

NAME OF CHILD: ADAM STRAIN

Name: Maurice Savage

Title: Professor

Present position and institution:

Retired from clinical practice July 2011.

Professor Emeritus School of Medicine Dentistry and Health Sciences Queen's University Belfast

Previous position and institution:

[Since your Witness Statement of 30th September 2011]

Membership of Advisory Panels and Committees:

[Identify by date and title all of those since your Witness Statement of 30th September 2011]

Previous Statements, Depositions and Reports:

[[Identify by date and title all those made since your Witness Statement of 30th September 2011]

Revised answer to WS 002/3 question 18 a-d. September 2011. Not listed below.

OFFICIAL USE:

List of previous statements, depositions and reports attached:

Ref:	Date:	
011-001	28.11.1995	Draft Statement
011-015	21.06.1996	Deposition to the Coroner
002/1	22.07.2005	Inquiry Witness Statement
093-006	08.05.2006	PSNI Witness Statement
002/2	14.04.2011	Second Inquiry Witness Statement
002/3	28.09.2011	Third Inquiry Witness Statement

002/4	28.09.2011	Fourth Inquiry Witness Statement
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IMPORTANT INSTRUCTIONS FOR ANSWERING:

Please attach additional sheets if more space is required. Please identify clearly any document to which you refer or rely upon for your answer. If the document has an Inquiry reference number, e.g. Ref: 049-001-001 which is 'Chart No.1 Old Notes', then please provide that number.

If the document does not have an Inquiry reference number, then please provide a copy of the document attached to your statement.

ADDITIONAL QUERIES

(1) In November 1995, Adam normally had 15 cycles of peritoneal dialysis overnight using 750ml fills of 1.36% Dianeal solution (Ref: 016-015-034). On 26th November 1995, he was commenced at 10pm on overnight peritoneal dialysis in advance of his renal transplant operation the following morning (Ref: 057-014-019). This was stopped at 6am and Adam received only 8 of his usual 15 cycles (Ref: 093-006-017)

(a) Please state the sodium concentration of the 1.36% Dianeal solution.

The sodium concentration of Dianeal solution (Baxter Healthcare) is 132 mmol/L

(b) Explain what you consider to be the effect of full overnight peritoneal dialysis on:

(i) a patient's serum sodium concentration. Peritoneal dialysis tends to normalise the patient's plasma sodium concentration overnight. This is because the Dianeal solution's sodium concentration is similar to that of normal plasma. The sodium will diffuse across the peritoneal membrane down any concentration gradient. Thus if the plasma sodium concentration was higher than that of the Dianeal solution the sodium would move by diffusion from plasma into Dianeal. If the Dianeal sodium was higher than that in the plasma the sodium would move from the higher level in the dialysis fluid into plasma to normalise the plasma concentration. It follows that after a period of peritoneal dialysis the plasma sodium should be within the normal range.

(ii) a patient's fluid balance. Overnight peritoneal dialysis tends to improve and normalise a patient's fluid balance status. Using the Dianeal 1.36% glucose solution the amount of fluid gained or lost overnight depends on the patient's fluid status at onset of dialysis. If the patient is slightly overloaded with fluid, a corresponding volume of fluid will be removed. If the patient starts the dialysis relatively dry, (for instance due to a fever causing sweating or the patient has vomited) less fluid will be removed. This means there is little chance of the patient becoming dehydrated or seriously fluid overloaded. This safety feature is one reason it is the preferred type of dialysis for most children

(c) Explain what you consider to be the effect of a shortened overnight peritoneal dialysis on:

(i) a patient's serum sodium concentration. Peritoneal dialysis is relatively efficient in children compared to adults because they have a significantly larger peritoneal membrane surface area/weight ratio compared to adults.

1.36% Dianeal dialysis fluid is manufactured to have a sodium concentration similar to the normal plasma sodium. This means that if the plasma sodium at the start of a dialysis period is relatively normal it should still be normal at the end of dialysis session (see b(i) above). I therefore would expect that at the end of a shortened period the plasma sodium would be normal.

- (ii) a patient's fluid balance. As explained in b(ii) above overnight peritoneal dialysis tends to normalise body fluid balance. Paediatric nephrologists are aware that the amount of fluid removed in a dialysis session varies depending on the patient's state of hydration. When a patient is relatively "dry", (for example due to a fever causing sweating or the patient has vomited), little fluid is removed. If on an occasion the patient drinks in excess of their normal fluid intake, the extra fluid tends to be removed by the dialysis overnight. The management of fluid balance is achieved by attention to the patient's weight, usual daily intake of fluid, output of urine and insensible loss. The peritoneal dialysis then fine tunes the balance. One shortened period of night dialysis is unlikely to produce a major fluid volume imbalance
- (d) In particular, explain what you consider to have been the effect of the shortened period of dialysis (8 cycles of his normal 15) on Adam's
- (i) serum sodium concentration. This should not have had a significant effect as explained in b(i) and c(i) above. I consider his plasma sodium should have been normal at the end of the dialysis session. Furthermore, when Adam was not receiving peritoneal dialysis on the morning of 27th November he was also not receiving any intravenous or enteral fluid. I ordered a repeat plasma sodium and electrolyte measurement, prior to surgery, to be performed by way of confirmation.
 - (ii) fluid balance. In a normal 24 hour period in November 1995 Adam received 2100mls of fluid as 3 x200ml boluses by day and 1500mls overnight (057-010-143). On the 24 hour period 26/27 November 1995 he received 600mls by day but only 952mls overnight (057-010-013). This suggests he was relatively dry overnight and as explained in b (ii) and c(ii) above, only a small volume of fluid would have been removed by dialysis. This type of response was previously noted in the clinical record when Adam was relatively dry on 17th July 1995 (058-033-121) and in the dialysis diary (WS-001/2 page 36). Since little fluid was likely to have been removed, I consider the dialysis period would have had little effect.
- (e) Adam's dialysis was stopped at 6am on 27th November 1995. State what you estimate Adam's
- (i) serum sodium concentration. I estimate his serum sodium would have been in the range 132-135 mmol/L
 - (ii) fluid balance. Taking into account Adam's input and output estimated over the previous 24 hours when this total input was 1552mls (as compared to 2100mls normally) and his estimated urine output was 1500mls daily, I would estimate he was 300-500mls in deficit. If I consider only the period from his admission at 8 pm on the 26th November to 6am when he went to theatre on 27th November, then his intake was 952mls, his urine output estimate 625mls (10

hoursX62.5mls), his insensible losses 100mls (10mls/hr) Adam would have been some 225mls in positive balance.

to have been at that time.

- (2) Please find attached a blank table regarding Adam's fluid balance. We should be grateful if you could fill in the table as follows:
- (a) State what you consider Adam's daily fluid intake to have been prior to his admission to RBHSC on 26th November 1995.
 - (b) State what you consider Adam's average daily fluid output to have been prior to his admission to RBHSC on 26th November 1995.
 - (c) State what you consider Adam's fluid losses to have been at each of the indicated stages on 26th and 27th November 1995, including your calculations and losses due to:
 - (i) Insensible losses
 - (ii) Urine output
 - (iii) Blood loss
 - (iv) Dialysis loss
 - (d) State what fluid was actually received by Adam at each of the indicated stages on 26th and 27th November 1995.
 - (e) Given what you consider Adam's fluid losses and fluid intake to have been state what you calculate as his fluid excess/deficit at each of the indicated stages on 26th and 27th November 1995.

THIS STATEMENT IS TRUE TO THE BEST OF MY KNOWLEDGE AND BELIEF

Signed:

Maurice Savage

Dated:

20/3/2012

Adam's perioperative fluid balance. (Assumes weight of 20.2 kg; surface area = 0.8)

Adam's usual daily intake (known)	Enteral intake = [2100] ml
Adam's usual daily output (estimated)	Urine output = [1500] ml; insensible perspiration loss = [~240] ml; dialysis loss = [~300] ml; faecal loss = [~60] ml. Total = [2100] ml

	Time between ward admission & start of preoperative fasting 2200-0500 = 7 h	Time between start of preoperative fasting period & anaesthesia 0500-0700 = 2 h	Time between induction of anaesthesia & start of surgery 0700-0800 = 1 h
Fluid losses			
a) Insensible losses	[10] ml/h = [70] ml	[10] ml/h = [20] ml	[10] ml/h = [10] ml
b) Urine output	[62] ml/h = [434] ml	[62] ml/h = [124] ml	[62] ml/h = [62] ml
c) Blood loss	[0] ml	[0] ml	[0] ml
d) Dialysis loss	[estimated range 50-250] ml	[0] ml	[0] ml
Total fluid losses	[554-754] ml	[144] ml	[72] ml
Actual fluid input	[952] ml	[0] ml	[750] ml
Estimated fluid excess	[~300] ml, range 200-400ml	[-144] ml	[678] ml
Comments + relevant information regarding Na⁺ content of : a) input fluids b) losses	<p>Comments: In positive fluid balance ~300ml in this period but received 500 ml less feed than on a normal night so Dialysis ultrafiltrate likely to be low.</p> <p>Na⁺ content of fluids given: Enteral Dioralyte 60mmol/L Na⁺ total + 57 mmol</p> <p>Na⁺ content of loss:- Urine 434mls@70mmol/L = 30mmol Dialysis loss 2.5mmol/L of dialysis fluid 6Ldialysis O/N so loss is2.5mmol x6=15mmol Total Na loss 30+15=45mmol</p>	<p>Comments: Cumulative fluid balance 300-144=166</p> <p>Na⁺ content of fluids give: 0 mmol</p> <p>Na⁺ content of losses: 9mmol (urine@70mmol/l)</p> <p>Na balance -9. In approximate Na balance pre-op. (12-9=3)</p>	<p>Comments: fluid balance from onset of anaesthesia +678</p> <p>Na⁺ content of fluids given:750 mls N/5 Saline Dextrose Na conc 31mmol/L total Na 23mmol Na loss 62mls urine@70mmol/L=5mmol Na Na balance 23-5=18mmol</p>

	Na balance 57-45=+12mmol		
Reasons why planned fluid infusion (content or infusion rate) should change due to change in estimated loss		At time of going to theatre Adam was in Sodium balance and bearing in mind his usual night feed was 1500 mls, although in positive fluid balance from the time of admission, he may have been in an overall 24hour deficit of perhaps 300mls compared to a normal day.	

Adam's perioperative fluid balance. (Assumes weight = 20 kg; surface area = 0.8 m²)

	Time from start of surgery until vascular clamps on (0800-1000)	Time while vascular clamps applied (1000-1030)	Time from when clamps released until end of surgery (1030-1130)	Time from end of surgery until arrival in ICU (1130-1215)
Fluid losses				
a) Insensible losses	[10] ml/h = [20] ml	[10] ml/h = [5] ml	[10] ml/h = [10] ml	[10] ml/h = [7.5] ml
b) Urine output	[62] ml/h = [124] ml	[62] ml/h = [31] ml	[62] ml/h = [62] ml	[62] ml/h = [45] ml
c) Blood loss	[600] ml	[200] ml	[~300mls] ml	[0] ml
Total fluid losses	[744] ml	[236] ml	[372] ml	[52] ml
Actual fluid input	[2050] ml	[250] ml	[450] ml	[0?] ml
Estimated fluid excess	[1306] ml	[+14] ml	[+78] ml	[-52] ml
Comments + relevant information regarding Na⁺ content of : a) input fluids b) losses	<p>Comments: Cumulative fluid balance from onset of anaesthesia 678 + 1306= 1984mls</p> <p>Na⁺ content of fluids given over 2 hours 800mls HPPF140mmol/L=112, 500mlsHartmanns 131 mmol/L=65, 500mlsN/5Saline dextrose 31mmol/L =16mol,250mls Packed cells=35mmol. Total Na⁺ input =228mmol</p> <p>Na⁺ content of losses: 600mls blood @134mmol/L = 81mmol,urine 9mmol total Na⁺ loss = 90mmol. This period Na⁺ balance +138mmol</p>	<p>Comments: Cumulative fluid balance 1998 mls since induction.</p> <p>Na⁺ content of fluids given: 250mls N/5 Saline Dextrose =8mmol Na⁺</p> <p>Na⁺ content of losses: blood 28mmol+urine 2 mmol</p> <p>Balance this period -22mmolNa⁺</p>	<p>Comments: cumulative fluid total + 2076 mls since induction</p> <p>Na⁺ content of fluids given: 250mlpacked cells= 35mmol Na⁺ 200mls Hartmanns =26mmol Na content of fluids given 35+26 =61</p> <p>Na⁺ content of losses: Urine 4 mmol + blood 40mmol Total Na= loss 44mmol</p> <p>Na⁺ balance this period 61-44=+17</p>	<p>Comments:Cumulative fluid balance since onset of Anaesthesia approximately 2024mls</p> <p>Na⁺ content of fluids given:0</p> <p>Na⁺ content of losses:3mmol</p> <p>Na⁺ balance this period -3 mmol</p>

<p>Reasons why planned fluid infusion (content or infusion rate) should change due to change in estimated loss</p>			<p>The record of blood loss in theatre is not timed making this analysis difficult and imprecise. The volume of urine outputs are estimates as Adam was not catherised. I was unable to find a record of fluids given in the final period between theatre and PICU</p>	<p>The fluid and sodium estimates during surgery are my best estimates based on the information in the Anaesthetic record 058-003-005. I had no involvement in the intra operative fluid management and have some difficulty interpreting the record. The time frames in your questions are not always clearly defined in the record. At the end of surgery Adam would appear to be some 2024mls in positive fluid balance and with a positive Sodium balance of 148 mmols</p>