

This is a CORRECTION to a previous report by

Dr Malcolm Coulthard

requested by the *Inquiry into Hyponatraemia-Related Deaths*

On 16/02/12 I submitted a report which included some calculations in Excel of the free water balances calculated by myself, Dr Haynes, Prof Gross. I also included calculations based upon the figures that Dr Taylor has presented at 2 different time-periods, from 1995 until recently, and new revised assumptions.

The inquiry team have noticed an arithmetic error in the Excel file due to me incorrectly using an assumed concentration of 75 mmol/l for sodium in the urine in some of Dr Taylor's calculations, instead of 40 mmol/l as I had intended.

This mistake makes no difference to the graphs that consider the current view of Adam's fluid balances, but it does change the graph I had presented of the what the balances would have been if Dr Taylor's original (now accepted as mistaken) assumptions had been used.

Here I have provided the corrected pages as they should have appeared in my report of 16/02/2012. The altered points are highlighted in red.

17/03/2012

Dr Coulthard; Hyponatraemia-Related Deaths Inquiry.

Signed .....  .....

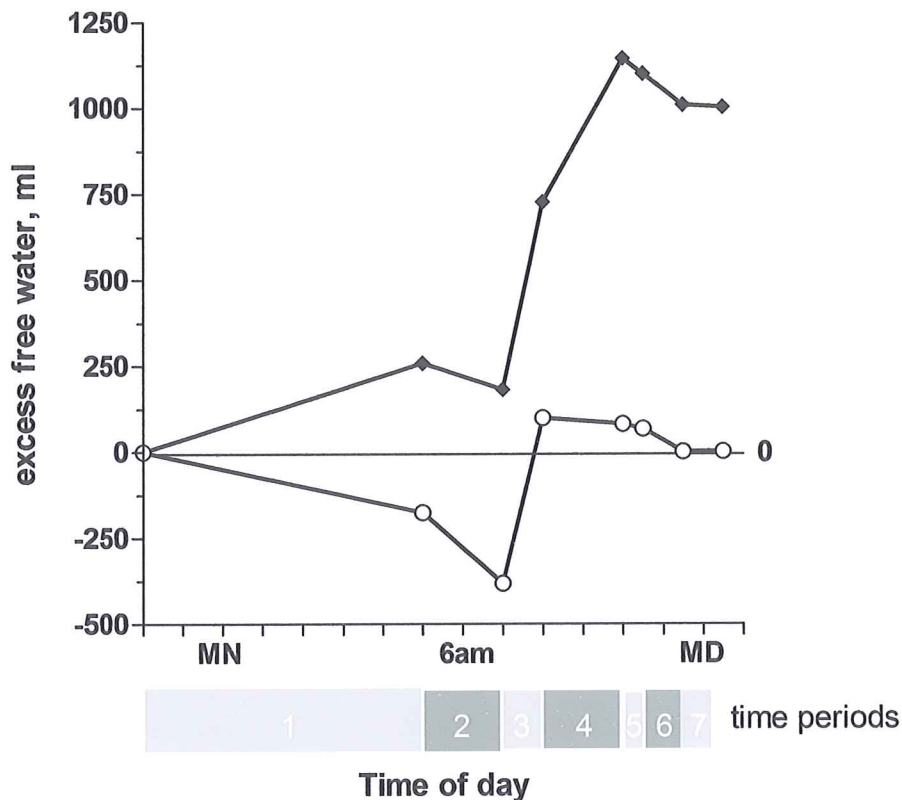
(a) His previous arguments

The table on page 28 shows the fluid balances that would have been achieved by Dr Taylor if his assumptions at the time about Adam's abilities to manage sodium and water had been correct. Figure 3 shows this graph plotted alongside the line (already shown in Figure 1) using the assumptions that I now consider most likely to be correct.

This shows that by assuming the urine output was unable to fall below 200 ml/hour, by assuming its sodium concentration was likely to be 40 rather than about 75 mmol/l, and by ignoring the effect of dialysis on stabilising his fluid volume and sodium concentrations overnight, Dr Taylor's predictions would have been that Adam would have become water depleted by almost 400 900 ml by the time he came to induce his anaesthetic.

He then infused 0.18% saline into him in order to correct this water deficiency. It can be seen that this is what partially happened, and the balance was then maintained close to correct (0) in water deficit right until the end of the operation.

**Figure 3** Graph of Adam Strain's peri-operative free water accumulation, divided into 7 time periods. In this version, the curve that Dr Coulthard considers to be the most likely to be valid is shown with solid diamonds, and the curve produced by using Dr Taylor's assumptions at the time are shown using open circles.



If Dr Taylor had been correct that Adam had been water depleted at the start of the anaesthetic (instead of being about 200 ml in surfeit, as he was), he should not have dealt with it by simply infusing in 0.18% saline quickly in this way because this will inevitably suddenly lower the sodium concentration. Falling from a high level to a more normal one is just as damaging as going from normal to very low – it is the rate of fall of plasma sodium that must be prevented in all circumstances.

~~Thus, it is fair to say that his fluid management did indeed match overall the fluid requirements that he had wrongly imagined Adam to have, but that it would have achieved that by inducing an acute fall in plasma sodium.~~

### **Conclusion about Dr Taylor's management in relation to his original assessments**

By (a) considering that Adam had a fluid output of at least 200 ml/hour, and with no upper limit, (b) accepting that his urine concentration would be unaltered from his pre-end-stage days, and (c) by failing to consider the stabilising impact that peritoneal dialysis has, Dr Taylor imagined that he was dealing with a clinical challenge that was very different from its reality. By deciding to ignore the CVP trace which contradicted his notion that Adam was fluid depleted, he missed an opportunity to correct his position, and gave up a vital tool for the rest of the procedure. With this background, he would have managed to maintain what would have been an overall relatively steady status quo (ending up in balance) for Adam if his physiology did indeed behave as he had thought it would, but at the price of a sudden increase in free water infusion and a predictably too-sharp fall in his plasma sodium concentration.

By not catheterising Adam he relinquished an opportunity to check that the urine output was indeed as high as he had imagined, or that it was unaffected by the anaesthetic, given how vulnerable such poorly functioning kidneys were likely to be.

By not checking the plasma sodium after discovering that the near-patient reading indicated a very low reading, and to disregard it instead, he opted to simply continue on blindly administering hypotonic fluids without the benefit of checking their impact upon Adam's blood levels.

Thus, while Dr Taylor's primary error was to fail to properly estimate Adam's normal losses (and thus his required replacement fluids), this would not have led to any mishap if (a) he had not used rapid boluses of hypotonic saline instead of isotonic or near-isotonic solutions and aiming for gentle biochemical changes, and if (b) he had ensured that he monitored his CVP, his urine output and his biochemistry, because the trend to induce hyponatraemia would have been detected earlier, and severe changes could have been avoided.

## Expert Witness Declaration

I Malcolm Coulthard DECLARE THAT:

- 1) I understand that my duty in providing written reports and giving evidence is to help the Court, and that this duty overrides any obligation to the party by whom I am engaged or the person who has paid or is liable to pay me. I confirm that I have complied and will continue to comply with my duty.
- 2) I confirm that I have not entered into any arrangement where the amount or payment of my fees is in any way dependent on the outcome of the case.
- 3) I know of no conflict of interest of any kind, other than any which I have disclosed in my report.
- 4) I do not consider that any interest which I have disclosed affects my suitability as an expert witness on any issues on which I have given evidence.
- 5) I will advise the party by whom I am instructed if, between the date of my report and the trial, there is any change in circumstances which affect my answers to points 3 and 4 above.
- 6) I have shown the sources of all information I have used.
- 7) I have exercised reasonable care and skill in order to be accurate and complete in preparing this report.
- 8) I have endeavoured to include in my report those matters, of which I have knowledge or of which I have been made aware, that might adversely affect the validity of my opinion. I have clearly stated any qualifications to my opinion.
- 9) I have not, without forming an independent view, included or excluded anything which has been suggested to me by others, including my instructing lawyers.
- 10) I will notify those instructing me immediately and confirm in writing if, for any reason, my existing report requires any correction or qualification.
- 11) I understand that;
  - 11.1) my report will form the evidence to be given under oath or affirmation;
  - 11.2) questions may be put to me in writing for the purposes of clarifying my report and that my answers shall be treated as part of my report and covered by my statement of truth;
  - 11.3) the court may at any stage direct a discussion to take place between experts for the purpose of identifying and discussing the expert issues in the proceedings, where possible reaching an agreed opinion on those issues and identifying what action, if any, may be taken to resolve any of the outstanding issues between the parties;
  - 11.4) the court may direct that following a discussion between the experts that a statement should be prepared showing those issues which are agreed, and those issues which are not agreed, together with a summary of the reasons for disagreeing;
  - 11.5) I may be required to attend court to be cross-examined on my report by a cross-examiner assisted by an expert;
  - 11.6) I am likely to be the subject of public adverse criticism by the judge if the Court concludes that I have not taken reasonable care in trying to meet the standards set out above.
- 12) I have read Part 35 of the Civil Procedure Rules and the accompanying practice direction including the "Protocol for Instruction of Experts to give Evidence in Civil Claims" and I have complied with their requirements.
- 13) I am aware of the practice direction on pre-action conduct. I have acted in accordance with the Code of Practice for Experts.

### Statement of Truth

I confirm that I have made clear which facts and matters referred to in this report are within my own knowledge and which are not. Those that are within my own knowledge I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer.

Signed  Dr Malcolm Coulthard

Dated 17/3/12 17/03/2012

**Dr Malcolm Coulthard, BSc, MB BS, DCH, FRCP, FRCPCH, PhD**

**Dr Taylor, on basis of his statement of 01/02/2012**

Time periods	1	2	3	4	5	6	7	totals
duration of period (hours)	7.0	2.0	1.0	2.0	0.5	1.0	0.75	14.25

**LOSSES**

General insensible (ml/h rate)	10	70	20	10	20	5	10	8	143
Wound insensible (ml/h rate)	80				160	40	80		280
urine output (ml/h rate)	78.1	547	156	78	156	39	78	59	1113
dialysis		0							0
blood					800	200	211		1211
all fluid losses		617	176	88	1136	284	379	66	2746
<b>Cumulative fluid losses</b>	<b>617</b>	<b>793</b>	<b>881</b>	<b>2017</b>	<b>2301</b>	<b>2680</b>	<b>2746</b>	<b>2746</b>	

**FLUIDS GIVEN**

Dioralyte	952								952
0.18% saline			750		400	100	150	100	1500
Hartmann's					500				500
Plasma/HPPF					800				800
Blood					250		250		500
All fluids in	952	0	750	1950	100	400	100		4252
<b>Cumulative fluid intake</b>	<b>952</b>	<b>952</b>	<b>1702</b>	<b>3652</b>	<b>3752</b>	<b>4152</b>	<b>4252</b>	<b>4252</b>	

Fluid balance

**Cumulative fluid balance**

	335	-176	662	814	-184	21	34		1506
<b>Cumulative fluid balance</b>	<b>335</b>	<b>159</b>	<b>821</b>	<b>1635</b>	<b>1451</b>	<b>1472</b>	<b>1506</b>	<b>1506</b>	
SODIUM LOSSES (urine Na 40)	22	6	3	118	30	33	2		214
SODIUM GAINS	57	0	23	224	3	40	3		351
Sodium balance	35	-6	20	106	-26	7	1		137
<b>Cumulative sodium balance</b>	<b>35</b>	<b>29</b>	<b>49</b>	<b>155</b>	<b>129</b>	<b>136</b>	<b>137</b>	<b>137</b>	

Mean Na of extra water (mmol/l)

Excess free water gained (ml)

Mean Na of extra water (mmol/l)	105	182	60	95	89	92	91	
Excess free water gained (ml)	84	-48	470	526	531	502	530	

**Dr Taylor on the basis of his original assumptions**

Time periods duration of period	1 7.0	2 2.0	3 1.0	4 2.0	5 0.5	6 1.0	7 0.75	totals
<b>LOSSES</b>								
General insensible (ml/h rate)	10	70	20	10	20	5	10	143
Wound insensible (ml/h rate)	80			160	40	80		280
urine output (ml/h rate)	200	1400	400	200	400	100	200	2850
dialysis blood	0							0
all fluid losses	1470	420	210	1380	345	501	158	4484
<b>Cumulative fluid losses</b>	<b>1470</b>	<b>1890</b>	<b>2100</b>	<b>3480</b>	<b>3825</b>	<b>4326</b>	<b>4484</b>	
<b>FLUIDS GIVEN</b>								
Dioralyte	952							952
0.18% saline		750		400		100	150	1500
Hartmann's				500				500
Plasma/HPPF				800				800
Blood				250		250		500
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Fluid balance	-518	-420	540	570	-245	-101	-58	-232
<b>Cumulative fluid balance</b>	<b>-518</b>	<b>-938</b>	<b>-398</b>	<b>172</b>	<b>-73</b>	<b>-174</b>	<b>-232</b>	
SODIUM LOSSES (urine Na 40)	56	16	8	128	32	38	6	284
SODIUM GAINS	57	0	23	224	3	40	3	351
Sodium balance	1	-16	15	96	-29	2	-3	67
<b>Cumulative sodium balance</b>	<b>1</b>	<b>-15</b>	<b>0</b>	<b>97</b>	<b>68</b>	<b>70</b>	<b>67</b>	
Mean Na of extra water (mmol/l)	-2	16	-1	563	-930	-402	-290	
Excess free water gained (ml)	-526	-832	-401	-519	-558	-674	-711	

Dr Coulthard: Hyponatremia-Related Deaths Inquiry.

Signed .....