PEDIATRIC SURGERY HANDBOOK

By

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PREFACE

I realized the need for a resident friendly handbook or "vade mecum" in Pediatric Surgery when I first set foot as a young trainee in the Pediatric Surgery wards at CMC, Vellore in the mid 80's. I was overwhelmed by the complexity of the disease processes, physiology and the need for a complete rethink of all procedures to be carried out in children. I fondly remember my seniors, the ward nurses, the anesthetists, and the fellow pediatric trainees who sort of hand held me into this wonderful and gratifying field of children's surgery. This handbook is a small effort at easing the burden of initiating yourself as a trainee in Pediatric Surgery. It is a compilation of information from various sources mixed with my own experience and the experience of many of my colleagues.

Please contact me for any clarifications and if you want any additional information to be added to this book. My e-mail ramac59@gmail.com.

Yours

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Acknowledgements

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- Dr. C.Ramachandra

TABLES OF FACTS AND FIGURES

Mean Blood Pressure Norms

Age	Boys (mmHg)	Girls (mmHg)
1 year		
- Systolic	98 – 101	98 – 102
- Diastolic	52 – 54	54 – 58
2 years		
- Systolic	100 – 104	101 – 106
- Diastolic	55 – 58	58 – 62
3 years		
- Systolic	101 – 105	102 – 107
- Diastolic	58 – 61	60 – 65
4 years		
- Systolic	102 – 107	103 – 108
- Diastolic	60 – 64	62 – 67
5 years		
- Systolic	103 – 108	104 – 110
- Diastolic	63 – 67	64 – 70
6 years		
- Systolic	105 – 110	105 – 111
- Diastolic	66 – 69	67 – 71
7 years		
- Systolic	106 – 111	106 – 112
- Diastolic	68 – 71	68 – 72
8 years		
- Systolic	107 – 112	107 – 113
- Diastolic	69 – 73	69 – 73

Age	Boys (mmHg)	Girls (mmHg)
9 years		
- Systolic	107 – 114	108 – 114
- Diastolic	70 – 74	71 – 73
10 years		
- Systolic	108 – 116	111 – 120
- Diastolic	72 - 76	72 – 73
11 years		
- Systolic	110 – 118	111 – 120
- Diastolic	74 - 76	74 – 75
12 years		
- Systolic	113 – 122	114 – 122
- Diastolic	75 - 76	75 – 76
13 years		
- Systolic	115 – 126	114 – 123
- Diastolic	74 – 77	75 – 76
14 years		
- Systolic	119 – 129	118 – 123
- Diastolic	74 - 80	76 – 77
15 years		
- Systolic	123 – 130	118 – 124
- Diastolic	75 - 81	78 – 78
16 years		
- Systolic	126 – 132	119 – 124
- Diastolic	77 - 82	78 – 78
17 years		
- Systolic	128 – 134	120 – 125
- Diastolic	78 - 83	70 – 76

American J of Epidemiology 2008/67(6):663

Mean Fetal Renal Length

Weeks Gest Age	Longitudinal Mean (cm)	Transverse Mean (cm)
16 – 20	1.7 – 2.1	1.0 – 1.4
21 – 24	2.1 – 2.8	1.5 – 1.7
25 – 28	2.9 – 3.3	1.6 – 1.9
29 – 32	3.5 – 3.7	2.0 – 2.1
33 – 36	3.7 – 4.1	2.2 – 2.5
37 – 40	4.2 – 4.3	2.4 – 2.6

J of Urol 2007; 178(5):2153

Mean Renal Length (Sonography)

Age	Length cm
0 – 6 months	4.5 – 6.2
6 – 10 months	6.2
1.5 – 3.5 yrs.	6.6 – 7.4
3.5 – 5.5 yrs.	7.4 – 8.0
5.5 – 7.5 yrs.	8.1 – 8.3
7.5 –9.5 yrs.	8.3 – 9.2
9.5 – 11.5 yrs.	9.2 – 9.6
11.5 – 13.5 yrs.	9.6 – 9.8
13.5 – 16.5 yrs.	9.8 – 10.0
16.5 – 18.5 yrs.	10.0 – 10.8

AJR

Normal Serum Creatinine levels based on age

Age	Creatinine Serum
0 – 2 yrs	0.2 – 0.6 mg/dl
8 yrs	0.3 – 0.7 mg/dl
11 – 13 yrs	0.4 – 0.8 mg/dl
14 – 16yrs	0.4 – 0.9 mg/dl
> 16 yrs	0.7 – 1.5 mg/dl

Society for Fetal Urology Hydronephrosis Classification

0 - No renal pelvis splitting

1 - Renal Pelvis dilatation / splitting only

2 - Renal pelvis dilatation / some caliceal dilatation

3 - Renal pelvis dilatation, all caliceal dilatation but no parenchymal thinning

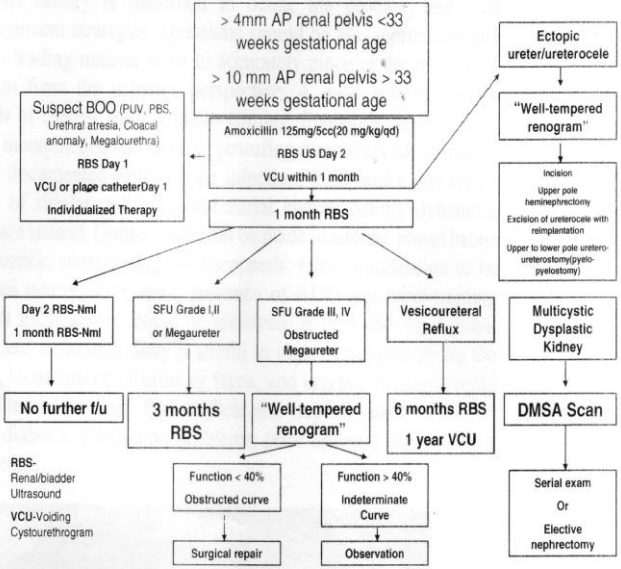
4 - Renal pelvis dilatation, all calyces blunted parenchymal thinning is present

Society for Fetal Urology Ureteral Dilatation Classification

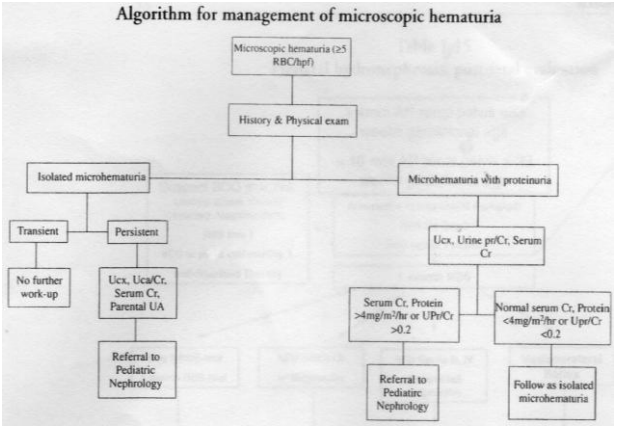
Gr 1	-	< 7mm
Gr 2	-	7 – 10 mm
Gr 3	-	> 10 mm

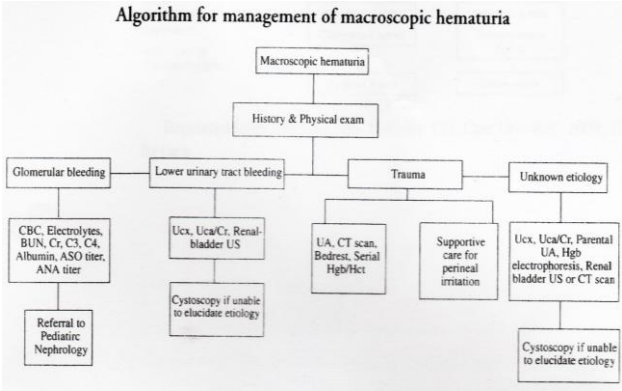
J Urol 1992; 148:609-612

Prenatal hydronephrosis: postnatal evaluation



Reprinted from Kitchens DM, Herndon CD. Curr Urol Rep. 2009; 10 (2): 126–133. Review


Algorithm for management of microscopic hematuria
Microscopic hematuria (≥5 RBC/hpf)
History & Physical exam
Isolated microhematuria
Microhematuria with proteinuria
Transient
Persistent
Ucx, Urine pr/Cr, Serum Cr
No further work-up
Ucx, Uca/Cr, Serum Cr, Parental UA
Serum Cr, Protein >4mg/m²/hr or UPr/Cr >0.2
Normal serum Cr, Protein <4mg/m²/hr or Upr/Cr <0.2
Referral to Pediatric Nephrology
Referral to Pediatirc Nephrology
Follow as isolated microhematuria


Algorithm for management of macroscopic hematuria
Macroscopic hematuria
History & Physical exam
Glomerular bleeding
Lower urinary tract bleeding
Trauma
Unknown etiology
CBC, Electrolytes, BUN, Cr, C3, C4, Albumin, ASO titer, ANA titer
Ucx, Uca/Cr, Renal-bladder US
UA, CT scan, Bedrest, Serial Hgb/Hct
Supportive care for perineal irritation
Ucx, Uca/Cr, Parental UA, Hgb electrophoresis, Renal bladder US or CT scan
Referral to Pediatirc Nephrology
Cystoscopy if unable to elucidate etiology
Cystoscopy if unable to elucidate etiology

International Grading System for VUR

Grade I	- Ureter Only
Grade II	- Ureter and renal pelvis & calices without dilatation
Grade III	- Mild dilatation of Ureter & renal pelvis no blunting of calices
Grade IV	- Moderate tortuosity & dilatation of ureter & renal pelvis, obliteration of sharp angles of fornices but papillary impression in majority of calices
Grade V	- Severe tortuosity and dilatation of ureter, pelvis & Calices, papillary impression not present

Pediatric Radiology 1985; 15(2):105-9

VUR Resolution Rate

VUR Resolution	1 Yr.	3 Yr.	5 Yr.
Grade I	39%	78%	92%
Grade II	28%	63%	81%
Grade III (2 – 5 yrs.) Unilateral	13%	35%	51%
Grade III (0 – 2 yrs.) Bilateral	7%	20%	30%
Grade III (2 – 5 yrs.) Bilateral			
Grade IV Unilateral	16%	41%	58%
Grade IV Bilateral	4%	8%	10%

AUA Guidelines

DJ Ureteral Stent Size

Age (years) + 10 = length in cm

J Urology 2007; 178:1566 - 1569

Bladder Capacity

< 2 year	= 2 x Age (Yrs) + 2	= 0z x 30 = cc OR
	= wt. in KG x 7.5	= cc
> 2 years	= (Age Years / 2) + 6	= 0z x 30 = cc OR
	= (Age + 2) x 30	= cc

Significant PVR > 10% of est.bladder volume (EBV)
Voided vol is < 65% EBV, it is small volume
Voided vol is > 150% EBV, it is large volume

Voiding Frequency ≥ 8 = $\uparrow$ daytime frequency
Voiding Frequency < 4 = $\downarrow$ frequency

J Urol 1997; 158(6)

Urodynamics Values

Flow rate (minimum)

Males: 4 – 7 yrs = 10ml/s when voiding 100 cc
8 – 13 yrs = 12ml/s when voiding 100 cc
≥ 14 yrs = 21ml/s when voiding 200 cc

Females: 4 – 7 yrs = 10ml/s when voiding 100 cc
8 – 13 yrs = 15ml/s when voiding 100 cc
≥ 14 yrs = 18ml/s when voiding 200 cc

Voiding pressure: Males = 55 – 80 cm H_20
Females = 30 – 65 cm H_20

Oral treatment options for Dysfunctional voiding

Anticholinergics	Dose	Max.
Oxybutynin Chloride	0.2 mg/kg/dose	0.6 mg/kg/dose
Ditropan XL	5 mg qd	15 mg qd
Hyoscyamine Sulfate	0.03 mg/kg bd	0.1 mg/kg bd
Probanthine (Methantheline Bromide)	0.5 mg/kg bd	0.5 mg/kg q.i.d
Tolterodine tartrate	0.02 mg/kg bd	2 mg bd
Tolterodine LA	2 mg qd	4 mg qd

Alpha-1 Adrenergic blockers

Tamsulosin (Flomax)	0.4 mg qhs	0.4 mg qhs
Afluzosin (Uroaxtral)	10 mg qhs	10 mg qhs
Doxazosin (Cardura)	0.5 mg qhs	1 – 2 mg qhs
Terazosin (Hytrin)	1 mg qhs	2 – 4 mg qhs

Pediatric Clinics 2006; 53:363-377

- **Table : Bathroom Dairy**

BATHROOM DAIRY					
Day One			Day Two		
Time	Amount	Body Motion	Time	Amount	Body Motion

- ***Table**: Sample of voiding diary to be filled out by the child and / or family. Careful recording allows the urologist to identify voiding patterns and should be coupled to a diary recording fluid and food intake*

Treatment options for Constipation

- Miralax PEG 3350 > 5 yrs 17g
  < 5 yrs 8.5g
- Lactulose 15cc p.o qd

- **Normal Stretched penile length by age**

Age	Length (cm)
Birth	> 2
2 yrs	> 2.5
4 – 12 yrs	> 4
14 yrs	> 5
16 yrs	> 6
20 yrs	> 8

- *J Urology 1994; 152:4-14*

CKD – Chronic kidney disease	GFR (ml/min/1.73 m^2)
Stage I	≥90
Stage II	60 - 89
Stage III	30 - 59
Stage IV	15 - 29
Stage V	< 15

- Normal GFR in adults: 100 – 130 ml/min/1.73 m^2
- Normal GFR in Children: 110 ml / min / 1.73 m^2 until 2 yrs. of age, then progressively decreases.
- After 40 yrs. GFR falls 0.4 to 1.2 ml/min/1.73/m^2/yr.

Foley Catheters & NGT

Age	ET Tube (mm)	Weight (Kg)	Foley (Fr)	NGT (Fr)
0 – 6 mo	3.5 – 4.0	3.5 – 7	6	8 – 10
1 yr	4.5	10	6 – 8	10
2 yrs	5.0	12	8	10
3 yrs	5.0	14	8 – 10	10 – 12
5 yrs	5.5	18	10	12
6 yrs	6.0	21	12	12
8 yrs	6.5	27	12	14
12 yrs	7.0	Varies	12 – 14	14 – 16

Tanner Staging

	Male	Female
Stage I	Preadolescent no pubic hair	Preadolescent no pubic hair
Stage II	Sparse long, slightly pigmented downy hair, straight or slightly curly, appearing mostly at base of penis	Sparse long, slightly pigmented downy hair, straight or slightly curly, appearing mostly along labia
Stage III	More dark, coarse & curled spreads over pubis	More dark, coarse & curled spreads over pubis
Stage IV	Hair is adult type but smaller area. No hair on inner thighs	Hair is adult type but smaller area. No hair on inner thighs
Stage V	Adult quantity & quality. Inverse triangle, inner thigh but not above linea alba	Adult quantity & quality. Inverse triangle, inner thigh but not above linea alba
Stage VI	Wide spread pubic hair above pubis (mid twenties)	

	Male Genitalia	Female Breasts
Stage I	Preadolescent; testes, scrotum & penis are same size and proportion as childhood	Preadolescent; papilla elevation only
Stage II	Scrotum & testes enlarged with change in scrotal skin (some reddening)	Breast bud stage; elevation of breast & papilla as a mound. Enlargement of areola
Stage III	Growth of Penis, mostly length but some breadth. Further growth of testes & scrotum	Enlargement of breast & areola, with no separation of contours
Stage IV	Penis further enlarged in length & breadth with development of glans. Testes & Scrotum further enlarged. Darkening of scrotal skin	Projection of areola & papilla to form a secondary mound above the level of the breast
Stage V	Genitals adult size & shape	Mature stage; projections of papilla only, recession of areola to the general contour of the breast

Tanner ADC *1970; 45:13-14*
1969; 44:291-292

BASICS OF PEDIATRIC FLUID ELECTROLYTES & NUTRITION

Body Components

Age	TBW	ECF	Blood Volume
Premature	80%	40%	10%
1 – 10 Days	75%	40%	9 – 10%
1 – 6 Months	70%	30%	8%
6 months – 3 yrs	60%	25%	7%
Adult	60%	20%	5 – 6%

Fluid Requirement

Neonate

Day 1 - 60 ml/kg/d
Day 2 - 80 ml/kg/d
Day 3 - 100 ml/kg/d
Thereafter - 100 – 150 ml/kg/d

Caloric Requirements

- Premie - 120 Kcal/kg
- 1 – 10 kg - 100 Kcal/kg
- 11 – 20 kg - 1000 cal + 50 Kcal/kg over 10 kg
- > 20 kg - 1500 cal + 20 Kcal/kg over 20 kg

An infant recovering from surgery will require about 125 kcal/kg/d for good wound healing and positive calorie balance. For the utilization of each 100 calories, 100cc water is required.

NaCl 3mEq/kg/d K 2 mEq/kg/d	0 -10 kg 11 – 20 kg > 20 kg	- - -	4 ml/kg/hr 40 ml + 2 ml/kg/over 10 kg 60 ml + 1 ml/kg over 20 kg	4-2-1 rule

- The Newborn needs adequate free water to excrete metabolic waste
- The Newborn has excess ECF in the 1st week of life, so maintenance requirements are less
- The vascular volume is small, so large fluid volumes should be given judiciously
- Because of limited ability to excrete sodium in the newborn period, sodium loads should be limited
- A rough guide of adequate urine output is 1 cc/kg/hr.

A loss of vascular volume initiates compensatory mechanism, among which is stimulation of volume receptors that cause secretion of ADH in response to volume depletion. If volume is restored with a hypotonic solution, there is dilution of serum electrolytes and osmolality. Ordinarily such a dilution would activate osmoreceptors which would shut off ADH. In the presence of hypovolemia, however, ADH continues to be secreted and dilute urine cannot be excreted, so an osmolar gradient remains between the vascular space and ECF.

For example, an infant reaching the recovery room reasonably well hydrated after a two hour operation for intestinal obstruction may have a calculated third space loss of 50% of maintenance. If the fluid replacement for this is too dilute, osmoreceptors may perceive a hypotonic state & ADH, a valuable means of protecting the vascular volume, will be diminished. Further more, an osmotic gradient will quickly pull the hypotonic fluid into ECF. A few hours later, hypovolemia may develop and ADH may increase in response, resulting in free water conservation and even greater hypotonicity. Therefore, for infants, the third space fluid needs should be replaced with D5 $^1/_2$ NS or NS on top of D5$^1/_2$ NS maintenance.

Replacement of losses

Gastric		D5$^1/_2$ NS + 20 mEq KCl / lt,1ml for 1 ml gastric output replaced q4 – 8h
Third space		↑maintenance rate to 1.5 to 2.0 times, N. Saline postop & PO D_2 ↓rate to maintenance and tonicity to D5$^1/_2$ NS when postop diuresis begins
Ileostomy	→	When NPO use RL ml to ml
	→	Oral NaCl supplementation may be required

Insensible losses	
0-3 yrs	1 ml/kg/hr
4-9 yrs	0.8 ml/kg/hr
>10 yrs	0.5 ml/kg/hr
Blood volume 80 cc/kg	

→ Spot check Urine Na whenever output replaced by PO intake. A low urine Na even in the face of normal serum Na will inhibit normal growth of infant. Oral Na bicarbonate may be necessary if hyperchloremic acidosis occurs.

Diahorrea (short gut) estimate daily stool loss & replace with RL with 20 mEq KCl **/** L

In TPN, lipid calories should never account for more than 60% of the total.

Dehydration

5% mild	10% Moderate	15% Severe
Isotonic	hypotonic Na<125	hypertonic>150

Calculate Na deficiency at 130 - Na x 0.6 wt. in Kg

Bicarb. Calculation. Base deficit x wt. in kg
X 0.5 for New Born
X 0.4 for infants
X 0.3 for children
Always give 50% of calculated deficit at over 3 - 4 hours

Daily requirements

Age	Calories	Protein
LBW	Kg x 110 – 150	-
0-6 months	Kg x 120	Kg x 2.2
6 months – 1 year	Kg x 110	Kg x 2.0
1 – 3 years	1300	23 gms
4 – 6 years	1800	30 gms
7 – 10 years	2400	36 gms

Conditions	Percent Increase
Severe injury or illness	25 – 100%
Previous injury	50 – 75%
Sepsis or burn	100 – 150%
Fever per degree C	12%
Cardiac Failure	5 – 25%
Surgical Procedure	10 – 25%
Major Surgery	20 – 30%
Long Term Growth failure	50 – 100%
Protein Calorie malnutrition	50 – 100%

Calorie Requirements

0 – 1 yr = 90 – 120 KCal / kg/d

1 – 7 yrs = 75 – 90 KCal / kg/d

7 – 12 yrs = 60 – 75 KCal / kg/d

12 – 18 yrs = 30 – 60 KCal / kg/d

Expected Wt Gain for infant is 1% of the infants wt per day

The Caloric density for breast milk & infant formula is

20kcal / 1 ounce = 20kcal/30ccc = 0.68kcal/cc

Caloric value of Dextrose Solution

D_5W → 0.17 kcal/ml
$D_{10}W$ → 0.34 kcal/ml
$D_{12.5}W$ → 0.42 kcal/ml
$D_{15}W$ → 0.51 kcal/ml
$D_{17.5}W$ → 0.59 kcal/ml
$D_{20}W$ → 0.68 kcal/ml
$D_{25}W$ → 0.70 kcal/ml
$D_{30}W$ → 0.85 kcal/ml

Peripheral TPN - do not exceed 12.5% D/W
Central TPN - do not exceed 20%

20% Intralipid solution has a caloric density of 2 kcal/ml
Guidelines for infusion of 20% Intralipid (g/kg/d)

	Premie	Term	Infant
Initial	0.5	1	1
Increase Density by	0.25	0.5	0.5
Max. Dose	3	4	2

Protein Requirement (g/kg/day)

Premie	- Term neonate 0 -1 month	3.0 – 3.5
Infant	- 1 – 12 months	2.5 – 3.0
Children	- 1 – 12 years	1.5 – 2.5
Adolescents		1.0 – 1.5

Total Calorie to N_2 ratio is 150 -180:1

$$\left(\frac{\text{K cal from dextrose + fat}}{\text{Gm of } N_2 \text{ infused}}\right)$$

Infant receives 500ml/d of TPN consisting D_{20} Solution and 50 ml of 20% Intralipid. He is also receiving 3g/kg/day protein

Weight is 5 kg

500 ml x 0.68 kcal/ml = 340 kcal/day from Dextrose

50 ml x 2 kcal/ml = 100 kcal/day from Lipid

3g/kg/day x 5 kg = 15 g protein

Conversion to N_2gms

6.25 g protein = One gram N_2

15/6.25 = 2.49 N_2

Calorie to N_2 ratio $= \frac{340 + 100}{2.4} = 183.1$

This ratio is important to optimally utilize carbohydrate & reduces the risk of TPN associated liver disease.

An example to calculate TPN order:

TPN for **20 kg child**

Estimated caloric requirement is 80kcal/kg/d

Fluid rate will be approx. 20% higher than this 80+16= 96ml/kg/d

i.e., 20kg x 96 = 1920 ml/d = 80 ml/hr

10% of this rate should be the intralipid rate and the other 90% should be TPN infusion rate

IL at 8ml/hr = 192 ml/d = 384 kcal/d

TPN at 72 ml/hr = 1728 ml/d = 1175 kcal/d

Total kcal/d = 1559 / 20 kg = 78kcal/kg

If the child is getting 3 g/kg/d of Protein in TPN than kcal:N ratio will be 162:1. Remember these are goal concentration or rates.

Initiate D_{10} TPN at 72ml/hr and IL at half the goal rate 4ml/hr.

Next advance to D15 TPN at 72ml/hr and increase IL to 6ml/hr, then advance to D20 TPN at 72ml/hr, IL at 8ml/hr if glucose & lipid tolerance are verified (dextrostix & Triglyceride levels).

How to cycle TPN – to reduce physiological consequences of TPN administration

To be given over 16-18hr period. One hour at each end of the infusion time will have the solution running at half the normal rate to allow pancreas to adjust insulin / glucagon secretion to prevent hypo or hyperglycemia.

20kg example
1920cc vol. is to be infused over 18 hrs
1920 / (18-1) = 113cc/hr
Start the infusion at 56cc/hr x 1hr then
Increase to 113 cc/hr x 16 hr then
Decrease to 56cc/hr x 1 hr
Then stop TPN for 6 hrs before resuming the cycle

Running D_{10} solution or other fluid should be unnecessary if the patient has been gradually tapered to this regimen **from a 24 hr infusion protocol**

Intralipids are not tapered, so that rate of the intra lipid will be 192/18 = 10.6cc/hr x 18 hrs

PYLORIC STENOSIS fluid management

1. Initially Na & Cl only to be given until electrolyte report is available (½ Normal Saline with 5% D/w)
    - Then add KCl at 2mEq (1ml) to 100 ml of IVF
    - Chloride replacement is crucial
    - Do not give RL or Isolyte P for two reasons
        a. Potassium
        b. Lactate
2. Stomach wash with warm normal saline at least twice before surgery
    - Replace NG output with NS or $^1/_2$ NS
    - Post op Continue with $^1/_2$ DNS till Cl level is normal and then $^1/_5$ DNS can be given
    - Feeds can be started between 6–24 hrs after surgery depending on the institution protocol and on the pre-op duration of symptoms
3. Vit K Pre-op is important
4. Rantac IV

Chasing the Urine Output

Common clinical scenarios

1. P.U.V. patient on catheter drainage (post obstructive diuresis)
2. Diuretric phase of ATN

Basic Science

Maintenance fluid requirement is of two major components – Renal & Non-renal and it is 50:50. In these situations the non-renal component will remain constant i.e., 50% of maintenance requirement but renal component needs to be replaced hourly to match the diuresis, hence it is called chasing the output.

Secure two IV lines

- One line dedicated to non-renal replacement
- Second line dedicated to renal replacement

The non renal replacement $^{1}/_{5}$ DNS (KCl depends on K^{+} level)

Renal replacement $^{1}/_{2}$ NS

Example: 3 kg Newborn with PUV post obstructive diuresis

Maintenance requirement is 3 x 4 = 12 ml/hr or 300 ml/day

Out of this 6 ml is non renal

and 6 ml is renal

In the dedicated IV meant for non-renal replacement the fluid ($^1/_5$ DNS ±KCl) is given at 6 ml/hr constantly

Now after catheterization or after fulguration or vesicostomy the child passes 50 ml Urine in the first hour post op.

This will be replaced initially volume to volume with D5 $^1/_2$ NS and then over a period of 12-24 hrs the volume is reduced to 4/5 → 3/5 → ½ → till the volume of approximately 6-12 ml/hr is reached.

By this time patient would also be on oral intake and will be able to manage the extra requirement.

The chasing of output is usually over 2-3 days in case of post obstructive diuresis but slightly longer in ATN Patients

If this protocol is not followed patient will end up with severe dehydration, electrolyte derangement and further deterioration of renal function.

……

Heparin flush for Hickman / Broviaccatheter 100 units/cc 3cc BD

Always use Huber needle to access chemoport. Standard needle will cut the silicone membrane and make the port leak.

Do not flush a catheter with any syringe that is smaller than 10 cc as the smaller syringes generate too high a pressure and will cause the line to burst.

COMMON ELECTROLYTE DISORDERS AND THEIR TREATMENT:

Electrolytes disorders in surgical patients can be confusing but a simple algorithm for identification and treatment of the common problems should be part of the skill set of the pediatric surgeon.

The most common imbalances seen in clinical practice involve sodium and potassium. Since most mild abnormalities are self-correcting, it is rarely necessary to even check electrolytes after an uncomplicated procedure in a healthy patient who resumes normal oral intake within 2-3 days of the operation.

Patients who need regular routine monitoring of electrolytes include those who are NPO for several days, have high GI fluid losses are being provided nutrition parenterally, or have another specific risk factor. Even these patients rarely need to have labs checked more than twice weekly unless there is a potentially dangerous value that is being actively corrected. It is still common to see daily or twice daily labs being drawn, especially in ICU patients, despite the values being minimally aberrant or entirely normal for days on end – this is a wasteful and potentially dangerous practice that should be abolished.

Mild hyponatremia is common in pediatric general practice due to a combination of factors: GI losses, over resuscitation in the OR and postoperative period with hypotonic solutions and a surgical stress induced SIADH.

Our current protocols for fluid resuscitation tend to err on the side of excess which contributes to hyponatremia, dilutional anemia and bowel edema / ileus.

Some fast track protocols recommend a slightly lower calculation for “maintenance” fluids, a preference for crystalloid boluses as needed, and early reliance on oral intake and thirst to guide fluid management.

It is also common for surgical resident to mistakenly use the fluid replacement strategy recommended for gastric fluid losses (1/2 ml per ml D 5 ½ NS + 20 mEq / L KCL) for other GI losses (Ileostomy output, diarrhea, biliary drainage), which are all isotonic and have higher concentrations of potassium.

Hypernatremia is less common and the cause is usually obvious, although insensible losses in infant can be more than expected. The most serious cases of hypernatremia (serum sodium >200) have occurred when parents are instructed to supplement their infant’s formula with a pinch of salt. Regardless of the cause, correction of hypo and hypernatremia should be gradual to prevent brain injury related to rapid fluid shifts.

Hyperkalemia can be dangerous but is very uncommon in the setting of normal renal function. It is much more commonly spurious, especially in infants, due to hemolysis of the specimen. Nevertheless, having to prove that, it is normal is time consuming (delays induction of anesthesia) and potentially dangerous in that, potassium is withheld from an infant who more likely has hypokalemia (Pyloric stenosis).

Hypokalemia must be profound to have clinical effects but it is dangerous because of the excitement it causes for nurses and physicians, who tend to overreact by giving large doses of potassium intravenously, which is hazardous, or orally, which induces vomiting and make the problem worse.

Calmly correcting acid base imbalances, replacing potassium losses in GI fluids, and providing moderate concentrations of potassium in the maintenance fluids or TPN solutions are usually all that is required.

Mild **hypocalcaemia** is relatively common but is more often spuriously due to hypoalbuminemia. Patients who are at risk (thyroidectomy) and who are symptomatic should be treated with oral calcium carbonate and calciferol. Rarely, intravenous calcium gluconate or calcium chloride needed and should be administered according to institutional guidelines for rate and cardiac monitoring.

Hypomagnesemia can be seen in patients with malnutrition or excessive GI fluid losses, often in conjunction with hypocalcemia. Oral magnesium supplement usually work best, but intravenous replacement is occasionally necessary.

Hypophosphatemia occurs commonly after massive hepatic resection and is due to transient hyperphosphaturia rather than consumption by the regenerating liver. It typically peaks on POD 2 and resolves by POD 5. Supplementation is necessary to prevent life threatening hypophosphatemia, but will not prevent the underlying parathyroid hormone spike that is the likely cause.

HYPONATREMIA:

- Treat Hyponatremia if Na < 130

- Most common cause for
  - Hyponatremia with Hypovolemia – Diarrhea and vomiting, Rx with Crystalloid fluid
  - Hyponatremia with Hypervolemia – Excessive fluid resuscitation with hypotonic crystalloid solution – prevent by not using hypotonic solution post op.
  - (Dilutional hyponatremia in post op. pts. is because of additional factor of propensity of the pt. to the "**third space**" fluid into the interstitium.)
  - Hyponatremia with Euvolemia – SIADH

- Hyponatremic encephalopathy – Medical emergency needs to be treated rapidly in an ICU setting with the use of 3% NaCl as a bolus 2 ml / Kg over 10 minutes to increase Sodium level by 5 – 6 mEq / L in the first 1-2 hrs. Rate of correction shouldn't exceed 20 mmol/L in the first 48 hrs. Of correction to mildly hyponatremic values.

- Demyelination risk is highest in adults (Na < 115) and least in newborn as their brain is not fully myelinated.
- Cerebral edema causes more brain shift in children because the Childs brain reaches adult size by 6 yrs. of age, whereas the skull doesn't reach adult size until 16 yrs. of age.
- Formula for calculating Sodium deficit

Na Deficit = (Desired Na.level – Actual Na.level)X0.6XBodywt.

Using 135 meq/L as desired level.

HYPERNATREMIA:

- Sodium > 150
- Hypernatremia with hypovolemia – Loss of body water due to excessive loss from bowel as in short bowel or under a radiant warmer.
- Hypernatremia with hypervolemia – Due to increase intake of Sodium

- Free water deficit = 0.6 X Body wt.(Kg)X[plasma/140]

- Free water deficit / 48 hrs. to determine free water infusion (5% D/W) / hr.

HYPERKALEMIA:

- Potassium > 6.5
- Life threatening emergency as it causes fatal arrhythmias
- Causes – Renal failure, Tumor lysis syndrome, Adrenal insufficiency, hemolysed blood sample
- Treatment – Temporising
    - Calcium Gluconate 10 mg/Kg (0.5-1ml/kg/dose, max. 20 ml/dose, dilute 1:1 with NS) of 10% Solution to stabilize cardiac membrane, over 3-5 min, can be repeated in 15 minutes.
    - $NaHCO_3$ 1 mEq/Kg IV Bolus. (1-2ml/kg/dose.
    - Insulin 0.1 unit/kg with D25 2ml/kg IV over 30 minutes
    - Albuterol nebulization 0.5 % 0.25 mg/kg/dose over 10 min.

- Treatment – Definitive
    - Kayexelate 1 g / Kg / day Q6Hrly Per Oral or Q 2 -4 hrly Per Rectal
    - Frusemide 0.5 – 1 mg / Kg IV Bolus
    - Hemodialysis

HYPOKALEMIA:

- Potassium < 3.5
- Common causes – Pyloric stenosis, DKA, Severe burns, Bladder augment (Hypokalemic alkalosis)

- IV Replacement. K **0.25 to 1 mEq/Kg** at the rate of **0.25 mEq/Kg/hr**. (maximum 10 – 20 mEq in a single administration)

- (0.3 – 0.5 mEq/kg/hr. via central line only. Dilute 2 ml in 10 ml NS. Max conc. Via. peripheral line 80 mEq/L i.e. KCl 4 ml / 100ml.)

- Oral replacement – KCl **0.5 to 1 mEq/Kg/dose** 2-3 times a day

EMERGENCY RESUSCITATION
DRUGS
PAIN MANAGEMENT
AND
POST OP MONITORING

Rapid Sequence Intubation

Category	Drug	Dose	Comments
VAGOLYTIC	• Atropine	0.02mg/kg IV	• Min. dose 0.1mg • Consider if <8 yrs to block laryngoscopy induced bradycardia
INTRACRANIAL ANTI HYPER-TENSIVE	• Lidocaine	1 mg/kg IV push	• Given when ↑ ICP is known / suspected
SEDATIVE	• Midazolam • Etomidate • Ketamine • Thiopental	0.1 mg/kg IV 0.3 mg/kg IV 1-2 mg/kg IV 1-2 mg/kg IV	• Less CVS effect than pentothal • Decreases ICP, no CVS effects • Bronchodilator, but increase ICP, BP, HR • Decreases ICP but may decrease BP & HR
PARALYTIC	• ROCURONIUM	1 mg/kg IV	• May have slower onset of action (30-90 vs 30-60 sec) and is longer in action (28-60 vs 3-12 min) than succinylcholine
	• Succinylcholine	0.3 mg/kg IV	• Contra indication glaucoma, penetrating eye injury, neuromusc. disease, Family history of malig. hyperthermia or pseudo cholinesterase def. Severe burns, crush injuries, hyperkalemia

ETT Size = Age (yrs) / 4 + 4	
Pre mature	2.5 – 3.0 mm ID
New Born	3.5 mm ID
3 – 12 months	4.0 mm ID
1 – 2 years	4.5 mm ID
> 2 years	4.5 plus Age in Years / 4

Tube length at angle of mouth(calc) Age in years / 2 + 12
or
Tube size x 3

Typical Ventilator Settings

Tidal vol : 7-10 ml/kg
Pressure : 25/5 cm H_2O
Rate : 30 (titrate)
FiO2 : 100 %(titrate)

Keep PO2 60 – 80 mm
PEEP at least 2 cm H_2O (physiologic PEEP)
Always humidify gases

Apnea in premies, neonates & infants < 1yr
R/o Hypoglycemia
Dehydration
Hypocalcemia
Temp. Fluctuation
Sepsis
Brain lesions
Theophylline p.o or IV loading dose 5 mg/kg followed by maintenance 1mg/kg/dose q4 – q8h

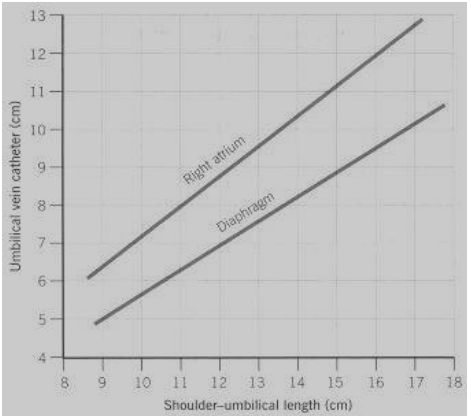
VITAL SIGNS BY AGE

Age	Wt(kg)	HR	RR	BP (Sys)	ET Tube I D mm	Chest tube Fr	NG / Foley Fr
NB	1	145	<40	42±10	2.5 Laryngoscope blade 0	8-10	5 Feeding
NB	2-3	125		60 ± 10	3.0 Laryngoscope blade 1	10-12	5 – 8 Feeding
1 Mo	4	120	24-35	80 ± 16	3.5	-	-
6 Mo	7	130	-	89 ± 29	3.5	-	-
1 Yr	10	130	20-30	96 ± 30	4.0 Laryngoscope blade 1	16–20	8
2-3 Y	12-14	120	-	99 ± 25	4.5	-	-
4-5 Y	16-18	100	-	99 ± 20	5.0-6.0 Laryngoscope blade 2	20-28	10
6-8 Y	20-26	100	12-25	105 ± 13	6.0-6.5	-	-
10-12 Y	32-42	75	-	112 ± 19	7.0 Laryngoscope blade 2-3	28-32	10-12
> 14 Y	> 50	70	12-18	120 ± 20	7.5 – 8.5 Laryngoscope blade 3	32-42	> 12

Vital Signs & Age

Age	BP	HR	RR
< 3 months	65 / 45	120 – 180	30 – 60
3 – 12 months	90 / 50	90 – 140	24 – 40
1 – 4 years	100 / 60	80 – 100	22 – 34
4 – 12 years	105 / 65	75 – 100	18 – 30
> 12 years	120 / 70	60 – 90	12 – 16

Umbilical vein catheter length



Pain Management

Neonate 0-30 days

Out-patient - Paracetamol 10-15mg/kg PO Q6H or

30-40mg/kg PR x 1
then 20mg/kg PR q6H

Inpatient (in addition to above)

- Morphine 0.05 – 0.1mg/kg IV q6H
- Morphine IV cont. Infusion 0.01 – 0.02 mg/kg/hr (NICU/PICU)

Infant (1 mo – 1 yr)

Out patient

- Paracetamol 10-15mg/kg PO q4H or 30-40mg/kg/PR x 1 then 20mg/kg PR q6H
- Ibuprofen (>6/12 of age) 4-10 mg/kg PO q6H

In patient (in addition to above)

- Morphine 0.05 – 0.1mg/kg IV q2 – 4H
- Morphine IV Cont.inf 0.01 – 0.04 mg/kg/hr (NICU or PICU)
- Fentanyl 1-4 mcg/kg/ IV q2 - q4H (NICU or PICU)
- Fentanyl 0.5 – 1 mcg/kg/hr IV inf.& titrate up (NICU / PICU)

Child

Out patient

- Paracetamol 10-15 mg/kg PO q4H 10-20 mg/kg PR q4H
- Ibuprofen 4-10 mg/kg PO q6H

In patient (in addition to above)

- Ketorolac 0.5mg/kg IV q6H (max 5 days use)
- Oxycodeine 0.05 – 0.15 mg/kg PO q4 - q6H
- Morphine 0.05 – 0.1 mg/kg IV q2 - q4H OR 0.01-0.02 mg/kg/hr (PICU)
- Fentanyl 1-2 mcg/kg IV q30 min - q6 min (PICU)

a) Estimated Blood volumes

- New born 90 ml/kg
- Child 80 ml/kg
- Teenager 70 ml/kg

b) Rough rules of thumb for blood replacement

- 10 ml/kg PRBC - Raise Hct – 3 - 4x
- 1 unit Platelets/10kg – Raise Plt count by 25,000
- 10-15 ml/kg of FFP for coagulopathy
- 1 unit/5kg of Cryoppt to replace Fibrinogen

c) Safe volumes to push empirically

- PRBC 10ml/kg
- 5% albumin 20ml/kg

Apnea and Bradycardia monitoring postoperatively

- Ex Premie less than 56 weeks post conceptional age – 24hr post surgical monitoring
- Term infants less than 44 weeks post conceptional age – 24hr post surgical monitoring

Chest Tube sizes

Neonate	10 – 12 F
6m – 18m	12 – 14 F
1 – 3 yr	16 – 20 F
4 – 7 yr	20 – 24 F
8 – 12 yr	28 – 32 F
Adolescent	28 – 40 F

Pediatric Trauma Score (PTS) **(Max : 12 / Min : 6)**

	+ 2	+ 1	- 1
Size	> 20 kg	10 – 20 kg	< 10 kg
Airway	Normal	Maintained with assistance	Un maintained
Systolic BP	> 90mm	50 – 90 mm	< 50 mm
CNS	awake	obtunded	coma
Open Wound	None	Minor	Major
Skeletal #	None	Closed	Open / multiple

GCS	
Eye Opening	
Spontaneous	: 4
To Loud voice	: 3
To Pain	: 2
None	: 1

Modified GCS for infants & Children	
Best Eye Response (E)	
4 →	Eye opening spontaneously
3 →	Eye opening to speech
2 →	Eye opening to pain
1 →	No eye opening

Verbal Response	
Oriented	: 5
Confused disoriented	: 4
Inappropriate words	: 3
Incomprehensiblewords	: 2
None	: 1

Best Verbal Response (V)	
5 →	Infant coos or babbles
4 →	Infant is irritable or continuously cries
3 →	Infant cries to pain
2 →	Infant moans to pain
1 →	No verbal response

Best Motor Response (M)	
ObeysCommands	: 6
Localizes	: 5
Withdraws (flexion)	: 4
Abnormal flexion posturing	: 3
None	: 1

Best Motor Response (M)	
6 →	Infant moves spontaneously or purposefully
5 →	Infant withdraws from touch
4 →	Infant withdraws from pain
3 →	Abnormal flexion to pain
2 →	Extension to pain
1 →	No motor response

< 8 indicates high risk of mortality.

Analgesics

Morphine: 0.1 mg/kg/dose Q5H

Codeine : 0.5 – 1.0 mg/kg/dose Q4H orally

Emergency Drugs

- Epinephine: 1:100,000 (0.1 mg/ml)
  Dose 0.1 ml/kg/IV or IT repeat q5 min if needed

- Atropine : 0.1mg/ml
  Dose 0.2 ml/kg IV or IT
  Max. Dose infants & Children = 1mg
  Max. Dose adolescents = 2mg

- Diazepam:
  1 mo – 5 yrs : 0.2 – 0.5 mg/kg IV q 15 – 30 min
  (max. dose 5mg)
  > 5 yrs : 0.2-0.5 mg/kg IV q 15 – 30 min
  (max. dose 10mg)

- Scoline:
  1 – 2 mg/kg/dose IV (duration 10 min)

- Pancuronium:
  0.1 mg/kg/dose IV (duration 1 – 2 hrs)

- Ketamine :
  2 – 3 mg/kg/dose IV

DRUGS

Laxatives & Bowel Prep.

- Peglec bowel prep - 20-30ml/kg/hr by NGT for 6 hrs or until clear stool
  - 0 - 3 yrs 10-40 mg/day (divided q8H)
  - 4 - 6 yrs 20-60 mg/day (divided q8H)
  - 7 - 12 yrs 40-120 mg/day (divided q8H)

- Lactulose - 0.5cc/kg/dose BID PO

- PEG 3350 (Laxopeg) 1gm/kg up to 15 gm/d once a day can push upto 25 gm/day

Anti Emetic

- Ondansetron: 0.15mg/kg/dose q8H Max 8 mg/dose
  4 – 11 yrs.: 4 mg PO TID
  > 11 yrs : 8 mg PO TID

- Domperidone: 0.3 – 0.6mg/kg/dose q6H 1ml = 1mg

H_2 blockers

- Rantac: 25mg/kg/dose BID P.O (Max 300 mg/d)
  1-2.5 mg/kg/dose I.V q6 – 8H (Max 50mg q6-8H)
  Continuous Infusion initially at 1mg/kg/dose then 0.08-0.17 mg/kg Or 2-4 mg/kg/day

PPI

- Omeprazole: 1mg (0.7 – 1.4) mg /kg /day OD or BID (Max. 40mg/d)
  < 20 kg: 10 mg PO OD
  > 20 kg: 20 mg PO OD

- Pantodac: 1mg/kg/ q24H PO/IV
- Lanzoprazole (Junior Lanz) : 1.5 mg/kg (max 30 mg) 12-24 hrly oral.

MECONIUM ILEUS:

- Treatment with N-acetylcysteine (mucomyst)
- Available as 20% solution
- Dilute to 10% or 5% (2 times / 4 times)
- Give thro' NG tube 1 – 2 ml/kg/6hrly)

  Note:↑ IVF to 1½ times maintenance

VASCULAR MALFORMATION TREATMENT:

1. Steroid → Systemically

   40 mg Prednisolone on alt. days x 10 doses

followed by 20 mg Prednisolone on alt. days x 10 doses

   keep halving every 10 doses till you reach

   ↓

   2.5 mg Prednisolone on alt. days x 10 doses

2. Propranolol 1mg/kg/day→ 4 mg/kg/day

   3 – 6 weeks up to 3 months

3. Intralesional Bleomycin (see below)

   Facial / Genital 0.66 u/kg

   Other 1 u/kg

LYMPHANGIOMA TREATMENT:

1. OK432 (Picibanil):

Available as 0.5 KE and 1 KE in freeze dried vials. This needs to made into a strength of 0.05 KE in 10ml or 20 ml NS for 0.5 KE and 1 KE vials respectively.

The dose prescribed will be based on volume aspirated. If you aspirate 10 ml of fluid you need to inject 10 ml of 0.05 KE solution.

2. Bleomycin:

0.1 to 0.5 unit/Kg/Dose

One unit of Bleomycin should be diluted in 10 ml NS

Cyst fluid to Bleomycin Ratio is 5:1.

Total dose for all sittings put together should not exceed 5 units / Kg.

The gap between two sittings is 4 – 6 weeks.

4. **2 % Sodium tetradecyl sulfate** is also effective

COMMONLY USED ANTIBIOTIC DOSAGES

1. Ampicillin : 100mg/Kg/d divided into 3 or 4 doses
2. Cefuroxime : 25mg/Kg per dose three times daily
3. Cefotaxime : 25mg/Kg per dose three times daily
4. Ceftriaxone : 100mg/Kg/d divided into two doses
5. Ceftazidime : 100-150mg/Kg/d divided into three doses
6. Cephalexin : 30mg/Kg/dose three times a day
7. Cefpodoxime : 10mg/Kg/day divided two doses
8. Cefixime : 8mg/Kg/day divided into two doses
9. Cefuroxime axetil (oral syrup):20-30mg/Kg/day divided into two doses
10. Gentamicin : 5-7.5mg/Kg/day as an OD dose given as an I.Vinfusion
11. Amikacin : 15mg/Kg/day as OD infusion
12. Co-trimoxazole : 8mg/kg/day of Trimethoprim divided into two doses
13. Co amoxyclav : 20-40mg/Kg/day of Amoxycillin divided into three doses
14. Nitrofurantoin : 5-7mg/Kg/day divided into 3 or 4 doses. For prophylaxis 1-2mg/Kg one dose
15. Ofloxacillin : 15mg/Kg/day divided into two doses
16. Ciprofloxacillin : 20-30mg/Kg/day divided into two doses

17. Norfloxacillin : 10mg/Kg per dose twice daily
18. Piperacillin : 300mg/Kg/day divided into three doses (same dosage when in combination with Tazobactam)
19. Meropenem : 20mg/Kg/dose 8hourly
20. Vancomycin : 40mg/Kg/day divided 3 to 4 times daily
21. Clindamycin : 25-40mg/Kg/day divided 3 to 4 times daily
22. Metronidazole : 7.5mg/Kg/dose (1.5 ml/kg/dose) three times daily
23. Fluconazole : 10mg/kg/day as a single daily dose
24. AmphotericinB : 2.5-5mg/Kg/day as once daily infusion
25. Albendazole : For worm infestation <2yrs 200mg as single dose, >2yrs 400 mg as a single dose. For Cysticercosis 7.5mg/Kg per dose twice daily for 8-30days same dose for Hydatid given over 28 days and repeated after a gap of 14 days.

Antituberculosis treatment

1. INH 10-15mg/Kg
2. Rifampicin 10mg/Kg
3. Pyrazinamide 35mg/Kg
4. Ethambutol 30mg/Kg
5. Streptomycin 15mg/Kg

Duration of treatment for TB Lymphadenitis – 9 months INH and Rifampacin.

Duration of treatment for abdominal TB – 18 months 3 drugs INH + Rifampicin + Ethambutol).

IAP IMMUNISATION SCHEDULE:

Age	Vaccines	Note
Birth	BCG OPV Zero Hepatitis B - 1	
6 Weeks	OPV-1+IPV-1 / OPV-1 DTPw-1 / DTPa-1 Hepatitis B - 2 Hib - 1	OPV alone if IPV cannot be given
10 Weeks	OPV-2 + IPV- 2 / OPV-2 DTPw-2 / DTPa-2 Hib - 2	OPV alone if IPV cannot be given
14 Weeks	OPV-3 +I PV-3 / OPV-3 DTPw-3 / DTPa-3 Hepatitis B - 3 Hib - 3	OPV alone if IPV cannot be given Hepatitis B- 3 can be given at 6 m.
9 Months	Measles	
15 – 18 months	OPV-4 + IPV- B1 / OPV-4 DTPw-booster1 / DTPa-booster1 Hib – booster MMR 1	OPV alone if IPV cannot be given
2 Years	Typhoid	Revaccination every 3-4 years
5 Years	OPV-5 DTPw-booster 2 / DTPa-booster 2 MMR 2	The second dose of MMR can be given any time 8 weeks after first
10 Years	Tdap HPV	HPV – only girls 3 doses 0, 1-2 and 6 months

Optional Vaccines

More than 6 weeks	Pneumococcal conjugate	3 primary doses at 6, 10 and 14 wks, booster - 15-18 m
More than 6 weeks	Rotaviral vaccine	2/3 doses 4-6 wk interval
After 15 months	Varicella	Age < 13 yr 1dose Age >13 yrs 2 doses 4-8 week apart
After 18 months	Hepatitis A	2 doses, 6-12 m

PRESPLEENECTOMY VACCINATION:

Conjugate vaccines against pneumococcus, meningococcus type c and Haemophilus influenza type b should be given at least 14 days before splencectomy or as soon as possible after the operation. Booster injection every 5 yrs. should be considered.

Oral phenoxymethylpenicillin (Penicillin V) (12.5 mg/kg/dose 12^{th} hrly.) or for patients allergic to penicillin, erythromycin (10mg/kg) should be given for atleast one to two yrs. After splenectomy. Immunocompromised patients are advised to take lifelong prophylaxis.

Upon cessation of penicillin prophylaxis, patients should have an amoxicillin tab (15 – 25 mg / kg / dose, 8^{th} hrly.) if fever develops, especially if immediate medical attention is not at hand.

PRE OPERATIVE PREPARATION

Normal Lab values by age:

CBC	Birth	1 Mo	2 Mo	6 Mo	7 Mo	2 Yr	6 Yr	10 Yr	12 Yr
WBC	5-20	5-19.5	6-17.5	-	-	5-14.5	-	4.5-8.5	-
RBC	3.6-4.9	2.7-3.8	3.1-3.8	3.7-4.5	3.9-4.6	-	4.0-4.6	-	4.1-4.6
Hb	13.5-16.5	10-14	-	9.5-11.5	10.5-12.0	11.5-12.5	11.5-13.5	-	12-14
HCt	39-51	31-43	28-35	-	33-36	34-37	35-40	-	36-41
MCV	86-105	85-104	77-106	74-91	70-78	75-81	77-86	-	78-90
MCH	28-34	-	26-30	-	23-29	24-27	25-29	-	25-30
MCHC	28-33	29-33	-	30-33	-	31-34	-	-	-
RDW	11.5-14.5	-	-	-	-	-	-	-	-
Platelet	150-400	-	-	-	-	-	-	-	-
MPV	7.4-10.4	-	-	-	-	-	-	-	-

Pre-Op Preparation – Major Case – General Checklist

1. Labs
2. Radiology – Contrast Studies
   Remember many patients will have CHD & therefore latest ECHO is important
3. Previous Discharge summaries and biopsy reports
4. Reserving blood components and blood
5. **Consent – PAC and discussion with Anaesthesia**
6. Materials i.e. tubes, sutures, stents, prosthetic material not usually stocked in OT
7. Antibiotics
8. Special preparation as per situation
9. Alert pathology department for possible frozen one day prior
10. Book ICU bed and d/w intensivist regarding need for ventilatory management post op

Major Bowel Surgery

In Addition to above

1. Bowel Prep
    a. Diet
    b. NPO (6 hrs. for Solids/Formula, 4 hrs. for Breast milk and 2 hrs. for Water)
    c. PEGLEC or saline with Electrolyte monitoring
    d. ? oral antibiotics
2. Antibiotics
    a. Ampicillin/ Cefuroxime / Ceftriaxone
    b. Gentamicin / Amikacin
    c. Metronidazole
3. In case of Colostomy closure / Pullthro'
    Distal stoma irrigation
4. Ensure stapler gun and reload in OT for Duhamel's

Major Urological Surgery

1. Antibiotic
2. RFT
3. Bowel prep for augment
4. Specific retractors and instruments unique to certain procedures (which are rarely done)

Major Onco Surgery

1. Ensure adequate blood & blood products
2. Important to remember need for Frozen section
3. Remember to keep vascular instruments and seek help of Vascular Surgeon if necessary (well in advance)

Biliary Surgery

1. Coagulation studies
2. Correct prolonged PT & PTT satisfactorily
3. Keep FFP & Blood
4. Specific antibiotics eg.: Augmentin, Ceftazidime, Cefotaxime
5. MRCP may be required in most cases for planning & prognosticating

RADIOLOGICAL PROCEDURES

Barium enema / Air contrast / Saline Enema for Intussusception reduction

a) IV line with IVF on flow
b) IV antibiotic - One dose of Gentamicin and
One dose of Metronidazole
Fluoroscopy / image intensifier / C-Arm in OT required
c) 20F – 2 way Foley Catheter
d) Balloon inflated to 25-30 ml
e) 1:1 dilution of Barium (liquid) with saline filled in enema can
f) Enema can kept at 3 ft (100 cm) height

Don't elevate can further!
Don't squeeze tube during procedure!
Don't palpate abdomen during procedure!

Restrain child by keeping knees together and holding firmly

Watch flow of contrast and ensure progress is made and stop only if there is free flow of contrast into small bowel (at least 5 loops). If there is no progress – Repeat after gap of 5 min.

1. **Barium enema diagnostic**

Barium: Saline (1:1)

- Keep patient lateral
- Introduce No.8 or No.10 F Feeding Tube till last eye is just inside
- Inject contrast under vision
- See flow into rectum and sigmoid - take a picture
- Turn baby supine and inject contrast if the rectum is not dilated till you see contrast filled dilated colon – take picture

2. **Gastrograffin for Meconium Ileus**

- Good IV line – keep flow at 1½ times maintenance
- Use Gastrograffin 1:1 per rectally under fluoroscopy or C Arm guidance, inject retrograde till contrast refluxes into the terminal ileum and then gets diluted

3. **Barium / Gastro - UGI Study**

- Use No. 5/6 Fr IFT
- Inject contrast and follow flow
- Concentrate on pylorus (for IHPS) and duodenal C loop and jejunum for Malrotation or Duodenal stenosis or atresia

4. VCUG / MCUG

- Ensure Urine is sterile (urine culture report)
- Patient has been on antibiotics
- Sterile prep as for catheterization
- Use 5 F or 6 F IFT
- Use Xylocaine Jelly to lubricate
- Some patients may require jelly to be injected into the urethra and instilled for 3 mts
- Fill bladder to estimated capacity (use formula)
- One picture at full bladder. Keep male patient oblique for micturating picture and lateral if ectopic ureter is suspected
- Take post void picture

5. Placing a trans pyloric tube

- Use 5 F or 6 F infant feeding tube
- Keep the straight tube in Refrigerator (not in freezer) for 1 hr prior to procedure to stiffen it
- Opacify the tube by filling with Barium and pass it after good lubrication. Once it reaches pylorus push it along lesser curve and on further pushing it goes into duodenum and then further into jejunum easily

6. **Pressure augmented distal colonogram**

- Use Gastrograffin : Saline 1:1
- Use foley10 – 12 F. Insert into stoma and fill the balloon
- Pull Foley against the stoma
- Occlude the inlet of Foley with a clamp and inject contrast using 18G needle into the catheter proximal to clamp while pulling the Foley to keep the pressure and prevent leak, push contrast till the distal rectal beaking is seen
- First picture is lateral
- Second picture is AP

7. **TOF test**

- Stiff red rubber catheter 10F to pass orally and push till it encounters resistance and tape it and take AP X-ray

8. **Pull Esophagogram for H-type fistula**

- Fill the feeding tube with contrast and place it in distal esophagus
- Keep baby in lateral position
- As you are pulling the tube, keep filling the esophagus with the contrast

9. Cross Table prone lateral view

- Wait for minimum 24 hours
- Keep the baby in the prone jack knife position with a roll under the pelvis so that the thigh is at 90^0 angle to the pelvis
- Tap the sacrum to dislodge meconium and let air come into rectum
- Marker may or may not be used at anal dimple
- Mark the greater trochanter of the side from which radiographer is shooting and ask him / her to focus the beam on that spot.
- It is important that both the thighs/femura are in the same line or superimposed
- Interpretation:

  PC line joins pubic bone center (boomerang shaped) to last opacified piece of sacrum.

  "I" point is the anterior and lowest point of ischium (comma shaped).

  Air has reached between PC line and I point- intermediate or translevator.

  Air above PC line- high or supralevator.

  Air below I point- low or infralevator

10. Removal of cricopharyngeal coin foreign body with Foley balloon using fluoroscopy

- Child should be awake and crying
- 20 F Foley catheter is used lubricated and passed through mouth into esophagus and under fluoroscopy balloon inflated with air and pulled as you are visualizing, the balloon engaging the coin and pulling it into mouth.

11. Interpretation of X-Rays

- Examine patient properly before looking at X ray
- Check and ensure X ray is taken in the view requested for and X ray is centered properly for example both clavicles are seen symmetrically in chest X ray
- Follow a proper sequence of observation for example start from least dense like air to most dense like bone or vice versa

12. CT/MRI – Important points to remember

- It is preferable to view the scan pictures on the console or computer screen from a DVD or CD rather than films
- Always ask for proper contrast
- Identify and visualize the normal organ and then the lesion in relation to normal organ
- Follow vascular structures along their normal course and normal relations
- Follow bowel from fixed entities like i.c. junction, duodenum etc and proceed proximally or distally in subsequent sections
- In MRI in t1 images fluid will be bright and in t2 images fat will be bright

NUCLEAR MEDICINE IN PEDIATRIC SURGERY (Courtesy Dr.Murali Nadig)

A. GI SYSTEM :

1. **Esophageal reflux/milk scan**: Dynamic Scans done with Tc99m sulphur colloid in milk

2. **Gastric Emptying scan**: Tc99m sulphur colloid in semisolid / solid meals

3. **Meckel's scan** – Dynamic scan done with Tc99m pertchnetate

4. **GI Bleed Scan**: Dynamic and serial static scans done with Tc99m labelled RBCs

B. HEPATOBILIARY:

1. **HIDA Scan**: Done with Tc99m mebrofennin

2. **Bile Leak** – done with Tc99m mebrofennin

3. **Liver spleen scan** – to know functional hepatic reserve, non-cirrhotic portal hypertension / ICC, done with Tc99m sulphur colloid.

4. **Denatured RBC scan** – to know accessory spleen / splenosis after splenectomy (ITP)

RENAL RADIOTRACERS:

Clinical Question	Agents used
Perfusion	EC > MAG3 > DTPA > GHA
Morphology	DMSA > GHA > EC
Obstruction	EC > MAG3 > DTPA
Relative Function	DMSA = EC, GHA, DTPA
GFR quantitation	DTPA
ERPF quantitation	MAG3, EC
VUR	Sulphur colloid

RENAL DYNAMIC SCAN: Technique.

- Supine position preferred
- Adequate hydration, Intravenous Injection

Flow (angiogram): 2-3 sec / frame x 1 min

Dynamic: 15-30 sec / frame x 20 - 30 min

(Display @ 1-3 min / frame)

- Catheterisation in cases of suspected VUJ obstruction, ectopic kidney with obstruction
- Static image at the end of the study
- Delayed static image if required.

RENOGRAM PHASES:

Vascular / Flow phase –

- Reflects perfusion to kidneys (30-60 sec)
- Measures relative flow to the kidneys
- Ratio of activity compared to aorta or K/A ratio help follow changes in perfusion

Cortical / Parenchymal uptake phase –

- Gradual increase in counts over time
- Proportional to the functional parenchyma in each kidney
- Normal curve peaks after 2-5 min, depending on the tracer

Clearance phase –

- Gradual decline in renal counts over time with a corresponding slow increase in bladder counts
- Reflects efficiency of urinary radiotracer excretion
- Norma time required for ½ of tracer to leave collection system or half time is <10 min
- Normal renogram excludes clinically significant obstruction

ONCOLOGY

- I – 131 scan and therapy – Differentiated thyroid ca.
- I – 131 MIBG scan : Neuroblastoma, Ganglioneuroma, Pheochromocytoma
- I – 131 MIBG therapy : Metastatic neuroblastoma, Ganglioneuroma, Pheochromocytoma
- F 18 FDG PETCT : Lymphoma, other malignancies
- Ga-68 PETCT : Neuroendocrine tumors, neuroblastoma, Ganglioneuroma, Pheochromocytoma, Meningioma

POST OP MANAGEMENT

Bowel Management Program

Teaching the patient or parents how to clean bowel once daily so as to stay completely clean in underwear for 24 hours

- Fecal incontinence
- Overflow pseudo incontinence

↓

Treat constipation + Laxatives

Fecal incontinence
- Constipation (chronic hypo mobility)
- diarrhea

Enemas:

3 – 4 teaspoon of salt in 1 liter of Water

Phosphate Enema

3–5 years (15 – 30kg) - 120 cc everyday
> 8 years (> 30 kg) - 240 cc everyday

Phosphate enema not cleaning in one day

↓

Saline Enema – Added

↓ Still not complete

+ Glycerine

Diarrhea

Constipating diet and/or medication
Starting: Enema + Strict diet + Loperamide

Dilatation Program (Pena)

1 – 4 / 12	No. 12
4 – 8 / 12	No. 13
8 – 12 / 12	No. 14
1 – 3 yrs	No. 15
3 – 12 yrs	No. 16
> 12 yrs	No. 17

Start with the dilator that is snuggly fitting
Twice a day
Every week: Size ↑ by 1 unit → desired size
Correct Size → Counting Closed
Easily dilatable → once / day x 1/12

Twice a week - 1/12
Once a week - 1/12
Once a week - 3/12

Post Kasai R_x

- UDCA 20mg/kg/day divided BD
- Ranitidine 4mg/kg/d divide BD
- Vit E 2.5 IU/kg/d divided BD
- Polyvisol 1ml/d
- ADEK 1ml/d
- TMP/SM x 8mg/kg/d of TMP x 40 mg/kg/d of SM x divided B/D
- Nystatin Oral Susp 100,000 U/ml & 1 ml to cheek & Tongue B/D
- Prednisone (total duration = 27 weeks = 6 months)
  - 4 mg/kg/day x 2 weeks
  - 3 mg/kg/day x 1 week
  - 2 mg/kg/d x 1 week
  - 1.5 mg/kg/d x 2 weeks
  - 1 mg/kg/d x 3 weeks
  - 0.75 mg/kg/d x 3 weeks
  - 0.50 mg/kg/d x 3 weeks
  - 0.25 mg/kg/d x 3 weeks
  - 0.25 mg/0.125 mg/kg//d (alt days) x 3 weeks
  - 0.25 mg (alt days) x 3 weeks
  - 0.125 mg (alt days) x 3 weeks
  - Discontinue Prednisolone

COMMONLY USED FORMULAS:

- Weight (kg) = 3 (age in years) + 7
- 1 – 8 yrs. Wt. = 10 + 2 x age in yrs.
- > 8 yrs. Wt.= 7 x age in yrs. – 5/12
- Birth wt. = X, at 5 month 2X, and at one year 3X

- Length:

Birth	1 yr.	4 yrs.	8 yrs.	12 yrs.
50 cm	75 cm	100 cm	125 cm	150cm
25cm/yr.	10cm/yr.	5cm/yr.	5cm/yr.	

- Head circumference – Rule of thumb

  At birth 33 – 35 cm, at one year 45 -47 cm

  First 3 months – 2 cm /month
  Next 3 months – 1 cm / month
  Next 6 months – 0.5 cm / month

- Systolic BP = [2 x age in years] + 80

- Renal length in cm.
  - < 1 yr. = 4.98 + (0.155 X age in months)
  - > 1 yr. = 6.79 + (0.220 X age in years.)

- Renal Volume in ml
  - Length + Width X [(D1 + D2) / 2] X 0.523
    - D1 Depth on longitudinal section
    - D 2 Depth on transverse section

- Glomerular Filtration Rate (GFR) in children: (Schwartz Formula)

  Creatinine Clearance = (K x Ht.) **/** Serum Creatinine

  Value of K

  Infant LBW < 1 yr. – 0.33
  Infant Term < 1 yr. – 0.45
  Child / Adolescent Girl- 0.55
  Adolescent Boy - 0.7

- **Bladder Capacity**

< 2 year = 2 x Age (Yrs.) + 2 = 0z x 30 = cc
OR
= wt. in kg x 7.5 = cc

> 2 years = (Age Years / 2) + 6 = 0z x 30 = cc
OR
= (Age + 2) x 30 = cc

- **DJ Ureteral Stent Size**

Age (years) + 10 = length in cm

- **Bicarb Calc**. Base deficit x wt in kg
x 0.5 for New Born
x 0.4 for infants
x 0.3 for children

Always give 50% of calculated deficit at over 3 - 4 hours

- 8.4 % Sod.Bicarbonate:

1-2 ml /kg/dose, should be diluted 1:1 with DW (Don't dilute in Normal saline)

Na Deficit = (Desired Na.level – Actual Na.level)X0.6XBodywt.

Using 135 meq/L as desired level.

- Free water deficit = 0.6 X Body wt.(Kg)X[plasma/140]

- Rule of Thumb to make solution where

  1 ml / hr. = 1 mcg/kg/min.
  Add 3 mg/kg of drug to 50 ml solution.

- Nasogastric Tube length
  - Age related height based (**ARHB**)
    - (1.95cm + 0.372) x (height in cm)
  - **NEMU** (Nose – Ear – Midpoint between Umbilicus and xiphoid)

- ET Tube

  ETT Size = (Age (yrs.) / 4)+ 4

  ETT length at angle of mouth :
  (Age in yrs./ 2) + 12
  Or
  Tube Size X 3

TEN COMMANDMENTS OF RESIDENCY

1. Enjoy your residency
2. See it yourself
3. Do it now
4. Be complete, double check
5. Write it down
6. Don't complain, fix it
7. Delegate with discretion, you are still responsible
8. Ask if you don't know
9. Read about it
10. Wash, wash, wash your hands

General Hints for Residents

1. Try to see all patients in your service once daily some twice daily-if you start early you will find enough time
2. Get hold of all investigations on the patient and formulate your own plan of action for the patient and present it to your colleagues and get their feedback
3. Listen to all caregivers of the child and get an idea of the patients' problem.
4. Read about your patients' disease condition from the masterly textbooks and cross-refer for rarer manifestations.
5. Prepare for every operation by reading atlas and textbooks or journal articles. Sometimes you will have to get details from other specialty books like urology, general surgery, thoracic surgery, plastic surgery etc.
6. It is good to keep one notebook of your own for writing all operations you have seen and learnt the way you understood it written in your own words sometimes in your own language. Keep adding to this book as you learn more. Another option is to have a standard operative surgery atlas and add your own notes as and when you do something different.
7. Accept mistakes and errors and own them up if you are the person responsible for that patient.
8. Remember being a Pediatric Surgeon is one of the greatest gifts to humanity, be proud of it but at the same time stay humble
9. Remember there is no shortcut to success and there is no substitute for hard work. If you are not getting something right try and try till you get it perfectly.
10. Respect your patient, respect your seniors and colleagues, respect the subordinate staff and it will go a long way in making you a successful surgeon and a good human being