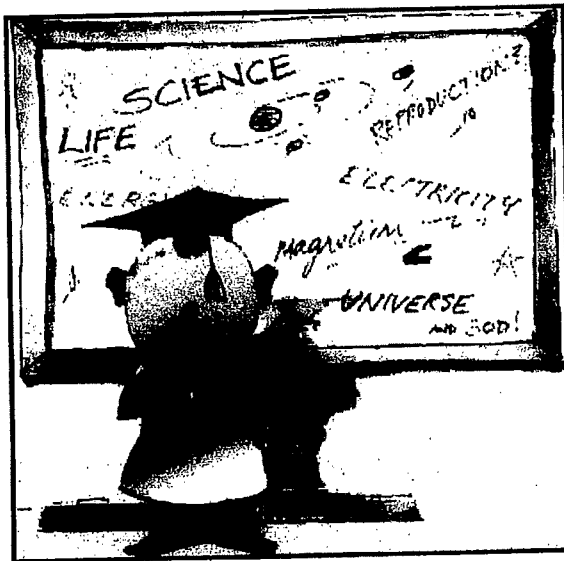


## Fluid Balance

1. Renal Physiology made easy
2. A case report of Hyponatraemia
3. Recommendations for Fluid Therapy in Children (*& now Adults*)

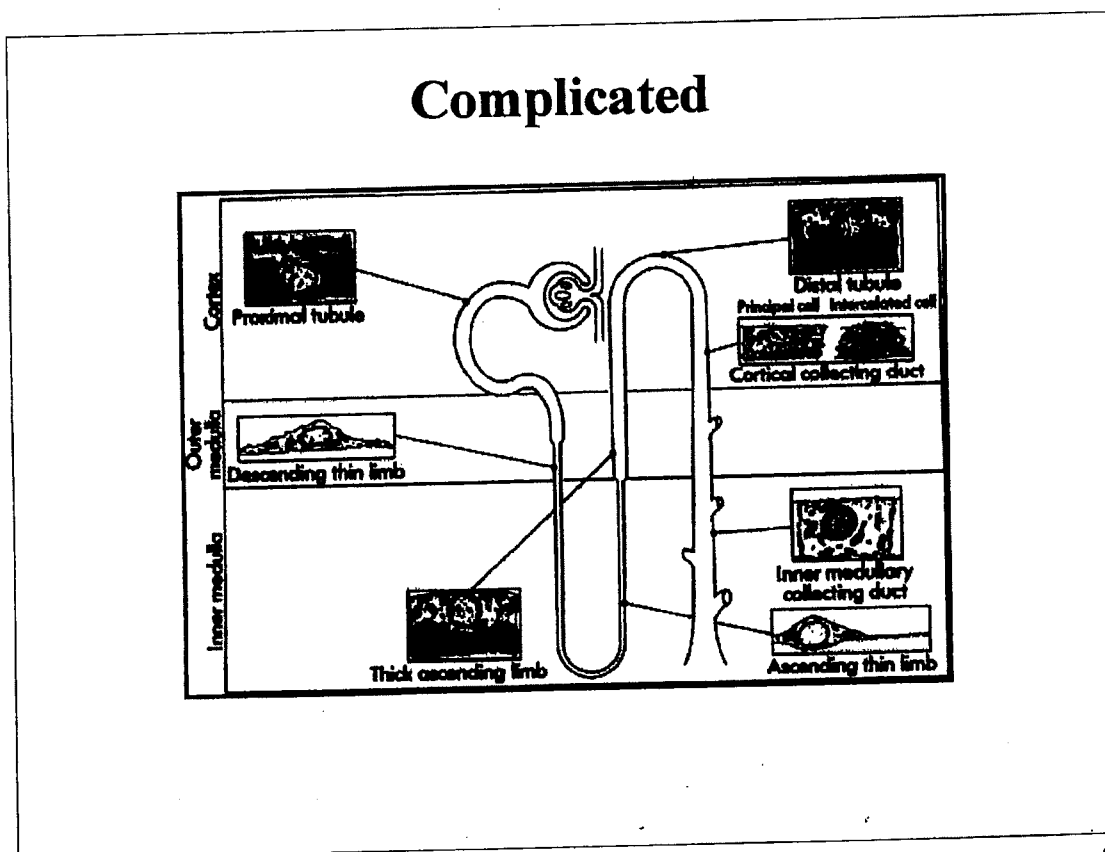
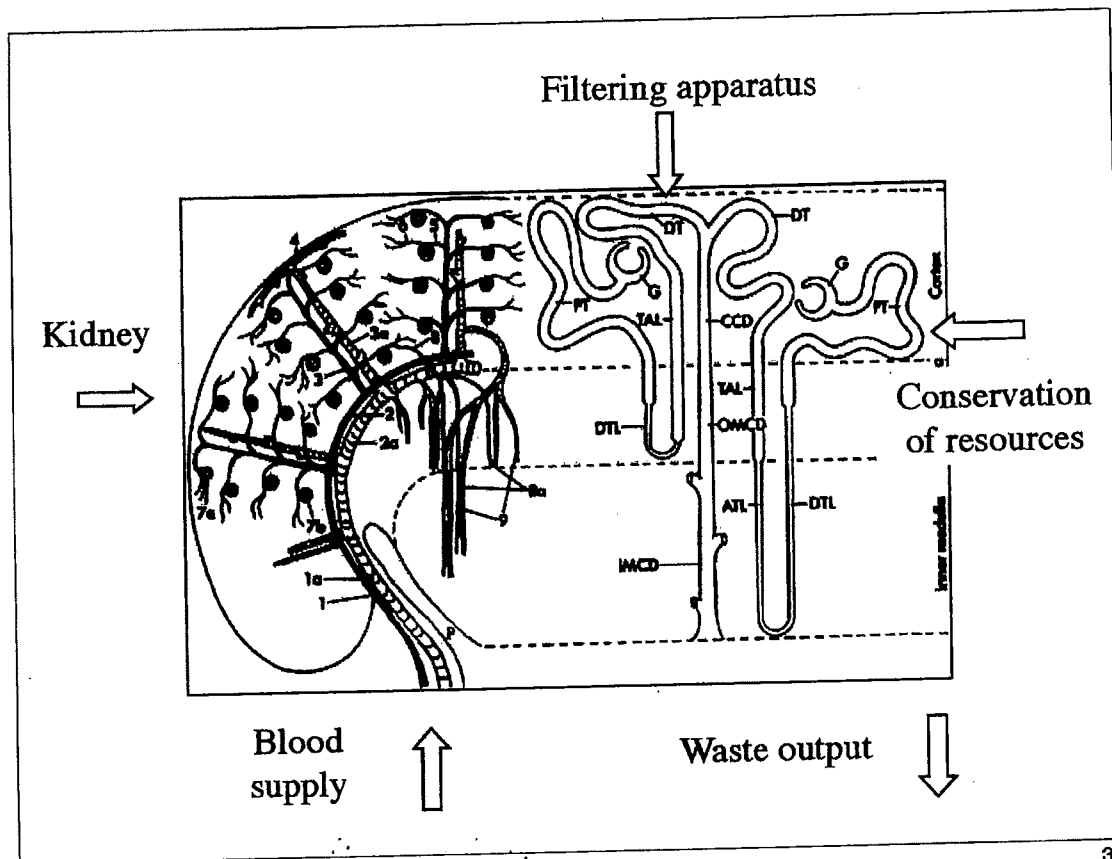
1

## Renal Physiology - is it complicated?

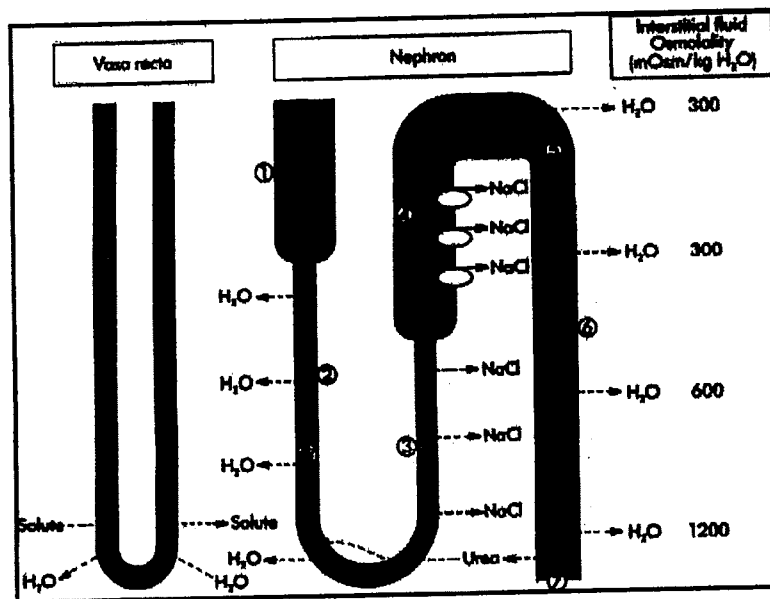


**Yes it is !**

2

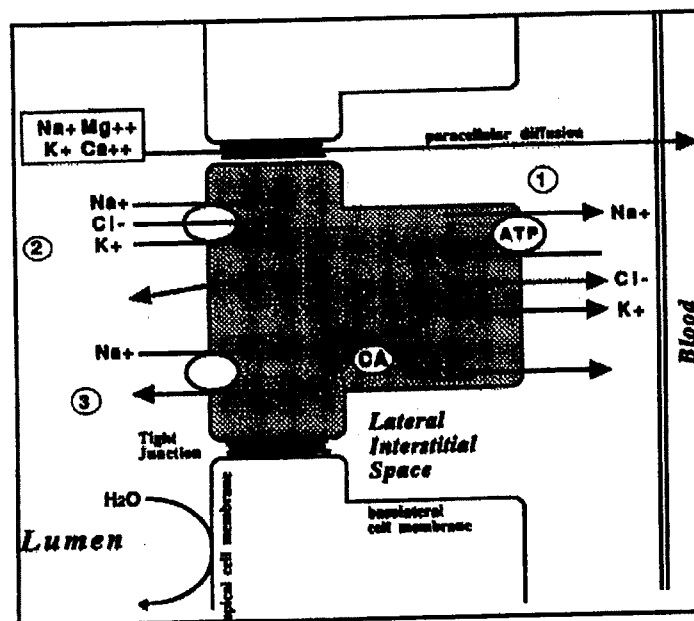


## Very Complicated

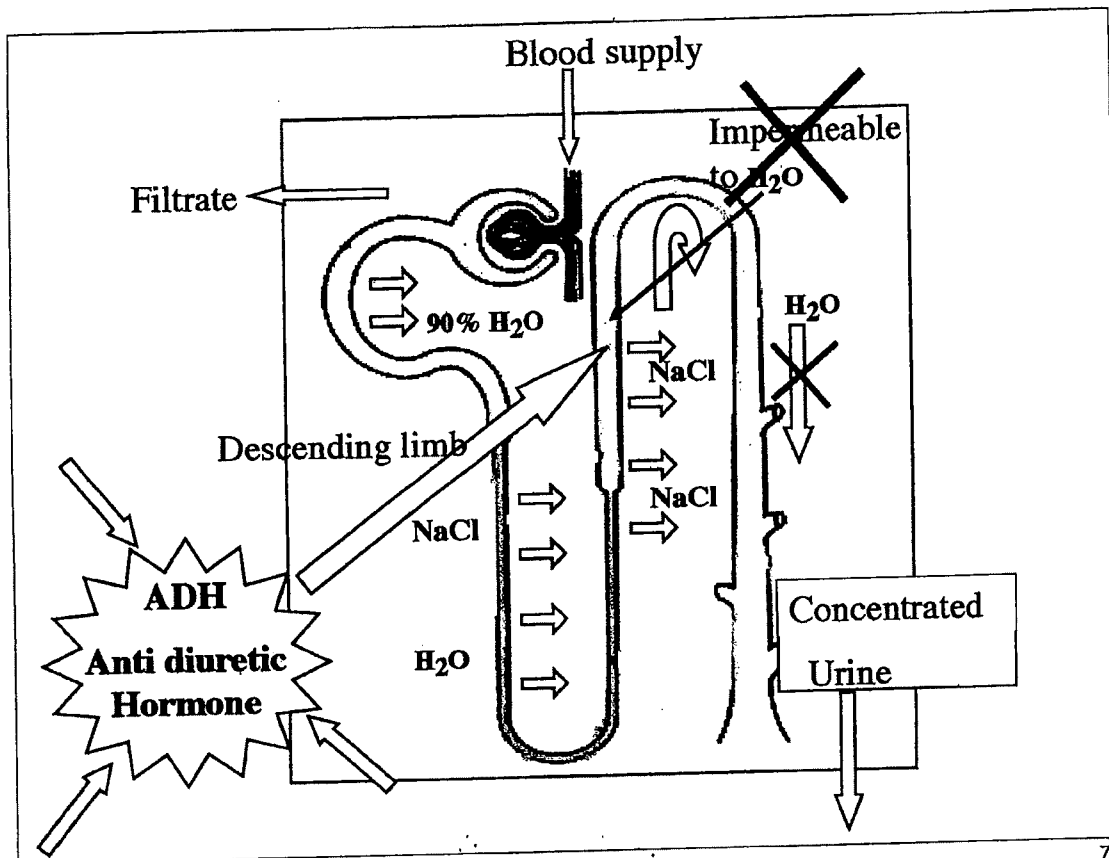


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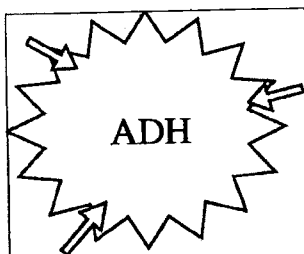
## Unbelievably Complicated



6



7



## At risk patients

- Hyponatraemia / hyposmolality
- Dehydration / shock
- Stress, nausea, pain, anxiety
- Drugs
- CNS disease
- Metabolic / Endocrine disorders

**Just about every surgical patient!**

8

# **Fatal Hyponatraemia following surgery**

A case report

9

- 9yr old girl. Weight 25kg
- Admitted via A&E 20.00hrs
- Diagnosis: "Suspected appendicitis"
- Treated with intravenous Morphine and admitted to ward 6

Na 137, K 3.6, Urea 4.8, Glucose 7.2

- Seen by Anaesthetist

- IV fluids prescribed (Hartmann's 80mls / hr)
- IV fluids changed to No.18 solution 80ml / hr  
(This was the "default solution" in paediatrics)

10

[illegible]

**ALTHAGELVIN HOSPITAL, NEO NATAL INTENSIVE CARE UNIT**  
**FLUID BALANCE FOR I.V. FLUIDS**

[illegible]

**RF - ALTNAGELVIN**

021-054-122

The image shows a document page with a grid pattern. A large oval is drawn around a section of the grid. The page is heavily textured and appears to be a scan of a physical document. The grid consists of many small squares, some of which contain text or numbers. The oval is drawn around a section of the grid that is approximately 10 squares wide and 10 squares high. The text inside the oval is mostly illegible due to the texture and the quality of the scan. The page is otherwise blank, with no other markings or text visible.

SPECIFY FLUID		INPUT				DITTAKE/OUT				ORAL				OUTPUT				LAB				OTHER			
TIME	AMT	TOT	AMT	TOT	AMT	TOT	AMT	TOT	AMT	TOT	AMT	TOT	AMT	TOT	AMT	TOT	AMT	TOT	AMT	TOT	AMT	TOT	AMT	TOT	
0800	180	30																							
0900	180	180																							
1000	150	210																							
1100	180	390																							
1200	150	540																							
1300	150	690																							
1400	150	840																							
1500	150	990																							
1600	150	1140																							
1700	150	1290																							
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2000	150	1740																							
2100	150	1890																							
2200	150	2040																							
2300	150	2190																							
2400	150	2340																							
0100	150	2490																							
0200	150	2640																							
0300	150	2790																							
0400	150	2940																							
0500	150	3090																							
0600	150	3240																							
0700	150	3390																							

8/6/01

ALTHAGELVIN HOSPITAL NEO NATAL INTENSIVE CARE UNIT  
FLUID BALANCE FOR I.V. FLUIDS

Date 8/6/01

PB, AB

Fluids continued at 80mls/hr

## History of events

- Returned to ward 02.00hrs. 8/6/01
- Seen by surgeons in am. Patient was well and being nursed by her father. Out of bed and "colouring in"
- Several episodes of vomiting
- "Seen" by several doctors throughout the day and anti emetics prescribed
- No notes and no U&E requested
- Headache at 21.30hrs. Treated with paracetamol
- Settled and sleeping 23.30hrs

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## History continued

- Further episode of vomiting 00.30hrs
- Found fitting at 03.00hrs
- Seen and treated by SHO in Paediatrics
- Check U&E  
Na 118, K 3, Mg 0.59, Urea 2.1, Glucose 11
- Treated with benzodiazepines to control seizures 03.30
- Consultant paediatrician called 04.30
- Anaesthetic Registrar contacted because of desaturation
- 04.45 sudden deterioration. Anaesthetist fast bleeped.
- Respiratory arrest
- Intubated and ventilated

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## **CT scan & Transfer to RBHSC**

- CT scan showed cerebral oedema and suspected subarachnoid bleed. 05.30hrs
- Transferred to ICU
- Re scanned at request of Neurosurgeons
- Transfer to Belfast RBHSC 11.00hrs

**Diagnosis: Brain Stem death**

**Parents told that “ the wrong fluid had been given”**

**(Allegedly)**

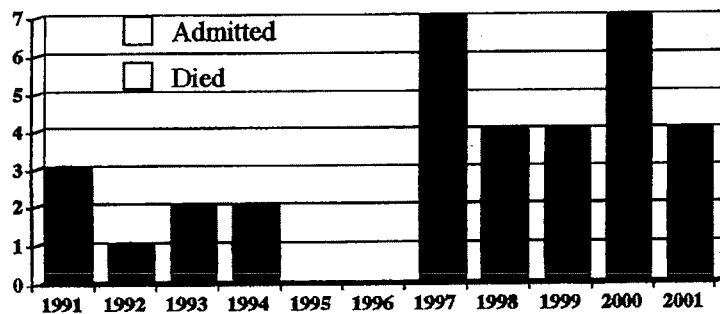
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## **Background**

- Incidence in N Ireland
- Review of literature
- Intravenous fluids & Sodium content
- Recommendations following meeting with Department of Health

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## Incidence of Hyponatraemia RBHSC



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## History

The traditional view held for 40 yrs...

- Paediatric fluids should be hypotonic
- Children cannot handle a salt load
- Children must be given sugar

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## Evolution of the problem

- Standard solution was No.18. Isotonic containing 30 mmols/l Sodium, provided the correct amount for the day.
- Free water is produced as glucose metabolised, especially by the sick child.
- ADH /Arginine-Vasopressin secretion adds to the problem by causing water retention and excretion of small volumes of hypertonic urine.
- A fluid challenge may be tried to improve the “poor urinary output” (often with hypotonic fluids)
- Large shifts of water lead to tissue and more importantly brain cell swelling.

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## Study findings

Halberthal et Al - BMJ 2001;322:780-2

- 23 patients with acute hyponatraemia
- Median age 5years ( range 1mth - 21yrs)
- 13 (57%) were postoperative.
- 18 (78%) developed seizures
- 5 (22%) died
- 1 severe neurological deficit

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## **Study findings**

Halberthal et Al - BMJ 2001;322:780-2

- 23 patients studied
- All received hypotonic fluids
- All had plasma Na < 140 mmols/l pre- treatment
- 16 (70%) received excessive maintenance fluids

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## **Our Case**

- Received hypotonic fluids
- Had a preoperative Na < 140 mmols/l
- Received excessive maintenance fluids
- 25kgs = 65 mls/hr
- Patient prescribed 80 mls/hr

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## **Study findings - conclusions**

Halberthal et al BML 2001;322:780-2

- Avoid hypotonic solutions if  $\text{Na} < 138 \text{ mmols/l}$
- Measurement of Na mandatory prior to IV therapy
- Hypotonic solutions only indicated if  $\text{Na} > 145 \text{ mmols/l}$
- Check plasma Na if child receives more than 30mls/kg fluids

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## **Measure the body weight**

- Measurement should be in Kg
- 
- Estimate weight using formula
  - $(\text{Age} + 4) \times 2$
  - i.e. a 2 yr old = 12kg
- 
- Plot on a centile chart as a cross check

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## Maintenance fluids

- For first 10 kgs body weight give 4 mls/kg/hr
  - 40 mls /hr for a 10 kg infant
- For second 10 kgs body weight give 2mls/kg/hr
  - 40mls + 20 mls = 60mls/hr for a 20kg child
- For each subsequent kg give 1 ml/kg/hr
  - 60mls + 10 mls = 70 mls/hr for a 30kg child

24hr requirements:

**100mls/kg for first 10kg**

**50 mls/kg for next 10kg**

**20mls/kg for each kg thereafter**

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## Sodium content

- 0.18% NaCl in 4% glucose contains 30 mmols/l
- 0.45% NaCl in 2.5% glucose contains 75 mmols/l
- 0.9% NaCl contains 150 mmols/l      Normal Saline
- Hartmann's contains 130 mmols/l

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## Recommendations

- Body weight measured or carefully estimated
- Total fluid not to exceed the maintenance
  - Once replacement has been given
- Maintenance should be at least 0.45% NaCl in 2.5% glucose
- Measurement of urine output, or serial body weight, is mandatory and should be recorded daily
- Baseline and regular measurement of blood biochemistry (Na & glucose) at least daily
- Do not use glucose containing solutions for fluid bolus or resuscitation fluids

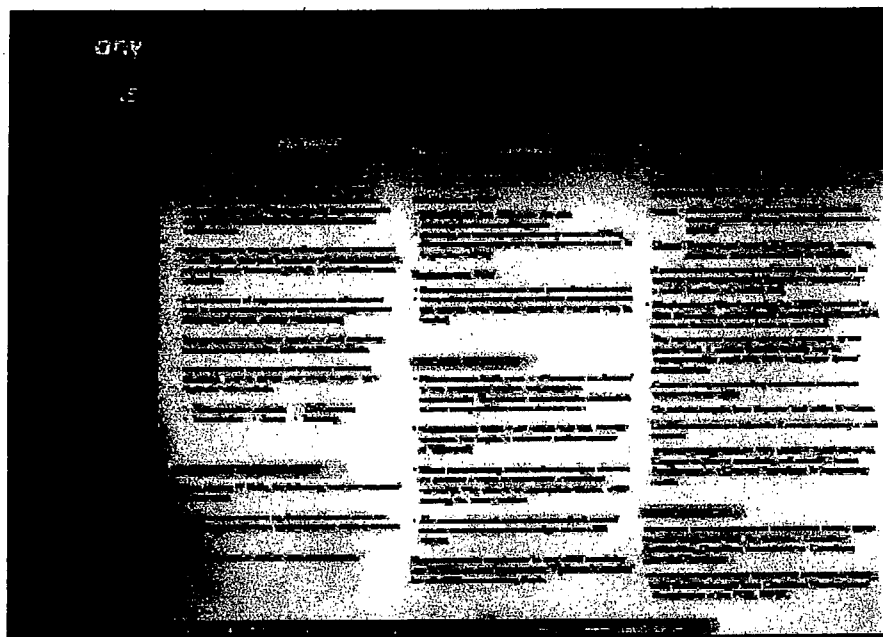
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## A Change of Practice

Not just a change of fluid

- Regular electrolyte & Blood sugar checks
  - This means blood tests on children
  - What about “short cases” who receive fluids ?
- A review of fluid balance at 12 hrs
  - Why is this patient still requiring fluids?
- Avoidance of No.18 solution
  - Use at least 0.45% NaCl
  - Perhaps only use 0.9%NaCl or Hartmann’s ?

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INTRAVENOUS FLUID PRESCRIPTION CHART FOR POST OPERATIVE CHILDREN									
Date: ____ / ____ / 20__									
<b>1 BASELINE INFORMATION</b>									
(AFFIX LABEL)				AGE	WEIGHT	HOURLY RATE (ml/hr)*	VOLUME OF LOSSES		
NAME: _____						4 ml/kg For 10 kg			
Disp No: _____						2 ml/kg new 10 kg			
Date of Birth: _____						1 ml/kg new 10 kg			
						<b>TOTAL =</b>	ml/hr		
<b>2 FLUID BOLUSES</b>									
	VOLUME (mls)	FLUID TYPE	RATE	PRESCRIBED BY	START TIME	ERECTED BY (NAME)	SIGNED & CHECKED	BATCH ID & EXPIRY	PUMP TYPE SERIAL No
A		Hartmann's solution							
<b>3 MAINTENANCE FOR FIRST TWELVE HOURS</b>									
	ELECTROLYTES Sample time : hrs	FLUID TYPE & Volume Delete if not applicable	RATE* (ml/hr)	START TIME	PRESCRIBED BY	ERECTED & CHECKED	BATCH ID & EXPIRY	CANCELLED BY (Signature/Time)	PUMP TYPE/SERIAL No
B	Sodium = Potassium = Chloride = Urea =	1L Hartmann's Solution Sodium 136 <input type="checkbox"/> 1L 0.45% Saline & 2.5% glucose (Sodium 136) <input type="checkbox"/>							
<b>4 MAINTENANCE FOR SECOND TWELVE HOURS</b>									
	ELECTROLYTES Sample time : hrs	FLUID TYPE & Volume Delete if not applicable	RATE* (ml/hr)	START TIME	PRESCRIBED BY	ERECTED & CHECKED	BATCH ID & EXPIRY	CANCELLED BY (Signature/Time)	PUMP TYPE/SERIAL No
C	Sodium = Potassium = Chloride = Urea =	1L Hartmann's Solution Sodium 136 <input type="checkbox"/> 1L 0.45% Saline & 2.5% glucose (Sodium 136) <input type="checkbox"/>							

32



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