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Special Care Nursery

Goals and Objectives

The goal of this rotation is to develop your ability to evaluate and manage critically ill infants with a broad range of medical and surgical problems. The SCN is made up of the Intensive Care Nursery (ICN), and the Intermediate Care Nursery (IMCN). You will be introduced to the procedures required to care for sick newborns and given the opportunity to develop these skills. The objectives of this rotation are designed to develop the residents' competencies in the following six areas:

I. Patient Care
II. Medical Knowledge
III. Practice-Based Learning and Improvement
IV. Interpersonal and Communication Skills
V. Professionalism
VI. Systems-Based Practice

I. Patient Care

a. Residents will take a detailed perinatal history when possible, review prenatal records, and perform a complete physical examination upon the patient's admission. After evaluating the patient, they will formulate a differential diagnosis and plan appropriate diagnostic and therapeutic interventions, in coordination with the attending neonatologist, respiratory therapist and neonatal nurse.
b. Through thoughtful review of diagnostic results and frequent reassessment of the patient, residents will reconsider the clinical status of the patient, along with the differential diagnoses on a continuing basis, making changes to the management plans as appropriate.
c. At all time, it is the residents' responsibility to educate and work with the patient and family, maintaining a strong therapeutic alliance.
d. Residents will be mindful of routine health care maintenance for infants under their care. They will order the Texas newborn screen, hearing screens, immunizations, car seat testing and ROP examinations as indicated.
e. As medically indicated, residents will perform appropriate diagnostic and therapeutic procedures after obtaining informed consent from the mother, with supervision from the attending neonatologist or NNP. Residents will document procedures in the chart and in their personal logbooks. On this rotation, these procedures may include:
    i. Arterial puncture
    ii. Endotracheal intubation
    iii. Intravenous catheter placement
    iv. Lumbar puncture

v. Thoracentesis and chest tube insertion
vi. Umbilical catheter placement
vii. Venipuncture
viii. Suprapubic catheterization

II. Medical Knowledge

a. Residents will draw from a wide range of patient diagnoses requiring admission to a level III NICU to broaden their exposure to a wide range of complex disease processes. In developing a differential diagnosis, the resident will demonstrate his/her ability to apply analytical thinking to the clinical situation.
b. During these four NICU rotations, it is expected that residents will manage infants diagnosed with, but not limited to:
    i. Congenital abnormalities
    ii. Congenital pneumonia
    iii. Hyperbilirubinemia
    iv. Meconium aspiration
    v. Necrotizing enterocolitis
    vi. Neonatal infectious diseases caused by bacteria, viruses, and parasites
    vii. Persistent pulmonary hypertension of the newborn
    viii. Pneumothorax
    ix. Prematurity (including apnea of prematurity, retinopathy of prematurity)
    x. Respiratory distress syndrome
    xi. Neonatal seizures
    xii. Perinatal complications
c. Residents will learn about the principles and application of parenteral and enteral nutrition, as well as fluid and electrolyte therapy in neonates.
d. Residents will work with attendings, respiratory therapists and other team members to manage conventional and high frequency mechanical ventilation of sick neonates.

III. Practice-Based Learning and Improvement

a. In caring for patients, residents will utilize a broad range of published medical information available through web-based resources, as well as printed textbooks and the medical school library. It is expected that decisions about patient care will be formed by review, synthesis and application of studies available in the literature. Daily work rounds will include discussion of information gathered from the literature by residents and other team members.
b. Residents will attend or review lectures on topics important to the care of neonates given by the neonatology staff.
c. Residents will take part in radiology rounds, reviewing radiologic imaging of their patients with the pediatric radiology attending and neonatology team.

d. All residents will take an active role in teaching third and fourth year TTUHSC medical students or any other visiting student rotating on the neonatology service.

IV. Interpersonal and Communication Skills

a. Residents will take part in daily collaborative interdisciplinary team rounds. They will provide innovative, state-of–the–art clinical care through a collaborative team of neonatologists, neonatal nurse practitioners, neonatal nurses, respiratory therapists, pharmacists, medical students, social workers, medical management, lactation specialists, occupational & physical therapists, speech therapists, chaplains and other support staff.
b. Residents will meet regularly with parents to listen to their concerns and keep them updated on their child's condition and care plan.
c. Residents will coordinate consult services and facilitate discussion among clinician members of the team the family.
d. Daily Site of Care notes in the chart clearly documenting patients' progress, diagnostic results and ongoing plans will be completed in order to maintain an accurate medical record and share information among team members. When leaving the rotation, an off-service summary will be prepared and made part of the medical record.
e. Residents will provide feedback to their co-residents, students and attendings on an ongoing basis throughout the rotation, completing written evaluations at the completion of the rotation. Similarly, they will receive regular verbal feedback and a final written evaluation from the attendings that will be placed in their permanent record. Residents will use constructive feedback to guide their efforts in ongoing learning and self-improvement.

V. Professionalism

a. Residents will interact with an extremely ethnically and socio-economically varied patient population that is treated in this SCN. Residents will care for patients independent of their ability to pay for services.
b. Residents will provide compassionate, empathetic and culturally sensitive communication with parents. They will be particularly sensitive to the unique situation of parents of severely ill infants. They will demonstrate sensitivity and responsiveness at all times to parents' culture, gender, sexual orientation and disabilities.
c. Maintenance of family confidentiality will be of highest priority.
d. Residents will at all times demonstrate ethical and professional behavior. During this rotation, in particular, residents will deal with issues of end-of-life care and withdrawal of support, potential for long-term disabilities and chronic illness. Residents will take part in discussions between attending physicians and families about end of life care decisions.

e. When appropriate, residents will utilize the Thomason Ethics Committee to facilitate team meetings to discuss difficult issues.
f. Residents will ensure that families give informed consent for all aspects of care.

VI. Systems-Based Practice

a. Residents are expected to provide high quality, but cost-effective health care. They will collaborate with case managers and other team members to implement appropriate discharge plans.
b. Residents will help arrange follow up with the Texas early child hood intervention (ECI), the Texas Tech High Risk Follow-up Clinic and specialists as indicated, in addition to the patent's primary care provider. Residents will communicate with the patient's primary care physician, especially near the time of discharge.

Introduction

Welcome to the Special Care Nursery. The Special Care Nursery (SCN) 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 welcomed. Your ongoing education should include reference to one or more of the listed reference texts. You are also to be given a suggested reading schedule from Klaus and Fanoroff. If this is followed 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.

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 please introduce yourself. Your TTUHSC name tag should be readily visible on your blue scrubs. Please give the mother the prepared paper 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.

Nurseries

Thomason Hospital has approximately 5,500 deliveries a year. There are 2 nurseries, the newborn nursery and SCN. The SCN is divided into 2 levels of care. The 18 bed ICN (Level III), and the 28 bed IMCN (Level II).

Admissions policies the ICN: (1:2-1:3 nursing to patient ratio)

- Infants < 1,600 grams
- All postoperative patients
- All preoperative patients requiring intensive care
- Infants intubated in the delivery room other than for just 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
- 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 O^2
Any infant with a glucose < 30 mg%
Persistent glucoses < 40mg%
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.

Teams:

There are 2-3 neonatologists (Dr. Ambat, Jesurun, Levin or Ipson) in SCN each weekday. Patient coverage is divided into two teams headed by one neonatologist for each team:

Teams consist of the following:

- ●1 second year pediatric residents 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

The 3rd neonatologist or floating resident is non-teaching neonatal coverage

- ●Covers L&D from 0700-1200
- ●Is responsible for all admissions from 0700 until 1100
- ●Will see simple IMCN infants (no discharges) and do progress notes when census exceeds the number of patients a resident should follow at their level.
- ●Supervises the 3rd year teaching resident during medical student rounds.

Rounds: **SCN nursery rounds** start each day at 0930-1130. Residents present their patients. Teaching will be primarily done by the SCN attending. Available resident or NNP on the team will write orders during rounds on the patient being presented to facilitate orders. The patients resident is responsible to double check that all orders discussed on rounds were written.

Clinics: **High Risk clinic** is held each Monday at 1300-1700. This clinic allows us to follow our at risk infants, infants on monitors, and/or O^2 during their first year of life. Attendance is mandatory unless the resident is post-call or has his/her continuity clinic.

Conferences: **SCN mini-lectures** each Tuesday and Thursday around 0915 (upon arrival of both attendings). These are 15-20 minute interactive/didactic case conferences or reviews of pertinent topics in the nursery presented by residents and faculty. Each resident will deliver 1-2 cases per month as assigned by the attendings at the beginning of the month. The last conference will be done by the two second year residents on an evidence based clinical therapy in the nursery.

Morbidity and Mortality Conference (M&M): is a shared conference with OB. During this conference statistics and evaluations of deaths including autopsies and pathology is discussed as well as a shared topic 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 the third Friday of each month (except July) from 12:00 hrs -13:00 hrs usually in the Texas Tech Auditorium.

Prenatal Update Meeting: is a shared conference with the perinatologists and the antepartum/high risk OB residents to discuss the pending high risk maternal and fetal problems. Presently this meeting is each Thursday in the Thomason 3rd floor antepartum conference room from 0730–0830. All free SCN residents and NNP's should attend.

Case Review Conference: is a conference shared with OB to discuss interesting newborn cases especially if preceded by a high risk pregnancy and delivery. This is held the first Friday of the month from 12:00 hrs-1:00 hrs in the Texas Tech Auditorium.

Radiology Rounds: will be at 09:00 hrs to 09:15 hrs. The radiology reading room is located in the SCN. When ordering X-ray studies please write the reason in your orders. Report the results in Site of Care 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 IMCN 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 NNPs). Interns must attend L&D calls with their seniors/NNP after 1200. NNPs 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.**

Infants for which the low risk team is to respond:

All normal spontaneous vaginal deliveries

The Following will or may have pediatrics:

Repeat cesarean sections with pediatrics.
Breech cesarean sections with pediatrics
Preterm births greater than 35 weeks

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 two weeks of age born at a lay midwifery center
Infants from zero to two weeks of birth born at home
Infants from zero to two weeks with cardiac/respiratory problems
Any birth in the ED (vaginal or cesarean section) or ambulance
Infants may be admitted to the SCN if 5 days of age or less.

***Infants 5 days or less may be admitted to the SCN if there is no evidence of a community acquired infection. Infants older than 5 days need to be admitted to pediatrics*.**

Infants for which the High Risk Team is to respond in Mother/Baby:

Infants with severe signs and symptoms of cardiopulmonary distress
Precipitous deliveries

Consults: The float, night PL-II/III and/or NNP covering L&D may be called 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 OB resident or attending should have called the neonatal attending on call to discuss the consult prior to paging the resident. 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 or pink copy into the resident communication file with the signed permits for UAC/UVC, blood and blood product transfusion and PICC line. 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. *Dr. Levin is presently in the process of forming a consent for resuscitation of borderline viable 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 hrs every morning on current patients, new admissions and the L&D board. Rounds with attending are at 0930 hrs and must be complete by 1130 hrs; High Risk Clinic starts at 1300 hrs every Monday. We advise you to start your day early. Residents are responsible for full patient care of the 6-8 newborns assigned to them including the initial complete history and physical exam as well as the ongoing assessment, plan of care, documentation, follow-up of all exams and tests ordered and extensive discharge planning of each individual patient. During this period residents should rotate carrying the resuscitation pager 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 on a regular basis.

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 8-10 infants in the ICN/IMCN and will be available to assist the PL-I with the care of their ICN patients and problems with their IMCN patients.

NEONATAL NURSE PRACTITIONER RESPONSIBILITIES:

Advanced trained masters or bachelors 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 High Risk Clinic and resident conferences. They will be available to assist in the education of residents.

FLOATER:

This is a PL-I-II assigned during a 4 week rotation from 1200-1700 hours to cover the patents of those residents assigned to the SCN who are post-call and to be relieved of the patient care responsibilities at 12:00 hrs.

NIGHT CALL RESPONSIBILITIES:

PL-I's: The PL-I should arrive to the nursery at 1630 for check-out. They are expected to evaluate new problems arising from 1700 – 0700 hours of infants in the IMCN and Well Baby Nursery. They are responsible for admission H&P's on infants admitted to NBN from 1700-2400 and all infants admitted to the IMCN during their call 1700-0700. They are to follow up on lab tests, evaluations and labs checked out to them by the other physicians caring for infants in the SCN. 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 SCN. They are responsible for answering all consults and resuscitations of infants requiring the HR team in labor and delivery, nursery and ER. They are to supervise the PL-I and MSIII/IV when needed and attend labor and delivery check out report with the obstetric team at approximately 1900-1930 hrs. It is desired for the resident to round with the charge nurse in ICN between 2200-2400 after rounding on the infants in the ICN.

PROCEDURES:

All residents are responsible for keeping a log of all of the procedures that you 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 program. There is a template for each procedure in Site of Care. Please fill in the blanks in the procedure note and then print it out and place it on the chart. Please enter your name 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 **Workbook in Practical Neonatology, Fourth Edition, by Polin and Yoder**. 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. DURING THE MONTH AND AT THE END OF YOUR ROTATION YOU WILL BE GIVEN A TEST ON THE BELOW READING MATERIAL. THE FINAL TEST GRADE WILL BE PLACED IN YOUR FINAL EVALUATION.

FIRST YEAR FIRST MONTH ROTATION

First week – Chapters 1&2
Second week – Chapter 3&4
Third week – Chapter 5&13
Fourth week - Natarajan G. Clinical Pharmacology of Caffeine in the Newborn. NeoReviews. Vol 8 No 5, May 2007.

FIRST YEAR SECOND MONTH SCN ROTATION

First week – Chapters 6&7
Second week – Chapters 12&19
Third week – Chapters 5&24
Fourth week (catch up)

SECOND YEAR FIRST MONTH SCN ROTATION

First week – Chapters 8&9
Second week – Chapter 10&11
Third week – Chapters 16&17
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 the *Third addition of Goldsmith and Karotkin's* Assisted Ventilation of the Neonate.

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

SECOND YEAR SECOND MONTH SCN ROTATION

First week – Chapters 14&15
Second week – Chapters18&20
Third week – Chapter 22&23
Fourth week – Review anything you want to. Suggest review articles "Alveolar

Fluid Clearance in Developing Lungs and its Role in Neonatal Transition," Pg. 585-599 and "Pulmonary Vascular Biology During Neonatal Transition," Pg. 601-619, both from *Clinics in Perinatology September 1999*.

References

Textbooks:

Klaus and Fanaroff: Care of the High Risk Neonate, 5th edition.
Fanaroff and Martin: Neonatal-Perinatal Medicine, 6th edition.
Avery: Avery's Diseases of the Newborn, 7th edition.
Cunningham: Williams Obstetrics, 19th edition.
Volpe: Neurology of the Newborn, 5th edition.
Smith: Recognizable Patterns of Human Malformation, 5th edition.
Polin and Fox: Fetal and Neonatal Physiology, 3rd edition.
Rudolph's or Nelson's 17th Ed. Textbook of Pediatrics.
Redbook 2006, 27th Edition.

Websites:

Neonatology on the Web.com
MD consult
Pub-Med
www.ttuhsc.edu/elpaso/som/pediatrics/neonatology
C:\Documents and Settings\mipson.TTUHSC\Desktop\UCSF Children's Hospital Intensive Care Nursery House Staff Manual.htm

STUDENTS

Third Year Medical Student Rotation in The Nurseries

WELCOME!!!

The following are guidelines to maximize your education about the well newborn and common diseases in the newborn. The nursery areas are a combination of the Well Baby Nursery (WBN) and the Special Care nursery made up of the level 3 nursery (ICN) and the level 2 Intermediate Care Nursery (IMCN). During this rotation you are still required to attend morning report with the Ward Team from 8:00-8:30 AM in the cafeteria dining rooms A&B in the basement on Mondays and Thursdays.

Day 1-3: (WBN)

The first three days of your 2 week rotation will be your newborn nursery experience. This is where you will learn the newborn exam, newborn care, newborn assessment skills and get checked off on your exam by the newborn faculty who are the ambulatory pediatricians and the 3rd year pediatric teaching resident. By day 2-3 the teaching resident is to observe your "graded clinical exam of the newborn". Each week day in the nursery rotation you are to do 2 well baby exams and 2 well baby exams each night on call. All your exams should be reviewed by a pediatric faculty, nurse practitioner, 3rd year teaching resident or physician assistant. The pediatricians, neonatologists, physician

assistance, NNP and senior residents are here to demonstrate exams, clarify and facilitate learning and expand what you started in newborn.

Days 4-14: SCN

Your day will be from 7:30-5:00 Monday through Friday. You will be assigned patients by the teaching resident and will spend the first hour seeing your assigned patients and going to morning report. It is suggested before rounds with the teaching resident you go over the assessment and plan with your patients assigned residents.

Each student will follow 1-2 patients. The teaching resident will assign these infants to you. These should be IMCN infants only. You should have infants with a spectrum of common illnesses as follows: Respiratory distress (TTN, meconium aspiration, and pneumonia), Trisomy 21, Suspected Sepsis, Hyperbilirubinemia, Hypoglycemia, Infant of a diabetic mom, polycythemia.

If you have completed evaluating and writing progress notes for your infants before the resident talks and rounds at 0830 then contact the attending pediatrician covering L&D and attend deliveries with him or her.

You are responsible for one formal H&P during your rotation. Submit it to Rosie no later than the 3rd day after starting your SCN rotation. We will return it to you 24-48 hours after we receive it. This allows time to discuss it with you if there are questions or problems. It is important for the problem list to be complete. The assessment should have a differential, as well as rational for all treatments and tests. Please include parental education which includes what you tell the family about the case. We will not routinely go over your progress notes unless there are organizational problems or questions. It would benefit you to have them accurate, organized and complete. We do not want you presenting Site of Care or computerized notes as they do not facilitate learning to organize data for presentation. We present in a system/problem oriented method (SOAP – Subjective information, Objective information, Assessment and Plan).

You are excused to attend morning report and all lectures. Please return in the afternoons so at 4:30-5:00 PM you may check your patients out to the on call team. Your information is frequently very important to the care of your infants.

When you are on call at night you will take call on the floor in the SCN resident's call rooms. Please accompany the pediatric intern/resident throughout the night-call. This will allow you to attend all the deliveries that occur during your call as well as the consults that the senior resident does in L&D and the newborn calls the intern attends to maximize your education.

MS IV ELECTIVE: (**ADVANCED NEONATOLOGY (MPED-8060-801))**

Course Number:	MPED-8060-801
Prerequisites:	Pediatric junior clerkship and arrangements 30 days in advance.
When offered:	Each month except July and December (1 student per month)
Location:	TTUHSC at El Paso

Faculty: Drs. Ambat, Ipson, Jesurun, and Levin

Objectives:
- Function as a sub-intern in a closely supervised four week rotation
- Assume responsibility for establishing the differential, primary diagnosis, management and follow up care of common diseases and problems of the ill newborn.

Objectives:

1) Review normal transition of fetal physiology in the newborn and common diseases, conditions and problems that prevent this normal transition.
2) Improve the ability to create a differential to common newborn diseases symptoms resulting in the ability to come to a appropriate primary diagnosis allowing initiation of therapy and follow up care i.e.; sepsis, asphyxia, infant of a diabetic mom, polycythemia, hypoglycemia, respiratory distress, hypotension, hyperbilirubinemia, intrauterine growth abnormalities, common birth defects and surgical problems of the newborn.
3) Expand the history and physical exam in a problem focused manner. Expand the ability to document multiple problems in a problem oriented manner with the object of communicating with other health care professionals.
4) Learn to communicate with parents of ill newborns.
5) Exposure to common procedures, skills and equipment used in the treatment of the ill newborn: Initial newborn resuscitation, venipuncture, umbilical vein and artery catheterization, urethral catheterization, lumbar puncture. Learn when these procedures are used.

During the second week of the rotation the student should select a topic for a 50 minute Power Point presentation approved by his/her attending. This is to be given to the neonatal teams the last week of his/her rotation. It is the responsibility of the student to schedule the room, time and equipment for the presentation by contacting Maria Garcia at 545-6776. The neonatal team members should be notified of the presentation time and place by the presenter.

Reading material: Care of the High Risk Neonate (5th ed.) by Klaus & Fanaroff.

First week: Chapter 1, 2, & 3
Second week: Chapter 4, 5, & 6
Third week: Chapter 11, 12 & 13
Fourth week: Chapter 14, 17, & 19

You may at times find it handy to have a physiology text available for certain parts of this book. I recommend you read additional articles for individual patient issues as Klaus and Fanaroff is a general text book and may not have the most recent diagnostic tools or therapy.

Monthly Reminders for House Officers and Students

Infection Control

Wash hands three minutes each morning at sink before coming into the nursery and between patient and before patient exams. 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. Wear gloves while examining those infants. 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 and Orders

Please use black ink for all documentation.

Date and time all orders. Make sure your orders have the babies name and MR on them.

Follow accepted abbreviations and don't short cut with unaccepted abbreviations.

DON'T USE DC (USE DISCHARGE OR DISCONTINUE)

QD to now be q day or daily.

When a mistake has been made draw a line through it, write error above it and initial.

Do not scribble out or use white out.

When you have written orders notify the nurse of the baby and leave it at the bedside to be noted by the nurse or unit clerk. Try to review the chart at the bedside and do not take the chart from the SCN area.

All copies made of notes in the chart need to be destroyed. Don't place in the trash AND PLEASE DON'T LEAVE CONFIDENTIAL PAPERS LYING AROUND.

Patient Care

Plot growth and head circumference each Wednesday on the **Dancis** growth chart. This is a permanent part of the chart to be kept in the graph area.

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, (the vaccine for all infants and HBIG only if the infant is $\leq$ 2 Kg). 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. A final test will be given at the end of the rotation on the assigned reading material. The grades go in the final evaluation.

There will be mini talks and case presentations (around 20 minutes) twice a week. These will be assigned by the senior residents. These will be lectures on Power Point with references. Approximately 0900-0915 we will review X-rays with Dr. Robinson and the lecture will follow. The last talk will be a combined talk by the two seniors on the evidenced basis for a clinical therapy in the nursery.

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 7:00 PM if possible. 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 file 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.

If you admit an infant to the SCN admitting area and the infant does so well he/she is ready to go to the NBN, a note needs to be written, orders need to be written for admission to the SCN and the transfer to NBN. These transitional infants need to be entered into **SOC**. Talk to the NBN resident on call to let them know that the infant is being transferred.

APGAR SCORE

	0	1	2
APPEARANCE (color)	Blue, pale	Body pink; hands & feet blue	Completely pink
PULSE (heart rate)	Absent	Slow (below 100)	Over 100
GRIMACE (response to stimulation)	No response	Cry with some motion	Vigorous cry
ACTIVITY (muscle tone)	Flaccid	Some flexion of extremities	Active motion, Well flexed
RESPIRATION (respiratory rate)	Absent	Slow, irregular, hypoventilation	Good Crying lustily

Apgar Scores at 1 minute of life:

- 7-10 Normal baby
- 4-6 Moderately depressed
- 0-3 Severely depressed

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. Normal infants temperature is 35.5-37.5ºC with a +/- 0.5ºC 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 25ºC with low humidity drops their temperature 0.2-1.0ºC/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 75-77 degrees.
- For extended resuscitation a probe should be placed
- Sides of the radiant warmer should be up to prevent radiant/conductive losses
  - Warm cap
  - Dry **warm** linen under port-a-warmer
  - 1 gallon plastic bag or wrap to immediately wrap infant without drying.
  - ETT and stylet ready or nearby
  - Bag and appropriate sized mask
  - Suction working with adequate sized suction catheter (6-8Fr)
  - O2 sat probe.

Handling Infant (minimally and gently):

- Place infant in the 1 gallon polyethylene bag without drying
  - DO NOT DRY OR RUB
- May use a port-a-warmer underneath
- Place a saturation probe to wean O^2 to keep sats < 94%
  - NO O2 TO BE USED INITIALLY
- Place a warm hat ASAP
- IF INFANT NOT STABLE DO NOT WEIGHT IN L&D
  - 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

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

Ventilation:

BPD or CLD (multifactorial and ventilator induced lung injury)

Lung injury develops rapidly with first breath in the delivery room

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

●Limit PIP and use rate with short inspiratory times
●Do not bag unless hooked up to a manometer
●Use PEEP as early as possible
●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 4 cm in infant with RDS < than 1,000 grams)
●Place on SIMV (sensitivity must be set)
●Tidal volumes of 4-7 cm/kg
●Inspiratory times of 0.3 or less
●Avoid too much oxygen
In SCN keep O_2 saturation 80 to 92%
●Avoid over-ventilation.
CO_2 less than 35 needs to be addressed immediately
Attempt to keep initial CO2 45-55, pH > 7.27
●If the infant is fighting the ventilator you may have to sedate
(not routine so discuss with attending first).
Morphine 0.1 mg/kg/dose IV q 3-4 hours

Fentanyl 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 Versalette with humidity (if available) for isolette care
- Avoid adhesives
- Minimal use of topical medications as irritating, easily toxic
  (especially if have preservatives)
- Use baggie or plastic wrap to avoid evaporative losses
- May use Aquaphor TP q 12 hours x 3 days;
  minimizes insensible losses
  may prevent skin breakdown decreasing infection/colonization rate
  do not allow infant to share TP medications.
- Increase humidity but limit to 3-5 days.

Example of Initial Orders for ELBW Infants (<1000 g):

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

Condition: Critical

Activity: Versalette Isolette

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

IVF: D5% W at 80–100ml/kg/day
if infusing in UVC add heparin 1 unit/ml
TPN may be started in first 24 hours
trophamine 1.0 Gram/kg/day
calcium gluconate 2 meq/kg, MVI AND MINERALS
NO K, NA OR PO4
TPN at 80ml/kg/day with additional fluid to meet fluid needs Y'd in
UAC fluid ¼ NS with 1 unit heparin/ml to run at 0.5ml/hr

Medications: Ampicillin 100-200 mg/kg/day divided IV q 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 MODE IN SIMV (sensitivity must be set)
PIP 16-22 cm H_2O if has lung disease, 10-14 cm H_2O if none
deliver Tidal Volumes no higher than 4-7 ml/kg
PEEP 4 cm H_2O
3 cm H_2O if no lung disease
Flow of 5-6 liters (usually more not needed)
Short inspiratory times of 0.3 seconds or less if using higher rates (> 40)
Respiratory rate of 30-40
Wean FIO_2 to keep saturations 85-92%
CXR and KUB for line and ETT placement as well as evaluation of lung disease then q AM until stable.

Skin care: Aquaphor TP lightly q 12 hour x 3 days if less than 800g
Cover with plastic wrap if intubated and under a radiant warmer
Humidification

LABS: Initial spun Hct.
CBC with diff at birth then 24 and 48 hours
CRP at 24 and 48 hours
Lytes q 12 hours the first 24 hours
Q 24 hours BMP for BUN/creatinine/Ca++ (preferably ionized)
T/D bili q 24 hours
bili 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

<u>INITIATION OF MECHANICAL VENTILATION</u>:

Respiratory distress (some causes):

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

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

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:**

Surfactant deficiency – 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):

Evolving lung disease

Result of;

positive pressure ventilation and it's associated barotraumas/volutrauma factors noted in pulmonary insufficiency of prematurity

Definition;

oxygen dependency at 36 weeks gestation

if born after 36 weeks oxygen dependency at 28 days.

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

Ventilation:

Two ventilators used in this nursery for ventilation

VIP Bird for conventional ventilation (CV) and the
Sensormedic 3100 for high frequency oscillatory ventilation (HFOV).

Continuous positive airway pressure (CPAP):

Delivered by 3 forms; VIP Bird, high flow by Nasal Cannula or Vapotherm
High Flow

Nasal cannula (NC) flows 500ml/min-2L/min
Vapotherm at 1-8L.
Infant should be in ICN
NC flows of 25-500 ml/min can be used in the IMCN
All O2 must be on a blender to allow weaning without weaning flow
keep saturations 88-92% unless ordered otherwise.

Conventional Ventilation (CV)

We most commonly use time cycled pressure limited ventilation (TCPL) as **Conventional Ventilation (CV)**

Definitions:

PIP (Peak Inspiratory Pressure):

Maximum pressure in cm of H_2O used to deliver a breath
PIP needed in each infant varies based 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 TV
Initial PIP assessed bagging with manometer noting pressure used to move chest
Adjustments made after placing infant on the vent and observing the TV provided

PEEP (Positive End-expiratory Pressure):

Pressure in cm of H_20 used at the end of a ventilator breath (Intubated)
Keeps functional residual capacity (FRC) which is about 30ml/kg
Keeps alveoli from going below the critical closing pressure
If FRC lost the alveolar collapse
Increase in pressure needed to reopen the atelectatic alveoli
Atelectasis can be avoided if adequate PEEP used
Atelectasis as harmful to the lungs as over distention
Infants ≤ 1,500g with minimal/no lung disease PEEP of +3 started
1,500 g infant with HMD/pneumonia may need +4-5
Older infants start on PEEP of +4 ↑ +5-6 with significant lung disease
Use of PEEP above numbers to be discussed with attending

IT (Inspiratory time):

Length of time in seconds to deliver PIP

Start all infants on an IT of 0.3 seconds
Adjust as needed based on the disease process

To increases MAP and improve oxygenation IT may be increased
Do not increase IT ↑ 0.4 seconds without talking to an attending
Some ELBWs with hyperexpansion/little lung disease shorter IT's used

IMV (Intermittent Mandatory Ventilation):

Respiratory rate (RR) set to deliver the PIP and IT in 1 minute at regular intervals
Example; if rate set at 20 the ventilator will deliver that breath 20 times a minute (every 3 seconds) whether the infant is inhaling or exhaling.

SIMV (Synchronized Intermittent Mandatory Ventilation):

Above RR is synchronized with the infant initiating the breath
This setting most frequently used
Infant has more control over his/her ventilatory rate
they are calmer, fight the ventilator less and need less sedation
If RR is set at 20
ventilator gives 20 bpm but irregularly based on infants trigger
if no infant trigger the ventilator goes to regular timed intervals
sensitivity needs to be set for synchronization to occur
most term infants set at 0.4 - 0.6 and preterms set at 0.2.

PS (Pressure Support):

Positive pressure allowing infant to breath↑ ventilator rate
Pressure calculated as (PIP + PEEP ÷ 0.75) = PS in cm H_2O
10 cm H2O is a relative upper limit
Prevents exposing infant to larger **Tidal Volume** or pressure given by PIP
Infant can breath spontaneously above the flow delivered by the ventilator

TV or V_t (Tidal Volume):

Volume delivered into the lungs when the PIP is delivered
Range we use is 4-7 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 to little (atelectasis) or to much tidal volume (volutrauma) contributing to BPD.

MAP (Mean Airway Pressure):

Area under the curve of the PIP, PEEP, rate, and IT
Needed to allow optimal ventilation and oxygenation
Excess contributes to air leaks and trauma to the lungs.

<u>High Frequency Oscillatory ventilation (HFOV):</u>

HFOV is ventilation with rapid rate and low tidal volume
HFOV used in this nursery
Active exhalation emptying the lung during expiratory cycle
Problems with **HFOV;**
over-distention with air trapping

causes cardiovascular compromise due to over distention.

Benefits of HFOV;

decreased PIP, decreasing the barotrauma

less volutrauma due to small V_t's used

Differences in CV and HFOV parameters:

Parameters	**CV**	**HFOV**
Respiratory Rate	0-60 breaths/minute	120-900 breaths/minute
Tidal Volume	4-7 cm H2O	0.1-1.5 cm H2O
Alveolar Pressure Swing	5-50	0.1-5
Gas Flow	Low 5-8 L	High 14-20 L
Temperature	37 C	39 C

Oxygenation:

Primarily determined by the Mean Airway Pressure (MAP)

Resultant optimal MAP;

optimal alveoli recruitment

optimal ventilation and perfusion (V/Q)

avoiding under and over alveoli distention.

Initial HFOV settings:

Place the infant on a MAP 8-15 according to GA, weight and history

MAP 1-2 cm H2O above the last MAP on CV

Start the infant on 50% O_2 and wean to keep saturations (sats) 88-92%

If O2 sats < 88 increase MAP by 1 until O_2 sats are > 88%.

Increasing MAP can be done q 2-5 minutes

Wean MAP if O2 < 30% and chest expansion adequate on CXR and chest "wiggling"

Watch BP closely

If mean blood pressure drops less that the 50% from baseline

consider volume (10ml/kg NS over 30 minutes)

mean BP should be no lower than 30 mmHg at any gestation

Management:

Obtain CXR 1 hour after HFOV begun

Check lung expansion

target is 8-9 ribs; no intercostal bulging, no flattened diaphragm

CXR < 8 ribs and on > 30% O_2 increase MAP by 1

CXR > 9 ribs and on < 30% O_2 decrease MAP by 1

CXR > 9 ribs and on > 30% consider volume or repeat surfactant

When the MAP is decreased and no change in O_2 requirements

Cont' decreasing MAP 1 Q 4 hours in 1st 24 hours

Decrease Q 2 hours is the second 24 hours

If O_2 needs increase > 30% go back the previous MAP

check CXR to rule out loss of lung volume

stop weaning until sats, O_2 need, and BP stable for 2-3 hours

Goal is avoid O_2 fluctuation and keep at the lowest oxygen

CXR monitoring:

Goal: 8-9 rib expansion with no intercostal bulging or flattened diaphragm.
Identify PIE early
Rule out volume loss or over-distention
Ensure adequate ETT placement

Ordering CXR: this may be modified by the situation or attending
One hour after HFOV initiated
Then every 6-8 hours and PRN x 24 hours
Then every 8-12 hours and PRN x 48 hours
Then every 24 hours and PRN

Stat CXR ordered:
Any sudden decrease in saturation
Gradual or sudden decrease in blood pressure
Oxygen requirement increases more than 10%
Blood gases showing a big change in O_2 and or $PaCO_2$.

●If the CXR shows over-distention wean MAP by 1 hour every 2-4 hours until FIO_2 needs begin to increase if clinically possible.

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)

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

Weight	**50% for Mean Blood Pressure**
1,000 grams	30 mmHg + 5 = **35 mmHg**
900 grams	29 mmHg + 5 = **34 mmHg**
800 grams	28 mmHg + 5 = **33 mmHg**
700 grams	27 mmHg + 5 = **32 mmHg**
600 grams	26 mmHg + 5 = **31 mmHg**
500 grams	25 mmHg + 5 = **30 mmHg**

pCO_2 monitoring:

Target CO_2 is 40-55 with pH above 7.25-7.28 unless discussed otherwise
Adequate chest expansion and lung recruitment assists with adequate ventilation
pCO_2 elimination is controlled by the Amplitude or Power
Adequate amplitude
assessed by the wiggling of chest between the xyphoid and umbilicus
and adequate pCO_2 on blood gases (40-55).

<u>Causes of CO_2 retention</u>:

Under-ventilation and over ventilation:

- pCO_2's 40-55 help avoid over-ventilation
  - Less over-ventilation the better the long term outcome
- $CO_{2\ retention}$ 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 thus increasing hyper-expansion and worsening the CO2 retention.**

Air leaks:

- **Pneumothorax**
- **Pulmonary interstitial emphysema (PIE) – interstitial air trapped around the alveoli widening the diffusion space for gases thus interfering with ventilation and perfusion.**
  - Both causes of CO2 retention not related to under or over-ventilation

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

<u>Goals for ventilation</u>:

Wean amplitude to maintain pCO2 in the target range.

Avoid at all times pCO2 less than 35 mmHg

- **Ventilatory emergency as low pCO2's acutely decrease cerebral blood flow resulting in white matter ischemia and resultant PVL.**

The following are **<u>suggested</u>** actions:

- CO2 < 35- decrease amplitude by 5 and repeat gas in 15 minutes.
- CO2 35-45-wean amplitude by 1 q 4-6 hours.
- CO2 40-50-no change needed but repeat 2 gases 2 hours apart
- CO2 50-55-increase amplitude by 1-2 following a gas in 1-2 hours
- CO2 55-65-increase amplitude by 3 following a gas in 30 minutes to 1 hour
  - If no improvement obtain a CXR and evaluate the infant
- CO2 65-evaluate and increase amplitude by 4, follow gas in 30 min
  - If no improvement obtain a CXR.

<u>Hertz (HZ) is the frequency</u>:

- <u>Decisions to change the HZ are made by a neonatologist only</u>
- 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

HZ recommended according to weight:

≤1,500 g	15 HZ
1,500-2,500 g	12 HZ
> 2,500g	10 HZ

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 are to be increased back to 10 as the first weaning strategy before decreasing the amplitude. Decreasing the HZ is also an alternative to decrease the $pCO_{2\ (>65)}$ early on in the disease process **if** amplitude is double the MAP and pH is still in the abnormal range.

NUTRITION

Caloric needs for the preterm vary individually but are around 120–140 cal/kg/day. The goal is a weight gain of 1- 2% of the present weight per day (mimicking intrauterine weight gain). Caloric needs at term are less at 100-120 cal/kg/day. To follow growth rate in the SCN a growth chart adapted from known intrauterine growth rate needs to be followed weekly. The process for this is noted at the end of the nutrition section and should be adhered to. The nurses document the head circumference and weight daily. Please enter these measurements into the **Site of Care** notes.

Suggested guidelines for the initiation of parenteral nutrition:

- TPN (parenteral nutrition) should be initiated ASAP after birth (when stock bag warmed) in infants less than 1,500 g.
- Infants > 1,500 gms can start 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 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.

THOMASON 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 **7.5% 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/k/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 rest of the total fluid requirement for the day.

Please allow time to warm the solution before starting infusion.

The early PN solution is incorporated in the revised admission orders for VLBW which is pending review and approval. Meanwhile, the order can be written on blank order sheet as **"Early PN solution: 7.5% dextrose, 4% amino acids, 200mg Ca gluconate/100mL and 0.5units/mL heparin."** and sent to pharmacy.

The table provides essential calculations of calorie and protein intake depending on administration rate.

Glucose concentration	Rate (ml/k/day)	Non-protein calories (kcal/kg/day)	G protein/kg/day
7.5%	40	12	1.6
7.5%	60	18	2.4
7.5%	80	24	3.2
7.5%	100	30	4

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

References:

1. David H. Adamkin. Nutrition Management of the Very Low-birthweight Infant: I. Total Parenteral Nutrition and Minimal Enteral Nutrition NeoReviews, Dec 2006; 7: e602 - e607.
2. Scott C. Denne. Evidence supporting early nutritional support with parenteral amino acid infusion. Semin Perinatol. 2007 Apr;31(2):56-60. Review.

Carbohydrate:

●Infants < 1,000g have ↑ glucose needs but may not handle glucose well

●Suggested glucose delivery rates are 6-8 mg/kg/minutes initially
    ▪D5W-D7.5W at 80-120 ml/kg/day usually meets this need
●Do not exceed 18 gm/kg/day glucose.
●Goal is a glucose range of 50-120 mg/dl, treating glucoses > 150 mg/dl.
●Glucose delivery should not increase greater than 2 mg/kg/minute per day
●Goal is maximize protein and intralipid delivering carbohydrate to deliver 120 cal/kg/day or weight gain of 1-2% per day.

Protein:
●Daily protein need for a preterm is 3.5-4.0 g/kg/day and term 2.5 g/kg/day
●Infants not receiving amino acids during first days lose 1% of endogenous protein stores or 1 gm/kg/day
●We can't deliver TPN protein of 4 gm/kg/day as this along with high CHO and limited enteral feeds facilitates TPN cholestasis
●3.0-3.5 g/kg/day is the goal for the preterm and 2.5 g/kg/day for term
●Trophamine is the amino acid solution used and can be initiated DOL 1
    ▪4% trophamine in preterms < 1,500 grams and 2 gm/kg at term
    ▪advance 0.5-1.0 gm/kg/day
    ▪Daily lytes or BMP's (if clinically indicated) should be followed in VLBW (those infants less than 1,500 g) while advancing TPN.

Intralipids:
●20% Intralipid used in this nursery
●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 0.5 gm/kg/day (max 3.0 g/kg/day)
●At least 0.5 -1.0 g is needed weekly to avoid fatty acid deficiency
●Triglyceride levels should be checked the morning after initiating intralipid
    ▪then after each two increases of 0.5 gm lipid/each day
●Reasons to decrease or stop IL infusion:
    ▪Triglyceride > 150 mg/dL or evidence of IL intolerance
    ▪Suspected clinical sepsis or documented bacteremia
        –Discuss with attending about IL infusion during this period
        –Until infection controlled some attendings stop or ↓ the infusion rate
    ▪Serum bilirubin rising quickly or close to exchange levels
        –lower infusion to 1.0 g/kg/day or less until bilirubin controlled
        –allows maximal transport of bilirubin by albumin
        –Please discuss this with your attending.

HELPFUL TIP:
1 gram dextrose as CHO = 3.4 kcal/gm
20% IL is 20 gms/dL. (0.2 g/ml) = 2 kcal/ml

Calcium, Phosphorous and Vitamin D administration in TPN:
Osteopenia of prematurity is caused by many factors affecting retention, excretion, and absorption of Ca and Phos in the preterm infant.

●TPN Ca/Phos never reaches the amount for intrauterine accretion rate of these minerals
●Goal is to maximize Ca/Phos in TPN
●Facilitate full enteral feeds on fortified HM or preterm formula ASAP
●TPN vitamin D in the vitamin additives is adequate
●On full enteral (150 ml/kg/day) feeds, vitamin D in preterm formula is usually adequate
●No research or clinical evidence that > than 400 IU Vitamin D intake daily is helpful

Maximize amount of Ca/Phos in TPN (avoiding precipitation) at ratio allowing max retention of both minerals.

Ratio of 1.7:1 to 1.3:1 Ca to Phos by milligram weight should be obtained.

1 meq Ca = 20 mg Ca Gluconate
1 mM Phos = 31 mg Phos as NaPO4 or KPO4

<u>Maximum safe Ca/Phos</u>:
●>120 ml/kg/day TPN: 90 mg/kg/day (4.5 meq/kg/day) Ca & 60 mg/kg/day (2 mM/kg/day) of Phos 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 Phos to 45 mg/kg/day (1.5 mM kg/day)
●< 100ml/kg/day limit Ca to 40 mg/kg (2 meq/kg) and Phos to 31 mg/kg/day (1 mM/kg) until TPN no longer used
●Do not deliver more than 3 meq/kg/day peripherally. Higher concentrations should be administered via central line (PICC, Broviac, CL or UVC) only.

<u>General Nutrition Labs</u>:
●500 – 1,500 g infants
- ▪ glucoses routinely done while on IVF
- ▪ Lytes daily until TPN fully advanced and infant stable.
- ▪ Some recommend a BMP Wed. & Sat. until greater than 1,500 g unless stable
- ▪ Calcium and Phos. each Wed. while on TPN until stable
- ▪ T&D Bilirubin Q Wed. while on TPN
  - -Direct Bili is the first lab to become elevated in TPN cholestasis
  - -If elevated then LFT's need to be followed with GGT every other wk
  - -If cholestasis identified follow direct bili even off TPN until less than 2.0 mg/dL
- ▪ Alkaline Phosphatase every other Wed. starting the second week of life
  - -Markedly elevated before changes noted on x-ray in osteopenia
  - -Abnormal if > 500 U/L
  - -Follow every other Wed. until less than 350 U/L on preterm formula
- ▪ Spun Hct each Wed;
  - -Order reticulocyte count every Wed. after three weeks of age.
- ▪ Triglyceride after first 24 hours on IL then

-24 hours after each total increase of 1.0 g/kg/day until stable on 3 g/kg/day.

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
- Protein and IL in g/kg/day should be entered daily in **Site of Care**

Preterm formula has increased protein, less lactose than term formula and increased Ca, Phos., Vitamins. It is made for preterms and can be initiated on any infant < 37 weeks. HM is the preferred form of nutrition in the preterm if fortified which increases protein, some CHO, vitamins, Fe, Ca and Phos.

HELPFUL HINTS:

20cal/oz formula (any kind)	**= 0.68 kcal/ml (same for HM overall)**
22cal/oz	**= 0.74 kcal/ml**
24 cal/oz	**= 0.81 kcal/ml**

INITIAL FLUID AND ELECTROLYTE MANAGEMENT IN THE NEONATE

- 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
- Term should loose 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 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.

●Most term infants tolerate advancing IVF 20 ml/kg/day unless

◦Inadequate urine output

◦Na < 135

◦Gained weight and not diuresing

●Hypoglycemia 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 COVERED BY PLASTIC WRAP IF UNDER A RADIANT WARMER AND INTUBATED (insensible losses may be reduced by 30-50 ml/kg/day).

●IF NOT INCUBATED THEY NEED TO BE IN AN ISOLETTE.

First 24 hours:

< 800 g 100-120ml/kg/day D5W or more

varies in Versolet vs radiant warmer

consider Aquaphor TP q 12 hours x 3 days).

800-1000 g 80-100 ml/kg/day D5W

1,000 -1,500 g 80 ml/kg/day D7.5-D10W

1,500-2,500 g 60-80 ml/kg D10W

Term 60 ml/kg D10W

Initial labs for monitoring fluid and electrolytes in infants on IVF:

< 1,000 g follow lytes q 12 hours until stable then q 24 hours.

> 1,000 g follow lytes q 24 hours

< 1,500 g/< 34 wks consider a BMP or CBG to follow CO2 at > 72 hours

↑HCO3 loss in the urine with high FENA due to renal immaturity

─Suspect if excess weight loss/poor weight gain despite adequate calories in the first week of life

●Fluid delivery should be based on Na and weight changes.

●Urine output in the preterm infant is not a good indicator of hydration status

< 1,250 g will continue to have brisk urine output despite significant fluid losses

●Serum ionized Ca should be monitored q 24 hour until stable in infants < 1,250 g.

Suggested management after the first 24 hours:
●Preterm < 34 weeks Na introduced at 48-72 hours if weight loss has occurred and the serum Na is 140 or less.
●Na started at 2-3 meq/kg and adjusted based on needs to keep Na 135-140.
●Remember urinary fractional excretion of Na (FENA) can be high, excreting ~ ½ NS in the urine and worse if on caffeine, aminophyllin or diuretics.
●K can be 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.
●All infant < 1,500 g should be placed on TPN shortly after birth if stable.
●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.
●Initially there will be no electrolytes except Ca Gluconate which should be introduced to IVF at 0-48 hours to avoid the excess nadir of serum Ca that occurs in preterm infants.
●2 meq/kg Ca Gluconate (1 meq = 20 mg Ca) can be given in less than 100 ml/kg IVF peripherally without putting the infant at risk for TPN burns if an infiltration occurs.

INITIATION OF ENTERAL FEEDS:
500-1000 g or < 28 weeks
●May start feeds as bolus or drip.
●Feeds initiated when infant clinically stable after discussion with the attending.
●Trophic feeds started initially at 5-10 ml/kg/day or 1-2 ml q 6 hours. ~
●Full strength human milk preferable but preterm 20 cal formula with iron can be used.
●Feeds can be started as early as DOL # 1 but usually by day 2 of life.
●When infants tolerate trophic feeds for ~ 2-3 days, advance 10ml/kg/day if < 1,000 g.
●When 100-120 ml/kg/day, feeds fortified by changing preterm formula to 22 calories then 24 calories.
●Breast milk fortifier is added after reaching 100-120ml/kg/day, by adding 1 packet per 50 ml one day then 2 packets per 50ml the next day.
●When increasing concentration do not advance volume of feeds that day.

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

1250–1500 g or 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.

1500-2500 g or 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.
●For ELBW 24 cal preterm formula or fortified HM is suggested until 42 weeks.
●VLBW/LBW preterms 22 calorie transitional formula (Enfacare) meets these infants higher protein, mineral and caloric needs.

●22 calorie transitional formulas approved for ELBW's until 9 months chronological age
●A WIC form needs to be filled out for special formula's prior to discharge.

≥ 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 first day of life is usually 60 ml/kg/day.
●If the infant does well then 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).
●These feeding advances should be reserved only for healthy infants.
●Infants with feeding difficulty, any feeding intolerance, 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;
-Start at 10-20ml/kg/day
-Advance no more than 20ml/kg/day unless discussed with an attending.
-Human milk or preterm formula (<36 wks) or term formula (≥ 37 weeks) may be used initially unless discussed otherwise.
-If there is a strong suspicion of short gut then a more elemental formula may be started.

Initiation of iron therapy:
●Fe should be considered when the infant is on full enteral feeds, at least 6-8 weeks old and/or 2-4 weeks after the last transfusion.
●The dose is 2-3 mg/kg or 4-6 mg/kg if on Epogen therapy. May not need if on formula.
●Ferinsol or MVI with Fe may be used.
●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 HM fortifier does have some fortification with vitamins/and some have Fe.
●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.

Monitoring Growth:
●Infants who stay in SCN last longer than one week should have a growth chart plotted.
●This should be done each Wednesday as nutrition labs are done that day.
●We presently use the Dancis growth chart on preterms and the regular NICHD chart for term infants.
●This should be a permanent part of the chart found in the graphic section.
●Adjusted age should be calculated by the post menstrual age (**Site of Care** dose this).

REGULATION OF GLUCOSE **(George Maldanado NNP)**

Guidelines for the management of hypoglycemia, hyperglycemia and normoglycemia in preterm and term infants.

Hypoglycemia

Definition: Plasma glucose < 40 mg/dL in both preterm and term infants.

●All infants admitted to the SCN will be screened for hypoglycemia on admission.

●The physician/NNP will be notified for a serum glucose < 40 mg/dL or > 120 mg/dL.

Risk factors:

Infant of a diabetic mom (IDM)
Infant of gestational diabetic mom (IGDM)
(especially if mom received oral hypoglycemic agents)
LGA and SGA
perinatal stress
sepsis/infections
post-asphyxiated or HIE or APGAR < 5 at 5 min of age
hypothermia
polycythemia
Beckwith-Wiedemann Syndrome
Pre and post mature infants
Infants born to mothers with toxemia
Decreased glycogen stores, endocrine/metabolic disorders.
Erythoblastosis fetalis.

Signs: apnea, hypotonia, inadequate sucking reflex, irritability, jitteriness, poor sucking or feeding, cyanosis, tremors, pallor, seizures, lethargy, temperature instability and coma.

Monitoring:

Serum glucose monitoring as follows:

a. q 30 min after intervention until stable
b. then q 3-6 hour if on IVF only
c. or ac (pc if borderline) for the first 24 hrs.

Diagnosis:

●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.

Treatment:

●If not clinically contraindicated and glucose is > 30 mg/dL, the infant can be

●If oral feeds fail to resolved hypoglycemia, glucose < 30 mg/dL or unable to feed secondary to respiratory distress;

-a "minibolus" is given at a dose of 200 mg/kg (2 ml/kg of D10W).

●IV therapy D10W at rate of 6 mg/kg/min, corresponds to 85 ml/kg/day with D10W

●Concentrations > D12.5% are sclerosing to veins and should only be administered via a central line (UV or PICC).

●If glucoses 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 glucoses.

●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.

Hyperglycemia

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

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

Signs: Polyuria due to glucosuria, all other signs associated with sepsis.

Monitoring: by serum glucose q 1 hr until < 150 mg/dL then q 4 hrs until normoglycemic

Treatment: if serum glucose > 150 mg/dL.

a. Reduce glucose infusion rate (GIR) 2 mg/kg/min by decreasing total fluids. If total fluids can not be decreased, decrease glucose concentration or Y-in lower dextrose concentration to maintain total fluids constant.
b. IV insulin administration (0.1 unit/kg IV) if reducing the GIR is not effective or is not possible. This treatment should only be undertaken after consulting the neonatologist. There is not a 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 or < 100 then q 1 hour until stable.

Glucose infusion rate: $\frac{\text{rate (ml/hr) x dextrose infusion (D10) x 0.167 (constant)}}{\textbf{Wt in Kg}}$

3 kg baby on D10W at 80 ml/kg/day = rate of 10 ml/hr $\frac{10 \times 10 \times 0.167}{3} = 5.5$ mg/kg/min

Normoglycemia

Definition: Serum glucose 50-100 mg/dL in infants not receiving IV fluids.

Monitoring: Certain infants not on IVF are at risk for hypoglycemia and need monitoring the first 24 hours of life. They should monitored hourly or ac and pc during transition then q 3-6 hours ac as the admit policy suggests x 24 hours.

LGA and SGA infants
Polycythemic infants
Infants of diabetic moms

All infants with infusions of IV glucose require periodic monitoring. These include infants receiving infusions for fluid requirements as well as caloric requirements.

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

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
6. Manipulative operative delivery

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

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:

a. Obtain from a peripheral vessel or as first specimen from a central line
b. Minimum two separate blood cultures 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.

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 + polymorphoneuclear 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.

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

Inflammatory mediators:

1. ESR or C-reactive protein
    - **a.** Not always a reliable tests of infection in the neonate, 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 amniotic fluid but infrequently used at this institution.

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).

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

1. Maternal antenatal treatment of suspected infection begins treatment of the fetus.
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 amninoglycosides) 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) are 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 guidelines for the care of neonates exposed to Group B Strep. (Refer to Neonatal Guidelines of Care: Isolation and Infection Control).

References available from Dr. G. Levin, M.D.

Present Antibiotic Administration Schedule for Gentamicin (2007)

Gentamicin Dosing Schedule:

Gestation	Age	Dose	Interval
<29 weeks	0-7 days	5 mg/kg	q 48h
	8-28 days	4 mg/kg	q 36h
	>29 days	4 mg/kg	q 24h
30-34 weeks	0-7 days	4.5 mg/kg	q 36h
	>8 days	4 mg/kg	q 24h
>35 weeks	all ages	4 mg/kg	q 24h

Routine monitoring of Gentamicin is usually not necessary, except in 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 Peak levels can be done 30 minutes after first dose and trough levels just before second dose.

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 2006

Antibiotic Administration for Ampicillin and Vancomycin
This is a copy of the same dosing schedule from September 20, 2002.

Ampicillin:

Neonate:

<7 days:

<2 kg: 100 mg/kg/24 hr /IV-Q12 hr
>2 kg: 100 mg/kg/24 hr /IV-Q8 hr

>7 days:

<1.2kg: 100mg/kg/24hr - Q12hr/IV
1.2-2kg: 100mg/kg/24hr - Q8hr/IV
>2kg: 100mg/kg/24hr - Q6/IV

Vancomycin:

Postnatal Age

Weight	*<7 Days*	*>7 Days*
<1.2 kg	15 mg/kg/dose Q24 hr	15 mg/kg/dose Q24 hr
1.2-2 kg	10-15 mg/kg/dose Q12-18 hr	10-15 mg/kg/dose Q8-12 hr
>2 kg	10-15 mg/kg/dose Q8-12 hr	15-20 mg/kg/dose Q8 hr

Therapeutic levels: peak 25-40mg/L trough <10mg/L

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 in 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. If TORCH titers are sent, you must request IGM titers. The Tzank test has low sensitivity and is not recommended as a **rapid** diagnostic test.

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 ophthalmic 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.

3 **Complications of Acyclovir:** Phlebitis, transient renal dysfunction, crystaluria. Less common complications: bone marrow suppression elevated LFT's, skin rash, CNS symptoms (seizures, lethargy).

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.
3. 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 wean 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, 2006):

1. Infants born at ≤ 28 weeks gestation up to one year of age at the onset of RSV season.
2. Infants born at 29-32 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 33-35 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.

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. Handel's Infectious Disease Clinic.

Reference:
Red Book 2006 Report of the Committee on Infectious Diseases, 27 Edition, Elk Ridge Village, IL, 2006.

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.

**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.

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 2003 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.

References: Red Book 2006 – American Academy of Pediatrics, 27th edition.

Maternal Status	Infant ≥ 2000 g	Infant < 2000 g
HBsAg positive	**Hepatitis B vaccine + HBIG** (within 12 h of birth) Immunize with 3 vaccine doses at 0, 1, and 6 mo of chronologic age Check anti-HBs and HBs Ag at 9-15 mo of age.[2] If infant I HBsAg and anti-HBs negative, re-immunize with 3 doses at 2-mo intervals and retest.	**Hepatits B vaccine + HBIG (within 12 h of birth)** Immunize with 4 vaccine doses at 0, 1, 2-3, and 6-7 mo of chronologic age. Check anti-HBs and HBsAg at 9-15 mo of age.[2] If infant is HBsAg and anti-HBs negative, re-immunize with 3 doses at 2-mo intervals and retest.
HBsAg status unknown	**Hepatitis B vaccine (by 12 h) + HBIG (within 7 days) if mother tests HBsAg positive**. Test mother for HBsAg immediately.	**Hepatitis B vaccine + HBIG (by 12 h).** Test mother for HBsAg within 12 h of birth and if unavailable, give infant HBIG.
HBsAg Negative	**Hepatitis B vaccine at birth preferred** Immunize with 3 doses at 0-2, 1-4, and 6-18 mo of chronologic age. May give hepatitis B-containing combination vaccine beginning at 6-8 wk of chronologic age. Follow-up anti-HBs and HBsAg testing not needed.	**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.** Immunize with 3 doses at 1-2, 2-4, and 6-18 Mo of chronologic age. May give hepatitis B-containing combination Vaccine beginning at 6-8 wk of chronologic age. Follow-up anti-HBs and HBsAg testing not needed.

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) (eg. 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.

IMMNUNIZATION 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:

< 1,000 grams	DOL 1-3	DOL 7	DOL 14	DOL 28	PTD
1,000-1,250 grams		DOL 7		DOL 28	PTD
1,251-1,500 grams		DOL7			PTD
1,501-2,000 grams		DOL 7 only if clinically indicated.			

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

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:

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

- 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 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

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. Radinovich'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

Infants of mothers with documented illegal substance abuse via urine toxicology immediately prior to birth or a strong history of recent use as per the mother are admitted to IMCN for observation for withdrawal for a minimum of four days. The approach to the infants includes the following in addition to a good history and physical exam:

- Minimal stimulation preferably in an isolette with reduced lighting and swaddling as indicated.

- Withdrawal scoring sheet at the bedside if opiate withdrawal suspected.

- Urine and meconium toxicology within the first 48 hours of life.

- Appropriate infectious disease evaluation. Please attempt to have these tests drawn on mom. Hepatitis C is not drawn routinely. Draw labs on the infant only if mom not available.

- Consult Social service.

- Drug specific evaluation as clinically indicated.

- Initiate the Tincture of Opium therapy for severe symptoms of abstinence syndrome as per the following protocol only after discussing with attending.

REMINDER: Narcan is not to be used in the delivery room if acute maternal opiate use is suspected.

Protocol for Tincture of Opium Dilution Therapy:

Orders will be written for **Tincture of Opium Dilution.**

Pharmacy will prepare by dilution of 1 ml Tincture of Opium, USP to 25 ml sterile water in 30 ml syringe. Label to read as follows:

Tincture of Opium Dilution (ORAL USE ONLY)
(0.4 mg/ml morphine equivalent)
Tincture of Opium, USP 1ml
Sterile Water, qs to 25 ml
Prep:
Expires:
Initial dose of dilution is 0.05 ml/kg (2 drops/kg or 0.02 mg/kg of morphine) every 4-6 hours and titrated by 0.05 ml (2 drops) every 4-6 hours until desired response is achieved. Once desired response is achieved, tapering can begin by gradual dose reduction every 2-3 days. In general, these infants are not discharged on Tincture of Opium.

INITIAL EVALUATION OF THE CYANOTIC NEWBORN

Dr. Jeffrey Schuster

1. **Initial diagnostic evaluation**
    - History
        - Obstetrical ultrasounds
        - Fetal echocardiograms
        - Meconium
        - GBS
        - Oligohydramnios
    - Physical examination
        - Respirations 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

NEOPROFEN FOR PDA CLOSURE

DOSE: 1ST DOSE – 10 mg/k/dose; 2nd and 3rd dose – 5mg/k/dose. Give at 24-hr interval. IV infusion by syringe pump over at least 30 minutes.

A course of therapy is three doses of NeoProfen administered intravenously. All doses should be based on birth weight. If anuria or marked oliguria (urinary output <0.6 mL/kg/hr) is evident at the scheduled time of the second or third dose of NeoProfen, no additional dosage should be given until laboratory studies indicate that renal function has returned to normal. If the ductus arteriosus closes or is significantly reduced in size after completion of the first course of NeoProfen, no further doses are necessary. If during continued medical management the ductus arteriosus fails to close or reopens, then a second course of NeoProfen, alternative pharmacological therapy, or surgery may be necessary.

Obtain BUN, Creatinine and platelet count prior to each dose.

INDICATION: Neoprofen is indicated to close a clinically significant patent ductus arteriosus (**PDA**) in premature infants weighing between **500-1500 g,** who are no more than 32 weeks gestational age when usual medical management (e.g. fluid restriction, diuretics etc.) is ineffective.

CONTRAINDICATIONS:

1. Preterm infants with proven or suspected infection that is untreated;

2. Preterm infants with congenital heart disease in whom patency of the PDA is necessary for satisfactory pulmonary or systemic blood flow (e.g., pulmonary atresia, severe tetralogy of Fallot, severe coarctation of the aorta);
3. Preterm infants who are bleeding, especially those with active intracranial hemorrhage or gastrointestinal bleeding;
4. Preterm infants with thrombocytopenia;
5. Preterm infants with coagulation defects;
6. Preterm infants with or who are suspected of having necrotizing enterocolitis;
7. Preterm infants with significant impairment of renal function.

GENERAL PREACATIONS:

1. There are no long-term evaluations of the infants treated with ibuprofen at durations greater than the 36 weeks post-conceptual age observation period. Ibuprofen's effects on neurodevelopmental outcome and growth as well as disease processes associated with prematurity (such as retinopathy of prematurity and chronic lung disease) have not been assessed.

2. NeoProfen may alter the usual signs of infection. The physician must be continually on the alert and should use the drug with extra care in the presence of controlled infection and in infants at risk of infection.

3. NeoProfen, like other non-steroidal anti-inflammatory agents, can inhibit platelet aggregation. Preterm infants should be observed for signs of bleeding. Ibuprofen has been shown to prolong bleeding time (but within the normal range) in normal adult subjects. This effect may be exaggerated in patients with underlying hemostatic defects. (SEE CONTRAINDICATIONS).

4. Ibuprofen has been shown to displace bilirubin from albumin binding-sites; therefore, it should be used with caution in patients with elevated total bilirubin.

5. NeoProfen should be administered carefully to avoid extravascular injection or leakage, as solution may be irritating to tissue.

OPERATIVE CONSIDERATIONS IN THE NEWBORN

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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. Omphalocele is also associated with Beckwith Wiedeman Syndrome (microglossia, gigantism, 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 Gastroschisis and Omphalocoele: Immediate coverage of the intestine is indicated for all newborns with gastroschisis 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 ventilatory 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 gastroschisis, bowel function does not usually return for several weeks, and therefore all neonates undergoing gastroschisis 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 4^{th} 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 bronchoscopist. 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. ExtraCorporeal 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 extension 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 VACTERRL 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. If you don't feel comfortable with this technique for colostomy, then adapt it to what you are comfortable with, but put it in the proximal sigmoid, not in the right colon.

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 appears to be physiologic maturation of the lower esophageal sphincter during the first 4 to 6 months of age. The major medical components of GER treatment include upright positioning, frequent and low volume feedings, thickened feedings, and pharmacologic treatment with antacids and prokinetic agents. Surgical correction is reserved for those children whose symptoms cannot be controlled medically or for those with an identifiable, contributing anatomic abnormality. The principles for surgical treatment of GER include the establishment of an intra-abdominal portion of the esophagus and the development of a lower esophageal sphincter that resists the passage of gastric contents from the stomach to the esophagus. After an anti-reflux procedure, an increase in intragastric pressure temporarily causes the portion of the stomach positioned around the intra-abdominal esophagus to act as a one-way valve. As soon as intragastric pressure decreases, the infolded stomach around the esophagus collapses and does not impinge on the esophagus. A floppy Nissen fundoplication is the most commonly performed procedure, but many recommend a partial anterior (modified Thal) or a partial posterior (Toupet) antireflux procedure. All of these procedures can be performed open or laparoscopically. Each procedure has its proponents. Gas bloat syndrome is more likely with the Nissen wrap, but recurrence rates are probably higher for the partial wraps.

PYLORIC STENOSIS

Pyloric stenosis is not normally seen in the intensive care unit since it usually occurs in 3-6 week-old, previously healthy infants. They have progressive, projectile vomiting of non-bilious material. The characteristic physical finding is an olive-shaped mass in the midepigastrium, although the art of feeling olives is disappearing as the use of UGI and ultrasonography is increasing. If the history is characteristic and a mass is identified, no further diagnostic studies are indicated. However, if there is not a palpable mass an upper GI series or ultrasonography (preferable) is indicated for definitive diagnosis. In less developed countries these radiographic studies may not be available, and in this scenario it is acceptable to operate on the basis of a convincing history even in the absence of a palpable mass. The characteristic fluid and electrolyte abnormality in these infants is volume deficit with a hypokalemic, hypochloremic alkalosis. Pyloromyotomy is not an emergent operation. Fluid and electrolyte abnormalities should be corrected before performing pyloromyotomy. The best operative incision is a transverse incision through the right rectus abdominis muscle midway between the xiphoid and the umbilicus. The pylorus is delivered through the wound. A longitudinal incision is performed through the serosa and into the muscularis from a point just proximal to the vein of Mayo up onto the stomach 1 cm proximal to the palpable hypertrophic area. A pyloric spreader or hemostat is used to gently separate all of the muscle fibers and allow the mucosa/submucosa to bulge. The most common mistake is to go too far distally where the duodenal wall is thin and to cut through the mucosa. If this happens the hole should be precisely closed and

a piece of omentum placed over the hole and sutured to the surrounding serosa to hold it in place. After an uncomplicated operation the child remains NPO for 6 hours and then is allowed to feed. The parents are warned that the child will probably vomit a few more times before reaching normal feeding status. Pyloromyotomy is now commonly performed laparoscopically.

BILIARY ATRESIA

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 phenobarbitol 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

Neonatal Crossmatch:

Tests done:

ABO
DAT
Rh
Antibody screen

Specimen requirement:

All neonates < 4 months
Plasma preferred
2 (1 ml EDTA plastic lavender top microtainers)
2 (1 ml plastic red top microtainer, no gel)

Turn around time:

Routine 8 hours
STAT 1 hour

PRBC Transfusion:

All blood Type O with correct Rh and antibody negative
All PRBC's are CMV negative leukocyte reduced (or washed) and irradiated.
All PRBC transfusions are IV using a blood filter
Must be transfused ≤ 4 hours

Transfusion guidelines (discuss all transfusions with attending):

Hct	Clinical criteria	Transfusion
Hypovolemic shock due to blood loss	●Symptoms of shock	20 ml/kg over 1 hour
Hct ≤ 35%	●Mech Vent MAP ≥ 8 ●O2 ≥ 40%	PRBC 15-20 ml/kg over 2-4 hours
Hct ≤ 30%	●CPAP ≥ 6 or mech vent ●O2 ≥ 40% non-vented ●Surgery	PRBC 15-20 ml/kg over 2-4 hours
Hct ≤ 25%	●Non-vented, O2 21-40% and any of following: ●HR>180, RR > 80 ●Poor weight gain ●No progress in nippling ●Unstable apnea	PRBC 15-20 ml/kg over 4 hours (may transfuse in 10 ml/kg aliquots)
Hct ≤ 21%	No symptoms but retic < 2%	PRBC 20 ml/kg over 4 hours (may transfuse in 10 ml/kg aliquots)

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):

Platelet Count	Clinical criteria	Transfusion
≤ 30,000	Healthy term newborn	10ml/kg over 1 hour
≤ 50,000	Healthy preterm ≤ 34 weeks Any bleeding Anticipate invasive procedures or surgery	10 ml/kg over 1 hour
≤ 80,000-100,000	Sick preterm ≤ 34 weeks	5-10 ml/kg over 1 hour

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

Pediatric Transfusion: A Physician Handbook, 1st edition, Bethesda, MD: American Association of B1ood Bank, 2003

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FORMULA TO RECONSTITUTE BLOOD FOR EXCHANGE TRANSFUSION

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*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. Need Weight of bag and Hematocrit of blood.
2. A Quad-pack bag weighs 35 grams whereas a donut bag weighs about 70grams.
3. We do not need to concern ourself with deglycerolized washed RBC'S being 80% more dilute than regular blood since we no longer freeze blood but irradiate it for CMV.

Example: Have nurse weigh bag and determine Hct.

WEIGHT OF BAG W/ BLOOD = 285 GRAMS
HCT OF BLOOD = 90%.
BAG DRY WEIGHT = 35 GRAMS.
DESIRED HCT = 50%

SOLUTION----

1) $\frac{90-55}{90}$ (285-35 + X) = X

2) $\frac{35}{90}$ (250+X) +X

3) (0.38) (250+X) = X

4) 95 + 0.38X = X

5) 95 = 1X – 0.38X

6) 95 = 0.62X

7) $\frac{95}{0.62}$ = X

8) X = 153

Therefore we need to add 153 ml of Fresh Frozen Plasma (FFP) to the bag containing 250 ml of blood giving us a total of 403 milliliters of blood with a hematocrit of 55%. Do not exceed more than 500 ml per bag. If a double-volume exchange exceeds this amount, you will need to prepare several bags. Always use a Pall filter through a port to filter the blood and products.