

**ADDENDUM BRIEF FOR EXPERT ON HYPONATRAEMIA
ADAM STRAIN**

Introduction

1. Following on from your expert report in respect of Adam Strain, the Inquiry Team would be grateful if you would clarify the following issues that have arisen upon examination of your report.

Issues

Definition of hyponatraemia

2. At page 13 of your report, you state that: *"the normal range of serum sodium for most laboratories is 136-148 mmol/L and any measurement below this range – provided it is not a spurious or an artifactual measurement – would be called a hyponatremic state."*
 - (i) What is your source for the normal range of 136-148 mmol/L?
 - (ii) Does this mean that a serum sodium reading of 135 mmol/L necessarily constitutes a hyponatraemic state?
 - (iii) Mr Koffman in his report at paragraph 2.6 (094-007-030) states that the normal sodium range is 135-145 mmol/L. Is this accurate?
 - (iv) Does any reading below 136 require action to be taken? If so is different action required on the basis of how far it is below 136? Are there levels below 136 which require no intervention?

Daily sodium input

3. At page 3 of your report, you state that Adam *"received 86 mmol of Na from the 2 L of NUTRISON, 14 mmol of Na from the 100 cc of 0.9% NaCl, and 50 mmol from the 50 cc of 8.4% Na-bicarbonate (containing 1000 mmol/L of sodium). Together this yields 150 mmol of Na input per day."*
 - (i) What is your source for stating that 2 litres of Nutrison contains 86 mmol of sodium?

EXPERTS

4. A letter from Janet Mercer, Adam's dietician, dated 13th June 1995 (057-068-128), states that the daily volume of Nutrison that Adam received was to be increased to 1200 ml, made up to 1700 ml with water and 100 ml saline. In his deposition to the Inquest, Dr Savage states that "[h]is night gastrostomy feeds are normally 1.5l of Nutrison [sic]." (011-015-109). His mother states that this intake was supplemented by 3 x 200 ml gastrostomy feeds during the day (070-012-055).
- (i) Is it possible that Adam received diluted Nutrison, in accordance with the request of the Dietician?
- (ii) If so, how does this affect your calculations?

Estimate of urinary sodium export

5. At page 2 of your report, you state that "Adam is said to have been polyuric most of the time and daily urinary volumes were estimated to be in excess of 1000 cc (Dr Savage's testimony)." In your calculations of daily sodium export on page 3 of your report you state "Hence with an amount of 1 L of urine excreted daily this should have caused a sodium export of approximately 30 mmol/day in Adam." On page 15 of your report you state "the (unmeasured) daily urinary volumes of Adam are said to have been 1000 cc or somewhat more by several observers including Dr Savage." On page 16 of your report you state that Adam's kidney would "produce an unconcentrated urine with an osmolality close to that of plasma and hence the amount excreted will have to remain relatively fixed between about 0.8 and 1.2 L/day".
6. At page 2 of the Witness Statement of Dr (now Professor) Savage to the Inquiry (included as Tab 4a of the original Brief for Expert on Hyponatraemia) he states that Adam "continued to pass in excess of 1 litre of urine each day." In addition, in Adam's clinical notes (059-006-021) for 26th November 1995, there is a note "PU ++ ? how much ? 1-2 litres."
- (i) Please confirm if Dr Savage's statement above is the reference to which you refer at page 2 of your report where you state "Dr Savage's testimony".
- (ii) Please confirm if the excretion figure of 1 litre of urine daily is a minimum figure / mean figure / maximum figure for Adam's daily input.

EXPERTS

- (iii) If the excretion figure was 1-2 litres as per Adam's clinical notes, how would this affect your calculation of his sodium output?
7. At page 2 of your report, on the final line and with reference to lost fluid via peritoneal dialysis, you state that *"It is not possible to exactly predict the amount of fluid and sodium that would be removed from Adam each night by this procedure because of interindividual variation, but, based on our own experience in adults it may be proposed that the amount removed should have ranged between 100 and 500 cc/night, with the lower figure being the more likely one."*
- (i) Is the range of 100 and 500 cc / night the range seen in adults, or a proposed range specifically for Adam?
- (ii) Why is the lower figure the more likely one?
8. At page 3 of your report, you state that *"[t]he urinary sodium concentration, last reported and measured between Dec of 1992 and Dec of 1993 was 34-26 mmol/L. It is likely that with a further decline of intrinsic kidney function over the ensuing years the urinary sodium concentration would have fallen. However for the present calculation we propose to work with an assumed mean value of 30 mmol/L. Hence with an amount of 1 L of urine excreted daily this should have caused a sodium export of approximately 30 mmol/day in Adam. [...] The ultrafiltration loss of volume into the dialysate of an assumed amount of 100 to 500 cc/night should have had the same sodium concentration as that in Adam's plasma, i.e. approximately 135 mmol/L. [...] This would yield a sodium export of between 13.5 and 67.5 mmol/day. Together Adam lost between 43.5 and 97.5 mmol of sodium daily."*
- (i) In your experience, what is the common range of urinary sodium concentration seen in children with end-stage renal failure from dysplasia?
- (ii) Are Adam's results within that common range? If not, why not?
- (iii) For this calculation, you have taken a mean value of his urinary sodium concentration measurements between December 1992 and December 1993. Why have the measurements taken between November 1991 and March 1992 been ignored in this calculation?
- (iv) Given that the last urinary sodium measurement was taken in December 1993, how accurate are these measurements in assessing Adam's sodium output in November 1995?

EXPERTS

Fluid balance and Sodium balance

9. At page 3 of your report, at the bottom in bold, you state *“The fluid balance therefore suggests that Adam was in a positive balance of between 400 and 800 cc of water per day. The sodium balance indicates that it was positive, too, in amounts between 52.5 and 106.5 mmol/day.”*
- (i) What is the common range for fluid balance seen in children with end-stage renal failure from dysplasia?
 - (ii) What is the common range for sodium balance seen in children with end-stage renal failure from dysplasia?
 - (iii) Does Adam’s polyuria account for him not maintaining the stated degrees of positive balance for sodium and water without becoming oedematous , hypertensive or hypernatraemic?
 - (iv) How does Adam’s sodium balance relate to his serum sodium level?

Excretion of free water

10. At page 15 of your report, you state that *“Adam’s situation was quite different from that: at a serum creatinine between 552 and 743 $\mu\text{mol/L}$ during the period of peritoneal dialysis his glomerular filtration rate (GFR) presumably as $\ll 5\text{ml/min}$, i.e. 7.2 L/day . Under optimal conditions, a patient can excrete 20% of the GFR as “free water”, i.e. in Adam’s case no more than 60cc/hr , i.e. 150cc in the 2.5 hrs from 7:00am to 9:32 am, on Nov.27 of 1995.”*
- (i) What value for creatinine did you use for the purpose of these calculations?
 - (ii) What method did you use to calculate the GFR from this creatinine value?
 - (iii) What are the ‘optimal conditions’ for excretion of 20% of the GFR as “free water”?
 - (iv) Were these ‘optimal conditions’ present at the time?

EXPERTS

Dioralyte received between 11pm on 26th November and 7am on 27th November 1995

11. At page 5 of your report, in the last sentence, you state that "Adam received 900 or 935 cc of Dioralyte by gastrostomy tube, containing 60 mmol/L of sodium." The Fluid Balance sheet (057-010-013) shows that 952 ml were given by gastrostomy. See also paragraph 22 of the Brief to Expert on Hyponatraemia.
- (i) Is the figure of 935 that you have stated correct, or is the correct figure 952?

Repeats of the Na and K tests

12. At page 15 of your report, you agree with Mr Koffman's opinion that "The sodium and potassium should have been repeated prior to start of surgery. The [...] patient with poor renal function would pass large quantities of dilute urine and may have difficulty controlling the concentration of sodium and potassium in the blood." (094-007-032)
13. At page 50 of your report, you state "Basically one could say that in a patient in whom no major interventions concerning his fluid and electrolyte status are to be expected between 9:30pm and the next morning (no fluid intake, no infusions etc.) a repeat measurement of the serum sodium in the morning would be dispensable, because the serum sodium at that time is predictable. It would be 1-2 mmol/L higher than the one at 9:30pm. Adam's situation differed from this scenario in 3 important ways: a) he received peritoneal dialysis treatment throughout the night, which can have [a] major influence on his fluid and electrolyte status; b) he received relatively large amounts of liquid feedings, containing water and electrolytes. One can never be certain how well these materials are reabsorbed on a particular day or during a night; c) Adam was a patient in renal failure, unable to adapt his amount and composition of urine to the physiological needs. Taken together a serum sodium of 134 mmol/L at 9:30pm more than justifies a re-test in the morning."
- (i) In your opinion, is a repeat test necessary prior to the start of surgery in all transplantation cases or before any surgical intervention in a child with end-stage renal failure?
- (ii) Is it only necessary where the previous serum sodium reading mandates it so?

EXPERTS

- (iii) If Adam's serum sodium reading at 9:30pm had been higher, for example 139 mmol/L, would that have mandated a retest in the morning prior to the start of surgery?
 - (iv) Should Dr Taylor (or Dr Savage) have requested serum electrolytes to be checked as soon as venous access had been established?
 - (v) Should Dr Taylor or a member of the surgical team have inserted a bladder catheter soon after the induction of anaesthesia?
14. At page 35 of your report, you state that *"Dr Taylor does not seem to have considered sodium balance of serum sodium concentration before the induction of anesthesia. Again, this appears relatively reasonable under the circumstances, given that a child that just returned from an efficient peritoneal dialysis session, which can be expected to bring fluid volumes and electrolytes to near normal values or at least to the vicinity of that area."*
- (i) How does this statement compare with those above stating that a retest in the circumstances was required or with your conclusions about his fluid and sodium balance as stated on page 3 of your report?
 - (ii) Would the peritoneal dialysis have ensured that Adam's serum sodium was normal or nearly normal prior to the start of surgery?
 - (iii) If not, how likely is it that any hyponatraemic values during or after peritoneal dialysis built up over a much longer period of time than the 2 ½ hours at the start of the transplant operation?

Volume of infusion

15. At page 7 of your report, you state that, between 7am and 9:32am on 27th November 1995, *"Adam received 1685 cc of 0.18% NaCl infusate, with a sodium concentration of 34.6 mmol/L" and "the infusion may be thought of as an input of approximately 400 cc of isotonic saline and 1285 cc of "free water".*
- (i) With reference to the Anaesthetic Record (058-003-005), Dr Taylor's deposition (011-014-096) and Dr Taylor's note to Mr Brangham, solicitor (059-004-007), how do you calculate that Adam received 1685 cc of 0.18% NaCl infusate between 7am and 9:32am on 27th November 1995?

EXPERTS

- (ii) How do you calculate the sodium concentration of the 0.18% NaCl infusate as being 34.6 mmol/L?
- (iii) How do you calculate that the said infusion constitutes approximately 400 cc of isotonic saline and 1285 cc of "free water"?

Choice of fluid

16. At page 13 of your report, you state that *"If iv fluid is given during renal transplantation to help improve the blood flow in the transplant then isotonic (0.9%) saline will be the best fluid to generate plasma volume expansion and improved peripheral circulation but not 0.18% saline."*
- (i) Would it be reasonable to prescribe 0.18% saline, if it was to replace only the insensible and predicted urine losses?
 - (ii) Why is 0.9% saline preferred to, for example, 0.45% saline?

Record-keeping

17. At page 32 of your report, you state that *"the documents found by the expert appeared quite incomplete."*
- (i) Assuming all casenotes were disclosed and provided to you, what additional documentation would you expect to have been made?
18. On page 10 of your report, you state that *"... additional events must have occurred to lead to a major additional degree of brain oedema beyond the degree dictated by osmotic swelling. The nature of these additional events is speculative, i.e. unknown"*. On what basis do you say there must have been additional causative events, albeit of unknown nature?

RBHSC Renal Transplant Guidelines

19. In his witness statement to the Inquiry, Professor Maurice Savage makes reference to Renal Transplant Guidelines dated 1990 which were revised in 1996 as a direct result of Adam's death. Copies of his statement and the two sets of guidelines are attached for your ease of reference. Your opinion is sought regarding:

EXPERTS

- (i) Whether or not the 1990 guidelines were complied with in relation to Adam
- (ii) Whether or not the requirements of the 1996 guidelines would have been met by the care and treatment provided to Adam
- (iii) The adequacy of the 1996 guidelines: (a) when they were first produced and (b) thereafter
- (iv) Whether there should be some system in place for periodic review of such guidelines and if so what it might involve