

**SERVICE MANUAL
for the *PEDIATRIC SURGICAL TEAM*
of the UNIVERSITY OF NORTH CAROLINA
at CHAPEL HILL**

2007 REVISION

**Compiled by:
Tim Weiner, MD
Daniel von Allmen, MD
J. Duncan Phillips, MD
Patty Lange, MD
William Adamson, MD
Don Nakayama, MD
Lynne Farber, MSN, CPNP
Amy Lamm, MSN, CPNP**

**This manual is dedicated to the residents, nurses and staff of the UNC Pediatric Surgical Service.
Special thanks to Jan Cheek, Craig Colliver MD, Jeff Abrams, MD, Tim Sadiq, MD.**

Disclaimer: The opinions, protocols and medication dosages in this manual represent the biases of the UNC Pediatric Surgeons and may not be appropriate for all patients.

**The Pediatric Surgical Service
at the University of North Carolina
at Chapel Hill**

INTRODUCTION

The mission of the Pediatric Surgery Service at UNC Hospitals is the surgical care and consultation for patients 18 years and younger and the education of residents, students and staff. Our team is available at all times.

This manual is designed as a concise reference for the routine problems we encounter. Unless otherwise indicated, the protocols are uniform for all the attendings.

PEDIATRIC SURGICAL WISDOM (various sources)

“Bilious emesis in an infant is intestinal obstruction until proven otherwise.”

“Gastrointestinal bleeding and obstruction is dead or dying bowel until proven otherwise.”

“A newborn’s first enema should be a contrast enema.”

“A minor injury is one that happens to someone else’s child.”

“Common things occur commonly.”

First Rule of the Intern: “Never go down alone.”

“The enemy of good is better.”

“Never trust a naked baby.”

“A wide prep is a good thing.”

“For some reason, parents are greatly relieved to hear that what their child has is “going around”.”

“Learn to recognize when a baby is whispering to you that they are sick.”

“If it takes three people to hold a child down for an exam, they probably aren’t real sick.”

“Children and their grandparents get along so well, because they share a common enemy.”

“One of the disadvantages of children is they get old enough to give you presents they make at school.”

“Never pull a tube at night.”

“A good plan today is usually better than a perfect plan tomorrow.”

“If good intentions are combined with stupidity, it is impossible to out-think them.”

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THE ESSENTIALS

1. This service is closely supervised.
2. Use this litmus test: "If this was MY CHILD I'd want..."
3. As part of an emphasis on kid-friendly, family-centered, atraumatic care we promote the use of adequate pain assessment and reevaluation, reduction of parent-child separation, teaching, and non-pharmacological (distraction, play) therapy, conscious sedation and appropriate analgesia.
4. Children are not given narcotics unless they are on a monitor and a senior team member is aware.
5. Morphine is used post-operatively at a dose of 0.05-0.1 mg/kg IV q 2 hr twice. Additional morphine may be used thereafter, but a team member must first assess the child. An extensive discussion of pediatric pain control is included in later sections of this manual.
6. Narcotics **cannot** be ordered by phone.
7. Narcotics and Ketorolac seem to have an excellent synergistic effect.
8. Bilious emesis in an infant is malrotation/volvulus until proven otherwise.
9. Glycerin chips, mineral oil, lactulose, MOM, Mirulax and senna (Ex-lax) work well for pediatric constipation.
10. Wash your hands alot and especially in front of parents and nurses.
11. In infants, IV fluids and TPN must be carefully calculated. Fluids are calculated in cc/kg/day, nutrition is calculated in kcal/kg/day.
12. TPN orders must be in by NOON.
13. Input and output should be closely reviewed 6-8 hours after surgery.
14. 1-2 cc/kg/hr is considered adequate urine output in infants and children.
15. In infants, mild hypovolemia or oliguria is treated by increasing the IV rate by 25% and reevaluating the patient in 3-4 hours. Fluid boluses are not typically used.
16. Standard maintenance fluid in infants and children is D5 ¼ (**quarter**) NS with 20 mEq/L KCl.
17. Resuscitation fluid (typically 1.5 to 2 times maintenance) is D5 ½ (**half**) NS with 20 mEq/L KCl.
18. Resuscitation boluses are 20 cc/kg of LR (NS is preferred for HPS), or 10 cc/kg of blood or 5% albumin.
19. High fluid rates or boluses can reopen a PDA in neonates.
20. The mean arterial blood pressure (MABP) in a neonate approximately equals their post-conceptual age in weeks.
21. Children are given 12 hours to void post-op after routine surgery; thereafter a bladder scan is done and if indicated a Foley is used and left in place for 12-48 hours. In and out (I/O) catheterizations are not done.
22. An infant who is NPO for more than 4 hours requires an IV.
23. Bowel preps are not routinely done in infants less than 4 kilograms.
24. Standardized protocols and CPOE orders are in available for bowel preps.
25. Chronic care infants (i.e. "feeders and growers") need a daily growth (weight) chart posted near their bed
26. Sign above bed and order in chart after UGI/perianal surgery: "No manipulation of NGT/anal area."
27. Write an order when a chest tube is placed on waterseal to avoid nurse confusion.
28. Orogastric (OG) or nasogastric (NG) tubes are removed when flatus has occurred.
29. Infant OG or NG tubes only come in two sizes (8 and 10 Fr "Replogle" tube). Do not use smaller feeding (gavage) tubes for decompression. Avoid alar necrosis. Continuous suction is preferred.
30. OG tubes are preferred in neonates since they are obligate nasal-breathers.
31. Diets are usually advanced from clears/Pedialyte to regular/breastmilk or formula. Avoid carbonated beverages for the first 24 hours post-op.
32. Use breast milk whenever possible. Encourage mothers to pump (it can be frozen).
33. Babies should gain 1% of their body weight (or about 10 gms/kg/day) each day.
34. Wound dressings are removed on POD #2.
35. Bathing may be done on POD #2.
36. Routine clinic follow-up is 2 weeks after d/c unless otherwise specified.
37. The Friday "NP Clinic" can be used for wound checks, GT problems, etc.
38. Several students should attend clinic.
39. Unless the child is a premature, routine pre-op labs are not usually necessary.

40. A blood bank sample should be obtained if the procedure carries a risk of blood loss (lysis of adhesions, Nissen, splenectomy, NEC surgery, etc.).
41. Platelets and coagulation studies should be checked in any child undergoing a line placement with a history of chemotherapy, bleeding diathesis or liver failure.
42. A pre-op platelet count above 50,000 for Broviacs and above 80,000 for ports is recommended. Additional platelets should be available for the OR. The Peds H/O team often arranges this for their patients.
43. Operative dictations are done by the attendings, unless specified.
44. A conscious sedation nurse (pager: 347-1131) is available during the day. At other times, the pediatric or PICU residents can assist. The child should be NPO for 3 hours prior.
45. Many line issues (PICC placement, repairs, declotting) are managed through the Pediatric Specialty Team ("PICC team")
46. Urgent access in the smaller, injured child is obtained by cutdown at the groin and/or antecubetal fossa. Intraosseous access is a good temporary option.
47. Diagnostic Peritoneal Lavage (DPL) is not routinely used in injured children. They either go to the CT scanner or the OR.
48. Rectal exams are not routinely done in injured children, unless requested by the neurosurgeon.
49. A low threshold for intubation is used in the trauma room (GCS < 8, uncooperative, unstable, etc.).
50. Multi-system traumas are managed by our service (including all non-ventilator orders) for at least the first 24 hours or until a clear transfer of service has been discussed.
51. Femoral arterial sticks for blood samples are not done in infants.
52. Inpatient and ER consults are accepted courteously and are seen promptly. A plan and follow-up to the referral source is done in a timely fashion. Consult forms are filled out completely, leaving space for an attending note.
53. Get a phone number and a physician name from outside referrals.
54. A form in the office for billing purposes documents procedures done on the floor.
55. Block OR days are M, T, W and F. Postings must be in by 10 am.
56. The 11 am intern/student lecture supersedes all other responsibilities.
57. The students should be rigorously coached by the senior residents in how to make directed, concise and plan-oriented afternoon presentations. A mid-rotation evaluation is done by the Chief Resident.
58. All transfers are accepted without complaint or sarcasm.
59. Rudeness toward parents, nurses or referral sources is not acceptable professional behavior.
60. The goal of the service experience is to leave with much less anxiety about dealing with pediatric surgical patients than when you arrived.

ESSENTIAL PEOPLE/PLACES:

| | | |
|--|----------|----------|
| Pediatric Surgery Nurse Practitioner, Lynne Farber | 216-6715 | |
| Amy Lamm | | 216-3873 |
| Chris Smith | | 350-7796 |
| Raleigh Clinic | 783-7809 | |
| Peds Admitting Resident | 216-8160 | |
| Peds ER | 966-1405 | |
| Ostomy Nurse | 843-9234 | |
| Peds Specialty Team (sedation, PICC, line care) | 347-1131 | |
| Admitting | | 966-2041 |
| Children's PreCare | | 966-2273 |
| Children's OR Front Desk | 842-1501 | |
| OR# 26 | 843-1509 | |
| Children's PACU | 843-1537 | |
| NICU | | 966-3481 |
| PICU | | 966-5491 |
| Peds Radiology | 966-7554 | |

DISCHARGE PLANNING CHECKLIST

1. The goal of a careplan is a *safe and timely discharge*. As you make a daily plan for a patient ask, “What do I need to do to get this child home?”
2. Children are ready for home when they no longer need daily PHYSICIAN care.
3. When the patient is within 24 hours of discharge, inform the nursing staff and write an “anticipate d/c” order.
4. Think of d/c planning issues early (i.e. when the child is admitted).
5. Order parent teaching (lines, stomas, and gubes) early. Inform Lynne Farber or Amy Lamm.
6. If the child will need home TPN, consult **Pediatric GI** one week before the expected d/c date.
7. If the child will need home TUBE FEEDS, inform Lynne farber or Amy Lamm, Social Work and order supplies listed in “Feeding Access” chapter.
8. If the child will need Broviac care, home antibiotics, weight checks, wound or stoma care, order a **HOME HEALTH** referral.
9. **OT, PT and Pediatric Rehabilitation** should evaluate complicated trauma or neurologically impaired children with feeding and/or other chronic issues..
10. The **Pediatric Surgery Social Worker** can help with difficult d/c issues.
11. Remind the family at d/c: **WE ARE AVAILABLE AT ALL TIMES.**
12. Send a copy of the d/c summary to the child’s primary physician.
13. Follow up visits should be in 2-3 weeks unless otherwise specified.
14. Try to coordinate multiple f/u visits when possible.
15. Discharge summaries should be dictated on the day of discharge and include:
 - a. primary care physician
 - b. consulting physicians
 - c. diagnoses
 - d. procedures and dates
 - e. d/c instructions
 - f. f/u dates
 - g. list of d/c medications

STRUCTURE AND MANAGEMENT OF THE SERVICE

UNC Services:

The office is located in 3010 Old Clinic Building. (966-4643/966-4220)

The clinic is located on the ground floor of the North Carolina Children's Hospital; the phone number is 966-1401.

Wake County Services:

Outpatient services in Raleigh are located at 3948 Browning Pl., #103 (off Six Forks Rd.). The phone number is 919-783-7809.

Inpatient services are provided at WakeMed (919-350-8000). The Nurse Clinician for the pediatric surgery team can be reached on beeper 393-6498

Conferences:

| | | | |
|--|------------|---------------------|----------------------|
| Monday (every week) | 11:00 a.m. | Ped. Pulmonary | Radiology Conf. Room |
| Monday (every week) | 4:00 p.m. | Perinatal Care | OR Conference Room |
| Thursday (2 nd week) | 7:45 a.m. | Pediatric Chair | W&C Conference Room |
| Wednesday | 7:15 a.m. | Grand Rounds | Clinic Aud. |
| | 5:00 p.m. | Morbidity/Mortality | OR Conference Room |
| Thursday (1 st /3 rd week) | 4:00 p.m. | Tumor Board | Pathology Conf. Room |
| Friday | 4:00 p.m. | Service pre-op | OR Conference Room |

Notes:

Presentation Format

1. Name, Diagnosis/Procedure, POD #
2. Significant events since last report.
3. Current weight and change in weight.
4. Pertinent vital signs.
5. Fluid/Electrolyte/Nutrition review:
 - a. total intake and output for 24 hours, including drains, chest tubes, NG
 - b. kilocalories/kg/day (normal : 60-120); gms fat/kg/day; gms protein/kg/day
 - c. fluid intake in cc/kg/day (normal: 80-140)
 - d. urine output in cc/kg/hr (normal: 1- 2), urine specific gravity
 - e. stool output in cc/kg/day (>40 is excessive)
 - f. stool guaiac/Clinitest (normal: <1% unless on breast milk)
6. Pertinent physical exam.
7. Lab results, pathology, radiology.
8. Medications, especially antibiotics (day #/total days planned).
9. Assessment.
10. Plan for next 24 hours, including how follow-up will be done.

ICU System Review (“head to toe” by SOAP format):

1. Overall condition/Key issues.
2. Neurologic.
3. Respiratory.
4. Cardiovascular.
5. Fluids/Electrolytes/Nutrition.
6. Renal.
7. Gastrointestinal.
8. Infection.
9. Hematologic
10. Musculoskeletal/Integument.
11. Psychosocial.
12. Concise Plan Summary/Avoidable Morbidity

Documentation:

All written orders should be concise, legible, dated and timed. Medication orders are calculated on a per kilogram basis on the order sheet and double-checked; a pharmacist is readily available for consultation (beeper 347-1378). Many CPOE protocols are in place.

Consult forms are fully completed by the resident in WEBCIS and forwarded to the attending.

SURGICAL ISSUES AND PREFERENCES

OR Scheduling:

Presently, we have block OR time available on all weekdays (2 rooms on Friday). We have a hold on our room until 6 am for late postings.

Pre-operative Tests:

Pre-operative testing is individualized for each patient, but the majority of children will **not** require any tests. Discuss this with the patient's attending if uncertain.

Same-day Admission:

Infants who are full term (>37 weeks at birth) and less than **45 weeks post conceptual age** and former premature infants who are less than **55 weeks post conceptual age** will require overnight admission with cardiorespiratory monitoring after any elective surgery.

Case Order:

The outpatients should go first in ascending age, followed by the inpatients. Shorter cases are generally done earlier. The senior residents should discuss the proposed case order with the attendings each day to confirm their availability and preferences.

Transports:

Transports are arranged through the PICU or NICU service fellow or attending. Traumas are triaged through the ER attendings who will assign a level of severity (red, yellow, green) and activate the Trauma Response System.

NPO Status:

- 6-8 hours for solids, formula.
- 4 hours for breastmilk
- 2 hours for clear liquids (water, Pedialyte, clear juices).
- 6 hours before conscious sedation.

Bowel Preps:

1. A CPOE order sheet is available.
2. Do not use Golytely in infants less than 4 kg.
3. Track patient if they are not admitted by noon.
4. Order Golytely to the floor early in the day.
5. Plan to place an NG tube for administering Golytely in most younger patients.
6. Attending preferences may vary, you may need to individualize the prep.
7. In general: start IV; type and screen: Golytely 25cc/kg/hr for 4 hours; continue for another 2 hours if effluent still has solid material; Cefoxitin 25 mg/kg OCTOR; 10cc/kg warm saline rectal enemas q 2 hr 3 times; may take water or Pedialyte after the prep; plan for on the table stoma and rectal irrigations.

Minor Cases Done Outside the OR:

1. Includes: chest tubes, Broviac removal, venous access, rectal biopsies, I/Ds, Gtube changes.
2. Document clearly in progress notes under "PROCEDURE/PEDIATRIC SURGERY".
3. Fill out minor procedure form in office and submit to the pediatric surgery secretary or dictate an op note.

Pre-operative Considerations:

1. Consent obtained (Social Work can help).
2. Coagulopathy evaluated/corrected.
3. Blood availability confirmed.
4. Decide where to meet the family post-op.
5. Check for rashes/URI.
6. Mark for ostomy/Ostomy Nurse consult
7. Check effectiveness of bowel prep.
8. Order peri-operative antibiotics.
9. Order stress steroids, if indicated.
10. X-rays available. Pathology notified.
11. ICU notified and/or other services notified (ENT, Heme/Onc).
12. Inform OR of special instruments/preps.

Management of Coagulopathies:

1. Stop heparin infusion 6 hours before OR.
2. Confirm that neonates have been given vitamin K (1 mg IM).
3. 10 cc/kg of FFP to normalize INR, if indicated.
4. 5 cc/kg (infant) or 4 units (older child) of platelets the night before surgery with the same amount available to be given in the OR. (1 unit=30-50 cc and 1 unit per 5 kg will increase the platelet count by 50,000).

Perioperative Transfusion:

1. In most cases, an infant's hematocrit should be kept above 30% (higher if they are on oxygen).
2. Premature infants may require a pre-operative CBC if they appear anemic.
3. PRBC transfusions are given as 10-15 cc/kg over 4 hours; Lasix is not routinely given.
4. Dextrose (D5 or D10) is provided during the transfusion (preferably through a second IV); dextrostix are checked q 1-2 hrs.
5. Recall that infants have a physiologic anemia at 6-8 weeks of age.
6. Sickle cell patients may require pre-operative transfusion therapy.
7. Neonatal blood bank samples are good for 4 months.
8. Always inform the parents and obtain consent before transfusion. If the family are Jehovah's Witnesses, inform the attending directly and before surgery; a special consent form is available.

Perioperative Antibiotics:

Neonates/Infants: Ampicillin and Gentamycin
 Children>6 months: Kefzol (+/- Flagyl) (if GI/GU tract opened)
 Broad spectrum: Ampicillin, Gentamycin and Clindamycin/Metronidazole or Zosyn.

CLEAN CASES (antibiotics not indicated): hernia, hydrocoele, orchiopexy, circumcision, small skin lesion, and pyloromyotomy, Nissen. (Drs. Weiner and Adamson prefers antibiotics on these cases.)

CLEAN CASES (antibiotics indicated): all newborns, Broviacs, splenectomy, cystic hygroma, nephrectomy

CLEAN/CONTAMINATED (antibiotics indicated): simple appendicitis, gastrostomy, cholecystectomy, lobectomy, congenital neck lesion, GI/GU tract opened

CONTAMINATED (broad-spectrum coverage): bowel spillage/perforation, complicated appendicitis, peritoneal/thoracic abscess, infected wound

SBE Prophylaxis:

1. All unoperated congenital cardiac defects except uncomplicated ASD.
2. Rheumatic and other acquired valve abnormalities.
3. All post-operative cardiac patients.
4. Previous episode of SBE.
5. Hypertrophic cardiomyopathy.
6. Mitral valve prolapse.

Undergoing:

1. Dental procedures.
2. Procedure involving respiratory mucosa.
3. Procedure involving infected tissue.
4. Procedure involving GI or GU tract invasion.

See Appendic and/or ask Pediatric Cardiology or Pediatric Infectious Disease for timing, dosage and antibiotic recommendations.

In the Operating Room:

1. Our team should accompany ICU transports.
2. The resident surgeon should be in the room upon the patient's arrival. (One 2006 minute of OR time is over \$14).
3. Keep the infant warm with high room temperatures, warming blankets and overhead lamps.
4. Anesthetic preparations take priority.
5. Review relevant x-ray films.
6. Use a headlight liberally.
7. Needle-tip Bovie, Thompson retractor.
8. Wide soap and paint prep three times; relatively "dry" prep.
9. Vicryl, PDS preferred absorbable suture.
10. Evaluate gallbladder, kidneys, and intestinal rotation when possible.
11. Mark and orient specimen for pathology.
12. ¼ % Marcaine (1 cc/kg) into the wound or caudal block by anesthesia.
13. Meticulous subcuticular closure.
14. Neatly applied steri-strips, collodion and/or dressing.
15. Attendings generally do the dictations.
16. Diagram/record important operative findings.
17. Tabulate fluids carefully.

Post-operative Considerations:

1. Assist in ICU transports.
2. All upper torso central lines placed percutaneously get a CXR post-op.
3. Write fluid orders carefully.
4. Evaluate fluid status in 4-6 hours post-operatively.
5. Urine output should be 1-2 cc/kg/hr.
6. Avoid fluid boluses in infants.
7. Start chest physiotherapy/mobilization early.
8. Consider bladder catheterization only after 10-12 hours.
9. Cardiorespiratory monitor for same-day, elective infants.
10. Dressings off on POD #2.
11. NGT out when flatus occurs; watch for alar pressure.
12. Antibiotic regimen per attending.
13. Senior resident supervision for CT, Broviac removals.
14. Consult stoma nurse early.
15. Anticipate discharge planning issues (weight checks, home TPN, antibiotics, feeding pumps, CR, apnea monitors).

Routine (Ambulatory) Post-operative Care:

Most parental questions/concerns can be handled by telephone by an experienced surgical resident. However, IF THERE IS ANY DOUBT IN YOUR MIND ABOUT A PATIENT, IT IS ESSENTIAL THAT YOU CONSULT WITH THE CHILD'S ATTENDING, OR THE ATTENDING ON-CALL.

Anesthesia: General endotracheal anesthesia is often used for pediatric surgical procedures. Thus, it is not uncommon for children to have transient nausea and vomiting during the first 4-8 hours after surgery. This usually does not require medical treatment. Reassure the parents that this should pass. If it persists beyond 8 hours they should call back. Sore throats from intubation are also common and can be eased by sore throat lozenges or Chlorasptic spray.

Pain: Incisional pain is usually greatest the first evening after surgery and generally diminishes over the next few days. Tylenol at a dose of 15 mg/kg q 4 hours is often adequate. Suppositories at 20 mg/kg can be used if the child is nauseous. Post-op pain that is more severe can be handled with Tylenol with codeine, Percocets or oxycodone (elixir or tablets).

Dressings: Most incisions are closed with absorbable (subcuticular) sutures covered by Steri-strips and collodion. Bandages on top of the Steri-strips can be removed on POD #2. The Steri-strips can be removed when they begin to peel off. Small amounts of blood on the dressing are usually not cause for concern; marked redness, drainage or pus is concerning. If the gauze dressing becomes soaked with blood,

water or urine, it should be removed and replaced. It is usually safe to begin bathing or showering of the surgical site on POD #2. The site should be kept clean and dry.

Fever: Low-grade fevers up to 100.5 C are common in the first 36 hours after surgery and are usually due to atelectasis. Tylenol and pulmonary toilet is typically all that is required. Persistent and/or high fevers (>101.5 C) may indicate a more serious problem and should be investigated (see below).

Follow-up: Routine follow-up is generally 1-3 weeks after the operation. Reassure the parent that a member of the surgical team is available at all times to answer questions or see the child in the ED. Offer them a follow-up phone call if they seek advice about a problem.

Post-operative Fevers:

1. The majority of early fevers are pulmonary (atelectasis). Order chest physiotherapy.
2. Catheter infections are considered in any child with a central line.
3. Examine the patient:
 - a. check the wound
 - b. examine IV sites
 - c. listen to the chest
 - d. look in the ears (NGTs in particular can cause OM)
4. Fever work-up, if clinically indicated:
 - a. CBC/diff
 - b. Urinalysis and/or cx if child is catheterized
 - c. Sputum cx if on a ventilator
 - d. CXR if pulmonary symptoms/poor mobilization
 - e. blood culture via catheter if the child has a central line
 - f. stool cultures (routine micro, toxigenic E. coli, rotavirus) if diarrhea
 - g. stool cultures, KUB if Hirschsprung's patient (enterocolitis)
 - h. KUB if gastroschisis patient (late NEC)
 - i. LFTs, blood cultures if s/p Kasai (cholangitis)
4. Routine peripheral blood cultures are generally not done.
5. Epidurals are usually removed.

Post-operative Analgesia:

1. Narcotics should not be used in newborns unless they're in a monitored ICU setting.
2. Narcotics should be used carefully in infants and young children. This must be discussed with a senior resident and/or attending. The dose is 0.05 mg/kg q 1-2 hours to 0.1 mg/kg q 2-3 hours for infants < 6 months, and 0.1 mg/kg q 2-3 hours for children older than 6 months THE CHILD MUST BE ON A CR MONITOR/PULSE OXIMETER. Reorders are discussed by the team **every day**. Narcotics cannot be ordered by phone.
3. Toradol and narcotics seem to have a synergistic effect.
4. A child who has had a narcotic caudal in the OR should not get further narcotic for 6-8 hours unless this is discussed with the attending or anesthesia team.
5. PCA may be used in children over 5 years (call Pharmacist for dosing).
6. The Acute Pain Service manages epidurals. A Foley is used until 6 hours after the epidural is removed.
7. Non-narcotic analgesics:
 - a. TYLENOL 15 mg/kg pr/po q 4 hours
 - b. MOTRIN 4-10 mg/kg po q 6-8 hours
 - c. TORADOL 1 mg/kg LOAD; 0.5 mg/kg/dose q 6-8 h, 48 hr. limit
 - d. EMLA CREAM 2.5 gms to skin for 1 hour
 - e. 1 % LIDOCAINE maximum 4.5 mg/kg/dose (buffer 9:1 L:NaBicarb)
 - f. ¼ % BUPIVICAINE maximum 1 cc/kg/dose
7. Narcotic analgesics
 - a. MORPHINE 0.05-0.1 mg/kg q 2-4 hours
 - b. CODEINE 0.5-1.5 mg/kg po q 4 hours
 - c. Tylenol with CODEINE <1y:1-2cc q6-8 h; 1-3y:2-3cc q6-8 h; 3-6y:5cc q6-8h
 - d. OXYCODONE 0.05-0.15 mg/kg/dose q 6 hours
 - e. PERCOCET ½-1 tablet po q 4-6 hours
 - f. FENTANYL 0.5-1.0 **MCG**/kg IV q 2-3 hours
8. Sedatives
 - a. VERSED 0.05 mg/kg/dose IV, repeat once
 - b. VALIUM 0.05 mg/kg/dose IV; 0.2-0.3 mg/kg po
 - c. ATIVAN 0.05 mg/kg/dose IV or po
 - d. CHLORAL HYDRATE 25-50mg/kg po/pr q 6-8 hours
 - e. BENADRYL 1 mg/kg IV/po q 6 hours
9. Reversals
 - a. NARCAN 0.005-0.01 mg/kg/dose q 2-3 minutes
 - b. FLUMAZENIL <20 kg: 0.01 mg/kg IV; >20 kg: 0.2 mg IV

Atraumatic Care

As part of the NC Children's Hospital emphasis on atraumatic care we promote the proper training of healthcare providers in the recognition, assessment and timely intervention for children experiencing perioperative pain and anxiety. Resources including pediatric pain scales, Child-life therapists, a Pediatric Anesthesia consult service, nurse specialists and conscious sedation are available.

Conscious Sedation

Healthcare providers including the Pediatric Specialty Team (843-0977) and certified PICU and ED physicians are available to provide and monitor conscious sedation during procedures on pediatric patients. The child should be NPO for 6 hours (solids) and 2 hours (clears) before the sedation. A pre-procedure form and consent must be filled out.

A trained healthcare provider does continuous monitoring of VS and saturation. Emergency equipment including oxygen, suction, intubation and resuscitation is immediately available.

Medications and recommended dosages are listed above or in the Appendix.

OTHER PEDIATRIC SURGERY PROTOCOLS AND PATHWAYS

(2007 Note: CPOE is now available for many of these)

Post-op Pectus Repair:

1. CXR in PACU
2. Clears on day 1, advance
3. Hospital bed, drain care
4. Epidural, 2-3 days
5. PCA, 2-4 days
6. Start Oxycodone, Motrin after PCA d/ced
7. Remove any drains when <40 cc/d
8. No heavy lifting for 8 weeks

Post-op Pyloromyotomy

1. see "Pyloric Stenosis" section in this manual

Post-op Nissen Fundoplication

1. NGT overnight, d/c in AM; meds per NGT or GT
2. If neurologically normal begin clears at 24 hours
3. If neurologically impaired begin clears at 48 hours
4. If Gtube-dependent, continuous feeds initially
5. Ask attending when to switch to bolus feeds
6. "No chunk" diet, no carbonated beverages diet for 4 weeks
7. Change Gtube to MIC-Key at 3-6 weeks (attendings vary)
8. Nutritionist consult.

Chest Tube management

1. If child less than 10 kg, suction to -10 cm/H2O
2. If child 10-20 kg, -15 cm/H2O
3. If > 20 kg, -20 cm/H2O
4. TEF, CDH repair, waterseal only
5. Portable CXRs with management changes
6. Suction to waterseal at 48 hours post-op or 24 hours after airleak stops and lung is fully reexpanded
7. Leave at waterseal for 24 hours, CXR prior to removal
8. If spine exposure chest tube: waterseal until daily output < 100cc or 1 cc/kg/d
9. Return to suction if lung drops
10. EMLA to tube site; conscious sedation as indicated
11. Senior resident supervision/assistance of tube removal
12. Post-pull CXR and occlusive dressing for 48 hours

Post-op Appendicitis

1. see "Appendicitis" section in this manual

Feeding after routine intestinal surgery

1. Remove NGT when flatus or second BM (and NGT output clear)
2. Offer clears 6-24 hours later
3. Advance to solids/formula after second feeding

Feeding tube/GER workup

1. see "GER" section in this manual

Post-pullthrough Hirschsprung's enterocolitis

1. (Rectal exam yields explosive, foul-smelling stool.)
2. (KUB shows colonic dilation and/or colon air-fluid level.)
3. NPO overnight, clears in AM if improved
4. IVF; Flagyl
5. First (admission) rectal irrigation by surgeon with 10cc/kg warm saline
6. Rectal tube (Foley with side holes) taped to buttocks (remove at 24 hrs)
7. Nurses to irrigate q 6 hours, interval to q 8-12 hours with improvement
8. Advance diet, change to po Flagyl for 2 weeks
9. Consider home irrigation

FLUIDS

Maintenance Fluid:

The standard pediatric maintenance fluid is D5 or D10 ¼ (**quarter**) NS with 20 mEQ/L KCl. Rates above maintenance should use D5 ½ (**half**) NS with 20 mEQ/L KCl. Blood sugar is monitored in neonates by dextrostix q 4-8 hours to avoid hypoglycemia. The hourly maintenance rate (which corresponds to 100 cc/kg/24 hr) is calculated by weight:

| | |
|---------|--------------------------------------|
| 0-10 kg | 4 cc/kg/hr times weight in kg |
| 11-20kg | 40 + 2 cc/kg/hr times kg above 10 kg |
| >20kg | 60 + 1 cc/kg/hr times kg above 20 kg |

Over the first week of life (during their physiologic, obligatory diuresis), infants require less maintenance fluid in a 24 hour period:

| | |
|----------|---|
| DOL #1-2 | 65 cc/kg/24 hr of D10W, add electrolytes after 24 hours |
| DOL #3-7 | 85 cc/kg/24 hr |
| DOL #8+ | 100 cc/kg/24 hr |

Resuscitation of Severe Dehydration:

1. Bolus with LR or NS at 20 cc/kg over 30 minutes.
2. Repeat if perfusion remains poor.
3. IVF: D5 ½ NS at 1.5 times maintenance (6 cc/kg/hr times weight in kg if less than 10 kg).
4. Add 20 mEQ/L KCl after first void.
5. Monitor lytes and glucose closely.

Replacement of Significant Fluid Losses:

| | |
|--------------|--|
| Gastric: | D5 ½ NS with 20 mEQ/L KCl at 1 or ½:1 q 4-8 hours |
| Third space: | D5 ½ NS with 20 mEQ/L KCl at 1.5 -2 times maintenance |
| Chest tube: | LR 1:1 q 4-8 hours |
| Ileostomy: | ½ NS with 20 mEQ/L KCl or LR 1:1 |
| Diarrhea: | LR with 20 mEQ/L KCl 1:1 |
| Fistulae: | check output electrolytes and match fluid; replace volume lost 1:1 |

ELECTROLYTES

Maintenance:

| | |
|-----------|----------------|
| Na and Cl | 3 mEQ/kg/24 hr |
| K | 2 mEQ/kg/24 hr |

Hypokalemia:

1. "K run" of 1-2 mEQ KCl in 50 cc maintenance fluid at child's maintenance IV rate.
2. Recheck serum level.
3. Repeat until K >3.5.
4. A CV line may be necessary to avoid painful vein sclerosis.

Hyperkalemia:

1. Recall that heelsticks can cause an artifactual elevation.
2. Place on cardiac monitor.
3. ICU if ECG changes (peaked T-waves).
4. Calcium gluconate at 30 mg/kg.
5. 1 gm/kg D25 glucose and 0.3 u/kg regular insulin.
6. Kayexelate at 0.5-1.0 gm/kg po/pr.

Refer to the **Potassium** and **Calcium** Dose Standardization Table in the Appendix

ENTERAL NUTRITION

The enteral route should be used whenever possible. Breast milk is the preferred baby food. Most infants feed on a q 3 hour schedule. Gavage (per OGT) feeds are used in premature infants. The nursing staff, the nutritionist, the Pediatric Gastroenterology Service and the Pediatric Rehabilitationist (Joshua Alexander, MD, beeper 216-1840) have experience in children with chronic feeding difficulties.

Daily Requirements:

| | | |
|------------------|---------------------|-----------------------|
| low birth weight | 120-160 kcal/kg/day | 2-3 gm protein/kg/day |
| 0-6 months | 100-140 kcal/kg/day | 2-3 gm protein/kg/day |
| 6-12 months | 90-110 kcal/kg/day | 2 gm protein/kg/day |
| 1-3 years | 1300 kcal/day | 23 gm protein/day |
| 4-6 years | 1800 kcal/day | 30 gm protein/day |
| 7-10 years | 2400 kcal/day | 36 gm protein/day |

Increased caloric requirements are anticipated with severe injury or illness, sepsis, fever, after surgery and with inflammatory bowel disease.

Caloric Densities:

Standard formulas and breast milk are 20 kcal/30 cc (1 oz). Formulas with greater caloric value are available (24, 27 and 30 kcal/30 cc) but have higher osmolar loads and can cause diarrhea.

| | |
|---|--------------|
| breastmilk/standard formula (20 kcal/30 cc) | 0.67 kcal/cc |
| breastmilk with fortifier (24 kcal/30 cc) | 0.8 kcal/cc |
| 24 kcal/30 cc | 0.8 kcal/cc |
| 27 kcal/30 cc | 0.9 kcal/cc |
| 30 kcal/30 cc | 1.0 kcal/cc |
| Pediasure | 1.0 kcal/cc |
| supplements: | |
| MCT oil | 7.7 kcal/cc |
| Microlipid | 4.5 kcal/cc |

Feeding Programs:

Post-operative goal feeds in otherwise healthy infants can be initially targeted at 100 kcal/kg/day and adjusted up if the daily weight gain (1% of body weight/day) is not achieved. Breastmilk or standard formulas provide 100 kcal/kg/day or 150 cc/kg/day of fluid when given at 18 cc/kg/3 hr feed. A growth chart is essential for monitoring these babies.

Infants with significant intestinal absorption problems (prematures, post-NEC, gastroschisis, short gut, extensive resections) may require a slower feeding advancement to prevent malabsorption. It is better to achieve fluid goals before nutritional goals so that the infant is not dependent on IV access. In general, volume and tonicity are not advanced simultaneously. When the tonicity of the feeds are increased (starting at ¼ or ½ strength) the stools are monitored for malabsorption of sugars (>1 % Clinitest, stool volume > 40cc/kg/day). TPN is tapered off over 1-2 days at ¾ of enteral goals.

Children with fluid restriction requirements (cardiac, renal patients) may require higher density formulas. Infants with significant cardiac or pulmonary compromise may require feeding tubes to decrease the work of feeding. Meconium ileus (CF) infants will require pancreatic enzymes.

Older children can be advanced from clears to solids rapidly as GI function returns following abdominal surgery. Avoid carbonated beverages initially.

Formulas:

| | |
|--|---|
| cow's milk, lactose tolerant | Similac, Enfamil, Good Start |
| premature | Enfamil Premature, Similac Special Care |
| cow's milk tolerant, lactose intolerant | Lacto-free |
| cow's milk, lactose intolerant (soy-based) | Isomil, Prosobee |
| cow's milk, lactose, soy intolerant (pre-digested) | Pregestimil, Alimentum, Nutramigen |
| (pre-digested) >1 year | Peptamen Jr. |
| high MCT (chylous leak, fat malabsorption) | Portagen |
| CHO intolerant | RCF (Ross), 3232A (Mead) |
| elemental, amino acid (if > 1 year) | Neocate, (Neocate 1+) |
| low solute (renal impairment) | Similac PM 60/40 |
| standard, lactose-free, > 1 year | Pediasure, Kindercal, Vivonex |

PARENTERAL NUTRITION

Ordering TPN has been greatly simplified by the standard order sheet. The orders must be in by 12:00 noon. Daily recalculations of the total fluids and calories must be done until the child is on a stable regimen. Thereafter, recalculations are done periodically to adjust for weight gains. Assistance is available from the pharmacist, the nutritionist and the Gastroenterology service.

Basic Numbers and Principles:

| | |
|-----------|--------------|
| D5 | 0.17 kcal/cc |
| D10 | 0.34 kcal/cc |
| D12.5 | 0.42 kcal/cc |
| D15 | 0.51 kcal/cc |
| D17.5 | 0.60 kcal/cc |
| D20 | 0.67 kcal/cc |
| D25 | 0.85 kcal/cc |
| D30 | 1.00 kcal/cc |
| 10% lipid | 1.00 kcal/cc |
| 20% lipid | 2.00 kcal/cc |

Dextrose starts at D10 or D12.5 and advances 2.5 %/day to a target of D25 (D15 if the catheter is not central). Do not advance if the child is hyperglycemic or hyperglycosuric.

Protein starts at 1.0 gm/kg/day and advances to a goal of 3.0 (infants) or 2.0 (children) by 0.5 gm/kg/day. The calorie:nitrogen ratio should be 150-200 calories:gm nitrogen. Proteins are not considered in the caloric calculation.

Lipids start at 1.0 gm/kg/day and advance to 3.0 by 0.5 gm/kg/day. Central access is not necessary to give 20% Intralipid. Lipids are not given if the infant has hyperbilirubinemia.

The final carbohydrate:lipid caloric ratio should be 50:50.

Children on long-term TPN, should be cycled to less than 24 hours infusions to avoid liver damage and cholestasis.

Fetal mineral accumulation occurs in the last trimester. Therefore prematures tend to be mineral deficient and require increased supplementation.

Monitoring TPN:

1. Daily weights.
2. Daily total fluid and calorie calculations.
3. Specific gravity and urine for sugar until TPN maximized.
4. Lytes, BUN, glucose, CBC monitored closely until TPN maximized.
5. LFTs, bilirubin, protein, albumin q week.
6. Triglycerides q week to check for fat overabsorption.
7. Alkaline phosphatase q week in prematures (elevated in neonatal hypocalcemia).
8. Septic evaluation if blood/urine sugars become unstable.

A Simple TPN Calculation Technique:

Example: Five-day old, 4 kg infant with central access starting on TPN.

1. Select target fluid *volume* (120 cc/kg/day would be appropriate in this child)
2. Calculate hourly IV rate for above (120 divided by 24 times 4 = 20 cc/hr).
3. *Start* lipids at 1.0 gm/kg/day and use the following shortcut formula: *cc/hr of 20% lipids = weight in kg (4) times gm/kg/day of lipids desired (1.0) times constant factor of 5 divided by 24.* In this case, 0.8 cc/hr. Thereafter, advance lipids 0.5 gm/kg/day.
4. Subtract lipid rate (.8) from total hourly rate (20) to give hourly rate of dextrose (19.2 cc/hr). *Start* dextrose at D12.5 at this rate. Thereafter, advance dextrose 2.5%/day.
5. *Start* protein at 1.0 gm/kg/day. Thereafter, advance 0.5 gm/kg/day.
6. Add appropriate vitamin, minerals, trace elements.
7. Calculate calories for day #1 at selected *volume* of 120 cc/kg/day: D12.5 at 19.2 cc/hr + 20% IL at .8 cc/hr (48 + 10 = 58 kcal/kg/day).
8. Advance carbohydrate, protein, lipids each day to maximums and recalculate calories each day. Advance fluid volume to obtain more calories as needed to achieve weight gain.
9. Calculate contribution of enteral calories and fluid as the infant begins to feed by mouth.

FEEDING ACCESS

Gastrostomy Tubes:

Gastrostomy tubes (GT) are placed for a variety of reasons (failure to thrive, severe GER, neurologic impairment, pure EA) and are often done with an anti-reflux procedure. *All patients who receive a GT, should also receive a copy of the GT Teaching video.* The GT is initially placed as a Pezzar or Malecot tube or primary MIC-Key and converted to a Foley tube, MIC-Key or Bard Button when the tract is mature (3-6 weeks). The tract can seal rapidly (4-6 hours) so that a dislodged tube should be replaced with a similarly sized Foley as soon as possible. The Foley balloon must not be blown up in or allowed to migrate into the pylorus or duodenum. Consider this possibility in a child with a GT and acute onset emesis. The balloon should not be filled beyond 5 cc. Only water or saline should be used in the balloon.

A contrast study should be obtained if:

1. the tract is less than 3 weeks old
2. the replacement was uncertain

A properly replaced tube should drain into the stomach with gravity and aspirate gastric contents. An “Accidental dislodgement” protocol is described below.

Granulation tissue often develops at the GT site and is managed with periodic applications of silver nitrate. GT sites rarely get infected. Excoriation can be treated with application of a barrier cream to the peri-GT area. More complex problems may benefit from a Wound/Stoma Nurse consult (843-9234)

Leaking GTs can be managed by downsizing the tract with a smaller Foley for 24-48 hours and then replacing the previous tube. Occasionally, “overfilling” a MIC-Key balloon by 1-2 cc will create a tighter seal.

MIC-Keys come in a variety of diameters (14, 16, 18 Fr) and stem sizes (1.2, 1.5, 1.7, 2.0 cm, as measured from the top to the top of the balloon). The stem size can be estimated or sized with a measuring device. MIC-Keys are kept in the OR or ordered from Central Supply (see stock list). Bard Buttons are kept in the OR and in central supply.

Gastro-jejunostomy (GJ) tubes are usually placed by Interventional Radiology. Problems and questions can be referred to them. A MIC-Key GJ tube is now available.

The Nurse Practitioners are an important resource in the care, teaching and management of GTs and gastrostomy sites. They will review our GT video before d/c.

Feeding Access Home Care Supplies, write prescriptions for following:

- portable pump
- feeding bags (31/month)
- formula or nutritional supplement
- MIC-Key gastrostomy tubes (3/year)
- Secur-Lok extension sets (5/box) (CD# 0121-12)
- 5cc syringes, 60cc catheter-tip syringes (4/month)
- 2x2 gauzes (box of 100)
- 1” paper tape

Emphasize that GT extension sets should be removed and cleaned when not in use and secured at all times when in use. Extension sets should be loosely taped when in use, so as to exit the GT stoma perpendicular to the skin in order to prevent pressure sores and “coring” and enlargement of the GT site.

Accidental Dislodgement of Gastrostomy Tube:

1. Replace G-tube with Foley catheter (10, 12, or 14 Fr).
2. Attempt to aspirate gastric secretions from Foley G-tube to verify placement.
3. Contact Pediatric Surgery.
4. If the gastrostomy tube site is "mature" (present longer than 4-6 weeks) and if aspiration of the tube confirms intraluminal position with the return of gastric juice and/or formula), no contrast study is indicated (unless, for some other reason, the clinician is concerned that the tube is not appropriately positioned). If the gastrostomy tube is "fresh" (surgically placed within the past 4-6 weeks, a contrast study should be obtained.
5. A contrast study ("Tube Injection Verification Study") should ideally be performed under fluoroscopy in the Radiology Department by the Pediatric Radiologist. However, if the study is ordered emergently (at night or on weekends), the study may be performed at the bedside by the fellow/resident or by the Pediatric Surgery resident (after discussing the plan with the attending neonatologist and attending surgeon) as a "one-shot study" (with bedside KUB). Review of the KUB may be by the Radiology Resident.
6. If the G-tube appears to be appropriately replaced in the gastric lumen, the tube should be taped in place and feeds should be held until the morning (pending review by the Pediatric Radiologist). The study should be repeated if the Pediatric Radiologist believes the study is inadequate.

If the tube appears to be out of the stomach, the resident should immediately contact the Pediatric Surgery Attending or Senior Resident on call due to the potential risk of leakage of gastric juice and feeds into the peritoneal cavity.

VASCULAR ACCESS

General Information:

The Pediatric Surgery Team provides a valuable and experienced venous access service to the Children's Hospital. Always receive the line consult courteously and in a reasonable way determine if the request for our expertise is appropriate and necessary. A teaching video is now available for families to review.

Short-term peripheral access can be obtained by the IV team, the NICU and PICU nurses, the senior Pediatric residents and the Pediatric Anesthesia service. The PICU team can do percutaneous subclavian and femoral lines. Peripherally inserted central catheters ("PICC lines"/Perqu-Caths) can be done by the neonatal nurse practitioners, Interventional Radiology and/or an IV team "PICC line nurse".

Percutaneous or cutdown long-term, central access (central lines, Broviacs, Port-a-caths) and venous cutdown PICC lines are offered by our service, usually as an OR or ICU-based procedure. The insertion site and the type of line will be determined by the *indication, length of time needed, risk to the patient, coagulopathies and ongoing infections.*

Lines available: 2.7, 4.2, 6.6, 9.6 Fr *single lumen* Silastic catheters ("Broviac")
7, 10 Fr *double-lumen* Silastic catheters ("Hickman")
12.5 Fr *triple lumen* Silastic catheters ("Hickman")
2, 3 Fr PIC lines
6.6, 9.6 Port-a-caths

Sites often used include the *external jugular, facial, internal jugular, subclavian, sapheno-femoral, antecubetal veins.*

Supplies are kept in Central Supply (see stock list), W&C ORs and in the NICU. Repair kits are kept in Central Distribution (see stock lists). Ask the Unit Clerk to order one of the floor Stat.

Be aware that Port-a-caths are accessed with a special, non-coring (Huber) needle.

The "line problem" Consult:

1. *The Pediatric Surgery NPs and the PEDIATRIC SPECIALTY TEAM (843-0977) and the Pediatric Oncology nurses are highly experienced in the management of catheter problems. Ask for their assistance early. Stay involved.*
2. *Did we put in the line?* Refer to the PICU team or Interventional Radiology if appropriate.
3. *Is it occluded?* Try flushing using sterile technique with a 10 cc syringe of saline. Try an instillation of tPA (see below). Check the tip position and catheter course by CXR.
4. *Is there evidence of extravasation (pain, local swelling)?* Obtain a contrast study.
5. *Is the skin stitch out?* Do nothing if the catheter has been in for more than 2 weeks.
6. *Is the cuff exposed?* The catheter will probably need to be replaced.
7. *It won't aspirate blood?* Try a tPA instillation. Inform the primary team that catheters are not replaced if they flush but don't aspirate.
8. *Is there diffuse upper torso swelling?* Consider major venous thrombosis and evaluate with either contrast or US. Plan to remove the catheter.
9. *Is there leg swelling?* Elevate the leg if distal pulses are OK and capillary refill is brisk. Remove the catheter if the swelling significantly worsens.
10. *Has it migrated?* Continue to use it if it works. Replace if central access is needed.
11. *Is it broken on the external portion?* Obtain the appropriately sized repair kit from Ostomy Nurse office/In-patient Pharmacy and repair aseptically (see stock list).
12. *Is exit site red?* Do nothing unless the catheter is infected. Remove the skin stitch if appropriate.

The Infected Line:

In pediatric patients, vigorous attempts are made to preserve central lines which become infected. *The protocol (available thorough the Pediatric Specialty Team) at UNC includes:*

1. Documenting the infection by a culture through the line.
2. Line removal is often necessary if the line has yeast in it or if the cuff or tunnel is draining pus.
3. Empirically start Vancomycin (15 mg/kg IV q 8 hours, levels at third dose) and Cefotaxime (50 mg/kg IV q 8 hours) after the culture is drawn. Stop the antibiotics if the initial culture is negative at 48 hours.

4. Repeat line culture on the third or fourth day of antibiotics.
5. Line removal if that culture remains positive.
6. Peripheral access and antibiotics for 24-48 hours.
7. Repeat culture at 24-48 hours.
8. Central line replacement as needed.

tPA Protocol:

1. Order 2mg/2cc tPA (Alteplase) to the floor.
2. Aseptic technique.
3. Instill tPA into catheter (0.2cc for 2.7 Fr, 0.3cc for 4.2/5.0 Fr, 0.7 cc for 6.6/7.0 Fr, 2.0 cc for 9.6 Fr, 1.2 cc for 6.6 Fr Port)
4. Allow to dwell for 2 to 24 hours.
5. Aspirate remaining tPA and attempt to flush with saline ($\frac{1}{2}$ -life is 5 minutes, so it may be forward-flushed if it does not aspirate).
6. If successful, restart IV fluids or heplock.
7. Replace line as needed if two attempts fail.

Line Removal:

Port-a-caths are removed in the OR as a scheduled (ambulatory) surgery.

Broviacs in infants are removed on the floor with a combination of restraints and local anesthesia.

In older children, conscious sedation on the floor and in the Heme/Onc clinic or removal in the OR is done. Care is taken to dissect the cuff and avoid breakage of the catheter. Document the procedure through the office for billing purposes.

The nurses can remove non-tunneled central lines and PICC lines.

Broviac Repair:

Breaks distal to a Broviac catheter exit site (e.g. external portion) can be repaired. Disruptions between the skin and tip (internal portion) require catheter replacement. Repair kits are kept in Central Distribution; see the Stock List in the Appendix. During the day, the NPs can assist with the repair.

1. Contact the attending on call before doing the repair.
2. Evaluate the catheter and take off the dressing. If the cuff is exposed, the catheter should be replaced. If the tubing "balloons" with infusion, tPA should be instilled after the repair.
3. At least 2 cm of external catheter is needed to allow a repair.
4. Obtain a pIV if the child requires continuous access.
5. Order the appropriate repair kit to the floor (see Stock List).
6. Review the instruction book thoroughly.
7. Have experienced supervision during your first 3 repairs.
8. Sedation is typically not necessary. Informed consent is not necessary.
9. All technique must be sterile.
10. Repair the catheter as distal as possible.
11. Equipment: blue plastic clamp, sterile scissors and #11 blade, sterile towels, Betadyne prep, sterile gloves, mask, 2x2 gauze, heparin flushes (10 u/cc or 100u/cc), tongue depressor. A cutdown or similar tray may also be useful.
12. The catheter should be occluded near the skin (non-sterile) with a non-crushing clamp to prevent bleeding and air emboli.
13. Use silicone glue included in kit. Avoid getting glue into the lumen.
14. Catheter should aspirate and infuse easily after the repair.
15. Stent the repair for 48 hrs. with the tongue blade and do not use line for at least 4 hours.
16. Document the repair in the Progress Notes and submit a Minor Procedure form to the office.

TRAUMA

Pediatric traumas generate great anxiety. This can be diminished by keeping some **Basic Principles** and ideas in mind:

1. Most children will be relatively stable.
2. Use a Broselow tape to size the patient and select tubes and lines.
3. Administer oxygen.
4. Many children will have a head injury; involve neurosurgery early.
5. Keep a low threshold for intubation.
6. Obtain urgent access by (in this order):
 - a. upper extremity pIVs
 - b. intraosseous
 - c. sapheno-femoral **cutdown or percutaneous**
 - d. antecubital **cutdown**
6. Keep the child warm.
7. Stabilize and transport to CT within 10-15 minutes.
8. Control the flow of people in the room.
9. Consider child abuse.
10. Stay calm.

Trauma Triage:

Pediatric Trauma referrals will be directed to and triaged by the ER attending. Based on the clinical data available, they will be given a severity level of RED, YELLOW or GREEN. Notification will occur through the pager system. The Pediatric Trauma Team (pediatric surgical attending and senior resident, PICU and anesthesia team) along with the Adult Trauma surgeon on call will respond to all RED traumas. The Pediatric Surgical Team will respond to all YELLOW traumas if requested by the ER staff. The ER will manage GREEN traumas. The Burn Team will manage burn victims.

While Waiting for Child to Arrive:

1. Warm the room.
2. Obtain estimate of child's weight.
3. Obtain Broselow tape, appropriately sized chest tube, cutdown, intubation equipment.
4. Notify Neurosurgery, other consultants.
5. Notify PICU, CT scanner, OR.
6. Position CXR plate on bed.
7. Clearly designate personnel:
 - a. Trauma leader to supervise
 - b. Anesthesia to control airway/spine
 - c. ICU/ER physician to administer medications/arrange transport
 - d. Trauma surgeon to obtain access
 - e. Nurse to obtain vital signs
 - f. Nurse to obtain bloodwork
 - g. Nurse to record
7. Remind team of need to stabilize and transport within 10-15 minutes.
8. Obtain O(-) blood.
9. Dismiss unnecessary personnel; calm and focus the team.

Protocol for the Child in Extremis:

1. Intubate.
2. CPR as needed.
3. Intraosseous and femoral cutdown access.
4. Two rounds of cardiac medications:
 - a. epinephrine (1:10,000, 0.1 cc/kg ET, IV)
 - b. atropine (0.02 mg/kg ET, ET)
 - c. calcium (gluconate, 100 mg/kg IV)
 - d. bicarbonate (1 mEq/kg IV)
5. Chest tubes bilaterally.
6. Pericardiocentesis.

7. Thoracotomy is rarely indicated

Routine Trauma Studies:

Labwork (in order of importance):

- a. Blood bank sample
- b. CBC
- c. amylase/lipase
- d. urinalysis
- e. LFTs
- f. PT/PTT, if requested by neurosurgery
- g. Toxicology, if indicated
- h. chem 7

Radiographs:

- a. lateral C-spine to C7 (AP (odontoid if >5 yrs) for full clearance)
- b. CXR
- c. pelvis/hip

Acute Care of the Child with a Closed Head Injury (CHI):

1. A,B,C's.
2. Optimize cerebral perfusion:
 - a. maintain adequate MABP
 - b. minimize intracranial hypertension
 1. elevate head to 30 degrees
 2. diuresis (Mannitol 0.5-1.0 gr/kg)
 3. consider ICP monitor/check fontanel
 - c. maintain adequate hemoglobin
 - d. avoid hyperglycemia
3. Avoid secondary injury:
 - a. anticonvulsants (Dilantin 15mg/kg load over 20-30 min,)
 - b. treat other traumatic injuries
 - c. avoid hyperthermia
4. Spinal injury:
 - a. maintain spinal precautions
 - b. if cord injury suspected, Methylprednisolone (30 mg/kg load over 60 min., then 5.4 mg/kg/hr over 23 hours)
 - c. monitor for spinal shock, treat with fluids, inotropes

Clearing the Pediatric Cervical Spine

1. Refer to the C-spine algorithms in the Appendix.
2. Children **without** altered sensorium, distracting injuries, neck pain, neck tenderness, or distal neurologic findings and a normal lateral c-spine x-ray to C7 can be cleared without neurosurgical consultation.
3. Children **with** neck pain or tenderness and a normal lateral c-spine to C7 should be left in a well-fitting c-collar and reexamined in 6-12 hours. If these symptoms resolve, the spine can be cleared without neurosurgical consultation.
4. Patients that do not fit the above criteria will have their c-spines managed by the Neurosurgical Team.
5. CTs of the cervical spine will NOT be routinely obtained. If a head CT is being done, the scan should image to C1.

Indications for CT scan:

1. Concern for abdominal/retroperitoneal injury.
2. Peritonitis/worsening exam.
3. Head injury/unreliable patient.
4. Significant mechanism of injury.
5. >50 RBCs/hpf in urinalysis.
6. AST > 250.
7. Hyperamylasemia/lipasemia.
8. Intubated patient.
9. "Lap-belt complex" (bruise, pain, lumbar fracture)

Indications for Operation:

1. Ongoing chesttube output (1-2 cc/kg/min) or massive air leak.
2. Free air.
3. Free fluid *without* solid organ injury.
4. Known or suspected major duodenal or pancreatic injury.
5. Penetrating trauma to the torso, mediastinal traverse of FB.
6. Cardiac, great vessel, esophageal, diaphragmatic injury.
7. Rectal injury.
8. Positive DPL.
9. Solid organ injury (see below).

Protocol for Management of Solid Visceral Injuries:

Many children with injuries to the spleen, liver, kidneys and pancreas are managed non-operatively. This includes close monitoring and labwork, often in the ICU.

The protocol at UNC will include:

1. ICU observation if: grade 4 liver or spleen injury in hemodynamically stable patients, multi-organ injury, gross hematuria or transfusion requirement.
2. Transfuse for hematocrit < 21%. Maintain hematocrit above 25% if there is ongoing blood loss.
3. Strict bedrest for 4-7 days.
4. Continuous cardiorespiratory monitors until stable.
5. CBC q 6-8 hours until stable; amylase/lipase q day until normalizing.
6. 2 units PRBCs available at all times in blood bank.
7. Begin po when stable and pain or pancreatitis resolving.
8. Ambulate with assistance when tolerating po.
9. Follow-up (baseline) US when ambulating (Weiner).
10. Follow-up clinic appointment in 4-6 weeks.
11. No heavy activity/gym until 8 weeks or follow-up US demonstrates minimal residual injury.

Operative exploration and therapy is indicated for:

1. Hemodynamic instability.
2. Pancreatic transection.
3. Complete renal hilar disruption.
4. Shattered spleen.
5. Ongoing transfusion requirement.
6. Peritonitis.

Splenectomy requires post-op prophylactic vaccinations (Pneumovax, H. influenzae, Meningovax) and antibiotics until age 18 years (250-500 mg Pen VK po q day).

INITIAL MANAGEMENT OF NEONATAL SURGICAL EMERGENCIES

Respiratory Distress: A neonate with significant respiratory distress should be immediately intubated by the most experienced person available. Surgical airways or bronchoscopic intubations, in the case of large airway-compressing neck lesions, can sometimes be obtained at birth before the umbilical cord is clamped. *Surgical lung lesions*, which may cause distress, include *congenital cystic adenomatous malformations (CCAM)*, *congenital lobar emphysema (CLE)*, *pulmonary sequestration*, and *congenital diaphragmatic hernia*. CLE and CCAMs occasionally require urgent thoracotomy and decompression. Large cystic hygromas and teratomas can cause airway compression.

Congenital (Bochdalek) Diaphragmatic Hernia (CDH): This condition, in which the abdominal viscera protrude into the chest through a postero-lateral defect, results in ipsilateral lung hypoplasia and a predisposition to pulmonary hypotension (PPHN, persistent fetal circulation (PFC), pre-ductal/post-ductal “shunt”). Attempts are made to stabilize the infant and control the degree of pulmonary hypertension with non-barotraumatic ventilator techniques (permissive hypercapnea, high-frequency oscillating ventilator (HFOV), nitric oxide(NO)). A delayed (2-7 days) repair is preferred. Extracorporeal Membrane Oxygenation (ECMO) can be used as a rescue therapy for malignant pulmonary hypertension.

A detailed protocol is available to assist in managing these infants.

1. Recommend delivery at UNC.
2. **IMMEDIATE INTUBATION; AVOID BAG-MASK VENTILATION** (to limit gastric and intestinal distension into chest).
3. Open warmer in NICU or PICU.
4. “Gentle”, permissive hypercapnea ventilation strategy as outlined in **UNC CDH protocol** (available in NICU).
5. OGT to suction.
6. Sedation and paralysis (0.1 mg/kg MS, 0.1 mg/kg Vecuronium)
7. Peripheral IV and/or UVC.
8. UAC, Foley.
9. IVF: D10W at 80 cc/kg/day.
10. Pre- and post-ductal pulse oximeters.
11. Ampicillin and Gentamycin.
12. Consider bicarbonate (1 mEq/L) if shunt > 10%.
13. Limit fluid boluses; use Dopamine to maintain MABP.
14. ECHO, head ultrasound (HUS), CXR.
15. Minimize stimulation in quiet room.
16. Inform ECMO team, OR.

Bilious Emesis: Bile-stained vomiting in the neonatal and infant period is intestinal obstruction until proven otherwise. Unless there are clear signs and certainty of a *distal* obstruction or NEC, **MALROTATION AND VOLVULUS MUST BE EXCLUDED IMMEDIATELY**. This requires an **emergent UGI (or surgical exploration in some cases)** to document the position of the duodenal-jejunal junction (“ligament of Treitz”). If malrotation and volvulus are excluded, the surgical differential can focus on the other causes of neonatal intestinal obstruction.

Neonatal Intestinal Obstruction: An infant with intestinal obstruction will typically present in three ways:

1. emesis (if bilious, volvulus must be considered as above)
2. abdominal distension
3. failure to pass meconium in an expected timeframe (within 48 hours if fullterm)

In the majority of cases, this obstruction will be from non-surgical causes (sepsis, perinatal stress, hypothyroidism, sluggish “preemie” gut). However, a surgical condition cannot entirely be excluded unless a contrast enema and /or UGI is done. An isosmolar or weakly hypertonic contrast enema is performed before anything (finger, saline) is inserted into the rectum. Antibiotics are often given before the enema to minimize bacterial translocation with the pressure and manipulation. **Hypertonic contrast can cause hypotension in small neonates.**

With a physical examination, UGI and/or contrast enema, most neonatal surgical intestinal obstructions can be diagnosed, including:

1. Non-volvulus duodenal obstruction (atresia, webs, annular pancreas)
2. Jejunal-ileal atresia

3. Meconium ileus (simple and complicated)
4. Meconium plug/short left colon syndrome.
5. Hirschsprung's disease.
6. Colonic atresia.
7. Imperforate anus
8. Incarcerated hernia

Rectal biopsies to evaluate for Hirschsprung's are usually done at the bedside. The suction device can be obtained from the OR or from Surgery Clinic. Specimens from 2 cms. above the anal verge are transported in formalin for analysis. Informed consent is required. A CF workup follows a diagnosis of meconium ileus.

Non-volvulus Duodenal Obstruction (atresia, annular pancreas, web, Ladd's bands): The infant presents with emesis (often bilious) and a "double bubble" on KUB. If there is any concern for malrotation/volvulus an emergent UGI and/or exploration is done as discussed above. (If the UGI cannot clearly distinguish volvulus from the other forms of duodenal obstruction, surgery should be undertaken directly.) There is a 30% incidence of trisomy 21 with duodenal obstructions. Many of these babies will have cardiac defects.

1. OG decompression.
2. IVF.
3. ECHO, HUS, renal US.
4. Duodenoduodenostomy as soon as possible when anomaly workup done.

Necrotizing Enterocolitis: Typically a disease of premature infants, it may be precipitated by early, hypertonic, non-breast-milk feeds, Indocin, UAC's, hypoperfusion conditions, respiratory distress. The infant may present with feeding intolerance, abdominal distension, and/or physiologic instability. Lab analysis may demonstrate thrombocytopenia and/or metabolic acidosis. Radiographs confirm the diagnosis by demonstrating cystic or linear pneumatosis or free air.

The therapy for suspected or proven NEC (stage I or II) includes:

1. IVF(120-180 cc/kg/day) to achieve an adequate urine output (1-2 cc/kg/hr).
2. NPO, NGT for 5-10 days.
3. Ampicillin, Gentamycin and Clindamycin for 5-10 days.
4. Serial CBC, ABG, specific gravity and left lateral decubitus radiographs q 6-8 hours until stable or a surgical indication develops. Q day thereafter.
5. TPN until taking po.

The indications for surgery (stage III) include:

1. Free air (only absolute indication).
2. Infected /bilious paracentesis
3. Failure to respond to maximal medical therapy and/or clinical deterioration (**signs of the very ill infant**):
 - a. physiologic instability (unstable MABP)
 - b. lethargy, temperature instability/hypothermia
 - c. renal failure (oliguria, rising urine SG/BUN)
 - d. respiratory failure (apnea/bradycardia, higher ventilator settings)
 - e. worsening metabolic acidemia
 - f. pancytopenia
 - g. glucose intolerance
 - h. belly wall erythema
4. Portal vein gas.
5. Fixed, dilated loop on serial films.
6. Gasless abdomen on x-ray
7. Abdominal mass.

The goals of surgical therapy include:

1. Effective pre-op volume resuscitation.
2. Correction of coagulopathy (platelet transfusions).
3. Removal of septic foci (debris, stool, necrotic tissue)
4. Diversion of the fecal stream.
5. Preservation (and measurement) of viable bowel.

Ostomy takedown is typically done 6-8 weeks after the initial surgery, when the child is stable and gaining weight or if the fluid loss from a high stoma is difficult to manage. A distal contrast study is always obtained preoperatively to evaluate for strictures.

Abdominal Wall Defects, Sacrococcygeal Teratoma (SCT), and Extrophy: *Gastroschisis* is an gut evisceration not covered by a membrane; the high fluid loss makes this a surgical emergency. They are not generally associated with other anomalies. There is a small incidence (12-15%) of *late-presenting NEC* after gastroschisis repair. *Omphalocoels* may contain solid viscera and are covered by amnion, which allows for a more extensive workup of possible anomalies (ECHO, renal US, genetic consult) before repair. Ruptured omphalocoels must be dealt with emergently. Giant omphalocoels may be managed non-operatively by promoting epithelialization with escharotic agents (Silvadene). SCT have a small risk of rupture, hemorrhage and/or high-output cardiac failure. Bladder or cloacal extrophy are at risk for mucosal excoriation and fluid loss and warrant Pediatric Urologic input.

1. Examine the gastroschisis and relieve any torsion of the bowel.
2. Cover the gastroschisis, SCT or extrophy with warm, moist gauze and place the infant's torso in a occlusive membrane (bowel bag, Saran wrap).
3. Place OGT to LCWS.
4. Establish IV access and anticipate a high fluid requirement (120-160 cc/kg/day).
5. Transport/position gastroschisis/SCT to prevent venous obstruction or volvulus (on left side).
6. Cover omphalocoel with dry gauze and initiate anomaly workup (ECHO, karyotype, etc).
7. Ampicillin and Gentamycin.
8. Consent to include Broviac catheter, silo placement.
9. Anticipate prolonged bowel inertia in gastroschisis (4-6 weeks).
10. Slow feeding advance in gastroschisis with breastmilk or Pregestimil.

Esophageal Atresia and Tracheo-esophageal Fistula (EA/TEF): The most common malformation is a proximal EA with a distal TEF (85%). The incidence of pure EA is 7-8%. The diagnosis is made by x-rays demonstrating that the OGT curls in the proximal pouch and whether there is air in the GI tract; contrast studies are generally not done. The repair is done via a right thoracotomy with an extrapleural dissection. The fistula is ligated first and an anastomosis of the esophagus is performed if possible.

Gastrostomies are rarely done but are necessary for pure EA.

1. CXR/AXR ("babygram") to demonstrate curling of the OGT tube, presence/absence of GI air. (Someone should apply pressure to the OGT at the time of the x-ray.)
2. OG suction of the proximal pouch.
3. Transport/position in a semi-upright position.
4. IVF, Ampicillin, Gentamycin.
5. ECHO to evaluate for cardiac anomalies, side of arch.
6. Search for other VACTERL anomalies.
7. UGI at 5-7 days post-op.

Ambiguous Genitalia: The evaluation of ambiguous genitalia is multidisciplinary problem involving neonatology, pediatric surgery, urology, genetics and endocrinology. The emergent issue is a sex assignment and evaluation for a mineralcorticoid (salt-losing) deficiency.

Imperforate Anus: The diagnosis should be self-evident. The management focuses on whether the malformation is low or high. Low defects should be repaired before the stool is colonized (24-48 hours post-natal). High or indeterminate defects require a colostomy.

1. Examine of male perineum looking for meconium/mucus beads, meconium in raphe, "bucket-handle" deformity or female perineum looking for a perineal body or vaginal forchette fistula (low imperforate anus).
2. Examine male meatus looking for meconium (high imperforate anus).
3. Examine female introitus for possible cloacal anomalies (may require EUA, fluoroscopy)
4. Assess sphincter tone, "flatness" of bottom.
5. OGT to LCWS.
6. IVF, Ampicillin, Gentamycin.
7. Search for other VACTERL anomalies.
8. Cross-table, knee-chest x-ray with marker on anal dimple at 8-24 hours.

VACTERL Workup:

1. "Babygram" to assess for vertebral defects.
2. Assess anal patency.
3. ECHOCARDIOGRAM.
4. Passage of OGT to rule out EA.
5. Renal US.
6. Extremity x-rays if clinically indicated.
7. Spine US if < 1 month old

Prolonged Jaundice: An infant with jaundice persisting for 2 weeks after birth or with a > 20% direct component raises concern for a structural/surgical extrahepatic obstruction including choledochal cyst, biliary atresia (BA), acute biliary hydrops, acalculous cholecystitis, biliary perforation. While a medical etiology is sought (sepsis, viral, CF, alpha 1-AT, etc.) a surgical w/u is also initiated.

1. Stools are inspected for pigment
2. US to check for GB, cyst, biloma
3. HIDA to document excretion in intestine

If the w/u comes to neonatal hepatitis v. BA, an operative cholangiogram and/or open liver bx is performed. If BA is suspected, a Kasai (portoenterostomy) is done at that operation. If the surgery is done before the child is 8 weeks old, about 30% of these patients will have a successful result; the rest will require liver transplant. The long-term risk is cholangitis and loss of bile flow. Such patients will develop acholic stools, fever and jaundice and may be salvaged with a combination of antibiotics (against G(-) organisms), steroids and choloretic agents (Actigall, phenobarbital). Reoperation is rarely successful.

COMMON PEDIATRIC SURGICAL CONDITIONS

Appendicitis: Appendicitis is the most common cause of an acute, surgical abdomen in children over 2 years. It tends to present in a typical fashion with periumbilical pain progressing to the right lower quadrant, followed by nausea, emesis and anorexia, fever to 102-103, local peritoneal signs and leukocytosis with a “left-shift”. A urinalysis is usually obtained; x-rays, ultrasounds and other studies are not generally helpful unless the diagnosis is equivocal. Symptoms longer than 36 hours with a marked fever and/or WBC suggest perforation and abscess formation; CT scans may be indicated.

Routine management includes:

1. Vigorous pre-op hydration including fluid boluses.
2. Withholding antibiotics and analgesia including Tylenol until diagnosis/plan is certain.
3. Serial abdominal exams, labs as indicated.
4. US, CT, laparoscopy in equivocal cases (e.g. teenage females).
5. Antibiotics pre-operatively; Kefzol +/- Falgyl (simple, early appendicitis), Zosyn (suspected perforation).
6. Continue abx post-op for simple (acute, suppurative) appendicitis
7. Consent to include bowel resection/ostomy (in case of Meckel’s, Crohn’s).

Management of complicated (gangrenous, perforated) appendicitis:

1. NGT until ileus resolves.
2. PICC line in OR or on floor.
3. Zosyn for 3-7 days (per attending).
4. Discharge home when eating, afebrile, (WBC nl).
5. Antibiotics: Bactrim or Cipro/Flagyl po for 10-14 days
6. If symptoms of abscess (fever, pain, emesis, frequent, small-volume diarrhea, persistent, elevated WBC): CT

Management of appendiceal abscess:

1. Percutaneous drainage by Interventional Radiology.
2. PICC line or CV line.
3. Continue IV antibiotics.
4. Interval appendectomy at 6 weeks.

Indications for incidental appendectomy: The procedure can be done by the inversion technique to avoid opening the bowel. If there is a possibility the child may need the appendix as a urinary conduit or as a stoma to manage constipation, it should be preserved.

1. Ladd’s procedure for malrotation (absolute indication).
2. Endorectal pullthrough.
3. Intussusception.
4. Repair of CDH (if patch not used).
5. Neurologically-devastated/non-communicative child undergoing elective abdominal surgery.

Intussusception: A common cause of acute abdomen in the toddler age group (8-24 months). The diagnosis is primarily historical with a previously healthy child presenting with intermittent episodes of severe colicky pain. During the attacks they are inconsolable and often draw their legs up, afterwards they are quiet and/or lethargic. The site of involvement is usually the ileo-colic junction and there may be signs of obstruction clinically or radiographically. Bloody stools are a late, more ominous sign. There is a small incidence of *small bowel intussusception* after retroperitoneal and thoracic surgery (e.g. Wilm’s tumor).

1. Mandatory surgical consultation.
2. Establish IV access, begin hydration, antibiotics (Cefoxitin).
3. Contrast (air, barium) enema urgently with surgeon present if possible
4. Inform OR.
5. Observe overnight if reduced; offer po in the morning.
6. Operate if:
 - a. unable to reduce in three attempts
 - b. pathologic lead point (lymphoma, Meckel’s, HSP hematoma)
 - c. atypical age (relative indication because of higher chance of pathologic lead point))
 - d. third recurrence
 - e. obstructed and physiologically unstable
 - f. evidence of peritonitis, perforation, gangrenous bowel, sepsis

Hypertrophic Pyloric Stenosis (HPS): Typically presents as persistent, forceful non-bilious emesis in the 3-6 week old infant. The differential diagnosis includes overfeeding and reflux. Physical exam (after gastric decompression) is the preferred diagnostic technique. Ultrasound is useful but operator dependent (normal channel length is 1.5 cm, normal thickness is 0.4 cm). UGI is used if reflux is high on the differential.

1. Feel for the “olive” (after aspirating the stomach) while feeding the infant glucose water.
2. Consider US or UGI if diagnosis uncertain.
3. Establish IV access: chem 7, CBC.
4. IVF: 20 cc/kg NS bolus then D5 ½ NS at 1.5 maintenance, add 20 mEq/L KCl after void.
5. 1 mg vitamin K IM
6. Kefzol OCTOR
7. NPO; NGT is usually not necessary (or to evacuate Ba after UGI).
8. Operate when the *hypochloremic, hypokalemic, hyponatremic metabolic alkalosis* is corrected.
9. Inform parents of the likelihood of post-op emesis.
10. Post-op feeding ladder (“puke ad lib”):
 - a. IVF: D5 ¼ NS + 20 mEq/L KCL at 1.0 maintenance
 - b. Offer 1-2 oz. q 3 hours (Pedialyte for first feed, then BM/formula)
 - c. Do not hold feeds for emesis
9. Discharge home when patient tolerates 60 cc twice without emesis.
10. Instruct parents to increase feeds 15 cc/day for 2 days and then offer ad lib.

Hernias: The acute management of inguinal hernias hinges on distinguishing an incarcerated hernia from a reducible hernia, a hydrocoele, or in older children, testicular torsion or epididymitis. Easily reducible hernias can be scheduled for elective repair. Incarcerated hernias that are successfully reduced are usually admitted for repair within 48 hours. Do not attempt reduction on any child with unstable vital signs, peritonitis or other evidence of infarcted bowel. Any child who receives sedation for reduction or had evidence of bowel obstruction before reduction is admitted for subsequent repair. Irreducible incarcerated hernias, uncertainty about a complete reduction or uncertainty about a hydrocoele v. an irreducible, incarcerated hernia requires urgent operation. Premature infants are typically repaired when they reach 1600 gms (females) or 1800 gms (males) or shortly before discharge. Full term infants who are inpatients are usually repaired before discharge. A contralateral exploration (laparoscopically or open) may be done in prematures or former prematures of both gender. Attending preference varies for term infants. Umbilical hernias are generally observed until age 4 or 5 years. Large, “proboscis” or symptomatic umbilical hernias may be repaired earlier.

Acute Scrotum: An red, swollen, painful hemiscrotum in a child is a testicular torsion until proven otherwise. Other possibilities include torsion of a testicular appendage or epididymitis in the older, sexually active male with a positive urinalysis. Any uncertain case or patient with symptoms longer than 4 hours should undergo urgent scrotal exploration. Doppler US or nuclear scans may be used but carry a false negative rate of 5-10%.

Undescended Testes (UDT): An undescended testes must be distinguished from a “retractile” testes (one which can be maneuvered into the scrotum). Unless there is an associated hernia, most UDT are observed for the first year of life; “retractile” testes are usually observed until puberty. Bilateral UDT with any abnormality of the phallus or bilateral “hernias” in a female with any genital abnormality raises a concern for ambiguous genitalia.

Gastroesophageal Reflux (GER): Reflux is a common condition in infants less than 2 months and is typically “physiologic”, caused by an immature lower esophageal sphincter and self-limiting with thickened feeds and frequent burping. *Pathologic reflux* is suggested by:

1. Recurrent aspiration pneumonias.
2. Esophagitis/Barrett’s changes.
3. Failure of medical management (H2 blockers, prokinetic agents).
4. Failure to thrive.
5. Sandifer’s syndrome (neck arching).
6. Infantile apneic/”death spells”.
7. Esophageal dysmotility conditions (EA/TEF, CDH).

The workup of a child with GER or a neurologically impaired child needing feeding access will start with an UGI. If this is negative, a 24-hour pH probe is placed. If the UGI is positive, a fundoplication is recommended without a pH probe. The preferred surgical technique is a 360 degree Nissen fundoplication (open or laparoscopically), often with a gastrostomy tube. Neurologically impaired children with GER have a more frequent need for surgical therapy as well as a higher complication and failure rate. Standard post-op management is outlined in a previous post-op protocol section.

Gastrointestinal Bleeding:

Causes of *upper GI bleeding* in children:

- NEONATE: ingested maternal blood, bleeding disorders, gastric ulcers
- TODDLER: stress ulcers, gastritis, and esophagitis
- 2-6 YEAR OLD: gastric ulcers, gastritis, and esophagitis
- >6 YEARS: PUD, gastritis, esophagitis, and varices

Cause of *lower GI bleeding* in children:

- NEONATE: ingested blood, bleeding disorders, colitis, formula intolerance, NEC, volvulus
- TODDLER: anal fissures, colitis, intussusception, Meckel’s, polyps
- 2-6 YEAR OLD: colitis, polyps, anal fissures, Meckel’s, IBD, HSP
- >6 YEARS: IBD, colitis, and polyps

Meckel’s diverticulum bleeding is characterized by *large volume*, bright red/melana, painless bleeding; *juvenile polyp* bleeding usually manifests as *small volume*, bright red, painless bleeding

Constipation: The majority of cases are idiopathic and managed expectantly with a bowel regimen. Organic causes, including late-presenting (short-segment) Hirschsprung’s disease, spinal tumors/tethered cord and CF should be considered. Chronic constipation can lead to rectal bleeding, anal fissures and rectal prolapse. Severe, persistent constipation may be an indication for an appendicostomy (MACE procedure)

A bowel regimen might include adequate hydration, high-fiber diet, saline enemas (10cc/kg), MOM (1 tsp. 1-3x/day), mineral oil (1-4 tsp./day), maltsupex or karo syrup (5-10 mL 2-4x/day), Lactulose (10g/15cc) (1-3cc/kg/day, qD or BID), Mirulax (1/2 to 1 cap q D).

Neck Masses: The majority of pediatric neck masses are reactive lymph nodes. These are red, tender, associated with respiratory infections and may require drainage if they form an abscess. A midline mass that moves with swallowing may be a thyroglossal duct lesion. A cyst or draining sinus along the sternocleidomastoid or anterior to the external ear may be a branchial cleft remnant. Dermoid cysts, cystic hygromas and lymphohemangiomas are also in the differential. Any mass that fails to resolve on 2-3 weeks of antibiotic therapy should be excised/biopsied to evaluate for malignancy. Ultrasound and/or CT or MRI may be useful imaging tests.

A Brief Pediatric Oncology Primer

Children with cancer and their families are a special patient population with unique medical, surgical and psychological concerns. An organized, multi-disciplinary and caring medical team is essential. Pediatric cancers in order of frequency are: leukemias, brain tumors, lymphoma, neuroblastoma, sarcomas, and nephroblastoma.

Leukemias: ALL is the most common with a 90+ cure rate. AML usually requires double lumen access as some of these children go on to BMT. Thrombocytopenia is evaluated and corrected pre-op.

Lymphomas: CXR and/or chest CT must assess the potential of mediastinal compression and airway collapse with paralytic anesthesia. Nodal biopsies may be needed.

Neuroblastoma: Arise from neural crest tissues (sympathetic ganglia, adrenals) and often surround major vascular structures. CT, MRI, urine metanephrines assist in diagnosis. Patient age, nMYC status and histology (Shimada classification) are the best prognostic predictors. Resection or generous biopsy, chemotherapy (cisplatin, adria, CPM, VP-16, etc.) and second-look and/or BMT for high-risk tumors.

Stage 1: localized tumor, complete excision, (-) nodes

Stage 2: tumor extension, incomplete excision, or (+) ipsilateral nodes

Stage 3: extension across midline or (+) contralateral nodes

Stage 4: metastatic to BM, liver, distant organs

Stage 4S: localized with mets to liver, BM, skin

Risk groups for treatment planning are based on surgical stage, nMYC status, age < or > 1 year, and/or Shimada score and are separated into LOW (stage 1 or 2, no nMYC), INTERMEDIATE (stage 3, 4, 4S, <1 y., no nMYC) and HIGH.

Nephroblastoma (Wilms' tumor): Most common malignant renal tumor of children. Ultrasound and/or CT to differentiate from NB and assess for IVC thrombus. CXR and/or chest CT to evaluate for mets. Nephroureterectomy or biopsy and node sampling followed by XRT (stage 2, 3, 4) and chemotherapy (vincristine/actinomycin-based).

Stage 1: localized tumor, complete excision

Stage 2: capsule extension, complete excision, biopsy/spillage

Stage 3: incomplete excision, (+) nodes, gross spillage, peritoneal implants

Stage 4: distant metastasis

Stage 5: bilateral

Oncology Vascular Access Checklist:

1. platelets available
2. # lumens, Broviac v Port?
3. BM, LP also?
4. CXR if lymphoma patient

Typhlitis: RLQ pain in a neutropenic patient that results from colon/cecum wall invasion by microorganisms. Most commonly seen with AML. Associated with bloody diarrhea and fever. CT demonstrates bowel wall edema and fat spiculation. US show hyperechoic bowel wall and can be done at the bedside. Therapy is bowel rest and broad spectrum Abx +/- antifungals. Exploration may be needed if appendicitis cannot be excluded. Severe typhlitis may require R hemicolectomy and ileostomy.

EXTRACORPOREAL MEMBRANE OXYGENATION (ECMO)

The ECMO team is a distinct service comprised of surgeons, pediatric intensivists, and specially trained nurses and pump technicians. The Pediatric Surgery service is primarily involved for cannulation and decannulation. *The indications for ECMO include:*

1. Persistent Pulmonary Hypertension of the Newborn (PPHN).
2. Meconium Aspiration Syndrome (MAS).
3. Severe Respiratory Distress Syndrome (RDS).
4. Congenital Diaphragmatic Hernia (CDH).
5. Congenital heart disease/Cardiac surgery rescue.
6. Neonatal Sepsis

The oxygenation index (OI) may help determine the appropriateness of ECMO therapy. $OI = \text{Mean Airway Pressure (MAP)} \times \text{Fraction Inspired Oxygen (FIO}_2) \text{ divided by post-ductal pO}_2$. An OI > 30 supports consideration for ECMO.

The pump can be set up for either venoarterial (VA) or venovenous (VV) ECMO. Cannulation is done in the ICU at the right neck via the carotid and internal jugular vessels. Runs last from 3 to 14 days and are managed by the ECMO service. *A pre-op checklist follows:*

1. Weight > 2 kg.
2. Obtain HUS (rule out IVH > grade 2).
3. Obtain ECHO (rule out fatal anomaly, TAPVR).
4. Transport to PICU.
5. Perform all invasive procedures (Foley, NGT, IVs).
6. Authorize pump priming (2-4 hours with crystalloid).
7. Authorize blood priming (1 hour).
8. Headlight, loupes.
9. Ampicillin and Gentamycin.

Positioning

1. X-ray plate under chest
2. Shoulder roll, arms at side
3. Right neck exposed, ear taped up
4. Bovie pad on, leads taped, ETT secure
5. Surgeon on patient's right
6. Spotlight from directly overhead

Procedure

1. Betadyne prep, full drape
2. 1% lidocaine, Fenatnyl, paralysis
3. Bovie incision
4. Transverse incision 1 cm above clavicle at bifurcation of SCM
5. Careful, bloodless exposure of IJ and carotid
6. Avoid vagus n injury/traction
7. Vessel loops and 2.0 silks around a and v
8. 100 u/kg heparin, circulate 2 min.
9. Estimate caliber and length of cannulas
10. Distal ligation of vessel (v then a)
11. Incise vessel and pass cannula with obturator in place
12. Withdrawl obturator and secure sterile tubing, clamps on
13. Cannula is secured with proximal tie and distal tie

Connecting circuit

1. One surgeon watches and holds cannulas at all times
2. Tubing is brought close to field
3. Sterile barrier is removed
4. Sterile cut is made between tubing clamps
5. Tubing is cleared of air bubbles with saline
6. Tubing connected to cannula without trapping air
7. Clamps are removed and flow begun
8. Volume is given as needed

9. CXR or ECHO to check and optimize cannula position
10. Surgicel and cautery to control any ooze
11. Wound closed with nylon and loose dressing placed
12. Cannulas stitched behind ear in neutral position
13. Tubing secured to bed to avoid malposition or drag

Miscellaneous points

1. Typical FT infant cannulas
 - a. 14 Fr VV
 - b. 8-10 Fr A
 - c. 12-14 Fr V
2. Typical FT infant distances
 - a. A: 2.5-3.5 cm (tip to sternal notch)
 - b. V: 7-9 cm (tip to xiphoid)
3. Less vessel manipulation, less spasm, larger the cannula
4. Place largest V cannula possible
5. Leave marker vessel loop on a after VV cannulation
6. Direct VV cannula at tricuspid valve

Decannulation

1. Sterile procedure
2. Wound opened, vessels controlled distally and proximally with 2.0 silks
3. Cannula stitches cut, assistant holds cannulas securely
4. Ties around cannula cut carefully with a knife
5. Cannulas removed in steady motion and proximal ties secured
6. Wound closed

CHECKLIST FOR CASES OUT SIDE THE OR

Broviac/PIC line:

1. Cutdown tray
2. NICU "line" or "PDA" tray
3. Yellow vein "pick"
4. Loupes
5. 10 u/cc heparin flush, 1 % lidocaine
6. 5.0 silk, 3.0 silk or 3.0 Nylon, 5.0 Vicryl, chromic, Monocryl
7. 2 or 3 Fr PIC line or 2.7 Fr Broviac (see stock list)
8. Extra pack sterile towels
9. Good overhead spotlight or headlight

PDA Ligation:

1. Bovie
2. Second assistant available
3. Small and medium hemoclips
4. Headlight, spotlight, loupes
5. 14 Fr angiocath, 3 Fr feeding tube, 10 cc syringe
6. Steri-strips, collodion
7. 0 silk tie, 5.0 silk on cardiovascular needle
8. 4.0 Vicryl pop-offs, 5.0 Monocryl
9. 8 or 10 Fr, chestube and Pleuravac (Phillips)

CDH Repair:

1. Bovie
2. Second assistant available
3. 1 mm Goretex patch
4. 3.0 Prolene, 3.0 Ethibond, pledgets
5. Endoscopic hernia stapler ("Universal stapler 65"), extra staples
6. "Pigtail" chest tube and 10 Fr chest tube
7. Headlight, spotlight, loupes
8. Surgicel, thrombin spray
9. #10 JP drain

Silo Placement/Turndown:

1. Sterile towels
2. Betadyne prep
3. 4/5.5/6 cm pre-made silo (in W&C OR stock room)
4. 3.0 Prolene on Keith (straight) needle, umbilical tape
5. Betadyne ointment, Kerlix, "tea-colored" Betadyne/saline, Saran wrap

Suction Rectal Biopsy

1. Informed consent
2. Biopsy forceps ("NJ" or "Australian")
3. Chux
4. Suction tubing
5. "cath-tip" 60cc syringe
6. Formalin specimen container
7. Surgilube
8. 500cc saline
9. 19# needle
10. Gloves

STOCK LIST FROM CENTRAL SUPPLY

MIC-Key Gastrostomy Devices:

| | |
|----------------------|------------|
| 14 Fr/1.2 cm MIC-Key | #07-107182 |
| 14 Fr/1.5 cm MIC-Key | #07-107184 |
| 14 Fr/1.7 cm MIC-Key | #07-107186 |
| 16 Fr/1.2 cm MIC-Key | #07-107188 |
| 16 Fr/1.5 cm MIC-Key | #07-107190 |
| 16 Fr/1.7 cm MIC-Key | #07-107192 |
| 16 Fr/2.0 cm MIC-Key | #07-107194 |
| 18 Fr/1.2 cm MIC-Key | #07-107196 |
| 18 Fr/1.5 cm MIC-Key | #07-107198 |
| 18 Fr/1.7 cm MIC-Key | #07-107200 |
| 18 Fr/2.0 cm MIC-Key | #07-107205 |

Broviacs/PIC lines:

| | |
|-------------------|------------|
| 2.0 Fr PERQU-CATH | #07-108438 |
| 3.0 Fr PERQU-CATH | #07-108405 |
| 2.7 Broviac | #07-101360 |
| 4.2 Broviac | #07-101370 |

“Pigtail” chest tube:

#07-105082

Thoracentesis kit:

#10-175700

CATHETER REPAIR KITS STOCK LIST

(Available from Stoma Nurse office (ground floor by in-patient pharmacy); in-patient pharmacist during off-hours)

Single lumen:

| | |
|-----------------------|--------|
| 2.7 Fr (.5 mm lumen) | #60160 |
| 4.2 Fr (.7 mm lumen) | #60161 |
| 6.6 Fr (1.0 mm lumen) | #60162 |
| 9.6 Fr (1.6 mm lumen) | #60163 |

Double lumen:

| | |
|------------------------|---------|
| 7.0, 10 Fr (white arm) | #060168 |
| 7.0, 10 Fr (red arm) | #060169 |
| 7.0 Fr (both lumens) | #060176 |
| 10 Fr (both lumens) | #060175 |
| 12 Fr (both lumens) | #060171 |

FREQUENTLY USED CPT CODES**FREQUENTLY USED CPT CODES**

| | | |
|--------------------------------------|-------|-------------|
| CVC | <5/>5 | 36555/36556 |
| CVC-tunneled | <5/>5 | 36557/36558 |
| CVC-tunneled, port | <5/>5 | 36560/36561 |
| Cath-tunneled removal/port removal | | 36589/36590 |
| PD cath insert / removal | | 49421/49422 |
| Chest tube insertion | | 32020 |
| Thoracoscopy, decortication | | 32651 |
| ECMO cannulation/ removal-close | | 36822/36815 |
| PDA repair | | 33820 |
| CDH repair | | 39503 |
| TEF/EA repair | | 43314 |
| Gastroschisis repair/silo | | 49605 |
| Gastroschisis remove silo & closure | | 49606 |
| Open Gastrostomy / neonatal | | 43830/43831 |
| Lap Gastrostomy | | 43653 |
| Gastrostomy tube change | | 43760 |
| Nissen fundoplication open/lap | | 43324/43280 |
| Pyloromyotomy open/lap | | 43520/43659 |
| Appendectomy open/lap | | 44950/44970 |
| Hernia inguinal /preemie<50 wks | | 49491 |
| Hernia inguinal/<6 m | | 49495 |
| Hernia inguinal/<6 m incarcerated | | 49496 |
| Hernia inguinal/6 m-5 yrs | | 49500 |
| Hernia inguinal/6 m-5 yrs, incar. | | 49501 |
| Hernia inguinal/> 5 yrs | | 49505 |
| Hernia inguinal/> 5 yrs, incar. | | 49507 |
| Hernia umbilical/< 5 yrs / incar. | | 49580/49582 |
| Hernia umbilical/> 5 yrs / incar. | | 49585/49587 |
| Exploratory Laparotomy | | 49000 |
| Re-explore Laparotomy | | 49002 |
| Diagnostic Laparoscopy | | 49320 |
| Extensive LOA/ Lap | | 44005/44180 |
| Ileostomy/jejunostomy non-tube | | 44310 |
| Ileostomy w/sm bowel resection | | 44125 |
| Small bowel resection/anastomosis | | 44120 |
| Malrotaion/Ladd's procedure | | 44055 |
| Reduce volvulus/intussusception | | 44050 |
| Colostomy/cecostomy | | 44320 |
| Colectomy/partial w/anastomosis | | 44140 |
| Colectomy/partial w/colostomy | | 44141 |
| Colectomy/partial w/ostomy&Hartman | | 44143 |
| Colectomy/partial ostomy&mucofistula | | 44144 |
| Colectomy/partial w/ileocolostomy | | 44160 |
| Colectomy/total w/S or J pouch | | 44153 |
| Enterostomy closure/ Lap | | 44620/44227 |
| Liver biopsy | | 47100 |
| Cholecystectomy/Lap | | 47600/47562 |
| Rectal biopsy | | 45100 |
| Anorectal exam/pelvic exam | | 45990/57410 |
| I&D abscess simple/complicated | | 10060/10061 |
| I&D perianal abscess | | 46050 |
| I&D perirectal abscess | | 46040 |

FREQUENTLY USED PHONE NUMBERS

| | |
|-----------------|----------------------|
| Von Allmen | beeper 216-0863 |
| Adamson | beeper 347-1115 |
| Weiner | beeper 347-0512 |
| Phillips | beeper 216-3298 |
| Lange | beeper 347-0301 |
| Farber CPNP | beeper 216-6517 |
| Lamm CPNP | beeper 216-3873 |
| Smith RN (Wake) | beeper 393-6498 |
| Valley | beeper 1693 (voice) |
| Bailey | beeper 3338 (voice) |
| Georges | beeper 1682 (voice) |
| PS OFFICE | 966-4643/4220 |
| CLINIC | 966-1401 |
| PEDS REHAB | 65164 |
| R McD HOUSE | 66752 or 913-2040 |
| COPA | 800-252-2672 |
| OR Front | 31501 |
| BLOOD BANK | 64011 |
| OR POSTING | 63680 |
| PICU | 65491 |
| NICU | 63481 |
| 7Children's | 63400 |
| 6Children's | 65101 |
| 5Children's | 62105 |
| Int/Cardiac | 65486 |
| L&D | 63422 |
| PEDS XRAY | 67554 |
| ARTAZ | 66831 |
| PEDS ER | 61405 |
| Ostomy Nurse | 39234 |
| TBI Nurse | 63657 |
| Lactation | 64148 |
| PEDS PULM | beeper 123-4395 |
| GI NURSE | beeper 216-3016/5000 |
| ENDO Rm | 31566 |
| PEDS ONC | 62931 |
| PEDS ADMIT | beeper 216-0117 |
| PATH | 31476 |
| SCHOOL | 61288 |

EMERGENCY DRUGS

| | |
|-------------------------|--|
| Epinephrine (1:10,000) | 0.1 cc/kg ET,IV drip at 0.01-0.5 mcg/kg/min |
| Epinephrine (1:1000) | 0.01 cc/kg SQ |
| Atropine | 0.02 mg/kg IV, ET |
| Benadryl | 1-2 mg/kg IV |
| Bicarbonate | 1 mEQ/kg IV |
| Calcium chloride (10%) | 10 mg/kg IV |
| Calcium gluconate (10%) | 100 mg/kg IV |
| Defibrillation | 2 Watts seconds/kg |
| Diazepam (Valium) | 0.2 mg/kg IV, pr |
| Dobutamine | 5-20 mcg/kg/min |
| Dopamine | 2-20 mcg/kg/min |
| Glucose | 2-4 cc/kg D25 |
| Lidocaine | 1 mg/kg IVP drip at 20-40 mcg/kg/min |
| Mannitol | 0.5-1.0 gm/kg IV |
| Methylprednisolone | 30 mg/kg IV |
| Naloxone | 0.1 mg/kg IV, IM |
| Succinylcholine | 1 mg/kg |
| Verapamil | 0.1 mg/kg IV |
| Vecuronium | 0.1 mg/kg IV |