

Witness Statement Ref. No. 041/1

**NAME OF CHILD:** Raychel Ferguson

**Name:** Brian Herron

**Title:** DR

**Present position and institution:** CONSULTANT NEUROPATHOLOGIST, ROYAL VICTORIA HOSPITAL, GROSVENOR ROAD, BELFAST, BT12 6BA

**Previous position and institution:** AS ABOVE  
*[As at the time of the child's death]*

**Membership of Advisory Panels and Committees**  
*[Identify by date and title all of those between January 1995-December 2004]*

**Previous Statements, Depositions and Reports:**  
*[Identify by date and title all those made in relation to the child's death]*

AUTOPSY REPORT SUBMITTED TO CORONER.  
DEPOSITION AT INQUEST.

**OFFICIAL USE:**  
List of previous statements, depositions and reports attached:

Ref:	Date:	
012-031-157	05.02.03	Deposition at Inquest into the death of Raychel Ferguson
022-070-171	11.06.01	Autopsy report on Raychel Ferguson

*BH 21/6/15*

**Particular areas of interest**

*[Please attach additional sheets if more space is required]*

1. **Explain in detail the reason why expert opinion was sought by you in respect of your findings at the post mortem you carried out on Raychel Ferguson on 11<sup>th</sup> June 2001.**

AS A CONSULTANT NEUROPATHOLOGIST, BASED AT THE ROYAL VICTORIA HOSPITAL, I WAS INSTRUCTED BY THE CORONER TO PERFORM AN AUTOPSY ON RAYCHEL FERGUSON. IN THIS CAPACITY I WAS ACTING FOR THE CORONER AND INDEPENDENT OF THE HOSPITAL. I FELT THERE WERE ISSUES RAISED BY THE AUTOPSY WHICH WERE OUTSIDE MY EXPERTISE. MORE SPECIFICALLY, THE CONTROL OF SODIUM LEVELS IN THE BODY AND THE EFFECTS ABNORMAL SODIUM LEVELS MIGHT HAVE, NEEDED INPUT FROM SOMEONE MORE FAMILIAR WITH THESE ISSUES.

2. **Describe your previous experience, if any, of cerebral oedema and hyponatraemia.**

AS A NEUROPATHOLOGIST I HAVE EXTENSIVE EXPERIENCE OF CEREBRAL OEDEMA. IT IS A FACTOR IN THE DEATH OF A LARGE PROPORTION OF AUTOPSIES I HAVE BEEN INVOLVED WITH. I HAVE SOME EXPERIENCE OF HYPONATRAEMIA AND THE COMPLICATIONS OF THIS CONDITION.

Particular areas of interest (Cont'd)

3. Give details of any communications you had either verbally or in writing in relation to the possible cause of Raychel's death with colleagues, the Coroner or the family of Raychel Ferguson, to include; (i) dates of such communications; and (ii) the nature of such communications.

11/6/01 RECEIVED AUTOPSY REQUEST FORM AND CLINICAL SUMMARY OF CASE WRITTEN BY DR LOUISE M'CLOUGHLIN, SHO IN PAEDIATRIC ICU.

DATE NOT RECORDED BUT PROBABLY 11/12/6/01 SENT PROVISIONAL REPORT OF AUTOPSY FINDINGS TO THE WARD.

11/6/01 SENT NOTICE TO CORONER THAT IT WAS NECESSARY TO RETAIN BRAIN AND SPINAL CORD FROM THE AUTOPSY.

13/6/01 RECEIVED A 'MISSING NOTE' FROM CHART FROM CLINICAL SERVICES MANAGER, ALTNAGELVIN.

SOMETIME BETWEEN 13/6/01 & 3/9/01 TELEPHONED DR CLODAGH LOUGHREY TO ASCERTAIN IF SHE WOULD BE PREPARED TO GIVE OPINION. I ARRANGED TO SEND HER FLUID SAMPLES (ANTE MORTEM) FOR FURTHER ANALYSIS. HAD SPOKEN TO CORONER TO OBTAIN PERMISSION TO REQUEST OPINION FROM DR LOUGHREY.

7/9/01 LETTER FROM DR JAMES CROSBIE, CONSULTANT PATHOLOGIST REGARDING THE REPORT ON THE APPENDIX.

12/9/01 RECEIVED LETTER FROM PROF CRANE FROM MR FERGUSON. REPLIED TO LETTER.

24/10/01 LETTER (HAND WRITTEN) FROM DR BOB TAYLOR REGARDING 'YELLOW CARDING'.

15/11/01 2.15PM MRS FERGUSON PHONED ASKING ABOUT REPORT.

15/11/01 LETTER TO MRS FERGUSON.

22/11/01 I PHONED MRS FERGUSON AT HOME AT HER SISTER'S REQUEST. FIRST CALL - MESSAGE LEFT ON ANSWER MACHINE - SECOND CALL RECEIVED.

28/11/01 LETTER FROM DR CHENG REGARDING 'YELLOW CARDING'.

30/11/01 LETTER FROM CORONER RE: DR LOUGHREY'S REPORT. RECEIVED A COPY OF REPORT AND OPINIONS ON ADAM STRAIN FROM CORONER.

30/11/01 INSTRUCTIONS FROM CORONER RE: TISSUE DISPOSAL.

3/12/01 10.30AM PHONE CALL FROM UNDERTAKER.

By 21/6/15

041

3. CONTINUED.

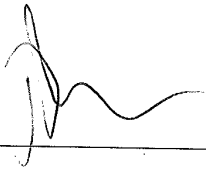
4/12/01 FURTHER COR.2 FORM FAXED AND POSTED.  
11/12/01 LETTER FROM CORONER INDICATING DR SUMNER WILL GIVE OPINION ON CASE.  
31/12/01 LETTER TO DIANE (MORTUARY) RE: TISSUE COLLECTION.  
4/4/02 LETTER FROM CORONER POSTPONING INQUEST.  
14/11/02 LETTER FROM CORONER POSTPONING INQUEST.  
23/5/05 LETTER FROM ENQUIRY TEAM REQUIRING WITNESS STATEMENT.  
9/6/05 COPY OF MY DEPOSITION FROM INQUEST RECEIVED FROM ENQUIRY TEAM.

THERE MAY HAVE BEEN OTHER PHONE CALLS WHICH HAVE NOT BEEN RECORDED.

BM 21/05

**Other points you wish to make including additions to any previous Statements, Depositions and or Reports**

*[Please attach additional sheets if more space is required]*

Signed: 

Dated: 2-1-15

DEPARTMENT OF NEUROPATHOLOGY  
AUTOPSY REPORT

Autopsy No.: NPPM 61/2001  
Name : FERGUSON, Rachel  
Date of Birth:4-Feb-92      Hospital No.: CH 476554  
Sex : F      Hospital:RBHSC  
Pathologist : Dr M Al-Husaini/  
                 Dr B Herron      Ward :PICU  
Clinician :Dr P Crean  
Date of Admission : 9-Jun-01  
Date of Autopsy : 11/6/01      Date of Death : 10-Jun-01  
Time of Autopsy : 10.00am      Time of Death : 12.09 pm  
Restrictions : Coroner's case  
Organs Retained: Brain and spinal cord

ANATOMICAL SUMMARY      SNOMED 3 CODES

History of appendicectomy 07/06/01 Altnagelvin, history of seizures 09/06/01 and brain stem death 09/06/01 at 12.09pm, acute cerebral oedema, aspiration pneumonia (see commentary).

P3-42000 TA0100 M36300

*[Handwritten signature]* 29/11/01

CLINICAL SUMMARY

She was admitted to Altnagelvin Hospital on 7/6/01 with abdominal pain and was diagnosed as having appendicitis. Appendicectomy was done on the same day and she was doing well after that. On 8/6/01 she was conscious and able to walk. However, she vomited 6 – 7 times but there was no fever or diarrhoea. On 9/6/01 at 3.00am she developed tonic seizures which lasted for 15 minutes. She received medication but did not improve. Soon after this she developed fixed dilated pupils with petechial haemorrhages on the anterior chest wall and possibly aspirated. An urgent CT scan showed possible subarachnoid haemorrhage with evidence of increased intracranial pressure. Electrolyte analysis showed sodium level of 118 mg./dl and potassium of 3 mg./dl. She was intubated and transferred to the RVH on 9/6/01. A second CT scan showed cerebral oedema and she was pronounced brain stem dead on 9/6/01 at 12.09 pm.

NPPM 61/2001

EXTERNAL EXAMINATION

The body is that of a female child with features in keeping with that of the age of the deceased. She weighed 25 kg. Head circumference is 144 cm. Crow-heel is 120 cm. Average foot length is 19 cm. Petechial haemorrhages were noted on the anterior chest wall.

INTERNAL EXAMINATION

## BODY CAVITIES:

There is no pleural or pericardial effusion and there is no ascites.

## HAEMATOPOIETIC SYSTEM:

Spleen This weighs 95.2 g. and appears unremarkable.

Histology shows this is congested.

Thymus This weighs 16 g.

This shows no abnormality.

## MUSCULO-SKELETAL SYSTEM:

No fractures are seen. No muscle wasting is seen.

The muscles examined show no abnormality.

## RESPIRATORY SYSTEM:

Lungs The right lung weighs 193 g. and left lung weighs 219 g. Both show haemorrhage in keeping with aspiration. There is no petechial haemorrhage on the pleural surface.

There is pulmonary oedema and haemorrhage with only occasional neutrophils. These features suggest the possibility of aspiration.

064-046-138



NPPM 61/2001

CARDIOVASCULAR SYSTEM:

Heart This weighs 137 g. There is no atrial, valvular or ventricular lesion. The aorta is unremarkable. The coronary arteries appear normal.

There is patchy myocardial inflammation and pericardial inflammation in keeping with stress haemorrhage secondary to cerebral oedema. It does not appear ischaemic in distribution.

DIGESTIVE SYSTEM:

Oesophagus, stomach, small and large intestine There is no lesion.

Histology of the oesophagus shows no pathological abnormality. The small and large intestine are autolysed, but show no definite abnormality. There is no peritonitis.

The site of the appendectomy was clean and showed no inflammation.

Liver This weighs 783 g. and shows no focal lesion.

There is no abnormality.

Gallbladder This is present and the biliary system is patent.

Pancreas This shows no abnormality.

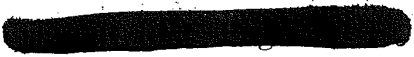
GENITO-URINARY SYSTEM:

Kidneys The right kidney weighs 770 g. The left kidney weighs 760 g. Both appear unremarkable. The collecting system is unremarkable.

There is no interstitial inflammation or acute pyelonephritis. There is no tubular necrosis and the glomeruli appear normal.

Bladder This is unremarkable.





NPPM 61/2001

ENDOCRINE SYSTEM:

Adrenals The combined adrenal weighs is 7.4 g.

These are unremarkable.

Thyroid This is unremarkable.

Parathyroids These are unremarkable.

Pituitary This is slightly congested, but shows no definite evidence of necrosis.

NERVOUS SYSTEM:

BRAIN DESCRIPTION

The brain weighs 1,475 g. On external examination the brain is quite pale. There is diffuse swelling with effacement of sulci and flattening of gyri. There is no infarct and there is no subarachnoid haemorrhage. On examination of the base of the brain the anatomy is normal. There is no abnormality to the blood vessels. There is bilateral uncal swelling and bilateral uncal necrosis.

On examination of the coronal sections the presence of diffuse cerebral oedema is confirmed with effacement of the ventricular system and slight caudal descent. There is no shift. There is evidence of diffuse hypoxic ischaemic necrosis due to perfusion failure with discoloration at the grey/white matter junction. However, there is no regional cortical lesion. The laminar pattern is normal. There are no heterotopias or suggestions of migration abnormality. The hypothalamus does not appear necrotic although the mamillary bodies are slightly elongated but this is more likely is an effect of cerebral oedema. There are no peticule haemorrhages. The brain stem and especially the pons appears normal. There is no intrinsic abnormality in the cerebellum. The cord appears normal.

9/7/01 DB

NPPM 61/2001

## HISTOLOGY

### Meninges

There is no acute meningitis. Very few inflammatory cells are present in the meninges which appear reactive in nature.

### Cerebral Cortex

This has been examined in multiple areas and shows cerebral oedema and established diffuse hypoxic ischaemic necrosis as suggested by the macroscopic findings. There is no laminar necrosis and there is no abnormal inclusion seen. There is no encephalitis.

### Deep Grey and White Matter

These show the changes of cerebral oedema, but no other abnormality.

### Hippocampus

Oedema is present and very early acute changes of diffuse hypoxic ischaemic necrosis are seen.

### Hypothalamus

Oedema is present, but there is no anatomical abnormality.

### Brain Stem

This has been serially sectioned. It shows focal evidence of diffuse hypoxic ischaemic necrosis with neuronal necrosis. There is no evidence of central pontine myelinolysis.

NPPM 61/2001

Spinal Cord

There is no intrinsic abnormality, but a few mononuclear cells are present in the meninges suggestive of origin in the cerebellar tonsils.

21/11/01 jl

## COMMENTARY

She had her appendix removed on 07/06/01 and developed seizures on 09/06/01. At autopsy she had cerebral oedema and aspiration pneumonia from which she died. Specialist opinion was sought as to the likely cause of the cerebral oedema and a report is enclosed. The summary of this was that the oedema was caused by rapid fall in plasma sodium concentration as a result of net sodium loss, coupled with hypotonic fluid administration in a situation (ie. post operative state +/- vomiting) where a normal physiological response inhibited the effective excretion of the excess free water. The abnormality of sodium balance and thus the cerebral oedema which led to her death was thought to be caused by three main factors:- 1. Infusion of hypotonic fluids, 2. Profuse vomiting, 3. Anti-diuretic hormone (ADH) secretion.

Established changes related to sodium imbalance such as central pontine myelinolysis were not seen possibly due to short time period between her deterioration and death. The relative contribution of these factors are unknown and as a combination they led to the brain swelling which eventually led to her death.

064-046-142

### POST MORTEM INFORMATION

Coroner's Office  
The Courthouse  
37 Church Road  
Newtownabbey BT36 7LA

Tel: (028) 90 869144

Mortuary - FGM/RVH/UHD/ANTRIM  
Tel: .....  
(To be completed by Investigating Police Officer)

MEMO TO (Investigating Police Officer) CONSTABLE ADAMS

PLEASE PERSONALLY DELIVER THIS FORM TO THE NEXT-OF-KIN AND/OR THE PERSON WHO HAS ASSUMED RESPONSIBILITY FOR THE FUNERAL ARRANGEMENT PRIOR TO RELEASE OF THE BODY OF

RACHEL FERGUSON

following the post-mortem examination on (date) 11-6-01

The following tissue/organs were retained for further examination:

Brain Heart Lungs Other(s) spinal cord

Signed Rachel New  
Pathologist/Investigating Police Officer

Any enquiries regarding the retention of the said tissue/organs should be directed to the Coroner's Office by the family or someone authorised on their behalf eg family GP or funeral director.

1. This Form should be completed once the post-mortem examination has taken place and a copy **FAXED IMMEDIATELY** to the Coroner's Office (Fax no: 028 90 869117).
2. One copy of the Form should be handed to the next of kin and/or the person who has assumed responsibility for the funeral arrangements who should sign an acknowledgement.
3. One copy should be left with the pathologist or a member of the mortuary staff.
4. A copy of ~~the~~ form signed by the person at 2. above should be attached to and forwarded with the Form 19.
5. **PLEASE NOTE THAT THE CORONER WILL NOT AUTHORISE THE RELEASE OF THE BODY UNTIL THE ABOVE FORMALITIES HAVE BEEN COMPLIED WITH.**

Signed Rachel Ferguson Next of kin and/or Person assuming responsibility for the funeral.

Date 11/6/01

012-049-237

REGIONAL NEUROPATHOLOGY SERVICE

3 September 2001

Dr C Loughrey  
Consultant Chemical Pathologist  
Belfast City Hospital

Dear Dr Loughrey

**Re: Rachel Ferguson DOB 4/2/92 Date of Death 10/6/01.**  
**Our ref: NPPM 61/2001**

I would be very grateful for your opinion on a case about which I spoke to you over the phone. I enclose photocopies of the Altnagelvin notes including anaesthetic notes, blood results and fluid management charts. I also enclose a copy of the clinical summary that I received prior to performing the post mortem. I would be grateful for your opinion concerning the cause of the profound hyponatraemia in this case. I have also obtained samples from Altnagelvin of urine and blood taken during her admission which I will provide for you if you have any need for these.

At autopsy the main finding was the presence of cerebral oedema with failure of cerebral perfusion. The Coroner is aware that I have asked for your expertise in this case.

Yours sincerely



Brian Herron  
Consultant Neuropathologist

cc Mr J Leckey, Coroner  
Enc

012-063-322

ALTNAGELVIN HOSPITAL

Name : FERGUSON, RACHAEL  
Sex : F  
D.O.B. : 04/02/1992  
Hosp.No : AH 313854  
Source Loc : ALTNAGELVIN HOSPITAL  
Ward/Clinic : WARD 6  
Cons/GP : MR R GILLILAND

Received : 08/06/2001  
Lab.Ref : 0105206

Copy to :

Specimen : APPENDIX

Secretary :- COK

CLINICAL HISTORY:

Right sided abdominal pain of 6 hour duration and tenderness and guarding.  
Peritoneal fluid reaction.

PATHOLOGIST'S REPORT:

Received a 6 cm long appendix which grossly appears normal. On section, there is a faecolith 1 cm from the proximal margin. (4 BL NTR).

Histology of the entire appendix confirms the presence of a faecolith and Gram Stains show Gram Positive Cocci within the faecal material. There is no mucosal ulceration in the sections examined and there is no acute inflammation within the mucosa. In a few sections, there are occasional eosinophils and an occasional polymorph within the muscle layer but no plasma cells are seen. The serosal surface shows no acute inflammation.

DIAGNOSIS:

APPENDIX : FAECOLITH

BS

Signed: *Glesche* Pathologist: DR J CROSBIE (Altnagelvin Hospital)

Date : 19/06/2001 Histopathology Report WHSSB Dept. of Pathology

012-002-068

24/10/01

HM CORONER'S OFFICE  
FOR  
GREATER BELFAST  
29 OCT 2001  
RECEIVED

Dear Mr Leckey,

Please find enclosed correspondence from Medicine Control Agency. I reported an "Adverse event" associated with the use of the iv fluids (0.18 NaCl/4% glucose) and also asked the MCA to consider issuing an "Hazard Notice" with this fluid. They have been to have a copy of the post mortem which is your property.

Yours

Bob Taylor  
Consultant Paed

012-071-411

Medicines Control Agency  
Market Towers  
1 Nine Elms Lane  
London SW8 5NQ

23rd October 2001

Medical Report. Re; Yellow card 433167 (RF)

Dear Dr Cheng,

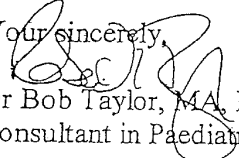
Thank you for your correspondence of the 17<sup>th</sup> October. I enclose the answer to your questions as follows;

1. RF admitted to a large DGH with abdominal pain (no vomiting or diarrhoea) on 7/6/01 at 20.30. iv fluids commenced, serum sodium = 137 mmol/l
2. Appendicectomy (mildly inflamed) at 23.30 on 7/6/01
3. iv fluids in operating theatre (100 mls Hartmanns solution). Recommended on 0.18% NaCl/4% Glucose at 80 mls/hour on return to ward.
4. Vomited 6-7 times on 8/6/01 from 12.30-13.00, complaining of headache. Sips of water allowed from 17.00 on 8/6/01
5. Seizures commenced at 03.00 on 9/6/01. Treated with diazepam 5mg PR followed by 10 mg iv.
6. Pupils fixed and dilated at 04.10 on 9/6/01. Intubated and ventilated for CT scan, which showed cerebral oedema. Serum sodium = 118 mmol/l
7. Transferred to PICU at our hospital (RBHSC)
8. Brain Stem tests performed 10.00 on 10/6/01
9. Ventilation discontinued at 12.09 on 10/6/01
10. Coroner informed and postmortem conducted by Neuropathologist for Forensic.

Unfortunately I am not in a position to supply a postmortem result as it is a Coroners case. I have spoken to the neuropathologist who has confirmed that the cause of death was cerebral oedema leading to herniation. I have copied this response to both these men who I hope will supply you with further details of this important matter.

I am also conducting an audit of all infants and children admitted to the PICU with hyponatraemia. My initial results indicate at least 2 other deaths attributable to the use of 0.18NaCl/4%Glucose.

Your sincerely,

  
Dr Bob Taylor, MA, MB, FFARCSI  
Consultant in Paediatric Intensive Care

Dr Brian Herron, Consultant Neuropathologist, Royal Victoria Hospital, Belfast  
Mr John Leckey, Coroner.



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Department of Health

MEDICINES CONTROL AGENCY

Market Towers 1 Nine Elms Lane London SW8 5NQ

Tel 020 7273 0101 - fax 020 7273 0282 - www.mca.gov.uk



Dr Bob Taylor  
Consultant Paediatric Intensive Care  
The Royal Belfast Hospital for Sick Children  
180 Falls Road  
Belfast BT12 6BE

17 October 2001

Dear Dr Taylor

**HYPONATRAEMIA AND 4% DEXTROSE/0.18% SALINE SOLUTION**  
**YELLOW CARD NO: 433167**

Thank you for your letter of 1 October 2001. We are currently initiating a review of the safety of 4% dextrose and 0.18% saline solution in children. We will be in contact again when we have the results.

In the meantime I would be grateful if you could provide me with some details about the case (R.F) you reported to us:

- the date of the appendicectomy and the results of pre-op electrolytes, if measured
- the date when the headaches and vomiting started
- the date when seizures started
- date of death
- a copy of the hospital summary
- a copy of the post-mortem results

With kind regards

Yours sincerely

*K Cheng*

Dr Katharine Cheng  
Medical Assessor  
Post Licensing Division

Copy ADROIT

012-071-413



041



COMMITTEE ON SAFETY  
OF MEDICINES

Market Towers • 1 Nine Elms Lane • London SW8 5NQ  
Telephone 020-7273 0263 • Facsimile 020-7273 0060



Dr Brian Herron  
Consultant Paediatric Intensive Care  
The Royal Victoria Hospital  
Belfast

28 November 2001

Dear Dr Herron

**YELLOW CARD NO:** 433167 (RF)

Dr Bob Taylor, Consultant Intensivist at the Royal Belfast Hospital for Sick Children has reported the above case of fatal hyponatraemia following the infusion of 4% dextrose/0.18% saline.

I would be grateful if you could forward me a copy of the post mortem report. If this is not possible please confirm the findings at post mortem.

With kind regards.

Yours sincerely

*Katharine Cheng*

**Dr Katharine Cheng**  
Medical Assessor  
Post Licensing Division

Copy ADROIT

AS DISCUSSED

Sent 12.12.01

Dr Brian Herron  
Consultant Neuropathologist  
Department of Pathology  
Royal Victoria Hospital  
Grosvenor Road  
BELFAST  
BT12 6BA

30<sup>th</sup> November 2001

**RE: RACHEL FERGUSON, DECEASED  
AUTOPSY NUMBER: NPPM 61/2001**

I am writing to acknowledge receipt of your postmortem report. The report of Dr Clodagh Loughrey was not enclosed but your secretary kindly faxed me a copy. I note that Dr Loughrey had not signed this (the space for the signature is blank) and I should be grateful if you would ask her to forward to me a signed copy of her report.

You may aware that in 1996 I held an Inquest into the death of a 4 year old child called Adam Strain. Bob Taylor was involved in his treatment at that time and I am sure he remembers the Inquest very well indeed. For your information I am enclosing 2 copies of the Postmortem Report and 2 copies of an independent report I commissioned from Dr Edward Sumner of Great Ormond Street Hospital for Children. I should be grateful if you could pass one set of the papers to Dr Loughrey. The reason I am sending these to you is to enable me to discover whether there are any parallels between the death of Adam Strain and Rachel Ferguson. I would be very willing to meet with you, Dr Loughrey and Bob Taylor to discuss this. Would you be willing to mention this suggestion to them?

A further point I would wish you to reflect on is the cause of death you give in your report - Cerebral Odema. You do not specify an underlying cause for the Cerebral Odema yet in the commentary section of your report you mention 3 factors that would have led to the onset of the Cerebral Oedema. Because of that I am writing to enquire

012-060-308

if these 3 factors should be referred to at 1(b). I assume the "fluids" issue is the most important. You will note the formulation of the cause of death given by of Dr Armour in relation to Adam Strain. Would a similar formulation of the cause of death in relation to Rachel Ferguson (ignoring the reference to the renal transplant operation) be appropriate?

I believe it would be advantageous if you felt able to give an underlying cause for the Cerebral Oedema. I am sure it is a question you would be asked at the Inquest. I will not send out copies of your report to those concerned until you have had an opportunity of considering this letter and until I have in my possession a signed copy of the report of Dr Loughrey.

Would you consider it advisable for me to obtain an independent report from Dr Sumner or someone similar?

With kind regards

Yours sincerely

012-060-309



HM CORONER'S OFFICE  
FOR  
GREATER BELFAST  
4 - DEC 2001  
RECEIVED

Dr Brian Herron  
Consultant Neuropathologist  
Department of Pathology  
Royal Group of Hospitals  
Grosvenor Road  
Belfast BT12 6BJ

24 October 2001

Dear Dr Herron

Re: Rachel Ferguson DOB 4/2/92  
Ref: NPPM 61/2001

Thank you for asking me to look at the Altnagelvin records of this girl who had a major seizure approximately 28 hrs after an apparently uncomplicated appendicectomy. Significant hyponatraemia was noted after the seizure and she subsequently died, cerebral oedema being your major finding at autopsy. I have summarised relevant sections of the notes available to me, the page of origin identified by the title in italics:

This 9-year-old girl was admitted via A&E on the evening of 7/6/01 with abdominal pain (*"Accident & Emergency" sheet*: not legible due to photocopy quality).

Admission and pre-operative period

*"Clinical notes" Pg. 1*: patient was examined on the Children's ward (ward 6?) by the surgical SHO, who documented periumbilical pain, which had shifted to the right iliac fossa (McBurney's point); she had RIF tenderness, guarding and mild rebound tenderness. Absence of urinary symptoms was recorded. She was felt to have acute appendicitis and consent was obtained for appendicectomy. Intravenous fluids were prescribed.

*"Observation sheet" (nursing) Pg. 1(7/6/01)* documented abdominal pain and pain on urination.

*"TPR chart"*: on admission, patient was afebrile, BP was 103/61, weight was 25kg. An (undated, time 23:19) urinalysis printout indicated proteinuria++.

*"Parenteral nutrition fluids prescription sheet" (Pg.1)*: Intravenous fluids ("No. 18 solution") were erected at 80mls/hr at 10.15pm.  
(FBP/U&E checked: see table of biochemistry results below.)

Intra-operative / peri-operative period

*"Theatre nursing care plan"*: arrived at 11.20pm. Alert, not premedicated, IV infusion site right arm.

*"Surgeon's report"*: mildly congested appendix. Peritoneum clean. Flagyl prescribed.

*"Intra-operative nursing care"*: received rectal Voltarol 12.5mg and paracetamol 500mg at 11.40pm.

*"Anaesthetic record" Pg1/2*: received ondansetron 2mg, fentanyl 50mg total, propofol 100mg, scoline 30mg, cyclimorph 5mg, mivacurium 2mg, metronidazole 250mg. Peri-operative event: "prolonged sedation due to opioids".

Hartmann's fluid 1L?: anaesthetist's intention indicated, but administration not confirmed by fluid balance chart.

"Parenteral nutrition fluids prescription sheet" (Pg. 1) (same document as for pre-op): Hartmann's fluid prescribed at 80mls/hr, signed by anaesthetist, but deleted (unsigned).

Post-operative period prior to seizure

"Fluid balance for IV fluids" (Pg. 1: 7/6/01): Received total 540 mls No. 18 solution between 22.15 on 7/6/01 and 07.00 hrs on 8/6/01. No record of urine output.

"Clinical notes" (Pg. 2: 8/6/01): "Free of pain. Apyrexial. Continue observation."

"Paediatric unit" sheet (7-8/6/01) (Apparently a nursing record chart.)

Temperature/respiratory rate/pulse/blood pressure recorded on return from theatre 01.55am, half-hourly until 4am, then 5am, 7am. BP range 78-96/41-57. Temp, resp rate and pulse only recorded 4 hourly from 9am until 21.15 on 8/6/01. Afebrile throughout. No problems documented until 21.15pm: "colour flushed → pale. Vomiting++. C/o headache."

[NB: No "Observation sheet" for 8/6/01 is present in copy of notes I received (7/6/01 and 9/6/01 both present: see above and below).]

"Parenteral nutrition fluids prescription sheet" (Pg. 2): 1L No. 18 solution prescribed at 80mls/hr and erected at 12.15pm. [A second litre of 0.9% NaCl was apparently prescribed early on 9/6/01: from subsequent nursing notes.]

"Fluid balance for IV fluids" (Pg. 2: 8/6/01): Received 1520mls No. 18 solution between 08.00 on 8/6/01 and 04.00 on 9/6/01. No record of urine output. No record of oral intake, if any. Seven episodes of vomiting documented between 08.00 on 8/6/01 and 01.00 am on 9/6/01, with "coffee-grounds" mentioned latterly, but no measure of volume ("large vomit", "vomit++").

"Observation sheet" (nursing) 9/6/01: 03.05am: major seizure. Bloods taken at 3.30am for electrolytes: see table.

Likely pathogenesis of cerebral oedema

I have little doubt that the cerebral oedema which you noted at autopsy was caused by an intracellular fluid shift as a result of rapid fall in tonicity of the extracellular fluid (ECF). As you can see from the table of biochemistry results, I have estimated a fall of 37mOsm/L (293 to 256 mOsm/L) over approximately 30 hrs. Sodium is the predominant extracellular cation and as such is the major determinant of extracellular tonicity. The cell membrane is relatively impermeable to sodium due to an active sodium pump mechanism, and rapid changes in the concentration of sodium in the ECF (in either direction) result in significant fluid shifts to maintain osmotic equilibrium between the intracellular and extracellular compartments. The brain is particularly susceptible to the effects of such fluid shifts and profound neurological damage such as occurred in this case has been well-described in association with rapid increases and decreases in plasma sodium concentrations. Cerebral oedema with its attendant acute neurological features is characteristic of rapidly-developing hyponatraemia.

I believe that in this case the fall in plasma sodium concentration and thus ECF tonicity was caused by a combination of 3 main factors:

1. infusion of hypotonic parenteral fluids (No. 18 solution contains 31mmol Na in 1 litre 4% glucose solution, one-fifth the concentration of plasma);

2. profuse vomiting in the post-operative period. Although vomitus contains 70-100mmol of sodium /L, which is relatively less than plasma (at 140mmol/L), if the ECF volume is replaced as in this case with fluids containing very little sodium, the net effect is a significant salt loss, with little or no water deficit;
3. Anti-diuretic hormone (ADH) secretion, known to be associated with stress (e.g. surgery), vomiting and pain, is likely to have been a major contributor to the overall picture by inhibiting excretion of excess free water.

The relative contributions of these factors will remain unknown. Normally administration of generous volumes of hypotonic fluids will result in a brisk diuresis, and certainly this will be noted by most healthy people who can tolerate drinking large amounts of dilute fluids without consequence. However in this case excess ADH secretion for the reasons mentioned above might have resulted in a net positive fluid balance and an inappropriately concentrated urine. Urine osmolality was indeed inappropriately high in the sample taken after the seizure (measured last week on the sample obtained by you from Altnagelvin laboratory), and the low urea notable in the post-seizure serum samples, relative to that on admission, might indicate relative water excess as a consequence of ADH action. However whether this was a cause or effect of the cerebral oedema cannot be judged and no plasma or urine samples are available from the post-operative but pre-seizure period. Unfortunately no record of fluid balance was apparent. A low urinary output might have given an early sign of evolving problems.

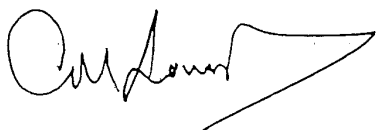
(I also measured cortisol in the post-seizure blood sample and this was appropriately elevated, excluding adrenal insufficiency as a cause of the hyponatraemia.)

In summary, I believe that the cerebral oedema which you noted at autopsy was caused by a rapid fall in plasma sodium concentration as a result of a net sodium loss coupled with hypotonic fluid administration in a situation (i.e. post-operative state  $\pm$  vomiting) where a normal physiological response inhibited the effective excretion of the excess free water.

I hope this has been of some help. Please do not hesitate to contact me if further clarification is required.

Best wishes.

Yours sincerely,



Clodagh Loughrey MD MRCP MRCPath  
Consultant Chemical Pathologist  
Belfast City Hospital



Table of relevant laboratory results: Rachel Ferguson (DOB 4/2/92)  
 (\*tests performed *post-mortem*)

Serum	Pre-operatively	Post-seizure			
Date	7/6/01	9/6/01	9/6/01	9/6/01	9/6/01
Time received in lab	9pm approx.	4.06am	4.40am	9.22 am	3pm
Lab. No.	01633	01742	01747	5380	(RBHSC)
Na (mmol/L)	137	119	118	119	130
K (mmol/L)	3.6	3.0	3.0	3.4	
Cl (mmol/L)	107	90	90	90	
CO2 (mmol/L)	22	16	15	22	
Urea (mmol/L)	4.8	2.3	2.1	2.5	
Creat (mmol/L)	47	44	43	22	
Glucose (mmol/L)	7.2	9.9	11	7.1	
T prot (mmol/L)	69	71	72	68	
Osmol (mOsm/L) (calc)	293*	256*		255*	
Urine					
Date				9/6/01	
Time				9am	
Lab. No.				5425	
Na (mmol/L)				90	13
Osmol (mOsm/L)				382*	73



041

Reference No.

NPPM 69/2001

# INSTRUCTIONS FOR DISPOSAL/RETENTION OF TISSUES/ORGANS RETAINED AT POSTMORTEM EXAMINATION

From H M Coroner

Regarding the death of -

RACHEL FERGUSON

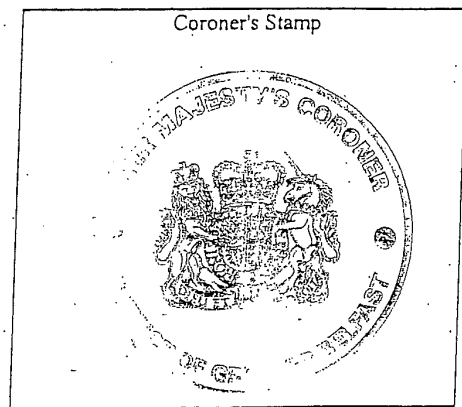
Please tick the appropriate box:

- (i) The tissue/organs retained can now be disposed of in accordance with current health and safety requirements
- (ii) The tissue/organs should be retained pending collection by a funeral director instructed by the next-of-kin
- (iii) The tissue/organs should be retained pending legal proceedings.

Signed: Phil Carley

H M Coroner for Greater Belfast

Date: 31/11/01



PM3  
012-060-312