

Paediatric Survival guide for pharmacists in Critical Care

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OBJECTIVES OF SESSION

- *To provide a survival guide for pharmacists with paediatric patients on ccs:-*
- Medicines Reconciliation
- Prescription monitoring :-including wt estimation
- Fluids volumes (mls/Kg)
- Differences in Physiological parameters BP & HR &UE's –adults & children
- Common conditions
- IV compatibility & infusions & access
- Renal failure & Haemofiltration
- Calculating Sodium Contents
- Minimising fluid volume

Medicines reconciliation

- NICE / NPSA 2007 - Specifically excludes <16yrs
- Continue as normal treat as for adults.
- Evidence:-**Chi Huynh et al showed med recon important in paediatric population.**
- **Results:**
- 1004 medication regimens were included from the 244 patients across 4sites.
- 588 of the 1004 (59%) medicines, had discrepancies between the PAM & Drug Chart; of these 36% (n = 209) were unintentional & included for clinically assessment. 189 drug discrepancies 30% were classified as class 1, 47% were class 2 and 23% were class 3 discrepancies

Prescription monitoring

- Role of ITU pharmacist is to ensure all prescriptions are monitored ,safe & effectively
- Fluids prescriptions in neonates & paediatrics
- Infusion Calculations & use of PICU spreadsheet – Kids infusions
- Awareness of diagnosis & disease conditions- as may have to modify Rx
- Need to look at Paediatric U&Es & Haematology
- Need to ensure can administer drugs thru' lines /routes available
- Tdm is this required ?

Estimating weight

- **Gold standard :- APLS formula $wt = 2 \times (age + 4)$**
- But evidence suggests:-
- Luscombe M D, "Kids aren't like what they used to be": a study of paediatric patient's weights and their relationship to current weight estimation formulae. *British Journal of Anaesthesia* 2005; 95(4): 578
 - **Weight = $2x(age+5)$**
- Whilst not as accurate on average as the other formula tried, it is:
 - 1) More accurate than $Weight = 2x(age+4)$
 - 2) Likely to avoid drug over-dosage
 - 3) Simple to calculate

BNFc –wt & ht

Prescribing for children: weight, height, and gender

The table below shows the **mean values** for weight, height, and gender by age; these values have been derived from the UK-WHO growth charts 2009 and UK1990 standard centile charts, by extrapolating the 50th centile, and may be used to calculate doses in the absence of measurements. However, an individual's weight and height might vary considerably from the values in the table and it is important to ensure that the value chosen is appropriate. In most cases the actual measurement should be obtained as soon as possible and the dose re-calculated.

Age	Weight (kg)	Height (cm)
Full-term neonate	3.5	51
1 month	4.3	55
2 months	5.4	58
3 months	6.1	61
4 months	6.7	63
6 months	7.6	67
1 year	9	75
3 years	14	96
5 years	18	109
7 years	23	122
10 years	32	138
12 years	39	149
14 year old boy	49	163
14 year old girl	50	159
Adult male	68	176
Adult female	58	154

Body surface area and wt <40kg

BODY SURFACE AREA IN CHILDREN

Body-weight under 40kg

Body-weight (kg)	Surface area (m ²)	Body-weight (kg)	Surface area (m ²)
1	0.10	17	0.71
1.5	0.13	18	0.74
2	0.16	19	0.77
2.5	0.19	20	0.79
3	0.21	21	0.82
3.5	0.24	22	0.85
4	0.26	23	0.87
4.5	0.28	24	0.90
5	0.30	25	0.92
5.5	0.32	26	0.95
6	0.34	27	0.97
6.5	0.36	28	1.0
7	0.38	29	1.0
7.5	0.40	30	1.1
8	0.42	31	1.1
8.5	0.44	32	1.1
9	0.46	33	1.1
9.5	0.47	34	1.1
10	0.49	35	1.2
11	0.53	36	1.2
12	0.56	37	1.2
13	0.59	38	1.2
14	0.62	39	1.3
15	0.65	40	1.3
16	0.68		

Values are calculated using the Boyd equation

Note Height is not required to estimate body surface area using these tables

Body wt S.A > 40kg

BODY SURFACE AREA IN CHILDREN

Body-weight over 40kg

Body-weight (kg)	Surface area (m ²)	Body-weight (kg)	Surface area (m ²)
41	1.3	66	1.8
42	1.3	67	1.8
43	1.3	68	1.8
44	1.4	69	1.8
45	1.4	70	1.9
46	1.4	71	1.9
47	1.4	72	1.9
48	1.4	73	1.9
49	1.5	74	1.9
50	1.5	75	1.9
51	1.5	76	2.0
52	1.5	77	2.0
53	1.5	78	2.0
54	1.6	79	2.0
55	1.6	80	2.0
56	1.6	81	2.0
57	1.6	82	2.1
58	1.6	83	2.1
59	1.7	84	2.1
60	1.7	85	2.1
61	1.7	86	2.1
62	1.7	87	2.1
63	1.7	88	2.2
64	1.7	89	2.2
65	1.8	90	2.2

Values are calculated using the Boyd equation

Note Height is not required to estimate body surface area using these tables

WETFLAG acronym

- Yes, the EPALS course uses the simple acronym **W E T F I A G** for children over the age of 1 year and up to 10 years old. This equates to:
- **W** Weight $(\text{Age} + 4) \times 2$ (kg)
E Energy/electricity $4 \times \text{weight (kg)} = \text{Joules}$
T Tube (endotracheal) $\text{Age}/4 \text{ plus } 4 = \text{ID mm (uncuffed tubes)}$
FI Fluids (bolus) $20 \times \text{weight (kg)} = \text{mL of isotonic fluid (caution in some cases)}$
A Adrenaline $10 \text{ mcg kg}^{-1} \text{ 1:10000 solution} = 0.1 \text{ mL kg}^{-1}$
G Glucose 2 mL kg^{-1} (10% Dextrose)

Example

For a 2 year old child:

$$\mathbf{W} = (2 + 4) \times 2 = 12 \text{ kg}$$

$$\mathbf{E} = 12 \times 4 = 48 \text{ J}$$

$$\mathbf{T} = 2/4 + 4 = 4.5 \text{ mm ID tracheal tube uncuffed}$$

$$\mathbf{FI} = 20 \text{ mL} \times 12 \text{ kg} = 240 \text{ mL } 0.9\% \text{ saline}$$

$$\mathbf{A} = 10 \text{ micrograms} \times 12 \text{ kg} = 120 \text{ micrograms } 1:10,000 = 1.2 \text{ mL}$$

$$\mathbf{G} = 2 \text{ mL} \times 12 \text{ kg} = 24 \text{ mL } 10\% \text{ Dextrose}$$

- Whilst this is not evidence based, it provides a simple, easy to remember framework in a stressful situation reducing the risk or error.
- *June 2016*
- Resus Council 2016

BAPM standards document

BRITISH ASSOCIATION OF PERINATAL MEDICINE

SERVICE STANDARDS FOR HOSPITALS
PROVIDING NEONATAL CARE
(3rd edition)



Neonatal physiology

Brief information about neonatal fluid prescribing Physiology at birth

Neonates have expanded extracellular fluid (ECF) compartment, with premature babies having ECF of 85% of Body wt & term babies 75% (compared to adults with approx 60%)

A physiological diuresis (driven largely by Atrial Natriuretic Peptide) causes the ECF compartment to contract during the first days after birth, resulting in a negative Na /H₂O balance during this time.

Fluids should be restricted during this period, & too liberal fluid regimes have been shown to cause increased incidence of PDA, Necrotising enterocolitis, & worse overall mortality in premature infants.

Reference :Kearns GL *et al.* Developmental pharmacology – drug disposition, action and therapy in infants and children. NEJM 2003; 349: 1157-67

Things to consider before prescribing to neonates

- Body composition for drug distribution
- Total body water and fat changes with age

	Preterm	Term	3 months	adults
TBW	85%	75%	75%	60%
ECF	50%	40%	30%	20%
Body fat	3%	12%	15%	18%

Reduced renal function

GRF	Birth	2-3 days
Preterm	0.7-0.8 mls/min	2-3 mls/min
Term	2-4 mls/min	8-20 mls/min

GFR takes 3-5 months to attain adult values

Risk of nephrotoxicity from gentamicin

This why fluid balance is critical in neonates

Prescribing for neonates

- IV- fluid requirements, 60,90,120 and 150ml/kg
- IA lines
- Multiple infusions / check with MDT/ formulary
- Small volumes should be given slowly
- Long half life so can be given OD or BD some levels are required
- Drugs are formulated for adults may need further dilution
- Stop drugs asap
- References:Esphergan 2003

IV Fluid considerations in neonates

- **Prematurity** – prem babies have increased fluid requirements, as high insensible losses result of their thin, immature skin allows significant evaporative (heat) losses. Humidication in an incubator is very important to minimise losses.
- **Hypoxic ischaemic injury** - babies can need fluid restriction as a result of acute renal impairment or raised ADH levels. Can become hypocalcaemic early.
- **Hypernatraemia/hyponatraemia** - plasma Na should be monitored at least daily, & up to 2-3 times daily in extremely preterm babies. Good guide to hydration status, where hypernatraemia (> 145 mmol/L) = dehydration and hyponatraemia (< 135 mmol/L) = water excess.
- **Urine output** - should be monitored carefully, aiming for > 1 ml/kg/hr.

Electrolytes replacement -Neonates

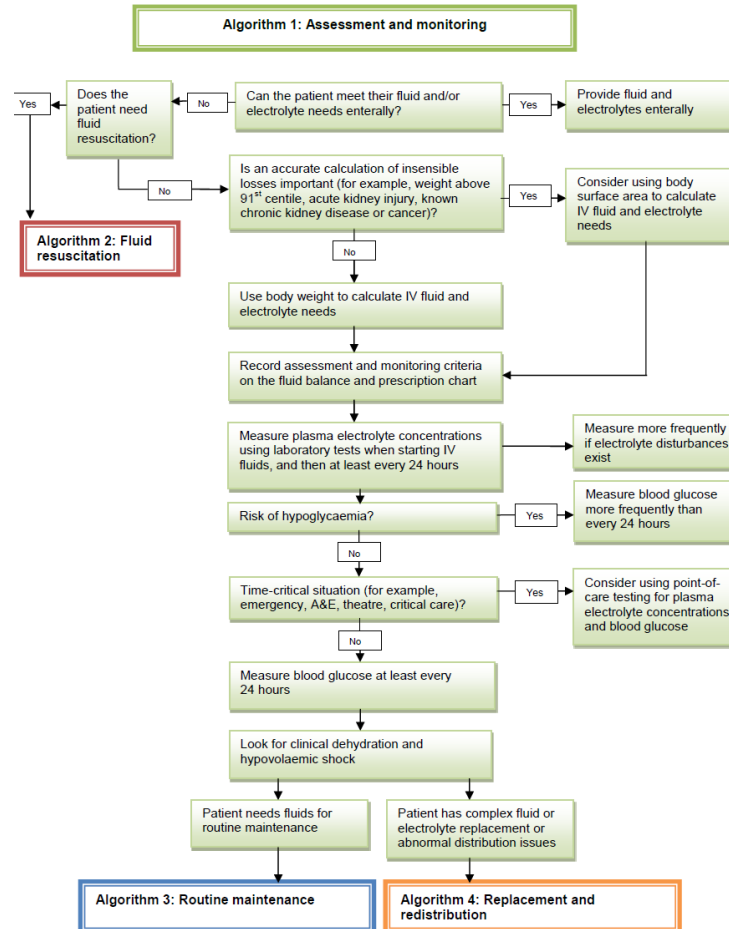
	Sodium	Potassium	Calcium
<i>Electrolyte requirements (mmol/kg/day)</i>			
< 30 weeks	4 - 8	2 - 4	1.5
30-36 weeks	4	2	0.5 - 1.5
Term	2 - 3	2	0.5

Paediatric fluid volumes

- **Less than 10kg** = 100 ml/kg/day or 4ml/kg/hour
- **10-20kg** 1000ml plus 50ml/kg/day for each kg over 10kg
- or 40ml/hour plus 2ml/kg/hour for each kg >10kg
- **over 20kg**= 1500ml plus 20ml/kg/day for each kg >20kg or 60ml/hour plus 1ml/kg/hour for each kg over 20kg
- **Up to a maximum of 2500 ml/day in males and 2000ml/day in females**

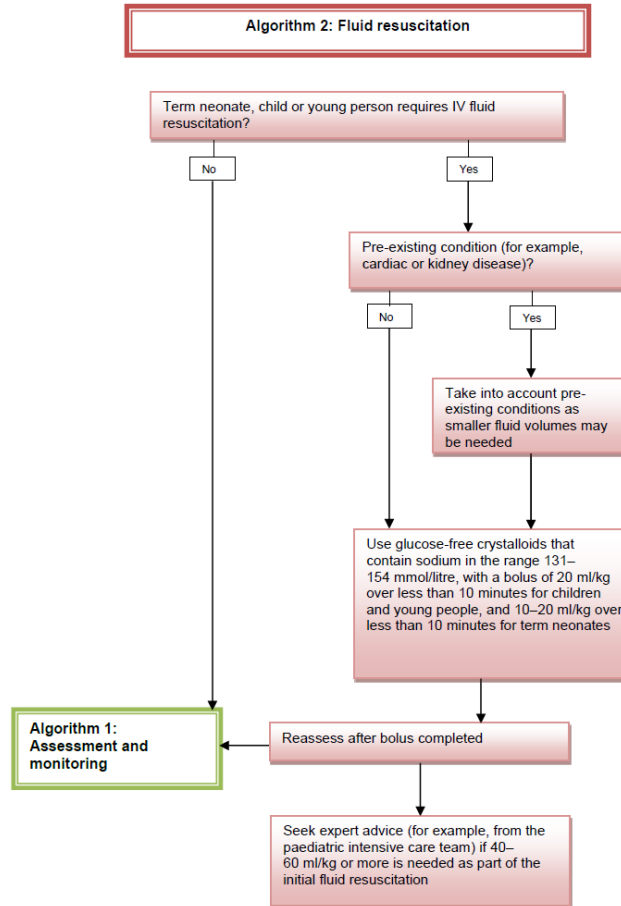
NICE fluid requirements in children

Algorithms for IV fluid therapy in children and young people in hospital

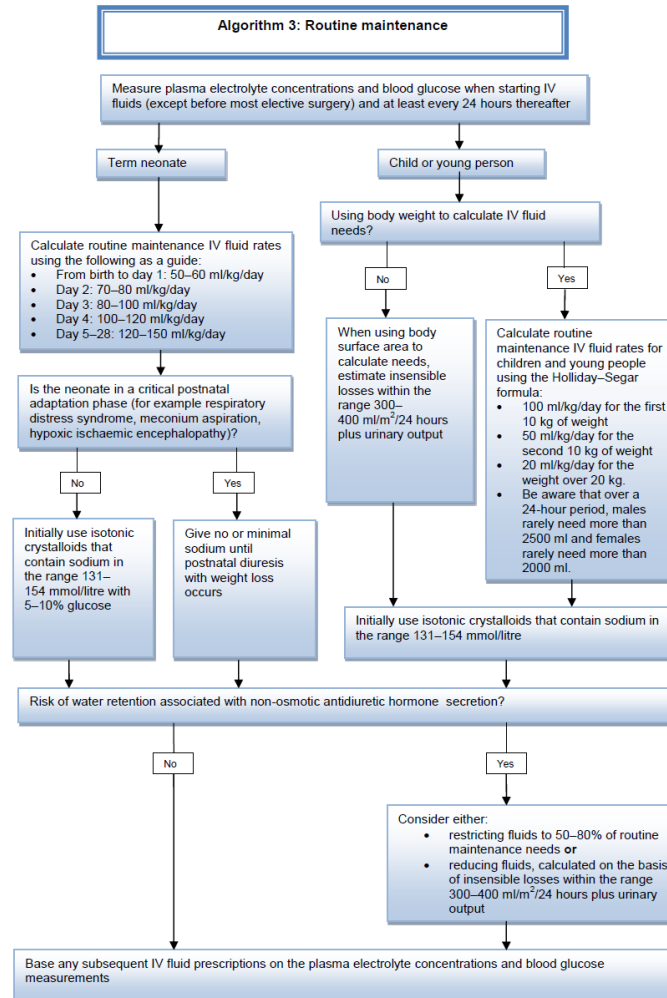


NICE Fluid requirement 2

Algorithms for IV fluid therapy in children and young people in hospital



Fluids requirement –maintenance



Fluid requirements-replacement & re-distribution

Algorithms for IV fluid therapy in children and young people in hospital

Algorithm 4: Replacement and redistribution

Adjust the IV fluid prescription to account for existing fluid and/or electrolyte deficits or excesses, ongoing losses or abnormal distribution

Consider isotonic crystalloids that contain sodium in the range 131–154 mmol/litre for redistribution.

Need to replace ongoing losses?

No

Yes

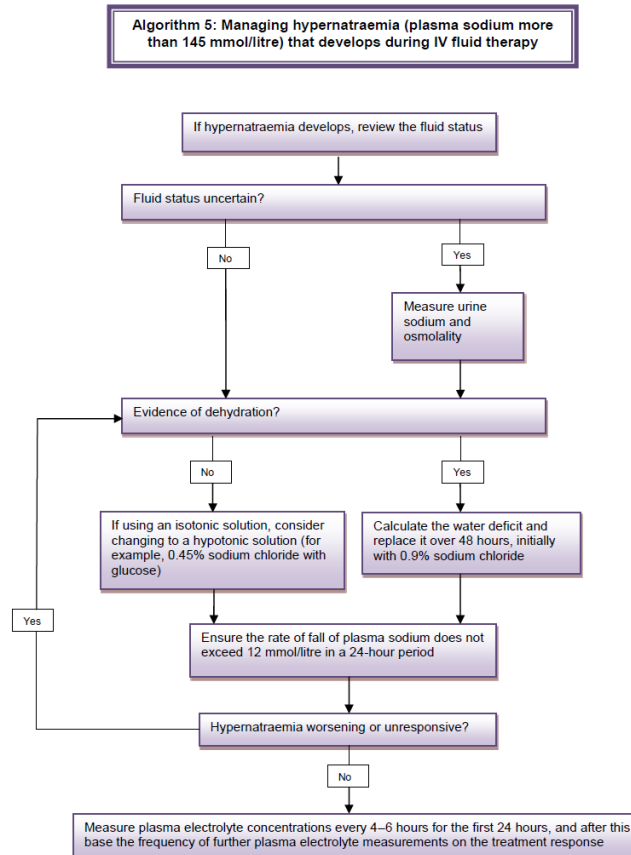
Use 0.9% sodium chloride containing potassium to replace ongoing losses

Base subsequent fluid composition on plasma electrolyte concentrations and blood glucose measurements



Managing hypernatraemia $\text{Na} > 145 \text{ mmol/l}$

Algorithms for IV fluid therapy in children and young people in hospital



Algorithms for IV fluid therapy in children and young people in hospital

Algorithm 6: Managing hyponatraemia (plasma sodium less than 135 mmol/litre) that develops during IV fluid therapy

Be aware that the following symptoms are associated with acute hyponatraemia:

- Headache.
- Nausea and vomiting.
- Confusion and disorientation.
- Irritability.
- Lethargy.
- Reduced consciousness.
- Convulsions.
- Coma.
- Apnoea.

Hyponatraemia symptoms?

No

If a child is prescribed a hypotonic fluid, change to an isotonic fluid (for example, 0.9% sodium chloride)

If hypervolaemic or at risk of hypervolaemia, restrict maintenance IV fluids by either:

- restricting maintenance fluids to 50–80% of routine maintenance needs **or**

Yes

Seek immediate expert advice (for example, from the paediatric intensive care team)

Consider a bolus of 2 ml/kg (maximum 100 ml) of 2.7% sodium chloride over 10–15 minutes

Symptoms still present after the initial bolus?

No

Yes

Paediatric IV fluids

- **What you need to know**
- Careful assessment & monitoring of wt, fluid balance, & fluid status essential for IV fluid therapy in children, as is the correct choice of fluid, to avoid serious complications including death & neurological injury
- To reduce anxiety & improve compliance with blood tests, explain their importance to children who understand & for carers; consider distraction techniques & comfort measures in younger children and use topical local anaesthetics before taking blood
- Isotonic crystalloids with a Na⁺ content of 131-154 mmol/L are appropriate for initial maintenance requirements
- In children receiving IV fluids, symptoms such as N & Vomiting, lethargy, confusion, and irritability may indicate hyponatraemia.
- Medical emergency requiring immediate expert advice & treatment

KIDS website for guidelines infusion

<https://kids.bwc.nhs.uk/healthcare-professionals-2/clinical-guidelines/>

Bronchiolitis	BSPED DKA Calculator	British Inherited Metabolic Disease group	Calcium Gluconate
Button battery ingestion	Drug infusions guide	PICS standards	Tranexamic Acid monograph
Diabetic Ketoacidosis (DKA)	Pre-intubation checklist	PICS UK website	Vasopressin
Difficult airway guideline	Neurosurgical emergency	RCPCH - High Dependency Care	
Fluid and electrolyte therapy	Emergency tracheostomy teaching slides (NTSP)	OPENPediatrics - World Share Practice Forums	
Hyperammonaemia/ Metabolic emergencies	Emergency tracheostomy SOP	Massive haemorrhage (BCH)	NTS guidelines
Major Trauma (BCH)	ETT strapping (oral) technique		PDA drive through SOP
Severe Sepsis & Septic Shock	Endotracheal intubation guideline		PDA drive through proforma
Status epilepticus			Neonatal network-guidelines 2015-17
SVT			

What patients might you see ?

Reason for admission to hospital	PICU hospitals N= 7053 n (%)	Non-PICU hospitals N= 472 n (%)	p-value ^c
Principal diagnosis			
Respiratory illnesses	2012 (28.5)	121 (25.6)	0.18
Acute infections	1341 (19.0)	48 (10.2)	<0.001
Asthma	348 (4.9)	56 (11.9)	<0.001
Congenital anomalies	1599 (22.7)	10 (2.1)	<0.001
Neurological disorders	597 (8.5)	30 (6.4)	0.11
Injury and external cause	501 (7.1)	137 (29.0)	<0.001
Neoplasms	534 (7.6)	5 (1.1)	<0.001
Endocrine/metabolic diseases	197 (2.8)	77 (16.3)	<0.001
Circulatory system disorders	267 (3.8)	18 (3.8)	0.98
Infections (except respiratory)	255 (3.6)	11 (2.3)	0.14
Musculoskeletal disorders	243 (3.5)	5 (1.7)	0.005
Appendicitis	41 (0.6)	6 (1.3)	0.07
Complications of medical care	152 (2.2)	^a (0.9)	0.05
Other miscellaneous	655 (9.3)	48 (10.2)	0.52
Chronic disease conditions ^b			


Diebele et al. BMC Health Services Research (2018) 18:264

<https://doi.org/10.1186/s12913-018-3041-x>

KIDS infusion calculator

- <https://kids.bwc.nhs.uk/healthcare-professionals-2/drug-calculator/>

Sample of drug dose calculator



KIDS Clinical Guideline - Drug dose calculator

All drugs to be given by intravenous route unless otherwise stated. It is the responsibility of the clinician to ensure drugs are used appropriately according to the clinical situation

Weight (kg):	Name:	
10		

Weight checked by: Name..... Signed..... Prescriber: Name..... Signed.....

Single drug doses:

Induction agents for intubation	Dose
Ketamine (2 mg/kg)	20mg
Thiopentone (2-4 mg/kg)	20 - 40mg
Fentanyl (1-5 micrograms/kg)	10 - 50micrograms
Propofol (2-5 mg/kg)	20 - 50mg

Muscle relaxants for intubation

Suxamethonium (Weight <10kg: 2mg/kg)	-
Suxamethonium (Weight >=10kg: 1mg/kg)	10mg
Rocuronium (1mg/kg)	10mg
Vecuronium (0.1mg/kg)	1 mg

Emergency drugs for cardiac arrest

Adrenaline 1:10,000 (0.1ml/kg)	1ml
Atropine (20micrograms/kg)	200micrograms
Adenosine (0.1 - 0.5 mg/kg)	1 - 5mg
Amiodarone (5mg/kg)	50mg
Calcium gluconate 10% (0.5ml/kg)	5ml
Sodium Bicarbonate 8.4% (1ml/kg)	10ml

Anticonvulsants and drugs for raised ICP

Lorazepam (0.1mg/kg)	1mg
Phenytoin (20mg/kg - over 20 mins)	200mg
Phenobarbitone (20mg/kg)	200mg
Paraldehyde 50%:Olive oil 50% (0.8ml/kg)	8ml PR
Mannitol dose (0.25 - 0.5 g/kg)	2.5 - 5.0grams
Mannitol volume Peripheral: 10% solution	25 - 50 ml
Mannitol volume Central: 20% solution	13 - 25 ml
3% saline (3ml/kg)	30ml

Drug doses for infusion:

Sedation	Amount	Diluent - see key*	Total Volume	Rate	Dose
Morphine	10mg	D5/D10/NS	50ml	0.5 - 2 ml/hr	10-40micrograms/kg/hr
Midazolam	30mg	D5/D10/D5/NS	50ml	0.5 - 3 ml/hr	0.5-3 micrograms/kg/min

Paralysis

Rocuronium	Neat solution 100mg in 10ml		20ml	0.6 - 1 ml/hr	0.6 - 1mg/kg/hr
Vecuronium	60mg	D5/D10/NS	50ml	0.5 - 2ml/hr	1 - 4micrograms/kg/min

Vasoactive drugs

Dopamine	Peripheral 80mg	D5/D10/NS	50ml	1.9 - 7.5ml/hr	5 - 20micrograms/kg/min
	Central 150mg	D5/D10/NS	50ml	1 - 4 ml/hr	5 - 20micrograms/kg/min
Dobutamine	Peripheral 80mg	D5/D10/NS	50ml	1.9 - 7.5ml/hr	5 - 20micrograms/kg/min
	Central 150mg	D5/D10/NS	50ml	1 - 4 ml/hr	5 - 20micrograms/kg/min
Adrenaline	Central 3mg	D5/D10/NS	50ml	0.1 - 10 ml/hr	0.01 - 1micrograms/kg/min

NB - when making up Adrenaline infusion, we recommend using 1:1000 concentration

Noradrenaline	Central 3mg	D5/DS	50ml	0.1 - 10 ml/hr	0.01 - 1micrograms/kg/min
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Ductal patency

Alprostadil (E1)	50micrograms	D5/D10/NS	50ml	3.0 - 12.0 ml/hr	5 - 20nanograms/kg/min
Dinoprostone (E2)	50micrograms	D5/D10/NS	50ml	3.0 - 12.0 ml/hr	5 - 20nanograms/kg/min

Asthma drugs

Salbutamol	For Salbutamol bolus dose please refer to BNFC				
	Infusion Peripheral 10mg	D5/NS	50ml	3.0 - 6.0 ml/hr	1 - 2micrograms/kg/min
	Infusion Central 25mg	D5/NS	50ml	1.2 - 2.4 ml/hr	1 - 2micrograms/kg/min

Aminophylline Loading dose: 50mg over 20 minutes; use 500mg/500ml concentration as per infusion

	500 mg	D5	500ml	10 ml/hr	1mg/kg/hr
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if patient is aged greater than 12 years please refer to BNFC for aminophylline dosing

Magnesium sulphate 50%	0.8 ml	D5/NS	20 ml	60 ml/hr	400 mg over 20 mins
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DKA drugs

Insulin	25.0units	D5/D10/NS	50ml	2 ml/hr	0.1units/kg/h
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*Diluent key: D5 = 5% glucose D10 = 10% glucose NS = 0.9% saline D5 = 0.45% saline and 5% glucose

KIDS guidelines on IV fluids



KIDS clinical guideline: Fluid and electrolyte therapy

Principles of management:

Fluid therapy comprises 3 main elements:

1. Restoring deficits (e.g. volume resuscitation / dehydration correction)
2. Maintenance therapy (i.e. routine replacement of physiological losses)
3. Replacement of non-physiological losses (e.g. diarrhoea)

1. Restoring deficits:

Volume resuscitation:

- use isotonic fluid e.g. of 0.9% Sodium Chloride, Hartmann's, Plasmalyte 148
- Use aliquots of 20 ml/kg of crystalloids (exceptions: trauma, DKA, neurosurgical emergencies - see separate guidance)
- be aware of
 - fluid overload
 - raised intracranial pressure
 - congestive cardiac failure
- Call KIDS if requiring > 40-60ml/kg volume - may need inotropes

Correcting dehydration:

- Replace estimated deficit in addition to maintenance replacement.
- Correct dehydration over 48 hrs.
- Use isotonic fluid as default fluid.

2. Maintenance fluid (excluding neonates):

First 10kg	100ml/kg/day	4ml/kg/hour
Second 10kg	50ml/kg/day	2ml/kg/hour
Every further kg	20ml/kg/day	1ml/kg/hour

Maximum 2400ml/day in males and 2000ml/day in females

Rules of thumb:

- In most cases, maintenance fluid should be restricted to 60-80% of calculated requirement.
- Use [0.9% sodium chloride+glucose 5%(potassium chloride 20mmol/1000ml)] as first choice maintenance IV fluid
- Isotonic crystalloids can be used alternatively
- Glucose content: 5% in infants and small children, 10% in neonates
- Monitor glucose and electrolyte levels daily
- Adjust potassium content as needed
- Daily weights should be performed and recorded where possible.

3. Replacement of losses:

- Anticipate, measure (if possible) and replace non-physiological losses such as diarrhoea, vomiting, large diuresis, burns-related fluid loss.
- Use 0.9% Sodium chloride +/- potassium chloride 10mmol/ 500ml depending on nature of losses.
- Keep an accurate fluid balance chart.

Electrolyte emergencies

Hyperkalaemia ($[K^+] > 5.5\text{mmol/l}$):

Monitor ECG (long PR interval or tall T waves).

Ensure external potassium delivery (ie. maintenance) stopped

Emergency Management (Discuss with KIDS team):

- Salbutamol nebulised (2.5mg for <10kg, 5 mg for > 10Kg)
- Calcium Gluconate 10% , 0.5-1ml/kg over 5-10 min
 - Use 5-fold dilution for peripheral us. [See BCH monograph](#)
- Sodium Bicarbonate 8.4% 1-2mmol/kg over 20 min
 - Use 4-fold dilution (i.e. 2.1%) for peripheral use
- Insulin and Glucose: Infuse 0.1Units/kg Actrapid with 1g/kg of Glucose (10ml/kg of 10% Glucose) over 10 minutes. Monitor Blood glucose for hypoglycaemia. [See BCH monograph](#)
- Salbutamol IV 4 micrograms / kg over 10 min
- Forced Saline diuresis – Furosemide 1mg/kg i.v.
- Calcium resonium 125-250 mg/kg orally or rectally

Symptomatic hyponatraemia: $[Na^+] < 125\text{ mmol/L}$ with CNS symptoms (seizures, coma or respiratory depression).

Emergency management (discuss with KIDS team):

- Give 3% Sodium chloride: 3 ml/kg over 10-15 minutes
- Measure plasma sodium at end of bolus, repeat bolus if necessary
- If still seizing, consider IV anticonvulsants and intubation and give further 2ml/kg 3% sodium chloride over 10-15 minutes.
- Aim to raise plasma sodium by no more than 0.5 mmol/L/hour, measure sodium at least hourly initially.
- Review therapy when symptoms resolve, or when $[Na^+] > 125\text{ mmol/L}$

Commonly disease conditions

- Dka – **BSPED & Local /kids calculator**
- Sepsis – **NICE Quality standard [QS161] Published date: September 2017**
- Respiratory tract infection-**local**
- Status epilepticus-**NICE Epilepsy in children and young people Quality standard [QS27] Published date: February 2013**
- Asthma www.brit-thoracic.org.uk/document-library/clinical-information/asthma/btssign-asthma-guideline-quick-reference-guide-2016/
- Trauma & NAI

Question 1

A two year (12kg) child needs IV fluids based on the table above:-

- a) Calculate fluid requirement for 24 hours assuming no other problems ?
- Using Kids calculator
 - 0-10kg $100\text{mls/kg} \times 10 = 1000\text{ml}$
 - 10-12 $50\text{mls/kg} \times 2 = 100\text{ml}$
 - Total = 1100ml per 24 hrs

Calculate Infusion rate of IV fluid

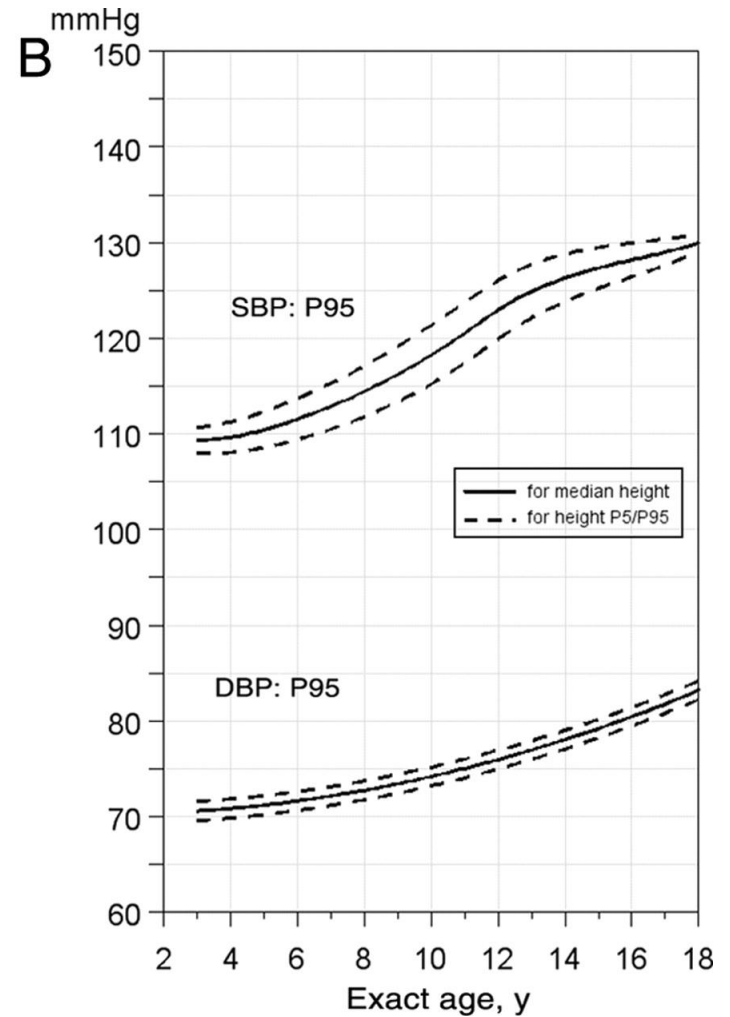
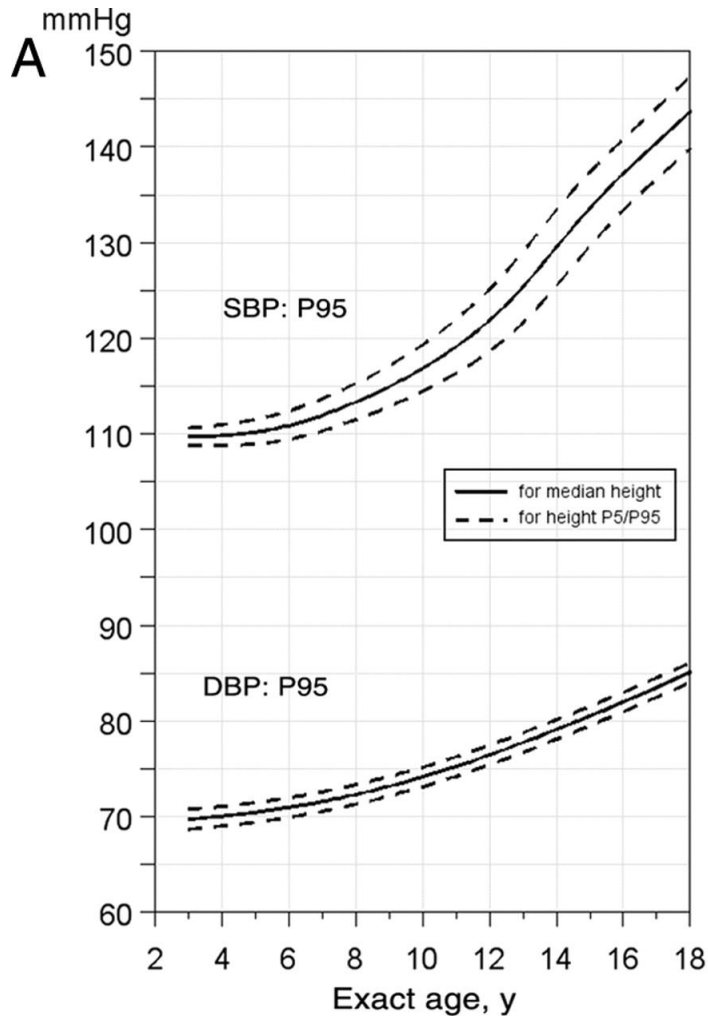
- a) $1100\text{mls}/24 = 45.8\text{ml/hr}$

Physiological targets

What else differs in children ? (I)

Age	BP (sys)(mmHg)	HR	RR
<1	70-90	110-160	30-40
1-2	80-95	100-150	25-35
2-5	80-100	95-140	25-30
5-12	90-110	80-120	20-25
>12	100-120	60-100	15-20

MAP and children age



What UEs differ in children

	term	pre-term
Base Excess mmol/l	-5 to +5*	-3 to +3*
Creatinine $\mu\text{mol/l}$	76 –156	37 –113
Calcium mmol/l	1.9 – 2.7	2.1 –2.7
Glucose mmol/l	2.6 – 5.5	2 – 5.5
Lactate mmol/l	0.5 – 2.2	0.5 – 2.2
Mag mmol/l	0.62 – 1.2	0.7-1.0
Phosp mmol/l	2.0 – 3.0 *	1.7 –2.6**
Potas mmol/l	3.5 – 6.0*	3.5 – 6.0**
Sodium mmol/l	135 – 146	135 -146
Urea mmol/l	2.0 – 5.0	3.4 – 6.7

IV access & compatibility and access for infusions

- Commonest problem is access
- Polypharmacy due to multipathology
- Sedation, analgesia, inotropes and antibiotics
- Practical considerations:-
- What can be given peripherally & centrally
- Use of Medusa & minimum volume guide
- Issues such as osmolality & pH

Infusions practical issues (I)

PICU- infusion table- Calculations

Experience of compatibilities

- Inotropes

3 of the following

Adrenaline, Noradrenaline, Dopamine,
Dobutamine & Milrinone

Sedation

Morphine + Midazolam + Rocuronium

Anecdotal experience

Infusion practical issues (2)

TPN – again some limited information on

- Heparin & y site but low concentrations
- Dopamine & y site
- Dobutamine & y site
- Vancomycin & y site

General rule discourage but have done

Remember you can monitor the outcome

Network bags for neonates !!

Infusions practical issues (3)

Access

- Have you got a central line ?
- Is it a triple or quad lumen ?
- What peripheral canula
- Use of CVP line
- Problems in neonates and prems – UAC /UVC ?

Other problems

- Problem of Sodium loads
- Problems of hyperglycaemia
- Problems with PN

Renal failure

What is renal failure & how do you measure RF ?

a) Adults-cockcroft gault $1.23^{**} \times 140 - \text{age} \times \text{wt} / \text{srCr}$ or 1.04^{**} for female (Can not use)

b) Children > 1yr (Schwarz eqn) $41.3 \times \text{Height}(\text{metres}) / \text{Sr Cr}$ (Sr Cr =mg/dl)

For reference, age-specific normal ranges for GFR are provided here. Standard CKD staging (e.g. for medication dose adjustments) is as above.

GFR, mL/min/1.73 m²	CKD stage	Severity
≥90	1	Normal
60-89	2	Mild
45-59	3a	Mild-moderate
30-44	3b	Moderate-severe
15-29	4	Severe
<15	5	End-stage

Question 2

- A 3 month baby is anuric & the weight is 5kg and Cr=120 ,length = 65cm

Calculate approximate gfr =20ml/min ckd stage 4

This baby is on aciclovir IV 10mg/kg 8 HRLY for encephalitis – please comment ?

Renal replacement therapies (RRT)

PD-oldest form peritoneal dialysis use of Peritoneum as semi-permeable membrane –works well in paed uses 1.36% & 3.86% p.d solutions

CVVH-haemofiltration –ultrafiltration & blood pump sieving effect approx GFR=10-20ml/min

CAHD-haemodialysis most efficient 20% of r.f

Dialysis fluid introduced counter current-diffusion & ultrafiltration

CAVHD combination of CVVH & CAHD

RRT (2)

What is the impact of RRT for patient ?

- Remove fluid & solute
- Impact on drug clearance
- Dose adjustment
- TDM
- Sources of information MFC & renal handbook
- Drugs in renal impairment & spc
- BNF appendix

Respiratory Support

- Why is ventilation so important ?
- What are the different modes of ventilation-CMV,SIMV,CPAP & BIPAP & HFO –works in neonates
- What are the implications for p'cists
- What electrolytes do you monitor ?
- Why do you need sedation ?

Sedation & analgesia

- ***Morphine***
- ***Remifentanil***
- ***Alfentanil***
- ***Fentanyl***
- ***Clonidine***
- ***Midazolam***

Liver disease

- Monitor LFTs:-Bilirubin,enzymes,alk phos,gamma GT,Albumin ,coagulation
- Issues care with sedative drugs
- Drug clearance reduced
- Support clotting & GI bleeds / varices
- Low sodium load
- Low protein load

Nutrition -PN

- Line infection
- Metabolic complications:-
- Fluid overload or dehydration
- Hyper/hypoglycaemia
- Respiratory distress xs glucose
- Acute lipid reaction
- Hyperlipidaemia
- Hyperammonaemia
- Hyperchloraemic acidosis-use acetate
- Compatibilities

Stress ulcer prophylaxis

- 90% of patients without prophylaxis or gastroprotection will ulcerate
- Use of ranitidine
- Use of PPIs-omeprazole doses proportionally > in paed
- Use of trophic feeds

Inotropes

- Use kids infusion guidance
- Dobutamine
- Dopamine
- Adrenaline
- Noradrenaline

Other drugs - antibiotics

- Sepsis & Septic shock –use of cefotaxime
- Meningitis –care neonatal 28d – 3month
- May be GM –ve
- Gp B strep
- Listeria
- Use cefotaxime & amoxicillin

Other infections

- Neutropenia –pip / tazobactam
- CAP amoxicillin
- 2nd choice azithromycin
- HAP 1st choice amoxicillin
- 2nd choice azithromycin or Clarithromycin
- UTIs –treat very aggressively

Antibiotics - refer separate guidelines

- Penicillins – mainly Ben Pen & Co-Amoxiclav
- Cephalosporins – mainly for UTIs /sepsis/meningitis
- Macrolides- clarithromycin preferred
- Quinolones- caution due cartilage damage
- Others;teicoplanin,
- Carbopenems - meropenem
- Antifungals – fluconazole / caspofungin/ambisome
- Antivirals – aciclovir for encephalitis

Sources of information

- BNFc
- Neonatal Formulary 5 for Neonates
- NPPG network
- Guy's Paediatric Formulary
- Guideline folder for paediatrics
- Colleagues

• **Questions**