

NAME OF CHILD: Adam Strain

Name: John Alexander

Title: Doctor

Present position and institution:

Retired

Previous position(s) and institution(s):

One time Consultant Anaesthetist and Intensivist, Belfast City Hospital

Membership of Advisory Panels and Committees:

Previous Statements, Depositions and Reports:

N/A

OFFICIAL USE:

List of reports attached:

Ref:	Date:	

## Particular areas of interest

Para 26 (Ref 011-012-083) refers to comments made by Mr Brangan and Miss Higgins. I have not seen these before but will endeavour to answer the queries to the best of my ability.

- (i) "There was a fluid deficit between 5 am and 7 am". I believe this to be untrue. In para 15 of the notes we are told that Adam received 959 ml 'clear fluid'. Normally he received either 1200 mls or ~~2000~~ 1500 mls overnight (para 13) as part of total gastrostomy feeds over 24 hours of either 1700 mls or 2100 mls, so I do not accept that there was a real fluid deficit.

In normal anaesthetic practice, oral fluids are discontinued 2 hours prior to induction of anaesthetic to minimise the risk of aspiration of regurgitated fluid up the oesophagus into the throat during induction of anaesthesia.

- (ii) During renal transplantation, the urinary bladder is allowed to fill, so that it is easy to identify when it is time to transplant the ureter into the bladder. This is normal practice.

- (iii) "I am not convinced that tying off the internal jugular vein effected drainage from the vein". I personally believe that this was crucial to the difficulty encountered in locating the vein and inserting a triple-lumen catheter.

- (iv) "I would not entirely concur..." (Ref 011-012-083)

I personally would agree with Dr Sumner.

Hyponatraemia in Adam's case was dilutional due to infusion of a large volume of hypotonic (0.18% sodium chloride) solution.

I do not believe that an abnormal renal function could alter ~~some~~ blood sodium concentration so drastically over the period of the surgery.

(v) "With the benefit of hindsight..." It is obvious that the graph of sodium levels shown in Para 11 was prepared post-mortem, but if it had been available at the time of surgery, much more attention would have been paid to sodium concentrations. How frequently should levels be monitored? Certainly daily during normal nursing, possibly 2 hourly if possible during prolonged surgery.

(vi) I personally would be very alarmed if serum sodium was 123 and if it occurred during or immediately after surgery, would warrant an immediate infusion of hypertonic saline. The person who made the statement "would not have been particularly alarmed" is, I believe, writing generally.

(vii) The problem was the very high venous pressure measurement as registered by the transducer. If, as we now believe the triple-lumen catheter ascended in the neck rather than down towards the heart. If this is the case and it was not recognised before the operation started, it would be impossible to gain access to the child once the operation started.

(viii) "... a high infusion of fluids". These are not my words. I might have used the adjective 'generous', and this would be par for the course in paediatric renal transplantation. This is explained in para (v) of the next paragraph 27.

Para 27. (i) The anaesthetic record indicates that the child was 20 kg (Ref 058-003-005) Somewhere in the patient notes his weight was recorded as 21 kg.

(ii) Normal limits in the Royal Belfast Hospital for Sick Children laboratory were 135-145 mmol/l (Ref 058-041-201)

(iii) I presume that the nature of the overnight fluid was not documented in the patient's notes. Even Dr Savage was unsure on this point (Ref 011-015-109).

(iv) Examination of the anaesthetic record (Ref 058-003-005) shows a decrease in heart-rate from 140 bpm to 90 bpm over the 4 hour period, with a rise in systolic blood pressure from 90 mmHg to 120. I would consider this record to be meticulously documented, especially in conjunction with the 'computerised printout' which seems to have disappeared, but must have been available at the time I wrote my report

(v) We now know that the triple-lumen catheter was misplaced, and instead of measuring pressures near the right atrium of the heart, was probably directed upwards towards the skull.

It is a recognised feature of paediatric renal transplantation that there is likely to be a dramatic fall in blood pressure, especially if, as in this case, the transplanted kidney is near adult size. When the vascular clamps are released, to restore blood supply to the new kidney, almost the entire vascular output is diverted to the new kidney. Therefore, the central venous pressure (CVP) is purposely maintained at a high level in an attempt to counteract this fall. This is achieved by giving liberal infusions of intravenous fluid.

In adult transplantation, we aim to maintain the central venous pressure at about 10-12 cm H<sub>2</sub>O.

I have no practical experience of pediatric transplantation.

(vi) These calculations can only be very approximate since one has no idea of the rate of fluid shifts from the vascular compartment to the extra-cellular and intra-cellular compartments. If we assume that after two hours of anaesthesia and surgery that the child has lost 800 ml of blood containing 112 mmol sodium (half the initial quantity of sodium in the blood), and has been replaced by a litre of 1/5 Normal saline which contains 41 mmol sodium plus about 200 ml HPPF (human plasma protein fraction) containing 28 mmol sodium. Add these together and assuming the blood volume remains constant, the total plasma sodium is now 181 mmol and the blood concentration would be 113 mmol/l. This calculation has not allowed for any shift of water into the extracellular space, the intracellular space, or excretion by the kidneys.

We do not know how long it would take for infused fluid to leave the vascular compartment.

I do not suppose the plasma sodium fell much below 120 mmol/l, but it was the speed or rate of fall which was the critical aspect of this case.

Release of antidiuretic hormone occurs in response to stress, general anaesthesia, opioids (morphine and related drugs), pain, blood loss and positive pressure ventilation. All these factors were present in this case.

The only conclusion that I can draw from the fact that plasma sodium levels remained so low for so long is that the intensivists looking after the child post-operatively recognised that the situation was hopeless and that aggressive treatment to correct sodium levels was pointless.

(vii) The child was fed by gastrostomy tube because he could not take nutrition or fluid by mouth. In addition he was having peritoneal dialysis six nights a week and was polyuric (producing a lot of urine) with a fixed output of about 2 litres daily. This is the stuff of nightmares, trying to balance all these issues during a major operation. It was thought that generous amounts of hypotonic (0.18%) saline would be balanced by the high urinary output while the glucose this solution contained would help to maintain nutrition.

Certainly,  $\frac{1}{2}$  normal saline which contains 77 mmol/l sodium, with enough dextrose (2.5%) to make the solution isotonic would be preferable, or Lactated Ringers's (Hartmann's) solution or even 'normal' isotonic saline could be used and if the dextrose component was considered important to maintain nutrition this could be added separately. The anaesthetic record (Ref 058-003-005) shows that 500 ml Hartmann's solution was started but over what period of time this was infused is not indicated.

I believe that this is a sufficient discussion of the problems of fluid replacement in this case, and the alternative types of intravenous solutions which could have been employed

The problem, of course, is that at the completion of surgery, it was realised that the child had developed severe cerebral oedema. During major surgery in children, the patient is completely covered by sterile towels, and the scrub nurse with her instrument trolleys will be as near the operation field as possible. Then the surgeon and his assistant must have access. There is no way in which the anaesthetic team can get near the patient's head to look at the pupils of the eyes, judge suffusion of neck veins, skin colour or turgidity. The anaesthetic team is entirely at the mercy of the monitoring equipment, and if arterial blood pressure, central venous pressure (CVP) and pulse oximetry (measuring oxygen content of blood) are all giving acceptable readings, they are naturally inclined to assume that all is normal. It is only when surgery is complete and the sterile drapes are removed, that any problems will be revealed.

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

Signed:

J. Alexakis

Dated: 02 06 11

NOTE

DECLARATION OF INTEREST FORM

TO Anne Dillon  
Solicitor to the Inquiry

FROM DR JP ALEXANDER

I confirm that I have read the list set out below and have marked on the attached sheet those individuals with whom and (where those individuals represent an organisation, firm or government department) that organisation, firm or government department with which I declare an interest:

I confirm that: (please delete as appropriate)

a) I have disclosed on an attached sheet the existence and particulars of any personal or professional interest that I have had with the following individuals and organisations:

~~Dr. Maurice Savage~~

~~Dr. Mary O'Connor~~

~~Dr. Robert Taylor~~

~~Dr. Terence Montague~~

~~Mr. Patrick Keane~~

~~Mr. Stephen Brown~~

~~The RBHSC and its administrators and management, including Dr. G. A Murnaghan, Dr. J. Gaston, Dr. S. McKaigue, Dr. P.M. Crean~~

~~Belfast Health and Social Services Care Trust formerly the Royal Group of Hospitals and Dental Hospital Heath and Social Services Trust~~

~~"Professional interest" includes contact through collaboration on research, other investigations and committee work.~~

b) I have no such interest to declare

I acknowledge that I am under a continuing duty to declare any personal or professional interest with those listed above that may arise hereafter.

SIGNED:

*JP Alexander*

DATE : 02 06 11



## The Inquiry into Hyponatraemia-related Deaths

Chairman: Mr John O'Hara QC

Dr J Alexander  
18 Cranmore Avenue  
Belfast  
BT9 6JH

Your Ref:

Our Ref: CMcG-0005-11

Date: 23<sup>rd</sup> May 2011

Dear Dr Alexander

### Investigation into the death of Adam Strain

I refer to your second witness statement in Adam Strain's case dated 3 May 2011 (ref WS 120/2). Copy enclosed

In answer to the question at paragraph 26 of the attached Note, dated 15<sup>th</sup> April 2011, you say:

"Para 26 (Ref 011-012-083) refers to comments made by Mr Brangam and Miss Higgins, presumably after my deposition was made to the Coroner. It would not be appropriate for me to try to interpret their comments....that is the way he operates".

Unfortunately you appear to have misunderstood the format of these depositions at the Inquest. Normally, a note is taken of the statement by the deponent and then the deponent's answers to questions from the legal representatives of the parties involved are noted. The questions or remarks of these legal representatives are generally not noted.

From the document and the information contained in the answers, it is clear that these are your answers (rather than comments by legal representatives) and that you gave two answers, one to Mr Brangam and one to Miss Higgins.

Accordingly, could you please answer the questions posed at paragraph 26 of the note on the attached pro forma witness statement – WS-120/3.

As you know, the Inquiry is working to a very tight timetable and I should be grateful if you could reply to me as soon as possible.

Yours sincerely



Clare McGivern  
Solicitor to the Inquiry

Secretary: Bernie Conlon

Arthur House, 41 Arthur Street, Belfast, BT1 4GB

Email: [inquiry@ihrdni.org](mailto:inquiry@ihrdni.org) Website: [www.ihrdni.org](http://www.ihrdni.org) Tel: 028 9044 6340 Fax: 028 9044 6341

NOTE

**NOTE FOR PROFESSOR JOHN ALEXANDER  
RE: ADAM STRAIN**

**Background**

1. Adam Strain, Claire Roberts, Raychel Ferguson and Conor Mitchell are four children who are the subject of a public Inquiry established under Article 54 of the Health and Personal Social Services (Northern Ireland) Order 1972 and being conducted in Northern Ireland by John O'Hara QC. The current terms of reference of the Inquiry are:

To hold an Inquiry into the events surrounding and following the deaths of Adam Strain and Raychel Ferguson, with particular reference to:

1. The care and treatment of Adam Strain and Raychel Ferguson, especially in relation to the management of fluid balance and the choice and administration of intravenous fluids in each case.
2. The actions of the statutory authorities, other organisations and responsible individuals concerned in the procedures, investigations and events which followed the deaths of Adam Strain and Raychel Ferguson.
3. The communications with and explanations given to the respective families and others by the relevant authorities.

In addition, Mr O'Hara will:

- (a) Report by 1 June 2005 or such date as may be agreed with the Department, on the areas specifically identified above and, at his discretion, examine and report on any other matters which arise in connection with the Inquiry.
- (b) Make such recommendations to the Department of Health, Social services and Public Safety and report on any other relevant matters which arise in connection with the Inquiry.
- (b) Make such recommendations to the Department of Health, Social Services and Public Safety as he considers necessary and appropriate.

The cases of Claire Roberts and Conor Mitchell have been added to the Inquiry's work by the Chairman under his discretionary power to examine and report on any other matters which arise in connection with the Inquiry

2. Adam Strain was born on 4<sup>th</sup> August 1991 with cystic, dysplastic kidneys with associated problems with the drainage of his kidneys related to obstruction and vesico ureteric reflux. He was referred to the Royal from the Ulster Hospital in Dundonald. He died on 28<sup>th</sup> November 1995 in the

## NOTE

Royal following kidney transplant surgery on 27<sup>th</sup> November 1995 from which he never recovered consciousness.

3. The Inquest into his death was conducted on 18<sup>th</sup> and 21<sup>st</sup> June 1996 by John Leckey the Coroner for Greater Belfast, who engaged you as an expert along with (i) Dr. Edward Sumner Consultant Paediatric Anaesthetist at Great Ormond Street Hospital for Sick Children ("Great Ormond Street"); and (ii) Professor Peter Berry of the Department of Paediatric Pathology in St. Michael's Hospital, Bristol. The Inquest Verdict identified Cerebral Oedema as the cause of his death with Dilutional Hyponatraemia as a contributory factor.
4. An investigation was subsequently carried out into the death of Adam Strain and the other children (save for Conor Mitchell) by the Police Service of Northern Ireland ("PSNI"). The PSNI engaged a number of Experts to assist them with their investigation into Adam's death. In addition to you, they also engaged Dr. Edward Sumner Consultant Paediatric Anaesthetist, Mr. Geoff Koffman Consultant Surgeon at Guy's & St. Thomas Hospital and Great Ormond Street and Professor R.A Risdon Consultant Paediatric Pathologist at Great Ormond Street.
5. All of the Experts engaged by the Coroner and the PSNI produced Reports.

## The Inquiry

6. The Inquiry has appointed a Panel of Advisers<sup>1</sup> to assist it in its investigations in respect of the children. It has also engaged Experts to deal with a number of discrete issues that are child-specific. The work of all the Inquiry's Advisers is peer reviewed by a team of international Experts.<sup>2</sup>

---

<sup>1</sup> Dr. Peter Booker (Paediatric Anaesthesia), Dr. Harvey Marcovitch (Paediatrics), Ms. Carol Williams (Paediatric Intensive Care Nursing), and Gren Kershaw (Health Service Management and Patient Safety)

<sup>2</sup> Professor Allen Arieff at the University of California Medical School in San Francisco (Internal Medicine & Nephrology), Dr. Desmond Bohn of the Critical Care Unit at the Hospital for Sick Children in Toronto (Paediatric Anaesthesia), Ms. Sharon Kinney at the Intensive Care Unit and Clinical Quality and Safety Unit at the Royal Children's Hospital in Melbourne (Paediatric and Intensive Care Nursing)

NOTE

**Background to Adam**

7. Adam Strain was born with cystic, dysplastic kidneys with associated problems with the drainage of his kidneys related to obstruction and vesico ureteric reflux. He was referred to the Royal from the Ulster Hospital in Dundonald and came under the care of Dr. Maurice Savage (Consultant Paediatric Nephrologist)<sup>3</sup> and Mr. Stephen Brown (Consultant Paediatric Surgeon).
8. Adam had multiple operations to his urinary tract, during which he was largely under the care of Mr. Stephen Brown. He had re-implantation of his ureters on 2 occasions and had nephrostomies performed during the early months of his life. On several occasions, he was critically ill and required care in PICU and a brief period of dialysis due to acute renal failure. In addition a fundoplication procedure was carried out in 1992 when Adam was less than a year old, to prevent gastro-oesophageal reflux. Eventually he required all his nutrition through a tube and in 1993 he had a cystoscopy and percutaneous gastrostomy. In October 1995 there was a change of his gastrostomy.<sup>4</sup>
9. Adam was subject to recurrent urinary tract infections and his renal function deteriorated to the point where he required dialysis for uraemia. His mother was trained in the home peritoneal dialysis technique so that he could be dialysed at home. Adam was polyuric and, when he was a few months old, the sodium content of his urine ranged between 29 and 52 mmol/L.<sup>5</sup>

---

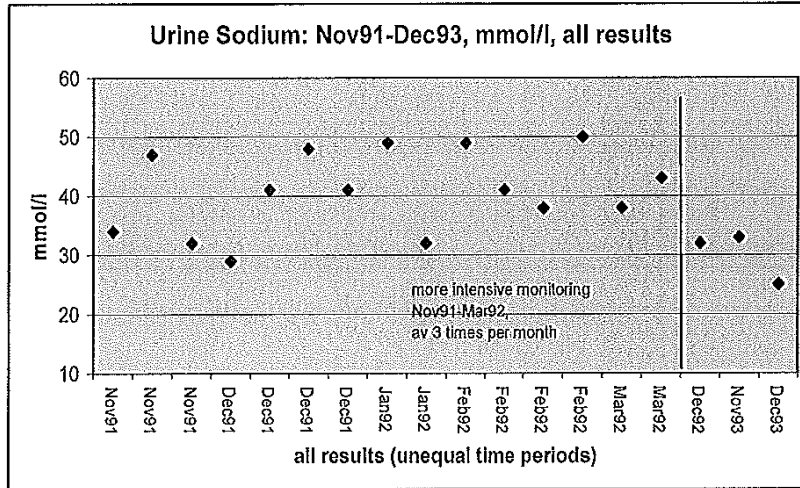
<sup>3</sup> Now Professor Maurice Savage

<sup>4</sup> A Schedule is attached-Tab 1 of the accompanying core files- showing all Adam's surgical procedures and their dates together with the surgeons and anaesthetists involved

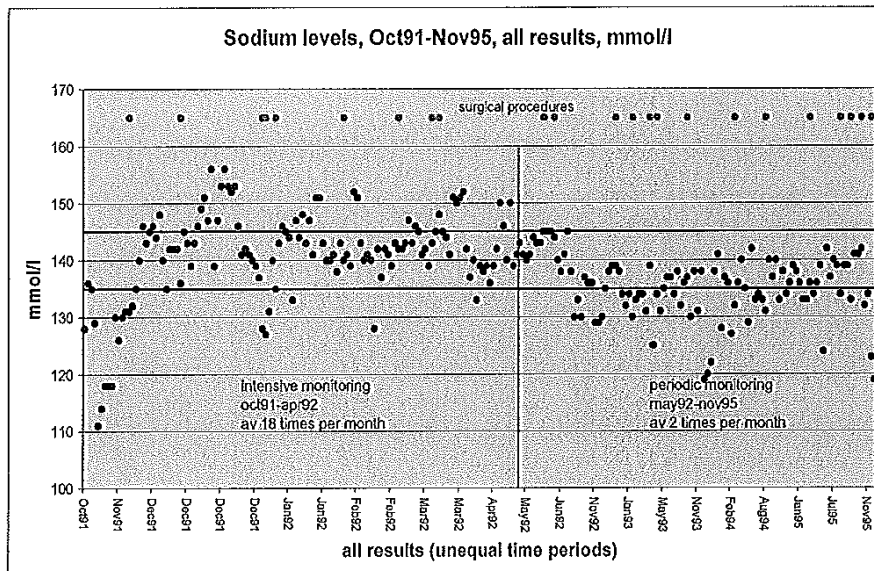
<sup>5</sup> See biochemistry results in 1995 at: ref: 058-041-187-224 and 050-018-055 - Tab 2

NOTE

10. A graph of all Adam's recorded urine sodium results is shown below:<sup>6</sup>



11. According to Dr. Maurice Savage,<sup>7</sup> Adam had a potential for generating low serum sodium concentrations and so he received extra sodium in his feeds as 100 mls/day of normal saline and 50 mls/day of 8.4% sodium bicarbonate. A graph of all of his recorded serum sodium concentrations is shown below:



<sup>6</sup> The 2 graphs and accompanying tables are found at Tab 3 of the accompanying core file. For ease of reference the parallel red lines indicate the normal range of 135-145 mmol/L.

<sup>7</sup> See ref. 011-015-113. See also letter dated 17<sup>th</sup> January 1996 from Adam's Mother to the Coroner referring to the fact that it was commonly known that Adam had an ongoing problem with his sodium for which he had been treated the previous 4 years - ref: 011-041-174 --Tab 4

NOTE

12. The management of his sodium levels appears to have been largely carried out under the care of Messrs. Victor Boston and Stephen Brown, both Consultant Paediatric Surgeons. Adam's recorded serum sodium concentrations for 1995, the year of his transplant surgery, show one very low result of 124 mmol/L and a number below the normal range of 135-145 mmol/L.
13. Adam was put on the waiting list for a kidney transplant once he was placed on dialysis. His total daily gastrostomy feeds in the months prior to the transplantation surgery are documented either as 1700 mls or 2100 mls (1200 or 1500 mls overnight) and he passed an undocumented, so unknown amount of urine, but probably in excess of 1000 ml each day.<sup>8</sup>
14. Adam received the offer of a reasonably matched kidney on 26<sup>th</sup> November 1995. The donor kidney had been removed from a heart-beating 16-year-old donor with normal renal function at 1.42am on 26<sup>th</sup> 1995.<sup>9</sup> Transplant surgery was scheduled for 6.00am on 27<sup>th</sup> November 1995.
15. At 11.00pm on 26<sup>th</sup> November 1995, Adam's serum sodium was recorded as either 139 or 134 mmol/L (no printed report available) and Hb 10.5. As part of the preparation for his surgery, his feeds were changed although there remains an issue as to exactly what they were changed to. According to his charts, he was given 952 ml of 'clear fluid' to stop 2 hours before going into theatre.<sup>10</sup> The nursing records do not state the nature of the 'clear fluids' given. Some witnesses have claimed that fluid was Dioralyte (containing 60 mmol of sodium /L). However, Dr. Maurice Savage corrected his Deposition to delete 'Dioralyte' and substitute 'N/S Saline Dextrose'.<sup>11</sup> In any event, it is thought that he received just over 1 litre of fluids. It was planned between Dr. Maurice Savage and Dr. Robert Taylor (Consultant Paediatric Anaesthetist) that Adam should receive intravenous fluid (75 ml/h)<sup>12</sup> after the tube feeds were discontinued and have his blood chemistry checked before going to theatre. In fact, IV fluids did not start until anaesthesia was induced and electrolytes were not re-measured preoperatively after 11pm. Suggested reasons were difficulty in achieving

---

<sup>8</sup> See ref: 059-006-121 - Tab 5

<sup>9</sup> See Report of Mr. Geoff Koffman Consultant Surgeon for the PSNI dated 5<sup>th</sup> July 2006, ref: 094-007-027 - Tab 6

<sup>10</sup> See ref: 057-010-013 Tab 7

<sup>11</sup> See ref: 011-015-109 - Tab 4

<sup>12</sup> See ref: 059-006-022 - Tab 8

NOTE

venous access<sup>13</sup> and estimated delay in receiving results back from the laboratory ("1-3 hrs").<sup>14</sup>

16. The main events surrounding Adam's transplant surgery are summarised in the following table:

Date	Event		Reference
26.11.1995	1.42am	Donor kidney removed by Mr. Casey at Southern General Hospital, Glasgow	058-009-025 (Kidney Donor Information Form)
	9.00pm	Adam admitted to Musgrave Ward at the RBHSC for possible renal transplant	011-009-001 (Deposition of Ms. Strain 18 <sup>th</sup> June 1996)
	9.30pm	Pre-op investigations for possible renal transplant carried out by Dr. Cartmill (Surgical SHO); Nursing admission details taken by SN Murphy	058-035-144 (Extract from Medical Notes and Records) 049-036-245 (Royal's Chronology of Care)
	10.00pm	Evaluation Nursing Report taken by SN Murphy	049-036-245 (Royal's Chronology of Care)
	11.00pm	i.v. fluids commenced prescribed by Dr. Larkin (Community SHO); Results of investigations recorded by Dr. O'Neill (SHO) as haemoglobin 10.5g/dl, sodium 139 (or 134) mmol/l and urea 16.8; Dioralyte (or some form of dextrose saline solution) instead of Nutrison gastrostomy feeds on Dr. Taylor's (Consultant Paediatric Anaesthetist) advice	<ul style="list-style-type: none"> <li>• 049-036-245 (Royal's Chronology of Care)</li> <li>• 011-014 &amp; 015 (Depositions of Drs. Savage and Taylor 21<sup>st</sup> June 1996)</li> <li>• 057-007-008 (biochemistry result list)</li> <li>• 058-035-144 (Manuscript Extract from Medical Notes and Records)</li> </ul>
	11.30pm	Medical history and clinical examination taken by Dr. O'Neill (Senior House Officer): (i) temp. 36.4; (ii) pulse 97; (iii) blood pressure 108/56; (iv) weight 20.2kg	059-006-009 (Extract from Medical Notes and Records)
27.11.1995	1.30am	SN Murphy recorded i.v. infusion tissues and informed	049-036-245 (Royal's Chronology of Care)

<sup>13</sup> See ref: 011-014-099 and ref: 093-006-017 for the explanation of the difficulty in achieving venous access. Tab 9 See also: 093-035-105 for the other basis as to the time taken to receive results back from the laboratory Tab 10

<sup>14</sup> See ref: 093-035-105 for the other basis as to the time taken to achieve results back from the laboratory Tab 10

## NOTE

		Dr. O'Neill	
	5.00am	Unsuccessful attempts at i.v. cannulation ; between 11.00 pm and 5.00 am 952 ml of 'clear fluids' given via gastrostomy, peritoneal dialysis as usual (750 ml 1.36% Dextrose solution - 8 cycles given before theatre)	<ul style="list-style-type: none"> <li>• 049-036-246 (Royal's Chronology of Care)</li> <li>• 011-015 (Deposition of Dr. Savage 21<sup>st</sup> June 1996)</li> </ul>
	7.00am	General anaesthesia induced in the presence of his mother. 0.18% NaCl in 4% glucose started i.v. by Dr. Taylor - 500 ml given by 7.30am and 685 ml by 7.55 am. Lumbar epidural catheter inserted.	<ul style="list-style-type: none"> <li>• 058-003-005 (Anaesthetic Record)</li> <li>• 011-014 (Deposition of Dr. Taylor 21<sup>st</sup> June 1996)</li> </ul>
	7.30am	Catheter inserted into right subclavian vein. Initial CVP reading taken at 0730 (as per Dr Taylor) or 0755 (as per trend monitor) was 17 mm Hg (normal 2-7 mm Hg); transplant surgery started by Mr. Keane (Consultant Urologist); further 500 ml of Dextrose Saline given up to 8.45am	<ul style="list-style-type: none"> <li>• 011-014-105 (Transcript of Dr. Taylor 21<sup>st</sup> June 1996)</li> <li>• 058-003-005 (Anaesthetic Record)</li> </ul>
	8.30am	Donor kidney removed from ice; 400 colloid fluids (HPPF) given	<ul style="list-style-type: none"> <li>• 058-009-027 (Kidney Donor Information Form)</li> <li>• 058-003-005 (Anaesthetic Record)</li> </ul>
	8.45am	Rate of Dextrose saline fluids drastically slowed (500ml of given up to 11.00am) and 500ml Hartmann's solution commenced	<ul style="list-style-type: none"> <li>• 058-003-005 (Anaesthetic Record)</li> <li>• 059-004-007 (Dr. Taylor's note to Mr. Brangam, Solicitor)</li> </ul>
	9.15am	400 colloid fluids (HPPF) given	<ul style="list-style-type: none"> <li>• 058-003-005 (Anaesthetic Record)</li> </ul>
	9.32am	Results of blood gases and electrolytes received, showing sodium at 123 mmol/L (normal 135-145 mmol/L) and haematocrit at 18% (normal 35-40%); 250 ml packed red blood cells given	<ul style="list-style-type: none"> <li>• 058-003-003 (BGE Report)</li> <li>• 058-003-005 (Anaesthetic Record)</li> </ul>
	10.45am	200 ml colloid fluids (HPPF) and 250 ml packed red blood cells given	058-003-005 (Anaesthetic Record)
	11.00am	Skin closure; neostigmine and glycopyrrolate administered by Dr. Taylor to reverse the	<ul style="list-style-type: none"> <li>• Ref:011-014 (Transcript of Dr. Taylor 21<sup>st</sup> June 1996);</li> </ul>



NOTE

		neuromuscular blockade; blood loss recorded from swabs (328 ml), suction (500 ml) and other (300 ml)	<ul style="list-style-type: none"> <li>• 058-003-005 (Anaesthetic Record)</li> </ul>
	11.55 noon	Adam failed to wake, did not breathe and pupils fixed and dilated	011-014 (Deposition of Dr. Taylor 21 <sup>st</sup> June 1996)
	12.05pm	Adam transferred to PICU for ventilation of his lungs and assessment; puffy appearance with CVP reading of approx 30 mm Hg dropping to 11 mm Hg; Mannitol 50 ml prescribed and reduction in fluids	<ul style="list-style-type: none"> <li>• 058-005-013 (Drug record sheet)</li> <li>• 058-005-014 (Extract from Medical Notes and Records recorded by Dr. O'Connor)</li> <li>• 094-006-022 (Theatre log)</li> </ul>
	12.15pm	Adam's appearance 'bloated'	011- 009 (Deposition of Ms. Strain 18 <sup>th</sup> June 1996) 093-003 & 093-005 (PSNI witness statements of Adam's mother) Photographs.
	7.35pm	First brain stem test carried out by Dr. Webb (Consultant Paediatric Neurologist)	058-004-009 (Brain Death Form)
28.11. 1995	9.10am	Second brain stem test carried out by Dr. Webb (Consultant Paediatric Neurologist)	058-004-009 (Brain Death Form)
	9.15am	Life pronounced extinct	011-010-011 (Report of Autopsy 29 <sup>th</sup> November 1995)
	11.30am	Ventilatory support withdrawn from Adam in the presence of his Mother	011-015-110 (Deposition of Dr. Savage 21 <sup>st</sup> June 1996)

Issues

17. Dr. Edward Sumner (Consultant Paediatric Anaesthetist) concluded in his Report to the Coroner dated 22<sup>nd</sup> January 1996:<sup>15</sup>

I believe that on a balance of probabilities Adam's gross cerebral oedema was caused by the acute onset of hyponatraemia (see reference) from the excess administration of fluids containing only very small amounts of sodium (dextrose-saline and plasma). This state was exacerbated by the blood loss and possibly by the overnight dialysis.

A further exacerbating cause may have been the obstruction to the venous drainage of the head. If drugs such as antibiotics were administered through a venous line in a partially obstructed neck vein then it is possible that they could cause some cerebral damage as well.

<sup>15</sup> See ref: 011-011-053 - Tab 11

NOTE

(emphasis added)

18. Dr. Sumner also gave evidence at Adam's Inquest and his Deposition of 18<sup>th</sup> June 1996<sup>16</sup> records him as having expressed the following views:

All the fluids given after dialysis may have been given to increase central venous pressure. It may have had the effect of causing the dilution of the sodium in the body. Fluid balance in paediatrics is a more controversial area with a variety of views. With kidney transplants one gives more fluids than in other operations [*it is usual to be generous with fluids to maintain a CVP of 10-12 to optimise perfusion of the new kidney and to establish its urine-producing function*<sup>17</sup>]. When the new kidney is perfused it is vital that sufficient fluids are available. I got the impression that Dr. Taylor was not believing the CVP readings he was getting. I believe they were probably correct but high. I think I would have believed them. A high CVP can mean too much fluid has been administered<sup>18</sup> ... The low sodium was indicative of the hyponatraemia. Below 128 is a hyponatraemic state.

(Emphasis and parenthesis added)

19. Dr. Robert Taylor (Consultant Paediatric Anaesthetist) gave evidence at the Inquest. His Deposition of 21<sup>st</sup> June 1996<sup>19</sup> shows that he disagreed with Dr. Sumner's principal finding:

I cannot understand why a fluid regime employed successfully with Adam previously, led on this occasion to dilutional hyponatraemia ... I believe that the underlying cause of the cerebral oedema was hyponatraemia (not dilutional) during renal transplant operation.

...

Adam was the only child with polyuric renal failure I have anaesthetised for renal transplant. He needed a greater amount of fluid because of the nature of the operation [*All the more important in this case is the need to avoid dehydration that will deprive the donor kidney of sufficient fluid to produce urine*<sup>20</sup>]. I believe the fluids given were neither restrictive or excessive. The new kidney did not work leading to a re-assessment of the fluids given. This made us think we have underestimated fluid and we gave a fluid bolus at 9.32.

(Emphasis added)

20. Dr. Robert Taylor commented on preparing Adam for the surgery:

<sup>16</sup> See ref: 011-011-042 - Tab 11

<sup>17</sup> See Dr. Sumner's Report of 22<sup>nd</sup> January 1996 at ref:011-011-059 - Tab 11

<sup>18</sup> Dr. Sumner prepared his Report on the basis that Adam received 900mls of Diorolyte. See at ref: 011-011-055. That figure was corrected in correspondence between the Coroner and Dr. Armour but it is not clear that the correspondence from Adam's mother referring to the lower figure was passed to Dr. Sumner. Dr. Armour thought that the difference between the two figures made no difference to her opinion on the cause of Adam's death: "*It is not just the volume of fluid he received but the type.*" See at ref: 011-079-214 - Tab 12

<sup>19</sup> See ref: 011-014-108 - Tab 9

<sup>20</sup> See Deposition at ref:011-014-100 - Tab 9

NOTE

"with paediatric anaesthesia there is a compromise to be made ... we knew from many times on dialysis that his blood chemistry and his water content of his blood were ... fixed so we could assumptions [sic], do we hurt him with needles or do we assume that this management of dialysis was the same as before."<sup>21</sup>

21. He further commented on the amount of fluids that Adam could tolerate:

"I agree with Drs. Sumner and Alexander that any other child would not have been given that quantity of fluid. Adam was very exceptional and I don't feel that those two individuals really understood Adam. Dr. Taylor confirmed that the 300mls given by Dr. Loan was given over one hour. The knowledge that Dr. Taylor had was that Adam could tolerate very high quantities of this fluid without any loss from his body and recover safely".

The reference to Dr. Loan's previous anaesthetic regime for Adam was relied upon by Dr. Taylor as establishing that: "Adam was not a normal child because a normal child could not cope with 300mls in one hour"<sup>22</sup>

22. Dr Taylor also commented on 'dilutional hyponatraemia' and its applicability to Adam:

"It was impossible for Adam to suffer from dilutional hyponatraemia contrary to the view of the Coroner and the experts because he could not concentrate urine. Therefore Adam could not fit Dr. Sumner's theory ... He stressed that dilutional hyponatraemia was only a theory, that cases had been described but only in children with intact kidneys."<sup>23</sup>

See also: "For the dilutional hyponatraemia theory to work intact kidneys were required which in periods of dehydration shut down and retain water. This was the mechanism in the deaths of Raychel Ferguson and Lucy Crawford who has passed small volumes of concentrated urine, retaining free water while losing sodium and hence suffered dilutional hyponatraemia. It was impossible for Adam to suffer from dilutional hyponatraemia contrary to the view of the Coroner and the experts because he could not concentrate urine. Therefore Adam could not fit Dr. Sumner's theory"<sup>24</sup>

See further: "Dr. Taylor then contended that it was possible that if Adam was given 500 ml he could pass 500 ml in urine. No-one knew what his maximum output was, only that his minimum output was 200 ml. Dr. Taylor's knowledge of the disease was such that he believed Adam could pass an unlimited amount of fluid. No one had established a maximum output for Adam."<sup>25</sup>

---

<sup>21</sup> See ref: 093-035-094. Dr. Robert Taylor was interviewed by the PSNI under caution in relation to 'manslaughter by gross negligence' in respect of Adam's death - ref: 093-035-089 - Tab 10

<sup>22</sup> See ref: 093-035-096

<sup>23</sup> See ref: 093-035-102 Tab 10

<sup>24</sup> See ref: 093-035-102

<sup>25</sup> See ref: 093-035-103.

## NOTE

See also: "the theory of dilutional hyponatraemia was improperly applied to Adam and involved making the diagnosis for a known disease. He stated there was no evidence that a child like Adam could get dilutional hyponatraemia."<sup>26</sup>

Finally: "Dr. Taylor had many patients in intensive care whose sodium is low at the time of death, whether that was the cause of death or the result of a dying process is debatable. He acknowledged that hyponatraemia was present but not that it caused his death. Police put to Dr. Taylor that he had said in a letter to a solicitor that 0.18% saline was isotonic, when in effect, its effect once infused is hypotonic. Dr. Taylor stated that depended on the metabolism of the patient, depending on how quickly he burned the glucose. Dr. Taylor explained that Adam did not need too much glucose as the body burns less under anaesthetic. This enhances the ability of the fluid to remain isotonic. This was another reason for the theory of dilutional hyponatraemia to be inapplicable - none of Arieff's patients had died on the table they had all died post-operatively."<sup>27</sup>

23. Mr. Geoff Koffman (Consultant Surgeon at Guy's & St. Thomas Hospital and Great Ormond Street), was retained by the Police Service of Northern Ireland (PSNI)<sup>28</sup> to assist with their investigation into the circumstances of all of the children's deaths. He states in his Report of 5<sup>th</sup> July 2006 that:

"The sodium and potassium should have been repeated prior to start of surgery. The polyuric patient with poor renal function would pass large quantities of dilute urine and may have difficulty controlling the concentration of sodium and potassium in the blood".<sup>29</sup>

See also "[it being] commonly agreed that he [Adam] was polyuric and could cope with an oral intake of in excess of 2 litres a day"<sup>30</sup> and, in respect of the "minority of patients that are polyuric", that "the bladder may be left of free drainage in these patients. It would not be particularly important to monitor the urine output in these patients."<sup>31</sup>

## Queries

24. You made a Deposition at the Inquest on 18<sup>th</sup> June 1996, in which you provided your written report<sup>32</sup> and oral answers to Counsel on cross-examination<sup>33</sup>.
25. The Inquiry has appointed Dr. Peter Gross as an Expert Witness on hyponatremia to assist its investigation in respect of the fluid management issues.

<sup>26</sup> See ref: 093-035-103 - Tab 10

<sup>27</sup> See ref: 093-035-110

<sup>28</sup> The PSNI conducted an investigation into the deaths of all of the children over a period of about 2 years before deciding not to prosecute anyone in connection with their deaths

<sup>29</sup> See ref: 094-007-032 - Tab 6

<sup>30</sup> See ref: 094-007-029

<sup>31</sup> See ref: 094-007-035

<sup>32</sup> See ref: 011-012-079 and ref: 011-012-084 - Tab 13

<sup>33</sup> See ref: 011-012-083

NOTE

26. Issues have arisen out of your Deposition that require clarification, expansion and/or further explanation:

(i) *"There was a fluid deficit between 5am and 7am. That would have been a normal precaution for any child coming to surgery."* (Ref: 011-012-083)

- Quantify the "fluid deficit" that you state would have existed and explain why that would have been "a normal precaution".

(ii) *"During surgery it would have been impossible for the anaesthetist to measure urinary output."* (Ref: 011-012-083)

- Explain the reasons why "it would have been impossible for the anaesthetist to measure urinary output" during Adam's transplant surgery.

(iii) *"I am not convinced that tying off the internal jugular vein effected drainage from the vein."* (Ref: 011-012-083)

- Explain the reasons why you are "not convinced that tying off the internal jugular vein effected drainage from the vein".

(iv) *"I would not entirely concur with Dr. Sumner's view that a compromised renal function is not a factor in the onset of hyponatraemia."* (Ref: 011-012-083)

- Explain the basis of your difference of view with Dr. Sumner in respect of compromised renal function being a factor in the onset of hyponatraemia.

(v) *"With the benefit of hindsight sodium levels in children with a compromised renal function should be monitored"* (Ref: 011-012-083)

- State the reasons why "sodium levels in children with a compromised renal function should be monitored"
- State how frequently "sodium levels in children with a compromised renal function should be monitored"

(vi) *"I agree that a reading of 123 suggests that something should be done but I would not have been particularly alarmed"* (Ref: 011-012-083)

NOTE

- Describe exactly what you consider "should be done" when there is "a reading of 123"
- State the reasons why you "would not have been particularly alarmed" by a reading of 123 and explain whether your statement is a general one or in relation to the particular circumstances of Adam's case.

(vii) *"If I thought a transducer was giving a faulty reading I would get another one. I think it was unlikely that a 1000ml infusion of saline would raise the venous pressure to 17mm. I do not know what volume would achieve that. I do not believe that the problem could be recognised until after the operation"* (Ref: 011-012-083)

- Specify what you mean when you refer to "the problem"
- Specify what you mean by "recognised"
- Explain the reasons for not believing "that the problem could be recognised until after the operation"

(viii) *"I would agree that in Arieff's paper and in Adam's case there was a high infusion of fluids"* (Ref: 011-012-083)

- Explain and quantify what you mean by "a high infusion of fluids"

27. Issues have arisen out of your Report<sup>34</sup> that also require clarification, expansion and/or further explanation:

(i) *"He was 4 years 3 months of age, weighed 21 kg"* (Ref: 011-012-084)

- State the basis upon which you report that Adam weighed 21 kg.

(ii) *"Relevant blood tests that evening were ... sodium 139 millimoles per litre (mmol/l) ... the remainder [of results] were within normal limits"* (Ref: 011-012-084)

- State what you consider as the "normal limits" for blood serum sodium results.

(iii) *"He was given 952ml 'clear fluid', presumably water, overnight into his gastrostomy and this was stopped at 0500 on the 27<sup>th</sup>"* (Ref: 011-012-084)

<sup>34</sup> See ref: 011-012-084 – Tab 13

NOTE

- State the basis upon which you state that the “clear fluid” was “presumably water”
- (iv) *“There were no dramatic changes and no evidence of either hypoxia or hypotension, as documented by Dr. Taylor’s meticulous records, and confirmed by the computerised print out obtained at the end of the operation” (Ref: 011-012-085)*
- Explain what you mean by “no dramatic changes”, describe what measurements you included in that assessment and explain why.
  - Identify the “computerised printout” to which you refer and (if you have access to it) provide a copy of it with your response
  - Explain the basis for your description of Dr. Taylor’s records as “meticulous”
- (v) *“Central venous pressure remained very high throughout the procedure; this may have been partly due to a technical problem with the pressure transducer but also partly deliberate, since releasing the clamps on a transplanted near-adult sized kidney in a child can divert most of the cardiac output into the new organ with a dramatic fall in blood pressure; a high venous pressure will encourage a high cardiac output and avoid this problem” (Ref: 011-012-085)*
- Explain how the central venous pressure remaining “very high throughout the procedure” was “partly deliberate”
  - Describe the “deliberate” acts which resulted in this “very high” central venous pressure
  - Describe and explain what you consider to be an acceptable range for central venous pressure during a paediatric renal transplant
- (vi) *“A simple calculation reveals that if 1500ml 1/5 isotonic or ‘normal’ saline is infused into a child of this size, plasma (or serum) sodium will fall to about 120mmol/l. Since it takes some time for infused fluids to leave the vascular compartment, serum (or plasma) sodium is likely to be even lower than this and the situation may be made worse by increased levels of antidiuretic hormone produced during anaesthesia which will cause water retention by the kidneys” (Ref: 011-012-085)*
- Explain the “simple calculation” which “reveals that if 1500mls 1/5 isotonic or ‘normal’ saline is infused into a child of this size, plasma (or serum) sodium will fall to about 120mmol/l”
  - Explain the length of time it would likely have taken “for infused fluids to leave the vascular compartment” in Adam

NOTE

- Assess and explain how much lower than 120mmol/l you consider that Adam's plasma sodium is likely to have been given the time it would have taken "for infused fluids to leave the vascular compartment"
- Describe and explain the levels of plasma sodium (ie the "situation may be made worse") that might have been achieved due to "increased levels of antidiuretic hormone produced during anaesthesia which will cause water retention by the kidneys"
- Explain what conclusions can be drawn from the fact that Adam's plasma sodium levels remained so low for so long (ie 123mmol/L at 9.32am falling to 119mmol/L at 1.00pm following his transfer to PICU and thereafter does not rise above 123mmol/L until 8.00am on 28<sup>th</sup> November 1995 when it is recorded at 125mmol/L)

(vii) *"The complex metabolic and fluid requirements of this child having major surgery led to the administration of a large volume of hypotonic (0.18%) saline which produced a dilutional hyponatraemia and subsequent cerebral oedema. The operation was difficult and prolonged and the problem could not be recognised until the surgery was completed"* (Ref: 011-012-086)

- Specify "the complex metabolic requirements" of Adam "having major surgery"
- Explain how these "complex metabolic requirements" led to Adam being administered "a large volume of hypotonic (0.18%) saline which produced a dilutional hyponatraemia and subsequent cerebral oedema"
- Explain what alternative type and volume of saline solution could have been administered to address Adam's "complex metabolic requirements" during this surgery
- Explain "the complex ... fluid requirements" of Adam "having major surgery"
- Describe and explain what alternative type and volume of saline solution could have been administered to address Adam's "complex ... fluid requirements" during this surgery
- Describe and explain "the problem" to which you refer
- Explain the reasons why this "problem could not be recognised until the surgery was completed"



NOTE

DECLARATION OF INTEREST FORM

TO Anne Dillon  
Solicitor to the Inquiry

FROM

I confirm that I have read the list set out below and have marked on the attached sheet those individuals with whom and (where those individuals represent an organisation, firm or government department) that organisation, firm or government department with which I declare an interest:

I confirm that: (please delete as appropriate)

a) I have disclosed on an attached sheet the existence and particulars of any personal or professional interest that I have had with the following individuals and organisations:

Dr. Maurice Savage

Dr. Mary O'Connor

Dr. Robert Taylor

Dr. Terence Montague

Mr. Patrick Keane

Mr. Stephen Brown

The RBHSC and its administrators and management, including Dr. G. A Murnaghan, Dr. J. Gaston, Dr. S. McKaigue, Dr. P.M. Crean

Belfast Health and Social Services Care Trust formerly the Royal Group of Hospitals and Dental Hospital Health and Social Services Trust

"Professional interest" includes contact through collaboration on research, other investigations and committee work.

b) I have no such interest to declare

I acknowledge that I am under a continuing duty to declare any personal or professional interest with those listed above that may arise hereafter.

SIGNED:

DATE :