

Witness Statement Ref. No.

012/2

NAME OF CHILD: Adam Strain

Name: Alison Armour

Title: Dr Alison Armour.

Present position and institution: Consultant Pathologist at the Royal Preston Hospital, Preston Lancashire. Also Consultant Home Office Pathologist MB BCh BAO FRCPath DMJ (Path).

Previous position(s) and institution(s):

[As at the time of the child's death] Senior Registrar Forensic Medicine -- State Pathologist's Department Belfast.

Membership of Advisory Panels and Committees:

[Identify by date and title all of those between January 1995-December 2010] None

Other Statements, Depositions and Reports:

[Identify by date and title all of those between January 1995-December 2010] I Am a Consultant Home Office Pathologist. As such I have compiled many reports and have appeared at many murder trials and trials regarding wounding offences. The reports and witness statements for these trials are numerous.

OFFICIAL USE:

List of previous statements, depositions and reports attached (*):

Ref:	Date:	
011-010-034	29.11.95	Report of Autopsy on Adam Strain
011-010-030	18.06.96	Deposition at the Inquest on Adam Strain
011-010-033		Transcript of oral evidence at the Inquest on Adam Strain
093-022	12.04.06	PSNI Witness Statement
WS-012/1	15-03-11	Inquiry Witness Statement

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 such a number then please provide a copy of the document.

I QUERIES ARISING OUT OF YOUR AUTOPSY REPORT

With reference to your Autopsy Report dated 29th November 1995 (Ref: 011-010-034), please provide clarification and/or further information in respect of the following:

- (1) *"Date and Hour of Autopsy: 29th November 1995. 2.40pm."* (Ref: 011-010-034)
- (a) State on what date the final autopsy report was written. **The report is not dated.**
- (2) *"The body of a young male child, 104 cm. in length and weighing 20 kilograms."* (Ref: 011-010-037)
- (a) State whether you weighed Adam at the autopsy, or whether you obtained the weight from the clinical notes. **It is routine for the mortuary technician to weigh the body prior to the commencement of the autopsy examination. As far as I can recall the body was duly weighed. It is not the job of the pathologist to weigh the body.**
- (b) Please describe the physical appearance of Adam's body before you internally examined him on 29th November 1995 and how it compared to that of an average young male approximately 4 years old, 102 cm in length and 20 kilograms in weight. **The autopsy report clearly states that the body measured 104 cm in length and not 102 cm as stated above. The external examination of Adam Strain was described in detail in my autopsy report under the heading external examination. I refer you to this on page 2 of the report.**
- (c) State and explain the extent to which his physical appearance related to your findings following your internal examination of Adam. **The external appearance of Adam Strain was clearly documented in my report. There was nothing unusual in his appearance. The main internal finding was that of cerebral oedema. This can only be identified during internal examination. There are no external findings that would lead you to suspect that the deceased has cerebral oedema.**
- (3) **INTERNAL EXAMINATION OF NECK:**
- "There was no evidence of congestion or obstruction of the major blood vessels or the carotid arteries and jugular veins. There was no evidence of superior vena caval obstruction. The carotid arteries were normal. There was a suture in situ on the left side of the neck at the junction of the internal jugular vein and the sub-clavian vein."* (Ref: 011-010-039)
- (a) Please detail the anatomical dissection of the neck that you carried out in this case (or

would usually carry out in such a patient if you cannot recall), detailing the veins and arteries you would have exposed and examined, in order to make your statement that "there was no evidence of congestion or obstruction of the major blood vessels (in the neck)". **Although I cannot recall, the examination was a routine examination of the neck structures.**

(b) Please examine the note of an operation performed on Adam Strain on 29th May 1992 (Ref: 053-015-052). This operation involved "insertion central line, cystoscopy and retrogram." The typed notes state "Insertion Broviac Line into left common facial vein. Transverse cervical incision. Left common vein identified, entering left internal jugular. Left common facial ligated with 5 x 0 PDS. Broviac line tunnelled from anterior chest wall using Westminster and inserted into common facial vein and then internal jugular. Check X-ray confirmed tip of broviac line in proximal SBC. Neck wound closed in layers of 5 x 0 PDS and wound anterior chest wall closed 5 x 0 PDS."

(i) State whether you saw this note before writing your final autopsy report. If not, explain why not. **I cannot recall if I saw this note or not.**

(ii) State whether this note correlates with your findings on internal examination of the neck. If so, explain how it is consistent. If not, explain how it is inconsistent. **My autopsy report clearly states where I identified the suture. For the avoidance of doubt I refer you to page 4 of the autopsy report under the heading internal examination of neck. There was a suture on the left side of the neck at the junction of the internal jugular vein and the subclavian vein. This is in consistent with the above.**

(4) "The brain was photographed sequentially" (Ref: 011-010-039)

(a) State where those photographs are currently held. If you can, please provide copies. **The photographs are held at The State Pathologist's Department Belfast. I cannot provide you with a copy as these images do not belong to me.**

(5) "Liver: There were scattered foci of clear cell change." (Ref: 011-010-040)

(a) State what you mean by 'clear cell change'. **The liver cells showed clear cell change.**

(b) Explain the significance of the 'clear cell change' and its likely cause. **Without viewing the slides again I cannot accurately answer this question. However, from the description in the microscopical section of my report it is my view that these changes are not significant.**

(c) State if you discussed this with Professor Berry at any time. If so, state when and where you discussed it. **I cannot recall.**

(6) "Brain: There was massive cerebral oedema of the cortex and white matter. There was no evidence of terminal hypoxia." (Ref: 011-010-040)

(a) State what you meant by "terminal" hypoxia. **As a result of the dying process.**

- (b) Explain if there was, or may have been, evidence of hypoxia, but which did not constitute "terminal hypoxia". I find this question very difficult to understand. If there was hypoxic change this would have been stated. I have clearly stated there was no evidence of terminal hypoxia.
- (7) *"The operation itself was technically difficult due to the previous surgical procedures and there was an increased blood loss calculated to be approximately 1,200mls. This was replaced by intravenous fluids of 500mls of Hartman's, 1,000mls HPPF and 500mls of packed cells"* (Ref: 011-010-040)
- (a) Explain the basis upon which you report the blood loss to be "approximately 1,200mls at the end of the procedure". If you obtained this from the clinical notes, indicate where in the notes you did so. I refer you to the deposition of evidence. In the last paragraph I stated that ' Dr Taylor advised me at the autopsy of the calculation he needed to replace blood loss '.
- (b) Describe and explain how the administration of "intravenous fluids of 500mls of Hartman's, 1,000mls HPPF and 500mls of packed cells" constituted a 'replacement' for Adam's "blood loss calculated to be approximately 1,200mls". If you obtained this from the clinical notes, indicate where in the notes you did so. Dr Taylor advised me of this calculation. Also it was stated in the accompanying autopsy request form that at the commencement of the procedure there was a fluid deficit of 300mls. It also stated on this request form that there was excessive bleeding throughout the transplant.
- (8) *"(The brain, spinal cord and histological slides were seen by Dr. M. Mirakhur, Consultant Neuropathologist)"* (Ref: 011-010-040)
- (a) State the purpose for which Dr. M. Mirakhur was shown Adam's "brain, spinal cord and histological slides". I have previously answered this question. My answer remains the same. The slides would have been shown to her for a second opinion.
- (b) State what comments, analysis and/or reports Dr. M. Mirakhur provided in respect of "the brain, spinal cord and histological slides" that she saw, and identify where, if at all, you have incorporated/reflected them in your Report. This has been clearly addressed in my autopsy report.
- (c) State whether you have any notes from your conversation with Dr. M. Mirakhur regarding the slides, and if so, please provide a copy. Other than the information I have been provided with I do not have any notes whatsoever regarding this case.
- (9) *"Transplanted kidney: There was complete infarction ... (The above slides were seen by Professor J. Berry, Consultant Paediatric Pathologist)"* (Ref: 011-010-040)
- (a) Describe, in respect of the transplanted kidney, the "slides ... seen by Professor J Berry". As previously answered Professor Berry saw the slides.

- (b) Identify the site(s) on the transplanted kidney from which the tissue was taken for those slides and state what determined the selection of that site(s). I have already answered this question. Suffice it to say I cannot recall the exact site where I took the histological sample/samples. However, it would have included a section of cortex and medulla.
- (c) State where any tissue blocks and/or slides in respect of the transplanted kidney were held following the post-mortem. I have already answered this question. To reiterate any slides or tissue blocks will be held at The State Pathologist's Department Belfast.
- (d) State whether you have any notes from your conversation with Professor J. Berry regarding the slides, and if so, please provide a copy. To reiterate and to restate, I do not have any notes whatsoever regarding this case -- other than those provided to me.

(10) *"The autopsy revealed gross cerebral oedema. The fixed weight of the brain at post-mortem was 1,680gms. the average weight for a boy of this age being 1,300gms and the average weight of a man's brain being 1,450 gms. It was the effects of this massive swelling of the brain which caused his death."* (Ref: 011-010-040)

- (a) In your experience, explain if there were any factors that could have led to an inaccuracy in the measurement of the *"fixed weight of the brain at postmortem"*, e.g. the scales used to weigh the brain being uncalibrated, etc. As far as I can recall the scales were accurate. Also from memory this was a massively swollen brain.
- (b) State whether, when you comment that *"the average weight [of a brain] for a boy of this age being 1,300gms"* you are referring to the fixed or unfixed *"average weight"*. Unfixed.

(11) *"In this case the volume of urine output was greatly increased"* (Ref: 011-010-041)

- (a) Explain the basis upon which you state that Adam's *"volume of urine output was greatly increased"*, including:
 - (i) his daily volume of urine output
 - (ii) the extent to which that represented a *"greatly increased"* volume.

If you obtained this from the clinical notes, indicate where in the notes you did so. Although I cannot accurately recall, this information would have been provided by the medical staff and included in the clinical notes. How much urine Adam Strain produced in a day I cannot accurately answer. I do however recall being told by medical staff that Adam Strain produced high volumes of dilute urine. This is known as polyuric renal failure as stated in the history part of my autopsy report line 2. Whether this was actually quantitated I cannot recall.

(12) *"Another factor to be considered in this case is cerebral perfusion. The autopsy revealed ligation of the left internal jugular vein ... This would mean that the cerebral perfusion would be less than that in a normal child. This would exacerbate the effects of the cerebral oedema and should also be considered as a factor in the cause of death. Therefore the most likely explanation is that the cerebral oedema followed a period of hyponatraemia and was compounded by impaired*

cerebral perfusion." (Ref: 011-010-041)

- (a) Describe and explain in detail why you reported that there was a "*ligation of the left internal jugular vein*". I have previously answered this question. The left internal jugular vein was ligated. I refer you to my post mortem report on the internal examination and specifically internal examination of neck on page 4.
- (b) Describe the extent of the anatomical dissection made in order to make this diagnosis. In particular, state whether you examined the veins in the neck during your examination, or whether you examined only the major veins lying within the thoracic cavity. I find this question very difficult to understand. It is impossible to examine the major veins of the neck by examining only the major veins lying within the thoracic cavity. I cannot envisage how the internal jugular vein can be examined in any way by this technique. I routinely examine the neck structures.
- (c) State and explain when you believe the "*ligation of the left internal jugular vein*" was carried out. Although I cannot accurately recall I think that I was informed that this had been done after the removal of a central/long line.
- (d) Describe and explain the impairment in Adam's cerebral perfusion that you consider occurred secondary to this vein ligation. I have already clearly answered the question you ask of me. This has clearly been addressed in my report.
- (e) Describe and explain the extent to which the "*ligation of the left internal jugular vein*" gave rise to "*cerebral perfusion ... less than that in a normal child*". I have clearly answered the question you ask of me. This has been clearly addressed in my report.
- (f) In reference to the note of the operation performed on Adam Strain on 29th May 1992 (Ref: 053-015-052) mentioned previously above:
 - (i) State whether this note correlates with your findings on that there was "*ligation of the left internal jugular vein*". If so, explain how it is consistent. If not, explain how it is inconsistent. No this does not correlate with my findings. The common facial vein lies high in the neck at the level of the hyoid bone. The site of the ligature identified at autopsy is low in the neck. However, this finding I made at autopsy would have accounted for the difficulty in gaining intravenous access at the start of the procedure. I had been informed that there were three attempts made with the left subclavian vein and one with the left internal jugular vein. Following this access was successfully gained in the right subclavian vein. Therefore this supported my internal findings. The failed attempts at cannulating a blood vessel on the left side are clearly set out in my autopsy report
 - (ii) If the "*left common facial vein*" had been ligated and not the "*left internal jugular vein*", explain how this affects your opinion that Adam may have suffered from "*impaired cerebral perfusion*" which would have "*exacerbate[d] the effects of the cerebral oedema*" and which "*should also be considered as a factor in the cause of death.*" I found that the internal jugular vein had been ligated at the junction of the subclavian vein. This finding was supported by the four failed attempts to cannulate this site for intravenous access. Therefore I cannot ignore this finding and find the question very difficult to answer.

(13) *"The autopsy also revealed changes in the kidneys, in keeping with chronic renal failure and total infarction of the transplanted kidney."* (Ref: 011-010-041)

- (a) Explain what you mean by *"total infarction of the transplanted kidney"*. I have already previously answered this question. The answer to the question is dead.
- (b) State what you consider caused that *"total infarction"*. I have already previously answered this question. The answer to the question is I am not sure.
- (c) Explain whether you were or are now able to estimate when that infarction occurred. I have already previously answered this question. The answer to the question is no.

II QUERIES ARISING OUT OF YOUR DEPOSITION

With reference to your Deposition to the Coroner taken on 18th June 1996 (Ref: 011-010-030), please provide clarification and/or further information in respect of the following:

(14) *"This was massive cerebral oedema and I have never come across anything of a similar degree. The cause of it in this case is extremely rare and never encountered by me previously. On a worldwide basis it would be equally rare."* (Ref: 011-010-033)

- (a) Explain what you considered to have been the *"cause"* of Adam's *"massive cerebral oedema"* and the basis upon which you reported that the *"cause of it ... is extremely rare"*. I have already previously answered this question. To reiterate -- I have clearly addressed the cause of this little boy's massive cerebral oedema. This is clearly and concisely laid out in the cause of death on the very first page of my autopsy report. In the child undergoing renal transplantation/operative intervention this is extremely rare. I was unaware of any other case at the time. From my reading of the literature I am still of the view that it is extremely rare today. My understanding of dilutional hyponatraemia was that in the main it was a post-operative complication.
- (b) Explain the basis upon which you reported that *"On a worldwide basis it would be equally rare"*. I have previously answered this question. From my reading of the literature.
- (c) Describe in detail the education and training you received in fluid management (in particular hyponatraemia) through the following, providing dates and names of the institutions/bodies:
 - (i) Undergraduate level
 - (ii) Postgraduate level
 - (iii) Hospital induction programmes
 - (iv) Continuous professional development.

I have previously answered this question. I am a pathologist and as such do not undergo training for the fluid management of patients. This is not my job.

(d) Prior to the date of the autopsy that you carried out on Adam on 29th November 1995, describe in detail your experience of conducting autopsies on children who were 5 years old or younger, including providing the estimated number of such cases and the dates when they took place (if you require any notes to answer this question, then please specify the notes and where they are likely to be located). I have previously answered this question. This is my answer. I had carried out many autopsies on children prior to that on Adam Strain. As this case occurred a long time ago I cannot recall whether cerebral oedema had caused or contributed to the deaths of these children. I cannot remember the details of every case I did in the past. However, as far as my memory serves me I am unaware of a case where dilutional hyponatraemia had caused the death of a child or contributed to it to any great extent. This was the first case I had undertaken of a child dying after renal transplant surgery. To date I have not carried out any such other case. Other than being allowed access to all my cases and reports that I carried out during my time in Northern Ireland it is not possible for me to answer the second part of this question.

(e) Prior to the date of the autopsy that you carried out on Adam on 29th November 1995, describe in detail your experience of conducting autopsies on children in the circumstances set out below, including providing the estimated number of such cases and the dates when they took place (if you require any notes to answer this question, then please specify the notes and where they are likely to be located):

- (i) Children who had undergone renal transplant surgery immediately prior to their death
- (ii) Children where cerebral oedema had caused or contributed to their death
- (iii) Children where hyponatraemia had caused or contributed to their death.

As above.

(15) *"He [Adam] experienced substantial blood loss during the operation and that made his haemodynamics very difficult to manage."* (Ref: 011-010-033)

(a) Explain what you mean by *"made his haemodynamics very difficult to manage"*. I have previously answered this question. By the expression haemodynamics I mean the management of his blood pressure, blood loss, fluid loss, replacement therapy and cardiovascular status.

(16) *"A critical point was the fluids used by the anaesthetist to replace blood loss ... Dr. Taylor advised me at the autopsy of the calculation he made to replace blood loss. Haematocrit = packed cell volume."* (Ref: 011-010-033)

(a) State whether Dr. Taylor was present during the autopsy that you carried out on Adam on 29th November 1995 and if not explain the circumstances in which Dr. Taylor advised of the *"calculation he made to replace blood loss"*. I cannot recall if Dr Taylor was present at the autopsy or not and I cannot recall in relation to the second part of the question.

(b) State what Dr. Taylor advised you was *"the calculation he made to replace blood loss"*,

including the type and volume of the fluid(s). I have previously answered this question. Dr Taylor would have made this calculation and told me of this calculation.

(17) "At the autopsy I had 10 sets of notes relating to Adam and the clinicians' statements" (Ref: 011-010-033)

(a) Identify the "10 sets of notes relating to Adam" that you had at the autopsy. I have previously answered this question. The notes I received prior to the autopsy would have been sent to me in the mortuary. I cannot list the notes now in 2011. I have no problem in recalling there were numerous hospital notes accompanying the body of this child.

(b) Identify the clinicians' statements that you had at the autopsy. I cannot recall the clinicians' statements I had at the time of the autopsy.

(18) "There was impaired cerebral perfusion as there was a suture on the left side and a catheter tip on the right ... The suture impaired blood flow to the brain and the catheter tip on the right may have had a role to play. The suture had been there for some time" (Ref: 011-010-033)

(a) With reference to the "suture had been there for some time", state the date when "the suture on the left hand side" was inserted. I cannot answer this question.

(b) Describe and explain the degree and extent to which "The suture impaired blood flow to the brain" and the basis on which you were able to estimate that degree and extent. I have already previously answered this question. This is clearly addressed in my autopsy report.

(c) State what effects you saw in the brain as a result of the 'impaired blood flow to the brain'. I find this question very difficult to answer. The brain showed massive oedema mainly as a result of the dilutional hyponatraemia. It is my opinion that in this case there was an additional factor responsible. That was clearly addressed in the cause of death. This opinion was based on reading of the literature where other cases did show some cerebral oedema but not as excessive as this. This was clearly stated in the discussion part of my single author publication. Therefore the answer to this question is that of opinion rather than visualising any specific reactions/changes.

(d) Explain why there was no sign of terminal hypoxia despite 'the impaired blood flow to the brain'. This would be because the degree of impaired blood flow was insufficient to cause hypoxic change.

(e) Please detail and explain the increase in cerebral venous pressure (such as pressure in the right internal jugular vein above the catheter tip, for instance) that you think would have resulted from a ligatured left internal jugular vein if the vein had been ligatured

- (i) one year before or
- (ii) three years before.

I don't really understand the question and therefore I cannot answer it.

- (f) Describe and explain what you meant by "the catheter tip on the right may have had a role to play." **I have already previously answered this question in my autopsy report.**
- (g) If the suture were on the common facial vein, rather than the internal jugular vein, explain whether your opinion about impairment of blood flow would have been different. **I find this question impossible to answer.**

III QUERIES ARISING OUT OF YOUR PSNI WITNESS STATEMENT

With reference to your PSNI Witness Statement dated 12th April 2006 (Ref: 093-022-062), please provide clarification and/or further information in respect of the following:

(19) *"D/Sergeant Cross has shown me a letter [from Dr Robert Taylor to Dr George Murnaghan dated 8th May 1996] numbered 059-036-072. I would state that my opinion was honestly held at the time and remains so now, based on the facts provided to me. I have not misrepresented any fact nor have I behaved in a prejudicial manner"* (Ref: 093-022-063)

(a) In his letter (Ref: 059-036-072), Dr Taylor raises "several fundamental problems with the [autopsy] report." Please comment on the claims Dr Taylor made in that letter regarding your autopsy report in respect of:

- (i) The sodium content of the fluids administered
- (ii) The jugular ligation and both 'impaired cerebral perfusion' and 'impaired cerebral drainage'
- (iii) The examination of the neck showing no evidence of congestion or obstruction of the major blood vessels and the conclusion that cerebral perfusion could have been impaired.

I cannot answer the question regarding the sodium content of the fluid administered, other than to state that dextrose saline contains a small amount of sodium. I have clearly explained the jugular ligation and its role in cerebral perfusion. The third part of this question is only indeed part of what I have clearly said as already stated laid out in my autopsy report of the top of page 4.

IV QUERIES ARISING OUT OF YOUR CONTEMPORANEOUS NOTES OF THE AUTOPSY

With reference to the contemporaneous notes of the autopsy, including typed 'draft report' and Autopsy Request Form (attached - Ref: INQ-0319-11), please provide clarification and/or further information in respect of the following:

(20) *"Lungs: The left weighed 190 gms. and the right lungs weighed 290 gms. Both were moderately oedematous throughout."*

(a) Explain why this comment was not included in the final autopsy report. **I cannot**

explain this other than this is a typographical error.

- (b) You state in the final autopsy report that 'there was no significant oedema of any other organ [than the brain]' (Ref: 011-010-040). Please explain:
- What you mean by "moderately oedematous"
 - What you mean by "significant oedema"
 - Why you did not note any pulmonary oedema in your final report.

Moderately oedematous means there was moderate oedema throughout. This can only be accurately determined by histological examination. Histological examination of the lungs revealed congestion and no evidence of oedema. Radiologically the opinion was that of pulmonary oedema. I refer you to my autopsy report -- second last sentence of the history section. Therefore the lungs were moderately congested. Significant oedema means there was no evidence of significant oedema. There was no evidence of pulmonary oedema histologically. The non inclusion of the weights of the right and left lung was a typographical error.

- (c) State if you have previously seen the chest x-ray taken of Adam in PICU on 27th November 1995 (attached). If you have, state when you saw it and what consideration (if any) you gave to it when preparing your autopsy report. I cannot recall.

(21)

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"Brain: Weighed 1,302gms. To be described after fixation.

Spinal Cord: To be described after fixation"

- Identify whose manuscript writing has been added to the typed 'draft report'. The handwriting is mine.
- Identify who changed the typed brain weight of 1,302gms to 1,320gms and why this was done. The handwriting is mine and there must have been an error.
- Explain why the Brain and Spinal Cord sections above have lines through them / above them. Lines were put through this part of the report as in the draft report they are not in the appropriate place. The correct format of the report is seen in the final copy.
- Explain why the figures for brain weight of 1,320g and/or 1,302g were not included in the final autopsy report. The fixed weight of the brain was included in the final autopsy report. I cannot recall why the fresh weight was not included.
- Explain how the figures for brain weight of 1,320g and/or 1,302g relate to the recorded fixed brain weight of 1,680g. It is my view that the above weight is probably an error. During fixation the brain increases in weight from between 5 and 10% with the fixed weight being 1680g. As I described massive cerebral oedema it is my view that the fresh weight of the brain was more likely to be 1520 g.
- Explain any reasons why Adam's brain weight may have changed from 1320g to 1680g after fixation. As above.

(g) From your experience, state the average change in brain weight seen after fixation. In particular, comment on whether the change from 1,320g to 1,680g was unusual. **As above.**

(22) Please identify the person(s) who completed the Autopsy Request Form and the accompanying notes.

(a) Describe any discussions you had with this person regarding Adam Strain's death and when and where you discussed same. **I cannot recall who completed the request form. Nor can I decipher the signature. I cannot recall any discussions.**

V QUERIES ARISING OUT OF YOUR CORRESPONDENCE WITH THE CORONER

With reference to the note by Mr John Leckey, HM Coroner dated 8th December 1995 (Ref: 011-025-125) please provide clarification and/or further information in respect of the following:

(23) *"[Dr Armour] had also discussed the case with the anaesthetist Dr Bob Taylor. Both she and he were mystified about what had happened. The following Friday (1st December) Dr Armour telephoned me and she indicated that she was becoming ever more convinced that there was a question mark against the equipment. She had discussed the case again with Dr Bob Taylor and she had gone through the anaesthetic readings and there was nothing in those to indicate any problem."* (Ref: 011-025-125)

(a) Describe any discussions you had with Dr Taylor regarding Adam Strain's death and autopsy, and when and where you had such discussions. **I cannot recall any specific discussions I had with Dr Taylor although I did discuss the case with him.**

(b) Specify which "anaesthetic readings" you examined and explain how "there was nothing in those to indicate any problem." **I cannot recall any specific discussions.**

(24) *"Today [8th December 1995] Dr Armour showed slides etc to Dr O'Hara and Dr Bharucha. Both stated there was clear evidence of hypoxia/anoxia/anaphylactic [sic] reaction. Those virtually are all the same thing. Both raised the question mark against the working of the anaesthetic equipment and Dr O'Hara raised the possibility of a problem that had occurred during induction of the anaesthesia which was not spotted."* (Ref: 011-025-125)

(a) Describe what "slides etc" you showed to Drs O'Hara and Bharucha and the process by which they were shown these. **I cannot recall any of this.**

(b) Explain why, and for what purpose, you "showed slides etc to Dr O'Hara and Dr Bharucha". **Although I cannot recall any of this the purpose would have been for their opinion.**

(c) Explain what Dr O'Hara raised about "the possibility of a problem that had occurred

during induction of the anaesthesia which was not spotted. "I cannot recall any discussions with Dr Bharucha or Dr Hara. I do not know what Dr O Hara meant and he is now sadly deceased.

- (d) Explain why the following were not included in your final autopsy report (Ref: 011-010-034):
- (i) The fact that you consulted with and "showed slides etc to Dr O'Hara and Dr Bharucha". Slides were shown to Professor Berry Consultant Paediatric Pathologist and Dr Mirakhur Consultant Neuropathologist and there was no evidence of the above. I was also of the same opinion.
 - (ii) Their conclusion that "there was clear evidence of hypoxia/anoxia/anaphylatic [sic] reaction." There was no evidence what so ever of this. Again clearly stated.
 - (iii) That a question mark was raised "against the working of the anaesthetic equipment". This was clearly raised by me in communication with HMC Mr. John Leckey and the equipment was subsequently checked. There was no fault with the equipment.
 - (iv) What Dr O'Hara had raised about "the possibility of a problem that had occurred during induction of the anaesthesia which was not spotted." This was subsequently clearly addressed and shown not to be the case.

With reference to the note by Mr John Leckey, HM Coroner dated 4th January 1996 (Ref: 011-033-165) please provide clarification and/or further information in respect of the following:

- (25) "Subsequently I spoke to Dr Armour. She had not sent copies of all 10 files to all the experts due to the huge number of records involved. I suggested that she should write to each saying that these files were in existence and would be available via Dr Murnaghan. She agreed to." (Ref: 011-033-165)
- (a) State what files you originally sent to the experts. I refer you to the letter I sent to Professor Berry dated 22nd December 1995.
 - (b) State whether you took up the Coroner's suggestion and wrote to each of the experts saying that the "files were in existence and would be available via Dr Murnaghan". If so, state when you wrote to them and provide a copy of the letters if available. If not, explain why. Again I refer you to the above letter. Although I cannot accurately recall and I am relying on memory, I do remember speaking to Professor Berry prior to sending him the information as I would not send such material without speaking to him first and discussing the case. I would have made it known of the complexities of the case and numerous case notes if he required them. This was addressed in the final sentence of my letter. Dr Mirakhur worked in the Royal Victoria Hospital and I would have communicated with her verbally.

VI QUERIES ARISING OUT OF YOUR LETTER TO PROFESSOR BERRY

With reference to your letter to Professor Berry dated 22nd December 1995 (Ref: 011-029-151)

please provide clarification and/or further information in respect of the following:

(26) "At postmortem, I found gross cerebral oedema (1,320 gms.)" (Ref: 011-029-152)

- (a) Explain why you used the figure of "1,320 gms" in your letter to Professor Berry. In my view this is the fresh weight of the brain.
- (b) Explain why you did not mention the fixed brain weight of 1,680g in your letter to Professor Berry. I refer you to the autopsy report page 4. It clearly states that the brain was examined on 12/01/1996 and fixed the brain weighed 1680 g. The letter I wrote to Professor Berry was dated 22/12/1995. As far as I'm concerned it is impossible to inform someone of the fixed weight of the brain prior to it actually being fixed. I do hope this answers your question.

VII QUERIES ARISING OUT OF YOUR JOURNAL ARTICLE

With reference to your article 'Dilutional hyponatraemia: a cause of massive fatal intraoperative cerebral oedema in a child undergoing renal transplantation' (J Clin Pathol 1997; 50: 444-446):

(27) "The brain, after fixation, weighed 1680 g; the cerebellum and brain stem weighed 176 g and the cerebellum alone 154 g. [...] At necropsy the brain was massively oedematous and when fixed it weighed 1680 g. The normal brain weight (unfixed) for boys aged four to five years is 1300 g. Thus the brain weight had increased by almost 30%, which is greatly in excess of other cases documented by Arieff et al."

- (a) Explain why the figures for brain weight of 1,320g and/or 1,302g were not included in your article. I cannot recall why the figures were not included. The fixed weight of the brain was included.

(28) "I thank Dr E Sumner, Consultant Paediatric Anaesthetist, Great Ormond Street Hospital, for his expert opinion, Dr Bob Taylor, Consultant Paediatric Anaesthetist, Royal Belfast Hospital for Sick Children, for his helpful comments, and HMC for Greater Belfast, Mr John Leckey, for his permission to use this case."

- (a) Please indicate the 'helpful comments' that Dr Robert Taylor provided for the purposes of the article. I cannot recall as it is too long ago.
- (b) State whether Dr Robert Taylor saw the article before publication. If so, state whether he offered any comment(s) on it and what those comments were. I cannot recall as it is too long ago.
- (c) Describe any discussions you have had with Dr Taylor regarding Adam Strain's death and autopsy since December 1995, and when and where you had such discussions. I cannot answer this question as it is too long ago. I know I did discuss the case with him

but where, when and the subject matter I cannot recall.

(29) In relation to Figures 1 and 2 showing the pathology of Adam Strain's brain:

- (a) Please provide copies of the photographs taken of Adam's brain and used in your article. I do not possess any photographs.
- (b) Please describe the process by which you obtained permission for publishing these photographs in your article, including whom you sought it from and when. If you did not seek permission, explain why. I clearly got permission from HMC Mr Leckey to publish this case. As far as I am aware GMC guidelines state that as long as the case is anonymised no permission is required to publish photographs of organs at autopsy.

VIII ADDITIONAL INFORMATION

(30) Provide any further points and comments that you wish to make, together with any documents, in relation to:

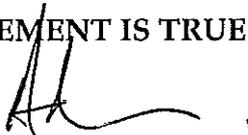
- (a) Record keeping.
- (b) Lessons learned from Adam's death and its effect on your work. I have previously answered this question. To reiterate, I published a paper in the Journal of Clinical Pathology as a specific case report and using this case. The object of the publication was to ensure that this should not happen again. However, I am aware that the Journal is read mainly by pathologists. I enclose a copy for completeness. Dilutional hyponatraemia: the cause of massive fatal intraoperative cerebral oedema in a child undergoing renal transplantation. Dr A Armour, The Journal of Clinical Pathology May 1997. Vol 50 number 5, p444-446.
- (c) Current 'protocols' and procedures. Previously answered. I am a pathologist and do not treat patients nor do I give fluid replacement therapy.
- (d) Any other relevant matter. Already answered. None.

IX DECLARATION OF INTEREST

(31) Confirm that you have completed and signed the attached 'Declaration of Interest'.

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

Signed:



Dated:

7th November

2011

DECLARATION OF INTEREST FORM

TO 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

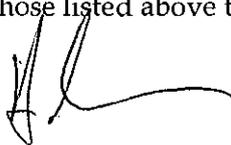
The RBHSC and its administrators and management, including Dr. G. A Murnaghan, Dr. J. Gaston, Dr. S. McKaigue, Dr. P.M. Crean
Belfast Health and Social Services Care Trust formerly the Royal Group of Hospitals and Dental Hospital Health and Social Services Trust

"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.

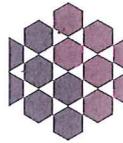
SIGNED:



DATE : 29th November 2011

STATE PATHOLOGIST

Professor J Crane
MB BCh FRCPath DMJ (Clin et Path)
FFPathRCPI FFLM



Department of
Justice

www.dojni.gov.uk

State Pathologist's Department
Institute of Forensic Medicine
Grosvenor Road
Belfast BT12 6BS

Our Ref: F46728

10 May 2011

Ms Anne Dillon
Solicitor to the Inquiry
Inquiry into Hyponatraemia-related Deaths
Arthur House
41 Arthur Street
BELFAST BT1 4GB

Tel: 028 9063 4648 (Direct) or
028 9024 0503
ext. 32698/32748
Fax: 028 9023 7357
Email: j.crane@qub.ac.uk

Dear Ms Dillon

Re: Adam Strain, Deceased

Further to your email to Professor Crane, requesting copies of the contemporaneous notes of Dr Armour's autopsy on the above-named, please now find these enclosed.

Many thanks.

Yours sincerely

Alison Graham
Secretary



Encs

NAME: Alan Strain
 ADDRESS: 20 Firbank Cres
Weywood
 DATE OF DEATH: 28.11.95 AGE: 65.5
 DATE OF P.M.: 29.11.95 Time: 2.45 PM
 MORTUARY: W.H.
 CORONER: Mr Bailey
 POLICE:
 Name: Sgt T. Jones Rank: COV.
 Station: Weywood Tel. No: 26705
 CAN YOU IDENTIFY THE BODY? Yes
 DOCTOR/CONSULTANT: Scott
 Address: Weywood Cres

Pathologist: AA F. No. 46728

CAUSE OF DEATH

I (a) Cerebral oedema
 due to (b) Diluted hyponatraemia
 and impaired cerebral perfusion.
 due to (c) perfusion.
 II

ANATOMICAL SUMMARY

HIB
SC11
U.M.B.m.
Cerebral Oedema
CoHb = 0.9 %.

HISTORY

He was a child + lived with his mother + grand parents in a Council flat in the town. He was born with an abnormality of both kidneys - posterior urethral valves. This had required a number of ~~last~~ operations in the past dialysis + a feeding tube to be inserted in the stomach on

Statements Medical History Fit Form

Microscopy <input checked="" type="checkbox"/>	Blood <input checked="" type="checkbox"/>	Alcohol <input type="checkbox"/>
Bacteriology <input type="checkbox"/>	Urine <input type="checkbox"/>	C.O. <input type="checkbox"/>
Biochem <input type="checkbox"/>	Vitreous <input type="checkbox"/>	Screen <input type="checkbox"/>
Virology <input type="checkbox"/>	Gastro <input type="checkbox"/>	Others <input type="checkbox"/>
Store <input checked="" type="checkbox"/>	Liver <input type="checkbox"/>	Diatoms <input type="checkbox"/>
Specimen <input type="checkbox"/>	CSF <input type="checkbox"/>	Brain + S.C. <input type="checkbox"/>
	Others <input type="checkbox"/>	

NOTES

g.f.f

EXTERNAL EXAMINATION

Blocks of brain

(1) right frontal white matter.
(to show congestion).

(2) left cerebellar gyrus (? vessels)

(3) left cranial ganglia (STB + congestion)

(4) right/left hippocampus (? vessels left)

(5) left occipital (post cerebral artery - ~~frontal~~)
Exten

(6) cerebellum

kas (CFB) → damage
Blocked in tubifurids

i. Greenfield:

Card: blocks cerebral
Thalamic
Lumb

No microscopic lesion

Brain photographed sequentially.

PLEURAL CAVITIES:

PERICARDIAL SAC:

Cut. 12.1.96

ABDOMINAL CAVITY:

Extrenal examination plain.

TONGUE:

Fixed wt 1650 Cerebellum + BS 17g.

PHARYNX:

Cerebellum: 187g.

OESOPHAGUS:

Esoph: grossly swollen

THYROID GLAND:

symmetrical

HYOID BONE and LAR. CARTS:

loss of sulci

LARYNX:

Ulcal swelling to recess

TRACHEA and MAIN BRONCHI:

Cerebellar tonsils swollen
o no ch

HEART: Weight gm.

o cortical venous trabeculae

PULM. TRUNK & VALVE:

Normal ^{anatomy} cortex of ^{ATRIA:} this

AORTIC VALVE:

MITRAL VALVE:

CORONARY ARTERIES:

Mediana ✓

Normal heart swelling
o vent branch of subilar septum

No any tumor

LEFT VENTRICLE:

Severe white matter congestion
Sever marked congestⁿ of tis
in the basal ganglia, white matter
+ deep grey matter.

RIGHT VENTRICLE:

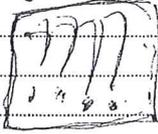
BS: o recess.

AORTA:

ADRENAL GLANDS:

KIDNEYS:

Kidneys



had been 10⁰
 80-90 mm
 type sugar
 C / potassium & acid

LUNGS:

\$ uretic replant

GALL BLADDER:

Older 8/8
 - are after 7 only, not injected.
 from along 2nd down

SPLEEN:

John Alexander
 668991 name

RECTUM:

Norman Hartman 546889

BLADDER:

PROSTATE/UTERUS:

INTESTINES:

↑ sugar low does not
 ↑ icp wt. liver to cerebral
 ↓ metabolism

APPENDIX:

STOMACH:

Top critical case ;

DUODENUM:

CREAS:

? the fluids
 ? glucose
 ? metabolic

? inhibited part: not.
 ? feeding

BRAIN:

Bob Taylor 2499

please corrected in cm.

The body of a young male child, 41 inches in length and weighing 20 kilograms. Rigor mortis was present. Hypostasis of light purple colour stained the back of the body.

Back: There was a needle puncture mark in the midline, centred 11 cm. above the natal cleft, corresponding to an epidural cannula.

Eyes: The corneae had been taken for transplantation.

Ears: Normal.

Nose: Normal.

Mouth: There were natural teeth in good condition in each jaw. The lips were dry and parchmented. The tongue was held between the clenched teeth.

Neck: There was a needle puncture mark on the left side. There was a healed operation scar, 3 cm. long, on the left side. There were two further healed operation scars on the right side, 2.5 cm. long.

Chest: There was a needle puncture mark on the left upper chest, corresponding to a ~~subclavian line~~ ^{subclavian} ~~line~~. There were a number of bruised needle puncture marks on the right upper chest, corresponding to a subclavian line, and a number of suture marks. There was a bruise, 1.5 x 1 cm., in the left upper chest, centred 3 cm. lateral and 1 cm. above the left nipple. There was a bluish-blackish bruise on the right chest, 2.5 x 1 cm., diameter, centred 3 cm. lateral to the right nipple.

Abdomen: There was a gastrostomy button situated in the left hypochondrium. The gastrostomy hole itself measured 6 mm. diameter. There was a healed operation scar, 18 cm. long, horizontally in the upper abdomen, corresponding to previous fundoplication. There was a further healed operation scar, 18 cm. long, ~~running across~~ ^{transversing} the mid-abdomen. There was a peritoneal dialysis tube in situ in the left upper abdomen. There were two further puckered scars, one situated in the left side of the lower abdomen, 5 cm. lateral and 2 cm. below the umbilicus. The other puckered scar was situated 4.5 cm. beneath the umbilicus. There was a recent elliptical surgical incision, 15 cm. long, on the right side of the lower abdomen with a drain protruding from its upper margin. Its edges were slightly bruised. A bladder catheter protruded from the lower end on the left side of the abdomen. There was a further drain in situ just at the level of the pubic bone, corresponding to the donor ureteric catheter.

Left Upper Limb: There were a number of bruised needle puncture marks in the fold of the elbow and a healed operation scar, 5 cm. long, again in the fold of the elbow.

Right Upper Limb: There were a number of bruised needle puncture marks in the fold of the elbow.

Left Lower Limb: There were a number of petechial bruises on the inner aspect of the thigh, in an area 4 x 1 cm. There was a bruise, 1 cm. diameter, on the front of the shin. There was a bruised needle puncture mark on the dorsum of the foot.

Right Lower Limb: There was a healed operation scar, 4 cm. long, in the right groin, corresponding to a ~~previous~~ ^{previous} orchidoplexy. There was a fading bruise, 0.5 cm. diameter, on the outer aspect of the upper thigh. There was a bluish bruise on the outer aspect of the thigh, 0.5 cm. diameter,

(L) not (R) subclavian

and there were a number of fading bruises on the front of the shin. There were two bruised needle puncture marks on the dorsum of the foot.

Scrotum: There was a healed operation scar, 3 cm. long, on the right scrotal sac. The right testis had been removed. The left testis was present.

Pleural Cavities: The left contained 35 mls. of straw-coloured fluid. The right cavity contained 5 mls. of straw-coloured fluid.

Pericardial Sac: Normal.

Abdominal Cavity: Was crossed by a number of adhesions. There was a little blood clot formation around the renal transplant on the right side.

Tongue: Normal.

Pharynx: Normal.

Oesophagus: Normal

Thyroid Gland: Normal.

Hyoid Bone and Laryngeal Cartilages: Intact.

Larynx: Normal.

Trachea and Main Bronchi: Contained a little frothy fluid.

Heart: 120 gm. The organ was taken for transplantation.

Pulmonary Valve and Trunk:

Atria:

Aortic Valve:

Mitral Valve:

Coronary Arteries:

Left Ventricle:

Right Ventricle:

Aorta: Normal.

Adrenal Glands: Normal.

Kidneys: Both were markedly contracted, scarred and contained a number of cysts. Little normal functioning kidney remained. Both ureters were hugely distended and dilated. The transplanted kidney was in situ in the right pelvis, the ureter drained freely and the vascular attachments were intact.

Lungs: The left weighed 190 gms. and the right lungs weighed 290 gms. Both were moderately oedematous throughout.

Gall Bladder: Normal.

Liver: Weighed 875 gms. A little congested.

Spleen: Normal.

Rectum: Normal.

Bladder: Contained a little straw-coloured urine.

Prostate: Normal.

Intestines: Externally appeared normal.

Appendix: Normal.

Stomach: A gastrostomy hole was present. The stomach contained a little bile.

Duodenum: Normal.

Pancreas: Normal.

Brain: Weighed 1,3²⁰~~00~~ gms. To be described after fixation.

Spinal Cord: To be described after fixation.

~~Neck. There was no evidence of congestion or obstruction of the major vessels. ie carotids or of SVC dist. Carotids: Normal. Suture (C) side at junction ISV + subclavian. Operative site: ✓ Transplanted kidney: Ureter + bladder tunnel. Dead vessels. vein → e.l. artery → e.l. Right hilus.~~

ROYAL VICTORIA HOSPITAL
AUTOPSY REQUEST FORM

NAME: ADAM STRAIN AUTOPSY No: A _____
D.o.B.: 4/8/91 SEX: M HOSPITAL No. 364377
CONSULTANT: SAVAGE WARD: PICU HOSPITAL 2BLRSC
DATE OF ADMISSION: 26/11/95 DATE OF DEATH: 28/11/95
DATE OF AUTOPSY: _____ TIME OF AUTOPSY: _____
TIME COMPLETE REQUEST RECEIVED IN MORTUARY: _____

CLINICAL PRESENTATION: (major symptoms)

RENAL FAILURE UNDERGOES RENAL TRANSPLANT.
APPARENTLY UNEVENTFUL GENERAL ANAESTHETIC BUT
BRAIN STEM DEAD / CEREBRAL OEDEMA AT END OF CASE

HISTORY OF PRESENT ILLNESS:

POLYURIC RENAL FAILURE (secondary to post Ureteral valves.)
ARRIVED in theatre @ 0645am 27/11/95 in fluid
deficit (≈ 3000 ml). GA. started, iv fluids given, excessive
bleeding throughout transplant - replaced by blood/HPPF
At end of case child found to have fixed, dilated pupils

PAST MEDICAL HISTORY (incl drug therapy):

RENAL FAILURE
CONTINUOUS PERITONEAL DIALYSIS.
G.A. with Thiopentone / Argona / Atrocum. No Hypertension episodes
No Hypoxia
Monitoring indicated urea fall / Replaced fluids given

INVESTIGATIONS: (include laboratory, ECG, X-ray etc).

CXR - pulm interstitial oedema.
CT Scan - gross cerebral oedema - obliteration of ventricles
U&E B. serum (4.0) AB. 38
No + 119

CLINICAL DIAGNOSIS

BRAIN STEM DEATH DUE TO "OSMOTIC DIS-EQUILIBRIUM SYNDROME"

NOTES

This is a somewhat bizarre case of a child undergoing renal transplantation. There were quite complex fluid requirements in this child who normally got 1500 ml of food into gastrostomy tube in the course of a night. On the morning of surgery this feeding (fluid) was interrupted and despite several attempts iv fluids could not be erected prior to surgery. Therefore replacement fluids consisted of $\frac{1}{5}N$ saline in 4% Glucose to replace the fluid deficit and provide maintenance and colloid fluids (HPPF) and Packed cells. (2 units). The on-going blood loss and poor vascular supply of the donor kidney encouraged further fluid administration over a prolonged anaesthetic (4 hours). Dopamine was also commenced to improve donor blood flow. The fluids were given according to the CVP which commenced at 17 mmHg and rose to 22-24 mmHg thro' the case.

I am surprised and devastated that the T-brain and CXR showed such gross oedema in the presence of normal serum albumin (colloid pressure) and blood sugar!

LIST CLINICAL PROBLEMS IN ORDER OF IMPORTANCE:

(This list will enable the pathologist to produce a more relevant report.)

- (1) RENAL TRANSPLANT - DONOR ORGAN w (RIF)
- (2) CEREBRAL / PULMONARY INTERSTITIAL OEDOMA
- (3) _____
- (4) _____

DEATH CERTIFICATE: If a death certificate has already been prepared please copy it below for our records.

(1)

(1)

Disease or condition directly leading to death:

(a)

_____ due to

Antecedent causes, morbid conditions, if any, giving rise to the above cause, stating the underlying condition last.

(b)

(c)

(2)

Other significant conditions, contributing to the death, but not related to the disease or condition causing it:

Will you or a colleague be attending the review session at 1.45 pm on the day of the autopsy? YES NO

Signature of requesting doctor _____

Please write your name legibly and give an extension number where you can be contacted _____

THE FINDINGS OF THE AUTOPSY WILL BE TELEPHONED TO THIS NUMBER

NOTES

Dr Tracy for 2398.

Theatre RBHSC.

2449
~~2449~~

ENT
RICH

ENT



HER MAJESTY'S CORONER

DISTRICT OF GREATER BELFAST

Telephone: (01232) 743040
Fax: (01232) 352578

John L Leckey LL.M.
H. M. Coroner
Coroner's Office
Courthouse
Crumlin Road
Belfast
N. Ireland
BT14 6AL

Dr Alison Armour
State Pathologist's Department
Institute of Forensic Medicine
Grosvenor Road
BELFAST
BT12 6BS

29 May 1996

Dear *Alison*

RE: ADAM STRAIN, DECEASED - YOUR REF 46,728

I am enclosing a copy of a letter I have received from Miss Strain and I should be grateful for your comments.

Yours sincerely

J L Leckey

**J L LECKEY
HM CORONER FOR GREATER BELFAST**

28th May 1996

Mr J.L.Leckey LL.M
H.M. Coroner
Coroner's Office
Courthouse
Crumlin Road
Belfast
BT14 6AL

Debra Strain
20 Firmount Crescent
Holywood
County Down
BT18 9QN

Dear Mr Leckey,

Thankyou for sending me a copy of Dr Armour's' report which although I found upsetting, was helpful. Unfortunately there was one point which was not quite right (see attached). Adam was only fed 600mls during the day not 900mls, as stated by Dr Armour. From what I have been told a major factor which caused Adam to suffer Dilutional Hyponatraemia was Fluid Overloading.

I thought it best to inform you that he was fed 2100mls in total per day, which was less than he received in his five hours of surgery.

I hope this information will be of some use to you.

Your sincerely


Debra Strain

enc.



copy



State Pathologist
Professor J Crane
MB BCh FRCPath DMJ (Clin et Path)

The Queen's University of Belfast & Northern Ireland Office

State Pathologist's Department,
Institute of Forensic Medicine,
Grosvenor Road,
Belfast BT12 6BS

Tel. (01232) 894648 (Direct) or
(01232) 240503 Ext. 2698, 2748, 2520 and 2559
Fax. (01232) 237357

AA/MDEC/F.46,728

3rd June, 1996.

Mr. J. L. Leckey, LLM,
H. M. Coroner,
Coroner's Office,
Courthouse,
Crumlin Road,
BELFAST BT14 6AL

Dear John,

Thank you for your letter dated 29th May, 1996 and a copy of Miss Strain's letter dated 28th May, 1996.

The figures regarding Adam's fluid management were provided by the medical staff involved in his care. My opinion on the cause of death stays the same regardless of whether he received 600 mls. or 900 mls. of fluid. It is not just the volume of fluid he received but the type. The fact that his sodium level was low intra-operatively is the critical point.

Yours sincerely,

Alison Armour
Senior Registrar



THE QUEEN'S
ANNIVERSARY PRIZES
1994

THE QUEEN'S UNIVERSITY OF BELFAST
NORTHERN IRELAND OFFICE

REPORT OF AUTOPSY

Name: Adam STRAIN **Sex:** Male **Age:** 4 yrs. **F.No:** 46,728
Date of Death: 28th November, 1995. MDEC
Date and Hour of Autopsy: 29th November, 1995. 2.40 p.m.
Place of Autopsy: The Mortuary, Royal Victoria Hospital, Belfast.

CAUSE OF DEATH:

I (a) CEREBRAL OEDEMA

due to

(b) DILUTIONAL HYPONATRAEMIA AND IMPAIRED CEREBRAL PERFUSION
DURING RENAL TRANSPLANT OPERATION FOR CHRONIC RENAL FAILURE
(CONGENITAL OBSTRUCTIVE UROPATHY)

On the instructions of H.M. Coroner for Greater Belfast, Mr. J. L. Leckey, LLM, I, Alison Armour, MB, BCh, MRCPATH, DMJ(Path), registered medical practitioner and pathologist approved by the Northern Ireland Office, made a postmortem examination of the body of -

ADAM STRAIN
aged 4 years

identified to me at the Mortuary, Royal Victoria Hospital, Belfast, on Wednesday, 29th November, 1995, by Constable S. R. Tester, R.U.C. Grosvenor Road.

THE QUEEN'S UNIVERSITY OF BELFAST
NORTHERN IRELAND OFFICE

REPORT OF AUTOPSY

Name: Adam STRAIN Sex: Male Age: 4 yrs. F.No: 46,728
Date of Death: 28th November, 1995. MDEC
Date and Hour of Autopsy: 29th November, 1995. 2.40 p.m.
Place of Autopsy: The Mortuary, Royal Victoria Hospital, Belfast.

HISTORY:

He was a child and lived with his mother and grandparents in a bungalow in the town. He was born with a renal abnormality - an obstructive uropathy which resulted in polyuric renal failure. He had five ureteric reimplant operations, a fundoplication for gastro-oesophageal reflux and more recently in October, 1995 an orchidoplexy. He ate nothing by mouth and was fed via a gastrostomy button 1,500 mls. at night and 900 mls. during the day. He also received peritoneal dialysis. He was being prescribed calcium carbonate, Keflex, iron, one alpha vitamin, sodium bicarbonate and erythropoietin.

On 26th November, 1996, he was admitted to the Royal Belfast Hospital for Sick Children at 11.30 p.m. for a renal transplant operation. His blood pressure was 108/56 and a haemoglobin of 10.5 g/dl with a sodium of 139 mmol/l, potassium 3.6 mmol/l and urea 16.8 mmol/l. Overnight he was given 900 mls. dioralyte (4% dextrose 0.18% saline). Peritoneal dialysis was performed as usual, 750 ml. fluid volume 1.36% dextrose solution. He was given 8 cycles before going to theatre the next morning.

He arrived in theatre at 6.45 a.m. and general anaesthesia was induced using thiopentone, atropine and atracium. Intravenous access was difficult and attempts were made to pass a central venous pressure catheter. Three attempts were made with the left subclavian vein, one with the left internal jugular vein and then the catheter was successfully passed into the right subclavian vein. A lumbar epidural between L1 and L2 was also sited with 0.25% bupivacaine and Fentanyl 5 mcg/kg. Apart from the anaesthetic drugs Augmentin an antibiotic, prednisolone, asathioprin (anti-rejection drug) and a continuous infusion of dopamine were administered intravenously. An initial central venous pressure reading was taken at 17 mm.Hg. Intravenous units were administered from 7.00 a.m. to 8.30 a.m., of three 500 ml. bags of dextrose saline (4% and 0.18%). The operation technically was difficult due to previous surgical procedures and there was an increase in blood loss, calculated to be approximately 1,200 mls. at the end of the procedure. Further fluids of 500 mls. Hartman's solutions 1,000 mls. of HPPF (human plasma protein fraction) and 500 mls. of packed cells were administered. At 9.32 a.m. a blood gas analysis revealed a sodium of 123 mmol/l (normal 135 - 145) and a haematocrit of 18% (normal. 35 - 40%). During the procedure the CVP rose to 20 - 21 mm.Hg, the Hb was 6.1 g/dl which was 10.1 g.dl. at the end of the procedure and the blood pressure rose and the pulse rate gradually decreased. The donor kidney perfused and the operation was completed. At the end of the procedure the neuromuscular block was reversed with neostigmine but this boy did not wake up. His pupils were noted to be fixed and dilated at midday. He was transferred from theatre to the paediatric Intensive Care Unit at 12.05 p.m. He was intubated and hand ventilated on admission. He was treated with intravenous mannitol and intravenous fluids were restricted. An emergency CT scan at 1.15 p.m. revealed gross cerebral oedema. His body temperature was 36.5°C. the CVP was 30, heart rate 120 beats per minute and systolic blood pressure 120. Electrolytes revealed a

sodium of 119 mmol/l; and a chest X-ray revealed pulmonary oedema with the CVP catheter tip in a neck vessel. Neurologists carried out brain stem tests and life was pronounced extinct by a hospital doctor on 28th November, 1995 at 9.15 a.m.

EXTERNAL EXAMINATION:

The body of a young male child, 104 cm. in length and weighing 20 kilograms. Rigor mortis was present. Hypostasis of light purple colour stained the back of the body.

Back: There was a needle puncture mark in the midline, centred 11 cm. above the natal cleft, corresponding to an epidural cannula.

Eyes: The corneas had been taken for transplantation.

Ears: Normal.

Nose: Normal.

Neck: There was a needle puncture mark on the left side. There was a healed operation scar, 3 cm. long, on the left side. There were two further healed operation scars on the right side, 2.5 cm. long.

Chest : There was a needle puncture mark on the left upper chest, in the region of the subclavian vein. There were a number of bruised needle puncture marks on the right upper chest, corresponding to a subclavian line. There was a bruise, 1.5 x 1 cm., in the left upper chest, centred 3 cm. lateral and 1 cm. above the left nipple. There was a bluish-blackish bruise on the right chest, 2.5 x 1 cm., diameter, centred 3 cm. lateral to the right nipple.

Abdomen: There was a gastrostomy button situated in the left hypochondrium. The gastrostomy hole measured 6 mm. diameter. There was a healed operation scar, 18 cm. long, horizontally in the upper abdomen, corresponding to previous fundoplication. There was a further healed operation scar, 18 cm. long, traversing the mid-abdomen. There was a peritoneal dialysis tube in situ in the left upper abdomen. There were two further puckered scars, one situated in the left side of the lower abdomen, 5 cm. lateral and 2 cm. below the umbilicus. The other puckered scar was situated 4.5 cm. beneath the umbilicus. There was a recent elliptical surgical incision, 15 cm. long, on the right side of the lower abdomen with a drain protruding from its upper margin. Its edges were slightly bruised. A bladder catheter protruded from the lower end on the left side of the abdomen. There was a further drain in situ just at the level of the pubic bone, corresponding to the donor ureteric catheter.

Left Upper Limb: There were a number of bruised needle puncture marks in the fold of the elbow and a healed operation scar, 5 cm. long, again in the fold of the elbow.

Right Upper Limb: There were a number of bruised needle puncture marks in the fold of the elbow.

Left Lower Limb: There were a number of petechial bruises on the inner aspect of the thigh, in an area 4 x 1 cm. There was a bruise, 1 cm. diameter, on the front of the shin. There was a bruised needle puncture mark on the dorsum of the foot.

Right Lower Limb: There was a healed operation scar, 4 cm. long, in the right groin, corresponding to an orchidoplexy. There was a fading bruise, 0.5 cm. diameter, on the outer aspect of the upper thigh. There was a bluish bruise on the outer aspect of the thigh, 0.5 cm. diameter, and there were a number of fading bruises on the front of the shin. There were two bruised needle puncture marks on the dorsum of the foot.

Scrotum: There was a healed operation scar, 3 cm. long, on the right scrotal sac. The right testis had been removed. The left testis was present

INTERNAL EXAMINATION:**HEAD:**

Brain: To be described after fixation.

Mouth: There were natural teeth in good condition in each jaw. The lips were dry and parchmented. The tongue was held between the clenched teeth.

Tongue, Pharynx: Normal.

NECK AND CHEST:

Hyoid Bone and Laryngeal Cartilages: Intact.

Thyroid Gland: Normal.

Pericardial Sac: Normal.

Heart: 120 gm. The organ was taken for transplantation.

Aorta: Normal.

ABDOMEN:

Abdominal Cavity: Was crossed by a number of adhesions. There was a little blood clot formation around the renal transplant on the right side.

Stomach: A gastrostomy hole was present. The stomach contained a little bile.

Intestines: Externally appeared normal.

Duodenum: Normal.

Liver: Weighed 875 gms. A little congested.

Gall Bladder: Normal.

Pancreas: Normal.

Native Kidneys: Both were markedly contracted, scarred and contained a number of cysts. Little normal functioning kidney remained. Both ureters were hugely distended and dilated.

Transplanted kidney: Was in situ in the right pelvis, the ureter drained freely and the vascular attachments were intact.

Bladder: Contained a little straw-coloured urine.

Prostate: Normal.

SPINAL CORD: To be described after fixation.

INTERNAL EXAMINATION OF NECK:

There was no evidence of congestion or obstruction of the major blood vessels or the carotid arteries and jugular veins. There was no evidence of superior vena caval obstruction. The carotid arteries were normal. There was a suture in situ on the left side of the neck at the junction of the internal jugular vein and the sub-clavian vein.

DESCRIPTION OF ORGANS AFTER FIXATION:

Brain - Was cut on 12.1.96

External Examination: Fixed weight of brain 1,680 gm; cerebellum and brain stem 176 gm; cerebellum only 154 gm. The brain was grossly swollen with loss of sulci and uncal swelling. This was symmetrical. There was no uncal necrosis. There was swelling of the cerebellar tonsils but no necrosis. There was no cortical venous thrombosis. The anatomy of the circle of Willis was normal.

On cut section there was massive brain swelling and constriction of the ventricles. There was no ventricular haemorrhage. There was no asymmetrical lesion. There was severe white matter congestion and marked congestion of the blood vessels in the basal ganglia, white matter and deep grey matter. There was no necrosis of the mid-brain or brain stem.

Blocks were taken from:

1. Right frontal white matter
2. Left cingulate gyrus
3. Left basal ganglia
4. Right and left hippocampus
5. Left occipital lobe
6. Cerebellum
7. Pons in toto
8. Thalamus

The brain was photographed sequentially

Cervical Cord: No macroscopical lesion seen.

Blocks were taken from:

1. Cervical
 2. Thoracic
 3. Lumbar
-

MICROSCOPY:

Lungs: There was congestion of the capillaries and there were moderate numbers of alveolar macrophages. There was no evidence of embolism or infarction.

Larynx: There was ulceration of the mucosa, in keeping with intubation.

Liver: There was no evidence of cyst formation within the portal tract. There were scattered foci of clear cell change.

Kidney: There was widespread scarring and cyst formation, interstitial fibrosis and chronic inflammation. There was widespread glomerulo-sclerosis and the arterioles were thickened.

Transplanted Kidney: There was complete infarction.

Spleen: There was congestion of the red pulp.

Lymph Node: Normal.

(The above slides were seen by Professor J. Berry, Consultant Paediatric Pathologist).

Brain: There was massive cerebral oedema of the cortex and white matter. There was no evidence of terminal hypoxia. There was no evidence of myelinolysis.

Spinal Cord: No specific pathological features were noted.

(The brain, spinal cord and histological slides were seen by Dr. M. Mirakhur, Consultant Neuropathologist)

COMMENTARY:

This little boy with a past medical history of polyuric renal failure, numerous hospital admissions and operations was admitted to hospital one evening for a renal transplant operation. He was fed via a gastrostomy and ate nothing by mouth. Usually he would receive 1,500 mls. a night and 900 mls. during the day. That night investigations included blood pressure 108/56, sodium 139 mmol/l and haemoglobin 10.5 g/dl. Overnight he was given 900 mls. dioralyte (4% dextrose 0.18% saline) and peritoneal dialysis was performed as usual. He went to theatre the next morning.

General anaesthesia was induced. Intravenous access was difficult and four attempts were made to pass a central venous pressure catheter before it was successfully passed into the right subclavian vein. A lumbar epidural was also sited with .25% bupivacaine and fentanyl. An initial CVP reading was taken at 17 mm.Hg. and intravenous fluids were given of 3 x 500 ml. bags of dextrose saline (4% and .18%). The operation itself was technically difficult due to the previous surgical procedures and there was an increased blood loss calculated to be approximately 1,200 mls. This was replaced by intravenous fluids of 500 mls. of Hartman's, 1,000 mls. HPPF and 500 mls. of packed cells. At 9.32 a.m. a blood gas analysis revealed a sodium of 123 mmol/l (normal 135-145) and a low haematocrit. During the operation the CVP increased to 20-21 mm.Hg., the haemoglobin fell to 6.1 g/dl., the systolic blood pressure rose to 150 mm.Hg. and the pulse gradually fell but rose steadily from 10.15 a.m. onwards. When the procedure was completed and the neuromuscular block was reversed this little boy did not wake up. A CT scan of the brain revealed gross cerebral oedema. Brain stem function tests were carried out and he was declared dead a little over 26 hours from the start of the operation.

The autopsy revealed gross cerebral oedema. The fixed weight of the brain at postmortem was 1,680 gms., the average weight for a boy of this age being 1,300 gms and the average weight of a man's brain being 1,450 gms. It was the effects of this massive swelling of the brain which caused his death. There was no significant oedema of any other organ.

This is a highly complex and difficult case. To try to understand the underlying cause for this cerebral oedema first some physiological mechanisms for maintaining fluid and electrolyte balance will be reviewed.

In healthy people the composition of body fluids vary within narrow limits. The kidneys are largely responsible for maintaining this constancy and the excretion of waste products of metabolism represents merely one aspect of this task. The control of water volume and sodium are maintained by the hormones A.D.H. (anti-diuretic hormone) and aldosterone.

In this case the volume of urine output was greatly increased and the urine was also dilute. This was probably due to the fact that the kidneys did not function and their ability to concentrate the urine was minimal.

Generalised cerebral oedema in children has many causes including hypoxia. In this case this has been excluded. The history indicates that during the operation this little boy received a quantity of intravenous fluids. There was also a considerable blood loss during the operation of 1,200 mls. However a CVP, central venous pressure, catheter was in situ in the right subclavian vein and is usually in place to avoid overloading of the circulation by intravenous fluids. A rise in the CVP indicates an excessive load and a fall can be an early sign of haemorrhage. In this case the initial reading was 17 mm.Hg. (for an operation such as this 10-12 mm.Hg. is the norm) and this was taken as the base line. A subsequent reading was a little higher again. Also during the operation the sodium was low along with the haematocrit. It is known that a condition called dilutional hyponatraemia can cause rapid and gross cerebral oedema. This is no doubt in this case that the sodium level was low during the operation. A study revealed that in children undergoing operations there was substantial extra renal loss of electrolytes and with a minimal positive balance of hypotonic fluid could lead to fatal hyponatraemia. This study however must be taken in context as it refers to healthy children undergoing operations like tonsillectomies. Thus they had normally functioning kidneys which was not the situation in this case. It seems likely therefore that the hyponatraemia in this case was the cause of the cerebral oedema and most of the intravenous fluids given in the cases sited in this paper were administered as 280 mmol glucose per litre in water or in sodium chloride 38 mmol/l.

Another factor to be considered in this case is cerebral perfusion. The autopsy revealed ligation of the left internal jugular vein. The catheter tip of the CVP was situated on the right side. This would mean that the cerebral perfusion would be less than that in a normal child. This would exacerbate the effects of the cerebral oedema and should also be considered as a factor in the cause of death. Therefore the most likely explanation is that the cerebral oedema followed a period of hyponatraemia and was compounded by impaired cerebral perfusion.

The autopsy also revealed changes in the kidneys, in keeping with chronic renal failure and total infarction of the transplanted kidney. These played no part in the fatal outcome.

There were marks due to treatment and bruises to both legs. They were trivial however.

REFERENCES:

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 "Hyponatraemia and death or permanent brain damage in healthy children"
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