Feeds initiated when infant clinically stable after discussion with the attending.
- Feeds can be started as early as DOL # 1 but usually by day 2 of life.
- Trophic feeds started initially at 5-10 ml/kg/day or 1-2 ml q 6 hours.
- When infants tolerate trophic feeds for ~ 2-3 days → advance 10ml/kg/day if < 1,000 g.
- When 100-120 ml/kg/day of PO feed reached → feeds fortified by changing preterm formula to 22 calories → 24 calories.
  o Breast milk fortifier is added after reaching 100-120ml/kg/day, by adding 1 packet per 50 ml one day → 2 packets per 50ml the next day.
  o When increasing concentrations do not advance volume of feeds that day.
  o If powdered HMF is not tolerated → Similac Special Care 30 can also be used as a human milk fortifier (Note that nutritional values are somewhat less than those provided by HMF powder). When human milk is mixed with Similac Special Care 30 in ratios 2:1, 1:1 or 1:2 → resulting fortified human milk provides 23, 25 or 27cal/oz.

Other considerations
- Although human milk is considered to be the optimal source of primary nutrition for premature infants, human milk does not completely meet the nutritional needs of premature infants.
- Human milk fortifiers should be used in premature infants fed human milk with BW < 1500g and considered in those with BW < 2000g.
- Preterm formulas are designed for use in-hospital as the sole source of nutrition for preterm infants who are not breastfed and may be used to supplement breastfeeding if supply is inadequate.
  o Preterm formula has increased protein, less lactose than term formula and increased Ca, P, and Vitamins.
  o It can be initiated on any infant < 37 weeks.

BW 1000–1250g or GA 28 – 30 weeks
- Same feeding suggestions as above but advancing feeds 15-20 ml/kg/day.
- Trophic feeds should be considered.

BW 1250–1500g or GA 30-32 weeks
- Trophic feeds usually are not needed.
- Start at 20ml/kg/day and fortify breast milk or formula when at 100-120ml/kg/day.

BW 1500-2500g or GA 33-36 weeks
- Start Full Strength preterm formula or HM at 30ml/kg/day advancing 30ml/kg/day.
- Preterm formula may be used up to 35-36 weeks.
- Preterm formulas are not needed after 36 weeks unless infant is an ELBW preterm.

GA > 35 weeks
- If healthy, the infant may be started on a term 20 calorie formula
- Start at 10 ml/feed advancing 3 ml/feed if ≤ 2,500 g
- Start at 15 ml/feed advancing 5ml/feed if > 2,500 g
- Initially advance to fluid goal which on the first day of life is usually 60 ml/kg/day.
- If the infant does well, after the first day of life feeds may be advanced 3-5ml/feed to the fluid goal for that day or if healthy ad libitum (ad lib) (usually 20-30 ml/kg/day).
  o These feeding advances should be reserved only for healthy infants.
- Infants with feeding difficulty, any feeding intolerance or neonatal depression should be initiated and advanced in a tailored conservative manner based on the infant’s clinical presentation and problems.
- Infants with any suspicion of NEC should have feeds initiated after a period of NPO;
  o Start at 10-20ml/kg/day
  o Advance no more than 20ml/kg/day unless discussed with an attending.
  o Human milk or preterm formula (<36 wks) or term formula (≥ 37 weeks) may be used initially unless discussed otherwise.
  o If there is a strong suspicion of short gut then a more elemental formula may be started.
**Initiation of iron therapy**
- AAP recommends 2-4 mg/kg/day of enteral iron daily depending on the degree of prematurity, once on full feeds beginning between 2 weeks and 2 months after birth and or 2 weeks after the last transfusion.
- Premature infants should be maintained on iron even after discharge.
- Formula fed infants may also benefit from additional iron at 1mg/kg.
- Infants on rhEpo will require more iron, dose of 4-6mg/kg.
- Fer-in-sol or MVI with Fe may be used.
  - Fer-in-sol: 15 mg of elemental Fe/ml
  - Poly-vi-sol with Iron: 10 mg of elemental Fe/ml
  - Tri-vi-sol: 10 mg of elemental Fe/ml
- MVI with Fe has 10mg /ml and the dose restricted to 0.5ml QD if the infant is < 2 kg.
- Do not give Fe with HM.

**Use of MVI**
- MVI not indicated for infants on preterm formulas unless they have osteopenia.
- The preterm infant formulas may not have enough vitamin D to meet the 400 IU/day requirement for osteopenia.
- MVI with Fe is recommended for infants on HM remembering that some HM fortifier has some MVI & Fe fortification.
  - Infants 1-2 kg should be started on 0.5ml per day, dividing the dose as 0.25ml BID
  - Infants over 2 kg may take 1 ml/day.

**POST DISCHARGE NUTRITION**
- Preterm infants are in a state of suboptimal nutrition at the time of discharge from the hospital and beyond.
- Improving this situation would be beneficial both in the short-term and potentially for longer-term health and development.
- Nutrient-enriched formula for preterm infants after hospital discharge (post-discharge formula [PDF]) is generally intermediate in composition between preterm and term formulas.
- Compared with term formula (TF), PDF contains
  - Increased amount of protein with sufficient additional energy to permit utilization
  - Contains extra calcium, phosphorous, and zinc, necessary to promote linear growth
  - Additional vitamins and trace elements to support the projected increased growth
- For ELBW 24 cal preterm formula or fortified HM is suggested until 42 weeks.
- For ELBW > 42 wks, VLBW/LBW: Preterm 22 calorie formula (Enfacare, Neosure) can be used.
  - PDF’s are approved for ELBW’s until 9-12 months corrected age.
  - A WIC form needs to be filled out for special formula’s prior to discharge.
- For breastfed infants, formula powder can be used to increase caloric density of human milk. See table below.

### Fortification of Human Milk for Home Use

<table>
<thead>
<tr>
<th>Caloric amount</th>
<th>Breast Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 cal</td>
<td>1 tsp formula powder to 90 ml EBM</td>
</tr>
<tr>
<td>26 cal</td>
<td>1 ½ tsp formula powder to 90ml EBM</td>
</tr>
</tbody>
</table>

Potential formulas: Enfacare, Neosure, Enfamil Lipil, Similac Advance
Other preparation: 1 tsp Neosure advance + 75 ml water (24 cal)

### HELPFUL HINTS

<table>
<thead>
<tr>
<th>20cal/oz formula (any kind)</th>
<th>0.68 kcal/ml (same for HM overall)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22cal/oz</td>
<td>0.74 kcal/ml</td>
</tr>
<tr>
<td>24 cal/oz</td>
<td>0.81 kcal/ml</td>
</tr>
<tr>
<td>26 cal/oz</td>
<td>0.87 kcal/ml</td>
</tr>
<tr>
<td>27 cal/oz</td>
<td>0.90 kcal/ml</td>
</tr>
<tr>
<td>30 cal/oz</td>
<td>1.00 kcal/ml</td>
</tr>
</tbody>
</table>

Additives:
- Corn oil 8.30 kcal/ml
- MCT oil 7.70 kcal/ml
- Safflower oil 8.00 kcal/ml
- BRC (3.5 g/tbsp = 1.16 g/tsp) 4.24 kcal/ml
- Beneprotein (1.3 g protein/tsp or 4 cal/g) 5.20 kcal/ml
- Polycose 3.80 kcal/ml
### REFERENCE TABLES

**ENERGY REQUIREMENT ESTIMATES FOR GROWING PREMATURE INFANTS**

| KCAL/KG/DAY | 
| --- | --- |
| **Resting Metabolic Rate** | 50 |
| **Energy of activity** | 5 |
| **Thermoregulation** | 10 |
| **Total Energy Expenditure** | 65 |
| **Energy excreted** | 15 |
| **Energy stored** | 30-50 |
| **Recommended Energy Intake** | 110-130 |

**REVISED ADVISABLE PROTEIN RECOMMENDATION FOR GROWING PRETERM INFANTS**

| 
| --- |
| **Without need for catch-up growth** | **With need for catch-up growth** |
| 26 – 30 wks PCA: 16 – 18 g/kg/day LBM 14 % protein retention | 3.8 – 4.2 g/kg/day PER: ± 3.0 
PER: 4.4 g/kg/day PER: ± 3.3 |
| 30 – 36 wks PCA: 14 – 15 g/kg/day LBM 15 % protein retention | 3.4 – 3.6 g/kg/day PER: ± 2.8 
PER: 3.6 – 4.0 g/kg/day PER: ± 3.0 |
| 36 – 40 wks PCA: 13 g/kg/day LBM 17 % protein retention | 2.8 – 3.2 g/kg/day PER: 2.4 – 2.6 
PER: 3.0 – 3.4 g/kg/day PER: 2.6 – 2.8 |

PCA: postconceptual age; LBM: lean body mass; PER: protein:energy ratio

**DIETARY EVALUATION/CONSULT POLICY:**

High risk neonatal infants identified at nutritional risk will receive an initial nutrition assessment to identify the need for care, the type of care to be provided and the need for further reassessment.

A. Neonatal infants identified to receive an initial assessment include the following:

- Neonates admitted into ICN > 48 hours
- All neonates ≤ 1500 grams
- All infants on parenteral nutrition
- Neonates on specialized formula
B. The interdisciplinary staff is also recommended to notify Clinical
• Nutrition Services if the following criteria occur
• Initiation of parenteral nutrition support
• Significant change in medical condition negatively impacting nutritional status
• Slow weight gain

PROCEDURE
A. An order for nutritional consult will be placed in Cerner.
B. The unit clerk will place the order for the nutrition consult via established process
C. Upon received order for consult, nutritional services will complete a nutrition assessment within 24-48 hours of notification.
D. Neonates will be followed by nutrition services until:
   a. Patient reaches full feeds
   b. Growth adequate
   Nutritional risk/problem resolved; no longer at nutritional risk

INITIAL FLUID AND ELECTROLYTE MANAGEMENT IN THE NEONATE:

- Appropriate fluid and electrolyte management during the first week of life requires anticipation of fluid and electrolyte losses that are likely to occur.
- Intakes must be individualized and evaluation of fluid and electrolyte balance must be periodically evaluated so that fluid and electrolyte intake can be appropriately adjusted.
- Fluid needs in first 24 hours depend on insensible losses (evaporative), respiratory losses, stool losses (minimal), and urine output.
- At term, insensible losses are minimal due to mature skin barrier, especially if in an isolette which minimizes these losses further.
- Preterm (34 weeks or less) however has an immature epidermis and under a radiant warmer with no plastic protective barrier and no previous antenatal steroids to mature the skin, the preterm < 1,000 g can have losses up to 7-9 ml/kg/hr.
- Serial weights on the same scales and electrolytes are the easiest tools to measure fluid needs in the newborn in the first 2-3 days of life.

Please weigh all infant < 1,500 g upon admission to the ICN on the same scale they will be weighed on each day. The following information is only a guideline to follow in the initial management of fluids in the newborn

Term to 35 weeks
- First 24 hours starting fluid is D10W at 60 ml/kg/day
- No Na+ or K+ is required the first 24 hours
- At 24 hours fluid is changed to D10 ¼ NS (2-3 mEq/kg/Na/day) if good urine output established
- If normal diuresis at 48 hours of life and K+ normal start K+ 2 mEq/100 ml IVF (2 mEq/kg/day)
  - Exception is in HMD, add Na only after diuresis and Na < 135
- Advancing fluids each day depends on weight change, serum Na and urine output
- Most term infants tolerate advancing IVF 20 ml/kg/day unless
  - Inadequate urine output, Na < 135, gained weight and not diuresing
- Term infants should lose 1-2% of birth weight per day (weigh on same scale) and maintain serum Na of 135-140.
- Normal urine output is 1-4 ml/kg/day.
  - Some term infant, on the first 24-48 hours may have UO < 1.0 ml/kg/day due to ADH output at delivery or ischemia.
  - If no sepsis or asphyxia, they should start urinating >2ml/kg/day by 24-48 hours of life.
- Hypoglycemic infants may have ↑ glucose needs.
  - Frequently D10 or D12.5 is advanced above the usual fluid goal in the first 24-48 hours putting the infant at risk for dilutional hyponatremia.
  - If infant needs more than 100 ml/kg/day IVF in the first 24-48 hours consider a UVC or central line for D15 or greater to ↓ fluid intake and avoid hyponatremia.
- DISCUSS THE INFANT WITH AN ATTENDING PRIOR TO PLACING A CENTRAL LINE FOR HYPOGLYCEMIA.
  - If the term infant is to be NPO > 72 hours consider TPN.

Preterm infant 34 weeks or less
- Due to gestation and heat source, fluid needs are higher but these infants frequently are unable to handle over 4-6 mg/kg/minute glucose.

The following are guidelines.
- ALL INFANT < 32 WEEKS SHOULD BE PLACED IN A GIRAFFE OMNIBED. IF NONE IS AVAILABLE, INFANTS SHOULD BE COVERED BY PLASTIC WRAP IF UNDER A RADIANT WARMER AND INTUBATED (insensible losses may be reduced by 30-50 ml/kg/day).
Fluid Requirement First 24 hours

<table>
<thead>
<tr>
<th>Weight Range</th>
<th>Fluid Requirement</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 800 g</td>
<td>100-120 ml/kg/day</td>
<td>D5W or more</td>
</tr>
<tr>
<td></td>
<td>(varies in Versalet vs radiant warmer)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(consider Aquaphor TP q 12 hours x 3 days)</td>
<td></td>
</tr>
<tr>
<td>800-1000 g</td>
<td>80-100 ml/kg/day</td>
<td>D5W</td>
</tr>
<tr>
<td>1,000 -1,500 g</td>
<td>80 ml/kg/day</td>
<td>D7.5-D10W</td>
</tr>
<tr>
<td>1,500-2,500 g</td>
<td>60-80 ml/kg</td>
<td>D10W</td>
</tr>
<tr>
<td>Term</td>
<td>60 ml/kg</td>
<td>D10W</td>
</tr>
</tbody>
</table>

Suggested management after the first 24 hours

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Management</th>
</tr>
</thead>
</table>
| Sodium   | o Introduced at 48-72 hours if weight loss has occurred and the serum Na < 140.  
          o Started at 2-3 meq/kg and adjusted based on needs to keep Na 135-140.  
          o Remember urinary fractional excretion of Na (FENA) can be high, excreting ~ ½ NS in the urine and worse if on caffeine, aminophylline or diuretics. |
| Potassium | o Placed in the IVF at 48-72 hours (1-2 meq/kg/day) if serum K normal (3.5-4.5 central and 3.5-6.0 capillary) and urine output is adequate. |
| Calcium  | o Initially there will be no electrolytes in the TPN or early PN solution except Ca Gluconate.  
          o Introduced to IVF at 0-48 hours to avoid the excess nadir of serum Ca that occurs in preterm infants. |
| Total fluids | o Fluid needs may still be in flux so 80 ml/kg TPN can be written for allowing extra fluid or glucose needs to be met by changing out or adding additional fluid. |

GLUCOSE METABOLISM IN THE NEWBORN:

- At birth, the maternal glucose supply is acutely interrupted and the neonate accommodates by increasing glucagon levels within minutes after birth → Decreasing insulin production → Increasing catecholamine secretion → → increase glycogenolysis, gluconeogenesis, lipolysis and ketogenesis.
- Glucose concentration is lowest at 30-90 minutes after birth in full term infant.
- Glucose production in full-term infant is ~4-6mg/kg/min, premature infant often with higher glucose production.

HYPOGLYCEMIA

**Definition**
- There is no general consensus defining a blood level diagnostic of hypoglycemia.
- In our NICU, regardless of gestation a serum glucose < 40 mg/dL is hypoglycemia.
- A serum glucose < 45 mg/dL if symptomatic will be treated as a hypoglycemia.

**Etiology**
- **Limited glycogen supply** (prematurity, perinatal stress)
- **Hyperinsulinism** (infant of diabetic mother, SGA, LGA, discordant twin, Beckwith-wiedemann syndrome, pancreatic adenoma, erythroblastosis fetalis)
- **Hormone abnormalities** (panhypopituitarism, growth hormone deficiency, cortisol deficiency – 21 hydroxylase deficiency, adrenal hemorrhage)
- **Hereditary abnormalities** (galactosemia, glycogen storage disease, hereditary fructose intolerance, MSUD, propionic acidemia, fatty acid oxidation defect etc)
- **Others** (hypothermia, sepsis, polycythemia)

**Signs and symptoms**
- Apnea, bradycardia, cyanosis, diaphoresis, jitteriness, lethargy, limpness, poor feeding, seizures, tachypnea, temperature instability, tremors

**Monitoring**
- All infants admitted to the SCN will be screened for hypoglycemia on admission.
- Serum glucose monitoring as follows:
  - q 30 min after intervention until stable
  - then q 3-6 hour if on IVF only
  - or ac (pc if borderline) for the first 24 hrs or beyond until stable

**Diagnosis**
- If cause of hypoglycemia is clearly self-limited (such as IDM, LGA infants) then complete diagnostic testing may not be needed.
- If the etiology is not clear or in cases of prolonged, severe hypoglycemia, the history, physical examination and laboratory findings should be used together to make the diagnosis.
  - Plasma should be obtained for the “critical” blood measurements at the time of hypoglycemia: lactate, free fatty acids,
ketones, insulin, cortisol and growth hormone.

- Additional tests of pituitary function should be included if pituitary deficiency is suspected.
- Obtain urine sample for urine organic acid as indicated.
- Glucagon stimulation test may also provide useful diagnostic information: At the time of hypoglycemia, 0.5 to 1 mg IV glucagon is given. A rise in serum glucose of >30mg/dL suggests inappropriate preservation of liver glycogen stores (hyperinsulinism, panhypopituitarism).

**Treatment**

- If not clinically contraindicated and glucose is > 30 mg/dL, the infant can be fed if the baby is in the well baby nursery.
- If oral feeds fail to resolve hypoglycemia, glucose < 30 mg/dL or unable to feed secondary to respiratory distress or is already admitted in SCN/IMCN
  - Glucose bolus is given at a dose of 200 mg/kg (2 ml/kg of D10W)
  - Glucose infusion is started with D10W at a rate of 85 ml/kg/day (GIR 6 mg/kg/min)
  - GIR can be increased by increasing either the fluid rate to max of 100ml/k/day or by increasing the dextrosity of the IV glucose solution.
  - Concentrations > D12.5% are sclerosing to veins and should only be administered via a central line (UV or PICC).
- If glucose remain unstable despite continuous glucose infusion, the decision to continue feeds should be discussed with the neonatologist.
- After the serum glucose has stabilized and enteral feedings have been initiated, taper IV fluids by glucose protocol.

**Glucose protocol**

- If the serum glucose is stable and the infant is feeding well, then determinations will be made by checking ac gluoses.
- If the serum glucose > 60 mg/dL, the IV fluids will be weaned by 2 ml/hr.
- If serum glucose > 50 mg/dL, wean by 1 ml/hr.
- If you are not able to wean the IVF do not advance enteral feeds.
- Once the IV is discontinued, then glucose determinations are done ac x 2.
- Specific therapies such as diazoxide or somatostatin (octreotide) may be indicated after appropriate diagnostic evaluation.
- Glucocorticoid should not be used for non-specific treatment of hypoglycemia in neonates.

**HYPERGLYCEMIA**

**Definition**

- Serum glucose > 125 mg/dL in term infants and > 150 mg/dL in preterm infants.

**Etiology**

- Excess glucose administration (> 8 mg/kg/min), sepsis, hypoxia, hyperosmolar formula, transient neonatal diabetes mellitus, medications, and stress

**Signs**

- Physiologic concerns with high glucose levels include osmotic diuresis, dehydration, and weight loss.
- Non-specific symptoms – may be related to the cause.
- Clinical studies suggest increased mortality, IVH and major handicaps in infants with hyperglycemia.

**Monitoring**

- Serum glucose q 1 hr until < 150 mg/dL then q 4 hrs until normoglycemic

**Treatment**

If serum glucose > 150 mg/dL.

- Reduce glucose infusion rate (GIR) 2 mg/kg/min by decreasing total fluids.
- If total fluids cannot be decreased, decrease glucose concentration or Y-in lower dextrose concentration to maintain total fluids constant.
- IV human regular insulin administration (0.1unit/kg IV) if reducing the GIR is not effective or is not possible.
- Continuous insulin infusion starting at 0.01 units/kg/hour increasing gradually to 0.05 to 0.1 units/kg/hour may sometimes be indicated.
- This treatment should only be undertaken after consulting the neonatologist. There is no standard glucose monitoring policy to follow insulin administration so you need to order glucose 30 minutes after the bolus then q 30 minutes if glucose > 150 mg/dL or < 100 mg/dL then q 1 hour until stable.

**Additional policy regarding monitoring gluoses**

- Certain infants not on IVF are at risk for hypoglycemia and need monitoring the first 24 hours of life.
- These include LGA and SGA infants, Polycythemic infants, Infants of diabetic mothers and others at risk.
  - They should be monitored hourly on IVF or ac and pc during transition then q 3-6 hours ac as the admit policy suggests x 24 hours.

- All infants with infusions of IV glucose require periodic monitoring.
- These include infants receiving infusions for fluid requirements as well as caloric requirements.
  - After any change in glucose concentration or increase in rate of infusion, monitor 30 minutes later.
  - All infants with infusions of D10W or TPN with normal serum glucose need glucose determinations q 6 hrs.
  - Infants with heparin locks previously documented to be normoglycemic and feeding well do not require glucose
• Normoglycemic infants who are feeding well and on IV therapy at a rate < 4 ml/hr do not need glucose monitoring unless otherwise ordered.

**GIR calculation**

- Glucose infusion rate: \[ \text{rate (ml/hr)} \times \text{dextrose infusion (D10)} \times 0.167 \text{ (constant)} \]

\[ \text{Wt in Kg} \]

- Example: A 3 kg baby on D10W at 80 ml/kg/day (rate of 10ml/hr)
  \[ \text{GIR} = \frac{10 \times 10 \times 0.167}{3} = 5.5 \text{ mg/kg/min} \]

---

**APPROACH TO SEPSIS IN THE NEWBORN:**

This guideline will only address the recognition and emergent management of early-onset bacteremia (less than 72 hours of age).

**Maternal Risk Factors:**

1. Onset of premature labor and delivery
2. Prolonged rupture of membranes (more than 18 hours)
3. Maternal chorioamnionitis
   - temperature greater than 37.5C
   - uterine tenderness
   - foul smelling amniotic fluid
   - fetal heart rate greater than 160 beats per minute
   - bacteria and white blood cells (WBC) in the amniotic fluid
4. Manipulative operative delivery
5. Maternal GBS colonization

**Neonatal Risk Factors:**

1. Perinatal asphyxia
2. Low birth weight
3. Prematurity
4. Invasive procedures
5. Presence of open congenital anomalies

**Clinical Signs in the Neonate:**

1. Respiratory distress
   - a. grunting, retractions, tachypnea, cyanosis, apnea
   - b. Lung is most common site of infection in the neonate
2. Temperature instability
   - a. Hyperthermia more common in term
   - b. Hypothermia more common in preterm
3. Cardiovascular
   - a. Poor perfusion
   - b. Tachycardia
   - c. Hypotension
   - d. Shock
   - e. Acidemia
4. Gastrointestinal
   - a. Poor feeding
   - b. Abdominal distention
   - c. Emesis, increased spits
   - d. Ileus
5. Neurologic
   - a. Seizures
   - b. Lethargy, decreased activity
   - c. Poor feeding
   - d. Hyptonia
6. Skin
   - a. Poor perfusion
   - b. Petechiae; purpura
   - c. Pallor
7. Metabolic
a. Glucose instability
b. Metabolic acidosis

**Investigations**

**General investigations** include parameters important in assessment of general well being of the infant eg blood gases, true blood glucose

**Infection related tests**

Non-specific markers e.g. C-reactive protein (CRP), Full Blood Examination

CRP rises approximately 12 hours after onset of sepsis and returns to normal within 2 to 7 days of successful treatment. If the CRP remains elevated or rises after initial improvement, care must be taken to look for possible collections, including endocarditis (particularly if 'long-lines' have been used) or fungal infection. CRP is raised in 85% of episodes of confirmed sepsis with a specificity of 90%. It can, therefore, be normal in cases of true sepsis and should be used in conjunction with clinical signs and culture results.

FBE - The Polymorphonucleocyte (PMN) count can be normal in 1/3 of cases of confirmed sepsis, but can also be elevated in the absence of infection. Neutropenia in the face of confirmed sepsis can indicate that the baby is extremely unwell. A raised immature to total white cell ratio (I:T ratio > 0.3) is about 85% sensitive and specific - particularly for early onset sepsis.

Tests to identify the infective organism

**Early onset sepsis**

Blood culture (mandatory)

Lumbar puncture (LP) should be performed where the 'index of suspicion' of meningitis is high i.e. abnormal conscious state or seizures. LP may need to be delayed until after the infant's condition has stabilised sufficiently to tolerate the procedure and abnormalities of coagulation status have been controlled. If the initial blood culture is positive. LP must be performed to exclude meningitis since the presence of meningitis alters the length of antibiotic treatment as well as prognosis.

There is little to be gained from performing urine aspiration for culture, as hematogenous spread is the mechanism behind positive urine cultures in the first few days of life

**Indications for early onset Sepsis workup (BC x 2 always and LP if clinically indicated):**

1. Chorioamnionitis
2. > 72 hours PROM
3. Symptoms such as emesis, temperature instability, poor feeding, unexplained apnea, respiratory distress etc.

**Blood Cultures (aerobic and anaerobic):**

a. Obtain from a peripheral vessel or as first specimen from a central line
b. Minimum two separate blood cultures sets from two separate sites
c. Minimum blood requirement 0.5 ml (preferably 1.0-2.0 ml per culture)
d. For late onset sepsis send cultures from all central lines and a peripheral culture

**Cerebral Spinal Fluid (CSF):**

Many centers elect to defer the lumbar puncture (LP) in rule out sepsis evaluations in asymptomatic neonates being evaluated for early onset sepsis.

a. If the neonate is symptomatic, a LP is indicated
b. It may be deferred if the neonate is clinically unstable or if it causes clinical deterioration.
c. If an LP is done after the initiation of antibiotics, interpretation of results might be difficult; although inflammatory changes may persist.

**Urine:**

Urine cultures are of little use in the diagnosis of early-onset bacteremia so not obtained on the initial workup after birth

**but very necessary if > 72 hours,**

a. Urine culture is part of a routine work-up on sepsis suspected in infants > 72 hours of life.
b. Bagged urine specimens for culture are not reliable thus not acceptable.
c. A suprapubic tap is the preferred method to obtain urine followed by a catheterized specimen.
Tracheal aspirates:
   a. Cultures and gram stains useful when obtained via the ETT of neonates requiring positive pressure ventilation at admission if suspected having of sepsis.
   b. They only reflect colonization of the upper airway after the initial intubation.

Other Cultures:
Amniotic fluid, gastric aspirate, ear canal, skin cultures and gram stains identify the flora of the fetal environment but do not confirm neonatal sepsis so are not routinely done.

X-rays:
Chest and abdominal x-rays should be obtained in neonates who have respiratory and or GI symptoms

Further lab evaluation:
Leukocyte profiles:
   a. 1st CBC has poor predictive value.
   b. Initial CBC is drawn followed by a 24 and 48 hour CBC.
   c. Total WBC < 5,000/mm3 (helpful if no maternal preeclampsia).
   d. Absolute neutrophil count less than 1,000/mm3.
   e. Bands/bands + polymorphonuclear ratio (I:T ratio) greater than 0.2.
   f. These profiles have the highest predictive accuracy and sensitivity for bacteremia.
   g. Leukocytosis may be a stress reaction and not indicative of sepsis.

Thrombocytopenia:
   a. Platelet count of less than 100,000 may be associated with bacteremia.
   b. If low platelet count; a venipuncture should be done to confirm.
   c. May need DIC Panel

Arterial blood gases: Look for acidemia and hypoxia if infant has respiratory distress or cardiovascular instability.

Late onset sepsis

Blood cultures (mandatory)

SPA specimen of urine should be obtained, as a primary UTI is not uncommon as a cause of sepsis after 5 days of age

The role of LP in late onset sepsis is controversial and depends on the clinical setting

Non-NICU infants suspected of being septic - LP should be performed to exclude CNS infection. If there is a high clinical index of CNS infection, appropriate treatment should be instituted early even if the LP is delayed until the baby is stable enough to tolerate the procedure.

Infants in NICU - The role of LP is limited since the commonest organism causing sepsis is the Coagulase Negative Staph (CONS). CONS rarely cause CNS infection unless a Ventriculoperitoneal shunt is present. LP when CONS is isolated from blood culture is reserved for infants who are not following the expected clinical course despite appropriate antibiotics. LP is performed when the infant's condition is suggestive of meningitis or blood culture identifies an organism other than CONS.

ETT cultures and skin swabs are of limited value for babies in NICU situations. Their value is as a guide to the profile and sensitivity of organisms in the nursery, particularly Staphylococcus aureus.

Inflammatory mediators:
1. ESR or C-reactive protein
   a. Not always a reliable test of infection in the neonate, particularly <24 hours.
      Might be useful in conjunction with other tests.
   b. These mediators are not elevated until 6-8 hours after the onset of bacteremia.
   c. CRP is used here at 24 and 48 hours in conjunction with the 24 and 48 hour CBC.
   d. Look for changes in the CRP. Levels below 10 are considered normal
   e. Check maternal cultures before and after delivery and notify appropriate pediatric personnel.
   f. Bacterial antigen identification: Latex agglutination or counter immune electrophoresis (CIE) may not be reliable. These screening tests can be performed rapidly on serum, urine, or
Treatment:  
Supportive:  
  1. Neutral thermal environment (Refer to Neonatal Guidelines of Care: Thermoregulation)  
  2. Intravenous fluids, glucose and electrolytes (Refer to Neonatal Guideline of Care: Maintenance Fluid and Electrolyte Therapy)  
  3. Adequate oxygenation and ventilation  
   a. Oxygen and assisted ventilation based upon arterial blood gas analysis  
   Capillary blood gases may be highly inaccurate in neonates with shock syndromes due to poor Peripheral circulation. (Refer to Neonatal Guidelines of Care: Respiratory Distress in the Neonate and Basic Guidelines for Administration of Oxygen).  
   b. Continuous cardio-respiratory monitoring and pulse oximetry  
  4. Maintenance of tissue perfusion:  
   a. Volume expanders, such as normal saline, fresh blood and plasma  
   b. Use of isotropic drugs for improved cardiac contractility as necessary. (Refer to Neonatal Guidelines of Care: Hypotension and Shock).  

Antibiotic choice  
Given the usual causative organisms the following regimes are recommended initially. Antibiotic choice can then be rationalised on the basis of culture results and clinical course.  

Early onset sepsis  
Ampicillin- 50mg/kg IV 12 hr  
100mg/kg/dose 12 hr if meningitis suspected  
Gentamicin – see table for weight and gestational age.  

Note: both can be given IM if IV access is not possible  
If history or clinical appearance suggests the possibility of Listeria, ampicillin 50mg/kg IV 12hourly can be used instead of penicillin (although data indicating that this is superior is lacking).  

For treatment of meningitis (until sensitivities are known)  
Cefotaxime - 50mg/kg/dose 12 hourly for preterm babies or term babies in the first week of life, 8 hourly after that time  
Ampicillin - 50mg/kg/dose 12 hourly for preterm babies or term babies in the first week of life, 8 hourly after that time  

Late onset sepsis  
Vancomycin and Tobramycin are the usual first choice antibiotics  
In meningitis use Ampicillin and Cefotaxime.  
For necrotizing enterocolitis use Ampicillin, Gentamicin, & Metronidazole  
Doses of antibiotics need to be adjusted for age of the baby and on the basis of levels in the case of gentamicin and vancomycin.  
An aminoglycoside other than gentamicin may be used in some hospitals at times depending on the profile of prevalent organisms.  

When to stop Antibiotics  
Duration of antibiotic treatment depends upon the clinical condition of the infant and the organism identified on culture.  

- where the likelihood of infection is low, with a baby in good condition and infective indices negative, antibiotics can be ceased if cultures are negative after 48 hours  
- sepsis strongly suspected, despite negative blood culture at 48 hours. It is advisable to repeat blood culture and continue antibiotics for at least 5 days providing infective indices have normalised. Another approach is to continue antibiotics for 48 hours after indices have normalised  
- proven gram negative bacteraemia, with clear CSF, treat for 10 days, antibiotics can be rationalised in the face of culture and
sensitivities

- **proven GBS bacteraemia**, with clear CSF, 10 days treatment should be sufficient

- **meningitis**, treat for 14 days for GBS and 21 days for gram negative organisms. In some centres, 48-hourly LPs are performed in cases of gram negative meningitis, with treatment continuing for 14 days after the first negative culture - in practice this usually equates with a 21 day treatment course

- **UTI** - treat with IV antibiotics for at least 5 days, a total of 10 days treatment is needed. The infant can be managed with appropriate oral antibiotics for the latter half of the treatment course if clinical condition is satisfactory. Ongoing prophylactic antibiotics will be needed until renal investigations (ultrasound and/or MCU) are completed

**Special Circumstances**

**The GBS colonised mother**

At delivery approximately 15% of women are colonised with GBS. Up to 70% of infants born to colonised women are themselves colonised. Infection occurs in 1% of colonised infants. 75% of early onset GBS disease in neonates occurs in term babies. The incidence of GBS disease varies, with the rate being 3 per 1000 live births in the USA, compared to 0.3 per 1000 in Australia and the UK. The risk is 3 times higher in the Aboriginal community.

Screening for GBS remains the subject of heated debate, but it is known that intrapartum administration of antibiotics (penicillin or amoxicillin) reduces neonatal colonisation by 90%, and early onset GBS disease by 90%.

The CDC in the USA recommends that all women be screened with anorectal and vaginal swabs at 35 -37 weeks' gestation.

Intrapartum antibiotics are given according to the following strategies

if screening is performed administer to

- GBS colonised women
- Non-colonised women with risk factors present

if screening is not performed administer to women with risk factors

- Preterm onset of labour (<37 weeks)
- ROM for >18 hours
- Maternal fever (>38°C)
- Previous baby with invasive GBS disease
- GBS bacteriuria this pregnancy

Use of the CDC guidelines is estimated to result in around 27% of women receiving antibiotics, with an associated reduction in early onset GBS disease of around 85%. The disadvantages of such an approach are the risk of maternal complications (anaphylaxis), and the cost (GBS rates of >0.5 per 1000 live births are needed to justify such an approach on a cost-effectiveness basis).

Intrapartum chemoprophylaxis consists of penicillin 1.2gms IV statim, then 0.6gms 4hrly (erythromycin can be used in cases of penicillin allergy). Should the infant be delivered before prophylaxis has been administered to the mother, or within 4 hours of the initial dose, the infant should be observed closely in hospital for 48 hours. Some workers recommend giving a single intramuscular injection of 100mg penicillin, IM, to such an infant while others recommend taking an FBE and blood culture prior to observation. Occasional treatment failure has been associated with the single IM dose regime.

**If the infant is initially (or becomes) symptomatic, or if significant prematurity (<35 weeks gestation) is present, the infant should undergo a septic evaluation and treatment with intravenous antibiotics despite maternal intrapartum prophylaxis.**

**Prolonged Rupture of Membranes (PROM)**

The majority of women will come into labour within 24 hours of rupture of the membranes; however, this may be delayed in up to 4% of cases. PROM for greater than 18 hours may lead to increased risk of infection in mother and baby - particularly if the mother is GBS positive or undergoes repeated vaginal examinations. In practice, the risk is greatest for preterm infants, but 75% of early onset GBS sepsis occurs in term babies. Since there is a lack of evidence from trials available there is debate as to the role of prophylactic antibiotics in PROM. Obstetric staff will need to consider signs of possible maternal sepsis, as well as risk factors such as GBS colonisation in deciding to administer antenatal antibiotics. Babies born with a background of PROM need to be viewed as potentially at
risk of sepsis.

**Preterm infants**, particularly those <35 weeks, are usually screened for sepsis and treated with IV antibiotics until infection in the baby has been excluded.

**Term infants**

if there are no risk factors, apart from the PROM, the infant is usually observed closely and treated only if symptoms develop if there is a risk factor present in addition to PROM, such as GBS positive mother, maternal intrapartum fever or suspected chorioamnionitis that infant should be treated as potentially septic, even if completely asymptomatic any symptomatic baby needs septic evaluation performed and treatment for infection regardless of the presence or absence of risk factors

**Fungal sepsis**

Generally seen in VLBW infants in NICU. Risk factors include multiple courses of IV antibiotics, presence of central lines and extensive areas of skin breakdown. Consideration of fungal sepsis is particularly necessary when such infants deteriorate whilst receiving antibiotics. Empirical treatment with Amphotericin until cultures are reported as clear for fungal organisms is appropriate. SPA of urine must be performed prior to starting Amphotericin as bag specimens will often be contaminated with Candida colonising the skin. If fungal sepsis is confirmed, then the addition of a further antifungal (e.g. fluconazole mg/kg stat, then 2mg/kg 48hrly) may be useful. Duration of treatment depends upon the site of infection but generally ranges from 3 to 6 weeks. Ultrasound of the kidneys and formal fundoscopy should be performed.

**Antimicrobial Therapy:** Intravenous antibiotic therapy should be initiated as soon as possible in neonates suspected of sepsis.

2. Empiric therapy pending the results of bacterial cultures usually consists of penicillin and an Aminoglycoside. (Ampicillin and Gentamycin).
3. Third generation cephalosporin antimicrobials (Cefotaxime) may replace (or be used in conjunction with aminoglycosides) the preceding regimen for treatment of neonatal Gram negative bacilli sepsis and/or meningitis. They are not routinely used as the first line due to risk of multi-drug resistant organisms.

**Immunotherapy:**

1. Exchange transfusion, granulocyte transfusion, granulocyte colony stimulation factor (Neupogen™) and intravenous (IV) immunoglobulin (IG) is still considered investigational therapies for neonatal sepsis.
2. These interventions may offer increased survival for rapidly deteriorating neonates. Such neonates should be cared for in the NICU.

**Prevention:**

The empiric therapy of neonates born after premature and/or prolonged rupture of membranes remains controversial. Some investigators have offered a scoring system to guide therapy.

1. Term neonates with prolonged rupture of membranes (greater than 18 hours) who are asymptomatic need only be carefully observed.
2. Neonates who have risk factors for infection should have blood cultures and neutrophil profiles obtained. Antimicrobial therapy may be indicated for these neonates pending bacteriologic results.
3. Maternal antibiotic therapy of the mother following premature or prolonged rupture of membranes may lower the incidence of neonatal Group B Streptococcal (GBS) bacteremia.
4. Penicillin prophylaxis in the neonate has also prevented subsequent GBS infection when given shortly after birth.
5. The CDC has set forth (2010) guidelines for the care of neonates exposed to Group B Strep. (Refer to Neonatal Guidelines of Care: Isolation and Infection Control).
Areas of Uncertainty in Clinical Practice

1. The role of antigen tests for GBS is controversial

Urine specimens for GBS antigen can be positive when babies are colonised, even when a SPA specimen is taken. If a bag specimen is used, then contamination with skin GBS colonisation will result in a positive test. Antigen tests are more sensitive and specific for CSF specimens, but cannot be relied upon to exclude infection. Antigen testing results need to be viewed from the point of view of adding supplementary evidence of possible infection, but cannot be relied upon to prove or disprove GBS infection, and are thus of limited value. Similar limitations exist in testing for other bacterial antigens.

2. Antifungal prophylaxis

A recent Cochrane review failed to demonstrate a reduction in fungal colonisation among patients receiving prophylactic oral nystatin compared to placebo. All patients in these trials were immuno-compromised but beyond the neonatal period.

A RCT of intravenous fluconazole compared to placebo during the first 6 weeks of life in 100 infants of less than 1000gm birthweight showed a reduction in fungal colonization and invasive fungal infection.

3. Treatment with Granulocyte Colony Stimulating Factor (G-CSF)

G-CSF has been shown to increase PMN counts in VLBW babies, but the effect on sepsis reduction or mortality from sepsis has not been demonstrated.

4. Intravenous immunoglobulin (IVIG)

Studies involving IVIG show a possible improvement in mortality in babies given IVIG as part of the treatment of sepsis. However, larger trials are needed to examine the role of IVIG in neonates with sepsis.

Other ancillary treatments that have been used include exchange transfusion and neutrophil transfusions, but insufficient data is available to recommend their use.

Further Reading


References available from Dr. G. Levin, M.D.
ADMINISTRATION SCHEDULE FOR GENTAMICIN (2010):

**Present Antibiotic**

**Gentamicin Dosing Schedule:**

<table>
<thead>
<tr>
<th>Gestation</th>
<th>Age</th>
<th>Dose</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤29 weeks</td>
<td>0-7 days</td>
<td>5 mg/kg</td>
<td>q 48h</td>
</tr>
<tr>
<td></td>
<td>8-28 days</td>
<td>4 mg/kg</td>
<td>q 36h</td>
</tr>
<tr>
<td>≥29 days</td>
<td></td>
<td>4 mg/kg</td>
<td>q 24h</td>
</tr>
<tr>
<td>30-34 weeks</td>
<td>0-7 days</td>
<td>4.5 mg/kg</td>
<td>q 36h</td>
</tr>
<tr>
<td></td>
<td>≥8 days</td>
<td>4 mg/kg</td>
<td>q 24h</td>
</tr>
<tr>
<td>≥35 weeks</td>
<td>all ages</td>
<td>4 mg/kg</td>
<td>q 24h</td>
</tr>
</tbody>
</table>

Routine monitoring of Gentamicin (this includes all aminoglycosides) is usually not necessary if treating only for 48 hours while ruling out sepsis. For those infants being treated for > 48 hours routine monitoring should be done obtaining levels around the 3rd dose (trough 30 minutes before the third dose and peak 30 minutes after the 3rd dose). Monitoring may be done sooner in case of renal dysfunction, birth asphyxia, symptomatic PDA needing indomethacin, and altered perfusion.

Desired peak level: 5-12 mcg/ml. Desired trough level: 0.5-1 mcg/ml

After the first week of life, give a dose of 4 mg/kg and measure the peak in 30 minutes after infusion and another level 24 hours later to determine dosing interval.

Reference: NeoFax 2009

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**Antibiotic Administration for Ampicillin and Vancomycin**

**Ampicillin:**

*Neonate:*

<table>
<thead>
<tr>
<th>&lt;7 Days:</th>
<th>&gt; 7 Days:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2 kg: 100 mg/kg/24 hr /IV-Q12 hr</td>
<td>&lt;1.2 kg: 100 mg/kg/24 hr - Q12hr/IV</td>
</tr>
<tr>
<td>&gt;2 kg: 100 mg/kg/24 hr /IV-Q8 hr</td>
<td>1.2-2 kg: 100 mg/kg/24 hr - Q8hr/IV</td>
</tr>
<tr>
<td>&gt;2 kg: 100 mg/kg/24 hr - Q6/IV</td>
<td></td>
</tr>
</tbody>
</table>

**Vancomycin Dosing and Monitoring in the NICU**

Dosing and Interval Chart by postnatal age and GA (gestational age) by PMA (post-menstrual age).

*Neofax 2009*

<table>
<thead>
<tr>
<th>Gestational Age by PMA (weeks)</th>
<th>Postnatal Age (days)</th>
<th>Interval (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 29</td>
<td>0 to 14</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>&gt; 14</td>
<td>12</td>
</tr>
<tr>
<td>30-36</td>
<td>0 to 14</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>&gt; 14</td>
<td>8</td>
</tr>
<tr>
<td>37-44</td>
<td>0 to 7</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>&gt; 7</td>
<td>8</td>
</tr>
<tr>
<td>≥ 45</td>
<td>ALL</td>
<td>6</td>
</tr>
</tbody>
</table>

This chart uses starting doses:

- 15 mg/kg/dose for suspected meningitis/deep infections such as osteomyelitis
- 10 mg/kg/dose for simple bacteremia.

**Dosing and Interval based on Creatinine (for immaturity or renal impairment).**


Creatinine based dosing (considers clearance decreased with decreased GFR).
<table>
<thead>
<tr>
<th>Creatinine (mg/dl)</th>
<th>Dose (mg/kg/dose)</th>
<th>Interval (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 1.7</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td>1.3-1.6</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>1.0-1.2</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td>0.7-0.9</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>≤ 0.6</td>
<td>15</td>
<td>12</td>
</tr>
</tbody>
</table>

**Monitoring:** Trough should be done 30 minutes before the 3rd dose. Although peaks are not routinely necessary, if choosing to do a peak it should be done 30 minutes after the 3rd dose. Peak levels should be between 30 to 40 mcg/ml if treating meningitis and 20-40 mcg/ml for other infections.

Because vancomycin exhibits time-dependent bacterial killing, effectiveness may be compromised if trough concentrations fall below the minimum inhibitory concentration (MIC) for prolonged periods. If initially concerned about obtaining therapeutic troughs rapidly, levels for above graphs can be done at the first dose and dose adjusted based on first dose pharmacokinetics, especially if dosed every 18-24 hours. 

Follow-up troughs after the 1st dose adjustment should be done before the next dose of the new time interval. Consider reassessing the trough weekly if on vancomycin for longer than 7 days. Troughs are affected by indocin and dopamine.

Due to the diverse population and disease states found in the NICU, nomograms should be cautiously applied and dose adjusted after troughs obtained.

**MANAGEMENT OF INFANTS BORN TO HERPES SIMPLEX VIRUS POSITIVE MOTHERS:**

1. **Care of infants born vaginally to a mother with active genital ulcerative lesions.** Primary 1st episode of HSV infection or known recurrent lesion or status unknown:
   A. **Asymptomatic Infant**
      1. Obtain HSV cultures (conjunctiva, nasopharynx, mouth, stool or rectal swab, urine) 24-48 hours after delivery. Cultures are delayed to distinguish between viral replication vs transient colonization.
      2. Observe carefully for signs and symptoms, vesicular scalp or skin lesions, RDS, seizures, or other signs and symptoms of sepsis.
      3. Initiate IV acyclovir only if HSV cultures are positive. Obtain a CSF analysis, culture, blood and CSF PCR for HSV prior to initiation of therapy.
      4. If this is presumed or proven maternal primary HSV infection, initiate therapy at birth after cultures are obtained.
      5. Infants who develop a vesicular rash or unexplained clinical signs and symptoms of sepsis should be evaluated immediately and managed similar to the asymptomatic infant with possible HSV infection.
   B. **Symptomatic infant** S/S of HSV infection or non-specific for sepsis, vesicular skin or scalp lesions
      1. HSV cultures (skin lesions + all of the above) immediately after birth
      2. Initiate IV Acyclovir immediately after cultures are obtained

2. **Care of the infant born via C/S to a mother with active genital ulcerative lesions (primary, recurrent or unknown)**
   1. Observe the infant carefully for the development of scalp or skin lesions or S/S of HSV infection or sepsis
   2. Obtain HSV cultures as above
   3. Initiate IV Acyclovir if cultures are positive
   4. Initiate therapy immediately after birth or at onset of clinical S/S and obtain HSV cultures if neonatal HSV infection is strongly suspected: S/S of sepsis, scalp or skin lesion, or ROM > 6 hours.
3. Care of the infant born to a mother with a history of HSV infection and no active lesions at delivery.
   1. Neither HSV cultures nor empiric therapy with IV Acyclovir are indicated
   2. No isolation necessary.

4. Diagnostic tests for HSV
   1. HSV Culture: HSV culture remains the “Gold Standard” for HSV detection. Specimens for HSV culture should be obtained from skin vesicles (if present), nasopharynx, conjunctiva, stool or rectum, urine, blood and CSF. A positive culture obtained from surface culture > 48 hours after birth indicates viral replication suggestive of infant infection rather than colonization after intrapartum exposure.
   2. HSV PCR: This is a very sensitive detection method for HSV encephalitis. HSV CSF culture is not very sensitive.
   3. Rapid diagnostic test: Direct fluorescent staining (DFA) of vesicle scraping or enzyme immunoassay detection of HSV culture. In general, HSV serology is not reliable.

5. Treatment for HSV infection:
   1. Acyclovir 20 mg/kg/dose q 8 hours for 14-21 days (SEM+14 days, disseminated disease or CNS disease = 21 days of treatment). The drug should be infused over 1 hour (the interval should be increased for premature infants < 34 wks PMA or in patients with renal impairment of hepatic failure).
   2. Topical opthalmic therapy is used for ocular involvement in addition to IV therapy. 1-2% trifluridine, 1% iododeoxyuridine or 3% vidarbine along with IV Acyclovir. Consider evaluation with the ophthalmologist. Topical corticosteroids are contraindicated.
   4. Monitor urinalysis, BUN, creatinine during the course of therapy. Consider monitoring liver enzymes and CBC.

6. Other recommendations
   1. Delay elective or ritual circumcision for 1 month after birth of infants at highest risk of disease.
   2. Neonatal HSV infection can occur as late as 6 weeks after delivery, although most infected infants are symptomatic by 4 weeks of age. Any rash or other symptoms that may be caused by HSV must be evaluated carefully.

7. Isolation
   1. Managed in private room when possible or strict contact precautions for the duration of the illness.
   2. Strict contact precautions should be maintained for all infants perinatally exposed to HSV.
   3. Women with active lesions should be managed with strict contact precautions. Careful hand washing is recommended. Mothers with cold sore or stomatitis should wear surgical masks when touching their newborn infant until the lesions are crusted and dried. She should not kiss or nuzzle her newborn until the lesions have cleared.
   4. Breastfeeding is acceptable if no lesions are present on the breast and if active lesions elsewhere are covered.

CANDIDATES FOR RSV PROPHYLAXIS:

Prior to discharge all infants meeting the following AAP guidelines will receive Synagis 15 mg/kg IM. This is a monoclonal antibody immunization prophylaxis for the ameliorization of RSV bronchiolitis.

AAP guidelines for Synagis (as per Red Book, 2009):
   1. Infants born at ≤ 28 weeks gestation up to one year of age at the onset of RSV season.
   2. Infants born at 29-31 6/7 weeks gestation up to six months of age at the onset of RSV season.
   3. Infants 24 months or younger with hemodynamically significant cyanotic and acyanotic congenital heart disease.
   4. Infants 24 months or less with CLD who have required medical therapy (supplemental oxygen, bronchodilators, diuretic or steroid therapy) for CLD within 6 months before the anticipated start of the RSV season.
   5. Infants born at 32 0/7-34 6/7 weeks gestation with 2 or more of the following risk factors for severe RSV disease.

These risk factors are not absolute. Managed care companies need to approve these factors.

Risk factors include:
   Day care attendance.
School age siblings.
Exposure to environmental air pollutants (smoking can be controlled and is not considered a risk factor; however, the family needs to be educated and counseled and this needs to be documented).
Severe neuromuscular disease.
Congenital abnormalities of the airways.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Max Number of Doses</th>
<th>Age (in months) at Onset of RSV Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 to &lt; 3</td>
</tr>
<tr>
<td>Hemodynamically significant Congenital Heart Disease (CHD) 2,3</td>
<td>5</td>
<td>Yes</td>
</tr>
<tr>
<td>Infants/children requiring medication to control congestive heart failure (CHF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infants/children with moderate to severe pulmonary hypertension</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infants/children with cyanotic heart disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic Lung Disease (CLD) formerly called Bronchopulmonary dysplasia defined as:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For infants &lt;32 weeks: Oxygen requirement at 36 weeks gestational age or at discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For infants &gt; 32 weeks: Oxygen requirement at age 28 days or greater at discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infants/Children who have received treatment for CLD within 6 months of the anticipated onset of the season with Oxygen Bronchodilators Diuretics and/or steroids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premature infants &lt; 28 weeks, 6 days gestational age OR</td>
<td>5</td>
<td>Yes</td>
</tr>
<tr>
<td>Infants with a significant congenital abnormality of the airway or neuromuscular condition that compromises handling of respiratory secretions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premature infants &gt; 29 weeks, 0 days; &lt; 31 weeks, 6 days, gestational age</td>
<td>5</td>
<td>Yes</td>
</tr>
<tr>
<td>Premature infants &gt; 32 weeks, 0 days; &lt; 34 weeks, 6 days with one of the following two risk factors:4</td>
<td>3</td>
<td>Yes</td>
</tr>
<tr>
<td>Child care attendance 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sibling &lt; 5 years of age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infants of 35 weeks, 0 days and older gestational age (without CLD or Hemodynamically Significant CHD) 6,7,8</td>
<td>0</td>
<td>No</td>
</tr>
</tbody>
</table>

**Additional Notes:**
1. If an infant receiving Synagis® has a breakthrough RSV infection during the season, Synagis® should continue to be given for a maximum of 3 doses for the 32 to <35 week infant category (until they reach 90 days of life) and for a maximum of 5 doses for the other high risk categories.
2. High-risk CHD patients receiving Synagis® who undergo heart surgery with the use of cardio-pulmonary bypass should receive a dose of Synagis® post-op as soon as medically stable.
3. Patients with CHD who are NOT candidates for Synagis® include:
   - Hemodynamically insignificant heart disease
   - Secundum ASD
   - Small VSD
   - Pulmonic stenosis
   - Uncomplicated aortic stenosis
   - Mild coarctation of the aorta
   - Patent ductus arteriosus (PDA)
4. Infants with corrected surgical lesions unless they continue to require medication for CHF
5. Infants with mild cardiomyopathy who are not receiving medical therapy
6. Premature infants 32 – 35 weeks should only receive prophylaxis until they turn 3 months old (maximum of 3 doses – many will require only 1 or 2 doses). Prophylaxis is not recommended after 3 months of age.

10. Participation in child care (two or more unrelated infants/children for more than 4 hours per week) should be restricted during the RSV season for high-risk infants whenever feasible. Parents should be instructed on the importance of careful hand hygiene.

8. All high risk infants and their contacts should be immunized against influenza beginning at 6 months of age.
9. Limited studies have suggested that some patients with cystic fibrosis may be at risk of RSV but it is not known whether RSV exacerbates the chronic lung disease in CF patients and there is insufficient data to determine the effectiveness of Synagis® in this population. Therefore there is no recommendation for routine prophylaxis for cystic fibrosis.

11. Synagis® has not been evaluated in randomized trials in immunocompromised children. However, children with severe immunodeficiencies (such as severe combined immunodeficiency syndrome or advanced AIDS) may benefit from prophylaxis.

Reference:

RECOMMENDATIONS FOR HEPATITIS C VIRUS (HCV) EXPOSED INFANTS:

Transmission Modes:
- 60-90% seropositive people have history of exposure to blood such as IV drug users.
- Can be sexually transmitted but that is not the major route of transmission.
- In US 1-2% of pregnant women are thought to be seropositive.
- HCV infection in infants born to HCV+, HIV neg. moms is 5-6% (range: 0-25%)
- Infection rates born to mom’s co-infected with HCV & HIV, 14% (range: 5-36%)
- Consistent factor associated with transmission is HCV RNA in mom at birth
- There is an association between virus titer and transmission of HCV.
- Transmission via breast milk not documented but due to the theoretical risk breast feeding is not recommended if nipples are cracked or bleeding. Discuss with mom.
- Screening recommended in moms with a history of:
  - Blood or blood product transfusions before July 1992
  - Organ transplants before July 1992
  - Persistently abnormal ALT levels
  - IV drug use or hepatitis

Detection of exposed infants and their follow-up:
- Screening test is the HCV IgG antibody. No IgM test available.
- If HCV antibody status on the mother not available check infant’s HCV antibody.
- If infant’s HCV antibody is positive and the mother has not been tested inform the mother’s obstetrician.
- Infant should be followed with the mother in Dr. Handal’s Infectious Disease Clinic.

Seroprevalence among pregnant women in the United States has been estimated at 1% to 2%. The risk of perinatal transmission averages 5% to 6%, and transmission occurs only from women who are HCV RNA positive at the time of delivery. Maternal co-infection with HIV has been associated with increased risk of perinatal transmission of HCV, which depends in part on the serologic concentration of HCV RNA in the mother. Serum antibody to HCV (anti-HCV) and HCV RNA have been detected in colostrum, but the risk of HCV transmission is similar in breastfed and bottle-fed infants.

All people with HCV-RNA in their blood are considered to be infectious.

The incubation period for HCV disease averages 6 to 7 weeks, with a range of 2 weeks to 6 months. The time from exposure to development of viremia generally is 1 to 2 weeks.

DIAGNOSTIC TESTS: The 2 major types of tests available for laboratory diagnosis of HCV infections are immunoglobulin (Ig) G antibody enzyme immunoassays for HCV and NAA tests to detect HCV RNA. Assays for IgM to detect early or acute infection are not
Food and Drug Administration (FDA)-licensed diagnostic NAA tests for qualitative detection of HCV RNA are available. HCV RNA can be detected in serum or plasma within 1 to 2 weeks after exposure to the virus and weeks before onset of liver enzyme abnormalities or appearance of anti-HCV. Assays for detection of HCV RNA are used commonly in clinical practice to identify anti-HCV-positive patients who have HCV infection, for identifying infection in infants early in life (ie, perinatal transmission) when maternal antibody interferes with ability to detect antibody produced by the infant, and for monitoring patients receiving antiviral therapy. However, false-positive and false-negative results can occur from improper handling, storage, and contamination of test specimens. Viral RNA may be detected intermittently, and thus, a single negative assay result is not conclusive. Quantitative assays for measuring the concentration of HCV RNA are available but are less sensitive than qualitative assays. The clinical value of these quantitative assays appears to be primarily as a prognostic indicator for patients undergoing or about to undergo antiviral therapy.

TREATMENT: Patients diagnosed with HCV infection should be referred to a pediatric hepatitis specialist for clinical monitoring and consideration of antiviral treatment. Therapy is aimed at inhibiting HCV replication, eradicating infection, and improving the natural history of disease. Therapies are expensive and can have significant adverse reactions. Interferon-alfa or peginterferon-alfa alone and peginterferon-alfa in combination with ribavirin are approved by the FDA for treatment of chronic HCV infection in adults. Response to treatment varies depending on the genotype with which the person is infected. Combination therapy with pegylated interferon-alfa and ribavirin is the preferred treatment and results in sustained virologic response, defined as undetectable HCV RNA concentrations 6 or more months after treatment cessation. A sustained viral response occurs in 40% to 45% of treated adult patients infected with genotype 1 and approximately 80% in patients with genotypes 2 or 3. The FDA has approved use of both nonpegylated interferon-alfa-2b in combination with ribavirin and pegylated interferon-alfa-2b combined with ribavirin for treatment of HCV infection in children 3 to 17 years of age. As in adults, pegylated interferon in combination with ribavirin is the preferred treatment with sustained virologic response documented in 55% of pediatric patients infected with HCV genotypes 1 and 4 following 48 weeks of therapy and in 96% of patients infected with HCV genotypes 2 and 3 following 24 weeks of therapy. The few studies of combination therapy in children suggest that children have fewer adverse events compared with adults; however, all treatment regimens are associated with adverse events. Major adverse effects of combination therapy in pediatric patients include influenza-like symptoms, hematologic abnormalities, neuropsychiatric symptoms, thyroid abnormalities, ocular abnormalities including ischemic retinopathy and uveitis, and growth disturbances. Of 107 patients 3 to 17 years of age in a clinical trial of pegylated interferon-alfa-2b plus ribavirin, severely inhibited growth velocity (<3rd percentile) was observed in 70% of the subjects during treatment. Of subjects experiencing severely inhibited growth, 20% had continued inhibited growth velocity (<3rd percentile) after 6 months of follow-up after treatment. Education of patients, their family members, and caregivers about adverse effects and their prospective management is an integral aspect of treatment.

A number of new direct-acting antiviral drugs (DAAs) are in development for treatment of chronic HCV infection. Preliminary results of studies conducted in adults with telaprevir or boceprevir in combination with pegylated interferon-alfa and ribavirin suggest that rates of sustained virologic responses with these new DAAs dramatically are higher, especially in adults with genotype 1 than with current standard of care. In addition, adults with HCV genotype 1 and evidence of rapid virologic response within the first 4 to 8 weeks of treatment may be successfully treated with shorter durations of DAAs plus standard of care therapy. Trials of these oral agents in pediatric patients, in combination with standard therapy, now are starting. All patients with chronic HCV infection should be immunized against hepatitis A and hepatitis B because of the very high rate of severe hepatitis in patients with chronic liver disease from HCV who become co-infected with hepatitis A or B virus.

DIAGNOSTIC TESTS: The 2 major types of tests available for laboratory diagnosis of HCV infections are immunoglobulin (Ig) G antibody enzyme immunoassays for HCV and NAA tests to detect HCV RNA. Assays for IgM to detect early or acute infection are not available. The third-generation enzyme immunoassays are at least 97% sensitive and more than 99% specific. False-negative results early in the course of acute infection can result from the prolonged interval between exposure and onset of illness and seroconversion. Within 15 weeks after exposure and within 5 to 6 weeks after onset of hepatitis, 80% of patients will have positive test results for serum anti-HCV antibody. Among infants born to anti-HCV-positive mothers, passively acquired maternal antibody may persist for up to 18 months.

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**TREATMENT:** Therapy is aimed at inhibiting HCV replication, eradicating infection, and improving the natural history of disease. Therapies are expensive, can cause significant adverse reactions, and are effective in approximately half of people treated. Response to treatment varies depending on the genotype with which the person is infected. The few studies of combination therapy in children suggest that children have increased sustained virologic response rates and fewer adverse events compared with adults, but The FDA has not approved use of (nonpegylated) interferon-alfa-2b in combination with ribavirin for treatment of HCV infection in neonates.

Reference:


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**APPROACH TO HIV EXPOSED NEONATES:**

Diagnostic tests for infants born to HIV infected mothers:

1. HIV DNA PCR is presently the preferred virologic method for diagnosis in the neonate and should be drawn within the first 48 hours after birth. Cord blood should not be used.
2. The second sample should be drawn at 1-2 months in Dr. Handel’s ID clinic. This can also be done at 14 days to help decide antiretroviral therapy at an early age if the first sample is positive.
3. The third sample should be drawn at 2-4 months of age. Any time an infant tests positive, testing should be repeated on a second blood sample as soon as possible to confirm the diagnosis.
4. An infant is considered HIV infected if two separate HIV DNA PCR’s are positive. Infection can be excluded when 2 HIV DNA PCR assays performed at or beyond 1 month of age, and a third performed on a sample obtained at 4 months of age or older, are negative.

In the United States, the preferred test for diagnosis of HIV-1 infection in infants is the HIV-1 DNA polymerase chain reaction (PCR) assay. Approximately 30% to 40% of HIV-1-infected infants will have a positive DNA PCR assay result in samples obtained before 48 hours of age. A positive result by 48 hours of age suggests in utero transmission. The DNA PCR assay routinely can detect 1 to 10 DNA copies of proviral DNA in peripheral blood mononuclear cells. Approximately 93% of infected infants have detectable HIV-1 DNA by 2 weeks of age, and approximately 95% of HIV-1-infected infants have a positive HIV-1 DNA PCR assay result by 1 month of age. A single HIV-1 DNA PCR assay has a sensitivity of 95% and a specificity of 97% for samples collected from infected infants 1 to 36 months of age. Detection of the p24 antigen (including immune complex dissociated) is substantially less sensitive than the HIV-1 DNA PCR assay or culture. An additional drawback is the occurrence of false-positive test results in samples obtained from infants younger than 1 month of age. This test generally should not be used, although newer assays have been reported to have sensitivities similar to HIV-1 DNA PCR assays. Plasma HIV-1 RNA assays may be used to diagnose HIV-1 infection. However, a false-negative test result may occur in neonates receiving ARV prophylaxis. Diagnostic testing with HIV-1 DNA or RNA assays is recommended at 14 to 21 days of age, and if results are negative, repeated at 1 to 2 months of age and again at 4 to 6 months of age. Viral diagnostic testing in the first few days of life (eg, less than 48 hours of age) is recommended by some experts to allow for the early identification of infants.

**Management of infants born to mothers with Western blot/DNA PCR positive:**

1. Zidovudine (AZT) – a nucleoside analogue reverse transcriptase inhibitor
   Must be started 6-12 hours after birth until 6 weeks of age
   Dosage: 2 mg/kg orally q 6 hour or 1.5 mg/kg IV over 1 hour q 6 hours
   (preterm infants < 2 weeks of age to be given q 12 hours then at 2 weeks q 6 hours).
   ●Breastfeeding is contraindicated.
   ●If complete HIV testing is pending after birth and the mom is Eliza positive with the ●Western Blot pending then breast feeding should not be initiated until the Western Blot has been reported negative.
   ●This should be discussed with the mother by the pediatrician.
   ●All infants born to mothers who are HIV positive should be followed in the Infectious Disease Clinic and the initial consult should be initiated while the infant is in the nursery.

Read JS; American Academy of Pediatrics, Committee on Pediatric AIDS. Diagnosis of HIV-1 infection in children younger than 18 months in the United States, *Pediatrics*. 2008;120(6):e1547-e1562. Available at: [http://pediatrics.aappublications.org/cgi/content/full/120/6/e1547](http://pediatrics.aappublications.org/cgi/content/full/120/6/e1547)
**PREVENTION OF PERINATAL HBV INFECTION:**

Perinatal transmission of HBV infection can be prevented in ~ 95% of infants born to
  ● HbsAg-positive mothers by early active and passive immunoprophylaxis of the infants.
    ● The infants (including preterms) should receive the initial dose of hepatitis B vaccine within 12 hours of birth and HBIG (0.5ml) IM given concurrently at a different site.
    ● The complete three vaccines should be completed by 6 months.
    ● In preterm infants the first vaccine should not be counted as one of the 3 serial immunizations.
    ● Four doses are recommended in this circumstance.

**Follow-up of Exposed Infants**

  ● Infant born to moms who are Hep B + should have an ID consult and follow-up in ID clinic in one month.
  
  ● The infants should then be tested serologically for anti-HBs and HBs Ag 1-3 months after completion of the immunization series.
  
  ● Testing for HbsAg identifies infants who become chronically infected and helps in long-term medical management.

Pregnant women whose HbsAg status is unknown at delivery should undergo testing ASAP. If the results are not back within 12 hours of delivery please refer to the chart below obtained from the Red Book 2012 with attention to the preterm and low birth weight infants < 2.0 kgs.

All infant born to mothers who are Hepatitis B positive should have an Infectious Disease consult and follow-up in the Infectious Disease clinic 1 month after discharge.

<table>
<thead>
<tr>
<th>Maternal Status</th>
<th>Infant ≥ 2000 g</th>
<th>Infant &lt; 2000 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbsAg positive</td>
<td><strong>Hepatitis B vaccine + HBIG (within 12 h of birth)</strong></td>
<td><strong>Hepatitis B vaccine + HBIG (within 12 h of birth)</strong></td>
</tr>
<tr>
<td></td>
<td>• Immunize with 3 vaccine doses at 0, 1, and 6 mo of chronologic age</td>
<td>• Immunize with 4 vaccine doses at 0, 1, 2-3, and 6-7 mo of chronologic age.²</td>
</tr>
<tr>
<td></td>
<td>• Check anti-HBs and Hbs Ag at 9-15 mo of age.²</td>
<td>• Check anti-HBs and Hbs Ag at 9-15 mo. of age.²</td>
</tr>
<tr>
<td></td>
<td>• If infant is HbsAg and anti-HBs negative, re-immunize with 3 doses at 2-mo intervals and retest.</td>
<td>• If infant is HbsAg and anti-HBs negative, re-immunize with 3 doses at 2-mo intervals and retest.</td>
</tr>
<tr>
<td>HbsAg status unknown</td>
<td><strong>Hepatitis B vaccine (by 12 h) + HBIG (within 7 days) if mother tests HbsAg positive.</strong></td>
<td><strong>Hepatitis B vaccine + HBIG (by 12 h).</strong></td>
</tr>
<tr>
<td></td>
<td>• Test mother for HbsAg immediately.</td>
<td>• Test mother for HbsAg within 12 h of birth and if unavailable, give infant HBIG.</td>
</tr>
<tr>
<td>HbsAg Negative</td>
<td><strong>Hepatitis B vaccine at birth preferred</strong></td>
<td><strong>Hepatitis B vaccine dose 1 at 30 days of chronologic age if medically stable, or at hospital discharge if before 30 days of chronologic age.</strong></td>
</tr>
<tr>
<td></td>
<td>• Immunize with 3 doses at 0-2, 1-4, and 6-18 mo of chronologic age.</td>
<td>• Immunize with 3 doses at 1-2, 2-4, and 6-18 Mo of chronologic age.</td>
</tr>
<tr>
<td></td>
<td>• May give hepatitis B-containing combination vaccine beginning at 6-8 wk of chronologic age.</td>
<td>• May give hepatitis B-containing combination Vaccine beginning at 6-8 wk of chronologic age.</td>
</tr>
<tr>
<td></td>
<td>• Follow-up anti-HBs and HbsAg testing not needed.</td>
<td>• Follow-up anti-HBs and HbsAg testing not needed.</td>
</tr>
</tbody>
</table>

**Hepatitis-B Vaccination Procedures (Newborn):**

**HEPATITIS-B VACCINATION PROCEDURES (NEWBORN)**

- All newborns will be administered the Hepatitis-B vaccine.
- For the Neonatal Intensive Care (NICU) and Intermediate Care Nursery (IMCN), administration of vaccines will be based on weight and risk status.
- The RN will notify the pediatrician if the mother’s HbAg results are positive.
- The Physician or Neonatal Nurse Practitioner will order the Hepatitis-B vaccine and/or Hepatitis-B Immune Globulin (HBIG).

**RESPONSIBLE:**

- Physicians
- Neonatal Nurse Practitioners (NNPs)
- Registered Nurses
- Licensed Vocational Nurses
- Registered Pharmacists
- Pharmacy Technicians

**LITERATURE REFERENCE:**


DEFINITIONS:

Low-Risk Infants: All newborn infants not otherwise designated as high-risk infants

High-Risk Infants: Newborns at high risk of developing Hepatitis-B infection, including:

- Newborns of IV substance abusers whose Hepatitis-B status is not known at delivery
- Newborns of Hepatitis-B surface Ag positive mothers as documented in mother’s medical record

PROCEDURE:

A. Vaccine Administration

1. For the Neonatal Intensive Care (NICU) and Intermediate Care Nursery (IMCN), administration of vaccines will be based on weight and risk status.

2. Vaccine Administration for Infants > 2 kg:

   i. Infants > 2kg born to known positive HBsAg mothers:
      1. Will receive Hepatitis B vaccine and HBIG as soon as possible, but within 12 hours of birth
      2. The Registered Nurse (RN) will notify pediatric provider at birth to order the appropriate stat medications
      3. If parents refuse administration of HBIG and/or Hepatitis B vaccine, RN will document and notify the attending physician as soon as possible

   ii. Infants > 2 kg born to mothers with unknown HBsAg status:
      1. Should receive Hepatitis B vaccine as soon as possible, but within 12 hours of life
      2. If the mother is found to be HBsAg positive, the infant will receive HBIG as soon as possible but within 7 days of life
      3. If the maternal status is unknown at the time of discharge or at 7 days (whichever is first), the infant will receive HBIG
      4. If maternal HBsAg status is unknown and parents refuse vaccine administration, RN will document and notify the attending physician as soon as possible

   iii. Medically stable infant > 2 kg whose mother is HBsAg negative:
      1. Will receive Hepatitis B vaccine by 12 hours of life
      2. If parents decline vaccination, document and notify the attending physician to ensure mother’s HBsAg-negative status is appropriately documented in the infant’s medical record

3. Vaccine Administration for Infants < 2 kg:

   i. Infants < 2 kg born to mothers with known positive HBsAg:
      1. Will receive Hepatitis B Vaccine and HBIG as soon as possible after birth, but within 12 hours
      2. RN will notify physician at birth to order the appropriate stat medications
      3. This first dose of Hepatitis B vaccine will not count toward the required three-dose schedule
      4. If parents refuse administration of HBIG and/or Hepatitis B vaccine, RN will document and notify the physician as soon as possible
ii. Infants < 2 kg born to mothers with unknown HBsAg status:
   1. Will receive Hepatitis B vaccine as soon as possible, but within 12 hours of life
   2. If maternal HBsAg status is found to be positive or will be unknown by 12 hours of life, give HBIG as soon as possible, but within 12 hours of life
   3. This first dose of Hepatitis B vaccine will not count toward the required three-dose schedule
   4. If parents refuse administration of HBIG and/or Hepatitis B vaccine, RN will document and notify the physician as soon as possible

iii. Infants < 2 kg born to mothers with known negative HBsAg:
   1. Will receive first dose of Hepatitis B vaccine at 1 month of chronological age or at the time of discharge if medically stable and exhibiting consistent weight gain
   2. If parents decline vaccination, document and notify the physician to ensure mother’s HBsAg-negative status is appropriately documented in the infant’s medical record

4. Newborn infants with household contacts or primary caregivers with acute HBV infection require protection and should receive Hepatitis B vaccine and HBIG prior to discharge from the hospital

5. The Hepatitis B Vaccine dose is 0.5ml IM for both preterm and term infants of “Recombivax HB”. The same dose is used regardless of maternal HBsAg status

6. Infanrix® (diphtheria and tetanus toxoids, and acellular pertussis) combination vaccine will not be used for the initial Hepatitis-B vaccination dose

7. HBIG dose is 0.5ml IM (given at a separate site than that used for Hepatitis B Vaccine).

Recommendation Summary

<table>
<thead>
<tr>
<th>Maternal HBsAg Status</th>
<th>Birth Weight &gt;2 kg Recommendation</th>
<th>Birth Weight &lt;2 kg Recommendation</th>
</tr>
</thead>
</table>
| Positive              | Hepatitis B Vaccine within 12 hours of birth  
                         HBIG within 12 hours of birth | Hepatitis B Vaccine within 12 hours of birth  
                         HBIG within 12 hours of birth  
                         Hepatitis B Vaccine does not count towards 1st in series |
| Unknown               | Hepatitis B Vaccine within 12 hours of birth  
                         HBIG within 7 days or prior to discharge | Hepatitis B Vaccine within 12 hours of birth  
                         HBIG within 12 hours of birth  
                         Hepatitis B Vaccine does not count towards 1st in series |
| Negative              | Hepatitis B Vaccine prior to discharge | Hepatitis B Vaccine at 1 month chronological or age or at discharge if infant medically stable and gaining weight |

8. Upon receiving the physician’s or NNP’s order indicating Hepatitis-B vaccination, the licensed nurse will follow the below administration procedures:

   i. Ask the mother/guardian to read form C-106 *Important Information About Hepatitis-B and Hepatitis-B Vaccine* at the time of admission, when the newborn is first brought to the mother, or by 12 hours of life.

   ii. Complete the *Vaccine Administration Record* form and have the mother or guardian sign the form after answering any questions they may have.

   iii. After verifying that the *Vaccine Administration Record* form has been completed, obtain the vaccine (Recombivax HB 0.5 ml or Engerix 0.5 ml) from In-Patient Pharmacy.
iv. Administer the vaccination intramuscularly and complete an immunization card for the newborn. Place the immunization card with the newborn’s flow chart.

v. If administering both Hepatitis-B vaccine and HBIG, the registered nurse will give in opposite thighs.

vi. Document the following information in the Electronic Medical Record (eMAR):

- Site of administration
- Date of administration
- Vaccine lot number
- Vaccine manufacturer
- Vaccine expiration date

5. The parent/guardian will be provided with the immunization card upon discharge.

B. Immune Globulin Administration

1. Upon receiving the physician’s or NNP’s order indicating Hepatitis-B Immune Globulin, the licensed nurse will follow the below administration procedures:

   i. Obtain Hepatitis-B Immune Globulin from Inpatient Pharmacy
   ii. Administer 0.5mL I.M. in the anterolateral aspects of the upper thigh or the deltoid muscle.
   iii. May be administered at the same time as the hepatitis vaccine. Do not administer the hepatitis vaccine and HBIG in the same limb (vaccine will be neutralized).

C. Control/Handling

1. Each Nursing unit will keep an acceptable inventory level as determined by the nurse manager of each area. The inventory will be monitored through use of the Pyxis® device.

2. Pharmacy will re-stock the Pyxis® inventory daily, as needed.

3. The registered nurse responsible for the patient must report all positive Hepatitis-B-antigen surface results to the Texas Department of Health.

### APPROACH TO SUSPECTED CONGENITAL SYPHILIS:

**Congenital syphilis in newborns:**

- Infant RPR titers > 1:4 are suspect and should be evaluated for possible treatment.
- What is important in interpreting any titer (even 1:1) is the history. Even when the maternal RPR is low if the maternal confirmatory test (TPPA) is positive, the infants receive treatment.
- Mothers are adequately treated if they receive three doses of Penicillin IM > one month prior to delivery.

**Positive Maternal RPR and MHATP:**

- Thorough History & PE
- Quantitative nontreponemal serologic test of serum (RPR on mother & infant)
- VDRL test of CSF
- Long bone radiograph (when clinically indicated)
- CBC and platelet count
- Other tests (when clinically indicated) (e.g. CXR and LFT’s)

**Treatment:**

- Recommended treatment is 10-14 days of aqueous penicillin G or procaine penicillin G. **In Most cases treatment for 10 days is adequate.**
- Aqueous crystalline penicillin G is recommended if congenital syphilis is proved or highly suspected.
- Presently there has been a shortage of Penicillin G so we use Procaine Penicillin.
- While Procaine Penicillin (50,000 U/kg IM) has been recommended as an alternative to treat congenital syphilis, but adequate
CSF concentration may not be achieved consistently so follow up is imperative.

**Further Outpatient Care:**
- Follow congenital syphilis at ages 1, 2, 4, 6, and 12 months in Dr. Handal’s ID clinic.
- Obtain nontreponemal titers at ages 3, 6, and 12 months after conclusion of treatment.
- Nontreponemal antibody titers should decline by age 3 months and negative by age 6 months
- Consider re-treatment for patients with persistently stable titers, including low titers.
- Infants treated for congenital neurosyphilis should undergo repeat clinical evaluation and CSF examination at 6-month intervals until their CSF examination result is normal.
- A positive CSF VDRL result at age 6 months is an indication for re-treatment.
- Follow-up early-acquired syphilis with a quantitative nontreponemal test at 3, 6, and 12-month intervals after conclusion of treatment.
- Patients with syphilis for more than 1 year also should undergo serologic testing 24 months after treatment.
- Pregnant patients who have received treatment should have quantitative serologic testing monthly for the remainder of their pregnancy.

**Congenital Syphilis**

**Clinical Manifestations**
- 75% of infants with early congenital syphilis will be asymptomatic
- If symptomatic, symptoms develop between the 3rd and 14th week of life and include:
  - IUGR
  - Hepatosplenomegaly (most common)
  - Snuffles (Syphilitic rhinitis)
  - Maculopapular rash- Start as pink, oval macules, then become coppery brown and desquamates.
  - Pemphigus syphiliticus- vesiculobullous eruptions on the palms and soles.
  - Jaundice
  - Elevated liver enzymes, leukocytosis, thrombocytopenia, or leukopenia.

**Diagnosis**
- A positive nontreponemal test (i.e. VDRL and RPR) and, if positive, treponemal testing for confirmation.
- An RPR titer in the infant, more than fourfold the Mother’s, is a strong indication of infection rather than just passive transfer of antibodies via the placenta
- Evaluation of the infant to include CBC, CSF exam and VDRL, and, when indicated, long bone x-rays, ophthalmologic exam, and LFTs.

**Treatment**
1. Maternal RPR is reactive, but TP-PA or FTA-ABS is nonreactive
   **OR**
   If the infant’s RPR is reactive, but less than fourfold the Mother’s, the infant’s physical exam is normal, and the Mother was treated during pregnancy:
   **THEN:** no treatment required
2. Maternal RPR and TP-PA/FTA-ABS are reactive and infant’s RPR is nonreactive
   **OR**
   If the infant’s RPR is reactive, but less than fourfold the Mother’s, physical exam is normal, and the Mother was treated more than 4 weeks before delivery:
   **OR**
   If the infant’s RPR is reactive, but less than fourfold the Mother’s, the infant’s physical exam is normal, and there is no documentation of treatment during pregnancy, treatment was with a non-penicillin drug, treatment was less than 4 weeks prior
to delivery, or there is evidence of relapse of infection in the Mother, and the CBC, CSF, VDRL, and long bones are normal in
the infant

THEN: Treat with a single IM injection of benzathine penicillin 50,000 units/kg

3. If the infant’s RPR is **more than fourfold** the Mother’s, the infant’s physical exam is abnormal, there is no documentation of
treatment during pregnancy, treatment was with a non-penicillin drug, treatment was less than 4 weeks prior to delivery, or
there is evidence of relapse of infection in the Mother, or the CBC, CSF, VDRL, or long bones are abnormal

THEN: Treat with aqueous penicillin G 50,000 units/kg IV every 12 hrs (if less than 1 week old) or every 8 hours (if more than 1
week old) or procaine penicillin G 50,000 units/kg IM daily for 10 days.

**Follow Up**

Follow up in the form of nontreponemal testing should be performed every 2-3 months until the test is either nonreactive or the titer has
decreased fourfold.

*Due to the devastation syphilis can cause if left inadequately treated, any infant who you feel may not receive adequate follow up
should be treated with the full 10 day course as outlined in #3 above.*

**References**


listeria, tuberculosis, syphilis, and varicella. *NeoReviews, 11; e681. doi: 10.1542/neo.11-12-e681*
RPR indicates rapid plasma reagin (test); VDRL, Venereal Disease Research Laboratory (test); TP-PA, Treponema pallidum particle agglutination (test); FTA-ABS, fluorescent treponema antibody absorption (test).

4 Test for human immunodeficiency virus (HIV) antibody. Infants of HIV-infected mothers do not require different evaluation or treatment.

5 Women who maintain a VDRL titer 1:2 or less (RPR 1:4 or less) beyond 1 year after successful treatment are considered serofast.

6 Evaluation consists of complete blood cell (CBC) and platelet count; cerebrospinal fluid (CSF) examination for cell count, protein, and quantitative VDRL. Other tests as clinically indicated: long-bone and chest radiographs, neuroimaging, auditory brainstem response, eye examination, liver function tests.

7 CBC, platelet count; CSF examination for cell count, protein, and quantitative VDRL; long-bone radiography.

TREATMENT:
(1) If the mother has had no treatment, undocumented treatment, treatment 4 weeks or less before delivery or evidence of reinfection or relapse (fourfold or greater increase in titer) AND the infant's physical examination is normal, THEN treat infant with a single intramuscular (IM) injection of benzathine penicillin (50,000 U/kg). If these criteria are not met, no treatment is required. In both scenarios, no additional evaluation is needed.

(2) Benzathine penicillin G, 50,000 U/kg, IM, x 1 dose.

(3) Aqueous penicillin G, 50,000 U/kg, IV, every 12 hours (1 week of age or younger), every 8 hours (older than 1 week), or procaine penicillin G, 50,000 U/kg, IM, single daily dose, x 10 days.
Systemic Candidiasis:


Invasive Disease. Treatment of invasive candidiasis in neonates and nonneutropenic adults should include prompt removal of any infected vascular or peritoneal catheters and replacement, if necessary, when infection is controlled. Avoidance or reduction of systemic immunosuppression also is advised when feasible. Immediate replacement of a catheter over a wire in the same catheter site is not recommended.

Amphotericin B deoxycholate is the drug of choice for treating neonates with systemic candidiasis; if urinary tract involvement and meningitis are excluded, lipid formulations can be considered. Echinocandins should be used with caution in neonates, because dosing and safety have not been established. Treatment for neonates is at least 3 weeks. In nonneutropenic and clinically stable children and adults, fluconazole or an echinocandin (caspofungin, micafungin, anidulafungin) is the recommended treatment; amphotericin B deoxycholate or lipid formulations are alternative therapies (see Drugs for Invasive and Other Serious Fungal Infections, p 835). In nonneutropenic patients with candidemia and no metastatic complications, treatment is 2 weeks after documented clearance of Candida from the bloodstream and resolution of clinical manifestations associated with candidemia.

In critically ill neutropenic patients, an echinocandin or a lipid formulation of amphotericin B is recommended because of the fungicidal nature of these agents when compared with fluconazole, which is fungistatic. In less seriously ill neutropenic patients, fluconazole is the alternative treatment for patients who have not had recent azole exposure, but voriconazole can be considered. The duration of treatment for candidemia without metastatic complications is 2 weeks after documented clearance of Candida organisms from the bloodstream and resolution of neutropenia.

Most Candida species are susceptible to amphotericin B, although C. Lusitania and some strains of C. glabrata and C. krusei have decreased susceptibility or resistance. Among patients with persistent candidemia despite appropriate therapy, investigation for a deep focus of infection should be conducted. Short-course therapy (i.e., 7-10 days) can be used for intravenous catheter-associated infections if the catheter is removed promptly, there is rapid resolution of candidemia once treatment is initiated, and there is no evidence of infection beyond the bloodstream. Lipid-associated preparations of amphotericin B can be used as an alternative to amphotericin B deoxycholate in patients who experience significant toxicity during therapy. Published reports in adults and anecdotal reports in preterm infants indicate that lipid-associated amphotericin B preparations have failed to eradicate renal candidiasis, because these large-molecule drugs may not penetrate well into the renal parenchyma. Fluconazole is not recommended routinely for use with amphotericin B deoxycholate for C. albicans infection involving the central nervous system because of difficulty in maintaining appropriate serum concentrations and the risk of toxicity.

Fluconazole may be appropriate for patients with impaired renal function or for patients with meningitis. However, data on fluconazole use for Candida meningitis are limited. Fluconazole is not an appropriate choice for therapy before the infecting Candida species has been identified, because C. krusei is resistant to fluconazole, and more than 50% of C. glabrata isolates also can be resistant. Although voriconazole is effective against C. krusei, it is often ineffective against C. glabrata. The echinocandins (caspofungin, micafungin, and anidulafungin) all are active in vitro against most Candida species and are appropriate first-line drugs for Candida infections in severely ill or neutropenic patients (see Echinocandins, p 830). The echinocandins should be used with caution against C. parapsilosis infection, because some decreased in vitro susceptibility has been reported. If an echinocandin is initiated empirically and C. parapsilosis is isolated in a recovering patient, then the echinocandin can be continued. Echinocandins are not recommended for treatment of central nervous system infections.

Ophthalmologic evaluation is recommended for all patients with candidemia. Evaluation should occur once candidemia is controlled, and in patients with neutropenia, evaluation should be deferred until recovery of the neutrophil count.

Chemoprophylaxis. Invasive candidiasis in neonates is associated with prolonged hospitalization and neurodevelopmental impairment or death in almost 75% of affected infants with extremely low birth weight (ELBW [less than 1000 g]). The poor outcomes, despite prompt diagnosis and therapy, make prevention of invasive candidiasis in this population desirable. Four prospective randomized controlled trials and 10 retrospective cohort studies of fungal prophylaxis in neonates with birth weight less than 1000 g or less than 1500 g have demonstrated significant reduction of Candida colonization, rates of invasive candidiasis, and Candida-related mortality in nurseries with a moderate or high incidence of invasive candidiasis. Besides birth weight, other risk factors for invasive candidiasis in neonates include inadequate infection-prevention practices and injudicious use of antimicrobial agents. Adherence to optimal infection...
control practices, including "bundles" for intravascular catheter insertion and maintenance and antimicrobial stewardship, can diminish infection rates and should be optimized before implementation of chemoprophylaxis as standard practice in a neonatal intensive care unit. On the basis of current data, fluconazole is the preferred agent for prophylaxis, because it has been shown to be effective and safe. Fluconazole prophylaxis is recommended for ELBW infants cared for in neonatal intensive care units with moderate (5%-10%) or high (>10%) rates of invasive candidiasis. The recommended regimen for ELBW neonates is fluconazole administered intravenously during the first 48 to 72 hours after birth at a dose of 3 mg/kg, twice a week, for 4 to 6 weeks, or until intravenous access no longer is required for care. This dosage and duration of chemoprophylaxis has not been associated with emergence of fluconazole-resistant *Candida* species.

Fluconazole can decrease the risk of mucosal (eg, oropharyngeal and esophageal) candidiasis in patients with advanced HIV disease. However, an increased incidence of infections attributable to *C krusei* (which intrinsically is resistant to fluconazole) has been reported in non-HIV-infected patients receiving prophylactic fluconazole. Adults undergoing allogenic hematopoietic stem cell transplantation had significantly fewer Candida infections when given fluconazole, but limited data are available for children. Prophylaxis should be considered for children undergoing allogenic hematopoietic stem cell transplantation during the period of neutropenia. Prophylaxis is not recommended routinely for other immunocompromised children, including children with HIV infection.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Intravenous</th>
<th>Oral</th>
<th>Intravenous or Oral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Caspofungin</td>
<td>Anidulafungin</td>
<td>Amphotericin B</td>
</tr>
<tr>
<td>Aspergillosis</td>
<td>A</td>
<td>A</td>
<td>...</td>
</tr>
<tr>
<td>Blastomycosis</td>
<td>P</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Candidiasis:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic, mucocutaneous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oropharyngeal, esophageal</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Systemic</td>
<td>P</td>
<td>P (severe cases)</td>
<td>P</td>
</tr>
<tr>
<td>Coccidioidomycosis</td>
<td>P</td>
<td>...</td>
<td>P, M</td>
</tr>
<tr>
<td>Cryptococcosis</td>
<td>P, S</td>
<td>S</td>
<td>A, M</td>
</tr>
<tr>
<td>Fusariosis</td>
<td>A</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Histoplasmosis</td>
<td>P</td>
<td>...</td>
<td>P, A</td>
</tr>
<tr>
<td>Mucormycosis (zygomycosis)</td>
<td>P</td>
<td>...</td>
<td>A, M</td>
</tr>
<tr>
<td>Paracoccidioidomycosis</td>
<td>P&lt;sup&gt;a&lt;/sup&gt;</td>
<td>...</td>
<td>P, M</td>
</tr>
<tr>
<td>Pseudallescherias</td>
<td>...</td>
<td>...</td>
<td>P</td>
</tr>
<tr>
<td>Sporotrichosis</td>
<td>P</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

<sup>a</sup> indicates preferred treatment in most cases; A, efficacy less well established or alternative drug; M, for mild and moderately severe cases; S, combination recommended if infection is severe or central nervous system is involved.

Efficacy has not been established for children.

Approved by the Food and Drug Administration for adults.

Preferred treatment in neonates; alternate treatment for children and adults.

Usually in combination with itraconazole or a sulfonamide.

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Table 4.6. Drugs for Invasive and Other Serious Fungal Infections
**IMMUNIZATION OF PRETERM INFANTS IN THE NURSERY:**

Preterm infants should be immunized at the usual chronologic age.

- Some studies suggest reduced immune response in VLBW infant (<1,500 g) immunized by the usual schedule, additional data needed to justify changing present schedule.
- Vaccine doses should not be reduced for preterm infants.
- If the infant is still hospitalized at 2 months the routine immunization schedule should be followed.
- This includes DPaT, HIB, Prevnar and inactivated poliovirus (IPV).
- The first hepatitis B vaccine should to given upon discharge to all infants > 2.0 Kg.
- The infants with weights ≤ 2 kg whose mothers are hepatitis B surface antigen negative should receive the vaccination (if thriving and well) at 30 days of age or upon discharge, which ever comes first (even if they weigh less than 2 Kg.). The exceptions are those infants born to mothers who are HbsAg positive (See hepatitis B exposed infant).

**ROUTINE HEAD SONOGRAM SCREENING FOR PRETERM INFANTS:**

Due to several factors related to prematurity, preterm infants are at risk for development of IVH (intraventricular hemorrhages) and PVL (periventricular leukomalacia). Infants less than 1,000 grams at birth are most likely to have an IVH in the first 72 hours of life with 75% of the IVH’s occurring before 3-5 days after birth.

The following schedule is recommended for screening VLBW infant for IVH and PVL:

<table>
<thead>
<tr>
<th>Weight Range</th>
<th>DOL 1-3</th>
<th>DOL 7</th>
<th>DOL 14</th>
<th>DOL 28</th>
<th>PTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1,000 grams</td>
<td>DOL 1-3</td>
<td>DOL 7</td>
<td>DOL 14</td>
<td>DOL 28</td>
<td>PTD</td>
</tr>
<tr>
<td>1,000 – 1,250 grams</td>
<td>DOL 7</td>
<td>DOL 28</td>
<td>PTD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,251 – 1,500 grams</td>
<td>DOL 7</td>
<td>PTD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,501 – 2,000 grams</td>
<td>DOL 7 only if clinically indicated</td>
<td>PTD</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Follow-ups beyond the above schedule as needed on a case by case basis.

**PREVENTION OF INTRAVENTRICULAR HEMORRHAGE BY INDOMETHACIN IN PRETERM INFANTS:**

Intraventricular hemorrhage (IVH) remains a major problem of preterm neonates. Indomethacin has been shown to reduce the incidence and severity of IVH in very low birth weight preterm infants. It has also been shown to reduce the incidence of symptomatic PDA and the rate of surgical ligation for PDA. These short term benefits are not accompanied by any of the adverse outcomes that were possible that is, important renal side effects, gastrointestinal perforation, and necrotising enterocolitis.

**Indication:** IVH prevention for LBW preterms, BW <1250g

**Dose:** Indomethacin 0.1mg/kg q24 hrs for 3 doses, beginning at 6 hours of age

**Monitoring:**
Monitor urine output, serum electrolytes, glucose, BUN and creatinine, platelet count. BUN/creatinine/platelet count must be obtained prior to each dose.

Observe for GI bleeding and prolonged bleeding from puncture sites.

**Adverse effects/precautions:**
If oliguria occurs, observe for hyponatremia, hypokalemia and elevated creatinine (>1.6) and consider prolonging the dosing interval of indomethacin and other renally excreted drugs such as gentamicin.

Withhold feedings during treatment.

Consider platelet transfusion if platelet count <80,000. May administer indomethacin if platelet count >80,000 and there is no active bleeding.

**Contraindications:** active bleeding, significant thrombocytopenia (<80,000) or coagulation defects, necrotizing enterocolitis, significantly impaired renal function, GI perforation.

**Other considerations:**
Obtain head ultrasound within the first 24 hours. If IVH is present discontinue treatment. Obtain cardiac echo at the end of treatment to determine presence of significant PDA that requires treatment. For <1500g use neoprofen for treatment of PDA.

**References:**
P W Fowlie, P G Davis. Prophylactic indomethacin for preterm infants: a systematic review and meta-analysis. Arch Dis Child Fetal
POLYCYTHEMIA:

Polycythemia is a normal state relative to adults in term infants but when the spun central venous Hct (preferably from the antecubitus) approaches 65% the viscosity of the blood increases dramatically placing the infant at risk for hyperviscosity syndrome. Hyperviscosity is when sludging of the RBC’s occurs in the capillaries decreasing O2 delivery to the tissues resulting in end-organ ischemia.

Symptoms of hyperviscosity:
- temperature instability
- feeding problems
- plethora
- irritability
- lethargy
- hypoglycemia
- respiratory distress
- hypoperfusion

Initially a peripheral Hct is obtained to screen infants to evaluate only infants at risk of polycythemia. If the Hct is 65-69% and the infant is asymptomatic no intervention is warranted. If the peripheral Hct is 70% or greater a central venous Hct needs to be done. If it is 65-69% and the infant is doing well no further intervention is needed. If it is ≥70% a partial reduction exchange needs to be performed. If the infant is symptomatic and the spun Hct is ≥ 65% a central venous Hct needs to be done. If the central Hct is ≥ 65% and the infant is symptomatic a partial exchange reduction needs to be done.

Reduction-Exchange Transfusion for Polycythemia/Hyperviscosity:

- Obtain an informed consent from the mother after discussing the polycythemia/hyperviscosity and need for transfer to the SCN if the infant is in NBN.
- The procedure can be done in IMCN or ICN.
- The Infant needs to be NPO with IVF D10W at 60-80ml/kg/day if in the first 24 hours or as indicated by need and age.
- The infant should be placed on a Cardiac/Apnea and Sat monitor on a radiant warmer with a temp probe attached.
- A UVC will be placed under sterile technique with cap, mask, sterile gown and gloves.
- A KUB should be done after line placement and before the procedure to check line placement and status of the bowel.
- Sterile IV Normal Saline without preservatives will be used to replace blood removed.

Formula for calculating the amount to be reduced and replaced with NS:

\[
\text{Hct observed} - \text{Hct desired (55%)} \times \text{Total Blood Volume (85ml)} \times \text{Wgt(Kg)}
\]

- The infant will be NPO 4 hours after the procedure. The infant may be fed after the 4 hour period only if clinically stable.
- Glucoses will be checked at the end of the procedure and 0.5 hours, 1 hour and hourly until 4 hour after the procedure, then as per routine for an infant on IVF.
- A central venous Hct will be checked 24 hours after the procedure.

SUCROSE ADMINISTRATION FOR PAIN IN INFANTS:

Use 24% Sucrose approximately 2 minutes prior to painful procedures.
- Used in conjunction with containment, rocking and swaddling.
- Target population is infants from 28-46 weeks PCA
- Some benefit in infants up to 4 months of age as well.
- Doses range from 0.05 ml to 2.0 ml.
- Daily safe doses have not been well established.
- Term drip 0.1-0.3 ml on a pacifier and give to infant.
• As hypertonic do not give > 2.0 ml to term infants per procedure.
• Infants < 31 weeks give 0.1-0.5 ml with no repeated doses per procedure.
• Sucrose has peak analgesic effect 2 minutes after administration and is effective for 5-7 minutes after a single dose is given.

**When Sucrose may be offered:**
- Heelsticks
- Arterial and venous punctures
- Lumbar puncture
- Gavage tube insertions
- Removal of adhesives
- IM injections including Vit K and immunizations
- In conjunction with more potent analgesia for circumcisions, eye exams, LPs, dressing changes, chest tube and PICC line placement.
- If the patient is on an opioid drip it is appropriate to give sucrose for procedures. Be careful as swallowing could be impaired.
- Any other procedure that would be painful to you or your own child!

**Side effects:**
- Increased risk of NEC and hyperglycemia in preterm as the solution is hyperosmolar.
- Infants with impaired swallowing may choke if given large volumes of solution.
- Most trials did not address the safety and side effects of the sucrose.
- Sucrose is an appropriate intervention only for procedural pain.
- Infants on respiratory support should be first evaluated for other causes of agitation, i.e. respiratory distress. Is the baby really crying or grunting?
- As sucrose is only effective 5-7 minutes, the infants with persistant pain or lengthy procedures could be exposed to multiple repeated doses of the medication which may not be safe.

**When to use with caution?** (0.1-0.3 ml/procedure, no repeated doses)
- Infants < 31 weeks GA in the first week of life
- A baby with any GI condition, especially NEC
- A baby with PDA on Indocin
- Intubated infants
- A baby on paralytics
- A baby with poor oral-motor control

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**RETINOPATHY OF PREMATURITY (ROP):**

ROP is a retinal vascular disorder of VLBW preterm infant potentially leading to visual impairment including blindness.

- All infants’ ≤ 32 weeks and/or ≤ 1,500 g are screened.
- First retinal exam is done at 4 weeks after birth for all infant born ≤ 32 weeks. These infants have a follow up exam based on their retinal findings at each exam per the **International Classification of Retinopathy of Prematurity**.

**Ordering initial exams:**
- It is the resident’s duty to identify these infants after birth.
- Fill out a consult for Dr. Radinovich and call her office; consult to go in front of chart.
- At time of 1st exam place infant’s name on list eye exams to be done at the front desk.
- Day of the exam the eye drops need to be ordered by the resident.
  - **Cyclomidril ophthalmic solution i-ii drops OU q 3-5 minutes x 2 at least 1 hour prior to the exam.**

Parents need to be notified about the first exam, understand the disease we are screening for and the follow up. They also need to understand the results of all eye exams. It is the resident or nurse practitioners responsibility to do this. The triplicate ROP Information Form needs to be signed by the parents prior to discharge informing them of the severity of ROP and need for outpatient follow up. The white copy goes in the chart, yellow to Dr. Radenovich’s office and pink to HRC.

**Infants that need to be screened:**
- ≤ 32 weeks
- ≤ 1,500 g
- 1,500-2,000 g with an unstable clinical course believed to be at risk for ROP.
INFANTS OF DRUG DEPENDENT MOTHERS:

These infants may be identified in L&D or mother baby. Until newborn nursery is trained to care for these infants, they may be transferred to EPCH NICU IMCN for a social service consult, evaluation, and care. The following is the new policy for care of infants identified with Neonatal Abstinence Syndrome.

Neonatal Abstinence Syndrome (NAS)

Opioids activate opiate receptors in the locus ceruleus (one of the major clusters of noradrenergic cells in the brain). This action decreases the activity of adenylate cyclase, resulting in a reduction in cAMP production. As a consequence, potassium efflux is increased and calcium influx into the cell is decreased, resulting in a decrease in nor-adrenaline release. During chronic opiate use, nor-adrenaline release is gradually increased towards its normal level as tolerance develops. Once the opiates are withdrawn there is loss of the inhibitory effect and significant increase in nor-adrenaline release to well above normal levels. This increase in noradrenergic activity coincides with withdrawal symptoms. Administration of opioids results in a reduction in neuronal activity and a decrease in withdrawal symptoms. Opioids are the best pharmaceuticals to treat neonatal abstinence although Phenobarbital in combination with opioids has been shown to decrease the time patients may need pharmaceutical treatment. As methadone and morphine have cross dependence and similar receptors they have been the most successful in most studies to decrease the symptoms of neonatal abstinence syndrome when non pharmacologic therapy is not successful. The following treatment guideline will first introduce you to the signs and symptoms of NAS while instructing how to score the severity of NAS with the modified Finnegan scoring system. It will also discuss the non-pharmacologic treatment of NAS and finally when using the Finnegan scale, how to initiate opioids for treatment of NAS, when to advance the dose and how to wean.

The Modified Finnegan Neonatal Abstinence Scoring System

This is a 31 item scale designed to quantify the severity of NAS and guide treatment. It is administered every 3 hours. Infants scoring 8 or greater after implementing non-pharmacologic treatment are recommended to receive pharmacologic therapy.

The Assessment of NAS

Excessive Crying: Infants with NAS cry more often and the cry in high pitched. This is scored when the infants discomfort has been alleviated.

- A score of 2 is given to infants that cry more often but are consolable.
- A score of 3 is given for non-consolable crying infants.

Sleeping: The amount of time the infant sleeps continuously between feeds. Those infants in a quiet alert state before a feeding can be considered spending time in sleep. Breast fed infants feeding every 2 hours should have the scale adjusted to their physiologic state.

- A score of 3 is given for Infants sleeping less than 1 hour.
- A score of 2 is given for those infant sleeping 1-2 hours.
- A score of 1 is given for those infants sleeping 2-3 hours.
- A score of 0 is given for those infants sleeping 3 or more hours.

Moro reflex:

- A score of 1 is given for an exaggerated Moro reflex (hyperactive response with excessive abduction at the shoulder and extension at the elbow with or without tremors).
- A score of 2 is applied for the response above plus marked adduction flexion at the elbow with arms crossing to the midline.

Tremors: These are involuntary movements that are rhythmical in nature and generally of equal amplitude. Tremors that occur in absence of stimulation are tremors occurring undisturbed. Those occurring with stimulation are tremors that occurred after being disturbed.

- A score of 1 is applied for mild tremors occurring in a fussy or crying state.
- A score of 2 is applied for moderate to severe tremors occurring in a drowsy state or often in a quiet alert state and consistently in a fussy or crying states or consistently and repeatedly in all states. Myoclonic jerks are involuntary rapid muscle contractions and not part of the scoring for tremors.

Increase muscle tone: Tone is the resistance of parts of the body to passive movement and can be observed with the infant at rest and assessed by testing the infant’s motor resistance with gentle handling. The infant’s arm and legs are passively extended and released to assess recoil. Hypertonia is increased resistance to extension or flexion; the extremity returns to its prior position spontaneously. Infant
tone should be evaluated at rest, with gentle handling, in a quiet alert state and mildly fussy state, but not when the infant is rigorously crying or over stimulated.

- A score of 1 is applied for generalized increased resistance to extension or flexion of the limbs (slight flexion or extension is possible) which is palpable on handling, and head lag on pulling to sit.

- As score of 2 is given for exaggerated increased tone, or increased tone visualized without handling, and/or increased resistance to extension of their limbs with difficulty in straightening or bending the arms with or without head lag (or alternatively have chin tuck) on pull to sit.

**Excoriation:** This is redness of the skin or broken/bleeding skin that is the result of rubbing an extremity or face on a linen covered surface and is generally found on elbows, knees, nose and/or chin due to excessive and uncontrolled movements of the extremities (tremors) and/or head (rooting). Facial excoriations may occur due to the neonate clawing at his face. Infants with excoriation are scored for this as long as the excoriation is present. Excoriations in the diaper area from movement should be distinguished from diaper dermatitis due to loose stools that should not be scored as excoriations.

- A score of 1 is applied if the skin is red but intact or healing.

- A score of 2 is applied if the skin is broken.

**Generalized seizure:** Any suspected seizure actively should be brought to the attention of the medical provider. The incidence of seizures as a symptom of NAS is low, but if present should be given a score of 8.

**Hyperthermia:** Elevations in body temperature should be assessed by a provider to rule out infection. If no infection is present the temperature should be scored as long as the fever is present.

- A score of 1 is applied for any axillary temperature of 37.3C (99.0F)

**Yawning, sweating, nasal stuffiness and sneezing:** These symptoms represent alteration in autonomic nervous system regulation.

- A score of 1 is applied for an infant yawning 4 times or more within the 3 hour testing period.

- A score of 1 is applied if there is dampness of the infant’s forehead or upper lip, when the environment is not hot or the infant is not excessively bundled.

- A score of 1 is applied for any nasal noise when breathing (avoid aggressive nasal suctioning as this may lead to trauma) and may or may not be associated with coryza and is not associated with illness.

- A score of 1 is applied if the infant sneezes 4 or more times within the 3 hour assessment period, whether individually or continuously.

**Tachypnea:** In scoring tachypnea all other medical conditions should be ruled out.

- A score of 2 should be given for a respiratory rate > 60 at rest and not in a fussy or crying state

**Poor feeding:** Poor feeding may be present for several reasons. It may be due to suck/swallow in coordination, positioning difficulties due to hypertonia, sensory integration difficulties, and inefficient suck for maladaptive tongue positioning.

- A score of 2 is given when feeding problems are present.

**Vomiting:** The effortless return of esophageal and/or stomach contents to the mouth. Small amounts of formula or milk lost during burping (“wet burp”) does not constitute vomiting. Projectile vomiting may indicate other pathology and should be evaluated for other than NAS.

- A score of 2 is applied to vomiting either a whole feed or two or more times during a feed not associated with burping unless the infant vomits a large amount with burping.

**Loose stool:**

- A score of 2 is given for a ½ solid ½ liquid stool or liquid stool with or without a water ring on the diaper.

**Failure to thrive:**

- A score of 2 should be given at any time the infant’s weight is < 10% below his/her birth weight. The score should be given at any time during the scoring period that the infant remains < the 10% below birth weight.

**Irritability:** Infants with NAS may manifest irritability or fussiness, even with light touch or handling despite attempts to console and may not cry excessively or at all. Irritability can also be expressed as grimacing or appearing sensitive to touch, light or sound, displaying symptoms such as gaze aversion, pull down (infant retreats and becomes quiet and non interactive, not feeding and at risk for failure to thrive) etc. and may or may not occur in conjunction with crying. Dysregulated behaviors in response to any internal or
external stimuli or rapid changes of state (termed poor state control, defined as moving rapidly between sleep/wake and quiet/fussy periods with little modulation between states) would constitute irritability.

- A score of 1 is given for minor irritability defined as an infant that calms/whose behaviors become more regulated only with intervention and displays 1 symptoms of irritability.

- A score of 2 is applied for an infant the displays 2-3 signs of irritability and is consoled only with intervention after time.

- A score of 3 is applied for an infant in whom no amount of consoling reduces the symptoms of irritability.

**Non Pharmacologic Treatment**

To fully be able to maximize non pharmacologic therapies for infants with NAS it is strongly recommended to read The Opioid dependent mother and newborn dyad: non-pharmacologic care by Drs. Martha Velez and Laren Jansson (4). These treatment guidelines stress various responses the care giver can give for various symptoms the infant with NAS may demonstrate. As the following symptoms are noted, educating the parents is important to help them identify symptoms as a result of NAS and that these symptoms are not a negative reaction to them as parents but NAS. Once the behavior is pointed out to the parent it is important for the caretaker to teach the parents how to respond to their infants special needs.

**Reactivity to sensory stimulation and regulatory issues:**

- For hyper- or under-responsive infant the room should be quiet with dim lighting and the infant handled in a soft, slow manner

  - **Holding/containing techniques**
    - Holding the newborn’s hands against her/his chest in a supine or side position
    - Providing firm but gentle pressure to the trunk or head
    - Swaddling

  - Pacifier to stimulate a non-nutritive suck and containment of the upper extremities while changing a diaper for an infant sensitive to touch

**Behavioral states and state control:**

- Respect sleep and wake a newborn slowly only if a feeding is needed

- Slow arousal while keeping the environment minimally stimulating and using gentle handling prior to the time of feeding, bathing and changing (preparing the infant for any interaction).

- If overstimulation results in poor eye-to-eye contact adjust the environment by such measures as giving a pacifier, gently and slowly rocking vertically and containing the arms with gentle pressure may facilitate eye contact and more normal interactions.

- Limiting bright colors, using black and white objects that may be less visually stimulating and comfortable preventing overstimulation. This may facilitate attention by obtaining better control of movements, allowing the infant to focus and follow.

**Motor and tone control:**

- Gentle handling and containment, positioning, non-nutritive sucking and swaddling (with careful observation of infant temperature) to treat motor and tone dysregulation manifested as tremors or disorganized motor movements and hypertonicity.

- Put the infant on her/his side or back and hold the infants hands. If the infant is on her/his side, the head and hips can be placed loosely in the fetal position.
  - Very gentle pressure or rubbing on head and or trunk

- Slow vertical rocking helps with relaxation

- Hyperthermic infants that can’t be swaddled may do well with a folded blanket across the chest to contain the arms.

- Mittens, frequent holding, swaddling and pacifiers may help infants that develop excoriations in attempt to self –soothe.

- Infants with feeding difficulties due to motor and or tone regulation:
o Small frequent feeds of high caloric formula (compensates for excessive caloric expenditures).

o Frequent burping (rubbing the back instead of patting)

o Evaluation for signs of stress during feeds at frequent intervals

o Interruption of the feeding if the infant is growing tired

o Some infants may need the pacifier if they become agitated upon removal of the nipple to burp

Autonomic signs of stress: As soon as signs of stress are detected (hiccups, color change, bowel sounds, sneezing, back arching) the interactions with the infant should be modified to stop the signs and prevent further dysregulation such as spitting up, gagging, excess stooling or abnormal bowel sounds in response to external changes or demands. There are those infants that exhibit under reactivity (pull down) and are under recognized but this can result in poor feeding and failure to thrive. The treatment for them is the same.

- Avoid vigorous stimulation
- Small and frequent feeds
- Gentle handling
- Quiet environment

Pharmacotherapy Management Guidelines

Pharmacotherapy should be used in combination with supportive therapy measures (swaddling, positioning, holding, minimizing environmental stimuli, pacifiers, feedings) to reduce the severity of NAS symptoms. Generally, severe irritability interfering with feeding and sleep, vomiting and diarrhea, temperature instability, tachypnea, and seizures are indications for pharmacological treatment. The goal of medication therapy is to reduce severity of withdrawal symptoms (Finnegan <8), allowing infants to gain weight, sleep and interact with caregivers. An opioid is the first-line therapy for NAS in infants with maternal opioid use. In cases that involve polydrug abuse, phenobarbital should be considered. The following guidelines serve as the basis for treatment.

A. Initiation of Pharmacotherapy (scores based on modified Finegan scoring tool)
1. Infants with score ≤ 8, continue to monitor and treat with supportive care only
2. Infants with score >8, rescore in 1 hour
3. Initiate therapy with oral methadone for below criteria:
   a. 3 consecutive withdrawal scores ≥8 or a mean of 3 consecutive scores ≥ 8
   b. Any 2 scores ≥12 or mean of 2 consecutive scores ≥12
4. Methadone Dosing:
   a. Initial Doses: Methadone 0.1 mg/kg/dose every 6 hours x 4 doses (24 hours), then methadone 0.05 - 0.1 mg/kg/dose PO every 12 hours
   b. Dose Escalation: Increase methadone dose by 0.05 mg/kg/dose until withdrawal symptoms are controlled (2 consecutive scores <8) or a maximum dose of 0.15 – 0.3 mg/kg/day has been reached.
      i. Use caution during dose escalation—methadone exhibits a long half-life, drug will accumulate and can result in excessive sedation.
      ii. Methadone should be used with caution in patients with congenital QT prolongation, hypokalemia, and hypomagnesemia.
   c. Breakthrough withdrawal symptoms:
      i. Morphine 0.05 mg/kg/dose (can be given every 4 hrs) or
      ii. Phenobarbital 15-20 mg/kg loading dose followed by 5 mg/kg/day maintenance dose. Order a level after the
5th dose and weekly. Phenobarbital should be stopped 72 hours prior to stopping methadone.

d. Continue to score patient every 3 hours

B. **Weaning Therapy**
1. 24-48 hrs after symptoms are controlled, lengthen the dosing interval to every 24 hours
2. Start methadone taper once patient has been stable for 72 hours (Finnegan scores <8 and consistent weight gain).
3. Wean the dose by 10% every 2-3 days as tolerated, continue to score patient
   a. If score >8, rescore in 1 hour
   b. 2 consecutive scores ≥8, increase methadone to previous dose
4. If infant tolerates the 10% daily dose wean for 2 consecutive weans, decrease daily dose by 20% every 2-3 days as tolerated
5. **The weaning amount is calculated by taking 10-20% of the original dose, not the new lower dose.**
6. Discontinue methadone once the daily dose is 0.05 mg/kg
7. Monitor the patient for 24-48 hours after discontinuing methadone

C. **Monitoring of Therapy**
1. Monitor for resolution of withdrawal symptoms, signs of excessive dosing (bradycardia, lethargy, hypotonia, irregular respirations, respiratory depression, etc)
2. Continue to score patient every 3 hours during hospital stay

D. **Reversal of Adverse Effects Therapy (over-sedation, respiratory distress)**
1. To reverse administer Naloxone (Narcan®)
2. Dose: 0.01 mg/kg/dose IM, IV, or ETT.
3. If response inadequate, can administer a second dose of 0.01 mg/kg in 2-3 minutes.

E. **Other Drugs of Abuse**
1. Marijuana
   a. Crosses the placenta slowly and is metabolized by the fetus
   b. May exhibit signs of nicotine toxicity—tremors, tachycardia, irritability, and poor feeding in infants of heavy users
   c. No known overt withdrawal
2. Cocaine
   a. Manifests on day 2-3 postnatally
   b. Vasoconstrictive effects cause neurological complications (IVH, infarcts, cystic lesions)
   c. Exposed infants may exhibit hyperactive Moro reflex, jitteriness, excessive sucking
   d. Higher incidence of prematurity, LBW, and placental abruption
   e. Association with higher incidence of genitourinary tract and GI anomalies
f. Short and/or long term neurobehavioral alterations

3. Alcohol
   a. May exhibit symptoms within a day or 2 of birth
   b. Acute ingestion: hyperactivity, tremors initially, followed by lethargy
   c. Chronic ingestion: spectrum of abnormalities (FAS)

Bibliography:
   iii. Lexi-Comp Online. Available at: https://online.lexi.com/lco/action/home.

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**INITIAL EVALUATION OF THE CYANOTIC NEWBORN:**
**Jeffrey D. Schuster, M.D.**

1. **Initial diagnostic evaluation**
   - History
     - Obstetrical ultrasounds
     - Fetal echocardiograms
     - Meconium
     - GBS
     - Oligohydramnios
   - Physical examination
     - Respiration and air movement
     - Rhythm and murmurs
     - Peripheral perfusion
     - Right hand pulse-ox
     - Chest X-ray
     - Lung Fields
     - Heart size and contour
     - Vital signs and non-invasive monitoring

2. **Oxygen therapy**
   - Head hood up to 100% FiO2
   - Intubation and ventilation
   - Failure to respond at all suggests but does not confirm cyanotic heart disease

3. **Arterial blood gases**
   - Blue babies are sick—put in a UAC for best data
   - CBG’s have no role in the initial evaluation of cyanotic newborns
   - Pay attention to acid/base status

**SECOND STEPS AND DIFFERENTIAL**

**Respiratory distress suggests lung disease**
- Quiet respirations without distress suggest cyanotic heart disease

**CXR is important in detecting lung disease**
- Black lung fields can mean ↓ pulmonary blood flow or pulmonary hypertension
- Small heart and massive pulmonary congestion could be TAPVR

**Right hand pulse ox is (almost always) pre-ductal.**
- Differential pulse ox’s (right hand and a leg) indicate one thing:
  - **Right-to-left ductal shunt**
    - Could be left heart obstruction with ductal systemic supply
    - Could be pulmonary hypertension with supra-systemic PA pressure
    - Reliable pulse oximetry requires adequate perfusion

**Failure to respond to oxygen therapy**
Assess adequacy of ventilation
Most cyanotic heart diseases have normal or near normal pCO2
Elevation of pCO2 suggests lung disease
Proceed to increase tidal volume and rate
Consider oscillatory ventilation

**Arterial blood gases**
- pO2 >250 excludes cyanotic heart disease—but not other heart diseases
- pO2 < 50 despite all manipulations suggests heart disease
- pO2 persistently in the 30’s suggests transposition
- Significant improvement in pO2 with oxygen and ventilation suggests lung disease

**Tertiary Evaluation**
Persistent cyanosis unresponsive to oxygen, ventilation, and correction of acid/base imbalance requires echocardiography to establish anatomic diagnosis.

Have the clerk call the echo tech. The resident should speak to the tech and convey the information about the cyanotic infant.

**STABILIZING TREATMENT**

**Right Heart Obstruction**

**Tetralogy of Fallot/ Pulmonary Atresia/ Tricuspid Atresia**
- Maintain Ductal patency to provide pulmonary perfusion
- Oxygen will not make a substantial difference in saturation and should be weaned to close to room air

**Left Heart Obstruction**

**Hypoplastic left heart syndrome/ Interrupted aortic arch/Critical coarctation/ Critical aortic stenosis**
- Oxygen will vasodilate the pulmonary circulation and steal from the systemic circulation
- Oxygen is **contraindicated** in left heart obstructions

**Transposition of the Great Arteries**
- Maintain ductal patency to increase pulmonary venous return to dilate the left atrium to promote atrial level mixing
- Keep volume status high to dilate the left atrium
- Oxygen will not significantly effect saturation

**MAINTAINING DUCTAL PATENCY**

Prostaglandin E1 requires continuous infusion
- Initial dose is 0.1 microgram/kg/min
- This is standardized by pharmacy so need only write as above (start PGE1 at 0.1 micrograms/kg/minute)
- Can start with double dose to open a closed ductus
- After good success, dose can be halved and halved again to 0.025 mcg/kg/min
- Must be given in a secure IV
  - UVC
  - UAC
  - PIC Line
  - Peripheral IV (least optimal)

**Side Effects:**
- **APNEA**
- Vasodilation: Hypotension
- ? Seizures
- Diarrhea

**OPERATIVE CONSIDERATIONS IN THE NEWBORN:**

**Donald E. Meier, MD**

**ABDOMINAL WALL DEFECTS**

**Omphalocoele** is a defect in the abdominal wall at the umbilicus. The protruding viscera are covered by membranes unless the membranes have ruptured in utero or peripartum. There is a high incidence of associated anomalies including serious abnormalities of the alimentary, cardiovascular, musculoskeletal, and central nervous systems. Omphalocoele is also associated with Beckwith Wiedeman Syndrome (microglossia, gigantism, and hypoglycemia).

**Gastroschisis** is a defect in the abdominal wall slightly superior and to the right of an intact umbilical cord. The protruding viscera are not covered by a membrane and are usually edematous and even fibrotic because of their prolonged in utero exposure to amniotic fluid. There is a low incidence of associated extra-intestinal anomalies, but a relatively high incidence of associated bowel atresias. Omphalocoele is more common than gastroschisis in many countries, but omphalocoele is less common in the United States, probably due to the high rate of voluntary interruption of pregnancy in cases of omphalocoele diagnosed prenatally.
**Management of Gastrochisis and Omphalocoele:** Immediate coverage of the intestine is indicated for all newborns with gastrochisis and for newborns with omphalocoele when the membranes have ruptured. Coverage can usually be achieved by placement of a spring loaded silo in the delivery room or intensive care nursery without intubation and mechanical ventilation. If successfully placed, the silo can be gradually shortened over the next few days and then the child can be taken to the operating room for removal of the silo, closure of the fascia and skin, and placement of a central venous line for parenteral nutrition. If a spring-loaded silo cannot be adequately placed at birth, the child should be taken to the operating room immediately. Under general anesthesia the abdominal wall musculature is manually stretched. Options after stretching include: (1) fascia and skin closure, (2) skin closure only, and (3) use of a silo. The ideal is to close fascia and skin, but this may result in a prohibitive increase in intraabdominal and diaphragmatic pressures. Closure of fascia and skin can be accomplished in 80% of cases, but in 20% the best treatment will be intraoperative placement of a silo. In children with gastrochisis, bowel function does not usually return for several weeks, and therefore all neonates undergoing gastrochisis repair should undergo placement of a central venous catheter for parenteral nutrition if PICC line placement has been unsuccessful. If the omphalocoele membranes are intact at the time of birth, non-operative treatment is a viable option. The membranes are coated with a desiccating agent such as silver sulfadiazine, and over the next few days or weeks the resultant dry scab serves as a barrier for the peritoneal cavity while the epithelium slowly grows in from the periphery. The end result is an umbilical hernia that can be more safely repaired at a later date when the child is better able to tolerate general anesthesia and an increase in intraabdominal pressure.

**Inguinal hernias** can be a cause of major morbidity and even mortality in the newborn. They are particularly common in premature infants. Most can be repetitively reduced in the neonatal period until the child is of adequate maturity to tolerate anesthesia. Some, however, will incarcerate and need urgent operation. In the intensive care nursery it is best to wait until the newborn is ready for discharge and then repair the hernias a couple of days before the planned discharge.

**Exstrophy of the bladder** refers to a lower abdominal wall defect associated with pubic diastasis, a deficient or absent anterior bladder wall, and epispadias. It can also be associated with imperforate anus and cloacal exstrophy. Treatment involves a series of operations. The initial operation achieves (1) approximation of the pubis, (2) closure of the bladder, and (3) creation of a neourethra. Further operations involve penile reconstruction at 2 years of age and a urinary continence operation at 4 years.

**ESOPHAGEAL ATRESIA AND TRACHEOESOPHAGEAL FISTULA**

**Esophageal atresia with a distal TEF** is the most common (90%) type. Less common types are **pure atresia without a fistula and an H-type fistula without atresia.** EA/TEF is suspected in any newborn with respiratory difficulties, excessive salivation, and vomiting. An orogastric tube is passed, and an X-ray taken. The diagnosis is confirmed by seeing the OG tube coiled in the atretic pouch and air in the GI tract. The major immediate danger in EA/TEF is pneumonitis secondary to gastric reflux through the TEF. The patient is best managed with the head of the bed elevated and suctioning of the pouch until operation can be performed. **DO NOT PERFORM ENDOTRACHEAL INTUBATION AND POSITIVE PRESSURE BREATHING UNLESS ABSOLUTELY NECESSARY FOR A CHILD IN RESPIRATORY DISTRESS.** Positive pressure breathing results in distention of the stomach without a way to decompress it and may to lead to a vicious cycle resulting in death from increased intraabdominal pressure. The EA/TEF abnormality is best repaired using a 4th intercostal space, extrapleural approach, although a transpleural approach is acceptable. The fistula is ligated, and the distal esophagus separated from the trachea. The proximal esophageal pouch is mobilized extensively, and a 1-layer primary anastomosis is performed. The minimum acceptable operation for EA/TEF in a very high risk newborn is ligation of the fistula and placement of a feeding gastrostomy.

**Pure esophageal atresia without a TEF,** the two ends of the esophagus are usually separated by a long gap, which precludes early primary anastomosis. With time the two ends may lengthen, and a primary anastomosis can sometimes be performed by 2 months of age. The initial neonatal operation for this defect involves simple placement of a feeding gastrostomy. Parenteral nutrition is not needed. Suction for the esophageal pouch is performed continuously. If the two ends do not spontaneously lengthen a thoracotomy can be performed to apply dynamic traction to both ends of the esophagus followed by another operation to perform an esophageal anastomosis.

**H-type fistula** is not associated with atresia. It is suspected in a child who coughs or chokes when feeding or one who has recurrent bouts of pneumonia. The diagnosis is made by a skilled pediatric radiologist carefully performing an esophageal contrast study with fluoroscopy or by a pediatric bronchoscoptist. These techniques are available only in the most sophisticated centers, and this diagnosis is therefore readily missed. The treatment for an H-type fistula is ligation of the fistula and separation of the trachea and esophagus using a right supraclavicular incision.

**CONGENITAL DIAPHRAGMATIC HERNIA (CDH)**

CDH results from incomplete fusion of the various components of the fetal diaphragm at 8 weeks of gestation. The bowel returning from the umbilical cord takes the path of least resistance up into the chest cavity, and the resultant increase in intrathoracic pressure causes hypoplasia of the lung. The incidence is 1 in 5000 births, and it is more common on the left than right. Many CDH’s in the US are diagnosed by antenatal ultrasound. Children with CDH usually develop respiratory distress soon after birth. The diagnosis is made by chest X-ray. Treatment involves passage of an orogastric tube to decompress the stomach and orotracheal intubation and ventilation to prevent hypoxia, hypercarbia, and acidosis. The immediate cause of death in these children is usually hypoxemia secondary to...
persistent fetal circulation with pulmonary artery constriction causing blood to shunt around the lung through the ductus arteriosus. ExtraCorporal Membrane Oxygenation (ECMO) is the usual next step in the US if ventilator therapy is unsuccessful. Emergency operation does not decrease mortality. One third of children will do well no matter what is done, and one third of children (those with severe pulmonary hypoplasia) will die no matter what is done. The middle third of children are the ones who may benefit from heroic measures in neonatal centers of expertise. Without availability of ECMO the best survival rate is probably in the 50% range.

**INTESTINAL ATRESIAS**

Atresias can occur anywhere in the gastrointestinal tract. The most common anomaly associated with an intestinal atresia is another intestinal atresia. Therefore when an atresia is repaired a tube must be passed or saline instilled throughout the rest of the intestinal tract to assess for other atretic segments.

Duodenal atresia, duodenal stenosis, and annular pancreas are all interrelated. One third of children with duodenal atresia have Down syndrome. In the US the diagnosis is often made by antenatal ultrasound performed for polyhydramnios. In other cases the presentation is characterized by feeding intolerance and vomiting (usually bilious) within a few hours of birth. The epigastrium appears full, but the rest of the abdomen is not distended. The classic X-ray picture is a “double bubble”. Operation is performed through a right upper quadrant transverse incision, and a duodenoduodenostomy is performed using a diamond anastomosis. No resection is performed since this may damage the pancreatic and biliary ducts.

Jejunal and ileal atresias present with bilious vomiting. The time interval from birth to vomiting and the amount of abdominal distention are directly related to the distance of the atresia from the Ligament of Treitz. An abdominal Xray shows dilated bowel proximal to the atresia. Treatment is resection of the atretic segment with a 1 layer end-to-oblique anastomosis.

**MALROTATION**

Malrotation is a spectrum of intraperitoneal abnormalities resulting from incomplete or abnormal rotation of the bowel when it reenters the peritoneal cavity in-utero. Children with malrotation: (1) may be asymptomatic; (2) may present with malnutrition from chronic vomiting caused by Ladd’s bands obstructing the duodenum; or (3) may present catastrophically with a midgut volvulus. The diagnosis must be emergently considered in any child (especially a neonate) with bilious vomiting. The diagnosis is best made by a pediatric radiologist using a fluoroscopically guided contrast upper GI series. The treatment is emergent operation to prevent strangulation from a midgut volvulus. The operative procedure (Ladd’s procedure) involves a transverse right supraumbilical incision with: (1) complete lysis of Ladd’s bands; (2) widening of the base of the small bowel mesentery; (3) appendectomy; and (4) intraperitoneal placement of the bowel in the position of nonrotation, with the cecum and colon in the left side of the abdomen and the small bowel on the right. In a rural hospital without UGI capabilities and without the capability for rapid referral to a major medical center, laparotomy may be indicated without radiologic confirmation. A negative laparotomy for suspected midgut volvulus is far better than a positive autopsy.

**MECONIUM ILEUS**

Meconium ileus is a form of intraluminal obstruction of the bowel resulting from abnormally thick meconium. Meconium ileus is almost always associated with cystic fibrosis. Typically a term neonate presents with abdominal distension and bilious vomiting and fails to pass meconium, not at all unlike the presentation of neonates with bowel obstruction from other causes. If meconium ileus is suspected, contrast studies can confirm the diagnosis and can also provide treatment by irrigating out the obstructing meconium pellets. If, however, meconium ileus cannot be differentiated radiographically from other causes of obstruction, or if the inspissated meconium cannot be cleared with intestinal washouts, then laparotomy is indicated. Meconium ileus is divided into two categories: uncomplicated and complicated. In complicated cases the meconium ileus has caused an in-utero volvulus, perforation, or atresia with formation of a giant pseudocyst secondary to the perforation. Operation for complicated meconium ileus involves resection of the atretic area or pseudocyst and exteriorization using a procedure such as a Bishop-Koop procedure. At operation for simple meconium ileus the pellets are mechanically evacuated out the rectum if possible and on-the-table, transrectal irrigations performed. If the meconium obstruction cannot be cleared with irrigations, an enterotomy is performed and converted to a Bishop-Koop or similar exteriorization procedure.

**HIRSCHSPRUNG’S DISEASE**

Hirschsprung’s Disease (HD) is aganglionosis of the colon, which results from failure of caudal migration of neural crest cells. The defect proceeds from distal to proximal. Therefore, the distal rectum is always involved and the proximal extent may go all the way into the proximal small bowel, but there are no skip lesions. The diagnosis is often made in the US in the newborn nursery when there is delayed passage of meconium. Any term child in the US who does not pass meconium in the first 48 hours deserves a barium enema and a suction rectal biopsy. If the diagnosis is definitively made, the newborn can undergo a one stage pull-through procedure, often laparoscopically. If the expertise is not locally available for histopathologic diagnosis, or if the surgical expertise is not available for a pull-through procedure, then the best form of urgent treatment for HD is a colostomy performed in the dilated colon proximal to the transition zone. This allows for a more elective workup and definitive treatment.

**ANORECTAL MALFORMATIONS**
The term “anorectal malformations” (ARMs) encompasses a wide spectrum of abnormalities. Children with ARMs tend to have multiple congenital abnormalities as evidenced by the VACTERL complex (Vertebral, Anorectal, Cardiac, TracheoEsophageal, Renal, Radial, and Limb abnormalities). The ARM is usually the most pressing problem and is the one that the surgeon is first consulted to manage. When a child is born with an ARM, the surgeon needs to decide within 24 hours if this is a high lesion or a low lesion. The first step is to look well at the perineum. If meconium is visible in the perineum or along the scrotal raphe, this is a low lesion and can be managed by an anoplasty, which is basically an incision and drainage in the area where you suspect the sphincter to be. If there is a well-established fistula tract, you can follow this tract back to the sphincter muscle complex. It is important when you do the anoplasty to place some sutures (absorbable preferably) between the anorectal mucosa and the anal skin.

Unfortunately most ARMs are high lesions. In females the most common fistula is into the vestibule of the vagina. This needs to be considered a high lesion for management purposes. In males the most common fistula site is the urethra. ALL high lesions need to have a colostomy in the neonatal period and a definitive procedure later by someone who knows how to do a proper Posterior Sagittal AnoRectoPlasty, an operation popularized by Dr. Pena. The colostomy should be performed in the proximal to mid sigmoid colon, not in the distal sigmoid since a distal colostomy tethers the colon and prevents if from being pulled down at a later operation. I use a left lower quadrant transverse incision, take down a bit of the mesocolon, transect the colon, and bring out the two ends of the colon through opposite ends of the incision. The colon needs to be secured to the fascia to minimize stomal herniation. The fascia and skin between the two ends of the colon are closed, thereby providing a divided or separated or double barrel colostomy.

Necrotizing Enterocolitis

Necrotizing Enterocolitis (NEC) of the neonate is the most common operative emergency and the most common gastrointestinal emergency in the neonatal intensive care unit (NICU). Ninety percent of cases are premature or low birth weight infants. The clinical signs of NEC are those of intestinal ischemia including abdominal distention, lethargy, feeding intolerance, bilious vomiting, and rectal bleeding. The early manifestations are indistinguishable from those of neonatal septicemia. Abdominal radiographs may show pneumatosis intestinalis, portal venous gas, or free air from bowel perforation. The first line of treatment for NEC is medical, including cardiovascular support, control of sepsis, and close observation for gangrene. One-half to two-thirds of infants survive with medical management alone. The only absolute indication for operation in NEC is intestinal perforation. A relative indication, however, is continued deterioration of a child on maximum medical therapy. The best monitors of ongoing sepsis in NEC children are thrombocytopenia and persistent acidosis. Premature infants who are too ill to undergo operation may benefit from bedside placement of intraperitoneal drains. If the child can undergo operation, the principles of operation for NEC are: (1) excision of the gangrenous bowel; (2) exteriorization of the marginally viable ends; (3) preservation of as much intestinal length as possible. If the gangrenous segment is short, resection with exteriorization of the ends is advisable. If resection of all non-viable bowel results in leaving less than 30-cm of viable intestine, resection should not be performed and the child should be managed expectantly. If there is an extensive amount of bowel of questionable viability, diverting stomae should be performed and a second look operation anticipated to determine if there are specific segments that have progressed to obvious gangrene. The stomae can be closed when the child is free of all infection and in an anabolic state. A contrast study of the distal small bowel and colon should be performed prior to stomae closure to locate strictures that should be resected at the time of stomal closure. Children who survive non-operative treatment for NEC may develop bowel strictures in the area of previously inflamed bowel. Contrast studies may be needed to determine the location, number of strictures, and need for operative intervention.

Inability to Feed and Gastroesophageal Reflux

Many neonates are unable to feed properly because of anatomical or physiological abnormalities. These children can be temporarily fed with oro- or naso-gastric tubes, but for long-term treatment a gastrostomy tube is preferred. Gastrostomy tubes can be placed either by a PEG technique (using a gastroscope) or by an open technique. Prior to insertion of a gastrostomy tube by either technique, an Upper GI Series should be performed to be sure that there is no gastric outlet obstruction (duodenal stenosis, malrotation) and to assess for reflux. If the child has any reflux on UGI series, the child will have a lot of reflux after placement of a gastrostomy tube unless an antireflux operation is also performed.

Gastroesophageal reflux is a major cause of morbidity in children, and in a number of children’s hospitals reflux-related operations are the most common intraabdominal procedures performed. Infants normally have some degree of emesis ranging from a wet burp to regurgitation of a significant amount, if not all, of a recent feeding. Children with pathologic GER, however, regurgitate larger volumes more frequently. Symptoms related to gastroesophageal reflux include vomiting, repeated respiratory infections, or poor feeding due to repetitive bouts of reflux esophagitis or stricture formation. The emesis with GER is usually non-bilious and typically occurs during a feeding or just after. If the GER is severe, there will be weight loss and failure to thrive. Aspiration of gastric contents into the tracheal/bronchial tree can cause apnea, pneumonia, bronchitis and asthma.

A contrast esophagogram is an excellent screening test with a sensitivity of approximately 85%. Monitoring of pH for a continuous 24 hours is quite specific and quite sensitive, but it is much more difficult to perform. A radionuclide scan can also be used to identify the presence of GER and to provide physiologic information regarding the efficacy of gastric emptying.

Non-operative treatment of GER is successful in at least 80% of children, particularly in those with mild to moderate reflux. There
The most common presentation is jaundice, and ultrasound is the diagnostic modality.

Biliary atresia (BA) is a malformation of the intra- or extra-hepatic ducts or both in which the ducts are either absent or only fibrous cords. Etiology is not defined. The duct obstruction is followed by progressive periportal fibrosis, biliary cirrhosis, portal hypertension, hepatomegaly, ascites, and death. There are many causes of neonatal jaundice other than BA (physiologic jaundice, systemic infections, genetic-metabolic disorders, choledochal cyst, neonatal hepatitis, TPN-induced cholestasis, etc). Abdominal ultrasound is performed to rule out choledochal cyst and to look for a gall bladder (often absent or fibrotic in BA). In BA a technetium scintiscan with thioacetazolamide pretreatment may show excretion of the isotope without clearance from the liver into the intestine. The definitive diagnostic test is a laparotomy which should be performed before 8 weeks of life. A cholangiogram is performed through the gall bladder if present. The surgical treatment for BA is a Roux-en-y hepaticojejunostomy (Kasai procedure). Over-simplified result assessment: 1/3 do well without transplant, 1/3 do well with late transplant, 1/3 need early transplant (12-16 months).

Choledochal Cyst

Choledochal Cysts are cysts of the common bile duct (CBD) occurring in 5 different types. Over 90% are Type I which is cystic dilatation of the common bile duct itself. Most infants have complete obstruction of the CBD at the pancreatic area, but adults usually have a small patency of the distal common duct. The most common presentation is jaundice, and ultrasound is the diagnostic modality of choice. Treatment is excision of the cyst with Roux-en-y biliary drainage. If the cyst is not excised there is a high chance of malignancy later in life. Treatment in years past was simple choledochal enteric bypass without excision. There are now adults who are walking around with choledochal cysts that have been bypassed. If you see these patients in practice they should be referred for excision because of this high incidence of malignancy.

NEWBORN LUNG ANOMALIES

1. Congenital cystic adenomatoid malformations (C-CAMS) are cystic, solid, or mixed intrapulmonary masses that communicate with the tracheobronchial tree and rarely have an anomalous blood supply. They may present with early respiratory distress when the lesions are large. Smaller lesions may be asymptomatic or may present with recurrent pulmonary infections.

2. Congenital lobar emphysema is a problem with air trapping, probably secondary to a partial obstruction of a bronchus, usually the LUL bronchus. These neonates present with progressive respiratory compromise due to the over-expansion of the involved lobe resulting in compensatory under-expansion of the other lobes and a mediastinal shift. Urgent thoracotomy is often indicated.
to get the affected lobe quickly out of the thoracotomy incision to allow ventilation. Resection of the involved lobe is the proper treatment.

3. **Pulmonary sequestration** is abnormal lung tissue that receives an anomalous blood supply and does not have a connection to the tracheobronchial tree. They are intralobar in 90% and extralobar in 10%. Infants are not usually symptomatic at birth. They are usually diagnosed after a CT scan is obtained in a child with recurrent pulmonary infections. The treatment is removal.

**NECK MASSES**

Here are a few neck masses you need to know about:

1. **Cystic hygromas** usually present as soft, non-tender multicystic masses in the lateral part of the neck. They reside near large veins and lymphatic ducts. Spontaneous remission is rare and infection of or bleeding into a hygroma is relatively common. Therefore excision of the hygroma is indicated but radical resection to include important nerves or major vessels is not indicated.

2. **Branchial remnants** can present as fistulae, cysts, sinuses, or cartilaginous remnants. Fistulae, cysts, and sinuses can become infected and should be excised prophylactically. Most remnants of the second branchial cleft present along the anterior border of the sternocleidomastoid muscle. A 2nd cleft fistula goes between the branches of the bifurcation of the common carotid artery.

3. **Thyroglossal duct cysts** result from abnormal descent or closure of the thyroid diverticulum which arises from the foramen cecum of the tongue and proceeds down the anterior portion of the neck. The cysts are midline, smooth, discrete, and non-tender (unless infected). The cyst should be excised when it is diagnosed to prevent infection which may lead to initial incision and drainage followed by a more difficult excision at a later date. Excision is performed by complete excision of the cyst and tract all the way to the foramen cecum. This involves taking a portion of the medial part of the hyoid bone en bloc (Sistrunk procedure).

4. **Torticollis** results from fibrosis of the sternocleidomastoid muscle, forming a fibrous mass and shortening of the involved muscle. Usually a mass is noted in the SCM after 2 weeks of age. The face rotates away from the affected side. Most cases resolve with passive stretching exercises. If not, operative transection of the middle third of the SCM is indicated.

**NEONATAL BLOOD PRODUCT TRANSFUSION GUIDELINES:**

<table>
<thead>
<tr>
<th>Neonatal Crossmatch:</th>
<th>Tests done:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ABO</td>
</tr>
<tr>
<td></td>
<td>DAT</td>
</tr>
<tr>
<td></td>
<td>Rh</td>
</tr>
<tr>
<td></td>
<td>Antibody screen</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specimen requirement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>All neonates &lt; 4 months</td>
</tr>
<tr>
<td>Plasma preferred</td>
</tr>
<tr>
<td>2 (1 ml EDTA plastic lavender top microtainers)</td>
</tr>
<tr>
<td>2 (1 ml plastic red top microtainer, no gel)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Turn around time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine 8 hours</td>
</tr>
<tr>
<td>STAT 1 hour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRBC Transfusion:</th>
</tr>
</thead>
<tbody>
<tr>
<td>All blood Type O with correct Rh and antibody negative</td>
</tr>
<tr>
<td>All PRBC’s are CMV negative leukocyte reduced (or washed) and irradiated</td>
</tr>
<tr>
<td>All PRBC transfusions are IV using a blood filter</td>
</tr>
<tr>
<td>Must be transfused ≤ 4 hours</td>
</tr>
</tbody>
</table>
**Transfusion guidelines (discuss all transfusions with attending):**

<table>
<thead>
<tr>
<th>Hct</th>
<th>Clinical criteria</th>
<th>Transfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolemic shock due to blood loss</td>
<td>● Symptoms of shock</td>
<td>20 ml/kg over 1 hour</td>
</tr>
<tr>
<td>Hct ≤ 35%</td>
<td>● Mech Vent MAP ≥ 8</td>
<td>PRBC 15-20 ml/kg over 2-4 hours</td>
</tr>
<tr>
<td>Hct ≤ 30%</td>
<td>● CPAP ≥ 6 or mech vent</td>
<td>PRBC 15-20 ml/kg over 2-4 hours</td>
</tr>
<tr>
<td>Hct ≤ 25%</td>
<td>● Non-vent. O2 21-40% and any of following:</td>
<td>PRBC 15-20 ml/kg over 4 hours (may transfuse in 10 ml/kg aliquots)</td>
</tr>
<tr>
<td>Hct ≤ 21%</td>
<td>No symptoms but retic &lt; 2%</td>
<td>PRBC 20 ml/kg over 4 hours (may transfuse in 10 ml/kg aliquots)</td>
</tr>
</tbody>
</table>

**Platelet Transfusions:**

Do not have to be ABO compatible though preferred
  • Unless anticipating multiple transfusions
  • Transfuse infants with ABO compatible if possible due to small size.

Should be Rh compatible to the recipient
Volume reduction of platelets prior to transfusion not recommended
Filtered during transfusion with 80-260 micron filter
Discuss all transfusions with attending

**Guidelines for platelet transfusions (5-10 ml/kg ↑ plt ct 50,000-100,000/µL):**

<table>
<thead>
<tr>
<th>Platelet Count</th>
<th>Clinical criteria</th>
<th>Transfusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 30,000</td>
<td>Healthy term newborn</td>
<td>10 ml/kg over 1 hour</td>
</tr>
<tr>
<td>≤ 50,000</td>
<td>Healthy preterm ≤ 34 weeks Any bleeding Anticipate invasive procedures or surgery</td>
<td>10 ml/kg over 1 hour</td>
</tr>
<tr>
<td>≤ 80,000-100,000</td>
<td>Sick preterm ≤ 34 weeks</td>
<td>5-10 ml/kg over 1 hour</td>
</tr>
</tbody>
</table>

**Fresh Frozen Plasma Transfusion:**

Indicated in severely ill infants bleeding or at risk for bleeding
Must be ABO compatible
Transfused 10-15 ml/kg over 1 hour
Transfuse with 80-180 micron filter
Discuss all transfusions with attending

Thomason Regional Laboratory Blood Preparation Protocol IH-021
Ohls RK, Transfusions in the Preterm Infant, NeoReviews, Vol. 8 No.9, September 2007.
FORMULA TO RECONSTITUTE BLOOD FOR EXCHANGE TRANSFUSION:
Garrett S. Levin, M.D.

- Exchange transfusion is generally performed for hyperbilirubinemia and or anemia, usually due to hemolytic disease of the newborn or prematurity.
- For treating anemia, a single volume (80-100mL/kg exchange is generally adequate.
- For management of hyperbilirubinemia, a double volume exchange (160-200mL/kg) is favored.
- Plasma reduced blood with hematocrit (HCT) of 0.5 - 0.6 is recommended.

Calculation of double volume exchange
Double volume exchange: [Infant's blood volume x weight (kg)] x 2
Blood volume: Term 80-85mL/kg; Preterm: 90-100mL/kg

Example
Exchange volume for a 3.5kg term newborn
Solution: [80mL/kg x 3.5kg] x 2 = 560mL

Formula to reconstitute blood for exchange transfusion
*Theoretically, this is the same as for doing a reduction-exchange transfusion except here we are reducing a bag of blood in contrast to a baby.
For convenience of calculation, one must assume weight = volume.
Therefore a unit bag of blood that weighs 300 grams has 300 milliliters of blood.

### Facts
1. Weight of bag
2. Weight of bag with blood
3. Hematocrit of blood
4. Desired Hematocrit = 55%

### Example
1. Weight of bag = 35 grams
2. Weight of bag with blood = 285 grams
3. Hematocrit of blood = 90%
4. Desired Hematocrit = 55%

### Solution
1. (90 - 55 / 90) (285-35 + X) = X
2. (35 / 90) (250 + X) = X
3. (0.38) (250 + X) = X
4. 95 + 0.38X = X
5. 95 = 1X - 0.38X
6. 95 = 0.62X
7. 95 / 0.62 = X
8. 153 = X

Therefore, we need to add 153mL of Fresh Frozen Plasma (FFP) to the bag containing 250mL of blood giving 403 mL of blood with a hematocrit of 55%.

Do not exceed more than 500mL per bag. If a double-volume exceeds this amount, you will need to prepare several bags.
Always use a Pall filter through a port to filter the blood and products.

AAP Guidelines – Readiness for Hospital Discharge for Discharge Planning

**Infant Readiness**
1. Sustained pattern of weight gain.
2. Adequate maintenance of normal body temperature in open crib.
3. Competence in breast and bottle feeding.
4. Physiological stability of cardio and respiratory status.
5. Appropriate immunization.
6. Appropriate metabolic screening
7. Stable Hematological status.
8. Nutritional risks assessments completed
9. Hearing test done
10. ROP screening
11. Neurobehavioral and developmental assessment
12. Car seat evaluation
13. Unresolved problems identified and plans of monitoring implemented
14. Home assessment made

**Family and Home Environmental Readiness**
1. 2 committed family members need to attend the discharge planning classes
2. Parents to demonstrate care for the infant in the rooming in setting
3. Psychological assessment of parents
4. Safety at home
5. Financial resources available

**Parental Readiness for Care of the Infant**
1. Competence in feeding
2. Basic infant care, bathing, skin, cord care, genital care
3. CPR training
4. Detection of early signs and symptoms of illness
5. Infant safety precautions, sleep safety and car seat safety
6. Safety of equipment and medication use
7. Competence in maintaining tracheostomy, ostomies and other attached devices

Revised 7/11/2013
**Community and Healthcare System Readiness**

1. Primary care provider and a medical home
2. Surgical and medical subspecialties
3. Neurodevelopment follow up provided by high risk follow up clinic
4. Early childhood intervention program
5. Home nursing
6. Lactation support for breast feeding mothers.

**INFANTS TO BE FOLLOWED IN SPECIAL CARE CLINIC:**

- All infants ventilated ≥ 96 hours or iNO therapy
- Infants’ ≤ 32 weeks or ≤ 1,500 grams
- Infants with BPD on O2 or medication at discharge
- Infants with complex congenital anomalies
- Infants with uncommon chromosomal abnormalities
- Infants with metabolic disorders
- Infants with apnea requiring a monitor (6 months to one year follow-up unless other criteria met)
- Infants with IVH ≥ grade II, hydrocephalous or PVL
- Infants with ≥ Stage II NEC
- Asphyxiated infants with: HIE or abnormal neurologic exams or cooling therapy
- Infants born to mothers on psychotropic or anticonvulsant drugs
- Infants exposed to illicit drugs in pregnancy treated for withdrawal symptoms and or presence of abnormal neurologic exams prior to discharge.
- Infants requiring double volume exchange transfusions

Most SCC patients are followed until 18 months (18 months corrected for premature infants). Follow-up for some patients may be extended beyond 18 months if needed as determined by the neonatologist. Other patients however may be qualified for earlier discharge. The above list is not inclusive. Patients who are deemed high risk with diagnoses other than those listed above may be referred to Special Care Clinic. Those referrals will be reviewed and will be accepted if services needed are within the scope of SCC.

**POLICY FOR VITAMIN A ADMINISTRATION TO ELBW INFANTS:**

Supplemental Vitamin A administration to ELBW infants has been shown in meta-analysis of clinical trials to decrease the incidence of BPD as well as mortality.

<table>
<thead>
<tr>
<th>Patients eligible:</th>
<th>All infants 1,000 grams at birth as ordered by the attending physician.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiation of therapy:</td>
<td>24-96 hours of age</td>
</tr>
<tr>
<td>Drug:</td>
<td>Vitamin A preparation 50,000 International Units per milliliter</td>
</tr>
<tr>
<td></td>
<td>(Retinyl Palmitate brand name Aquasol A, Astra USA, Westborough, Mass.).</td>
</tr>
<tr>
<td></td>
<td>Refrigerate and shield at all times from direct light.</td>
</tr>
<tr>
<td>Dose:</td>
<td>5,000 International Units (0.1ml) Monday, Wednesday, Friday for four weeks (total of 12 doses). Same dose used regardless of birth weight as smallest infants have the highest incidence of chronic lung disease, the lowest vitamin A stores at birth and the lowest enteral intakes.</td>
</tr>
<tr>
<td>Route:</td>
<td>IM in a 0.3 ml syringe (Becton Dickinson, Cockeysville, Md)</td>
</tr>
<tr>
<td></td>
<td>29-guage needle.</td>
</tr>
<tr>
<td>Pain Control:</td>
<td>Pacifier and swaddling</td>
</tr>
</tbody>
</table>

Bibliography:
NEONATAL DOCUMENTATION OF GESTATIONAL AGE ASSESSMENT:

Best obstetrical information will be used. LMP confirmed US or early prenatal clinical assessment.
- Following prenatal US confirms maternal LMP
  - Sono ≤ 20 wks (+/-) 5-7 days of LMP
  - Sono > 20 wks (+/-) 2 weeks of LMP

If only unsure LMP known then perform a Ballard at 24 hours of life.
- If Ballard is (+/-) 2 weeks then use the LMP as the Ballard is not sensitive even in the best examiner's hands.
- If Ballard is (+/-) 3 weeks on two separate exams then use the Ballard.
- The Ballard should not be used as the sole determiner of GA if OB criteria is available.

For documentation of GA, full completed week of gestational age will be used (if 23 5/7 wks then 23 wks will be documented). Document method used to assess GA.

NEWBORN SCREENING:

1. Biotinidase Deficiency
   - Disorder of biotin recycling
   - Biotin: water-soluble vitamin of the B complex, binds to carboxylases to enhance function
   - Biotinidase: an enzyme that releases biotin from carboxylases
   - Clinical Manifestations
     Autosomal recessive
     Most infants first exhibit clinical symptoms between 3-6 months of age
     CNS and skin – most commonly affected
     Myoclonic seizures, hypotonia, seborrheic or atopic dermatitis, partial or complete alopecia, and conjunctivitis
     Other features: developmental delay, sensorineural hearing loss, lethargy, ataxia, breathing problems, hepatosplenomegaly, and coma
     Laboratory findings: keto and lactic acidosis, organic aciduria, mild hyperammonemia
   - Diagnosis
     1. Newborn screen: Semiquantitative colorimetric assessment of biotinidase activity performed on whole blood spotted on filter paper
     2. Follow-up and Diagnostic Testing
        Positive screening result → definitive testing → quantitative measurement of enzyme activity on a fresh serum sample
        Residual enzyme activity determines whether the patient has profound (10% activity) or partial (10%–30% activity) biotinidase deficiency
   - Treatment
     Profound biotinidase deficiency: Carnitine: 5–20 mg/day
     Partial biotinidase deficiency: Consider lower doses of biotin 1–5 mg/day and/or only during times of metabolic stress

2. Congenital Adrenal Hyperplasia
   - Newborn screening focuses exclusively on the most common form of CAH - 21-hydroxylase (21-OH) deficiency
   - 21-OH deficiency - autosomal recessive disorder caused by a mutation of the CYP21 gene
   - Pathophysiology
     21-OH deficiency → cortisol deficiency ± aldosterone deficiency
     Cortisol deficiency → increased ACTH secretion → excess secretion of the precursor steroids 17-OHP → hyperplastic changes of the adrenal cortex
     The precursor steroids metabolized by the androgen biosynthetic pathway → excess androgen production → virilization
     Aldosterone deficiency → Salt wasting
   - The increased circulating 17-OHP: diagnostic for 21-OH deficiency
   - Clinical Manifestations
     1. Salt wasting form
        Adrenal crisis during the 1st-4th weeks of life: Poor feeding, vomiting, loose stools or diarrhea, weak cry, FTT, dehydration, and lethargy. If untreated → circulatory collapse → shock → death.
        Affected females have ambiguous genitalia (AG) with normal internal reproductive anatomy → diagnosis.
        In milder cases, females present later with hirsutism, menstrual irregularities, and decreased fertility.
        Affected males have no obvious physical signs of CAH. If no salt-wasting, may present later with precocious puberty and advanced bone age.
     2. Simple virilizing form
        No adrenal-insufficiency symptoms unless subjected to severe stress but exhibit virilization
        Males and some females not diagnosed until later (virilization, precocious pseudopuberty, growth acceleration)
        Advanced skeletal age diagnosed late → short adult stature
     3. Mild 21-OH deficiency
        No symptoms at birth and manifests as premature sexual hair, acne, and mild growth acceleration in childhood and hirsutism, excessive
acne, menstrual disorder, and infertility later in life

- **Diagnosis**

1. **Prenatal**
   Carrier testing for CAH - performed most accurately using CYP21 genotyping
   Pregnant women known to be at risk of having a fetus with CAH - First-trimester prenatal diagnosis indicated
   An elevated 17-OHP concentration in amniotic fluid (6–18 ng/mL) is also diagnostic

2. **Postnatal**
   Newborn screen: elevated 17-OHP, ideal to measure after 24 hours, falsely elevated in premature infants
   Follow-up and diagnostic testing: Immediate evaluation (serum electrolytes, 17-OHP)

- **Treatment**

1. **Prenatal**
   Indicated for female fetuses with classic virilizing CAH
   Maternal dexamethasone therapy at 20 mg/kg per day beginning at 5 to 8 weeks’ fetal age prevents or reduces AG in most affected females

2. **Postnatal**
   Replacement of cortisol \(\rightarrow\) suppresses increased ACTH, 17-OHP, and androgen secretion
   Replacement of aldosterone with an analog of mineralocorticoid (Florinef) for patients with SW CAH
   Special medical care is needed in case of stress
   In virilized female infants \(\rightarrow\) surgical correction generally performed before 1 year of age and, if necessary, again before menarche

3. **Congenital Hearing Loss**

- Defined as permanent and is bilateral or unilateral, is sensory or conductive, and averages 30 dB or more in the frequency region important for speech recognition
- Many etiologies, with at least half associated with genetic risk factors

**Pathophysiology**

\(\sim 50\%\) of the cases of CHL are thought to be attributable to environmental factors: acoustic trauma, ototoxic drug exposure [aminoglycosides], bacterial or viral infections such as rubella or CMV

Remaining cases are attributable to genetic mutations

- **Screening** - performed before discharge from the nursery
- Computerized equipment: automated auditory brainstem response (AABR), distortion product otoacoustic emissions (OAEs), or transient evoked OAEs

- **Follow-up:**
   Infants who do not “pass” the screening”: Re-screen before discharge or give an appointment for re-screening as outpatient
   Failure to pass the screening: refer to a qualified audiologist for confirmatory testing for congenital hearing loss

- **Treatment**

Comprehensive pediatric and genetic evaluation
Core personnel: individuals with expertise in the genetics of hearing loss, dysmorphology, audiology, otolaryngology, genetic counseling. Others: ophthalmology, cardiology, nephrology, neurology
Referral to the state early intervention program and/or the state program for children with special health care needs as appropriate

4. **Congenital Hypothyroidism**

- Thyroid hormone deficiency at birth is one of the most common treatable causes of mental retardation
- Inverse relationship between age at diagnosis and neurodevelopmental outcome: the later treatment is started \(\rightarrow\) the lower the IQ

**Pathophysiology**

1. Thyroid dysgenesis (75%) – due to thyroid aplasia, hypoplasia or ectopy
2. Thyroid dyshormogenesis (10%) – defect in thyroid hormone synthesis due to TSH unresponsiveness, iodide transport, organization, thyroglobulin abnormality or deiodinase deficiency
3. Hypothalamic-pituitary defect (5%) – panhypopituitarism, hypothalamus or pituitary abnormality, isolated TSH deficiency or TH resistance
4. Transient hypothyroidism (~10%) – maternal anti-thyroid medications (PTU crosses placenta) or maternal antibodies (TSH receptor-blocking antibodies), neonatal iodine exposure
5. Transient hypothyroxinemia of prematurity – etiology unknown or may be due to immature hypothalamic-pituitary axis
6. Sick euthyroid – acute or chronic illness \(\rightarrow\) Abnormal thyroid tests yet normal thyroid function

**Clinical manifestations**

Most affected infants appear normal at birth
5% are more severely affected – have recognizable features at birth (large fontanels, wide suture, macroglossia, distended abdomen with umbilical hernia, and skin motting)

As maternal thyroid hormone is excreted and disappears in the first few weeks \(\rightarrow \) clinical features gradually become apparent:
Slow to feed, constipated, lethargic, sleep more, hoarse cry, cool to touch, hypotonic with slow reflexes, prolonged jaundice – due to immaturity of hepatic glucuronyl transferase, goiter, common in those with an inborn error of T4 synthesis, if undiagnosed beyond 2 to 3 months of age \(\rightarrow\) slow linear growth, if untreated \(\rightarrow\) loss of IQ proportionate to the age at which treatment is started
Other long-term neurologic sequelae: ataxia, gross and fine motor incoordination, hypotonia, spasticity, speech disorders, problems
with attention span, associated sensorineural deafness, strabismus

- Some NBS programs also detect secondary or hypopituitary hypothyroidism: associated midline defects: syndrome of septooptic dysplasia or midline cleft lip and palate; Other pituitary hormones, such as growth hormone, may also be missing

- **Diagnosis**  
  **1. Newborn screening**  
  Majority initially measure T4, if low T4 measure TSH

- **2. Follow-up testing**  
  Abnormal screening confirmatory serum T4 testing
  Measure of thyroid binding proteins (triiodothyronine [T3] resin uptake), free T4 level, TSH
  Once diagnosis is confirmed determine etiology (Should never delay onset of treatment)
  Thyroid ultrasound or thyroid uptake and scan (technetium 99m pertechnetate or iodine 123)
  If evidence of maternal autoimmune thyroid disease measure thyrotropin-binding inhibitor immunoglobulin in the mother and infant identify those with likely transient hypothyroidism
  If iodine exposure or deficiency is suspected measure urinary iodine confirm this etiology

- Treatment
  Levothyroxine is the treatment of choice: recommended starting dose is 10 to 15 g/kg per day

- Treatment goals
  Keep T4 (10–16 \( \mu \text{g/dL} \)) or free T4 (1.2–2.3 ng/dL) in the upper half of the reference range
  Thyrotrpin in the reference range (6 mU/L)

- Laboratory evaluation should be conducted
  At 2 and 4 weeks after initiation of T4 treatment
  Every 1 to 2 months during the first year of life
  Every 3 to 4 months between 1 and 3 years of age
  2 to 4 weeks after any change in dosage

---

5. **Cystic Fibrosis**

- Pathophysiology
  Abnormalities in the CF transmembrane conductance regulator (CFTR) protein (Membrane glycoprotein that regulates ion flux at epithelial surfaces)
  - cause thick secretions that obstruct pancreatic ductules
  - exocrine pancreatic destruction
  - in the airway, dehydration of airway surface liquid
  - chronic infection and neutrophil dominated inflammation
  - bronchiectasis and progressive obstructive lung disease

- Inheritance: Autosomal recessive
  Mutation F508 – accounts for > 70% of affected chromosomes

- Clinical manifestations
  Usually presents in infancy - Meconium ileus occurs in ~17% of infants with CF
  Beyond the perinatal period – FTT, Hypoelectrolytemia from sweat salt loss, chronic respiratory symptoms: cough, wheeze, chronic endobronchial infections

- Diagnosis
  **1. Newborn screening:** determination of Immunoreactive trypsinogen (IRT) concentrations from dried blood spots
  **2. Follow-up testing:** Two approaches can be taken if the IRT concentration is high
    1. Perform mutation analysis from the dried blood spot for a set of CF mutations - a second specimen is not required
    2. Persistent elevation of IRT concentration - require a second dried blood spot taken at 2 to 3 weeks of age in infants with a high concentration on the first specimen
  For programs that perform mutation analysis diagnosis of CF can be made if 2 mutations are identified from the dried blood spot. If only one mutation is identified sweat testing (definitive diagnostic test) should be performed ASAP.
  In programs that do not perform mutation analysis sweat testing should be performed within a few days of the repeat IRT test.
  Sweat testing should be performed at > 1 week of age. Sweat collection inadequate in preterm infants perform mutation analysis. Sweat chloride > 40 mmol/L required for diagnosis of CF in the newborn. Values > 30 mmol/L requires follow-up.

---

6. **Galactosemia**

- Pathway
  \[
  \text{Lactose} \rightarrow A \rightarrow \text{Galactose + glucose} \rightarrow B \rightarrow \text{Galactose 1-phosphate + UDP glucose} \rightarrow C \rightarrow \text{UDP galactose + glucose 1-phosphate}
  \]
  A Lactase B Galactokinase C Galactose-1-phosphate-uridytransferase

- Clinical manifestations
  Autosomal recessive
  Typically presents soon after feeds are introduced: Poor feeding, vomiting. Lethargy, hepatomegaly, liver failure, renal tubular dysfunction (acidosis, glycosuria, amino aciduria), Cataracts at birth due to fetal exposure to galactose, Increased risk of neonatal infection – E coli sepsis
  If mild neonatal symptoms, can present later with FTT
Older children with learning disabilities despite therapy

- **Diagnosis**
  1. **Newborn Screening:** Test for galactose, galactose 1-phosphate + galactose, or GALT enzyme deficiency - Some laboratories test for all of these substances
  2. **Follow-up testing:**
     Diagnostic studies for classic galactosemia: quantitative analysis of GALT and red blood cell galactose 1-phosphate
     Evaluated rapidly for feeding difficulty, signs of sepsis, jaundice, and hepatomegaly

- **Treatment**
  Galactose-free formula until diagnostic testing confirms diagnosis
  Supportive care: vitamin K, FFP, antibiotics for presumed Gram(-) sepsis, phototherapy for hyperbilirubinemia
  Milk and milk products are excluded from the diet indefinitely - Significant ingestion of galactose at any age can be toxic
  Regular nutritional evaluation, ensure adequate calcium intake

7. **Homocystinuria**

- **Pathway**
  Methionine $\rightarrow$ A $\rightarrow$ Homocytene $\rightarrow$ B $\rightarrow$ Cystathionine $\rightarrow$ Cysteine

  A. Betaine-homocytene methyltransferase and methytetrahydrofolate-homocytene methyltransferase
  B. Cystathionine synthase
  Cystathionine -synthase (CBS) deficiency (most common defect) $\rightarrow$ high concentrations of serum methionine

- **Pathophysiology:** 2 mechanisms explain most of the clinical symptoms
  1. Abnormal (hyper) coagulation because of “sticky” platelets; and
  2. Direct toxicity of homocystine and its metabolites, causing endothelial cell damage

- **Clinical Manifestations:**
  Multiple, recurrent thromboemboli
  Ectopia lentis, glaucoma, cataracts, developmental delays/mental retardation, seizures, psychiatric disturbances, muscle weakness with a shuffling gait
  Osteoporosis with bone deformities, scoliosis, high palatal arch, and a marfanoid habitus

- **Diagnosis**
  1. **Newborn Screening:** The bacterial inhibition assay (BIA) test - detect increased concentrations of blood methionine
  2. **Follow-up testing**
     Quantitative serum or plasma amino acid determination - used for diagnosis of homocystinuria
     Plasma amino acids: increased methionine and homocystine, with reduced cystine and absent cystathionine
     A urine organic acid profile: may be used to determine the presence or absence of methylmalonic acid

- **Treatment**
  1st step: trial of pyridoxine (vitamin B6) - ~50% of patients respond to large doses of this vitamin
  Non-responsive patients with CBS deficiency:
  Methionine-restricted, cystine supplemented diet
  Folic acid and betaine therapy may be helpful
  In the disorders of cobalamin metabolism and transport in which methylmalonic acid and homocysteine appear in the urine $\rightarrow$
  hydroxycobalamin treatment (vitamin B12, not cyanocobalamin) may be beneficial
  Aspirin and dipyridamole $\rightarrow$ decrease the occurrence of thromboembolic phenomena

8. **MSUD**

- Caused by a deficiency in activity of the branched chain -keto acid dehydrogenase (BCKD) complex $\rightarrow$ accumulation of the branched-chain amino acids (BCAAs) leucine, isoleucine, and valine and the corresponding branchedchain -keto acids (BCKAs)

- **Clinical Manifestations**
  Classic MSUD (residual enzyme activity 2%) – most severe and most common form
  Normal at birth, with symptoms developing between 4 and 7 days
  Lethargy and poor sucking with little interest in feeding, weight loss
  Abnormal neurologic signs (alternating hypertonia and hypotonia; dystonic posturing of the arms)
  Characteristic odor of the urine - smelling like maple syrup, burnt sugar, or curry
  Seizures and coma, leading to death (in untreated cases)
  Laboratory: increased concentrations of BCAAs, ketosis, acidosis, and occasionally hypoglycemia

- **Diagnosis**
  1. Newborn screen: elevated leucine, isoleucine, valine
  2. Follow up testing: Blood leucine concentration > 4 mg/dL, or a concentration of 3 to 4 mg/dL (305 mmol) in the first24 hours of life $\rightarrow$ immediate medical follow-up
     Plasma amino acid analysis reveals findings diagnostic for MSUD: increased concentrations of BCAAs, low alanine concentrations, and the presence of alloisoleucine

- **Treatment**
  Regulated diet that provides sufficient BCAAs for normal growth and development. The goal of long-term dietary management is normalization of blood BCAA concentrations while providing nutrition adequate to sustain growth and development in children.
Dietary therapy should be continued for life. Natural protein must be limited, a medical food product (BCAA-free) supplement is necessary. A metabolic team: physician metabolic specialist, metabolic nutritionist. A trial of thiamine supplementation (50–300 mg/day for at least 3 weeks) is recommended. Treatment during acute illnesses should be aggressive → dialysis to remove toxic metabolites

### 9. MCAD Deficiency

- **Pathophysiology**
  Disease of hepatic FAO, with the most frequent presentation being episodic hypoketotic hypoglycemia provoked by fasting
  The inability to break down fats to ketone bodies for an energy source while fasting → hypoglycemia
  FA that are not oxidized will be excreted in urine as carnitine esters → carnitine deficiency
  Encephalopathy due to hypoglycemia and hypoketonemia
  Severe acidosis

- **Diagnosis**
  1. NBS: MS/MS - measuring octanoylcarnitine (a compound normally not present) on the filter paper blood spot
  2. Any child with an octanoylcarnitine concentration of ≥ 1.0 mol/L will require definitive diagnostic testing. Follow-up testing: plasma acylcarnitine analysis, urinary organic acid analysis, and molecular testing.
     - Plasma acylcarnitine analysis and urinary organic acid analysis will confirm the diagnosis
     - The molecular analysis should provide guidance regarding prognosis

- **Brief Overview of Disease Management**
  Avoidance of fasting
  Mildly decreased intake of dietary fat
  L-carnitine supplementation
  Patients should be treated aggressively even during minor illnesses to avoid a severe episode

### 10. PKU

- **Classic phenylketonuria (PKU):** when the concentration of Phe is very high (20 mg/dL or 1210 mol/L) and there is accumulation of phenylketones

- **Deficiency of activity of a liver enzyme, phenylalanine hydroxylase (PAH) → increased concentrations of Phe in the blood and other tissues**

- **Pathway**
  Phenylalanine → A → Tyrosine → B → Dopamine
  A Phenylalanine hydroxylase: produce in the liver, requires BH4
  B Tyrosine hydroxylase, requires BH4

- **Clinical Manifestations**
  Rarely diagnosed before 6 months of age without newborn screening
  Most common manifestation without treatment is developmental delay → mental retardation
  Microcephaly, delayed or absent speech, seizures, eczema, and behavioral abnormalities
  Musty or mousy urine odor (due to phenylacetate) often, normal at birth

- **Diagnosis**
  1. Newborn screening: measures whole blood phenylalanine (elevated by 12 -24 hours of age)
  2. Follow up testing: Quantitative determination of plasma Phe and tyrosine concentrations
     - If low or normal tyrosine → PKU. If high tyrosine → transient tyrosinemia.

- **Brief Overview of Disease Management**
  Metabolic control should be achieved as rapidly as possible
  Medical foods - medical protein sources low in Phe
  Small amounts of Phe must also be provided - use of small amounts of natural protein
  Can be given breast milk along with Phe-free formula under the direction of a metabolic dietitian
  Monitoring - periodic measurement of blood Phe concentrations, assessment of growth parameters, and review of nutritional intake.
  The most commonly reported blood Phe concentration recommendations: 2 to 6 mg/dL for individuals 12 years or younger, 2 to 10 mg/dL for persons older than 12 years
  Fetuses exposed to increased concentrations of Phe → risk of microcephaly, congenital heart disease, and reduced IQ
  Woman with PKU - Phe concentrations of < 6 mg/dL at least 3 months before conception and maintained between 2 and 6mg/dL throughout pregnancy
11. Sickle Cell Disease

- Sickle cell disease (SCD) - group of genetic disorders characterized by chronic hemolysis and intermittent episodes of vascular occlusion → recurrent episodes of severe pain and a wide variety of other disease manifestations
- Incidence: Overall, SCD occurs in 1 of 2500 to 1 of 2000 US newborns (1 of 346 black infants, 1 of 1114 Hispanic infants in the eastern US). Highest in persons of African, Mediterranean, Middle Eastern, Indian, Caribbean, and Central and South American ancestry
- Clinical Manifestations
  Healthy at birth and become symptomatic later during infancy or childhood
  Most common clinical manifestation: musculoskeletal or abdominal pain
  Acute manifestations that may rapidly become life-threatening: bacterial sepsis or meningitis, splenic sequestration, acute chest syndrome, and stroke
  Other acute complications: aplastic crises, priapism, and renal papillary necrosis
  Chronic manifestations: anemia, jaundice, splenomegaly, hyposthenuria, hematuria, proteinuria, cholelithiasis, and delayed growth and sexual maturation
- Pathophysiology
  Sickle hemoglobin is caused by a point mutation in the ε-globin gene → amino acid change that causes hemoglobin to polymerize when deoxygenated
  Sickle red blood cells → shortened red cell survival and intermittent episodes of vascular occlusion → tissue ischemia and organ damage
- Diagnosis
  1. NBS: Isoelectric focusing to separate hemoglobins eluted from dried blood spots. Infants with SCD also show a predominance of F at birth: FS, FSC, or FSA
  2. Follow-up and Diagnostic Testing: Infants with possible SCD (FS, FSC, FSA) → confirmatory testing of a second blood sample accomplished before 2 months of age (isoelectric focusing, HPLC, hemoglobin electrophoresis (cellulose acetate and citrate agar), and/or DNA-based methods)
  3. Family testing to identify carriers, for the purpose of defining an infant’s diagnosis and/or providing genetic education and counseling: CBC, hemoglobin separation by electrophoresis, isoelectric focusing, and/or HPLC
- Brief Overview of Disease Management
  Family and patient education
  Health maintenance issues: prophylactic medications, particularly prophylactic penicillin (should be started no later than 2 months of age), and timely immunizations, especially with the pneumococcal conjugate and polysaccharide vaccines
  Periodic comprehensive medical evaluations
  Timely and appropriate treatment of acute illness is critical

12. Tyrosinemia

- Type I (hepatorenal) tyrosinemia
  Liver toxicity → increased tyrosine and other metabolites → hepatocellular damage
  Jaundice and increased transaminase concentrations → high risk of hepatic cancer
  Other features: renal Fanconi syndrome, peripheral neuropathy
  Caused by deficiency of the enzyme fumarylacetoacetate hydrolase (FAH)
- Type II (oculocutaneous tyrosinemia, also known as Richner-Hanhart syndrome
  Corneal lesions and hyperkeratosis of the palms and soles
  Caused by deficiency of the enzyme tyrosine aminotransferase (TAT).
- Neonatal tyrosinemia
  More common in preterm infants
  Most common cause of abnormal initial NBS results for tyrosinemia and PKU
  Increased concentrations of serum tyrosine that can be detected on newborn screening
- Pathophysiology
  Type I: Increased concentrations of tyrosine and its metabolites → inhibit transport functions and enzymatic activities
  Type II: Deficiency of hepatic TAT, the rate-limiting enzyme of tyrosine catabolism. Tyrosinemia, tyrosinuria, and increases in urinary phenolic acids, N-acetyltirosine, and tyramine persist for life
  Neonatal: Relative deficiency of p-hydroxyphenylpyruvate oxidase stressed by high-protein diets, with resulting high tyrosine and phenylalanine concentrations. Mild decrease in TAT activity
- Diagnosis
  1. NBS: The BIA can be used to screen for tyrosinemia using dried blood spots. Abnormal concentrations of tyrosine > 6 mg/dL.
     Best if measurements are obtained 48 to 72 hours after milk feeding.
  2. Follow-up testing: Determination of the concentrations of tyrosine and other amino acids and metabolites in the blood and urine
- Brief Overview of Disease Management
  Type I
  Dietary therapy, liver transplantation, and pharmacologic agent NTBC
  Type II
  Therapy with a diet low in tyrosine and phenylalanine is curative in type II tyrosinemia
  Neonatal
May be transient and controlled by reducing the protein intake to 2 to 3 g/kg per day or by breastfeeding.

Some patients respond to ascorbic acid supplementation.

### Evaluation of Inborn Error of Metabolism (IEMs):

Sudden metabolic deterioration after a period of apparent normalcy is highly suggestive of a metabolic disorder but evaluation and treatment for sepsis and evaluation for CHD need to be done in this metabolic crisis. During this acute period it is crucial to set aside samples (at least 5 ml plasma and 5 ml urine) before attempting to correct metabolic abnormalities as some metabolic defects are seen only during the crisis.

### Clinical Presentation of Neonates with Inborn Errors of Metabolism

Majority present after 48 hours of age. Consider diagnosis of metabolic disease if:

**Family History**
- Neonatal death of unclear etiology
- History of child with neurological deterioration (note: majority of metabolic diseases are AR and thus typically no family history)
- History of miscarriages
- Consanguinity

**Clinical**
- Decreased oral intake and or vomiting
- Lethargy, coma, seizures, changes in tone or reflexes
- Cardiomegaly
- Hepatosplenomegaly, dysmorphic features
- Cataracts
- Developmental delay or failure to thrive
- Asymptomatic infants who become sick typically have metabolic disorder associated with intoxication effects (e.g. organic academia, urea cycle defect) while infants who have overwhelming abnormal neurological findings immediately at birth typically have a metabolic disorder associated with energy deficiencies (e.g. mitochondrial disorder, nonketotic hyperglycinemia)

**Laboratory Findings**
- Infant with hypoglycemia of unexplained etiology
- Metabolic acidosis of unexplained etiology (typically increased anion gap)
- Respiratory alkalosis (primary)
- Abnormal liver function tests
- Hyperbilirubinemia that is not consistent with physiologic jaundice or other causes
- Ketonuria or ketosis
- Abnormal urine odor
- Hypoammonemia
- Urine reducing substances

### Diagnostic Evaluation in an Infant with a Possible Metabolic Disorder:

<table>
<thead>
<tr>
<th>Initial Evaluation</th>
<th>Secondary evaluation targeted based on results from initial evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC to assess for neutropenia and or thrombocytopenia</td>
<td>Plasma amino acid analysis</td>
</tr>
<tr>
<td>Electrolytes and arterial blood gas to assess for acidosis/alkalosis, increased anion gap</td>
<td>Urine organic acid analysis</td>
</tr>
<tr>
<td>Glucose and presence/absence of urine ketones</td>
<td>Plasma carnitine and acylcarnitien profile</td>
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<tr>
<td>Serum ammonia (arterial)</td>
<td>Plasma uric acid</td>
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<tr>
<td>Lactate (arterial) and pyruvate concentration with ratio of lactate to pyruvate</td>
<td>CSF amino acid analysis</td>
</tr>
<tr>
<td>Liver function tests</td>
<td>Peroxisomal function tests</td>
</tr>
<tr>
<td>Urine ketones</td>
<td></td>
</tr>
<tr>
<td>Check newborn screen results , if available</td>
<td></td>
</tr>
<tr>
<td>Others: urinalysis, urine reducing substance</td>
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</tr>
</tbody>
</table>
### Key Lab Finding for Neonates with IEM:

<table>
<thead>
<tr>
<th>Laboratory Findings</th>
<th>Metabolic Disease Consideration</th>
</tr>
</thead>
</table>
| Neutropenia, thrombocytopenia | OA (propionic, isovaleric, and methylmalonic acidemia)  
GSD I  
Respiratory chain defects |
| Hemolytic anemia | G6PD, pyruvate kinase |
| Metabolic acidosis with elevated anion gap | OA (propionic, isovaleric, and methylmalonic acidemia)  
FA oxidation defects (short, medium, long and very long chain abnormalities), carnitine deficiency  
Congenital lactic acidosis (pyruvate dehydrogenase complex deficiency, pyruvate carboxylase deficiency, Mito)  
Secondary lactic acidosis (hereditary fructose intolerance, GSD I, FAO, biotinidase deficiency, propionic, methylmalonic and isovaleric acidemias, HMG CoA lyase deficiency)  
Others (prematurity, HIE, severe hepatitis, portal venous obstruction, abnormal mitochondrial oxidation from hypoxia) |
| Normal anion gap | Diarrhea, RTA, Galac, Tyr, some Mito |
| Respiratory alkalosis | UCD |
| Plasma amino acids elevated | MSUD (increased leucine, isoleucine, valine)  
Organic acidemias (increased glycine)  
Tyrosinemia (increased methionine and tyrosine)  
Arginosuccinic acid synthetase deficiency and argininosuccinic acid lyase deficiency (increased citrulline)  
Hyperammonemia (increased glutamine)  
Lactic acidosis (increased alanine)  
Prolonged alimentation in premature infants |
| Ketotic hyperglicemia | Propionate pathway abnormalities |
| Ketotic hypoglycemia | GSD, OA (propionic, isovaleric, and methylmalonic acidemia), short chain acyl-CoA dehydrogenase deficiency |
| Hypoketotic hypoglycemia | FAO (MCAD, LCHAD, hydroxymethylglutaryl CoA lyase deficiency), Carnitine deficiency |
| Serum ammonia | UCD, OA, FAO, PDH, PC |
| Increased creatinine kinase | FAO |
| Increased serum uric acid | GSD I |
| Decreased serum uric acid | [Molybdnum cofactor |
| Plasma acylcarnitine profile | FFAO, OA |
| Plasma (Total&Free) carnitine | FFao, OA |
| Urine organic acids | OA, FAO, Mito, PDH, PC |
| Urine reducing substances | Galac, HFI, Try 1 |
| Urine mucopolysaccharides | Lysosomal storage disorder |
| Urine oligosaccharides | Lysosomal storage disorder |
| 7-dehydrocholesterol | Smith Lemli Opitz syndrome |
| Serum transferring glycoforms | CDG |
| Very long-chain FA | Peroxisomal disorders |

Legend:  
CDG (congenital disorder of glyclosylation), FAO (fatty acid oxidation defect), Galac (galactosemia), GSD I (glycogen storage disease type I), G6PD (glucose 6 phosphate dehydrogenase), HFI (hereditary fructose intolerance), Mito (mitochondrial energy metabolism defects), OA (organic aciduria), PD (pyruvate carboxylase deficiency), PDH (pyruvate dehydrogenase), Try 1 (tyrosinemia type 1), UCD (urea cycle defect), UOA (urine organic acid).

![Metabolic Acidosis Diagram](image-url)

- **Increased anion gap**: check serum lactate  
- **Abnormal UOA**: check urine organic acid (UOA)  
- **Increased pyruvate & lactate**: normal pyruvate:lactate ratio → check glucose  
- **Low glucose**: GSD, fructose intolerance  
- **Normal glucose**: Pyruvate DH complex def, pyruvate carboxylase def, some Mito  
- **Normal lactate**: check UOA  
- **Abnormal UAO**: Organic acidemia  
- **Normal anion gap**: hypochloremia  
- **Abnormal bicarb loss, diarrhea, RTA, Galac, Tyr, Some Mito**
Algorithm for evaluation of hypoglycemia if IEM suspected:

**HYPOGLYCEMIA** → assess urine for non-glucose reducing substances

- Present
  - Galactose, hereditary fructose intolerance, Tyr

- Absent
  - Check for ketones

  - High
    - Check serum lactate and UOA
      - ↑lactate
        - GSD, FI-6 biphosphatase def, phosphoenolpyruvatekinase def
      - Abnormal UOA
        - Organic acidemia
      - Normal UOA
        - Potential endocrine etiology Succinyl-Co-A:3-oxoacid-CoA transferase def
        - SCHAD (+↑ketones)

  - Low or absent
    - FAO (also with abnormal UOA)
    - Hyperinsulinism
    - 3OH-MH-CoA lyase def
    - Other glycosylation defects
      - SCHAD (+↑ketones)

Algorithm for evaluation of Hyperammonemia:

**HYPERAMMONEMIA**

- Acidosis + ketonuria
  - Propionic, methylmalonic and isovaleric acidemia,
  Lactic academia, Glutamic aciduria, Pyruvate carboxylase def, B-methyleneocrotonyl glycinuria

- No acidosis, no ketonuria

- Acidosis, no ketonuria
  - Plasma citrulline
    - Absent or trace → check urine erotic acid
    - Normal to moderately increased → check urine argininosuccinic acid

  - Low or normal
    - Carbamoylphosphate synthetase def
    - N-acetyl glutamate synthetase def

  - Low or normal
    - Ornithine transcarboxylase def
    - Check plasma arginine

  - Normal or low
    - Transient neonatal hyperammonemia
    - Lysine protein intolerance

  - Elevated
    - Argininosuccinic acid lyase def
    - Arginase def
### IEM Associated with Hydrops Fetalis:

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Test</th>
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</thead>
<tbody>
<tr>
<td>Hematologic Abnormality</td>
<td>CBC with peripheral smear for hemolytic anemia.</td>
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<tr>
<td>G6PD deficiency</td>
<td></td>
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<tr>
<td>Pyruvate kinase deficiency</td>
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<tr>
<td>Lysosomal Storage Disease</td>
<td>Urine screen for mucopolysaccharides and oligosaccharides.</td>
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<tr>
<td>Mucopolysaccharidoses, sphingolipidoses, mucolipidoses.</td>
<td>Lysosomal enzyme studies.</td>
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<td>Disorders of Steroid Metabolism</td>
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<tr>
<td>Smith-Lemli-Opitz syndrome</td>
<td>7-dehydrocholesterol</td>
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<td>Mevalonic aciduria</td>
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<tr>
<td>Other</td>
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<tr>
<td>Zellweger syndrome</td>
<td>Plasma very long-chain fatty acids</td>
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<tr>
<td>Congenital disorders of glycosylation</td>
<td>Serum transferring isoforms</td>
</tr>
<tr>
<td>Mitochondrial disorders</td>
<td>Serum lactate</td>
</tr>
<tr>
<td>Glycogen storage disease type IV</td>
<td>Enzyme studies, liver biopsy</td>
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<tr>
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</tbody>
</table>

### Samples to collect in a dying neonate with undiagnosed suspected IEM:

**Samples collected and stored for future testing**
- Plasma (at least 5 ml) frozen
- Urine (at least 5 ml) frozen
- Dried blood spot on a newborn screening filter paper card

**Postmortem tissue samples (after proper consent):**

Skin biopsy in sterile saline or culture medium at room temperature  (Caution: povidone-iodine is toxic to cell growth)
- Liver tissue unfixed, immediately frozen below -20C
- Muscle biopsy, immediately frozen below -20C
- *Tables from NeoReviews 2008; 9; e291-298.*

### SPECIAL CARE NURSERY RE-ADMISSION POLICY:

1. The EPCH NICU can accept infants from outside the hospital up to 14 days of age or less.
2. Infants may be accepted for admission if the physician feels that there is no evidence of community acquired or respiratory infection. This would not pertain to any perinatally acquired newborn infection.
3. These infants may be admitted from another hospital, lay midwife birthing center, home, or ED.
4. This policy does not pertain to infants back-transferred from another hospital at any age unless there is evidence of infection.
5. If there is an admission of an infant who has just been discharged and they are greater than 5 days from discharge, they will not be re-admitted to the NICU.

*July 12, 2012*
Terminology: Perinatal hypoxia-ischemia is commonly used to describe infants that experience impairment of placental gas exchange proximate to birth. Asphyxia is a more accurate term for this event and it is important to recognize that asphyxia and hypoxia-ischemia are not physiologically equivalent. However the term asphyxia carries far greater medical-legal implications than hypoxia-ischemia and unfortunately these concerns are often inappropriate. Given that asphyxia, hypoxia-ischemia, and ischemia are often used interchangeably in the literature, it is best that discussions and charting be limited to the use of the term hypoxia-ischemia.

General Considerations: Newborn encephalopathy is characterized by difficulty initiating respirations at birth, and is accompanied by decreased levels of activity, tone, reflexes, consciousness, and possibly seizures. It is a diagnosis of near-term and term infants and is usually not considered for preterm infants since neurological features of prematurity can be similar to encephalopathy. Recognition is typically at birth or shortly thereafter, although symptoms may evolve over the first few days. Encephalopathy is a non-specific response to multiple different events of which intrapartum hypoxia-ischemia represents one specific type.

Diagnostic Considerations: The challenge for “diagnosing” perinatal HIE is two fold; first, biochemical abnormalities of placental gas exchange, as evidenced by fetal acidemia, do not correlate well with clinically important problems(1), and second, perinatal HIE has etiologic links to neurodevelopmental outcomes such as cerebral palsy (2). Thus, it is difficult to translate a simple physiologic concept of hypoxia-ischemia into an easily characterized clinical diagnosis. Essential criteria have been formulated by the American College of Obstetricians and Gynecologists (ACOG), and the International Cerebral Palsy Task Force to define an acute intrapartum event that is sufficient to cause cerebral palsy(3).

These criteria include:

a) fetal acidemia with a prominent metabolic component (pH<7.0, BE>-12mmol/L),
b) moderate or severe encephalopathy
c) CP of the spastic quadriplegic or dyskinetic type
d) exclusion of other identifiable etiologies as outcomes such as CP can only be linked to perinatal events if moderate or severe encephalopathy has occurred

These criteria however are focused on establishing links between perinatal events and long term outcome. Previously published criteria by both ACOG and the AAP are probably better suited for evaluation and clinical management in the immediate neonatal period (4).

These criteria include:

a) profound fetal acidemia (pH<7.0)
b) depression at birth with Apgars of 0-3 for more than 5 minutes
c) evidence of encephalopathy
d) multi-system organ dysfunction

These criteria were also meant to provide links to outcome accounting for the severity of the parameters. More modest alterations within these categories (eg umbilical artery pH of 7.00-7.10, 10 minute Apgar of 5 with consequent need for ventilation at birth) can still be accompanied by important organ dysfunction that may impact neonatal management. Organ dysfunction may not be apparent immediately after birth and the diagnosis is sometimes only established at 48-72 post birth after evolution of neurological findings and exclusion of other causes of encephalopathy. Thus, a reasonable approach to diagnosis is a step wise sequence in which the history is suggestive of an acute peri-partum event, followed by the presence of birth depression with fetal acidemia, and accompanied by organ system dysfunction noted in the first 48 hours following birth. The latter may be non-CNS alone, but if encephalopathy is present, there will invariably be other organ system dysfunction. Finally exclusion of other causes of encephalopathy is essential.

Surveillance for Organ System Dysfunction and Metabolic Abnormalities:

CNS Injury: The principal manifestation of hypoxic-ischemic cerebral injury is encephalopathy and severity is most easily characterized using the Sarnat stages (5). This assumes that an acute event has occurred around the time of birth. Neurological abnormalities reflecting events remote from delivery can usually be differentiated from acute processes; however, superimposition of acute upon chronic events can be challenging to distinguish. Abnormalities of the neurological examination, seizures and Sarnat stages are not specific for hypoxia-ischemia. An important observation is that the extent of neurological finding may progress over the first 12-48 hours following birth. Sarnat stages are often used to provide prognostic information as follow-up studies indicate that prognosis is very accurate when the maximal extent of encephalopathy is Sarnat stages I or III (mild or severe) and corresponds to a good or poor outcome for death/disability, respectively. In contrast, there is a variable outcome for infants in whom the maximal stage of encephalopathy is Sarnat II.

Renal Dysfunction: Assessment of renal function is the simplest means to assess the presence or absence of non-CNS organ dysfunction (6,7). Parameters that can be assessed include urine output, weight, serum Na, urine analysis, and serum BUN and creatinine. The latter should be assessed at an interval following delivery (eg, at 24 hours of age) and knowledge of the maternal creatinine may be necessary depending on the presence of specific maternal diagnoses (eg, advanced diabetes, severe pre-eclampsia etc).
**Pulmonary Dysfunction:** Persistent pulmonary hypertension of the newborn (PPHN) and meconium aspiration syndrome (MAS) can be associated with perinatal hypoxia-ischemia. PPHN without MAS will often be self limited and resolves with improvement in oxygenation, perfusion pressure and correction of metabolic acidemia.

**Myocardial Dysfunction:** Adverse effects on the myocardium are not common but can include tricuspid insufficiency, and global ischemia. Suspicion of myocardial dysfunction can reflect obvious inability to maintain perfusion pressure or more subtle difficulty in resolving metabolic acidemia.

**Hematopoietic Abnormalities:** Thrombocytopenia can occur following hypoxia-ischemia. Laboratory abnormalities of clotting function are common but clinically apparent consumption coagulopathy is less frequent.

**Hepatic Dysfunction:** Biochemical abnormalities supportive of hepatic injury can occur in response to hypoxia-ischemia but clinical manifestations are rare.

**Gastrointestinal Dysfunction:** Evidence of bowel hypoxia-ischemia is difficult to assess due to absence of easily monitored laboratory parameters.

**Metabolic Abnormalities:** Reductions in serum concentrations of glucose, calcium and magnesium should be actively surveyed. Changes in glucose concentrations are most common immediately after birth while changes of calcium and magnesium are more characteristically found between 12-24 hours after birth.

**Electrolyte Disturbances:** Hyponatremia can occur and may reflect excess free water administration or SIADH. Hypernatremia secondary to diabetes insipidus occurs but is rare.

**Differential Diagnosis:** Since the diagnosis of HIE is a composite diagnosis (perinatal events, evidence of impaired placental gas exchange, respiratory depression at birth, and multi-organ system dysfunction), there can be multiple conditions that mimic the effects of hypoxia-ischemia. Considerations that should be considered include:

1. Infection
2. CNS malformation
3. CNS vascular event
4. CNS trauma
5. CNS hemorrhagic lesions
6. Drug and anesthetic effects
7. Congenital neuromuscular disorders
8. Inborn errors of metabolism

**Brain Imaging:** Given the above differential diagnosis, brain imaging is recommended for near term and term infants manifesting encephalopathy. Recommendations for imaging are as follows; after birth when the infant is unstable a head ultrasound can be done to rule out hemorrhages in the periventricular area, (realizing that epidural, subdural and subarachnoid abnormalities will not be visualized well with this imaging study). CT scans were the preferred initial study but risks of radiation exposure have limited routine use. When the infant is stable a MRI later in the first week can establish the pattern of injury and provide additional prognostic information for counseling. These recommendations have been endorsed by the American Academy of Pediatrics, American Society of Pediatric Neuroradiology, and the Society for Pediatric Radiology (8). Infants that are sick enough to warrant brain cooling should have MRI imaging performed as part of their care.

**Initial Stabilization:** Like any other acutely ill newborn, priorities for stabilization include securing the airway, effective ventilation, and supporting the circulation. Of particular importance in the acute stabilization are correction of hypotension, hypoglycemia, and metabolic acidemia. Both persistent hypotension and hypoglycemia will limit the recovery of cerebral high energy phosphorylated metabolites (e.g., ATP) following acute hypoxia-ischemia (9). The urgency in correction of metabolic acidemia is less clear. Rationale for rapid correction of acidosis is potential deleterious effects on myocardial function and pulmonary vasomotor tone. Rapid correction of acidosis has little effect on cerebral tissue acidosis; correction of the latter is largely dependent upon establishment of adequate perfusion pressure and cerebral blood flow since there is limited passage of exogenous alkali across the blood brain-barrier. An alternative approach to rapid correction is serial measurements of blood gases and pH to determine the rapidity of self-correction. The latter may give important information regarding hemodynamic instability; metabolic acidemia is usually rapidly cleared in the presence of adequate myocardial function.

**Therapy:** Management and treatment of infants with evidence of hypoxia - ischemia can be considered under categories of supportive care and brain specific interventions.

**Supportive Intensive Care**

1. **Correct metabolic abnormalities:** This will include hypoglycemia, hypocalcemia, hypomagnesaemia, and acidosis. Consideration can be given to addition of supplemental calcium to the IV fluid given the frequency of hypocalcemia with moderate/severe HIE.

2. **Correct hypotension/hypo-perfusion:** Usual management guidelines of volume expansion followed by pressor support should be used judiciously in these patients, and only when assessments support hypo-perfusion and persistant MAP at less than the 5%. Consideration can be given to obtaining an echocardiogram to assess myocardial function and fluid status.

3. **Fluid management:** In general fluids should be administered judiciously for infants with hypoxia-ischemia once
perfusion and blood pressure are stabilized. This approach is based on the associated renal and CNS morbidities that may be exacerbated with excess free water administration. Consideration can be given to placement of a UVC to facilitate fluid restriction. This will also allow simultaneous provision of high glucose concentrations to meet glucose requirements with restricted fluids.

4. **Treatment of seizures:** The potential of seizures exacerbating brain injury remains a concern but without strong corroborating human data. However this concern drives the practice of treating clinically detectable seizures; treatment of electrographic seizures in the absence of clinical evidence is unclear. Phenobarbital and phosphenytoin are the drugs most commonly used in neonates and have been evaluated better than other agents for effectiveness (10). Consideration should be given to obtaining EEG studies early if there is an index of suspicion for seizures. In addition the EEG background activity may provide helpful prognostic information.

5. **Bleeding and/or thrombocytopenia:** Clinical bleeding from presumed DIC is usually responsive to replacement therapy. Whether asymptomatic thrombocytopenia secondary to hypoxia-ischemia needs to be treated is uncertain.

6. **PPHN and/or MAS:** Treatment and management for these conditions should reflect broader approaches to these conditions irrespective of the etiology.

7. **Treatment of cerebral edema:** Cerebral edema may be suspected based upon a full/bulging fontanel, or abnormalities on imaging. There is no evidence that intervention to reduce edema (osmotic diuretics, hyperventilation etc.) change outcome. Experimental data supports the notion that cerebral edema is a manifestation of injury and occurs beyond the stage when interventions may be helpful (11).

**Brain Specific Therapies**

1. **Modest brain cooling:** The NICHD Neonatal Network randomized trial of modest hypothermia demonstrated that whole body cooling (esophageal temperature of 33.5°C) reduced the incidence of death and disability (moderate to severe in extent) in near term and term infants with moderate or severe encephalopathy (12). Benefits of this therapy were not associated with an increase in predefined serious adverse events (13). It is recommended that this therapy be offered only to infants that fulfill the entry criteria of the above study; evidence of effectiveness and safety of this therapy for infants who do not meet these criteria is unknown.

2. **Other therapies:** At this time there are no data to justify the implementation of other potential neuroprotective therapies (eg, high dose barbiturates, magnesium, and allopurinol). Use of high dose phenobarbital for other indications, eg, control of seizures, achieving sedation etc, need to be individualized.

**Algorithm For Potential Use of Modest Hypothermia:**

**Inclusion Criteria:** Infants will be evaluated in two steps; evaluation by clinical and biochemical criteria (**Step A**), followed by a neurological exam (**Step B**).

**Step A:** All infants will be evaluated for the following:

1. History of an acute perinatal event (abruptio placenta, cord prolapse, severe FHR abnormality: variable or late decelerations).
2. An Apgar score ≤5 at 10 minutes.
3. Cord pH or first postnatal blood gas pH at ≤1 hour ≤7.0.
4. Base deficit on cord gas or first postnatal blood gas at ≤1 hour ≥16 mEq/L.

Continued need for ventilation initiated at birth and continued for at least 10 minutes.

**IF BLOOD GAS IS AVAILABLE:**

<table>
<thead>
<tr>
<th>A1</th>
<th>Infant should have: (3 or 4 from above)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Cord pH or first postnatal blood gas within 1 hour with pH ≤7.0</td>
</tr>
</tbody>
</table>

**OR**

<table>
<thead>
<tr>
<th>A2</th>
<th>Infant should have: (1 and 2 or 5 from above)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Acute perinatal event and either</td>
</tr>
<tr>
<td></td>
<td>• An Apgar score ≤5 at 10 minutes</td>
</tr>
</tbody>
</table>

**IF BLOOD GAS IS NOT AVAILABLE**

<table>
<thead>
<tr>
<th>IF BLOOD GAS IS NOT AVAILABLE OR pH between 7.0 and 7.15, BASE DEFICIT 10 to 15.9mEq/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

**OR**

<table>
<thead>
<tr>
<th>OR</th>
<th>Infant should have: (3 or 4 from above)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Base deficit on cord gas or first postnatal blood gas within 1 hour at ≥16 mEq/L</td>
</tr>
</tbody>
</table>

If an infant meets either A1 or A2, proceed to the neurological examination.

**Step B.** The presence of moderate/severe encephalopathy defined as seizures OR presence of signs in 3 of 6 categories in the table below.
### Revised 7/11/2013

#### Table: Neurological Examination

<table>
<thead>
<tr>
<th>Category</th>
<th>Moderate Encephalopathy</th>
<th>Severe Encephalopathy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Level of consciousness</td>
<td>Lethargic</td>
<td>Stupor/coma</td>
</tr>
<tr>
<td>2. Spontaneous activity</td>
<td>Decreased</td>
<td>No activity</td>
</tr>
<tr>
<td>3. Posture</td>
<td>Distal flexion</td>
<td>Decerebrate</td>
</tr>
<tr>
<td>4. Tone</td>
<td>Hypotonia (focal, general)</td>
<td>Flaccid</td>
</tr>
<tr>
<td>5. Primitive reflexes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suck</td>
<td>Weak</td>
<td>Absent</td>
</tr>
<tr>
<td>Moro</td>
<td>Incomplete</td>
<td>Absent</td>
</tr>
<tr>
<td>6. Autonomic system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils</td>
<td>Constricted</td>
<td>Skew deviation/dilated/non-reactive to light</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Bradycardia</td>
<td>Variable HR</td>
</tr>
<tr>
<td>Respirations</td>
<td>Periodic breathing</td>
<td>Apnea</td>
</tr>
</tbody>
</table>

**Performance of the examination:** The neurological examination should be performed by physician examiners, two attendings or one attending and the 3rd or 2nd year pediatric resident/NNP. Examinations should be performed independently by attending and resident/NNP and then jointly discussed. This will provide important training for the residents and NNPs. The decision of eligibility as per the examination findings and whether to offer the treatment will be based on a joint decision of the resident or NNP and attending. In cases where the decision to use the therapy is unclear either due to the findings of the examination or specific issues related to the infant, consultations with other available attendings should be pursued.

**Timing of the examination:** In general there is decreasing efficacy of neuroprotective treatments the further into the therapeutic window treatment is started. Initial management needs are to prioritize stabilization of the airway if intubated, adjustment of ventilator support, establishment of intravenous and/or arterial vascular access, correction of acid-base disturbances, insurance of adequate perfusion pressure, and maintenance of a normal blood glucose concentration. Categorizing neurological findings after birth is complex given the transitional physiology, maternal medications, evolving neurological abnormalities, and other non-CNS conditions. Thus, appropriate attention to the above priorities is beneficial to obtaining accurate assessments of the neurological examination since it prevents detailed judgments in the first 1-3 hours after birth. If examinations are performed too early after birth, more infants may be needlessly exposed to treatment. Given the uncertainty of duration of the therapeutic window, neurological examinations and a decision to initiate cooling must be made by 6 hours after birth. If an infant meets criteria A1 or A2 and criteria B and does not meet exclusion criteria, the infant is eligible for whole body cooling.

#### Exclusion Criteria

- Inability to complete the neurological examination by 6 hours of age.
- Presence of known chromosomal anomaly.
- Presence of major congenital anomalies.
- Severe intrauterine growth restriction (weight ≤1800g).
- Infants in extremis for whom no additional intensive therapy will be offered by attending neonatologist.

#### Equipment Required

- Cincinnati Sub-Zero (CSZ) Blanketrol III Hyper-Hypothermia system with hoses
- Patient probe jack
- CSZ Esophageal temperature probe, 491B
- One blanket, 25 x 33 inches
- Two gallons of sterile or distilled water (not de-ionized)

<table>
<thead>
<tr>
<th>Equipment (Item Number)</th>
<th>Units needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blanketrol III, Model 223R</td>
<td>1/unit</td>
</tr>
</tbody>
</table>
Hose #286
Rectal/Esophageal: sterile disposable probe, #491B
Reusable Probe Adapter Cable, RJ11
Maxi-Therm Lite Pediatric Blanket #874 (25in x 33in)

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hose #286</td>
<td>1 carton/center</td>
</tr>
<tr>
<td>Rectal/Esophageal: sterile disposable probe, #491B</td>
<td>1 carton/center</td>
</tr>
<tr>
<td>Reusable Probe Adapter Cable, RJ11</td>
<td>2 cartons (includes 1 backup)</td>
</tr>
<tr>
<td>Maxi-Therm Lite Pediatric Blanket #874 (25in x 33in)</td>
<td>1 Box/center</td>
</tr>
</tbody>
</table>

**Operation of the CSZ Blanketrol Unit** – A separate summary is provided for operation of the cooling unit including salient features of the system, initiation of cooling, monitoring of cooling, rewarming infants, and an algorithm for trouble shooting problems with the cooling system.

**Monitoring of Temperatures and Vital Signs during Body Cooling**

a. During cooling all exogenous heat sources should be off.

b. Temperatures should be recorded from the esophageal and skin probes at 15 min intervals for the first four hours of cooling to insure that the system is functioning properly. Of note, there is an initial overshoot in esophageal temperature with the present system (mean ±sd temperature of 32.7±0.9°C in the hypothermia group of the Network trial with initial cooling and by 2 hours increased to close to 33.5°C; thereafter temperature fluctuated around the set point from 33.0 to 34.0°C).

c. Esophageal and skin temperatures should be recorded at hourly intervals from 12 hours until 72 hours, and at hourly intervals during reheating.

d. Measurement and recording of axillary temperatures and other vital signs should continue as per NICU policy.

**Blood Gas and pH Measurements during Body Cooling** – Blood gases will be temperature corrected while infants are undergoing whole body cooling. This is an arbitrary recommendation since there is no firm data to drive the decision for or against temperature correction. Temperature correction of blood gases and pH was performed in the Network trial.

1. **Follow-up of Infants with Perinatal Hypoxia-Ischemia:** Given the potential link between perinatal hypoxia-ischemia and early childhood adverse neurodevelopmental outcome, it is recommended that all infants with a moderate or severe encephalopathy of any duration should be followed-up in the Special Care Clinic in addition to routine pediatric health maintenance. This recommendation is irrespective of imaging findings, absence of seizures, or normal evaluation at the time of discharge. Infants with no CNS involvement or encephalopathy limited to stage I Sarnat (mild encephalopathy) do not need follow-up unless there are unusual findings (eg, abnormalities on MRI imaging etc).

**References (available if needed)**