Supplementary Report to the Inquiry on Hyponatraemia Related Deaths in Northern Ireland:

Regarding Adam Strain following Further Brief dated February 2012:

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Signed: Simon R. Haynes
6th March 2012

Dr. Robert Taylor's sixth Witness Statement to the Inquiry

1: *The extent to which you agree or disagree with the points made by Dr. Taylor*

There are 8 points I have identified in Dr Taylor's statement .

- 2nd para page 2: I agree that Dr Taylor had the necessary training and experience to be able to undertake anaesthesia for Adam's transplant operation
- 3rd para page 2: I have previously commented in an adverse manner on Dr Taylor's failure to see and assess Adam prior to him arriving in the anaesthetic room. It is clear that Dr Taylor now accepts that this was a failure on his part
- 1st para page 3: Dr Taylor now accepts that he failed to accurately assess Adam's preoperative urine output and that he gave an excessive volume of hypotonic intravenous fluid.
- 2nd Para page 3: Dr Taylor accepts that he failed to measure with adequate frequency Adam's serum electrolytes during the transplant operation.
- 3rd para page 3: I agree that the central venous catheter was positioned such that it could not be relied upon to give reliable measurements of central venous pressure.
- 3rd para page 3: I agree with Dr Taylor that he was under time pressure, and that there was a need not to delay implantation of the donor kidney.
- 4th para page 3: I agree with Dr Taylor's statement that excessive volumes of hypotonic fluids eg 0.18% saline/4%glucose can cause dilutional hyponatraemia (which in turn causes movement of water into cells, which may in turn lead to cerebral oedema).
- Final para: I agree that Dr Taylor was responsible for all the fluid calculations and administration during Adam's transplant.

2: *The significance of Dr. Taylor's statement for the issues to be considered by the Inquiry*

(1) *Your assessment of Dr. Taylor's conduct at the time and subsequently from 1995 to 2012 in light of this statement*

As noted above, I agree with the statements made by Dr Taylor in his sixth witness statement to the Inquiry. I cannot explain why he has waited over 16 years to acknowledge that he made some errors of judgment - these errors were highlighted at an early stage by Dr Sumner in his expert report dated September 1995 (094-002-002 to 9). I accept that Adam's death must have been devastating to Dr Taylor, but it may have lessened the ongoing psychological distress and trauma to Adam's family had this most recent statement, or a similar statement, been made at a much earlier date. Dr Taylor's previous denial in the light of Dr Sumner's report is hard to comprehend.

(2) *Whether there is anything arising that requires further query or investigation.*

I do not believe there are any further matters arising following Dr Taylor's most recent statement

(3) *Whether the statement causes any amendment of your previous expert reports to the Inquiry, and if so, what amendment is required and the reason(s) for the amendment(s).*

This statement does not cause me to amend any of my previous reports

Statement of Dr. Leslie Dyer

(1) The extent to which you agree or disagree with the points raised by Dr. Dyer

A2(a): I agree
A2(b): I agree. Adam's death was caused by inappropriate fluid management. I have previously commented (204-004-160 final paragraph and first paragraph 204-004-161) that I did not agree with Dr Gibson's statement regarding the conduct of Adam's anaesthetic.

B1: I agree
B2: I agree
B3: I agree

B4: I disagree. I have previously commented that the CVP reading was probably unreliable. One has Dr Taylor's word that there were both respiratory and venous waveforms on the CVP, but there was no printout of these waveforms (nor would I expect there to have been one). I find it very hard to believe that Adam's CVP was as high as 22 mm Hg following dialysis - especially given the pictures of him "well", taken some time before his transplant, which have been provided to me by the Inquiry. A child with a CVP of 22 would be swollen and oedematous; Adam was not

B5: If Adam' was in a slightly head down position, the intracranial pressure would have been higher than the venous pressure measured at the level of the right atrium.

C1-4: These statements are correct, but presented in isolation they do not help the reader understand the cause and evolution of cerebral oedema and brain stem death.

D1 - D13. These points combine to describe the pathophysiology of raised intracranial pressure which is subsequently explained very clearly by Professor Kirkham in her report paragraph 55 p208-002-039 to 41). Most of his references refer to patients with traumatic brain injury and are not necessarily pertinent to Adam's case

Dr Dyer also emphasizes that Adam's haematocrit had been allowed to decrease to 18% by 0923h. This is a low level, and it is my opinion that this reflects excessive dilution of Adam's blood by the large amount of fluid given intravenously by Dr Taylor as well as some blood loss. The haematocrit is lower than would be ideally be accepted beyond the short term by most anaesthetists.

(2) *In particular, whether you agree with his assessment that cerebral hypoxia was "inevitable" (paragraph D14) and was "the dominant cause" (paragraph H2) of Adam's death.*

I concur that cerebral hypoxia was inevitable. It is my opinion that hyponatraemia caused cerebral oedema which in turn caused cerebral hypoxia which ultimately caused brain stem death . I cannot pinpoint the point beyond which this situation became irrecoverable, but it may have been as as early as 0932h when the blood gas sample was measured.

(3) *The significance of Dr. Dyer's statement for the issues to be considered by the Inquiry*

The issues raised by Dr Dyer's statement are covered by previous reports to the Inquiry. He correctly draws attention to the Monroe Kellie principle which is subsequently elaborated on in more detail by Professor Kirkham

(4) *Whether there is anything arising that requires further query or investigation*

I do not believe that there is any other matter arising not covered elsewhere.

(5) *Whether the statement causes any amendment of your previous expert reports to the Inquiry, and if so, what amendment is required and the reason(s) for the amendment(s).*

I do not wish to amend any of my previous reports in light of Dr Dyer's statement.

Comparison of fluid balance assessments

(1) *Check that your calculations and assumptions have been transcribed correctly onto this comparison table.*

My calculations and assumptions have been transcribed correctly; however there is an arithmetical error in my original calculation of cumulative fluid balance, underestimating the total by 100mls. I enclose an annotated copy

showing the correction. This does not alter my overall interpretation of events

(2) *Comment on any differences (if any) that are apparent between your calculations and the other Inquiry expert witnesses.*

The differences are minor and in detail only

(3) *Comment on the assumptions and calculations used by Dr. Robert Taylor, particularly in the light of:*

(a) *His previous arguments*

The assumptions and calculations included by Dr Taylor on the comparative table are not very different from those of myself and the other experts. Thus by his calculations as quoted on this table, Adam was up to +ve 2500 mls by1000h, and at least 1500 mls +ve by 1215h. According to these figures, Adam had been allowed to gain a very large volume of fluid by 1000h, much of it given as hypotonic fluid over a short period of time

(b) His most recent statement

Dr Taylor now accepts that Adam's fluid balance calculations reflect the inappropriate administration of intravenous fluids to Adam during his transplant operation.

Adam's operation of 18th October 1995

ii. Dr Robert Taylor has stated:

"[Adam] had undergone a shorter procedure on 18th October 1995. I examined the anaesthetic record (058-025-069 to 074) [...] Although there were no fluid calculations performed on this, I noted that 300mls of "1/5 NSaline/4%" were given over approximately 1hr". (WS-008-1, Answer to Q.1(ii))

iii. He later stated that this record led him to conclude that *"Adam could tolerate a large volume of 0.18NaCl/4% Glucose to replace deficit and urine losses."* (WS-008-2, Answer to Q.11(c)), that Adam *"was not a normal child cause normal children shouldn't cope with 300 ml over an hour"* (Ref: 093-038-192) and so Dr. Taylor was *"confident [...] by the previous anaesthetic that Adam was exceptional"* (Ref: 093-038-193)

iv. The Inquiry would be grateful on your comment and opinion on the following:

(1) *Whether those were appropriate and/or reasonable conclusions to draw from the anaesthetic record of the operation of 18th October 1995?*

The anaesthetic on 18th October 1995 was of approximately 75 minutes duration, commencing at 1145am. The operation was insertion of a gastrostomy button and an orchidopexy, both relatively minor procedures. I presume that Adam had had his overnight dialysis the night before, and there is no mention of him receiving intravenous fluids during the morning leading up to the anaesthetic. I also assume that he had continued to produce urine during that morning at around 50 mls/hour and there would also have been insensible fluid losses. Therefore, 300 mls of 0.18% saline in 4% glucose replaced urinary losses. During the period when he would have been nil by mouth leading up to the operation only 300 mls of hypotonic fluid was given, in contrast with the 1500 mls given during the transplant. I cannot see how the fluid management on 18/10/95 led Dr Taylor to make the statement that "Adam could tolerate a large volume of 0.18% saline/4% glucose". To describe Adam as "not a normal child" is inappropriate; his renal function certainly was outwith the normal population range, but he was otherwise a normal child. Finally, most 20 kg children fasted for surgery would be able to cope with 300 mls of fluid given over one hour.

(2) How the anaesthetic record of 18th October 1995 should be read in terms of:

(a) How much fluid was given

According to the record, 300mls

(b) The period of time over which the fluid was given

According to the record, one hour

(c) Whether all the fluid noted was actually administered

According to the record, yes

Composition of the transplant team

v. As you are aware, the presence or otherwise of the following are in dispute:

(1) A dedicated anaesthetic nurse

(2) A replacement trainee anaesthetist for Dr. Terence Montague

(3) Dr Rosalie Campbell, Consultant Paediatric Anaesthetist, leaving an operation in the theatre adjacent to Adam's operation to assist with Adam's operation

To that end, it would assist if you were able to provide sample theatre logs from your hospital in 1995, and detail whether you would have expected the identity or involvement of any of the above to have been noted on the logs/notes.

An anonymised page is enclosed. The name of the anaesthetic nurse is usually, but not reliably, noted. In the example I have provided the anaesthetic nurse details (often either initials or first name are entered in the column labeled "packs or drains". Later logbooks include a

column identifying anaesthetic nurse involvement). I would not expect a replacement trainee anaesthetist to be included in the details in the logbook, and if another consultant assisted I would only expect that individual's name to be noted if he or she attended for a large part of the duration of operation. It would be unusual therefore for Dr Campbell's name or for that of the anonymous trainee to be included in the theatre log for Adam's transplant,

Ligation of the left internal jugular vein

vi. The Inquiry team would like you to examine Adam's schedule of surgical procedures, and the relevant notes and records if necessary, and comment on whether there was any previous occasion during which a suture was likely to have been placed in Adam's left internal jugular vein.

vii. In particular, the Inquiry would like you to address the following queries, having regard to Adam's previous surgical procedures:

(1) The likely explanation for why Dr. Armour identified *"a suture in situ on the left side of the neck at the junction of the internal jugular vein and the subclavian vein"* and when it was likely to have been placed.

As far as I can ascertain from the schedule of Adam's operations as provided to me by the Inquiry, the only occasion that a suture as described by Dr Armour could have been placed in the area referred to would have been on 29/5/92. It is not an issue if the internal jugular vein rather than the common facial vein had been ligated. In a child of this size, it is my understanding that many surgeons would ligate an internal jugular vein whilst securing long term venous access.

(2) *In the light of the note of the procedure on 29th May 1992 and the witness statements of those involved in it (McCallion (WS-232/1), Brown (WS-007/4) and Stewart (WS-228/1), how likely it was that a mistake could have been made between the left common facial vein and the left internal jugular vein.*

In my experience of surgical access to neck veins in children (which is extensive) I would think it unlikely, but not impossible, that even an inexperienced operator would confuse the two

(3) *How likely it would be that the suture referred to in the note of the procedure on 1992, the left common facial vein is noted as being ligated with "5 x O PDS", would still be in existence in November 1995?*

The manufacturer's web site states that the average period of time taken to absorb PDS suture material is 180 days. If a different suture material (eg prolene, nylon, or silk) had in fact been used, then it would not have been absorbed in this time, and would still have been present at autopsy.

(4) Dr Mary O'Connor in her witness statement to the Inquiry (WS-014-1, Answer to Q.2) states:

"I assumed that [Adam] may have had one of his external jugular veins tied off as this was common practice at the time of insertion of central lines in RBHSC in 1995."

Was it common practice in 1995 when central lines were being inserted for one of the external jugular veins to be tied off?

Yes. It would have been common practice if the central line was inserted in the external jugular vein beyond the ligature. There is no other reference in the documents provided by the enquiry to the external jugular vein being cannulated or ligated

Dr Armour's autopsy report

The Inquiry would be grateful if you would provide a diagram of the marks on Adam's neck as identified in Dr. Armour's autopsy report, explaining where the various lines had previously been inserted and the surgical procedure to which they correspond. Please refer as appropriate to the schedule of surgical procedures.

Please see following page for diagram:

Annotations:
1: (3cm scar on left side of neck) : Broviac line insertion on 29/5/92 (057-115-336)

2: (needle puncture mark on left side of neck). If recent, this will be following attempted percutaneous central line placement for renal transplant by Dr Taylor on 27/11/95.

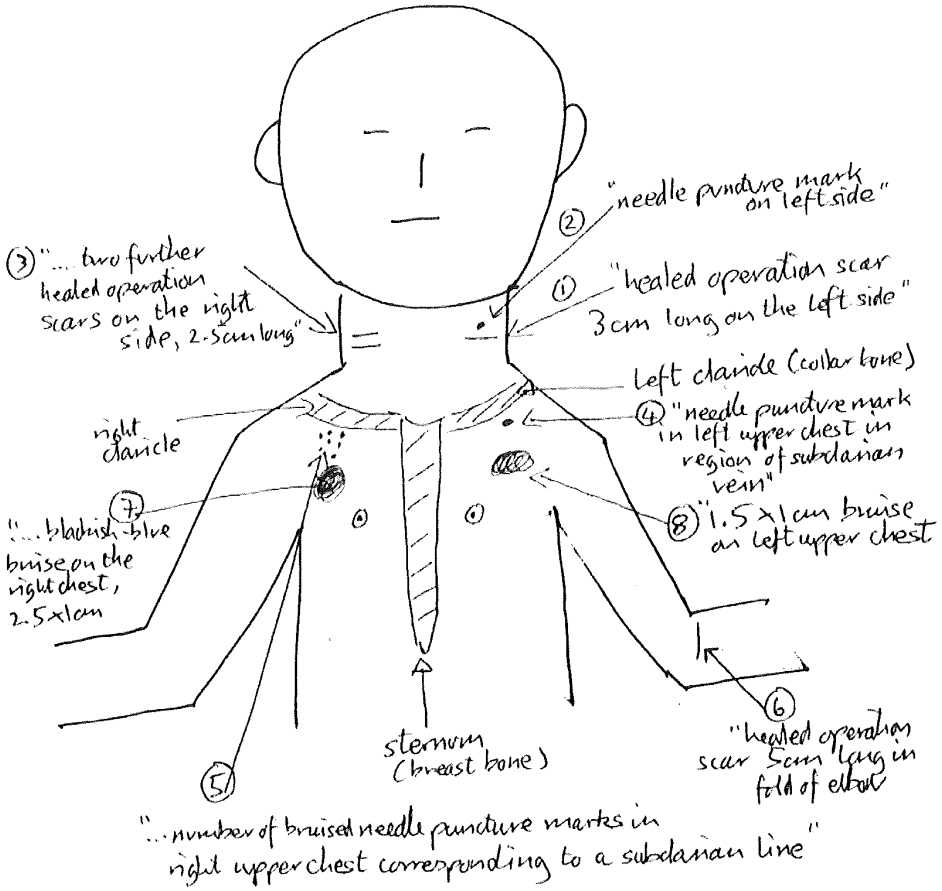
3: (two healed scars on right side of neck). I can only account for one of these, when a Broviac line was inserted on 8/12/91. (049-026-063) There is no operation note, but it was noted that there was already a percutaneous central line in the left subclavian vein (inserted on 28/11/92 049-028-073 nb Dr Gallagher's note reads "L subclavian to right side....). It is unlikely that the Broviac line would have ben inserted on the same side as a pre-existing subclavian line. I cannot find reference in the charts provided to a second cut down procedure for line insertion to account for the presence of second scar on the right side of the neck line

4: (needle puncture marks left upper chest) would have related to attempted percutaneous subclabvian line insertion on 27/11/95. If old, a percutaneous left subclavian vein line was inserted on 28/11/91 (049-028-073)

5: (needle puncture marks right upper chest). These would relate to attempted and actual percutaneous subclavian line insertion on 27/11/95 by Dr Taylor.

6: (scar at left elbow). A cutdown for long line insertion took place on 28/12/91 (050-015-047)

7 and 8(bruises) these bruises would have been caused during attempted and actual subclavian vein line insertion on 27/11/95, and also on the right by any sutures used to secure the line in place.



External marks on Adam Strain as described by Dr Armour's post-mortem report (011-010-037)

Adam's vital signs during the renal transplant operation

viii. *It would be useful for the Inquiry if you would be able to provide the normal range of the following values you would expect for a child of Adam's height and weight during a renal transplant operation:*

- *Heart rate*
- *Blood pressure*

There are many factors which will influence heart rate and blood pressure during any operation. These include anaesthetic and analgesic drugs used, the intensity of surgical stimulus at any particular time, the use of epidural analgesia, temperature, and intravascular volume status. As a guide the normal resting heart rate for a 4 year old will be in the region of 90-110 bpm. A heart rate within the ranges 85 - 120 bpm with occasional increases outside these limits according to intensity of surgical stimulus, effectiveness of analgesia and depth of anaesthesia would be complete acceptable. A high heart rate would be expected due to anxiety on arrival in the anaesthetic room, and this would take some minutes to settle after induction of anaesthesia.

The normal systolic blood pressure of a 4 year old is within the range 80-100 mm Hg. Again, the factors influencing heart rate during anaesthesia will similarly influence blood pressure. Depending on the effectiveness of analgesia, intensity of surgical stimulus, depth of anaesthesia, and intravascular volume status, one would expect the systolic blood pressure of a 4 year old to be approximately within the range 70 - 110 mm Hg during an operation

Further issues

ix. *Please comment on whether there are any further issues in Adam's case you would like to see the Inquiry consider investigating further, or in greater detail.*

I cannot identify further issues

Dr Simon R. Haynes: 5th March 2012

FREEMAN HOSPITAL

THEATRE REGISTER

P.C.L. FH 31

DATE and TIME	DIAGNOSIS	OPERATION	OPERATOR	ANAESTHETIST	ANAES-THETIC	SCRUB NURSE	SWAB CHECK NURSE	PACKS or DRAINS
18.11.95 12.39 Start Finish 1340	Sternotomy leak	Wound Rev/Wash [?]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
28.11.95 Start 1333 Finish 1624	Coarct.	Coarct Repair	[redacted]			[redacted]	[redacted]	[redacted]
29/11/95 14.00 Start Finish		Caesarian Section.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
30.11.95 Start 08.35 Finish	2° ASD	Closure 2° ASD.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
30.11.95 Start Finish	DORV	Atrial septectomy [?] PMV Repair LAV [illegible]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]

Adam's daily fluid balance

	Daily (24 hr period)						
	Haynes	**Gross**	**Coulthard**	**Sumner**[1]	**Taylor**	**Savage**	
Weight	20 kg	20 kg	19 kg		21 kg	21kg[2]	
Surface area	0.8 m^2	0.8 m^2	0.8 m^2		0.75 m^2	0.75 m^2[3]	
Adam's usual daily intake (known)	Enteral intake = 2100ml per day						
Fluid losses						**Inquiry WS**[4]	**Letter to Dr. George Murnaghan dated 07/06/96**[5]
a) Insensible losses	[400ml/m^2] 400x0.8 = 320 ml	[400ml/m^2] 400x0.8 = 320 ml	[300ml/day/m^2] 300*0.8= 240 ml	400-500ml	[300ml/day/m^2] 300x0.75 = 225 ml	[300ml/day/m^2]	300ml-400ml
b) Urine output (assumption that = 2100ml - insensible loss - dialysis losses)	[1380ml/day] = 57.5 ml/h	[1350ml/day] =56.3 ml/h	[1500ml/day] = 62 ml/h	[≤75ml/kg/day = 1500 ml/day] = ≤62.5 ml/h	[1875ml/day] =78.1 ml/h	[1200mls—1500mls] 50ml/hr to 62.5ml/hr	70-75ml/hr
c) Dialysis loss (15 cycles)	400 ml	290 ml	Up to 292 ml	100-200 ml		400 ml	
d) Faecal loss		100 ml	68 ml				

[1] Ref: 059-054-114
[2] Ref: 059-006-011
[3] Answer to WS-002-3, Q.36(b) at p.39
[4] Answer to WS-002-2, Q.10(d) at p.18
[5] Ref: 059-003-005

Adam's perioperative fluid balance

	Time between ward admission & start of preoperative fasting 2200-0500 = 7 h				**Time between start of preoperative fasting period & anaesthesia 0500-0700 = 2 h**			
	Haynes	**Gross**	**Coulthard**	**Taylor**	**Haynes**	**Gross**	**Coulthard**	**Taylor**
Fluid losses								
a) Insensible losses	[400ml/m²/day] (400x0.8)x7/24 = 93 ml	[1.05 ml/kg/h] = 147 ml	[300ml/day/m²] (300*0.8)x7/24 = 70 ml	[300ml/day/m²] (300x0.75)x7/24 70 ml	27 ml	42 ml	20 ml	20 ml
b) Urine output (assumption that = 2100ml - insensible loss - dialysis losses)	[1380ml/day] = 57.5 ml/h 57.5 x 7 = 403 ml	[2.8 ml/kg/h] = 392 ml	[1500ml/day] = 62 ml/h 62 x 7 = 434 ml	[1875ml/day] =78.1 ml/h 78.1 x 7 = 547 ml	115 ml	112ml	124 ml	156 ml
c) Dialysis loss (received 8 of usual 15 cycles)	8/15 x 400 = 213ml	154 ml	Much less than 292 ml	0	0	0	0	0
Total (cumulative) fluid losses	**709 (709) ml**	**693 ml**	**500-800 (most likely 600) (600)**	**617 (617) ml**	**142 (851) ml**	**154 ml**	**144 (744) ml**	**176 (793) ml**
Actual (cumulative) fluid input	**952 (952) ml**	**970 ml**	**952 (952) ml**	**970 (970) ml**	**0 (952) ml**	**0 ml**	**0 (952) ml**	**0 (970) ml**
Estimated (cumulative) fluid excess	**243(243) ml**	**277 ml**	**152-452 (152-452)**	**353 (353) ml**	**-142 (101) ml**	**-154 ml**	**-144 (8 to 308) ml**	**-176 (177) ml**
Comments + relevant information regarding Na^+ content of: **a) input fluids** **b) losses**	Given as Dioralyte (60 mmol Na+/l Urine Na+ assumed 40 mmol/l Na^+ given= 57 mmol Na^+ content of losses: urine=16 mmol Dialysis=30 mmol	Na^+ content of fluids given:59.5 mmol Na^+ content of losses:44.3 mmol	Input= Dioralyte 953ml = 57 mmol Na+ Output= Insensible Na approx 0 + urine likely to be 75/l = 33 Na loss + dialysis likely to be 130/l = <38 Na loss Na balance = less than 14 mmol deficit (PD loss likely to be much less than 38, so prob in POS Na balance)	Na+ content of fluids given: 0.18NaCl/4% Glucose: 30mmol/l Dioralyte=35 mmol/l Na+ content of losses: Urine estimate= 30-40 mmol/l Insensible Loss= 0mmol/l	Na^+ content of fluids given: nil Na^+ content of losses: urine 4.6 mmol	Na^+ content of fluids given: 0 mmol Na^+ content of losses: 7.4 mmol	Input= 0 mmol Na+ Output = Insensible Na approx 0 + urine likely to be 75/l = 9 Na loss Na balance = -9 (Thus cumulatively likely to be overall approx 0 i.e. went to theatre in sodium balance)	Na+ content of fluids given: None given Na+ content of losses: Urine estimate= 30-40 mmol/l Insensible Loss= 0mmol/l

Reasons why planned fluid infusion (content or infusion rate) should change due to change in estimated loss		The positive fluid balance should be watched . It should not increase much further .		Fluid input exceeded estimate loss due to the fact that urine losses had occurred during the day prior to admission and would normally have been replaced by giving 1500mls of feed overnight.		The fluid and sodium gains from the preceding period are diminished by the small present losses . A small amount of total fluid excess (by 120 ml) remains however .	Overall, estimated water balance pre-op is close to ZERO from +12 to 312 ml Overall, the estimated Na balance pre-op is also quite close to ZERO, given the unknowns including the UF value and the urine sodium concentration. Therefore reasonable to assume that Adam went to theatre in approx normal salt and water balance.	

Adam's perioperative fluid balance

	Time between induction of anaesthesia & start of surgery 0700-0800 = 1 h				Time from start of surgery until vascular clamps on 0800-1000 = 2 hr			
	Haynes	**Gross**	**Coulthard**	**Taylor**	**Haynes**	**Gross**	**Coulthard**	**Taylor**
Fluid losses								
a) Insensible losses	14 ml	21 ml	10 ml	10 ml	Basal losses = 27 ml Evaporative losses from wound = 4ml/kg/h = 160 ml	[0.5 ml/kg/h] = 20 ml	20 ml	2-4ml/kg/h = 84-168 ml
b) Urine output (assumption that= 2100ml-insensible loss-dialysis losses)	58 ml	56 ml	62 ml	78 ml	115 ml	112 ml	Up to 124 ml	156 ml
c) Blood loss	0	0	0	0	600 ml	518 ml	600 ml	Approx 800 ml
Total (cumulative) fluid losses	**72 (923) ml**	**[77] ml**	**72 (816) ml**	**88 (881) ml**	**902 (1825) ml**	**650 ml**	**Up to 744 (1560) ml**	**1040-1124 (1921-2005) ml**
Actual (cumulative) fluid input	**750 (1702) ml**	**[650] ml**	**750 (1702) ml**	**750 (1720) ml**	**2300 (4002) ml** 750 ml 0.18% NaCl /4% Glucose, 500 ml Hartmann's 800 ml HPPF 250 ml Blood	**1750 ml**	**2300 (4002) ml**	**1950 (3670) ml** 400 ml 0.18% NaCl / 4% Glucose 500ml Hartmann's 800ml HPPF 250ml Blood
Estimated (cumulative) fluid excess	**678 (779) ml**	**573 ml**	**678 (686 to 986)**	**662 (839) ml**	**1398 (2177) ml**	**1100 ml**	**1556 (2242-2542) ml**	**826-910 (1665-1749) ml**
Comments + relevant information regarding Na^+ content of : **a) input fluids** **b) losses**	Received 750 ml 0.18% saline/4% glucose Na^+ content of fluids given = 23 mmol Na^+ content of losses: urine:2.3 mmol	Na^+ content of fluids given:16 mmol Na^+ content of losses:3.4 mmol	Input = 31 mmol/l = 23 mmol Na+ Output = Insensible Na approx 0, + urine likely to be 75/l = 5 Na loss	Na+ content of fluids given: 0.18NaCl/4% Glucose: 30mmol/l Dioralyte=35 mmol/l Na+ content of losses:	Na^+ content of fluids given: 0.18% NaCl /4% Glucose: 30mmol/l Hartmann's: 131mmol/l HPPF: 130mmol/l Blood: 130 mmol/l Na^+ content of fluids given: 202 mmol	Na^+ content of fluids given: 173 mmol Na^+ content of losses: 71 mmol	Input = 226 mmol Na+ Output = blood 78 + urine = approx 9 mmol total.	Na^+ content of fluids given: 0.18% NaCl /4% Glucose: 30mmol/l Hartmann's: 130mmol/l HPPF: 130-150mmol/l Blood: 135-145 mmol/l

			Na balance = +28 (If accept arrival in theatre in approx NA balance, now cumulative Na balance = +28 ml)	Urine estimate= 30-40 mmol/l Insensible Loss= 0mmol/l	Na^+ content of losses: 83 mmol		Na balance = +139	Na^+ content of losses: Urine estimate: 30-40 mmol/l
Reasons why planned fluid infusion (content or infusion rate) should change due to change in estimated loss	Since 2200h previous evening has gained 779 ml fluid. There was no fluid deficit at the start of anaesthesia, the 0.18% saline / glucose given to Adam will have diluted the sodium present in his serum. His kidneys cannot respond to lose the excess water he has been given.	The total water excess (considering the total fluid excess of 696 ml and the total sodium excess of 20.4 mmol) is now 555 ml .	Cumulative Na and water balance since induction of anaesthesia, assuming he was in balance on arrival in theatre IS: Water: +678 Na: +28 Concentration of the accumulated fluid therefore = 28/678 = 41 mmol/l	I had planned to correct fluid deficit and increase the circulating blood volume at this stage.	Note cumulative fluid excess of 2177 ml at end of this period. This may be more since the blood volume lost may well be overestimated, and the allowance for evaporative loss is generous. Adam's kidneys cannot respond to make extra urine. **Too much fluid has been given, and although a lot of Na+ given, it is too dilute, resulting in a lowering of the serum sodium as measured at 0932h.**	The previous positive (total) fluid balance (696 ml) increased by a further 1100 ml. Because of the present positive sodium balance (102 mmol) the previous (total) positive water balance (555 ml) is now increased by an additional 372 ml .		I had planned to increase the circulating blood volume at this stage. There were insensible operative losses of approximately 4ml/kg/hr during open abdominal surgery. Blood transfusion given at this stage to increase the haemoglobin.

Adam's perioperative fluid balance

	Time while vascular clamps applied 1000-1030 = 0.5 hr				Time from when clamps released until end of surgery 1030-1130 = 1 hr			
	Haynes	**Gross**	**Coulthard**	**Taylor**	**Haynes[6]**	**Gross**	**Coulthard**	**Taylor**
Fluid losses								
a) Insensible losses	Basal losses = 7 ml Evaporative losses from wound = 40 ml	5ml	5 ml	21-42 ml	Basal losses = 14 ml Evaporative losses from wound = 80 ml	10ml	10 ml	42-84 ml
b) Urine output	29 ml	28 ml	Up to 31 ml	39 ml	58 ml	56 ml	Up to 62 ml	78 ml
c) Blood loss	200 ml	130 ml	200 ml	Approx 200 ml	328 ml	259 ml	328 ml	Approx 211 ml (1211 ml total)
Total (cumulative) fluid losses	**276 (2101) ml**	**163 ml**	**Up to 236 (1796) ml**	**260-281 (2181-2286) ml**	**480 (2581) ml**	**325 ml**	**Up to 400 (2196) ml**	**331-373(2512-2659) ml**
Actual (cumulative) fluid input	**200 (4202) ml** 200 ml HPPF	**200ml**	**200 (4202) ml**	**100 (3760) ml** 100ml 0.18% NaCl/4% Glucose	**250 (4452) ml** 250 ml Blood	**400ml**	**250 (4452) ml**	**400 (4070) ml** 150ml 0.18% NaCl /4% Glucose 250ml Blood
Estimated (cumulative) fluid excess	**-176 (2001) ml**	**37ml**	**-136 (2106-2406) ml**	**-160 - -181 (1484-1589)ml**	**-230 (1771) ml**	**75ml**	**-150 (1956-2256) ml**	**27-69 (1511-1658)ml**
Comments + relevant information regarding Na^+ content of : **a) input fluids** **b) losses**	Na^+ content of fluids given: 26 mmols Na^+ content of losses: 27.2 mmol	Na^+ content of fluids given:15.8 mmol Na^+ content of losses:18 mmol	Input = 26 mmol Na+ Output = blood 26 + urine = approx 2 mmol total Na balance = -2	Na^+ content of fluids given: 0.18% NaCl /4% Glucose: Na^+ content of losses: Urine estimate: 30-40 mmol/l	Na^+ content of fluids given: 35 mmols Na^+ content of losses: 47 mmols	Na^+ content of fluids given:44.8 mmol Na^+ content of losses:36 mmol	Input = 33 mmol Na+ Output = blood 43 + urine = approx 5 mmol total Na balance = -15	Na^+ content of fluids given: 0.18% NaCl /4% Glucose: 30mmol/l Blood: 135-145 mmol/l Na^+ content of losses: Urine estimate: 30-40 mmol/l

[6] Note that Haynes uses time period 1030-1100 and 1100-1215 – the numbers are therefore extrapolated from his periods. The most affected figure by this is the evaporative losses which doubles when using Taylor's time periods.

Reasons why planned fluid infusion (content or infusion rate) should change due to change in estimated loss		**The previous positive water balance (927 ml) increased mildly by 37 ml.**				**The previous (total) positive fluid balance increased by 75 ml. In view of the positive sodium balance in this period the positive (total) water balance may be said to have remained unchanged.**	The cumulative Na and water balance since induction of anaesthesia, carrying forward the 07:00 to 08:00 values above, is therefore: Minimum water excess = 1956 Sodium excess = 150 The concentration of the accumulated fluid therefore = maximum of 150/1948 = 77 mmol/l This is equivalent to retaining 1071ml of fluid with a physiological Na concentration of 140 mmol/l and an extra 885 ml of water.	This was done to maintain the circulating blood volume at this stage following release of the clamps. Blood transfusion given at this stage.

Adam's postoperative fluid balance

	Time from end of surgery until arrival in ICU 1130-1215 = 0.75 hr			
	Haynes	**Gross**	**Coulthard**	**Taylor**
Fluid losses				
a) Insensible losses	Basal losses = 10ml	16 ml	7 ml	7.5 ml
b) Urine output	43 ml	42 ml	Up to 46ml	59 ml
c) Blood loss	0 ml		0 ml	0 ml
Total (cumulative) fluid losses	**53 (2634) ml**	**58 ml**	**Up to 53 (2249) ml**	**66.5 (2579-2726) ml**
Actual (cumulative) fluid input	**0(4452) ml** Nil	**25 ml**	**0(4452) ml**	100 ml 0.18 NaCL/4% Glucose **100 (4170) ml**
Estimated (cumulative) fluid excess	**-53 (1718) ml**	**-33 ml**	**-53 (1903-2203) ml**	**43.5 (1554.5-1701.5)ml**
Comments + relevant information regarding Na^+ content of: **a) input fluids** **b) losses**	Na^+ content of fluids given: nil Na^+ content of losses: 2.9 mmol	Na^+ content of fluids given:3.5 mmol Na^+ content of losses:2.6 mmol	Input = 0 mmol Na+ Output = urine = approx 4 mmol Na balance = -4	Na^+ content of fluids given: 0.18% NaCl /4% Glucose: Na^+ content of losses: Urine estimate: 30-40 mmol/l
Reasons why planned fluid infusion (content or infusion rate) should change due to change in estimated loss	Note cumulative fluid balance of +ve 1748 ml. May be more if blood loss and evaporative losses over-estimated	**The previous (total) positive fluid balance decreased by 33 ml . The sodium balance was minimally positive. The previous positive(total)water balance decreased mildly by 33 ml.**		