PAEDIATRIC PROTOCOLS

For Malaysian Hospitals

3rd Edition

Hussain Imam Hj Muhammad Ismail
Ng Hoong Phak
Terrence Thomas

Kementerian Kesihatan Malaysia

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Paediatric Protocol 3rd Edition

Kementerian Kesihatan Malaysia

FOREWORD BY THE DIRECTOR GENERAL OF HEALTH

Malaysia like the rest of the world has 3 more years to achieve the Millennium Developmental Goals (MDG). MDG 4 is concerned with under 5 mortality. Although we have done very well since lndependence to reduce our infant and toddler mortality rates, we are now faced with some last lap issues in achieving this goal.

Despite urbanization there are still many children in the rural areas. This constitutes a vulnerable group in many ways. Among the factors contributing to this vulnerability is the distance from specialist care.

There is a need to ensure that doctors in the frontline are well equipped to handle common paediatric emergencies so that proper care can be instituted from the very beginning.

Although all doctors are now required to do 4 months of pre-registration training in Paediatrics, this is insufficient to prepare them for all the conditions they are likely to meet as Medical Officers in district hospitals and health clinics. Hence the effort made by the paediatricians to prepare a protocol book covering all the common paediatric problems is laudable. I would also like to congratulate them for bringing out a third edition within 4 years of the previous edition.

l am confident that this third edition will contribute to improving the care of children attending the Ministry's facilities throughout the country.

Dato'Sri Dr Hasan Bin Abdul Rahman
Director General of Health, Malavsia

FOREWORD TO THE THIRD EDITION

It has been 7 years since we produced the first edition of a national protocol book for Paediatrics. This effort was of course inspired by the Sarawak Paediatric Protocols initiated by Dr Tan Poh Tin. The 2nd edition in 2008 has proven to be very popular and we have had to recruit the services of the Malaysian Paediatric Association (MPA) to produce extra copies for sale. It is now the standard reference for House officers in Paediatrics.

In producing a third edition we have retained the size and style of the current version, essentially only updating the contents. Again it is targeted at young doctors in the service many of whom seem to have had a suboptimal exposure to paediatrics in their undergraduate years. It is hoped that the protocol book will help them fill in the gaps as they prepare to serve in district hospitals and health clinics.

The Ministry of Health has once again agreed to sponsor the printing of 1000 books and 500 CDs for distribution to MOH facilities. We shall be soliciting the help of the MPA in producing extra books to be sold to those who wish to have a personal copy. As a result of the full PDF version being available on the MPA website, we have had requests from as far away as Kenya and Egypt to download and print the material for local distribution. We have gladly allowed this in the hope that it will contribute to better care of ill children in those and other neighbouring countries.

As previously this new edition is only possible because of the willingness of busy clinicians to chip in and update the content for purely altruistic reasons and we hope this spirit will persist in our fraternity. Prof Frank Shann has gracefully agreed for the latest edition of his drug dosages handbook to be incorporated into the new edition. The Director General of Health has also kindly provided a foreword to this edition.

We wish to thank all who have made this new edition possible and hope this combined effort will help in improving the wellbeing of the children entrusted to our care.

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TABLE OF CONTENTS

Section 1 General Paediatrics

Chapter 1: Normal Values in Children 1
Chapter 2: Immunisations 5
Chapter 3: Paediatric Fluid and Electrolyte Guidelines 19
Chapter 4: Developmental Milestones in Normal Children 27
Chapter 5: Developmental Assessment 31
Chapter 6: Developmental Dyslexia 37
Chapter 7: The H.E.A.D.S.S. Assessment 45
Chapter 8: End of Life Care in Children 49

Section 2 Neonatalogy

Chapter 9: Principles of Transport of the Sick Newborn 55
Chapter 10: The Premature Infant 63
Chapter 11: Enteral Feeding in Neonates 67
Chapter 12: Total Parenteral Nutrition for Neonates 71
Chapter 13: NICU - General Pointers for Care and Review of Newborn Infants 77
Chapter 14: Vascular Spasm and Thrombosis 85
Chapter 15: Guidelines for the Use of Surfactant 91
Chapter 16: The Newborn and Acid Base Balance 93
Chapter 17: Neonatal Encephalopathy 97
Chapter 18: Neonatal Seizures 101
Chapter 19: Neonatal Hypoglycemia 107
Chapter 20: Neonatal Jaundice 111
Chapter 21: Exchange Transfusion 117
Chapter 22: Prolonged Jaundice in Newborn Infants 121
Chapter 23: Apnoea in the Newborn 125
Chapter 24: Neonatal Sepsis 127
Chapter 25: Congenital Syphilis 129
Chapter 26: Ophthalmia Neonatorum 131
Chapter 27: Patent Ductus Arteriosus in the Preterm 133
Chapter 28: Persistent Pulmonary Hypertension of the Newborn 135
Chapter 29: Perinatally Acquired Varicella 139

Section 3 Respiratory Medicine

Chapter 30: Asthma 149
Chapter 31: Viral Bronchiolitis 161
Chapter 32: Viral Croup 163
Chapter 33: Pneumonia 165

TABLE OF CONTENTS

Section 4 Cardiology

Chapter 34: Paediatric Electrocardiography 171
Chapter 35: Congenital Heart Disease in the Newborn 173
Chapter 36: Hypercyanotic Spell 181
Chapter 37: Heart Failure 183
Chapter 38: Acute Rheumatic Failure 185
Chapter 39: Infective Endocarditis 187
Chapter 40: Kawasaki Disease 191
Chapter 41: Viral Myocarditis 195
Chapter 42: Paediatric Arrhythmias 197

Section 5 Neurology

Chapter 43: Status Epilepticus 205
Chapter 44: Epilepsy 207
Chapter 45: Febrile Seizures 213
Chapter 46: Meningitis 215
Chapter 47: Acute CNS Demyelination 219
Chapter 48: Acute Flaccid Paralysis 221
Chapter 49: Guillain Barré Syndrome 223
Chapter 50: Approach to The Child With Altered Consciousness 225
Chapter 51: Childhood Stroke 227
Chapter 52: Brain Death 231

Section 6 Endocrinology

Chapter 53: Approach to A Child with Short Stature 237
Chapter 54: Congenital Hypothyroidism 241
Chapter 55: Diabetes Mellitus 245
Chapter 56: Diabetic Ketoacidosis 255
Chapter 57: Disorders of Sexual Development 263

Section 7 Nephrology

Chapter 58: Post-Infectious Glomerulonephritis 275
Chapter 59: Nephrotic Syndrome 279
Chapter 60: Acute Kidney Injury 285
Chapter 61: Acute Peritoneal Dialysis 293
Chapter 62: Neurogenic Bladder 299
Chapter 63: Urinary Tract Infection 305
Chapter 64: Antenatal Hydronephrosis 313

TABLE OF CONTENTS

Section 8 Haematology and Oncology

Chapter 65: Approach to a Child with Anaemia 321
Chapter 66: Thalassaemia 325
Chapter 67: Immune Thrombocytopenic Purpura 331
Chapter 68: Haemophilia 337
Chapter 69: Oncology Emergencies 343
Chapter 70: Acute Lymphoblastic Leukaemia 353

Section 9 Gastroenterology

Chapter 71: Acute Gastroenteritis 359
Chapter 72: Chronic Diarrhoea 365
Chapter 73: Approach to Severely Malnourished Children 373
Chapter 74: Gastro-oesophageal Reflux 377
Chapter 75: Acute Hepatic Failure in Children 383
Chapter 76: Approach to Gastrointestinal Bleeding 387

Section 10 Infectious Disease

Chapter 77: Sepsis and Septic Shock 391
Chapter 78: Pediatric HIV 397
Chapter 79: Malaria 413
Chapter 80: Tuberculosis 419
Chapter 81: BCG Lymphadenitis 425
Chapter 82: Dengue and Dengue Haemorrhagic Fever with Shock 427
Chapter 83: Diphteria 439

Section 11 Dermatology

Chapter 84: Atopic Dermatitis 445
Chapter 85: Infantile Hemangioma 451
Chapter 86: Scabies 455
Chapter 87: Steven Johnson Syndrome 457

Section 12 Metabolic Disorders

Chapter 88: Inborn errors metabolism (IEM): Approach to Diagnosis and Early Management in a Sick Child 461
Chapter 89: Investigating Inborn errors metabolism (IEM) in a Child with Chronic Symptoms 471
Chapter 90: Approach to Recurrent Hypoglycemia 483
Chapter 91: Down Syndrome 489

TABLE OF CONTENTS

Section 13 Paediatric Surgery

Chapter 92: Appendicitis 495
Chapter 93: Vomiting in the Neonate and Child 497
Chapter 94: Intussusception 507
Chapter 95: Inguinal hernias, Hydrocoele 511
Chapter 96: Undescended Testis 513
Chapter 97: The Acute Scrotum 515
Chapter 98: Penile Conditions 519
Chapter 99: Neonatal Surgery 521

Section 14 Rheumatology

Chapter 100: Juvenile Idiopathic Arthritis (JIA) 535

Section 15 Poisons and Toxins

Chapter 101: Snake Bite 543
Chapter 102: Common Poisons 549
Chapter 103: Anaphylaxis 559

Section 16 Sedation and Procedures

Chapter 104: Recognition and Assessment of Pain 565
Chapter 105: Sedation and Analgesia for Diagnostic and Therapeutic Procedures 567
Chapter 108: Practical Procedures 571

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VITAL SIGNS

Respiratory (Breath) Rate			
Normal, Breath rate at rest		Abnormal	
Age (years)	Rate/min	*These values define Tachypnoea*	
<1	30-40	Age	Rate/min
1-2	25-35	< 2 months	> 60
2-5	25-30	2 mths - 1 year	> 50
5-12	20-25	1-5 years	> 40

Heart (Pulse) Rate			
	Abnormal	Normal	Abnormal
Age (years)	Low *(Bradycardia)*	Average	High *(Tachycardia)*
Newborn	< 70/min	125/min	> 190/min
1-11 months	< 80/min	120/min	> 160/min
2 years	< 80/min	110/min	> 130/min
4 years	< 80/min	100/min	> 120/min
6 years	< 75/min	100/min	> 115/min
8 years	< 70/min	90/min	> 110/min
10 years	< 70/min	90/min	> 110/min

Ref: Nelson Textbook of Pediatrics, 18th Edition

Blood Pressure		
	Hypotension *if below*	Normal (average)
Age (years)	5th centile for age	50th centile for age
< 1 year	65 - 75 mmHg	80 - 90 mmHg
1-2 years	70 - 75 mmHg	85 - 95 mmHg
2-5 years	70 - 80 mmHg	85 - 100 mmHg
5-12 years	80 - 90 mmHg	90 - 110 mmHg
> 12 years	90 - 105 mmHg	100-120 mmHg

Calculation for Expected Systolic Blood Pressure
= 85 + (2 x age in years) mmHg for 50th centile - Median Blood Pressure
= 65 + (2 x age in years) mmHg for 5th centile - Hypotension if below this value

Ref: Advanced Paediatric Life Support: The Practical Approach, Fifth Edition 2011

Blood Pressure in Hypertension				
Age	Significant Hypertension		Severe Hypertension	
1 week	Systolic	96 mmHg	Systolic	106 mmHg
1 wk - 1 mth	Systolic	104 mHg	Systolic	110 mmHg
Infant	Systolic	112 mmHg	Systolic	118 mmHg
	Diastolic	74 mmHg	Diastolic	82 mmHg
3-5 years	Systolic	116 mmHg	Systolic	124 mmHg
	Diastolic	76 mmHg	Diastolic	86 mmHg
6-9 years	Systolic	122 mmHg	Systolic	130 mmHg
	Diastolic	78 mmHg	Diastolic	86 mmHg
10-12 years	Systolic	126 mmHg	Systolic	134 mmHg
	Diastolic	82 mmHg	Diastolic	90 mmHg
13-15 years	Systolic	136 mmHg	Systolic	144 mmHg
	Diastolic	86 mmHg	Diastolic	92 mmHg
16-18 years	Systolic	142 mmHg	Systolic	150 mmHg
	Diastolic	92 mmHg	Diastolic	98 mmHg

ANTHROPOMETRIC MEASUREMENTS

Age	Weight	Height	Head size
birth	3.5 kg	50 cm	35 cm
6 months	7 kg	68 cm	42 cm
1 year	10 kg	75 cm	47 cm
2 years	12 kg	85 cm	49 cm
3 years	14 kg	95 cm	49.5 cm
4 years		100 cm	50 cm
5-12 years		5 cm/year	0.33 cm/year

Points to Note

Weight

- In the first 7 - 10 days of life, babies lose 10 - 15% of their birth weight.
- In the first 3 months of life, the rate of weight gain is 25 gm/day
- Babies *regain* their birth weight by the 2nd week, *double* this by 5 months age, and *triple* the birth weight by 1 year of age
- Weight estimation for children (in Kg):

  Infants: (Age in months X 0.5) + 4

  Children 1 – 10 years: (Age in yrs + 4) X 2

Head circumference

- Rate of growth in preterm infants is 1 cm/week, but reduces with age. Head growth follows that of term infants when chronological age reaches term
- Head circumference increases by 12 cm in the 1st year of life (6 cm in first 3 months, then 3 cm in second 3 months, and 3 cm in last 6 months)

Other normal values are found in the relevant chapters of the book.

References:

1. Advanced Paediatric Life Support: The Practical Approach Textbook, 5th Edition 2011
2. Nelson Textbook of Pediatrics, 18th Edition.

HAEMATOLOGICAL PARAMETERS

Age	Hb	PCV	Retics	MCV *fl*	MCH *pg*	TWBC	Neutrophil	Lymphocyte
	g/dL	%	%	Lowest	Lowest	*x1000*	Mean	Mean
Cord Blood	13-7-20.1	45-65	5.0	110	-	9-30	61	31
2 weeks	13.0-20.0	42-66	1.0	-	29	5-21	40	63
3 months	9.5-14.5	31-41	1.0	-	27	6-18	30	48
6 mths - 6 yrs	10.5-14.0	33-42	1.0	70-74	25-31	6-15	45	38
7 - 12 years	11.0-16.0	34-40	1.0	76-80	26-32	4.5-13.5	55	38
Adult male	14.0-18.0	42-52	1.6	80	27-32	5-10	55	35
Adult female	12.0-16.0	37-47	1.6	80	26-34	5-10	55	35

Differential counts	
< 7 days age	neutrophils > lymphocytes
1 wk - 4 years	lymphocytes > neutrophils
4 - 7 years	neutrophils = lymphocytes
> 7 years	neutrophils > lymphocytes

Points to note

- **Differential WBC:** eosinophils: 2-3%; monocytes: 6-9 %
- **Platelets counts** are lower in first months of age; but normal range by 6 months
- **Erythrocyte sedimentation rate (ESR)** is < 16 mm/hr in children, provided PCV is at least 35%.

National Immunisation Schedule for Malaysia (Ministry of Health, Malaysia)

	Age (months)										School years		
Vaccine	birth	1	2	3	5	6	9	10	12	18	7 yrs	13 yrs	15 yrs
BCG	1										if no scar		
Hepatitis B	1	2				3							
DTaP			1	2	3					DT B^+			T B^+
IPV			1	2	3					B^+			
Hib			1	2	3					B^+			
Measles						Sabah							
MMR									1				
JE (Sarawak)							1	2		B*			
HPV												3 doses	

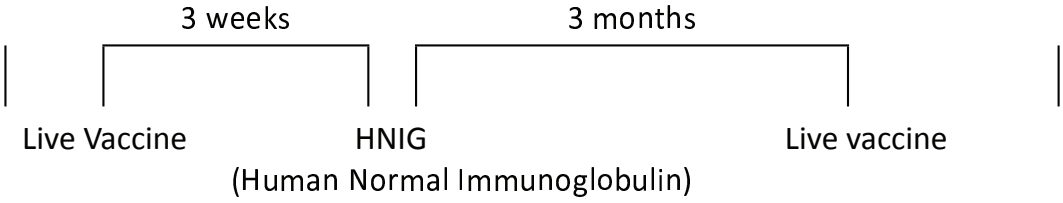
Legend: B^+, Booster doses; B, Booster at 4 years age; BCG, Bacille Calmette-Guerin; DTaP, Diphhteria, Tetanus, acellular Pertussis; DT, Diphtheria, Tetanus; T, Tetanus IPV, Inactivated Polio Vaccine; Hib, Haemophilus influenzae type B; MMR, Measles, Mumps, Rubella; JE, Japanese Encephalitis, HPV, Human Papilloma Virus;*

General Notes

- Many vaccines (inactivated or live) **can be given together simultaneously** (does not impair antibody response or increase adverse effect). But they are to be given at different sites unless given in combined preparations. Vaccines are now packaged in combinations to avoid multiple injections to the child.
- sites of administration
  - oral – rotavirus, live typhoid vaccines
  - intradermal (ID) - BCG. Left deltoid area (proximal to insertion deltoid muscle)
  - deep SC, IM injections. (ALL vaccines *except* the above)
    - anterolateral aspect of thigh – preferred site in children
    - upper arm – preferred site in adults
    - upper outer quadrant of buttock - associated with lower antibody level production

Immunisation : *General* contraindications

- **Absolute contraindication** for ***any* vaccine**: severe anaphylaxis reactions to previous dose of the vaccine or to a component of the vaccine.
- Postponement during **acute febrile illness**: Minor infection without fever or systemic upset is NOT a contraindication.
- A relative contraindication: avoid a vaccine within 2 weeks of elective surgery.
- **Live vaccine: Absolute contraindications**
  - *Immunosuppressed children* -malignancy; irradiation, leukaemia, lymphoma, primary immunodeficiency syndromes (but NOT asymptomatic HIV).
  - On *chemotherapy* or < 6 months after last dose.
  - On *High dose steroids*, i.e. Prednisolone ≥ 2 mg/kg/day for > 7 days or low dose systemic > 2 weeks: delay vaccination for 3 months.
  - If topical or inhaled steroids OR low dose systemic < 2 weeks or EOD for > 2 weeks, can administer live vaccine.
  - If *given another LIVE vaccine including BCG < 4 weeks ago*. (Give live vaccines simultaneously. If unable to then give separately with a 4 week interval).
  - Within *3 months following IV Immunoglobulin* (11 months if given high dose IV Immunoglobulins, e.g. in Kawasaki disease).



  - Pregnancy (live vaccine - theoretical risk to foetus) UNLESS there is significant exposure to serious conditions like polio or yellow fever in which case the importance of vaccination outweighs the risk to the foetus.
- **Killed vaccines are generally safe**. The only absolute contraindications are SEVERE local (induration involving > 2/3 of the limbs) or severe generalised reactions in the previous dose.

The following are *not* contraindications to vaccination

- Mild illness without fever e.g. mild diarrhoea, cough, runny nose.
- Asthma, eczema, hay fever, impetigo, heat rash (avoid injection in affected area).
- Treatment with antibiotics or locally acting steroids.
- Child's mother is pregnant.
- Breastfed child (does not affect polio uptake).
- Neonatal jaundice.
- Underweight or malnourished.
- Over the recommended age.
- Past history of pertussis, measles or rubella (unless confirmed medically)
- Non progressive, stable neurological conditions like cerebral palsy, Down syndrome, simple febrile convulsions, controlled epilepsy, mental retardation.
- Family history of convulsions.
- History of heart disease, acquired or congenital.
- Prematurity (immunise according to schedule irrespective of gestational age)

Vaccination: Special Circumstances

- Measures to protect **inpatients exposed to another inpatient with measles**:
  - Protect all **immunocompromised children** with Immunoglobulin (HNIG) 0.25-0.5 mls/kg. (Measles may be fatal in children in remission from leukaemia)
  - Check status of measles immunisation in the other children. Give measles monocomponent vaccine to **unimmunised children** within 24 hrs of exposure. Vaccination within 72 hours aborts clinical measles in 75% of contacts
  - Discharge the inpatient child with uncomplicated measles.
  - Do not forget to notify the Health Office.
- Immunisation in *children with HIV* (Please refer to Paediatric HIV section)
- In patients with **past history or family history of febrile seizures**, neurological or developmental abnormalities that would predispose to febrile seizures:-
  - Febrile seizures may occur 5 – 10 days after measles (or MMR) vaccination or within the first 72 hours following pertussis immunisation.
  - Give Paracetamol (120 mg or ¼ tablet) prophylaxis after immunisation (esp. DPT) 4-6 hourly for 48 hours regardless of whether the child is febrile. This reduces the incidence of high fever, fretfulness, crying, anorexia and local inflammation.
- Maternal Chicken Pox during perinatal period. (Please refer to Perinatally acquired varicella section)
- **Close contacts of immunodeficient children and adults** must be immunized, particularly against measles and polio (use IPV).
- In **contacts of a patient with invasive Haemophilus influenzae B disease**:
  - Immunise all household, nursery or kindergarden contacts < 4 years of age.
  - Household contacts should receive Rifampicin prophylaxis at 20 mg/kg once daily (Maximum 600 mg) for 4 days (except pregnant women - give one IM dose of ceftriaxone)
  - Index case should be immunised irrespective of age.

- Children with **Asplenia** (Elective or emergency splenectomy; asplenic syndromes; sickle cell anaemia) are susceptible to encapsulated bacteria and malaria.
  - Pneumococcal, Meningococcal A, C, Y & W-135, Haemophilus influenza b vaccines should be given.
  - For elective splenectomy (and also chemotherapy or radiotherapy): give the vaccines preferably 2 or more weeks before the procedure. However, they can be given even after the procedure.
  - Penicillin prophylaxis should continue ideally for life. If not until 16 years old for children or 5 years post splenectomy in adults.
- **Babies born to mothers who are HbeAg OR HbsAg positive** should be given Hepatitis B immunoglobulin (200 IU) and vaccinated with the Hepatitis B vaccine within 12 hours and not later than 48 hours. Given in different syringes and at different sites.
- **Premature infants** may be immunised at the same chronological age as term infants. (Please refer section on The premature infants for more discussion)

Vaccine	Indication/Dose	Contraindication	Possible Side Effects	Notes
BCG	To be given at birth and to be repeated if no scar is present	Not to be given to symptomatic HIV infected children. Can be given to newborns of HIV infected mother as the infant is usually asymptomatic at birth.	BCG adenitis may occur.	Intradermal. Local reaction: a papule at vaccination site may occur in 2 - 6 weeks. This grows and flattens with scaling and crusting. Occasionally a discharging ulcer may occur. This heals leaving a scar of at least 4 mm in successful vaccination.
Hepatitis B	All infants, including those born to HBsAg positive mothers All health care personnel.	Severe hypersensitivity to aluminium. The vaccine is also not indicated for HBV carrier or immuned patient (i.e. HBsAg or Ab positive)	Local reactions. Fever and flu-like symptoms in first 48 hours. Rarely, erythema multiforme or urticaria.	Intramuscular. Give with Hep B immunoglobulin for infants of HBsAg positive mothers.
Diphtheria, Tetanus (DT)	All infants should receive 5 doses including booster doses at 18 months and Standard 1	Severe hypersensitivity to aluminium and thiomersal	Swelling, redness and pain A small painless nodule may develop at injection site – harmless. Transient fever, headaches, malaise, rarely anaphylaxis. Neurological reactions rare.	Intramuscular

Vaccine	Indication/Dose	Contraindication	Possible Side Effects	Notes
Pertussis	All infants should receive 4 doses including booster at 18 months It is recommended that booster doses be given at Std 1 and at Form 3 due to increased cases of Pertussis amongst adolescents in recent years	Anaphylaxis to previous dose; encephalopathy develops within 7 days of vaccination Precautions: severe reaction to previous dose (systemic or local) and progressive neurological diseases.	Local reaction. Severe if involve 2/3 limbs Severe systemic reaction: Anaphylaxis (2 per 100 000 doses), encephalopathy (0 – 10.5 per million doses), high fever (fever>40.5), fits within 72 hours, persistent inconsolable crying (0.1 to 6%), hyporesponsive state. Acellular Pertussis vaccine associated with less side effects	Intramuscular. Static neurological diseases, developmental delay, personal or family history of fits are NOT contraindications.
Inactivated Polio Vaccine (IPV)	All infants to be given 4 doses including booster at 18 months.	Allergies to neomycin, polymyxin and streptomycin Previous severe anaphylactic reaction	Local reactions.	Intramuscular.
Haemophilus Influenzae type B (Hib)	All infants should receive 4 doses including booster at 18 months. Patients with splenic dysfunction, and post splenectomy.	Confirmed anaphylaxis to previous Hib and allergies to neomycin, polymyxin and streptomycin	Local swelling, redness and pain soon after vaccination and last up to 24 hours in 10% of vaccinees Malaise, headaches, fever, irritability, inconsolable crying. Very rarely seizures.	Intramuscular

Vaccine	Indication/Dose	Contraindication	Possible Side Effects	Notes
Measles	Sabah, Orang Asli population at 6 mths. Not usually given to children <12mth. If there is a measles outbreak, can be given to children 6 -11 mths age. This is later followed by MMR at 12 mths and 4-6 years age.	Avoid in patients with hypersensitivity to eggs, neomycin and polymyxin. Pregnancy. Children with untreated leukemia, TB and other cancers. Immunodeficiency.	Transient rash in 5%. May have fever between D5-D12 post vaccination. URTI symptoms. Febrile convulsions (D6-D14) in 1:1000 – 9000 doses of vaccine. (Natural infection 1:200) Encephalopathy within 30 days in 1:1,000,000 doses. (Natural infection 1:1000 - 5000)	Intramuscular. ** *Long term prospective studies have found no association between measles or MMR vaccine and inflammatory bowel diseases, autism or SSPE.*
Measles, Mumps, Rubella (MMR)	All children from 12 to 15 months. Booster at 4-6yrs (or at Std 1).	Severe reaction to hen's eggs and neomycin. Pregnancy	Measles: As above	Intramuscular. Can be given irrespective of previous history of measles, mumps or rubella infection.
Mumps			Rarely transient rash, pruritis and purpura. Parotitis in 1% of vaccinees, > 3 weeks after vaccination. Orchitis and retro bulbar neuritis very rare. Meningoencephalitis is mild and rare. (1:800,000 doses). (natural infection 1:400).	Intramuscular

Vaccine	Indication/Dose	Contraindication	Possible Side Effects	Notes
Rubella			Rash, fever, lymphadenopathy, thrombocytopenia, transient peripheral neuritis. Arthritis and arthralgia occurs in up to 3% of children and 20% of adults.	Given as MMR
Japanese Encephalitis (JE)	Given in Sarawak at 9, 10 and 18 months Booster at 4 years.	Immunodeficiency and malignancy, diabetes , acute exacerbation of cardiac, hepatic and renal conditions	Local redness, swelling, pain, fever, chills, headache, lassitude..	Inactivated vaccine. Subcutaneous. Protective efficacy > 95%.
Human Papilloma Virus (HPV)	Indicated for females aged 9-45 years.	Not recommended in pregnant patients.	Headache, myalgia, injection site reactions, fatigue, nausea, vomiting, diarrhoea, abdominal pain, pruritus, rash, urticaria, myalgia, arthralgia, fever.	2 vaccines available: Cervarix (GSK): bivalent. Gardasil (MSD): quadrivalent. - 3 dose schedule IM (0, 1-2month, 6 month). Recombinant vaccine. Protective efficacy almost 100% in preventing vaccine type cervical cancer in first 5 years.

Vaccine	Indication/Dose	Contraindication	Possible Side Effects	Notes
Pneumo-coccal (conjugate) vaccine: PCV 13/ PCV 7	Dosage: Infants 2-6 mth age. 3-dose primary series at least 1 mth apart from 6 wks of age. Booster: 1 dose between 12-15 mths of age. Unvaccinated: infants 7-11 mths 2 doses 1 month apart, followed by a 3rd dose at 12- 15 months; children 12-23 months 2 doses at least 2 months apart; healthy children 2 - 5 years: Single dose Unvaccinated high risk children 2-5 yrs age may be given 2 doses (6-8 wks apart)	Children who have severe allergic reaction to previous pneumococcal vaccine Healthy children under 6 weeks and more than 59 months of age	Decreased appetite, irritability, drowsiness, restless sleep, fever, inj site erythema, induration or pain, rash.	*Not in Blue Book* Immunogenic in children < 2 years Inactivated vaccine. Intramuscular High risk children: immunosuppression (includ-ing asymptomatic HIV), asplenia, nephrotic syndrome and chronic lung or heart disease.

Vaccine	Indication/Dose	Contraindication	Possible Side Effects	Notes
Pneumococcal (polysaccharide vaccine)	Recommended for children at high risk. > 2 years old. Single dose. Booster at 3-5 years only for high risk patients.	Age < 2 years old. Revaccination within 3 years has high risk of adverse reaction; Avoid during chemotherapy or radiotherapy and less than 10 days prior to commencement of such therapy – antibody response is poor. Pregnancy.	Hypersensitivity reactions.	Listed in Blue Book. Intramuscular, Subcutaneous Immunogenic in children ≥2 yrs. Against 23 serotypes. High risk: immunosuppression, asymptomatic HIV, asplenia, nephrotic syndrome, chronic lung disease. If these children are <2 yrs old, they should first receive pneumococcal conjugate vaccine; when > 2 yrs, then the polysaccharide vaccine is used.
Rotavirus	First dose given to infants ≥ 6 wks old. *Rotateq* (3 doses) Subsequent doses given at 4-10 wks interval. 3rd dose given ≤ 32 weeks age. *Rotarix* (2 doses). 2nd dose to be given by 24 weeks age. Interval between doses should be > 4 wks.	Prior hypersensitivity to any vaccine component. Uncorrected congenital GIT malformation, e.g. Meckel's diverticulum Severe combined immunodeficiency disease (reported prolonged shedding of vaccine virus reported in infants who had live Rotavirus vaccine)	Loss of appetite, irritability, fever, fatigue, diarrhoea, vomiting, flatulence, abdominal pain, regurgitation of food.	Oral live-attenuated vaccine. Protective efficacy 88-91% for any rotavirus gastroenteritis episode; 63-79% for all causes of gastroenteritis.

Vaccine	Indication/Dose	Contraindication	Possible Side Effects	Notes
Varicella Zoster	*12 mths to 12 yrs:* Single dose *> 12 yrs:* 2 doses ≥4 wks apart. Non immune susceptible health care workers who regularly come in contact with VZV infection Asymptomatic/mildly symptomatic children with HIV (with CD4% > 15%); 2 doses at 3 mths interval. Children in remission from leukemia for ≥1 yr, have >700/ml circulating lymphocytes may receive vaccine under paediatrician supervision (2doses).	Pregnant patients. Patients receiving high dose systemic immunosuppression therapy. Patients with malignancy especially haematological malignancies or blood dyscrasias. Hypersensitivity to neomycin.	Occasionally, papulovesicular eruptions, injection site reactions, headache, fever, paresthesia, fatigue	Live attenuated vaccine. Subcutaneous. 70 – 90% effectiveness.
Hepatitis A	For children >1 yr. 2 doses., given 6-12 months apart.	Severe hypersensitivity to aluminium hydroxide, phenoxyethanol, neomycin	Local reactions. Flu-like symptoms lasting 2 days in 10% of recipients	Intramuscular. Inactivated vaccine. Protective efficacy 94%.

Vaccine	Indication/Dose	Contraindication	Possible Side Effects	Notes
Cholera	Children 2-6 yrs: 3 doses at 1-6 wk interval. Children > 6 yrs: 2 doses at 1-6 wks interval. Booster dose >2 yrs.		Gastroenteritis	Oral inactivated vaccine. Protective efficacy 80-90% after 6 mths waning to 60% after 3 yrs.
Influenza	Single dose. Min age 6 mths. Unprimed individuals require 2nd dose 4 - 6 wks after 1st dose. Recommended for children with: chronic decompensated respiratory or cardiac disorders, e.g. cyanotic heart diseases chronic lung disease, HIV infection. In advanced disease, vaccination may not induce protective antibody levels.	Hypersensitivity to egg or chicken protein, neomycin, formaldehyde. Febrile illness, acute infection.	Transient swelling, redness, pain and induration locally. Myalgia, malaise and fever for 1 – 2 days starting within a few hours post vaccination. Very rarely, neurological (Guillain-Barre), glomerulonephritis, ITP or anaphylactic reaction occurs.	Intramuscular. Inactivated vaccine. Protective efficacy 70-90% Require yearly revaccination for continuing protection.

Vaccine	Indication/Dose	Contraindication	Possible Side Effects	Notes
Rabies	Pre-exposure: 3 doses at Day 0, 7, 28. Booster every 2-3 yrs. Post-exposure treatment: Fully immunised: 2 doses at Day 0, Day 3. Rabies Immune Globulin (RIG) unnecessary. Unimmunised: 5 doses at Day 0, 3, 7, 14 and 28. RIG (20 IU/kg given half around the wound and the rest IM.		Headache, dizziness, malaise, abdominal pain, nausea, myalgia. Injection site reactions such as itching, swelling, pain.	Inactivated vaccine. (Available in Malaysia as Purified Vero Cell Rabies Vaccine (PVRV). Intramuscular.
Meningococcus A, C, Y & W-135	Single dose. Immunity up to 3 yrs.		Local reactions. Irritability, fever and rigors for 1-2 days. Very rarely, anaphylaxis.	Intramuscular.
Typhoid (Typhim Vi)	Single dose. Seroconversion in 85-95% of recipients; confers 60-80% protection beginning 2 wks after vaccination. Boosters every 3 yrs.	Children < 2yrs. (Immunogenicity < 2 yrs of age has not been established)	Local reactions. Myalgia, malaise, nausea, headaches and fever in 3% of recipients.	Intramuscular. Polysaccharide vaccine
Typhoid (Ty21a vaccine)	Three doses two days apart. Effective 7 days after last dose. Booster every 3 years.	Infant <6 mth. Congenital or acquired immunodeficiency. Acute febrile illness & acute intestinal infection.	Very rarely: mild GIT disturbances or a transitory exanthema.	Oral. Live attenuated vaccine.

Recommended Immunisation Schedule for Infants and Children *Not Immunised* at the Recommended Time

Time of Immunisation	Age at first visit	
	Between 6 wks -12 mths	12 months and older
1st visit	BCG, DPT/DTaP, Hib1, IPV1, HBV1	BCG, DPT/DTaP1, Hib1, IPV1, HBV1, measles (footnote 2) at 6 or 9 mths, MMR at 12 mths of age
2nd visit (1 mth later)		DPT/DTaP2, IPV2, HBV2, Hib2
3rd visit (1 mth later)	DPT/DTaP2,Hib2, IPV2, HBV2	DPT/DTaP3, IPV3,
4th visit (4 mths after 3rd visit)	DPT/DTaP3,Hib3, IPV3,	HBV3, DPT/DTaP4, IPV4,
2-8 mths later	HBV3, DTaP4, Hib4 & IPV4 (booster), measles in Sabah at 9 mths age, MMR at 12 mths age	Polio, DT/DTaP, MMR (at school entry)

Footnotes:

1. *For infants < 6 wks age, use "Recommended Immunisation Schedule for Infants & Children".*
2. *Measles vaccine should be given only after 9 mths. (exception - given at 6 months in Sabah)*
3. *For special groups of children with no regular contact with Health Services and with no immunisation records, BCG, HBV, DTaP- Hib-IPV and MMR can be given simultaneously at different sites at first contact.*
4. *I**t is not necessary to restart a primary course of immunisation regardless of the period that has elapsed since the last dose was given.** Only the subsequent course that has been missed need be given. (Example. An infant who has been given IPV1 and then 9 months later comes for follow-up, the IPV1 need not be repeated. Go on to IPV2.). Only exception is Hepatitis A vaccine.*

Well children with *Normal hydration*

Very few well children require intravenous fluids (IV). Whenever possible use an enteral (oral) route for fluids.

These guidelines apply to children who are unable to tolerate enteral fluids.

The safe use of IV fluid therapy in children requires accurate prescribing of fluids and careful monitoring because incorrectly prescribed or administered fluids are hazardous.

If IV fluid therapy is required then **maintenance fluid requirements should be calculated using the Holliday and Segar formula based on weight.**

However this should be only be used as a starting point and the individuals' response to fluid therapy should be monitored closely by clinical observation, fluid balance, weight and a minimum daily electrolyte profile.

Prescribing Intravenous fluids

Fluids are given intravenously for the following reasons:

- Circulatory support in resuscitating vascular collapse.
- Replacement of previous fluid and electrolyte deficit.
- Maintenance of daily fluid requirement.
- Replacement of ongoing losses.
- Severe dehydration with failed nasogastric tube fluid replacement (e.g. on-going profuse losses, diarrhoea or abdominal pain).
- Certain co-morbidities, particularly GIT conditions (e.g. short gut or previous gut surgery)

Resuscitation

Fluids appropriate for bolus administration are:	
Crystalloids	0.9% Normal Saline
	Ringer's Lactate @ Hartmann's solution
Colloids	Gelafundin, Voluven
	4.5% albumin solution
Blood products	Whole blood, blood components

- Fluid deficit sufficient cause **impaired tissue oxygenation (i.e. clinical shock)** should be **corrected with a fluid bolus of 10-20mls/kg**.
- **Always reassess circulation** - give repeat boluses as necessary.
- **Look for the cause of circulatory collapse** - blood loss, sepsis, etc. This helps decide on the appropriate alternative resuscitation fluid.
- **Fluid boluses of 10mls/kg in selected situations** - e.g. diabetic ketoacidosis, intracranial pathology or trauma.
- **Avoid low sodium-containing (hypotonic) solutions** for resuscitation as this may cause hyponatremia.
- **Check blood glucose:** treat **hypoglycemia** with 2mls/kg of 10% Dextrose solution.

- **Measure Na, K and glucose at the outset and at least 24hourly** from then on. More frequent testing is indicated in ill patients or those with co-morbidities. Rapid results of electrolytes can be done with blood gases measurements.
- **Consider septic work-up or surgical consult in severely unwell patients with abdominal symptoms** (i.e. gastroenteritis).

Maintenance

- Maintenance fluid is the volume of daily fluid intake. It includes insensible losses (from breathing, perspiration, and in the stool), and allows for excretion of the daily production of excess solute load (urea, creatinine, electrolytes) in the urine.
- **Most children can safely be managed with solution of 0.45% saline with added glucose** (i.e. 0.45% saline in 5% glucose or 0.45% saline in 10% glucose) depending on glucose requirement.
- Sodium chloride 0.18 saline with glucose 5% should not be used as a maintenance fluid and is restricted to specialist area to replace ongoing loses of hypotonic fluids. These areas include high dependency, renal, liver and intensive care.
- Most children will tolerate standard fluid requirements. However some acutely ill children with inappropriately increased anti-diuretic hormone secretion (SIADH) may benefit from their maintenance fluid requirement being restricted to two-thirds of the normal recommended volume.
- **Children who are at high risk of hyponatremia should be given isotonic solutions (i.e. 0.9% saline ± glucose) with careful monitoring to avoid iatrogenic hyponatremia in hospital.**

  These include children with the following conditions:
  - Peri-or post-operative
  - Require replacement of ongoing losses
  - A plasma Na at lower normal range of normal (definitely if < 135mmol/L)
  - Intravascular volume depletion
  - Hypotension
  - Central nervous system (CNS) infection
  - Head injury
  - Bronchiolitis
  - Sepsis
  - Excessive gastric or diarrhoeal losses
  - Salt-wasting syndromes
  - Chronic conditions such as diabetes, cystic fibrosis and pituitary deficits.

Calculation of Maintanence Fluid Requirements

The following calculations approximate **the maintenance fluid requirement of well children according to weight in kg.** (Holliday-Segar calculator)

Weight	Total fluids	Infusion rate
First 10 Kgs	100 ml/kg	4 mls/kg/hour
Subsequent 10 Kgs	50 ml/kg	2 mls/kg/hour
All additional Kg	20 ml/kg	1 mls/kg/hour

Example: A Child of 29 kg will require:		
100mls/kg for first 10kg of weight	10 x 100	= 1000 mls
50mls/kg for second 10kg of weight	10 x 50	= 500 mls
20mls/kg for all additional weight	9 x 20	= 180 mls
	Total	= 1680 mls
	Rate	= 1680/24 = 70mls/hour

Composition of commonly used intravenous solution				
	Osmolality	Na content	Osmolality	Tonicity
Fluid	(mOsm/l)	(mmol/l)	compared to plasma	with ref to cell membrane
Na chloride 0.9%	308	154	IsoOsmolar	Isotonic
Na chloride 0.45%	154	77	HypoOsmolar	Hypotonic
Na chloride 0.9% + Glucose 5%	586	150	HyperOsmolar	Isotonic
Na chloride 0.45% + Glucose 5%	432	75	HyperOsmolar	Hypotonic
Na chloride 0.18% + Glucose 5%	284	31	IsoOsmolar	Hypotonic
Dextrose 5%	278	Nil	IsoOsmolar	Hypotonic
Dextrose 10%	555	Nil	HyperOsmolar	Hypotonic
Hartmann's	278	131	IsoOsmolar	Isotonic

Deficit

• A child's water deficit in mls can be calculated following an estimation of the degree of dehydration expressed as % of body weight.

Example: A 10kg child who is 5% dehydration has a water deficit of 500mls.		
Maintenance		
100mls/kg for first 10 kg	= 10 × 100	= 1000mls
Infusion rate/hour	= 1000mls/24 hr	= 42mls/hr
Deficit (give over 24hours)		
5% dehydration (5% of body water): 5/100 × 10kg × 1000mls		= 500mls
Infusion rate/hour (given over 24 hrs)	= 500mls/24 hr	= 21mls/hr

- **The deficit is replaced over a time period that varies according to the child's condition.** Precise calculations (e.g. 4.5%) are not necessary. The rate of rehydration should be adjusted with ongoing clinical assessment.
- **Use an isotonic solution for replacement of the deficit, e.g. 0.9% saline.**
- **Reassess clinical status and weight at 4-6hours**, and if satisfactory continue. If child is losing weight, increase the fluid and if weight gain is excessive decrease the fluid rate.
- Replacement may be rapid in most cases of gastroenteritis (best achieved by oral or nasogastric fluids), but **should be slower in diabetic ketoacidosis and meningitis, and much slower in hypernatremic states** (aim to rehydrate over 48-72 hours, the serum Na should not fall by >0.5mmol/l/hr).

Ongoing losses (e.g. from drains, ileostomy, profuse diarrhoea)

- These are best measured and replaced. Any fluid losses > 0.5ml/kg/hr needs to be replaced.
- Calculation may be based on each previous hour, or each 4 hour period depending on the situation. For example; a 200mls loss over the previous 4 hours will be replaced with a rate of 50mls/hr for the next 4 hours).
- Ongoing losses can be replaced with 0.9% Normal Saline or Hartmann's solution. Fluid loss with high protein content leading to low serum albumin (e.g. burns) can be replaced with 5% Human Albumin.

SODIUM DISORDERS

- The daily sodium requirement is 2-3mmol/kg/day.
- **Normal serum sodium is between 135-145mmol/l.**

Hypernatremia

- **Hypernatremia is defined as serum Na^+ > 150mmol/l,**
  moderate hypernatremia is when serum Na^+ is 150-160mmol/l, and *severe* hypernatremia is when serum Na^+ > 160mmol/l.
- It can be due to:
  - water loss in excess of sodium (e.g. diarrhoea)
  - water deficit (e.g. diabetes insipidus)
  - sodium gain (e.g. large amount of NaHCO3 infusion or salt poisoning).

Clinical signs of Hypernatremic dehydration
Irritability
Skin feels "doughy"
Ataxia, tremor, hyperreflexia
Seizure
Reduced awareness, coma

- If the cause of the hypernatremia is central diabetes insipidus, it is advisable to consult Endocrinology team regarding management.
- In **hypernatremia the child appears sicker than expected for the degree of dehydration.**
- **Shock occurs late because intravascular volume is relatively preserved.**
  Signs of hypernatremic dehydration tend to be predominantly that of intracellular dehydration and neurological dysfunction.

Management

This will depend on the cause of hypernatremia.
For hypernatremic dehydration with Na^+> 150mmol/l

- **If the patient is in shock, give volume resuscitation with 0.9% Normal saline as required with bolus/es.**
- **Avoid rapid correction** as this may cause cerebral oedema, convulsion and death.
- Aim for correction of deficit over 48-72 hours and a fall of serum sodium concentration not more than 0.5mmol/l/hour.
- Give 0.9% saline to ensure the drop in sodium is not too rapid.
- Remember to also give maintenance and replace ongoing losses following the recommendation above.
- **Repeat blood urea and electrolytes** every 6 hours until stable.

Special considerations

- A slower rate will be required for children with chronic hypernatremia (present for more than 5 days).
- **Calcium and glucose need to be checked** as hypernatremia can be associated with hypocalcaemia and hyperglycemia, these conditions need to be corrected concurrently.

Hyponatremia

- **Hyponatremia is defined when serum Na^+ < 135mmol/l.**
- **Hyponatremic encephalopathy is a medical emergency** that requires rapid recognition and treatment to prevent poor outcome.
- As part of the general resuscitative measures, **bolus of 4ml/kg of 3% sodium chloride should be administered over 30 minutes.** This will raised the serum sodium by 3mmol/l and will usually help stop hyponatremic seizures.
- Gradual serum sodium correction should not be more than 8mmol/day to prevent osmotic demyelination syndrome.

Calculating sodium correction in acute hyponatremia	
mmol of sodium required	= (135-present Na level)× 0.6 × weight(kg)
The calculated requirements can then be given from the following available solutions dependent on the availability and hydration status:	
0.9% sodium chloride contains 154 mmol/l	
3% sodium chloride contains 513mmol/l	

- Children with **asymptomatic hyponatremia** do not require 3% sodium chloride treatment and if dehydrated may be managed with oral fluids or intravenous rehydration with 0.9% sodium chloride.
- Children who are hyponatremic and have a normal or raised volume status should be managed with fluid restriction.
- For Hyponatremia secondary to **diabetic ketoacidosis**; refer DKA protocol.

POTASSIUM DISORDERS

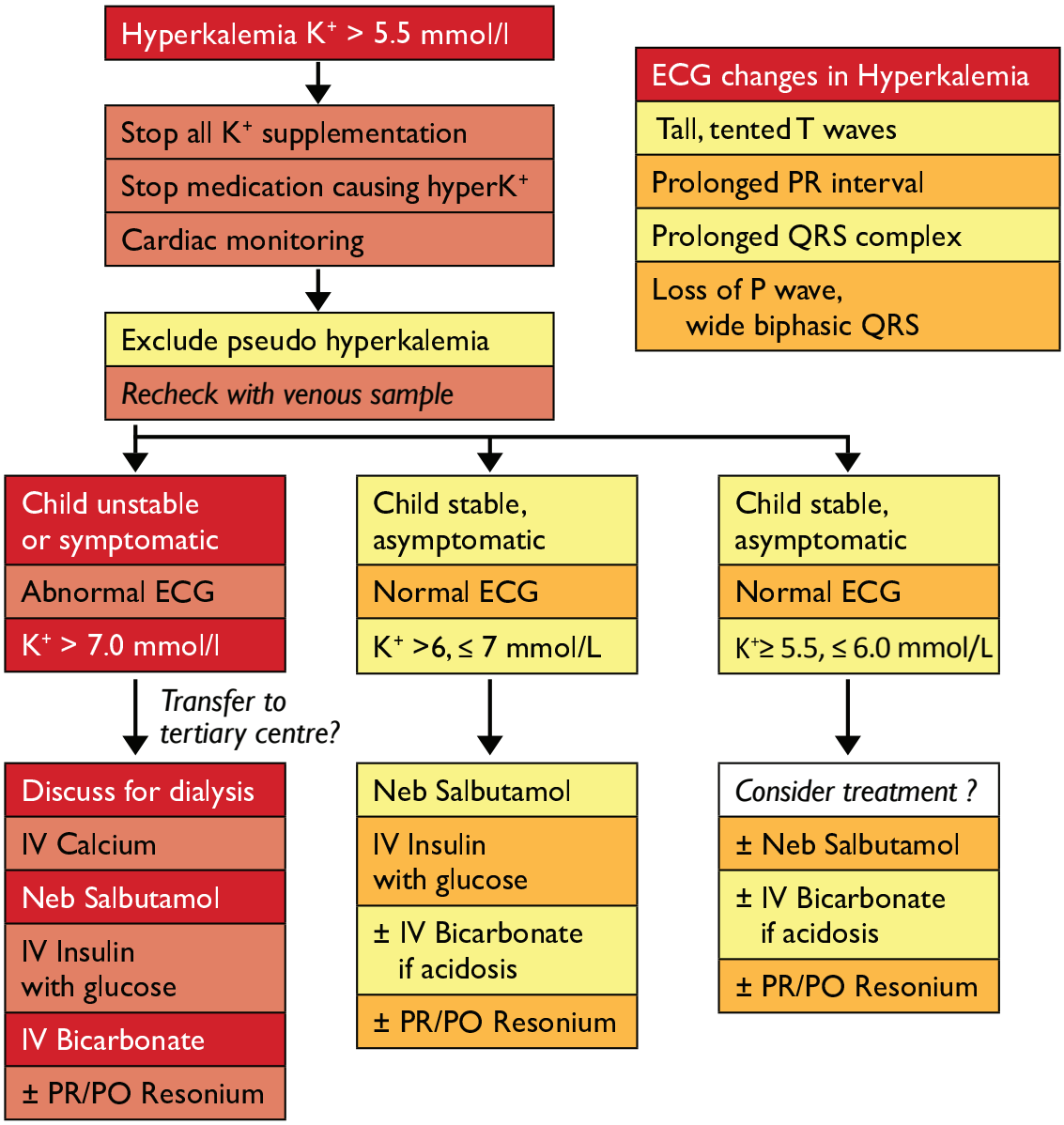
- The daily potassium requirement is 1-2mmol/kg/day.
- **Normal values of potassium are:**
  - **Birth - 2 weeks: 3.7 - 6.0mmol/l**
  - **2 weeks – 3 months: 3.7 - 5.7mmol/l**
  - **3 months and above: 3.5 - 5.0mmol/l**

Hyperkalemia

- Causes are:
  - Dehydration
  - Acute renal failure
  - Diabetic ketoacidosis
  - Adrenal insufficiency
  - Tumour lysis syndrome
  - Drugs e.g. oral potassium supplement, K^+ sparing diuretics, ACE inhibitors.

Treatment: ***see algorithm on next page***

Hyperkalemia Treatment Algorithm



Drug doses:

- IV Calcium 0.1 mmol/kg.
- Nebulised Salbutamol:
  Age ≤2.5 yrs: 2.5 mg; Age 2.5-7.5 yrs: 5 mg; >7.5 yrs: 10 mg
- IV Insulin with Glucose:
  Start with IV Glucose 10% 5ml/kg/hr (or 20% at 2.5 ml/kg/hr).
  Once Blood sugar level >10mmol/l and the K^+ level is not falling,
  add IV Insulin 0.05 units/kg/hr and titrate according to glucose level.
- IV Sodium Bicarbonate: 1-2 mmol/kg.
- PO or Rectal Resonium : 1Gm/kg.

Hypokalemia

- **Hypokalemia is defined as serum Na^+ > 3.4 mmol/l**
  (Treat if < 3.0mmol/l or Clinically Symptomatic < 3.4 mmol/l)
- Causes are:
  - Sepsis
  - GIT losses - diarrhoea, vomiting
  - Iatrogenic- e.g. diuretic therapy, salbutamol, amphotericin B.
  - Diabetic ketoacidosis
  - Renal tubular acidosis
- Hypokalaemia is often seen with chloride depletion and metabolic alkalosis.

ECG changes of Hypokalemia
These occur when K^+ < 2.5mmol/l
Prominent U wave
ST segment depression
Flat, low or diphasic T waves
Prolonged PR interval (severe hypoK^+)
Sinoatrial block (severe hypoK^+)

- **Refractory hypokalaemia** may occur with hypomagnesaemia.

Treatment

- Identify and treat the underlying condition.
- **Unless symptomatic, a potassium level of 3.0 and 3.4 mmol/l is generally not supplemented** but rather monitored in the first instance.
- The treatment of hypokalaemia does not lend itself to be incorporated into a protocol and as a result each patient will need to be treated individually.

Oral Supplementation

- Oral Potassium Chloride (KCL), to a maximum of 2 mmol/kg/day in divided doses is common but more may be required in practice.

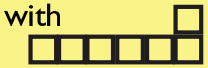
Intravenous Supplementation (1gram KCL = 13.3 mmol KCL)

- **Potassium chloride is always given by IV infusion, *NEVER* by bolus injection.**
- **Maximum *concentration* via a peripheral vein is 40 mmol/l** (concentrations of up to 60 mmol/l can be used after discussion with senior medical staff).
- **Maximum *infusion rate* is 0.2mmol/kg/hr** (in non-intensive care setting).

Intravenous Correction (1gram KCL = 13.3 mmol KCL)

- K^+ < 2.5 mmol/L may be associated with significant cardiovascular compromise. In the emergency situation, an IV infusion KCL may be given
  - Dose: initially 0.4 mmol/kg/hr into a central vein, until K^+ level is restored.
  - Ideally this should occur in an intensive care setting.

Age	Gross Motor	Fine Motor	Speech/Language	Social
6 wks	*Pull to sit:* Head lag, rounded back *Ventral Suspension:* Head briefly in same plane as body. *Prone:* Pelvis high, knees no longer under abdomen. Chin raised occasionally.	Fixates and follows to 90 degrees	Vocalising by 8 weeks. Quiets to sound. Startles to sound.	Smiles responsively.
3 mths	*Pull to sit:* Slight head lag. Head occasionally bobs forward. *Ventral Suspension:* Head above plane of body. *Prone:* Pelvis flat. Lifts head up 45°- 90°.	Hand regard. Follows object from side to side (180°). Hands held loosely. Grasps object placed in hand. Not reaching out.	Squeals with delight. Turns head to sound.	Laughs.
5 mths	*Pull to sit:* No head lag and sits with straight back. *Lying supine:* Feet to mouth.	Reaches for objects. Plays with toes.		Mouthing.
6 mths	*Pulls to sit:* Lifts head in anticipation. Sits with support. Bears weight on legs. *Prone:* Supports weight on hands; chest, upper abdomen off couch. Rolls prone to supine.	Palmar grasp of cube, ulnar approach. Moves head, eyes in all directions. No squint (after 4 months).		

Age	Gross Motor	Fine Motor	Speech/Language	Social
18 mths	Gets up and down stairs holding on to rail or with one hand held. Pulls toy or carries doll. Throws ball without falling. Sits on a chair.	Tower of 3 cubes. Scribbles spontaneously. Visual test: Picture charts. Handedness	Points to 2 - 3 body parts. Picture Cards - identify one.	Imitates housework. Toilet trained. Uses spoon well. Casting stops.
2 yrs	Goes up and down stairs alone, 2 feet per step. Walks backwards (21 months) Runs. Picks up toy without falling. Throws, kick ball without falling.	Tower of 6 cubes. Imitates cubes of train with no chimney.  Imitates straight line. Visual test: Snellen's chart.	2-3 word sentences. Uses 'you' 'me' 'I'. names 3 objects. Obeys 4 simple commands. Points to 4 body parts.	Puts on shoes, socks, pants. Dry by day. Play near other children but not with them.
2.5 yrs	Jumps on both feet. Walks on tip toes.	Tower of 8. Imitates train with chimney.  Holds pencil well. Imitates — and |	Knows full name and gender. Names one colour.	
3 yrs	Goes up stairs one foot per step. Down stairs 2 feet per step. Jumps off bottom step. Stands on 1 foot for seconds. Rides tricycle.	Tower of 9. Imitates bridge with cubes:  Copies O Imitates + Draw a man test. (3 - 10y)	Can count to 10. Names 2 colours. Nursery rhymes. Understands "on", "in", "under".	Dresses, undresses with help. Dry by night. Plays with others.

Age	Gross Motor	Fine Motor	Speech/Language	Social
4 yrs	Goes up and down stairs one foot per step. Skips on one foot. Hops on one foot.	Imitates gate with cubes. Copies  Goodenough test 4.	Names 3 colours. Fluent conversation. Understands "in front of", "between", behind".	Buttons clothes fully. Attends to own toilet needs.
4.5 yrs		Copies gate with cubes. Copies square. Draws recognisable man and house.		
5 yrs	Skips on both feet. Runs on toes.	Copies 'X' (5 years)  Copies (5½ years) triangle.  Goodenough test 8.	Knows AGE. Names 4 colours. Triple order preposition. Tell's the time.	Ties shoelaces. Dresses and undresses alone.
6 yrs	Walks heel to toe Kicking, throwing, climbing.	Copies:  Goodenough test 12. Imitates or copies steps with 10 cubes		
Note: Goodenough test: 3 + a/4 years (a = each feature recorded in his picture).				

Age	Gross Motor	Fine Motor	Speech/Language	Social
7 mths	Sits with hands on couch for support. Rolls from supine to prone.	Feeds self with biscuits. Transfers objects - hand to hand. Rakes at pea.	Babbling in single syllables. (combined syllables at 8 months). Distraction Test.	Stranger anxiety.
9 mths	Sits steadily. Leans forward but cannot pivot. Stands holding on. Pulls self to sit.	Inferior pincer grasp (Scissors grasp)	Localises sound at 3 feet, above and below the ear level.	Feeds with spoon occasionally. Looks for fallen toys. Understands "NO!"
10 mths	Crawls on abdomen. Pull self to stand.	Index approach. Uses index finger to poke at pea. Lets go of cube in hand.		Waves "Bye bye" Plays "Pat-a-Cake"
11 mths	Creeping on all fours. Pivoting. Cruising. Walks with *both* hands held.		*One* word with meaning.	Plays "peek-a-boo"
1 year	Gets from lying to sitting to crawling to standing. Walks like a bear. Walks with *one* hand held. Walks well (13 months). Stands alone	Neat pincer grasp. Bangs 2 cubes. Sees and picks up hundreds and thousands.	Understands phases; 2 - 3 words with meaning. Localising sound above head.	Casting (13 months) Less mouthing. Shy.
13 mths	Creeps upstairs. Stoops for toy and stands up without support. (best at 18 months)	Tower of 2 cubes. Scribbles spontaneously (15-18 months)	More words. Points to objects he wants. Continual jabber and jargon.	Takes off shoe. Feeds self with cup and spoon (but spills). Mouthing stops

Chapter 5: Developmental Assessment

Development is the progressive, orderly, acquisition of skills and abilities as a child grows. It is influenced by genetic, neurological, physical, environmental and emotional factors.

Important points to note:

- child **must be co-operative**, not tired, fretful, hungry nor sick. Remember that a child may behave differently in an unfamiliar environment
- allowance must be made for prematurity up to two years.
- take note of parental account of what child can or cannot do. **Note parental comments on abnormal gait, speech defects, etc.**
- normal development is **dependent on integrity of child's hearing and vision.**
- normal pattern of speech and language development is essential for a normal social, intellectual and emotional development.
- delay in development may be global i.e. affecting all areas equally, or specific areas only e.g. oro-motor dysfunction causing speech delay.

Key Developmental Warning Signs	
1	Discrepant head size or crossing centile lines (too large or too small).
2	Persistence of primitive reflexes > 6 months of age
3	No response to environment or parent by 12 months
4	Not walking by 18 months
5	No clear spoken words by 18 months
6	No two word sentences by 2 years
7	Problems with social interaction at 3 years
8	Congenital anomalies, odd facies
9	Any delay or failure to reach normal milestones
Note: Parental concerns must always be taken seriously	

Assessment of children with suspected developmental delay

History

- consanguinity
- family history of developmental delay
- maternal drugs, alcohol, illness and infection in pregnancy
- prematurity, perinatal asphyxia
- severe neonatal jaundice, hypoglycaemia or seizures
- serious childhood infections, hospital admissions or trauma
- home environment conditions (environmental deprivation)

Physical examination

- head circumference, dysmorphic features
- neurocutaneous markers
- neurological abnormalities
- full developmental assessment

Investigations

(individualised according to history and physical findings)

- Visual and auditory testing
- T4, TSH
- Chromosomal Analysis
- Consider
  - Creatine kinase in boys
  - MRI Brain
  - Metabolic screen
  - Specific genetic studies (Fragile X, Prader Willi or Angelman syndrome)
  - Refer to a geneticist
  - EEG if history of seizures

Consider
Hypothyroidism
Chromosomal anomaly
Cerebral palsy
Congenital intrauterine infection
Congenital brain malformations
Inborn errors of metabolism
Autistic spectrum disorder
Attention deficit hyperactivity disorder
Prior brain injury, brain infections
Neuroctaneous disorders
Duchenne's muscular dystrophy

Assessment of Children with Suspected Hearing Impairment or Speech Delay

History

- Congenital infection
- Perinatal medications
- Severe neonatal jaundice
- Family history of deafness or speech delay
- Chronic ear infections
- Quality, quantity of speech

Physical examination

- Examine ears
- Dysmorphic features
- Distraction Test
- Assess expressive, receptive speech
- Neurological / development assessment

Warning Signs for Hearing Impairment	
1	Child appears not to hear
2	Child makes no attempt to listen.
3	Does not respond to name, "No" or clue words e.g. "Shoe", by 1 yr age
4	Any speech/language milestone delay
Consider	
Congenital sensorineural deafness	
Familial, genetic deafness	
Congenital rubella infection	
Oro-motor dysfunction	

Management

- Formal hearing assessment
- Speech-language assessment and interventions

Hearing Tests at different ages		
Age	Test	Comments
Newborn screening	Automated Otoacoustic Emission (OAE) test	Determines cochlear function. Negative test in conductive hearing loss, middle ear infections, or in moderate to severe sensorineural hearing loss.
Any age	Brainstem Auditory Evoked Responses (BAER)	Measures brainstem responses to sound. Negative test in sensorineural hearing loss
7-9 months	Infant Distraction Test (IDT)	Determines response to sound whilst presented during a visual distraction.
Infants	Behavioural Observation Assessment (BOA) test	Audiologist identifies bodily reactions to sound, i.e. cessation of activity, body movement, eye widening and opening suckling rate.
> 2.5 years	Conditioned Play Audiometry	Earphones placed on child and various games are done when test tone is heard.
Older Children	Pure Tone Audiometry	Patient presses a response button or raises a hand when the test tone is heard

Assessment of Children with Suspected Visual Impairment

Children at risk

- Prematurity.
- Intrauterine Infection (TORCHES)
- Family history of cataracts, retinoblastoma or squint.
- Previous meningitis, asphyxia
- Dysmorphic babies

Warning Signs for Visual Impairment	
1	Does not fix on mother's face by 6 wks
2	Wandering or roving eyes after 6 wks
3	Abnormal head postures
4	Leukocoria (white eye reflex)
5	Holds objects very close to eye.
6	Squint after 6 months of age.

Assessment of Children with Suspected Learning Difficulties

It is sometimes a challenge to identify the primary cause of the learning difficulty as conditions like dyslexia , ADHD and intellectual impairment share common symptoms.

A. History *(A thorough history is important)*

- Antenatal perinatal and postnatal complications
- High risk behaviour like substance abuse in mother
- Family history of development delay, learning difficulties etc.
- Detailed developmental milestones
- When learning problems were first noted (preschool achievement, etc. as children with dyslexia or ADHD will have symptoms in early childhood)
- Past and current education performance
- Areas of learning difficulties
- Specific: e.g. reading difficulties (dyslexia) , writing difficulties (dysgraphia) but extremely good in tasks that require visual stimulation, e.g. art, music
- General : more commonly seen in children with some degree of intellectual impairment or from an extremely understimulated environment
- Strength of the child perceived by parents and teachers
- Who is the main caregiver at home ?
- Social background of the family

B1. Review School concerns with the patient, parents & teachers (always ask for teachers report). Common symptoms

- Apathy towards school
- Avoidance or poor performance in specific subject areas
- Disruptive or negative behaviour in certain classes

B2. Review all school workbooks (not only report card)

C. Basic Cognitive (intellectual functioning) screening tool in a Pediatric Clinic:

- Ask child to tell about a recent event : birthday, visit to grandparents etc. (note whether language is fluent, coherent, organized)
- Ask parents whether child has difficulty taking retaining classroom instructions or instructions at home (short term memory)
- Observe the child using a pencil to copy symbols and words (visual perceptual motor disorder characterized by confusing symbol, easy distractibility , inability to copy information)
- Ask the child to perform a 3-step command (sequencing ability to communicate and understand information in a orderly and meaningful manner)
- Ask the child to repeat four words , remember them and repeat them again when asked in 5 -10 minutes (memory , attention)
- Ask the child to repeat three, then four digits forward then repeat three, then four digits backward (concentration)

D. Physical Examination

- Anthropometric measurement
- General alertness and response to surrounding
  (Children with dyslexia will be very alert and usually very enterprising)
- Dysmorphism
- Look for neurocutaneous stigmata
- Complete CNS examination including hand eye coordination
  as children may have a associated motor difficulties like dyspraxia
- Complete developmental assessment.
- Ask child to draw something he or she likes (this can help to get a clearer picture about intellect of the child)

Block and Pencil test (From *Parry TS: Modern Medicine, 1998*)		
Age	Block Test	Pencil Test
3 - 3.5 yrs	Build a bridge 	Draw a circle 
3.5 - 4 yrs		Draw a cross 
3 - 4.5 yrs	Build a gate 	Draw a square 
5 - 6 yrs	Build steps 	Draw a triangle 
This test screens cognitive and perceptual development for age. Block test: build the structure without child observing then ask the child to copy the structure. Pencil test: Draw the object without child observing then ask the child to copy it.		

E. Differential Diagnosis that need to be ruled out:

Common causes

- Autism
- ADHD or combination of both
- Specific learning difficulty like Dyslexia
- Limited environmental stimulation

Genetic or a chromosomal disorder

- Fragile X
- Hypothyroidism
- Intellectual impairment
- Tourette
- Neurofibromatosis

Neurological

- Seizures
- Neurodegenerative condition

Miscellanous causes

- Anaemia
- Auditory or visual impairment
- Toxins (fetal alcohol syndrome, prenatal cocaine exposure, lead poisoning)

F. Plan of Management

Dependent on the primary cause for learning difficulties

- Dyslexia screening test if available
- DSM 1V for ADHD or Autistic Spectrum Disorder
  (Refer CPG for management of children and adolescents with ADHD :2008)
- Refer Occupational therapist for school preparedness (pencil grip, attention span etc) or for associated problems like dyspraxia
- Refer speech therapist if indicated
- Assess vision and hearing as indicated by history and clinical examination
- Targeted and realistic goals set with child and parents
- One-to-one learning may be beneficial
- Registration as a *Child with Special Needs* as per clinical indication and after discussion with parents

G. Investigations

Clinical impressions guides choice. Consider:

- DNA analysis for Fragile X syndrome for males with Intellectual impairment
- Genetic tests, e.g. Prader Willi, Angelman, DiGeorge, Williams syndromes
- Inborn errors of metabolism
- TSH if clinically indicated
- Creatine Kinase if clinically indicated
- MRI brain study abnormal neurological examination
- EEG only if clinically indicated

When is IQ Testing Indicated?

When diagnosis is unclear and there is a need to determine options for school placement.

If unsure of diagnosis refer patient to a Pediatrician, Developmental Pediatrician, Pediatric Neurologist, Child Psychiatrist and Child Psychologist depending on availability of services in your area.

Some first signs suggestibe of dyslexia	
Preschool and Kindergarten	
Language	• May have difficulty pronouncing words and slow to add new vocabulary words • May be unable to recall the right word • Trouble learning nursery rhymes or playing rhyming • Trouble learning to recognize letters of the alphabet (important predictor of later reading skills: recognition of letters of alphabets starts before decoding)
Memory	• Difficulty remembering rote information (name, phone number, address)
Fine motor skills	• Fine motor skills may develop more slowly than in other children
Lower Grades in School	
Language	• Delayed decoding abilities for reading • Trouble following directions • Poor spelling and using of pronouns, verbs
Memory	• Slow recall of facts • Organizational problems • Slow acquisition of new skills
Attention	• Impulsive, easily distractible and careless errors
Fine motor skills	• Unstable pencil grip • Trouble with letter formation
Visual skills	• Confuses words, e.g. at –to, does –goes, etc • Consistent reading and spelling errors • Transposes number sequence, maths signs (+,- X/=)
Middle Grades of School	
Language	• Poor reading comprehension • Trouble with word problems • Lack of verbal participation in class
Memory	• Slow or poor recall of math facts and failure of automatic recall
Attention	• Inconsistency and poor ability to discern relevant details
Fine motor skills	• Fist-like or tight pencil grip • illegible, slow or inconsistent writing
Visual skills	• May reverse sequences (e.g.: soiled for solid)

Higher Grades in School	
Language	• Weak grasp of explanation • Poor written expressions • Trouble summarizing
Memory	• Trouble studying for test • Slow work pace
Attention	• Memory problems due to poor attention • Mental fatigue
Fine motor skills	• Less significant
Visual skills	• Misreads information • Trouble taking multiple choice questions • Difficulty with sequencing (maths, music and science: physics)

Essentials in making a diagnosis of dyslexia

History *(A thorough history is important)*

- When reading problems was first noted
- What were the problems?
- What is the current reading problem faced by the child at school
- Neurodevelopment (esp speech delay)
- Family history (esp. speech delay and learning disability)
- Significant birth and medical history
- Assessment of school work (esp. exam papers and teacher's report) .
- Strength of the child
- Any educational interventions or others attempted before

Physical Examination

Look for this, as some of these findings may be associated with features of dyslexia:

- Microcephaly
- Vision and Hearing problems
- Syndromic facies
- Neurocutaneous stigmata
- Neurodevelopmental examination

Neurodevelopmental assessment

Look specifically for problems in the following areas:

Gross motor

- Coordination (some can be "clumsy")
- Motor planning
- Visual motor & spatial functioning.

Fine motor
- Small muscle manipulation (dyspraxia)

Visual motor integration
- Spatial relationship
- Patterns in written material
- Meaning of maths symbols

Temporal sequential organization
- Auditory sequencing
- Understanding time
- Organization & planning

Language
- Receptive and Expressive language.
- Comprehension.
- Grammar
- Spoken and written instructions

Behavior
- Attention
- Adaptation
- Self monitoring

Investigations

Tailored to patients needs.
- IQ testing for those where diagnosis or underlying cause is unclear e.g. Borderline intellectual impairment with dyslexic features.

Differential Diagnosis
- Hearing and visual problems.
- Attention deficit hyperactivity disorder (ADHD)
- Global developmental delay
- Intellectual impairment

Minimum Interventions that can be done:
- Advocate for the educational needs of the child
- Network for services that child may need out of the school, e.g. one-to-one tuition
- Discuss with parents how to tackle child's difficulties, best school placements, registration as a *child with special needs*, etc.
- Refer to other disciplines e.g. Dyspraxia and Pencil grip: Occupational therapist
- May need referral to speech therapist

Suggestions for School Based Interventions

- A phonics-based reading program that teaches the link between spoken and written sounds
- A multi-sensory approach to learning, which means using as many different senses as possible such as seeing, listening, doing and speaking
- Arrangements with the child's school - for example, for them to take oral instead of written tests
- Learning via audiotape or videotape
- Arrange for extra time for exams
- Arrange for readers for UPSR students (need to write to JPN one year ahead of the UPSR exams)

Features of Dyslexia that can be elicited in the General Pediatric Clinic Setting

(tables in following pages)

- Assessment needs to be done in accordance to the child's cooperativeness level (may require 2-3 visits for a thorough assessment)
- This is not a validated assessment checklist, when in doubt refer to a Pediatrician, Developmental Pediatrician or an Educational Psychologist, depending on services available at your hospital.

At the end of the assessment, please answer these 2 questions below, and tick the appropriate column.

Question	Yes	No
1. Does the limitation in reading, spelling and writing cause significant learning difficulty in school?		
2. From your clinical assessment do you agree that the IQ of the child is appropriate for age?		

If the answer to the **both the above questions is "yes"** then the probable diagnosis is **Dyslexia**.

If unsure about diagnosis please refer to Pediatrician, Developmental Pediatrician or Educational Psychologist depending on services available in your area.

References

1.Shaywitz, NEJM 1998
2.Kenneth L.Grizzle Pedia N Am 54; 2007
3. Center for community child health
4. Dyslexia screening Test
5. Dr Khoo Teik Beng's Dyslexia Clinic

Skill	Features	Examples	How to Test in Clinic
Reading	Unable to read appropriately for age	Give age appropriate passage or books	Listen to the child read aloud from his or her own grade level reader. (Keep a set of graded readers available in your clinic)
	Child may appear visibly tired after reading for only a short time		
	Reading will be slow, labored, inaccurate reading of even single words (ensure that there is no visual cues while doing this)	Single Word Reading • Boy • Chair • Kite • Hope	Show single words as suggested and ask child to read.
	Unable to read unfamiliar words or pseudo words and usually will try to guess or make up words because of some familiarity.	• Pilau = Pulau • Karusi = Kerusi • Maja = Meja	
Phonological processing / awareness	Difficulty in differentiating words that sounds alike	• Mana • Nama • Mama • Dapat • Padat	Consider the educational background of the child
Letter Indentification	Difficulty to name letters of the alphabet	A, B, C, D, E . . .	Prepare a table of alphabets and ask child to read out (ensure you point to the alphabets that you want the child to read). Take note that child maybe able to recite from memory

Skill	Features	Examples	How to Test in Clinic
Letter-Sound Association	Difficulty identifying words beginning with the same letter	• Doll, Dog, etc • Buku, buka, etc	
Segmentation	Difficulty in identifying word that would remain if a particular sound were removed	• What remains if the /k/ sound was taken away from "cat" = at • What remains if the /Ta/ sound taken away from "table"= ble • What remains if the /p/ sound was taken away from "paku" = aku • What remains if the sound /ma/ sound taken away from "mata" = mata	
Short term Verbal memory (eg, recalling a sentence or a story that was just told)	Difficulty recalling a sentence or a story that was just told	Narrate story to the child then ask questions like: • Apa nama kuching Ali? • Tompok suka makan apa? • Di mana Ali pergi memancing?	Have a short story which goes like this: "Ali ada seekor kuching bernama Tompok. Tompok suka makan ikan. Ali pergi memancing ikan di sungai dan memberikan ikan itu kepada Tompok."

Skill	Features	Examples	How to Test in Clinic
Rapid Naming	Difficulty in rapidly naming a continuous series of familiar objects, digits, letters, or colors	Use flash cards with pictures only, colours or numbers	Can use numbers for rapid naming or to test ability of remembering numbers in a reverse order. Ask child to name colours. If child not be able to do so ask child to point to a particular colour in a book. Usually the child will not have difficulty in doing so.
Expressive vocabulary or word retrieval	Difficulty in listing out name of animals or objects		Give me the names of animals you know
Rote memory	Difficulty in memorizing non-meaningful facts (facts that are not personally interesting and personally relevant)	• Multiplication tables • Days of the week or months of the year in order	Ask child to recite simple multiplication table or to say out days of the week or months of the year in order.
Sequencing steps in a task	Difficulty in performing task that needs sequencing	• Tying shoelaces • Printing letters: can't remember the sequence of pencil strokes necessary to form that letter. May write a in an odd way	

Skill	Features	Examples	How to Test in Clinic
Spelling	Difficulty in spelling even simple words that is age appropriate	• Buku, meja, mata, sekolah, etc	Ask child to do simple spelling with 2 syllables first if able to do then proceed to multisyllable words
Directionality	Left-Right confusion Up-Down confusion	• Substitution : b-p or d-q, n-u, and m-w • Confusion about directionality words: First-last, before-after, next-previous, over-under	
Dysgraphia	Poor, nearly illegible handwriting or difficulty in writing on a straight line. Difficulty in differentiating small or big letters. Unusual spatial organization of the page.	• Words may be widely spaced or tightly pushed together. • Margins are often ignored.	Observe school workbook for writing problems.
Copying	Difficulty in copying from blackboard Takes a long time to copy and copied work will have a lot of mistakes	• Tying shoelaces • Printing letters: can't remember the sequence of pencil strokes necessary to form that letter. May write a in an odd way	Observe school workbook which needs copying

Chapter 7: The H.E.A.D.S.S. Assessment

A Psychosocial Interview for Adolescents

Introduction

Adolescence is the developmental phase between childhood and adulthood and is marked by rapid changes in physical, psychosocial, sexual, moral and cognitive growth.

Dr. Cohen refined a system for organizing the developmentally-appropriate psychosocial history that was developed in 1972 by Dr. Harvey Berman.

The approach is known by the acronym **HEADSS** (**H**ome, **E**ducation /employment, peer group **A**ctivities, **D**rugs, **S**exuality, and **S**uicide/depression). It was subsequently expanded to **HEEADSSS** by adding **E**ating and **S**afety.

Preparing for the Interview

Parents, family members, or other adults should not be present during the HEADSS assessment unless the adolescent specifically gives permission, or asks for it.

Starting the interview

1. *Introduction*
   Set the stage by **introducing yourself** to the adolescent and parents. If the parents are present before the interview, **always introduce yourself to the adolescent first.**
2. *Understanding of Confidentiality*
   Ask the adolescent to **explain** their understanding of confidentiality.
3. *Confidentiality Statement*
   After the adolescent has given you his/her views, acknowledge his/her response and add your views accordingly (confidentiality statement), based on the particular situation.

The HEADSS assessment Items are in listed in the following pages

Suggestions for ending interviews with adolescents

- give them an opportunity to express any concerns you have not covered, and ask for feedback about the interview.
- ask if there is any information you can provide on any of the topics you have discussed. Try to provide whatever educational materials young people are interested in.

Item	Examples of Questions
Home	• Who lives at home with you? Where do you live? Do you have your own room? • How many brothers and sisters do you have and what are their ages? • Are your brothers and sisters healthy? • Are your parents healthy? What do your parents do for a living? • How do you get along with your parents, your siblings? • Is there anything you would like to change about your family?
Education	• Which school do you go to? What grade are you in? Any recent changes in schools? • What do you like best and least about school? Favourite subjects? Worst subjects? • What were your most recent grades? Are these the same or different from the past? • How much school did you miss last/this year? Do you skip classes? Have you ever been suspended? • What do you want to do when you finish school? • How do you get along with teachers? How do you get along with your peers? • Inquire about "bullying".
Employment	• Are you in any full time or part time job?
Eating	• What do you like and not like about your body? • Has there been any recent change in your weight? • Have you dieted in the last one year? How? How often? • How much exercise do you get on an average day ?Week? • Do you worry about your weight? How often? • Does it ever seem as though your eating is out of control? • Have you ever made yourself throw-up on purpose to control your weight?

Item	Examples of Questions
Activities	• Are most of your friends from school or somewhere else? Are they the same age as you? • Do you hang out with mainly people of your same sex or a mixed crowd? • Do you have a lot of friends? • Do you see your friends at school and on weekends, too? • Do you do any regular sport or exercise? Hobbies or interests? • How much TV do you watch? What are your favourite shows? • Dave you ever been involved with the police? Do you belong to a group or gang?
Drugs	• When you go out with your friends, do most of the people that you hang out with drink or smoke? Do you? How much and how often? • Have you or your friends ever tried any other drugs? Specifically, what? • Do you regularly use other drugs? How much and how often?
Sexuality	• Have you ever been in a relationship? When? • Have you had sex? Number of partners? Using contraception? • Have you ever been pregnant or had an abortion? • Have you ever been checked for a sexually transmitted infection (STI)? • Knowledge about STIs and prevention? • For females: Ask about menarche, last menstrual period (LMP), and menstrual cycles. Also inquire about breast self examination (BSE) practices. • For males: Ask about testicular self-examination (TSE) practices.

Item	Examples of Questions
Suicide, Depression	• Do you have difficulties to sleep? Has there been any change in your appetite recently? • Do you mix around well others? Do you have hopeless or helpless feelings? • Have you ever attempted suicide?
Safety	• Have you ever been seriously injured? Do you always wear a seatbelt in the car? • Do you use safety equipment for sports and or other physical activities (for example, helmets for biking)? • Is there any violence in your home? Does the violence ever get physical? • Have you ever been physically or sexually abused? • Have you ever been bullied? Is that still a problem? • Have you gotten into physical fights in school or your neighborhood? Are you still getting into fights?

Chapter 8: End of Life Care in Children

Introduction

Paediatric palliative care has been defined as 'an active and total approach to care embracing physical, emotional and spiritual elements. It focuses on quality of life for the child and support for the family and includes management of distressing symptoms, provision of respite and care through death and bereavement'. [1]

Causes of Paediatric Mortality (Malaysian Public Hospitals)

- In paediatric departments at Malaysian public hospitals, 70% of deaths occur in neonates and 30% are in older children. [2]
- Under Five Mortality Study data shows that 76% are hospital deaths; 24% are non hospital deaths.
- A third (33%) of hospital deaths were congenital malformations, deformations and chromosomal abnormalities; 5% had oncology disorders. It is difficult to ascertain the exact percentage who require palliative care in the latter group.

The data suggests that there is plenty of work to be done in paediatric palliative medicine and end of life care. Why is this important?

Impact of the lost of a child

- The care of dying children is different from adults as the dying process of a child affects many individuals with grief over the loss that is more intense, long lasting and complicated.[3] This is because children are generally expected to outlive their parents.
- Parental grief is the most severe form of grief [4]; with an associated increase in morbidity and mortality.[5] It often intensifies in 2nd or 3rd year (when friends and relatives expect them to be 'over it').
- For parents who have lost a child , there is an increased risk of psychiatric hospitalisation. [6] This risk is higher in bereaved mothers than bereaved fathers, the risk is highest in the 1st year following their child's death, and remains elevated for ≥ 5 years.[7]
- Care-related factors may influence parents' psychological outcomes.[8] Among factors that continued to affect parents 4-9 years following their child's death was the memory of the child having had unrelieved pain and experienced a 'difficult moment of death'. Interviews with 449 bereaved parents suggest that the child's physical pain and circumstances at the moment of death contributed to parents' long term distress.[9]

Quality of End of Life Care

Parents associated quality end of life care with physicians.[10]

- Giving clear information about what to expect in the End of Life period
- Communicating with care and sensitivity
- Communicating directly with child where appropriate
- Preparing the parent for circumstances surrounding the child's death

As healthcare providers we have the unique opportunity to contribute towards quality end of life care. A bereavement clinic follow up, or home visit, can be arranged in 6-12 weeks after death.

End of life Care for Paediatric Patients

When the disease trajectory of a patient has reached the final days, and the family or caregivers understand the situation, the following steps can be taken to help the patient and family. Existing medical orders and management strategies should be reviewed with the goal of enhancing comfort and decreasing noxious and invasive interventions.

Aspects of care that should be addressed are

- Discontinue parenteral nutrition. Enteral feeding reduced, discontinued or offered as a comfort measure; breastfeeding may be offered if desired by mother and baby; a lactation referral for breastfeeding mothers to stop milk production.
- Discontinue tests and treatments to minimize noxious or painful procedures.
- Intravenous access maintained for medications to decrease pain, anxiety or seizures. Alternatives to IV access are oral, sublingual or rectal medications.
- Discontinue antibiotics.
- Discontinue cardiac sustaining medications e.g. dopamine, adrenaline.
- Ventilator support: parents must be included in the decision to disconitnue mechanical ventilation support and should be provided with information about the expected sequence of events surrounding disconnection from the ventilator as well as the infant's physical response, including the possibility that the infant may not die immediately. [12]
- Moral and ethical issues e.g. do not resuscitate status; Do not resuscitate (DNR) orders should be explicit and developed collaboratively with the family.
- Pain management; comfort measures e.g. discontinue non essential investigations, observations for pain, agitation, nausea and vomiting; appropriate management to improve the quality of life; give additional morphine for breakthrough pain.
- Communication with care givers; their understanding of what to expect, choice of place where they prefer the child to die; how the rest of the family is coping or understands; patient's desire or wish list ; organ donation.
- Religious and spiritual needs of the parents and family.
- For the child dying in hospital, whether the family wants to take the body home, how will the body be transported; are there any specific religious requirements, and does the family want symbolic memorials (e.g. hand prints, hair lock).
- Transitional care, family support, sibling support, staff support, organ donation, follow up support for family.

Neonatal Palliative Care Plan for the Infant with Lethal Anomalies

"The goal of palliative care is the best quality of life for patients and their families"

The following is a list of lethal congenital anomalies:

- *Genetic*
  Trisomy 13 or 18, triploidy, thanatophoric dwarfism or lethal forms of osteogenesis imperfecta; inborn errors of metabolism that are lethal even with available therapy.
- *Renal* (with oligo/anhydramnios and pulmonary hypoplasia)
  Potter's syndrome, renal agenesis, multicystic or dysplastic kidneys, polycystic kidney disease, renal failure that requires dialysis.
- *Central nervous system*
  Anencephaly, holoprosencephaly, complex, severe meningomyelocele, large encephaloceles, hydranencephaly, congenital severe hydrocephalus with absent or minimal brain growth; neurodegenerative diseases, e.g. spinal muscular atrophy type 1.
- *Cardiac*
  Acardia, Inoperable heart anomalies, hypoplastic left heart syndrome, pentalogy of Cantrell (ectopia cordis).
- *Other structural anomalies*
  Certain cases of giant omphalocoele, severe congenital diaphragmatic hernia with hypoplastic lungs; inoperable conjoined twins.

Some of these conditions may be prenatally diagnosed – thus allowing the paediatric palliative care team to be activated early.

Others may need further evaluation to ensure certainty – in these cases it is advisable to do what is medically necessary to support the baby. The life sustaining medical support can be withdrawn once a definitive diagnosis or prognosis is established.

Neonatal Palliative Care Plan for the Infant with Lethal Anomalies

Comfort measures for babies:

- dry and warm baby, provide warm blankets.
- provide a hat.
- allow mothers to room-in.
- minimize disruptions within medically safe practice for mother
- lower lights if desired.
- allow presence of parents and extended family as much as possible without disruption to work flow in the unit.
- make siblings comfortable; they may wish to write letters or draw for the baby.
- begin bereavement preparation and memory building, if indicated, to include hand and footprints, pictures, videos, locks of hair.
- encourage parent/child bonding and interaction: bathe, dress baby; feeds, diaper change.

Selected medical interventions

- Humidified oxygen (_____ %)
- Nasal cannula oxygen (_____ L/min)
- Suctioning of airway and secretions.
- Morphine sublingual 0.15 mg/kg or IV 0.05 mg/kg, as needed.
- Buccal midazolam or oral clonazepam as needed.
- Artificial hydration or nutrition : _____
- natural hydration or nutrition : _____

Note: Avoid distressing delays in treating symptoms by making medications available in all available concentrations and doses.

Spiritual care

- religious preference: _____
- identified religious leader: _____
- religious ritual desired at or near time of death: _____

In the event of child's death in hospital

- Diagnostic procedures: _____
- Autopsy preference: _____
- Tissue/organ procurement preferences: _____
- Funeral home chosen by family:_____
- Rituals required for body care: _____

Please notify:_____

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Introduction

- Transport of neonates involves **pre-transport intensive care level resuscitation and stabilisation and continuing intra-transport care** to ensure that the infant arrives in a stable state.
- Organized neonatal transport teams bring the **intensive care environment to critically ill infant before and during transport.**
- **Good communication and coordination** between the referring and receiving hospital is essential.
- **There is rarely a need for haste.**
- However, there must be a balance between the benefits of further stabilization versus anticipated clinical complications that may arise due to delay in the transport.

Special Considerations in Neonates
Apnoea
Premature and septic babies are especially prone to apnoea
Bradycardia
Hypoxia causes bradycardia followed by heart block and asystole
Oxygen toxicity to the lungs and retina
especially important in the premature infant
Reversal to fetal circulation (Persistent pulmonary hypertension of the neonate, PPHN)
Precipitating factors: hypoxia, hypercarbia, acidosis and sepsis
Hypothermia
Thermoregulation is less developed, infant has a larger body surface area to mass ratio. If bowels are exposed, heat and fluid loss are compounded by evaporation. The effects of hypothermia are acidosis and subsequent PPHN, impaired immune function and delayed wound healing.
Hypoglycemia
The neonate lacks glycogen stores in liver and fat deposits.

Mode of transport

Careful consideration must be made as to the mode of transport.

- The best mode of transfer is “in utero”, e.g. a mother in premature labour should be managed in a centre with NICU facilities or for an antenatally detected surgical, the mother should be advised to deliver at a centre with paediatric surgical facilities.
- The advantages and disadvantages of road, air (helicopter / commercial airlines) and riverine transport must be considered in each child
- Transport incubators with monitors, ventilators, oxygen and suction equipment are ideal.

Air Transport

Patients can be transported by either commercial airlines with pressurised cabins or by helicopters flying without pressurised cabins at lower altitudes. There are special problems associated with air transport:

- *Changes in altitude* – Reduced atmospheric pressure causes decreased oxygen concentration and expansion of gases. This may be important in infants with pneumothorax, pneumoperitoneum, volvulus and intestinal obstruction. These must be drained before setting off as the gases will expand and cause respiratory distress. Infants requiring oxygen may have increased requirements and become more tachypnoeic at the higher altitude in non-pressurised cabins.
- *Poor lighting* - Can make assessment of child difficult .
- *Noise and Vibration* – May stress the infant and transport team; May also cause interference with the monitors, e.g. pulse oximeters. Use ear muffs if available. It is also impossible to perform any procedures during transport.
- *Limited cabin space* – Limits access to the infant especially in helicopters. Commercial aircraft and helicopters are unable to accommodate transport incubators. The infant is thus held in the arms of a team member.
- *Weather conditions and availability of aircraft* – Speed of transfer may be compromised by unavailability of aircraft/flight or weather conditions. Stress and safety to the infant and team during poor weather conditions needs to be considered.
- *Take off and landing areas* – special areas are required and there will be multiple transfers: hospital – ambulance – helicopter – ambulance - hospital.
- *Finances* – Air transport is costly but essential where time is of essence.

Pre-transport Stabilisation

Transport is a significant stress and the infant may easily deteriorate during the journey. Hypothermia, hypotension and metabolic acidosis has a significant negative impact on the eventual outcome. Procedures are difficult to do during the actual transport. Therefore, pre-transport stabilization is critical.

The principles of initial stabilisation of the neonate

(see tables on following pages)

Airway
Breathing
Circulation, **C**ommunication
Drugs, **D**ocumentation
Environment, **E**quipment
Fluids – electrolytes, glucose
Gastric decompression

The principles of initial stabilisation of the neonate
Airway
Establish a patent airway
Evaluate the need for oxygen, frequent suction (Oesophageal atresia) or an artificial airway (potential splinting of diaphragm).
Security of the airway – The endotracheal tubes (ETT) must be secure to prevent intra-transport dislodgement
Chest X-ray – to check position of the ETT
Breathing
Assess the need for intra-transport ventilation. Does the infant have: • Requirement of FiO2 60% to maintain adequate oxygenation. • ABG – PaCO2 > 60mmHg. • Tachypnoea and expected respiratory fatigue. • Recurrent apnoeic episodes. • Expected increased abdominal/bowel distension during air transport.
If there is a possibility that the infant needs mechanical ventilation during the transfer, it is safer to electively intubate and ventilate before transport. Check the position of the Endotracheal tube before setting off.
In certain conditions it may be preferable not to ventilate, e.g. tracheo-oesophageal fistula with distal obstruction. If in doubt, the receiving surgeon/paediatrician should be consulted. If manual ventilation is to be performed throughout the journey, possible fatigue and the erratic nature of ventilation must be considered.
Circulation
Assess: • Heart rate, Urine output, Current weight compared to birth weight - are good indicators of hydration status of the newborn infant. Also note that: • Blood pressure in infants drops just before the infant decompensates. • Minimum urine output should be 1-2 mls/kg /hr. • The infant can be catheterised or the nappies weighed (1g = 1 ml urine) • Ensure reliable intravenous access (at least 2 cannulae) before transport. • If the infant is dehydrated, the infant must be rehydrated before leaving.

The principles of initial stabilisation of the neonate

Communication

Good communication between referring doctor, transport team and neonatologist / paediatric surgeon aids proper pre-transfer stabilization, coordination, timing of transfer, and preparedness of receiving hospital.

- Inform receiving specialist, emergency department of receiving hospital.
- Provide Name and telephone contact of referring doctor and hospital
- Provide patient details
- Give a clear history, physical findings, provisional diagnosis, investigations
- Detail current management and status of the infant
- Discuss mode of transport, expected departure time, arrival at referral centre
- Decide on destination of the patient (e.g. A&E, NICU, Ward)

Drugs as required

- Antibiotics – needed in most sick neonates
- Analgesia or Sedation – if infant has peritonitis or is intubated
- Inotropes
- Vitamin K
- Sodium bicarbonate

Documentation

- History including antenatal and birth history, physical findings, diagnosis
- Previous and current management
- Previous operative and histopathology notes, if any
- Input/output charts
- Investigation results, X-rays
- Consent – informed and signed by parents for high risk infants and especially if parents are not accompanying child.
- Parents' contact address, telephone numbers, if not accompanying infant.
- 10 mls of Mother's blood for cross match, if she is not accompanying infant.

Environment

Maintain a **Neutral Thermal Environment**

Optimal temperature for the neonate (axilla) – 36.5 ^{0}C– 37.0 ^{0}C.

Prevention of heat loss involves maintaining an optimal ambient temperature as well as covering the exposed surfaces.

- Transport Incubator – would be ideal.
- Wrap limbs of the infant with cotton, metal foil or plastic.
- Do not forget a cotton-lined cap for the head.
- Remove all wet linen as soon as possible.
- Care of exposed membranes. (See section on Abdominal Wall Defects)
- Warm intravenous fluids.
- ELBW placed in polyethylene bags for newborn infants to prevent heat loss by evaporation.

The principles of initial stabilisation of the neonate

Environment (continued)

Special Consideration.
In **Hypoxic Ischaemic Encephalopathy**, *therapeutic hypothermia* may be indicated. Please discuss with receiving neonatal team prior to transfer.

Equipment *(see Table at end of chapter)*

Check all equipment: completeness and function before leaving hospital.

- Monitors- Cardiorespiratory monitor/ Pulse oximeter for transport. If unavailable or affected by vibration, a praecordial stethoscope and a finger on the pulse and perfusion will be adequate.
- Syringe and/or infusion pumps with adequately charged batteries. If unavailable, intravenous fluids prepared into 20 or 50ml syringes can be administered manually during the journey via a long extension tubing connected to the intravenous cannulae.
- Intubation and ventilation equipment; Endotracheal tubes of varying sizes.
- Oxygen tanks – ensure adequacy for the whole journey.
- Suction apparatus , catheters and tubings.
- Anticipated medication and water for dilution and injection.
- Intravenous fluids and tubings. Pre-draw fluids, medication into syringes if required during the journey.

Fluid therapy

Resuscitation Fluid

- Give boluses of 10 - 20 mls/kg over up to 2 hours as per clinical status
- Use Normal Saline or Hartmann's solution.
- If blood loss then use whole blood or pack red cells.

This fluid is also used to correct ongoing measured (e.g. orogastric) or third space losses as required. The perfusion and heart rates are reliable indicators of the hydration.

- If ongoing or anticipated losses in surgical neonates, e.g. gastroschisis, intestinal obstruction, , then use 0.45% Saline + 10% Dextrose
- Watch out for hyponatraemia and hypoglycemia.

Gastric decompression

- An orogastric tube is required in most surgical neonates, especially in intestinal obstruction, congenital diaphragmatic hernia or abdominal wall defects.
- The oral route is preferred as a larger bore tube can be used without compromising nasal passages (neonates are obligatory nasal breathers).
- As an orogastric tube is easily dislodged, check the position regularly.
- 4 hourly aspiration and free flow of gastric contents is recommended.

Immediately before Departure

- Check vital signs and condition of the infant.
- Check and secure all tubes.
- Check the equipment.
- **Re-communicate with receiving doctor about current status and expected time of arrival.**

Intra-transport Care

- **Transport Team.** Ideally, there should be a specialised neonatal transport team. Otherwise, a neonatal-trained doctor with/without a neonatal-trained staff nurse should escort the infant. A minimum of 2 escorts will be required for a ventilated/critically ill infant. The team should be familiar with resuscitation and care of a neonate.
- **Safety of the team must be a priority.** Insurance, life jackets and survival equipment should be available.
- **Monitoring.** Regular monitoring of vital signs, oxygenation and perfusion of the infant should be performed.
- **Fluids.** Intravenous fluids must be given to the ill infant to prevent dehydration and acidosis during the transport. Boluses need to be given as necessary depending on the haemodynamic assessment . If catheterised, the urine output can be monitored. The orogastric tube should be aspirated and kept on free drainage. Losses are replaced as required.
- **Temperature Regulation.** Check temperature intermittently. Wet clothes should be changed especially in the infant with abdominal wall defects. Disposable diapers and one way nappy liners are useful.

Arrival at the Receiving Hospital

- Reassessment of the infant
- Handover to the resident team

Intrahospital Transport

- Use transport incubator if available.
- Ensure all parties concerned are ready before transfer.
- Send team member ahead to commandeer lifts, clear corridors.
- Ensure patient is stable before transport.
- Skilled medical and nursing staff should accompany patient.
- Ensure adequate supply of oxygen.
- Prepare essential equipment and monitors for transport.
- Ensure venous lines are patent, well secured.
- Infusion pumps should have charged batteries. To decrease bulk of equipment, consider cessation of non-essential infusions.

Pre-Departure Checklist	
Equipment	
	Transport incubator (if available)
	Airway and intubation equipment are all available and working (ET tubes of appropriate size, laryngoscope, Magill forceps)
	Batteries with spares
	Manual resuscitation (Ambu) bags, masks of appropriate size
	Suction apparatus
	Oxygen cylinders-full and with a spare
	Oxygen tubing
	Nasal oxygen catheters and masks, including high-flow masks
	Infusion pumps
	Intravenous cannulae of various sizes
	Needles of different sizes
	Syringes and extension tubings
	Suture material
	Adhesive tape, scissors
	Gloves, gauze, swabs (alcohol and dry)
	Stethoscope, thermometer
	Nasogastric tube of different sizes
	Pulse oximeter
	Cardiac monitor if indicated
	Portable Ventilator if indicated
Patient Status	
	Airway is secured and patent (do a post-intubation chest X-ray before departure to make sure ET tube is at correct position.)
	Venous access is adequate and patent (at least 2 IV lines) and fluid is flowing well.
	Patient is safely secured in transport incubator or trolley.
	Vital signs are charted.
	Tubes - all drains (if present) are functioning and secured .

Pre-Departure Checklist *(continued)*	
Medications	
	Intravenous fluids • 0.9% Normal Saline • Hartmann's solution • 5% Albumin in Normal Saline • 0.18% Saline with 10% Dextrose • 0.45% Saline with10% Dextrose • 10% Dextrose water
	Inotropes • Dopamine • Dobutamine • Adrenaline
	Sedative/ Analgesia • Morphine • Midazolam
	Blood product if indicated
	Others • Atropine • Sodium bicarbonate • Sterile water for injection • Normal saline for injection • Antibiotics if indicated
Documentation	
	Patient notes, referral letter
	X-rays
	Consent form
	Vital signs chart
	Input, Output charts
	Maternal blood (for infant less than 6 months)

Introduction

- The *Premature* infant: < 37 weeks gestation
- *Low Birth Weight* (LBW): < 2500 g
- *Very Low Birth Weight* (VLBW): < 1500 g
- *Extremely Low Birth Weight* (ELBW): < 1000 g
- *Small for Gestational Age*: < 10th centile of birth weight for age.

Early and Late Complications in premature infants
Hypothermia
Respiratory distress syndrome, Apnoea
Hypotension, Patent ductus arteriosus
Intraventricular haemorrhage, Periventricular leukomalacia
Gastrointestinal: Paralytic ileus, Necrotizing enterocolitis
Hypoglycaemia, Hyperglycaemia
Neonatal Jaundice
Hypoprothrombinaemia
Fluid and Electrolyte disorders: hyponatraemia, hyperkalemia, metabolic acidosis
Septicaemia
Anaemia
Osteopaenia of prematurity
Retinopathy of prematurity
Chronic lung disease
Neuro-developmental disability
Psychosocial problems

Management

Before and During Labour

- Prewarmed incubator and appropriate equipment for neonatal intensive care should always be kept ready in the labour room or operating theatre.

Adequate Resuscitation

Transfer from Labour Room (LR) to NNU (Neonatal Unit)

- Use prewarmed transport incubator if available. If not the baby must be wiped dry and wrapped in dry linen before transfer. For extremely low birth weight infant, from birth, the infant should be wrapped up to the neck with polyethylene plastic wrap or food plastic bag to prevent evaporative heat loss.

- **If infant's respiration is inadequate, keep the infant intubated with manual bag ventilation with oxygen during the transfer.**
- For those with mild respiratory distress, preferably initiate CPAP in labour room, and if tolerated CPAP during transport. Use a pulse oxymeter where available.

Admission Routine

- Ensure thermoneutral temperature for infant. An incubator or radiant warmer is necessary for more premature and ill infants.
- Ventilation in NICU is often necessary if ventilated during transfer. However, some infants take longer to adapt to extrauterine life and may not require ventilation especially those with no risk factors and given a full course of antenatal steroids. For the larger preterm infants above 1250 grams, review the required ventilation to maintain a satisfactory blood gas and consider extubation if the ventilator requirements are low, patient has good tone and good spontaneous respiration.
- Maintain SaO_2 between 89-92% for ELBW; 90-94% for the larger preterm
- Head circumference (OFC), length measurements, bathing can be omitted.
- Quickly and accurately examine and weigh the infant.
- Assess the gestational age with Dubowitz or Ballard score when stable (see end of this section for score).
- Monitor temp, HR, RR, BP and SaO_2.

Immediate Care for Symptomatic infants

- Investigations are necessary as indicated and include:
  - Blood gases.
  - Blood glucose (dextrostix)
  - Full blood count with differential WBC and IT ratio (if possible)
  - Blood culture.
  - CXR (if respiratory signs and symptoms are present)
- Start on 10% dextrose drip.
- Correct anaemia.
- Correct hypotension (keep mean arterial pressure (MAP) > gestational age (GA) in wks). Ensure hyperventilation is not present (a cause of hypotension). If the baby has good tone and is active, observe first as the BP may rise after first few hours of life towards a MAP approximating GA in weeks.
- Correct hypovolaemia: Give 10 ml/kg of Normal Saline over 20-30 mins, or packed cells if anaemic. Avoid repeat fluid boluses unless there is volume loss.
- Start inotrope infusion if hypotension persists after volume correction.
- Start antibiotics after taking cultures e.g. Penicillin and Gentamycin
- Start IV Aminophylline or caffeine in premature infants <32-34 weeks.
- Maintain SaO_2 at 89-92% and PaO_2 at 50 –70 mmHg.

General Measures for Premature infants

- Monitor vitals signs (colour, temperature, apex beat, respiratory rate). Look for signs of respiratory distress (cyanosis, grunting, tachypnoea, nasal flaring, chest recessions, apnoea). In VLBL and ill infants pulse oximetry and blood pressure monitoring are necessary.
- Check Blood Sugar (see Hypoglycaemia protocol).
- Keep warm in incubator at thermoneutral temperature for age and birth weight. ELBW should preferably have humidified environment at least for the first 3 days.
- Ensure adequate nutrition.
- Provide parental counselling and allow free parental access.
- Infection control: observe strict hand washing practices.
- Immunisation:
  - Hep B vaccine at birth if infant stable and BW is >1.8 kg. Otherwise give before discharge.
  - Ensure BCG vaccine is given on discharge.
  - For long stayers other immunisation should generally follow the schedule according to chronological rather than corrected age.
  - Defer immunisation in the presence of acute illnesses.
- Supplements:
  - At birth: IM Vitamin K (0.5 mg for BW<2.5 kg; 1 mg for BW ≥ 2.5 kg)
  - Once on full feeding, give Infant Multivitamin drops 1 mls OD (continue till fully established weaning diet). For preterm infants, use a formulation with Vit D 400 IU, and Folic acid 1 mg OD.
  - Starting at about 4 weeks of life: Elemental Iron 2-3 mg/kg/day – to be continued for 3-4 months.

ICU care and Criteria for Replacement Transfusion in Neonates

See relevant chapter.

Discharge

- Cranial Ultrasound for premature infants ≤ 32 weeks is recommended at:
  - Within first week of life to look for intraventricular haemorrhage (IVH).
  - Around day 28 to look for periventricular leucomalacia (PVL).
  - As clinically indicated.
- Screening for Retinopathy of Prematurity (ROP) at 4-6 weeks of age is recommended for
  - All infants ≤ 32 weeks gestation at birth or birth weight <1500 g.
  - All preterms < 36 weeks who received oxygen therapy depending on individual risk as assessed by the clinician.
- The infants are discharged once they are well, showing good weight gain, established oral feeding and gestational age of at least 35 weeks.

Prognosis

- Mortality and morbidity are inversely related to gestation and birth weight.
- Complications include retinopathy of prematurity, chronic lung disease, neurodevelopmental delay, growth failure, cerebral palsy, mental retardation, epilepsy, blindness and deafness.

Chapter 11: Enteral Feeding in Neonates

Introduction

- The goal of nutrition is to achieve as near to normal weight gain and growth as possible.
- **Enteral feeding should be introduced as soon as possible.** This means starting in the labour room itself for the well infant.
- **Breast milk is the milk of choice.** All mothers should be encouraged to give breast milk to their newborn babies.
- Normal caloric requirements in: **Term infants: 110 kcal/kg/day**
  Preterm infants : 120 – 140 kcal/kg/day
- Babies who have had a more eventful course need up to 180kcal/kg/day to have adequate weight gain.

Types of milk for Newborn feeding

There are three choices:

- expressed breast milk
- normal infant formula
- preterm infant formula

Breast Milk

Breast milk is preferred as studies have shown that breast fed babies had low risk for necrotising enterocolitis and had better development quotients. However, expressed breast milk (EBM) alone is not adequate for the nutritional needs of the **very preterm infant** as it:

- Has insufficient calories and protein to for **optimal early growth** at 20 kcal/30mls.
- Has insufficient sodium to compensate for high renal sodium losses.
- Has insufficient calcium or phosphate - predisposes to osteopenia of prematurity.
- Is low in vitamins and iron relative to the needs of a preterm infant.

Human Milk Fortifier (HMF)

- It is recommended to add HMF to EBM in babies < 32 wks or < 1500 grams.
- HMF will give extra calories, vitamins, calcium and phosphate.
- HMF should be added to EBM when the baby is feeding at 75 mls/kg/day.
- VLBW infants on exclusive breastmilk may require sodium supplementation until 32-34 weeks corrected age.

Infant Formula

Infant formula should only be given if there is no supply of EBM. There are 2 types of infant formula: Preterm formula and Normal Term Formula.

- Preterm formula : for babies born < 32 weeks or < 1500 grams.
- Normal infant formula : for babies born ≥ 32 weeks or > 1500 grams.

Strategies of administering enteral feeding

Orogastric Route

- Neonates are obligate nose breathers thus nasogastric tubes can obstruct the nasal passage and compromise breathing. Thus the orogastric route is preferable.

Continuous vs. intermittent bolus feeding

- Bolus fed babies tolerate feeds better and gained weight faster. Babies on continuous feeding have been shown to take longer to reach full feeding but there is no difference in days to discharge, somatic growth and incidence of necrotising enterocolitis (NEC).

Cup feeding

- If the baby is able to suckle and mother is not with the baby, cup feeding is preferable to bottle feeding to prevent nipple confusion.

When to start milk?

- As soon as possible for the well term babies
- However, in very preterm infants there may be an increased risk for NEC if feeding is advanced too rapidly, although early feeds with EBM is to be encouraged. Studies suggest that rapid increments in feeds has a higher risk for NEC than the time at which feeding was started.
- **Minimal enteral feeding (MEF)** is recommended in very preterm infants. The principle is to commence very low volume enteral feeds on day 1 - 3 of life (i.e. 5 - 25 mls/kg/day) for both EBM and formula milk. MEF enhances gut DNA synthesis hence promotes gastrointestinal growth. **This approach allows earlier establishment of full enteral feeds and shorter hospital stays, *without any concomitant increase in NEC.***

How much to increase?

- Generally the rate of increment is about 20 to 30 mls/kg/day.
- Well term babies should be given breastfeeding on demand.
- Milk requirements for babies on full enteral feed from birth:

Day 1	60 mls/kg/day
Day 2 – 3	90 mls/kg/day
Day 4 – 6	120 mls/kg/day
Day 7 onwards	150 mls/kg/day

Add 15% if the babies is under phototherapy

- In babies requiring IV fluids at birth: The rate of increment need to be individualized to that baby. Babies should be observed for feeding intolerance (vomit or large aspirate) and observe for any abdominal distention before increasing the feed.

What is the maximum volume?

- Target weight gain should be around 15g/kg/day (range 10-25g/kg/day). Less weight gain than this suggests a need to increase calories especially protein calories.. More weight gain than 30g/kg/day should raise the possibility of fluid overload particularly in babies with chronic lung disease.
- Preterm infants
  - Increase feed accordingly to 180 to 200 mls/kg/day. (This should only be achieved by Day 10 to Day 14 respectively if baby had tolerated feeds well from Day 1)
  - If on EBM, when volume reaches 75 mls/kg/day: add HMF.
- Term infants: allow feeding on demand.

When to stop HMF or Preterm Formula?

- Consider changing preterm to standard formula and stop adding HMF to EBM when babies are breastfeeding on demand or have reached their expected growth curve.
- Preterm with poor weight gain can be given specially formulated post discharge formula for preterm infants. Preterm formula meant for newborn preterm infants should not be given to infants > 2 months post conceptual age in view of potential Vitamin A and D toxicity.

Vitamin and mineral supplementation

- *Vitamins*: a premature infant's daily breast milk/ breast milk substitute intake will not supply the daily vitamin requirement. Multivitamins can be given after day 14 of life when on feeding of 150 ml/s kg/day. Vitamin supplements at 0.5 mls daily to be continued for 3-4 months post discharge.
- *Iron:* Premature infants have reduced intra uterine iron accumulation and can become rapidly depleted of iron when active erythropoiesis resumes. Therefore babies of birth weight < 2000g should receive iron supplements. Iron is given at a dose of 3 mg/kg elemental iron per day.
  - Ferric Ammonium Citrate (400mg/5mls) contains 86 mg/5 mls of elemental iron.
  - Start on day 42, continue until 3-4 months post discharge or until review.
  - Babies who have received multiple blood transfusions may not require as much iron supplementation.

Special Cases

- IUGR babies with reversed end-diastolic flow on antenatal Doppler: Studies have show that these babies are at risk of NEC. Thus feeds should be introduced slowly and initially use only EBM.

Composition of Various Milk

Component		Cow's milk	Standard formula	Mature breastmilk	Preterm formula	Preterm breastmilk
Carbohydrate	g/100ml	4.6	7.5	7.4	8.6	6.4
Fat	g/100ml	3.9	3.6	4.2	4.4	3.1
Protein	g/100ml	3.4	1.5	1.1	2.0	2.7
Casein : Lactalbumin ratio		4:1	2:3	2:3	2:3	2.3
Calories	KCal/100ml	67	67	70	80	74
Sodium	mmol/l	23	6.4	6.4	14	17
Potassium	mmol/l	40	14	15	19	17
Calcium	mg%	124	46	35	77	29
Phosphate	mg%	98	33	15	41	13
Iron	mg%	0.05	0.8	0.08	0.67	

Chapter 12: Total Parenteral Nutrition for Neonates

Introduction

- Total parenteral nutrition (TPN) is the intravenous infusion of all nutrients necessary for metabolic requirements and growth.
- Earlier introduction and more aggressive advancement of TPN is safe and effective, even in the smallest and most immature infants.
- Premature infants tolerate TPN from day 1 of post-natal life.

The goal of TPN is to

- Provide sufficient nutrients to prevent negative energy and nitrogen balance and essential fatty acid deficiency.
- Support normal growth rates without increased significant morbidity.

Indication for TPN

- Birth weight < 1000 gm
- Birth weight 1000-1500 gm and anticipated to be not on significant feeds for 3 or more days.
- Birth weight > 1500 gm and anticipated to be not on significant feeds for 5 or more days.
- Surgical conditions in neonates: necrotizing enterocolitis, gastroschisis, omphalocoele, tracheo-esophageal fistula, intestinal atresia, malrotation, short bowel syndrome, meconium ileus and diaphragmatic hernia.

Components of TPN

The essential components of parenteral nutrition are:

- Fluids
- Carbohydrate
- Protein
- Lipids
- Electrolytes
- Vitamins
- Trace minerals

Goal is to provide 120-130 KCal/kg/day.

- 10% dextrose solution provides 0.34 KCal/ml.
- 10% lipid solution gives 0.9 KCal/ml; 20% lipid solution gives 1.1 KCal/ml.
- Protein/Energy ratio: 3-4 gm/100 KCal is needed to promote protein accretion. A baby given only glucose will lose 1.5 grams body protein/day.

Thus it is important to start TPN within the first 24 hours of life in the smaller preterm infants <1250 grams birth weight.

Fluid

- Fluid is an essential component.
- Usually started at 60-80 ml/kg/day (if newborn), or at whatever stable fluid intake the baby is already receiving.
- Postnatal weight loss of 5 - 15 % per day in the ELBW is acceptable. Volumes are increased over the first 7 days in line with the fluids and electrolytes protocol with the aim to deliver 120-150 ml/kg/day by day 7.

Amino acids

- Amino acids prevents catabolism; prompt introduction via TPN achieves an early positive nitrogen balance.
- Decreases frequency and severity of neonatal hyperglycaemia by stimulating endogenous insulin secretion and stimulates growth by enhancing the secretion of insulin and insulin-like growth factors.
- Protein is usually started at 2g/kg/day of crystalline amino acids and subsequently advanced, by 3rd to 4th postnatal day, to 3.0 g/kg/day of protein in term and by 5th day 3.7 to 4.0 g/kg/day in the extremely low birthweight (ELBW) infants.
- Reduction in dosage may be needed in critically ill, significant hypoxaemia, suspected or proven infection and high dose steroids.
- Adverse effects of excess protein include a rise in urea and ammonia and high levels of potentially toxic amino acids such as phenylalanine.

Glucose

- There is a relatively high energy requirement in the ELBW and continuous source of glucose is required for energy metabolism.
- In the ELBW minimum supply rate is 6 mg/kg/min to maintain adequate energy for cerebral function; additional 2-3 mg/kg/min (25 cal/kg) of glucose per gram of protein intake is needed to support protein deposition. Maximum rate: 12 - 13 mg/kg/min (lower if lipid also administered) but in practice often limited by hyperglycaemia.
- Hyperglycaemia occurs in 20-80% of ELBW as a result of decreased insulin secretion and insulin resistance, presumably due to to glucagon, catecholamine and cortisol release.
- Hyperglycaemia in the ELBW managed by decreasing glucose administration, administering intravenous amino acids and/or infusing exogenous insulin.
- Glucose administration is started at 6 mg/kg/min, advancing to 12-14 mg/kg/min and adjusted to maintain euglycaemia.
- If hyperglycaemia develops glucose infusion is decreased. Insulin infusion is generally not required if sufficient proteins are given and less glucose is administered during the often transient hyperglycaemia. Insulin infusion, if used for persistent hyperglycaemia with glycosuria, should be titrated to reduce risk of hypoglycaemia.

Lipid

- Lipids prevent essential fatty acid deficiency, provide energy substrates and improve delivery of fat soluble vitamins.
- LBW infants may have immature mechanisms for fat metabolism. Some conditions inhibit lipid clearance e.g. infection, stress, malnutrition.
- Start lipids at 1g/kg/day, at the same time as amino acids are started, to prevent essential fatty acid deficiency; gradually increase dose up to 3 g/kg/day (3.5g/kg/day in ELBW infants). Use smaller doses in sepsis, compromised pulmonary function, hyperbilirubinaemia.
- It is infused continuously over as much of the 24 hour period as practical.
- Avoid concentrations >2g/kg/day if infant has jaundice requiring phototherapy.

- Preparation of 20% emulsion is better than 10% as 20% solutions require less fluid volume and provide a lower phospholipid-to-triglyceride ratio. 10% solution interferes with triglyceride (TG) clearance leading to higher TG and cholesterol values. Use of preparations containing lipids from fish oil and olive oil may reduce the risk of cholestasis with prolonged TPN.
- Heparin at 0.5 to 1 units/mL of TPN solutions (max 137 units/day) can facilitate lipoprotein lipase activity to stabilize serum triglyceride values.
- Lipid clearance monitored by plasma triglyceride (TG) levels. (Max TG concentration ranges from 150 mg/dl to 200 mg/dl).
- Exogenous lipid may interfere with respiratory function. Suggested mechanisms include impaired gas exchange from pulmonary intravascular accumulation or impaired lymph drainage resulting in oedema. Lipid may also aggravate pulmonary hypertension in susceptible individuals.
- The syringe and infusion line should be shielded from ambient light.

Electrolytes

- The usual sodium need of the newborn infant is 2-3 mEq /kg/day in term and 3-5 mEq/kg/day in preterm infants after the initial diuretic phase(first 3-5 days). Sodium supplementation should be started after initial diuresis(usually after the 48 hours), when serum sodium starts to drop or at least at 5-6% weight loss. Failure to provide sufficient sodium may be associated with poor weight gain.
- Potassium needs are 2-3 mEq/kg/day in both term and preterm infants. Start when urine output improves after the first 2-3 days of life.

Minerals, Calcium (Ca), Phosphorus (P) And Magnesium

- In extrauterine conditions, intrauterine calcium accretion rates is difficult to attain. Considering long-term appropriate mineralization and the fact that calcium retention between 60 to 90 mg/kg/d suppresses the risk of fracture and clinical symptoms of osteopenia, a mineral intake between 100 to 160 mg/kg/d of highly-absorbed calcium and 60 to 75 mg/kg/d of phosphorus could be recommended.
- Monitoring for osteopaenia of prematurity is important especially if prolonged PN.
- A normal magnesium level is a prerequisite for a normal calcaemia. In well balanced formulations, however, magnesium level does not give rise to major problems.

Trace Elements

- Indicated if PN is administered for ≥ 1 week. Commercial preparations are available.

Vitamins

- Both fat and water soluble vitamins are essential. It should be added to the fat infusion instead of amino-acid glucose mixture to reduce loss during administration.

Administration

- TPN should be delivered where possible through central lines.
- Peripheral lines are only suitable for TPN ≤ 3 days duration and dextrose concentration ≤ 12.5%.
- Peripheral lines are also limited by osmolality (<600 mOsm/L) to prevent phlebitis.
- Percutaneous central line: confirm catheter tip position on X-ray prior to use.
- Ensure strict aseptic technique in preparation and administration of TPN.
- Avoid breakage of the central line through which the TPN is infused, though compatible drugs may be administered if necessary.

Caution

- **Hyperkalaemia.** Potassium is rarely required in first 3 days unless serum potassium < 4 mmol/l. Caution in renal impairment.
- **Hypocalcaemia.** May result from inadvertent use of excess phosphate. Corrects with reduction of phosphate.
- **Never add bicarbonate**, as it precipitates calcium carbonate
- **Never add extra calcium to the burette**, as it will precipitate phosphates.

Complications

Delivery

The line delivering the TPN may be compromised by;

- Sepsis - minimized by maintaining strict sterility during and after insertion
- Malposition. X-ray mandatory before infusion commences
- Thrombophlebitis - with peripheral lines; requires close observation of infusion sites.
- Extravasation into the soft tissue, with resulting tissue necrosis.

Metabolic complications

- Hyperglycaemia
- Hyperlipidaemia
- Cholestasis

Monitoring

Before starting an infant on parenteral nutrition, investigation required:

- Full blood count, haematocrit
- Renal profile
- Random blood sugar/dextrostix
- Liver function test, serum bilirubin

While on TPN, monitoring required :

Laboratory

- Full blood count, plasma sodium, potassium and creatinine.
  Daily for 1 week then 2-3 times a week until stable.
- Plasma calcium, magnesium, phosphate. Twice/wk until stable then weekly.
- Triglyceride levels. After dose changes then weekly.
- Liver function test: If long term TPN (> 2 weeks duration).

Clinical

- Blood sugar / dextrostix, 4-6 hrly first 3 days, twice a day once stable.
- Daily weight
- Meticulous care of the catheter site and monitoring for infection.

Prevention of hospital acquired infection

- Aseptic precautions during preparation of PN.
- Use of laminar air flow.
- No compromise on disposables.
- Trained staff.
- No reuse of the PN solutions.
- No interruption of the venous line carrying PN.
- Use of bacterial filter in AA-glucose line.

Checklist for Review of an infant in Intensive Care

- *Age of infant*

  If <72 hours state in exact hours of age. Beyond this, state in completed days.

- *Weight*

  Note birth weight and current weight. Initial drop in weight is expected for newborn infants, term up to 10% BW in first 3-5 days, preterms up to 15% in first 1 week. Less weight loss is expected with use of humidified incubators. Abnormal weight gain/loss in the first days implies suboptimal fluid therapy.

- *General condition.*

  Note: ill, unstable, handles poorly e.g. desaturates on handling, stable, active, responsive to handling, improving, or good tone.

- *Cardiopulmonary system*
  - Check for:
    - (i) Adequacy of the blood pressure – an estimate of normal BP for preterm infant is that of the gestational age at birth. However, there is no necessity to treat immediately if the baby is stable, responsive and of good tone. Review after one hour to check for improvement in the BP.
    - (ii) Signs of poor perfusion (with poor peripheral pulses, rapid pulse, poor capillary refilling and cold peripheries) – but these signs have not been found to be very reliable for hypotension. Hypothermia can also be a cause of poor perfusion.
    - (iii) Examine for presence of a patent ductus arteriosus (PDA) in preterm infants.
  - If BP is low and there has been a history of volume loss at birth or risk of sepsis, infuse a fluid bolus of 10 ml/kg of Normal Saline. This may be repeated if there is no improvement. After the 2nd dose of normal saline 5% albumin can be considered for volume expansion in severely hypotensive infants. Caution: Risk of IVH in repeat doses especially in ELBW or ill preterm infants – check first for volume loss or reduced vascular volume due to extravascular fluid losses such as in sepsis or intestinal obstruction. Albumin is required only in severe sepsis such as in NEC.
  - Inotropic agents like adrenaline, dobutamine or dopamine may be needed. Consider hydrocortisone in ill preterm infant at birth if no response to volume or inotropes. Check that there is no iatrogenic hyperventilation as a cause of hypotension.

- *Fluids and Electrolytes*
  - Is the volume and type of fluid given to the child appropriate?
  - Empiric fluid therapy for newborns:

    0-24 hours : 60 ml/kg/day
    24-48 hours : 90 ml/kg/day
    48-72 hours : 120 ml/kg/day
    > 72 hours : 150 ml/kg/day
  - Slower rates of increment for preterm infants, i.e. of 20 mls/kg/day. More increments may be needed if evidence of dehydration, i.e. excessive weight loss and hypernatraemia >145 mmol/l.

- Generally, 10% Dextrose fluid is given on the 1st day; and Sodium and Potassium added on the second/third day.
- Total parenteral nutrition should be started as soon as possible for the infant below 1000 -1250 grams, preferably within the first day of life. Larger preterm infants may be started on parenteral nutrition if expected to not able to be fed enterally for 5 or more days (for eg congenital diaphragmatic hernia, omphalocele/gastrochiasis) .
- Empirically:
  - A preterm infant need 4-5 mmol/kg/day of sodium and 2-3 mmol/kg/day of potassium, after the first few days of life.
  - ELBW infants are prone for hyperkalaemia and adjustments should be made based on serum electrolytes.
  - Term infants need 2-3 mmol/kg/day of both sodium and potassium.
- Fluid and electrolyte therapy are influenced by underlying illness, complications: make neccesary adjustments based on these conditions, intake/output, weight, blood urea and electrolytes (BUSE).
  - Monitor BUSE; correct any imbalances after considering underlying cause.
  - Ensure the urine output is > 1 ml/kg/hr after the first day of life.5

- *Infection*
  - Is there a possibility of infection? Is the child on antibiotics?
  - Fungal infection should be considered if the infant is a preterm infant who has been on several courses of broad spectrum antibiotics and on total parenteral nutrition. Consider discontinuing antibiotics if the blood culture is negative and the patient improved “too quickly” after starting antibiotics, probably responding to other measures to improve dehydration or inadequate ventilatory support.
- *Feeding*
  - Enteral feeds can be given via oro or nasogastric tube. Orogastric tube is preferred in small infants as it prevents blockage of airway.
  - Encourage expressed breast milk to be started within the first 2 days of life.
- *Temperature Control*
  - ***Use of cling wrap/plastic wrap with cap for preterm infants soon after delivery will help maintain normothermia.***
  - Under the radiant warmer, covering the open area of open hoods with cling wrap and increasing water content with a humidifier will help in temperature control and fluid regulation of the ELBW infant. Transfer to a closed humidified incubator as soon as possible. Ensure thermoneutral environment. Humidity is essential to maintain temperature in the extremely preterm infants and reduce excessive weight loss in the first few weeks of life. Below is a humidification guide for preterm infants.

26 weeks gestation and below	27-30 weeks gestation
80% Humidity for at least 4 wks (may require higher % to cope with increased sodium)	80% Humidity for at least 2 wks
The infant's skin should have keratinised fully at the end of this period, therefore the humidity can be gradually reduced, as tolerated, to maintain a satisfactory axillary temperature	
Reduce the humidity gradually according to the infant's temperature (70% - 60% - 50%) until 20-30% is reached before discontinuing.	

- *Skin care*
  - A vital component of care especially for the premature infants.
  - Avoid direct plastering onto skin and excessive punctures for blood taking and setting up of infusion lines.
  - Meticulous attention must be given to avoid extravasation of infusion fluid and medication which can lead to phlebitis, ulceration and septicaemia.
  - Group your blood taking together to minimise skin breaks/ breakage of indwelling arterial lines.
  - Observe limbs and buttocks prior to insertion of umbilical lines and at regular intervals afterwards to look for areas of pallor or poor perfusion due to vascular spasm.
- *Central nervous system*
  - Check fontanelle tension and size, condition of sutures i.e. overriding or separated, half-hourly to hourly head circumference monitoring (when indicated e.g. infants with subaponeurotic haemorrhage).
  - Sensorium, tone, movement, responses to procedures e.g. oral suctioning, and presence or absence of seizure should be noted.
- *Ventilation*
  - Check if ventilation is adequate. Is the child maintaining the optimum blood gases? Can we start weaning the child off the ventilator?
  - Overventilation is to be avoided as it may worsen the infant's condition.

Endotracheal tube (ETT) Care

Infant weight	ETT size	ETT position (oral)[1,2,3]
<1000g	2.5	
1000g-2000g	3.0	7 cm
2000g-3000g	3.5	8 cm
>3000g	3.5-4.0	9 cm

Footnotes:
1. oral ETT "tip-to-lip" distance; 2. or weight in kg + 6
3. for nasal ETT: add 2 cm respectively; For 1 kg and below - add 1.5 cm
Note:
The length of ETT beyond the lips should be checked as to be just sufficient for comfortable anchoring and not excessively long so as to reduce dead space.

Suction of ETT

- Performed only when needed, as it may be associated with desaturation and bradycardia.
- During suctioning, the FiO_2 may need to be increased as guided by the SaO_2 monitor during suctioning.
- Remember to reduce to the level needed to keep SaO_2 89-95%.

Umbilical Arterial Catheter (UAC) and Umbilical Venous Catheter (UVC) care

- Do not use iodine to prepare the skin for UAC or UVC placement .
- Do not allow the solution to pool under the infant as it may burn the skin particularly in the very low birthweight infant.
- Change any damp or wet linen under the infant immediately following the procedure.
- Sterile procedure is required for inserting the lines.
- For other than the time of insertion, wash hands or use alcohol rub before taking blood from the UAC.
- Ensure aseptic procedure when handling the hub or 3 way tap of the line to withdraw blood.
- **UAC position**
  - Length to be inserted measured from the abdominal wall is:
    3 X BW(kg) + 9 cm.
  - Confirm with X-ray to ensure that the tip of the UAC is between T6 to T9 or between L3-L4.
  - Reposition promptly if the tip is not in the appropriate position. The high positioning of the UAC is associated with less thrombotic events than the low position.
  - The UAC is kept patent with a heparin infusion (1U/ml) at 1 ml/hr and can be attached to the intra-arterial blood pressure monitor.

- **UVC position**
  - Length to be inserted measured from the abdominal wall is:
    ½ UAC length as calculated above +1 cm.
  - This usually put the tip above the diaphragm. However, this formula is not as accurate as using catheter length based on shoulder umbilical length. (Check available graph) . The shoulder umbilical length is taken as a perpendicular line dropped from the shoulder to the level of the umbilicus.
  - Placement of the catheter tip in the portal circulation or liver is not acceptable and catheter should be removed and a new catheter inserted under sterile technique. In an emergency situation, it can be withdrawn to the level of the umbilical vein to be used for a short period until an alternative venous access is available.
- Remember to add on the length of the umbilical stump for calculating the length of both UAC and UVC.

Ventilation

- Initial ventilator setting (in most situations):

Total Flow:	8 - 10 litres/min
Peak Inspiratory Pressure (PIP):	20-25 mmHg (lower in ELBW infants and those ventilated for non-pulmonary cause, i. e normal lungs)
Positive End Expiratory Pressure (PEEP):	4 - 5 mmHg
Inspiration Time:	0.3- 0.35 sec
Ventilation rate:	40- 60 / min
FiO_2:	60 to 70% or based on initial oxygen requirement on manual positive pressure ventilation.
When Volume Guarantee is used:	VG = 4 – 6 ml/kg

- The ventilator setting is then adjusted according to the clinical picture, pulse oximetry reading and ABG which is usually done within the 1st hour.
- Note:
  - The I:E ratio should not be inverted (i.e. > 1) unless requested specifically by a specialist.
  - Tailor the ventilation settings to the baby's ABG.

Keep:	pH	7.25 - 7.40
	PaO_2	50 - 70 mmHg for premature infants 60 - 80 mm Hg for term infants
	$PaCO_2$	40 - 60 (NB. the trend is not to 'chase' the $PaCO_2$ by increasing ventilator settings unless there is respiratory acidosis).
	SaO_2	89 - 92% for preterm infants.

- Changing of ventilator settings:
  - To produce an increase in PaO_2 either: -
    - Increase FiO_2 concentration.
    - Increase PEEP.
    - Increase PIP (increases minute volume).
    - *rarely*, increase I/E ratio (prolong inspiration).
  - To produce a decrease in $PaCO_2$ either: -
    - Increase Rate (increases minute volume).
    - Decrease I/E ratio (prolong expiration).
    - Increase PEEP in worsening lung disease.
    - Decrease PEEP in recovery phase.
    - Increase Targeted Volume in Ventilation
  - Do the opposite to decrease PaO_2 or to increase $PaCO_2$.
- Minute volume = tidal volume (volume per breath) x rate per minute. Minute volume should be about 0.1 – 0.3L/kg/min
- With volume-limited settings, minute volume can be calculated (use tidal volume = 4-6 ml/kg).
- With pressure-limited mode - increasing peak inspiratory pressure results in increased minute volume.

Sedation and Ventilation

- Avoid the use of paralysing agents as far as possible. Paralysis has been shown to result in poorer lung function, more dependent oedema and longer duration of ventilation.
- Use morphine infusion as an analgesia and sedative, if required.

Consider the following if the child *deteriorates* on ventilation:
Worsening of primary condition, e.g. RDS or congenital pneumonia
Mechanical problems : • ETT Dislodged or Obstructed • ETT displaced/ too deep • Pneumothorax • Ventilator tubes disconnected • Ventilator malfunction
Overventilation of the lung
Pneumonia such as nosocomial pneumonia
PDA or heart failure
Persistent pulmonary hypertension

High Frequency Oscillatory Ventilation (HFOV)

Indications

- When conventional ventilation fails HFOV should be considered. This is to be discussed with the specialist.
- Care should be taken not to overinflate the lungs as this can lead to further deterioration of child's condition – i.e. worsening saturation, hypotension.

Practical management

- Switching from conventional ventilation to HFOV :
  - Initial setting
    - Leave FiO_2 level at the same level as that on conventional ventilation.
    - MAP - For RDS, start at 2 cmH_2O above the MAP of conventional ventilation. In cases of air trapping, start MAP at same level as conventional ventilation and adjust according to CXR and blood gas.
    - Amplitude - 50-100% (Draeger Babylog 8000), Amplitude in Sensor Medic (start with twice MAP value); adjust until chest and upper abdomen vibrates but not whole abdomen.
    - Frequency - 10Hz.
    - Tidal volume - about 2 to 2.5ml/kg. (VThf on Draeger Babylog 8000)
  - Continuation of HFOV
    - Chest X-ray after 30-60 minutes, aim for lung expansion to 8-9th rib level
    - Hypoxia - increase MAP or FiO_2 if not already on FiO_2 of 1.0
    - Hyperoxia - reduce FiO_2 or decrease MAP (MAP to be reduced first if CXR shows diaphragm to be below T9 or flattened or hyperinflated lung fields)
    - Hypercapnia
      - Increase amplitude
      - Decrease frequency
      - Increase MAP (if persistent or lung volume still poor)

- Hypocapnia
  - Decrease amplitude.
  - Increase frequency.
  - Decrease MAP.
- Overinflation
  - Reduce MAP.
  - Consider discontinuing HFOV.

- Weaning
  - Reduce FiO2 to 0.3-0.5.
  - Reduce MAP by 1 to 2 mbar per hour until 8 to 9 mbar.
  - Reduce amplitude.
  - Extubate to head box/CPAP or change to conventional ventilation.

Guidelines for packed red blood cells (PRBCs) transfusion thresholds for preterm neonates.

< 28 days age, *and*	• Assisted ventilation with FiO_2 > 0.3: Hb 12.0 gm/dL or PCV < 40% • Assisted ventilation with FiO_2 < 0.3: Hb 11.0 g/dL or PCV < 35% • CPAP: Hb < 10 gm/dL or PCV <30%
> 28 days age, *and*	• Assisted ventilation: Hb < 10 gm/dL or PCV < 30% • CPAP: Hb < 8 gm/dL or PCV < 25%
Any age, breathing spontaneously, *and*	• On FiO_2 > 0.21: Hb < 8 gm/dL or PCV < 25%* • On Room Air: Hb < 7 gm/dL or PCV < 20%* **Consider transfusion if there is poor weight gain or metabolic acidosis as an indication of tissue hypoxia.*

Guidelines for platelet transfusions in non-immune thrombocytopaenic neonates

Platelet count < 30,000/mm^3	• Transfuse all neonates, even if asymptomatic
Platelet count 30,000/mm^3 - 50,000/mm^3	Consider transfusion in • Sick or bleeding newborns • Newborns <1000 gm or < 1 week of age • Previous major bleeding tendency (IVH grade 3-4) • Newborns with concurrent coagulopathy • Requiring surgery or exchange transfusion
Platelet count 30,000/mm^3 - 99,000/mm^3	• Transfuse only if actively bleeding.

Thromboembolism (TE) is being increasingly recognised as a significant complication of intravascular catheters in sick newborn infants. Many factors contribute to neonatal catheter-related thrombosis, including the small caliber of the vessel, endothelial damage, abnormal blood flow, design and site, duration of catheterisation and composition of the infusate, in addition to the increased risk of thrombus formation in sick infants. Sepsis and catheters are the most common correlates of thrombosis in the NICU.

Definitions

- *Vascular spasm* – transient, reversible arterial constriction, triggered by intravascular catheterisation or arterial blood sampling. The clinical effects of vascular spasm usually last < 4 hours from onset, but the condition may be difficult to differentiate from the more serious TE. The diagnosis of vascular spasm may thus only be made retrospectively on documenting the transient nature of the ischaemic changes and complete recovery of the circulation.
- *Thrombosis* – complete or partial occlusion of arteries or veins by blood clot(s).

Assessment

Clinical diagnosis

- Peripheral arterial thrombosis/ vasospasm – pallor or cyanosis of the involved extremity with diminished pulses or perfusion.
- Central venous line (CVL) associated venous thrombosis – CVL malfunction, superior vena cava (SVC) syndrome, chylothorax, swelling and livid discolouration of extremity.
- Aortic or renal artery thrombosis – systemic hypertension, haematuria, oliguria.

Diagnostic imaging

- Contrast angiography is the "gold standard", but difficult to perform in critically ill neonates and requires infusion of radiocontrast material that may be hypertonic or cause undesired increase in vascular volume.
- Doppler ultrasonagraphy – portable, non-invasive, useful to monitor progress over time. False positive and false negative results may occur, as compared to contrast angiography.

Additional diagnostic tests

- Obtain detailed family history in all cases of unusual or extensive TE.
- In the absence of predisposing risk factors for TE, consider investigations for thrombophilic disorders: anticardiolipin, antithrombin III, protein C, protein S deficiency.

Management of vascular spasm

- Immediate measures to be taken:
  - Lie the affected limb in horizontal position
  - If only one limb is affected, warm (using towel) opposite unaffected leg to induce reflex vasodilatation of the affected leg.
  - Maintain neutral thermal environment for the affected extremity, i.e. keep heat lamps away from the area.

- Inform the paediatrician immediately.
- Consider removing the catheter. If mild cyanosis of the fingers or toes is noted after insertion of an arterial catheter, but peripheral pulses are still palpable, a trial of reflex vasodilatation with close observation is reasonable – check continuously to see that the cyanosis is improving within a few minutes. **A white or "blanched" appearing extremity is an indication for immediate removal of the catheter.**
- Other risk factors contributing to thrombosis includes dehydration, sepsis, and polycythaemia. These factors may need to be corrected immediately.
- Maintain good circulatory volume. If there is no immediate improvement with removal of catheter, try volume expansion 10 mls/kg of normal saline.
- Topical nitroglycerine – using patch or topical 2% ointment at a dose of 4 mm/kg body weight, applied as a thin film over the affected body area; may be repeated after 8 hours. Monitor for hypotension and be prepared to treat immediately.
- If the limb ischaemia persists for > 1 hour without any improvement, refer urgently to the radiologist if available. An urgent doppler ultrasound scan is needed to ascertain whether the limb ischaemia is caused by vasospasm or thrombosis.

Management of catheter-related thromboembolism

- Management of vascular TE may involve one or more of the following: supportive care, anticoagulation, fibrinolytic therapy, surgical intervention.
- Treatment for neonates is highly individualised and is determined by the extent of thrombosis and the degree to which diminished perfusion to the affected extremity or organ affects function.
- Consultation with a paediatric haematologist, orthopaedic or vascular surgeon may be required.
- Initial management
  - As for vascular spasm for peripheral arterial ischaemia
  - Removal of catheter as soon as blanching is seen.
  - Supportive care – correct volume depletion, electrolyte abnormalities, anaemia and thrombocytopaenia; treat sepsis.
- Anticoagulant/ thrombolytic therapy
  - The risk of serious bleeding associated with antithrombotic therapy in neonates must be balanced against the possibility of organ or limb loss or death without appropriate treatment. Adequate randomised trials to guide therapy in neonates are not available.
  - Contraindications:
    - Major surgery within the preceding 10 days.
    - Major bleeding: intracranial, pulmonary, gastrointestinal.
    - Pre-existing cerebral ischaemic lesions.
    - Known history of heparin induced thrombocytopaenia or allergy to heparin.

- Relative contraindications –
  - Platelet count < 50,000 x 10^9 /L.
  - Fibrinogen levels < 100mg/dL.
  - Severe coagulation factor deficiency.
  - Hypertension.

  Note: anticoagulation/thrombolytic therapy can be given after correcting these abnormalities.
- Precautions:
  - no arterial punctures
  - no subcutaneous or IM injections
  - no urinary catheterisations
  - avoid aspirin or other antiplatelet drugs
  - monitor serial ultrasound scans for intracranial haemorrhage

- Anticoagulants
  - Standard or unfractionated heparin (UFH)
    - Anticoagulant, antithrombotic effect limited by low plasma levels of antithrombin in neonates. For dosage see Table below.
    - Optimal duration is unknown but therapy is usually given for 5-14 days
    - Monitor thrombus closely during and following treatment.
    - Anti- Factor X activity (if available) aimed at 0.3-0.7 U/mL.
    - Baseline aPTT is prolonged at birth and aPTT prolongation is not linear with heparin anticoagulant effect. Therefore Anti factor X activity more effectively monitors UFH use in newborn infants.

Stage	Description	aPTT (s)	Bolus (U/kg)	Hold (min)	% Rate change	Repeat aPTT
I	Loading dose		75 IV over 10 mins			
II	Initial maintainence dose		28/h			
III	Adjustment	<50	50	0	+10	4 hrs
		50-59	0	0	+10	4 hrs
		60-85	0	0	0	next day
		85-95	0	0	-10	4 hrs
		96-120	0	30	-10	4 hrs
		>120	0	60	-15	4 hrs

- *A loading dose of 75 U/kg over 10 min followed by a maintainence dose of 28 units/kg (infants < 1 year) is recommended.*
- *An aPTT should be checked 4h after the heparin loading dose and 4h after every change in infusion rate. Once aPTT is in therapeutic range, a complete blood count and aPTT should be checked daily or as clinically indicated.*
- *For preterm infants, loading dose is 50U/kg.*
- *Initial maintenance dose for newborn < 28 weeks: 15U/kg/hr, newborn 28-36 weeks : 20U/kg/hr*

Abbreviations: aPTT, activated partial thromboplastin time.