NOTE FOR PROFESSOR BRIAN HARDING
RE: CLAIRE ROBERTS

Introduction

1. Claire Roberts is one of 4 children who are the subject of a public inquiry being conducted by John O'Hara QC.

2. Claire was born on 10th January 1987. She was admitted to the RBHSC Belfast Hospital for Sick Children ("RBHSC") on 21st October 1996 with a history of malaise, vomiting and drowsiness and she died on 23rd October 1996. Her medical certificate recorded the cause of her death as Cerebral Oedema and Status Epilepticus. That certification was subsequently challenged after a television documentary into the deaths of Adam and 2 other children (Lucy Crawford and Raychel Ferguson).

3. The Inquest into Claire's death was carried out nearly 10 years after her death by John Leckey on 4th May 2006. He engaged as experts: (i) Dr. Robert Bingham Consultant Paediatric Anaesthetist at Great Ormond Street; and (ii) Dr. Ian Maconochie Consultant in Paediatric A&E Medicine at St Mary's, London. The Inquest Verdict found the cause of Claire's death to be Cerebral Oedema with Hyponatraemia as a contributory factor.

4. The other 3 children are :

   (i) Adam Strain was born on 4th August 1991. He died on 28th November 1995 in the RBHSC following kidney transplant surgery.

   The Inquest into his death was conducted on 18th and 21st June 1996 by John Leckey the Coroner for Greater Belfast, who engaged as experts: (i) Dr. Edward Sumner Consultant Paediatric Anaesthetist at Great Ormond Street Hospital for Sick Children ("Great Ormond Street"); (ii) Dr. John Alexander Consultant Anaesthetist at Belfast City Hospital; and (iii) Professor Peter Berry of the Department of Paediatric Pathology in St. Michael's Hospital, Bristol. The Inquest Verdict identified Cerebral Oedema as the cause of his death with Dilutional Hyponatraemia as a contributory factor.

(ii) Raychel Ferguson was born on 4th February 1992. She died in the RBHSC on 10th June 2001 after an appendectomy carried out on 8th June 2001 at the Altnagelvin Area Hospital.

The Inquest into her death was conducted on 5th February 2003 by John Leckey who engaged Dr. Edward Sumner as an expert. The Inquest Verdict found the cause of Raychel's death to be Cerebral Oedema with Acute Dilutional Hyponatraemia as a contributory factor. It also made findings that the hyponatraemia was caused by a combination of inadequate electrolyte replacement following severe post-operative vomiting and water retention resulting from the secretion of anti-diuretic hormone (ADH).

(iii) Conor Mitchell was born on 12th October 1987 with cerebral palsy. He was admitted to A&E Craigavon Hospital on 8th May 2003 with signs of dehydration and for observation. He was transferred to the RBHSC on 9th May 2003 and died on 12th May 2003.

The Inquest into Conor's death was conducted on 9th June 2004 by John Coroner who again engaged Dr. Edward Sumner as an expert. Despite the Inquest, the precise cause of Conor's death remains unclear. Dr. Edward Sumner commented in his Report of November 2003 that Conor died of the acute effects of cerebral swelling which caused coning and brainstem death but he remained uncertain why. He noted that the volume of intravenous fluids was not excessive and the type appropriate but queried the initial rate of administration. That query was raised in his correspondence shortly after the Inquest Verdict. In that correspondence Dr. Sumner described the fluid management regime as 'sub-optimal'. The Inquest Verdict stated the cause of death to be Brainstem Failure with Cerebral Oedema, Hypoxia, Ischemia, Seizures and Infarction and Cerebral Palsy as contributing factors.

5. The impetus for this Inquiry was a UTV Live Insight documentary 'When Hospitals Kill' shown on 21st October 2004. The documentary primarily focused on the death of a toddler called Lucy Crawford (who was subsequently also found to have died in hospital in 2000 from hyponatraemia). The programme, effectively, alleged a cover-up and criticized the hospital, the Trust and the Chief Medical Officer. The programme also referred to the deaths of Adam and Raychel in which hyponatraemia had similarly played a part. No connection was made, at that time, with the deaths of Claire and Conor.

Terms of Reference

6. The Inquiry was established under the Health and Personal Social Services (Northern Ireland) Order 1972, by virtue of the powers conferred on the Department by Article 54 and Schedule 8 and it continues pursuant to the Inquiries Act 2005.

7. The original Terms of Reference for the Inquiry as published on 1st November 2004 by Angela Smith (then Minister with responsibility for the Department of Health, Social Services and Public Safety) were revised in 2008 in response to the Crawford family's wish to have Lucy excluded from the Inquiry's work. The Revised Terms of Reference under which the Inquiry is operating are:

> To hold an Inquiry into the events surrounding and following the deaths of Adam Strain and Raychel Ferguson, with particular reference to:
>
> 1. The care and treatment of Adam Strain and Raychel Ferguson, especially in relation to the management of fluid balance and the choice and administration of intravenous fluids in each case.
>
> 2. The actions of the statutory authorities, other organisations and responsible individuals concerned in the procedures, investigations and events which followed the deaths of Adam Strain and Raychel Ferguson.
>
> 3. The communications with and explanations given to the respective families and others by the relevant authorities.
>
> In addition, Mr O'Hara will:
>
> (a) Report by 1 June 2005 or such date as may be agreed with the Department, on the areas specifically identified above and, at his discretion, examine and report on any other matters which arise in connection with the Inquiry.
>
> (b) Make such recommendations to the Department of Health, Social services and Public Safety as he considers necessary and appropriate.

8. The case of Claire Roberts (and to a more limited extent that of Conor Mitchell) was included into the Inquiry's work by the Chairman under his discretionary powers. That decision arose out of the belated recognition by the RBHSC that hyponatraemia had played a part in Claire's death notwithstanding that only a few months earlier the Inquest into Adam's death had established hyponatraemia as a contributory factor and drawn attention to the dangers of the condition

9. The Police Service of Northern Ireland ("PSNI") carried out an investigation into the death of Claire Roberts (together with those of Adam, Lucy and Raychel). The PSNI engaged a number of Experts to assist them with their investigation into Claire's death. In addition to you, they also engaged: (i) Dr. Dewi Evans Consultant Paediatrician then at Singleton Hospital, Swansea; (ii) Dr Rajat Gupta Consultant Paediatric Neurologist at Birmingham Children's Hospital**;** and (iii) Ms. Sue Chapman Nurse Consultant for Acute and High Dependency Care at Great Ormond Street.

10. All of the Experts engaged by the Coroner and the PSNI produced Reports.

The Inquiry

11. The Inquiry has appointed a Panel of Experts[1] to assist it in its investigations in respect of all 4 children. It has also engaged Experts to deal with a number of discrete issues that are child-specific.

12. The work of all the Inquiry's Experts is peer reviewed by a team of international Experts.[2]

Background to Claire

Referral to the RBHSC (1996)

13. On 21st October 1996 Claire's GP referred her for admission to the RBHSC. He described Claire as a 9 year old girl with a severe learning disability and a past history of epilepsy who had been seizure-free for 3 years and had been weaned off anticonvulsant drugs 18 months previously. The referral also stated: "No speech since coming home. Very lethargic at school today. Vomited x 3 – speech slurred. Speech slurred earlier". Claire was described as pale, not liking the light and with no neck stiffness. The GP considered her tone increased on the right side and suggested that Claire was post-seizure and had an underlying infection.

---

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

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

14. Claire was admitted to the RBHSC later on 21st October 1996, exactly 4 months after the Inquest into Adam Strain's death at the RBHSC of Cerebral Oedema in which hyponatraemia was found to have been a contributory factor.

15. The A&E note repeated parts of the GP's history. It noted non-bilious vomiting "since this evening" and that she was "drowsy, tired, apyrexial" with no other abnormal signs except for increased left sided muscle tone and reflexes. At 20:45 a decision was made to admit Claire to hospital under the care of Dr. Heather Steen.

16. The admission note (timed at 20:00) refers to Claire as "vomiting at 3 pm and every hour since" and to her having experienced a loose bowel motion 3 days previously. The admitting doctor, Dr. O'Hare, noted that Claire had severe learning difficulties but normally had meaningful speech and referred to the recent trial of Ritalin and its apparent side effects. Dr. O'Hare also noted that Claire "sits-up and stares vacantly" and was ataxic. She was not responding to her parents' voice and only intermittently responding to a deep pain stimulus. She had cogwheel rigidity of her right arm and increased tone in all other limbs. Tendon reflexes were brisker on the right than the left and there was bilateral ankle clonus.

17. The admission diagnoses were noted as: (1) Viral illness; (2) Encephalitis (but this was subsequently scored through).

18. Blood was taken for a full blood count, urea and electrolytes, bacteriological culture and viral studies. Treatment to be given was noted as 'IV fluids, IV diazepam if seizure activity'. She was to be reassessed after fluids. An IV prescription chart was prepared, ordering 500 ml of 0.18% sodium chloride in 4% dextrose to be given at 64 ml/h (equivalent to 65 ml/kg/24 h). The nursing care plan referred to administering 'IV fluids as prescribed by doctor, according to hospital policy'.

19. The nursing record includes a fluid balance chart, which shows that treatment was started at 2130 with 64 ml hourly of 5/N saline. By 07:00, Claire had received 536 ml (just under 57 ml hourly). During those 9½ hours, she was noted by Nurse McRandal to have had 1 "medium" and 5 "small' vomits". The nursing notes of the night of 21st October and early morning on 22nd October 1996 describe those vomits as bile-stained, which was a change from the A&E note where the vomits were described as "non-bilious".

20. A medical note at midnight stated that Claire was "slightly more responsive" and had no meningism. It was noted that she would be "observed and reassessed a.m". Directly beneath this note is a manuscript entry for the blood biochemistry results. These were:

> Sodium 132; Potassium 3.8; Urea 4.5; Glucose 6.6; Creatinine 36; Chloride 96; Haemoglobin 10.4; Packed cell volume 31; White cell count 16.5; platelets 422,000

21. The laboratory reference range for sodium ('normal range') is given as 135-145. Next to the sodium result is the symbol ↓ and next to the white cell count is the symbol ↑.

22. The nursing record at 0700 by Nurse McRandal states: "Slept well. Much more alert and brighter this morning. One further bile stained vomit … no oral fluids taken". A nursing note timed at 0800 - 1400 states: "Slept for periods during early morning – bright when awake; no vocalisation but arm [?] active. Late morning Claire became lethargic and 'vacant'. Parents concerned as usually Claire is very active. Seen by Dr. Sands – status epilepticus – non-fitting. Rectal diazepam given".

23. The first medical note on 22nd October 1996.10.96 referred to a ward round by Dr Sands (at the time, a registrar in paediatric cardiology) and stated: "Admitted ? viral illness. Usually very active, has not spoken to parents as per normal. Wretching [sic]. No vomiting. Vagueness/Vacant appearance (apparent to parents). No seizure activity observed". The sodium of 132mmol/L and raised white count were restated. She was described as apyrexial, pale and showing little response compared to normal. Her pupils were "sluggish to light". The impression was of "non-fitting status". A different hand has added "encephalitis/encephalopathy".

24. A plan was noted to give rectal diazepam (actually administered at 12:30), to discuss her past medical history with Dr. Gaston and to consult Dr. Webb. Dr. Webb also attended Adam Strain when he was admitted to PICU after he failed to regain consciousness following his renal transplant surgery.

25. The fluid chart for 22nd October 1996 does not note the solution given. However, an undated prescription chart also referred to 500 ml of "No 18 solution at 64 ml/hr". A total of 562 ml was given over 8hs from 08:00, i.e. 70 ml/hr.

26. At 15:30 Claire was reported as having a 5 minute "strong seizer [sic]" at 15:25. At 16:30 her teeth tightened slightly. At 16:00, Dr. Webb made a note. He saw Claire with her grandmother, noting a history of "Vomiting and listless yesterday p.m. – followed by prolonged period of poor responsiveness". He added that she had appeared to improve after rectal diazepam, given at 12:30. She was afebrile and pale with no meningism. She opened her eyes to voice, was non-verbal, withdrew (limb) from painful stimulus and had (questionably) reduced movements on the right side. He found mildly increased tone in her arms and symmetrical brisk reflexes, sustained ankle clonus and upgoing plantar responses. Claire was sitting up with eyes open and looking vacant, not obeying commands. She did not have papilloedema. Dr. Webb's impression was: "I don't have a clear picture of prodrome + yesterday's episodes. Her motor findings today are probably long-standing but this needs to be checked with notes. The picture is of acute encephalopathy, most probably postictal in nature. I note (N) [normal] biochemistry profile".

27. Dr. Webb suggested starting Claire on the anticonvulsant phenytoin intravenously: 18 mg/kg as a first dose, followed by 2.5 mg/kg 12 hourly. He asked for hourly neurological observations and a CT scan the following day "if she doesn't wake up".

28. Although Dr. Webb's note is timed at 4pm, he states in his Deposition at the Inquest that he believed he saw Claire at about 14:00. The SHO noted calculations of phenytoin dose at 14:30 and ordered a dose of 18[mg] x 24 [h] which he or she wrongly calculated as 632 mg rather than 432 mg. The calculation of the continuing dose of 2.5 mg/kg 12 hourly is then stated as 60 mg 12 hourly.

29. Those doses were ordered on a prescription chart. The nursing notes record a stat dose of phenytoin given at 2.45pm, with a second dose at 11pm following blood sampling for phenytoin levels.

30. The next medical note (untimed) referred to Claire being seen by Dr. Webb and being "still in status". It went on to calculate a dose of the anticonvulsant/sedative midazolam to be given as a first dose of 0.5 mg/kg (12 mg) followed by 2 mcg/kg/minute, calculated as 2.88 mg/h. The nursing notes record "stat IV hypnovel (midazolam) at 3.25pm". No dosage was recorded against this entry. The continuing infusion of midazolam was ordered as 69 mg in 50 ml normal saline to be given at 2 ml/h, which is confirmed by the fluid charts as having been given from 16:30. Also from

16:00, No 18 solution was continued with 452 ml given over 7 hrs to 23:00 (64 ml/hr).

31. At 17:00, Dr Webb, having received information from Claire's mother about the onset of the illness, described Claire as "largely unresponsive" with intermittent vomiting and chewing. He prescribed the antibiotic cefotaxime and the anti-viral drug acyclovir for 48 hours, although he noted that he did not think meningoencephalitis very likely. He noted that stool, urine, blood and a throat swab should be checked for evidence of enterovirus infection. He also suggested an additional anticonvulsant intravenous infusion: sodium valproate 20 mg/kg as an initial dose, followed by 10 mg/kg over 12 hr. A nursing note at 17:15 referred to Claire being given a stat dose of Epilim and added: "Very unresponsive – only to pain. Remains pale. Occasional episode of teeth clenching".

32. At 21:00 a nurse reported that Claire had a 30 second episode of screaming and drawing up of her arms with her pulse rising to 165. A doctor was informed.

33. At 23:30, an SHO (possibly Dr. Stewart) noted that a blood sample likely to have been taken when the doctor attended at 21:00 – 21:30, showed a sodium concentration of 121 mmol/L, potassium 3.3 mmol/L, urea 2.9 mmol/L and creatinine 33 µmol/L. The phenytoin level was 23.4 mg/L (reference range 10-20 mg/L). It was noted: "Hyponatraemic - ? Fluid overdose with low sodium fluids. ? SIADH" and "Imp[ression]. ? need for ↑ sodium content in fluids. Discussed with registrar - ↓ fluids to ⅔ of present value – 41 ml/h. Send urine for osmolality".

34. In fact, between 23:00 and 02:00 Claire received 56 ml of No 18 solution (18.5 ml/h) and 7.6 ml of normal saline. Also between 22:00 and 01:00 Claire received 170 ml of other fluids, recorded as IV Acyclovir 60 (presumably 'ml') and Phenytoin 110 (? 'ml') recorded in the oral fluids columns. The exact nature of the fluids in which the Acyclovir and Phenytoin were dissolved is not stated.

35. A nursing note at 21:30 referred to Claire receiving midazolam at 3 ml/h, completed by 22:40. At 23:00 she was given IV phenytoin over 1 hour. In addition, the fluid chart refers to two "small mouthfuls" of vomit/aspirate recorded at 24:00 and 01:00. It is unclear whether these were discussed with the doctors, as they are not referred to in the medical or nursing notes. As a result of instructions from "a registrar", 20 mmol of potassium chloride was added to the No 18 solution and the rate reduced to 41 ml/h. At 02:30 a

nurse noted: "Slight tremor of right hand noted lasting few seconds. Breathing became laboured and grunting. Respiratory rate 20 per minute. Oxygen saturations 97%. Claire stopped breathing. Dr contacted immediately. Oxygen and suction given. Registrar attempted to pass ET tube but unsuccessful – anaesthetist called and ET tube inserted. Transferred to intensive care at 3.25 am".

36. The medical note states that Claire "had been stable when suddenly she had a respiratory arrest and developed fixed dilated pupils". The doctor who attended noted she was "Cheyne-Stoking". Oxygen was being administered by a face mask and "bagging" with oxygen saturation in the "high 90s" and a "good volume pulse". The doctor unsuccessfully attempted intubation. It was subsequently carried out by the on-call anaesthetist and Claire was then transferred to the ICU.

37. The neurological observation chart, started at 1300 on 22nd October 1996, shows that at 13:00 she was noted as *opening her eyes to speech* and at 14:30 as *opening eyes to pain*. Thereafter, hourly recordings until 02:00 on 23rd October 1996 all stated there was "*no eye opening*". "Best verbal response" was noted as "*none*" from 13:00 to 18:00 and thereafter as "*incomprehensible sounds*". Her "best motor response" was noted as "*obey commands*" at 13:00 and at 20:00, "*localise pain*" between those times and "*flexion to pain*" thereafter.

38. Her Glasgow Coma Scale (GCS) score was given as 9 on first checking and thereafter was 6 - 7, except recorded as 8 at 20:00. There was a rise in temperature from normal to between 37.5 C and 38 C from 19:00 and of pulse rate from <90 at 1300 to 115 at 1800, thereafter remaining at 100-105. There was no significant change recorded in blood pressure.

39. Claire was admitted to ICU at 03:15 on 23rd October 1996 and the first ICU note was made at 04:00. It reiterated the history as given above and noted that Claire was "now intubated and ventilated. Pupils fixed and dilated. Bilateral papilloedema [swelling of the optic discs visible using an ophthalmoscope and implying raised intracranial pressure] L>R. No response to painful stimuli". She was given mannitol to reduce the cerebral oedema and dopamine and a brain CT scan was requested. At that time, the serum sodium concentration was recorded at 121mmol/L, which was equivalent to the result recorded at 23:30 on 22nd October 1996. It is not clear precisely when those bloods were taken or the laboratory results communicated but the phenytoin result states that it was received at 04:20 and vetted at 04:38. The blood could therefore have been taken between 03:15 and 04:00.

40. Dr. Webb noted, at 04:40, "SIADH (syndrome of inappropriate antidiuretic hormone secretion] – hyponatraemia, hyposmolarity, cerebral oedema + coning following prolonged epileptic seizures. Pupils fixed and dilated following mannitol diuresis. No eye movements".

41. A first test for brain stem death was conducted by Drs. Webb and Steen at 0600. The CT scan was reported as showing "severe diffuse hemispheric swelling with complete effacement of the basal cisterns. No focal abnormality identified".

42. Dr. McKaigue, ICU Consultant, reiterated the history of her hospital admission in a note at 07:10. This included the serum sodium, checked by Drs. Webb and Steen at the same time as brain stem tests [0600], and found on the ICU blood gas analyser, was 133 mmol/L(and pH 7.13, PO_2 124.5 mm Hg and PCO_2 79.2 mm Hg). A laboratory sample sent at the same time was reported as: sodium 129 mmol?L and osmolality 274 mOsmol/kg. Dr. McKaigue noted a plan to "maintain circulatory support as Claire is a potential organ donor" and ordered a dopamine infusion to maintain blood pressure and a "close check on serum sodium and osmolality and urine output. If serum sodium >150 mmol/L and osmolality >300 mOsmol/kg then commence desmopressin". He changed the IV infusion fluid to 0.9% saline and at 0810 or 0850 requested 2 hourly measurements of urea and electrolytes.

43. An untimed note, placed between that of Dr. McKaigue at 08:10 or 08:50 and that of Dr. Steen at 18:25 referred to Claire becoming hypotensive (BP 70/?) "with DI [diabetes insipidus], given HPPF 500 ml. Needs DDAVP to limit polyuria. Appears brain stem death informally. Sodium 129 (from 121)". In her witness statement to the PSNI, Dr. Steen identifies the writer as Dr. Robert Taylor, Consultant Paediatric Anaesthetist in charge of the PICU on 23rd October 1996. Dr. Taylor was the Paediatric Anaesthetist in charge of Adam's anaesthesia and fluids for his kidney transplant at the RBHSC 26th November 1996.

44. Two untimed laboratory reports on 23rd October 1996 showed serum sodium concentrations as 139 mmol/L and 152 mmol/L respectively, with osmolality 274 and 313 mOsmol/kg. The latter blood sample was identified by Dr. Steen as having been taken in the afternoon.

45. At 18:25 on 23rd October 1996 the brain stem death test protocol was repeated, and it was noted there was no spontaneous respiration while the

$PaCO_2$ was 70 mm Hg. These findings were discussed with the parents who agreed that ventilation should be withdrawn; consent for limited post-mortem examination was given. Ventilation was discontinued at 1845. The Death Certificate issued for Claire gave the cause of death as cerebral oedema secondary to status epilepticus.

46. An untimed 'Relative Counselling Record' for 22nd October 1996 (query whether it should be 23rd October 1996) stated that parents were seen by Drs. Steen and Webb. Dr Steen [?] explained that Claire had trouble with her breathing and needed to have ventilatory support now. Following the CT scan she explained that "Claire had swelling of the brain and could be (possible) brain dead". Dr. Webb [?] explained that Claire's brain had swollen and that the CT scan and brain stem tests showed Claire's brain had died. Only the ventilator was keeping her heart beating. "When they asked why her brain had swollen, they were told it was probably caused by a virus".

47. Dr. Sands made a note on 11th November 1996 that he had spoken at length with Claire's parents, talking through the events before her death "and also talked generally with them". He noted that they were anxious to know the post mortem findings and he would "pass this on to Dr. Steen ASAP".

Post-mortem findings

48. Certain pathological investigations requested during her life were reported after Claire's death. These included a blood culture which was sterile, an unremarkable urine specimen, absence of blood antibody to mumps, measles, herpes simplex, herpes zoster, cytomegalovirus, adenovirus, Q Fever, PLG virus, Mycoplasma pneumoniae, and Influenza A & B. A cerebrospinal fluid sample [taken post-mortem] was bloodstained with protein 95 gm/L (normal 0.15 -0.45 gm/L), globulin present +++, red cells 300,000/μL and white cells 4000/μL – mostly lymphocytes. No organisms were cultured.

49. An autopsy of the brain only was carried out on 24th October 1996 by Dr. Herron. The clinical summary referred to Claire's admission with vomiting after contact with a relative with diarrhoea and vomiting. It went on to refer to her increasing drowsiness, that "she was felt to have subclinical seizures" and mentioned her anticonvulsant treatment and that her serum sodium concentration had decreased to 121. There was a query of inappropriate ADH secretion. There is a statement that Claire had "iatrogenic epilepsy since 10 months".

50. Dr. Herron noted Claire's brain weighed 1606 g. His evidence to the Coroner's Inquest was that he would have expected it to be 1300 g. There was no cortical venous thrombosis or meningeal exudate. There was symmetrical brain swelling with effacement of gyri, confirmed on sectioning. He reported observing focal meningeal thickening over the cortex and a cellular reaction in the meninges and perivascular space. In the deep white matter there were focal collections of neurones arranged in a "rather haphazard manner". Dr. Herron also described focal collections of neuroblasts in the subependymal grey matter suggestive of a migration problem. There was focal haemorrhagic necrosis in the brain stem.

51. Dr. Herron's diagnosis was cerebral oedema with neuronal migrational defect and a low grade subacute meningoencephalitis. He concluded that the reaction in meninges and cortex was suggestive of a viral aetiology although viral studies were "negative during life and on a post-mortem cerebrospinal fluid". Dr. Herron could not rule out a metabolic cause.

52. On 5th March 1997, Dr. Steen wrote to Claire's GP stating that the abnormal neuronal migration [as described by Dr Herron] would have accounted for her learning difficulties and that other changes "were in keeping with a viral encephalomyelitis meningitis". She added that she and Dr. Webb had discussed the findings with Claire's parents and "we will be happy to see them if they want to discuss things further with ourselves".

53. Dr. Webb wrote to Claire's parents on 28th February 1997 (letter typed on 21st March 1997), offering condolences and summarising the post-mortem findings similarly. He added that the reaction in the meninges and cortex suggested a viral cause with which the history of diarrhoea and vomiting was in keeping.

54. A brief handwritten summary and a typed précis written by Dr. Mannam, an ICU SHO, dated 29th October 1996 records the principal diagnosis is recorded as Cerebral Oedema, other diagnoses are listed as Status Epilepticus and finally hyponatraemia. This summary dealt only with the events in ICU, not those preceding it.

Coroner's Inquest (2005)

55. The Inquest into Claire's death was carried out on 4th May 2006 by the Coroner who had engaged as experts Dr. Robert Bingham Consultant Paediatric Anaesthetist at Great Ormond Street and Dr. Ian Maconochie

Consultant in Paediatric A&E Medicine at St Mary's, London. The Inquest Verdict found the cause of Claire's death to be Cerebral Oedema with Hyponatraemia as a contributory factor.

56. Dr. Bingham considered the admission diagnosis was reasonable and acute encephalopathy (viral or ictal) a likely cause of the presenting illness. He did not consider the serum sodium concentration of 132 mmol/L a likely cause. He also considered it reasonable to give Claire intravenous fluids as she could not hydrate herself and noted that she was given the fluid used as standard in 1996 within the recommended volume for full maintenance fluid therapy. He believed there were, however, reasons why Claire might have required fluid restriction – namely low level of metabolism related to impaired consciousness (what is the evidence that you produce significantly less urine just because your conscious level is impaired, as long as a 'normal' fluid intake is maintained) and possible reduced urinary output due to secretion of ADH which often accompanies both encephalopathy and nausea and vomiting. He concluded that if the reported sodium concentration of 121 mmol/L was accurate, then it was the likely cause of her deterioration and death. He could not exclude the possibility of an inaccurate reading given the subsequent ICU measurements, in which case acute encephalopathy was involved or even central. He considered it possible that "aggressive treatment at 2100 when her coma score reduced from 8 to 6, may have been effective".

57. In his evidence at the Inquest, Dr. Bingham stated he agreed with Dr. Maconochie's formulation of cause of death and that he considered her neurological illness caused ADH secretion. Hyponatraemia was not her presenting problem.

58. Dr. Maconochie considered the diagnosis of encephalitis/encephalopathy was made at an early stage and that of non-convulsive status epilepticus had a high probability given her past history of seizures. He regarded management of these diagnoses was appropriate and did not comment on hyponatraemia as it was addressed by Dr. Bingham. He considered Dr. Webb and other members of the team looking after Claire gave careful and informed advice. At the Inquest he gave his opinion as to cause of death as I(a) cerebral oedema; (b) encephalitis/encephalopathy and hyponatraemia and II status epilepticus.

59. He considered that the finding of a sodium concentration of 121 mmol/L should have led to an immediate repeat sample and clinical reassessment. Also a blood sample should have been taken the morning after her

admission which may have shown a decrease in serum sodium concentration. Consideration would have had to be given to the cause. He considered her symptoms on 22nd October 1996 were consistent with a number of conditions including hyponatraemia but there was no hyponatraemia issue on presentation.

60. Dr. Sands informed the Inquest that he had seen Claire first on the morning of 22nd October 1996, requested notes to be faxed from the Ulster Hospital and went to speak to Dr. Webb to seek his opinion. He emphasised that he was very concerned regarding Claire's level of consciousness, and this concern prompted the urgent neurology referral. He recalled spending some time with Claire and her mother to get a clear history and idea of her normal behaviour and also believed he explained his concerns without causing alarm.

61. Dr Webb's statement to the Coroner listed the GCS findings and gave as his interpretation that there had been a period of change between 13:00 and 15:00 on 22nd October 1996, which may have been related to administration of anticonvulsants, especially midazolam, or to the observed seizure at 15:25. After 20:00 there was a definite and sustained change.

62. He stated that when he first saw Claire he was uncertain whether there had been seizure activity on the day before admission but concluded, after speaking to Mrs Roberts, that there had been a definite right-sided seizure the previous day. His conclusion was that Claire was having subtle non-convulsive seizure activity provoked by a viral infection, so appeared "encephalopathic". He also raised other differential diagnostic possibilities. He commented that his note about her blood results as normal (when her serum sodium concentration was <135 mmol/L) was likely to be because he believed her sodium concentration was a product of her recent vomiting and diarrhoea and could not on its own have explained her current encephalopathy or seizures. He also believed he erroneously understood the result to have been from a sample taken that morning (rather than the night before) and his entry in the note was a memo to himself that it could not have explained her clinical state. He stated that he believed if he had understood the result to be from the previous evening he would have asked for an urgent repeat sample.

63. Dr. Webb also stated that he was not sure Claire would have met the criteria for admission to ICU when he left the hospital on 22nd October 1996, as there was no problem with her airway or breathing and no supportive signs

of raised intracranial pressure such as papilloedema, hypertension or bradycardia.

64. In his deposition, Professor Young noted that losses were not accurately recorded on Claire's fluid chart so that fluid balances could not be judged. He judged the possibility of an inaccurate laboratory result for sodium as negligibly small, provided an appropriate sample was taken.

65. Dr. Steen, the consultant paediatrician under whose care Claire had been admitted, stated to the Inquest that the blood test result at 23:30 on 22nd October 1996 should have led to a repeat test, reduction in fluid intake and a clinical reassessment. She recalled being told that Dr. Webb had taken over her management, that she was not contacted again until 03:00 on 23rd October 1996 and that the Glasgow coma score at 21:00 should have led to a discussion with a consultant.

66. The Coroner accepted Dr Steen's evidence that the sodium concentration of 121 mmol/L should have been repeated and have led to fluids being reduced and a clinical reassessment. However, by then it was unlikely that her condition was survivable even if prompt action had been taken.

67. The Inquest verdict gave as the cause of death 1(a) Cerebral Oedema due to (b) meningoencephalitis, hyponatraemia due to excess ADH production and Status Epilepticus.

PSNI Investigation (2008)

68. Following investigations into the deaths of initially Lucy Crawford and then Adam and Raychel, the PSNI decided to investigate Claire's death. The PSNI engaged a number of experts to assist with its investigations.

69. You provided a report to PSNI on 22nd August 2007 reported on numerous stained sections taken from Claire's cerebral hemispheres. You found no evidence of meningitis, encephalitis, haemorrhage or stroke. He found no evidence of malformation. You summarised his findings as:

> Brain swelling (macroscopic description)
> Acute hypoxic damage to nerve cells (probably terminal)
> No evidence of acquired or inherited disease

70. You noted the Inquest verdict on cause of death and stated that you considered meningoencephalitis excluded both by microbiology and post-mortem neuropathology. You found no neuropathological sequelae of

status epilepticus, and so concluded that hyponatraemia was the only causative factor positively identified as the reason for brain swelling.

71. Dr. Dewi Evans Consultant Paediatrician (then) at Singleton Hospital, Swansea provided a report at the request of the PSNI on 1st March 2008, having read your Report for the PSNI dated 22nd August 2007. Dr. Evans stated that there was nothing in the medical notes to suggest Claire had suffered a seizure prior to admission. He further stated that: "I suspect my primary diagnosis [on admission] would have been an encephalopathy secondary to an unknown viral infection".

72. He drew attention to the post-mortem cerebrospinal fluid examination and compared the findings with the three peripheral blood samples reported during her admission. In Claire's blood the ratio of white to red cells varied between 1:228 and 1:696. In the CSF it was 1:75. He pointed out that conventional teaching was that a CSF sample [contaminated accidentally by blood when inserting the needle] should contain a ratio of 1:500. Thus, there was an excess of white cells over what was to be expected (predominantly lymphocytes) which would be compatible with a diagnosis of viral meningoencephalitis.

73. Dr. Evans referred to the admission serum sodium concentration of 132 mmol/L with no clinical or biochemical evidence of dehydration. It is his opinion that in the context of her having an encephalopathy, "one needs to consider seriously the possibility of her already experiencing the syndrome of inappropriate ADH secretion". He did not disagree with the calculated volume of fluid prescribed. He attached to his report a copy of the 1997 *Advanced Paediatric Life Support Manual*, which recommended the routine use of 1/5th normal saline but that his own practice had been to use 0.45% saline because of the risk of 'waterlogging.' Nonetheless, despite the recommendation for such routine use, he considers Claire's case merited a more concentrated solution because of the reasons expressed above.

74. He is also critical of the failure to measure urinary volume or its analysis for sodium concentration and osmolality and the failure to re-measure blood electrolytes the following morning. He considers the combination of urine and blood investigation would have allowed the medical staff to adjust her fluids carefully and accurately.

75. Dr. Evans notes the first record of an observed seizure was at 15:25 on 22nd October 1996. Given the disturbing GCS scores, he considers this event to have reflected raised intracranial pressure due to relatively early cerebral

oedema, rather than primary epilepsy or non-convulsive status. This, he states, mandated CT scanning, the result of which would have led to treatment to control any such oedema.

76. Dr. Rajat Gupta Consultant Paediatric Neurologist provided a report for the PSNI dated 9th September 2008, having read your Report. He concluded that the cause of death was cerebral oedema, itself most likely caused by hyponatraemia.

77. Dr. Gupta considers there was no clear evidence for the diagnosis of non-convulsive status epilepticus, although it was reasonable that it was considered as a possible diagnosis during Claire's admission: "While possible it was unlikely and would have required EEG analysis for confirmation". He commented that there was no definite improvement in Claire's condition following the use of anticonvulsants and that the (possible?) seizures seen during her admission may "very well have been precipitated by hyponatraemia". In support for his opinion he states that: (i) Dr. Harding saw no pathological evidence of status epilepticus; (ii) Claire had not before had any episodes of non-convulsive status and (iii) Dr. Harding saw no damage to the hippocampus as might be seen in children with chronic epilepsy.

78. Dr. Gupta considered it reasonable that a diagnosis of meningoencephalitis was entertained although unlikely in the absence of fever and meningism.

79. He pointed out that Claire's GCS scores were between 6 and 7 from 1400 to 2000 on 22nd October 1996 (or 6-8 by Dr Webb's calculations). Dr. Gupta stated that as a GCS <8 is generally regarded as evidence of severe brain injury, serious consideration should have been given at that time to transferring her to ICU.

80. Ms. Susan Chapman, Nurse Consultant for acute and high dependency care at Great Ormond Street provided a report to the PSNI on 11th April 2008. She considered Nurse McRandal's initial assessment and care plan acceptable as was the overnight nursing assessment and the observation chart. Claire was placed on four hourly observations of temperature, pulse, respirations and blood pressure, which were described by Nurse McRandal as "within normal limits". However, Ms Chapman states that the pulse rate and blood pressure were elevated, and later suggests that "there was an overall lack of recognition of the seriousness of Claire's clinical condition".

81. Ms Chapman also considers the neurological observation chart, the intravenous therapy and fluid charts, drug chart and record of observed attacks to be completed to an acceptable standard. In particular, she notes that it was acceptable practice in 1996 not to calculate an accurate fluid balance by recording actual output, rather than an estimate of amount and frequency. We note that the nursing care plan requires nurses to 'record accurate fluid balance chart'. As Claire wore a nappy at night and possibly during the day as well whilst she was drowsy and lethargic, it may have been possible to weigh the nappies to provide a more accurate assessment of urine output. On 22nd October 1996 it would appear that the nurses had collected a urine specimen; this was sent to the lab at 1100, but the urine volume was not recorded on the fluid chart.

82. Ms. Chapman notes the absence of neurological observations from admission and considers this was related to the medical staff initially regarding the problem as 'viral' and subsequently not making it explicit that Claire's condition required regular neurological observation, until requested by Dr. Webb.

Queries

83. The Inquiry instructed Professor Keith Cartwright Consultant Clinical Microbiologist. His advice on certain specific aspects of Claire's care in the following context:

    (i) The Inquest in to Claire's death was held in 2006 and gave as cause of death, cerebral oedema due to meningoencephalitis, hyponatraemia due to excess ADH production and status epilepticus.

    (ii) A statement from Dr. Brian Harding to the PSNI described his examination of 32 H&E stained sections, 23 immunostained sections and 4 semi-thin slides of Claire's brain. His conclusion was brain swelling and acute hypoxic damage to nerve cells (probably terminal). He found no evidence of meningitis or encephalitis, which he considered excluded both by microbiology and postmortem neuropathology, and that the evidence suggested brain swelling was the immediate cause of death and hyponatraemia was the only causative factor identified.

    (iii) In a report for the PSNI by Dr. Dewi Evans, pointed out the apparent disparity between the in vivo blood results and the postmortem

Cerebral Spinal Fluid ("CSF") result. He suggested that could be taken as evidence in favour of there having been a viral meningoencephalitis.

(iv) The clear difference of opinion between the pathologists concerned, with Dr. Dewi Evan's hypothesis perhaps providing evidence in favour of Dr Herron's analysis rather than that of Dr .Harding.

84. He was asked to address the following issues identified by the Inquiry's Expert Advisors:

(i) The reliability of using CSF red blood count ("RBC")/ white blood count ("WBC") ratio as a guide to meningeal inflammation?

(ii) Whether the answer would be different when the CSF figure depends on a postmortem sample.

(iii) The CSF report is not dated. Does the protein level (95g/l) allow for an inference that it must have been a postmortem sample?

(iv) Does the fact that Claire's total WBC fell from 16,520 on admission to between 5,540 and 9350 the following day assist in interpreting the nature of her illness?.

85. Professor Cartwright provided his Report to the Inquiry on 1st March 2011. He concluded that:

1. It is outwith my expertise to assess whether or not hyponatraemia caused or contributed to the cerebral oedema that led to coning and to Claire's death though I observe that inappropriate ADH secretion is a well-recognised complication of both meningitis and encephalitis.

2. Claire did not die from (or with) meningitis, either viral or bacterial.

3. In my view her clinical presentation, the progression of her illness and results of tests on blood and CSF were consistent with an acute and fulminant encephalitis.

4. However, Dr Harding, consultant neuropathologist, found no neuropathological evidence to support such a diagnosis.

5. It would be helpful to gain an understanding from Dr Harding as to whether, in his experience, an acute and fulminant encephalitis causing cerebral oedema, coning and death in the space of three days could occur in the absence of clear neuropathological changes, possibly as a result of the rapidity of development of such an infection.

86. Accordingly, the Inquiry seeks your advice on:

> *Whether, in your experience, an acute and fulminant encephalitis causing cerebral oedema, coning and death in the space of three days could occur in the absence of clear neuropathological changes, possibly as a result of the rapidity of development of such an infection.*

87. Your response should be provided in the form of a Report and, together with your Report for the PSNI of 22nd August 2007, it will form part of the Inquiry's investigation and be published along with its other papers.