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Northern Ireland Inquiry
Into Hyponatraemia Deaths
Re: Raychel Ferguson

Compendium Report by
General Paediatrician Expert

Introduction

Following my initial expert report dated 29th November 2011, I have been asked to supply a second, 'compendium' style report, going into more detail of some aspects of Raychel's care, and responding to some specific questions. Although reference is made to my initial report, this compendium report can be taken as a complete free-standing report in itself, relating to all the issues concerned, and repeating some of the content of the initial report where necessary.

This report is set out initially as a narrative of the events that happened between her admission to Altnagelvin Hospital on the 7th June 2001, up until her admission to the Intensive Care Unit at Altnagelvin on the 9th June 2001. The second part consists of responses to questions posed following my initial report, and some general comments

Terms which require explanation are typed in *italics* the first time they are used, and each of these is fully explained in a glossary at the end.

I will not address the events subsequent to her admission to Intensive Care, or her transfer and subsequent treatment at the Royal Belfast Hospital for Sick Children. Similarly I will not address the issues arising from media coverage and legal proceedings long after the event.

**1. Time period 21.00 hours on 7th June 2001 until 23.30 hours 7th June 2001.
Admission to Altnagelvin until operation.**

1.a

Raychel was brought by her parents to the Accident and Emergency Department of Altnagelvin Hospital at 21.00 hours with a history of onset of abdominal pain, that according to her mother, was initially central, and then became localised to the *right iliac fossa*. Her initial assessment at the Accident and Emergency Department suggested *localised tenderness* at the right iliac fossa. She was not particularly unwell in herself at the time and her observations were normal. Because of the typical and characteristic history and the findings on clinical examination, a provisional diagnosis of acute appendicitis was made. She was seen by a surgical SHO, Mr Makar, and a decision was made to surgically remove her appendix.

1.b

Routine blood tests were done on admission, which is normal practice when a child is admitted with acute abdominal pain. These were normal, and in particular her sodium at that time was normal at 137 mmol/l.

1.c

According to the A&E notes Raychel complained of pain on urination although this was not confirmed on the subsequent admission history. Urinalysis tests revealed first 1+ then 2+ protein in the urine. Everything else was negative. (020-015-030)

1.d

Because of the need to keep her *nil by mouth*, as is routine with *pre-op* surgical patients, an *IV cannula* was inserted in order to keep her adequately hydrated while awaiting surgery. Initially in A&E Mr Makar, surgical SHO, prescribed *Hartmann's solution*, but according to his statement (WS-022/1 page2) he was asked by the ward staff to change the prescription to *0.18% Saline 4% Dextrose*. This was standard practice on the ward at that time. This is presumably the explanation for the 'crossed-out' prescription for Hartmann's on the undated IV fluid prescription chart (020-021-040).

1.e

According to the mother's witness statement, they were told that Raychel would go to theatre early the following morning, but in the event it appears that a theatre slot became available earlier and she went to theatre at 23.30 hours. At this time she was receiving 0.18% Saline 4% Dextrose at a rate of 80mls an hour.

Comment

1.f

Raychel's initial assessment, management in the Accident and Emergency Department, and the decision made to plan an appendicectomy for her, were in my view entirely straightforward and in keeping with best practice. The history and *symptoms* of appendicitis were typical, with a typical duration of a few hours, and a history of localisation of pain moving from the whole abdomen to the right iliac fossa. It is well recognised that even when the appendix is not inflamed, these typical symptoms can occur, and because of the danger of missing an acute appendicitis, routine practice would have been to arrange an appendicectomy. It appears that Mr Makar carried out the surgery competently and made satisfactory records.

1.g

Because of an expected delay in taking her to theatre, and because of the need to keep her nil by mouth, it was the correct decision to start intravenous fluids before the operation. Patients are always kept nil by mouth before any operation involving a general anaesthetic, because of the risk of having a general anaesthetic with a full stomach, which can lead to accidental aspiration of the stomach contents into the lungs.

1.h

The choice of what intravenous fluid to give her was in keeping with the standard policy on the ward at the time, and there was nothing in Raychel's condition or on the initial blood results that suggested that she should have had a different *fluid regime*.

1.i

Regarding the urinary symptoms and tests, it was good practice to ask about this in the history as the pain of a urinary infection can sometimes mimic that of appendicitis. However, children this age often complain of painful urination just because they feel unwell without it being indicative of a urinary infection. One or two + of protein in the urine may be normal. The leucocyte and nitrite tests were negative on both occasions, which virtually rules out a urinary infection. It would therefore have been acceptable to not send a urine specimen to the lab.

2) Time period 23.30 hours on 7th June 2001 to 02.10 hours on 8th June 2001.

Operation and immediate post-operative period

2.a

The surgery and the anaesthetic were entirely uneventful. As is routine, Raychel was given the normal anaesthetic drugs, but also given *analgesia* in the form of a Diclofenac suppository, and intravenous Cyclimorph. This is standard practice. She was also given a Metronidazole suppository. This antibiotic is given routinely to prevent infection as a result of surgery, and this would also have been standard practice.

2.b

The intravenous fluid administered during the operation was 200mls of *Hartmann's solution*, which is standard anaesthetic practice for abdominal operations.

2.c

The surgeon noted a mildly congested appendix which later turned out not to be inflamed on *histology*. This frequently occurs, is not of great significance, and it does not mean that the decision to perform an appendectomy was incorrect.

2.d

In the immediate post-operative period, it appears that Raychel was observed closely in the recovery area, and her observations remained normal. By 01.30 hours she was awake and she was subsequently returned to the Children's ward. At this time the *peri-operative* Hartmann's solution was discontinued and when she arrived back on the ward, the ward staff set up again the same intravenous fluid regime that she had been on pre-operatively i.e. 0.18% Saline 4% Dextrose at 80mls per hour.

Comment

2.e

The drugs given before and immediately after the anaesthetic were appropriate. The quantity of fluid given during the procedure was appropriate, given that there are often significant fluid losses as a consequence of the surgery (from bleeding, evaporation etc).

2.f

Restarting the standard ward fluid regime on returning to the ward would have been normal practice and there would have been no reason to vary this.

2.g

Dr Gund, anaesthetic SHO, in his statement states that he had prescribed Hartmann's solution post-operatively, but was told that fluids on the ward would be prescribed by the 'paediatric doctors'. (WS-023/1 page2). Subsequently the fluid regime was changed to 0.18% Saline 4% Dextrose.

2.h

This is an important point of confusion. In my experience, in most hospitals, when children return to the ward from theatre, the post-operative fluid regime prescribed by the anaesthetist is continued for the initial few hours (perhaps 4 to 6 hours, or until the bag runs out). Thereafter the nurses would normally request one of the ward doctors to prescribe more fluids if necessary, or to take the decision that no more IV fluids were necessary if the child was by that time awake, drinking adequately and not vomiting. If a further prescription was required, in most units, it would be the surgical team's responsibility to do this, and it is uncertain whether this was the standard practice at Altnagelvin at that time. Hartmann's is not usually continued beyond this time. Dr Gund's comments suggest either that he was unfamiliar with local procedures at that time, or that there was an expectation that the paediatric team would prescribe.

2.i

In any event, it seems that whoever had written the prescription for fluids when Raychel returned to the ward, she would have been prescribed 0.18% Saline 4% Dextrose, as this was standard ward practice. Although with hindsight one might surmise that if Raychel had continued to receive Hartmann's solution she may not have developed hyponatraemia, I do not consider that any member of staff was at fault in prescribing 0.18% Saline 4% Dextrose solution.

2.j

The anaesthetic registrar Dr Jamison in her statement confirms that the Hartmann's was discontinued as Raychel returned to the ward (WS-024/1 page2). Dr Jamison added a retrospective note to the operative anaesthetic notes. This is clearly indicated as being retrospective and dated 15/6/01, after Raychel had died and presumably after the staff involved had learnt of the possible cause of her death. I assume that Dr Jamison's note was intended to be helpful to the inevitable inquiry that she assumed would follow the death. It simply clarifies the quantity of fluid she received during the operation which is obviously relevant. It does not appear to be an attempt to alter the records in the light of events.

3) Time period 02.10 hours to 10.00 hours on 8th June 2001

3.a

During this time Raychel underwent what appeared to have been a straightforward post-operative recovery on the ward. According to the nursing observations she slept through most of the night, and did not vomit during the night. No problems or concerns were reported at the *nursing handover* at 08.00 hours, or on the surgical *ward round* that morning, which would probably have been around 09.00 hours.

3b

Although the fluid balance chart (023-018-037) recorded a vomit at 08.00, this was not mentioned in the medical notes. She was seen by Dr Zafar, surgical SHO, who had not been involved previously. In his statement (WS-025/1 page3) he states that he was unaware of the vomiting, and that she appeared to be making a normal recovery. He told the nursing staff that she could drink small amounts of clear fluids. Normally intravenous fluids would have been continued until she was taking what the medical team might consider an adequate amount of fluid by mouth. In practice this is normally taken to be about half of her calculated intravenous fluid requirements, i.e. in her case about 40mls an hour.

Comment

3.c

There is very little written in the medical notes in this period, but from the observation charts and the witness statements it is possible to deduce that her progress and her care was straightforward and as would be expected in a routine post-operative appendicectomy case. Even if the medical team had been made aware of one small vomit at 08.00, they would probably still have suggested starting oral fluids, unless the vomiting persisted.

3d

I do not believe that any significance should be attached to Dr Zafar's comments about 'continuous' or 'continuing' observations. He was just asking for routine observations.

3e

The ward round note here is very brief and untimed but in my opinion this is not indicative of poor practice.(020-007-013) Routine surgical ward rounds are usually rapid as most of the patients are straightforward and decisions are simple. As they usually occur at the same time each day, a timing in the notes is unnecessary.

4) Time period 10.00 hours to 21.00 hours on 8th June 2001

4a

It is during this point that the accounts of Raychel's condition diverge in respect of those given by the medical staff and those given by her parents. There is nothing written in the medical notes. According to the nursing observation chart vomiting is noted to have occurred at 10.30, 13.00, 15.00 and 21.00 hours. It appears that the nursing staff were not unduly concerned by this, and the parents were reassured that this was normal post-operative vomiting. The accounts of the quantity and frequency of the vomiting vary. The nurses' witness statements refer to "mouthfuls" of vomit. The parents describe her vomiting as being severe and prolonged.

4b

At 12.10 Dr Butler, paediatric SHO, was asked to write a prescription for continuing IV fluids. She, it appears, was merely asked to continue the prescription that had already been started by someone else previously. She was therefore not required to make any changes to Raychel's fluid regime. She duly complied, and simply wrote up the standard fluid regime that was in use on that ward at that time i.e. 0.18% Saline 4% Dextrose, and this was what was administered. The infusion rate was not changed.

4c

The attention of medical staff was not drawn to Raychel's condition until about 17.30 hours when Dr Joe Devlin was asked to prescribe an anti-emetic. Dr Devlin considered this to be post-operative vomiting and did not undertake an assessment to look for other causes (WS-027/1). An assessment in this situation would have involved a clinical examination, to look for *signs* of other conditions e.g. infection, and taking blood tests to look not only for electrolyte disturbances but evidence of infection and other conditions.

4d

It is clear from Dr Devlin's statement that he did look at Raychel, and found her not to be dehydrated or distressed, although this was not recorded in the notes and he does not appear to have done a more thorough examination. He prescribed intravenous Ondanestron (Zofran), a commonly used *anti-emetic* drug. During this time she continued to receive 0.18% Saline 4% Dextrose at 80mls per hour. Her urine output is not recorded.

4e

There is also a discrepancy in the accounts about her general condition. Her mother in her witness statement described her as quiet and listless, and not her normal self. (012-028-146). The nursing staff were of the opinion that she was behaving normally (012-041-202).

Comment

4.f

The question arises at this point as to how long following a simple surgical procedure like an appendicectomy, can continued vomiting be considered 'normal'. There are many factors that may contribute to vomiting in this situation.

4.1.f Firstly the anaesthetic drugs themselves given to maintain anaesthesia during the operation, can sometimes cause nausea and vomiting. In Raychel's case, as she had no immediate post-operative vomiting it is unlikely that these were cause.

4.2.f Secondly, the drugs given during and immediately after the operation to relieve pain, can have nausea as a side-effect. In Raychel's case she was given Cyclimorph, a

preparation of Morphine, during the operation as analgesia, and this is well known to cause nausea and vomiting as a side-effect. It is possible that it could still have been exerting some effect up to twenty-four hours later. Metronidazole (Flagyl) is an antibiotic given routinely to appendicectomy patients, to reduce the incidents of post-operative infection. In Raychel's case it was given rectally as a suppository. This can also cause nausea and vomiting as a side-effect.

4.3.f Thirdly, vomiting can be a consequence of the illness that caused the child to develop the symptoms in the first place. Frequently, children who are admitted to hospital with abdominal pain, are thought to have appendicitis when it turns out that they don't, as in this case. It follows therefore that something else must have caused the abdominal pain the first place. Frequently this may be a viral infection, for which many different viruses may be responsible, and many of which can cause vomiting as a direct result. The same virus infections can also cause abdominal pain, which may mimic appendicitis. Many such viruses can also cause inflammation of the stomach (gastritis) of which vomiting is the main manifestation. Strictly speaking vomiting from this cause is not post-operative vomiting in that it is not a direct result of the operation or the anaesthetic, but because of the circumstances in which these children present, it may be difficult to distinguish.

4.4.f Fourthly the process of having an abdominal operation in itself, with the intra-abdominal tissues being manipulated by the surgeon, can cause vomiting. This would normally be in the early stages.

4.5.f Fifthly, in some cases, anxiety may contribute to the symptoms, and it is well-recognised that children of any age can vomit in direct response to anxiety.

4.g

To make matters more complicated, any of these factors can interact with each other to produce vomiting when they would not on their own: for example a mild virus infection that might just have caused mild tummy ache could also result in vomiting with the added factor of surgery and an anaesthetic.

4.h

In Raychel's case, it seems unlikely that the anaesthetic agents or the operation itself caused her vomiting as this would have been in the first few hours afterwards. The first recorded vomit is not until eight hours after she left theatre. Any of the other factors might have played a part.

4.i

In practice it is usually impossible to distinguish which of these factors are the cause of the vomiting. They are all likely to resolve within a day or two of surgery anyway. It is more important to address the consequences of the vomiting.

4.j

In this case, by the mother's account, the vomiting was severe and frequent, and contained bile and blood. Also she stated that her general condition had deteriorated as shown by listlessness, looking pale, and 'lying without opening her eyes'; this account was corroborated, at least in part, by the accounts of visitors to Raychel during the day (095-006-022), and the mother of another child in the ward (095-007-020). If this were true, then action should have been taken earlier in the day. This should have involved the nurses alerting the medical staff, a more detailed examination by the junior medical staff, and the attending doctor taking advice from someone more experienced: this might have been a more senior member of the surgical team, or the paediatric team. The examination and assessment should have included blood tests. How much earlier this

should have been done depends entirely on the severity of the symptoms and the speed of her deterioration.

4.k

Raychel's non-specific symptoms at that time, according to the accounts of her parents and visitors, included listlessness, uncharacteristic quietness, failure to engage in conversation with her friends and family, and reluctance to leave the bed. If she had been assessed by an experienced paediatrician, it is possible that these symptoms may have been appreciated as the subtle early signs of a more significant illness, as paediatricians are trained to recognise these. This may have prompted earlier action.

4.l

However, according to the case records and the statements of all the professionals involved, the medical staff were not made aware of either the severe and frequent nature of the vomiting, or of these non-specific symptoms. Therefore in my view they cannot be held responsible for lack of action at that stage. According to the statements of all the nurses concerned, they were not aware of Raychel's apparent deterioration. (WS-049, WS-050, WS-051). If they were, it seems likely that they would have alerted medical staff.

4.m

Regarding Dr Butler's involvement, it is a very common situation on any children's ward that a passing doctor will be asked by the nursing staff to write up routine prescriptions, either for intravenous fluids, analgesia, or antibiotics, and this is very common practice throughout the NHS. Although it could be argued that any doctor prescribing anything for any patient should first assess the situation and possibly examine them, in the real world this does not happen. Any doctor who was requested to do this, and then insisted on doing a detailed assessment would be perceived by the nursing staff as being overly cautious, and obstructive to the running of a busy ward. This does not mean that undue pressure is put on a doctor to do this. It is simply understood that in a straightforward situation, where everything appears to be going well and there are no decisions to be made, this prescription could be done by almost anybody with a medical qualification.

4.n

In this particular situation, Dr Butler was a paediatric SHO, while the patient was under the surgical team. On any children's ward, the paediatric doctors are the ones who are most likely to be present for most of the time. The surgical team will also have adult patients on other wards, and may be tied up operating, and therefore are often not immediately available. Therefore, as a means of running a ward efficiently and saving unnecessary delay, nurses will often ask the paediatric doctors to write up prescriptions for surgical patients. This is quite acceptable. If either the nurses did not ask the doctor, or the doctor refused, this would entail calling a surgical doctor who might be engaged elsewhere, causing considerable delay to the writing of the prescription and possibly the patient going without the required fluids for a period of time.

4.o

Regarding the nature and extent of communications between the surgical and paediatric teams, this will vary very much between hospitals, and indeed between different wards. Generally, on most children's wards, children who are admitted with a clearly surgical condition, such as appendicitis, have their care primarily under the surgical team. The surgeons would be responsible for making all the decisions, and discharge etc. The paediatric team in most hospitals are normally only asked to become involved by the surgeons if there is a significant problem. Again the threshold for calling the paediatricians would depend very much on local policy, and on the

4.0

experience that the doctors involved have in dealing with children. Regarding the situation where a child is continuing to vomit more than twelve hours after surgery, I would not consider it obligatory for a paediatrician to be involved. If the child was clearly extremely unwell with sepsis, shock, or an abnormal conscious level, then I would consider it to be obligatory. However just vomiting would probably not qualify in this situation. Most surgical teams should be competent to assess the situation appropriately. Another situation where the paediatric team may be involved, as happened in this case, is when the surgical team are unavailable, and the only doctors immediately available are the paediatricians.

5. Time period 21.00 hours on 8th June 2001 to 02.00 hours on 9th June 2001

5.a

At 21.00 hours Raychel vomited again and this time produced "coffee grounds". Around about this time Raychel also started to complain of headache. The nursing staff were sufficiently concerned to call another junior surgical doctor, Dr Curran, who according to his witness statement (WS-028) examined Raychel and prescribed an anti-emetic. This examination is not recorded in the notes. Another commonly used anti-emetic Cyclizine (Valoid) was prescribed. It did not appear that Dr Curran discussed her with either more senior surgical doctors or with the paediatric team at that point. Raychel had a further vomit documented by the nursing staff at 23.00 hours in spite of the second anti-emetic. There was a further vomit documented at 00.35 hours. After this she appeared to go to sleep.

Comment

5.b

The first anti-emetic Ondansetron given at 17.30 hours is in fact generally considered to be more potent than the second one, Cyclizine, given at 22.00 hours. (Ondansetron is often used to treat the severe nausea and vomiting due to cancer chemotherapy, while Cyclizine is considered inadequate for this purpose.) In my view, the lack of response to the first anti-emetic after 4 hours, and certainly the lack of response to the second one, should have prompted more concern and discussion by the more junior medical staff with more senior colleagues. Raychel should also have been examined for signs of reduced conscious level, for signs of infection, (i.e. rash, fever), and have had her abdomen examined for evidence of surgical complications, such as *bowel obstruction* or *ileus*. Even if the examination had been normal or unhelpful, in my view blood tests should still have been taken around about 21.00 hours after failure to respond to the first anti-emetic, continued vomiting, resulting in coffee grounds vomit. Although this was less than twenty-four hours post-operatively, it was coming up to the point at which she would have been on intravenous fluids for twenty-four hours (given that fluids were started pre-operatively). In any event, the degree of vomiting and the lack of any significant oral intake would have made blood tests necessary. As well as checking her *electrolytes* (sodium, potassium, chloride, calcium, magnesium, urea, creatinine) blood tests would have been advisable to look for other possible causes of persistent vomiting e.g. infection. A blood test should have included a full blood count, where a sudden rise in the white cell count may have indicated infection, and a C-reactive protein (CRP), a blood measurement that will go up during acute infections of any cause. If a specimen was available, a urine specimen should have been tested for evidence of urinary tract infection which can also cause vomiting.

5.c

Had a low sodium been noted around about 21.00 hours, and acted on appropriately with a change to 0.9% Saline, then it is possible, though by no means certain, that the subsequent *cerebral oedema* could have been avoided, or at least mitigated.

5.d

There was nothing documented in the medical notes about an assessment or discussion with senior colleagues during this time period.

5.e

The observation of coffee-grounds vomit is worthy of comment. It occurs when there has been a small amount of blood leaking from the lining of the stomach or the oesophagus which has remained in the stomach for long enough for the stomach acid to have changed it from red liquid to black particulate matter. It may occur in vomiting of any cause. In my view, of itself it is not diagnostic of severe or prolonged vomiting. I have not infrequently seen coffee-grounds produced in children who have vomited only 2 or 3 times previously, with a mild vomiting illness. It rarely leads on to more serious gastric bleeding and usually does not require any treatment. In this case, it is the frequency and severity of the vomiting which is critical, not the occurrence of coffee-grounds.

5.f

Petechiae were noted later, after the seizure. If these had been noted at this point, it would have been another indicator of persistent vomiting (see below).

5.g

At around 21.00 Raychel also started to complain of severe headache. With hindsight this may have been an early symptom of cerebral oedema, but headaches can occur for many other less serious reasons. These include dehydration of any cause, fever, a number of acute infections, and indeed persistent vomiting in itself. Headache was one of the range of symptoms which put together should have prompted earlier action, but by itself was not diagnostic of a more serious problem.

5.h

In summary, in my view, by 21.00 on the 8th June, with persistent vomiting, and with Raychel continuing to receive nearly all intravenous fluids and very little by mouth, an assessment of her blood electrolytes status by doing blood test would have been appropriate, even if the symptoms of coffee-grounds and headache were not appreciated. At that time she had had no seizures and her conscious level was normal, so there would have been no reason to address any concerns about her brain or neurological status.

5.i

Therefore the advice would have been to clinically assess Raychel for her hydration status both in terms of clinical signs of over or under-hydration, and her urine output, and her observations i.e. temperature, pulse, respirations, blood pressure. Even if this examination had not revealed any major problems, then in my view it would have been advisable to take a blood test to check her urea and electrolytes. However it should be pointed out, as it was in several of the witness statements, that most hospitals at that time had a policy of checking blood electrolytes only when a child had been on intravenous fluids for twenty-four hours. In the early evening the twenty-four hour deadline had not been reached. In spite of this the continued vomiting I believe should have prompted an assessment before that time.

5.j

According to both the medical records and the mother's account, Raychel went to sleep after the final vomit at about 00.35. With hindsight this may have been a deterioration into unconsciousness, but it would have been difficult for either the nurses or her mother to distinguish that from a normal deep sleep, which would be expected in a very tired child at that time of night.

6. Time period 02.00 hours to 05.00 hours on 9th June 2001

6.a

At 03.00 hours, Raychel was found by the nursing staff to be having what appeared to be a *generalised seizure*, with urinary incontinence. The immediate first aid actions appear to have been appropriate, with her being kept in the *left lateral position* and oxygen being administered. Appropriate observations were done and she did not appear to be hypoxic. Her pulse rate was surprisingly low at 76 for a child having a seizure as the pulse rate normally increases in this situation.

6.b

The nearest available doctor Dr Johnston, who was a paediatric SHO, immediately attended. The immediate treatment of the seizure was appropriate, with Diazepam given initially rectally, and then when this was ineffective, a bigger dose was given intravenously. Dr Johnston asked the junior surgical doctor, Dr Curran, who would have been primarily responsible for the patient, to ask for more senior help. An electrolyte abnormality was considered as one of several possibilities at that time and blood was sent to the lab. Initially, although she was unconscious, Raychel's pupils were reacting normally. Dr Curran contacted his immediate senior Dr Zafar. Dr Zafar was unable to attend immediately, and so for the next hour or so, Dr Curran and Dr Johnston managed Raychel as best they could. They sent appropriate blood samples to the lab for urgent analysis, and performed an ECG (electrocardiogram). After treating the seizure effectively Dr Johnston went to consult his senior, paediatric registrar Dr Trainor. When she attended the ward at around 0400 she found that Raychel had deteriorated further and her pupils had become *dilated and unreactive*. *Petechiae* on her neck and chest were noted. Her previously low heart rate, had now become rapid up to 160, as would be expected in a very unwell child. The Consultant Paediatrician on-call Dr McCord was summoned and attended as soon as possible. At around about 05.00 hours she continued to deteriorate such that an anaesthetist had to be *fast bleeped*. She was subsequently *intubated*. Arrangements were then made for an urgent *CT scan*.

Comment

6.c

The sudden occurrence of the generalised seizure clearly changed the perspective. This is not by any consideration a "normal" post-operative complication, and did not relate to any previous diagnoses that had been made on Raychel. It should be noted at this point that there are many causes of a generalised seizure in a child, and that hyponatraemia is one of the less common ones. All of them would need to be considered, investigated where possible and acted upon appropriately. Some of the causes of the seizure in this situation could be listed as follows, in very rough order of frequency (the list is not exhaustive):

Fever without any more serious cause

Meningitis, either bacterial or viral

Encephalitis

New onset of idiopathic (otherwise unexplained) epilepsy

First presentation of a mass inside the head e.g. brain tumour or cerebral abscess

Hypoglycaemia (low blood glucose)

Hypocalcaemia (low blood calcium)

Hypomagnesaemia (low blood magnesium)

Hyponatraemia (low blood sodium)

Spontaneous brain haemorrhage

Unexplained encephalopathy

New presentation of an inherited metabolic disorder
Previously unrecognised poisoning
Adrenal gland failure

6.d

Most of these are uncommon, and for most of them the occurrence at this time would have been entirely co-incidental to the hospital admission and the surgery. Thus many of these causes are rare, but it should be born in mind that post-operative hyponatraemia is also very rare.

6.e

With hindsight the low pulse rate may have been significant, because an inappropriately low pulse rate is one of the cardinal signs of raised intracranial pressure. However it increased spontaneously shortly afterwards.

6.f

The petechiae noted on her neck and chest at that time may have been either to the previous vomiting, or due to the recent seizure. Both of these can give rise to a transient rise in the pressure in the venous system, which can cause the small fragile capillary blood vessels in the skin to rupture and cause petechiae.

6.g

Regarding the appropriateness of the investigations done after the seizure, most of the conditions listed above would have been diagnosed by this means. The infective causes i.e. meningitis, encephalitis should have produced a fever, and would often have produced a characteristic rash, and an increase in CRP in the blood tests. All the causes that relate to abnormal levels of substances in the blood would have been revealed on the blood tests. The possibility of a brain haemorrhage, or a mass inside the head would have been revealed on the CT scan.

6.h

The question may arise as to whether any action should have been taken while awaiting the result to come back from the laboratory, which apparently took about 45 minutes. It is easy with hindsight to say that the fluids should have been restricted or changed to 0.9% Saline, but we must remember that the staff there at the time had absolutely no idea that the sodium was going to be so low, and had no reason to suspect hyponatraemia. There could have been a wide range of electrolyte abnormalities found, even possibly hypernatraemia i.e. a high blood sodium, and these would have resulted in the need for a very different course of action. I therefore do not think any criticism should be attached to Dr Johnston for not assuming that hyponatraemia was the problem in advance of the blood result.

6.i

There was about half an hour's delay until the second blood test confirmed a very low serum sodium. The difference between 119mmol/L and 118mmol/L is insignificant and is within the limits of laboratory error. Therefore the result was effectively the same on both occasions. The appropriate steps were taken after the second confirmatory serum sodium result, and her fluids were restricted to half the original infusion rate, and changed to 0.9% Saline.

6.j

As she also had a low serum magnesium, and hypomagnesaemia is known to cause convulsions, I think it was appropriate to give her a single injection of magnesium. Even if this was not the cause, it would not have done any harm.

6.k

Prompt action was taken when the very low sodium result was known, but unfortunately it seems that by this time it was probably too late for any change in treatment to make much difference. It was clearly appropriate to do a second blood test, as any result that is so abnormal could be the result of laboratory error. This did result in some delay in treatment but I think this was appropriate given the risks of taking action on a false result. A high sodium level might have indicated severe dehydration and the need for more fluid, the opposite of what was actually needed.

6.l

Thus in conclusion the investigations done after the seizure were appropriate, the appropriate diagnosis of hyponatraemia was made as quickly as might be expected under the circumstances, and the intravenous fluid regime was changed accordingly.

6.m

The question arises as to whether the post-operative vomiting was exacerbated by the development of cerebral oedema. This can certainly happen, but it seems highly unlikely that Raychel had significant cerebral oedema earlier in the day and in my view it probably only developed in the few hours before the seizure. The seizure in itself may have made the situation worse.

7. Time period 05.00 hours onwards

7.a

Raychel was transferred to the intensive care unit at Altnagelvin, and before that a CT scan was done. There was some suggestion on the initial scan that there could have been a subdural or subarachnoid haemorrhage, but once the CT scan had been seen by a Consultant Radiologist this was discounted. The clear diagnosis was cerebral oedema.

7.b

A discussion took place between clinicians at Altnagelvin and the RBHSC and the decision to transfer was made at 11.00 hours on the 9th June 2001. There was no neurological improvement, and eventually irreversible brain damage was diagnosed and ventilation was discontinued.

7.c

Subsequent post-mortem and neuro-pathological findings confirmed cerebral oedema as the cause of death. The pathologist gave the opinion that this was due to the hyponatraemia, and this was accepted by the Coroner.

Comment

7.d

The management following her resuscitation at 04.00 hours and her subsequent admission to intensive care unit at Altnagelvin and the RBHSC appears to have been appropriate. The diagnosis of hyponatraemia was made appropriately and the fluid regime was changed to correct this, but unfortunately by this time, the damage as a the consequence of the cerebral oedema was too extensive to have prevented the fatal outcome.

8. General Comments on the Care Raychel Received

8.a

Raychel's case up until she deteriorated late on 8th June was entirely straightforward and there was nothing about her case that could possibly have indicated to the staff that such a catastrophic outcome was about to occur. All the staff would have dealt with many similar cases of children presenting with acute abdominal pain, with suspected appendicitis, and then going to theatre. The fact that the appendix did not turn out to be inflamed is irrelevant as this frequently happens and is not the result of any diagnostic error. I am sure it was the right thing to do to remove her appendix if appendicitis was a serious possibility.

8.b

The main issue that appears to have been contentious at the internal inquiry and at the inquest, was the degree of post-operative vomiting. Although with modern surgical techniques and anaesthetics, post-operative vomiting is less of a problem than it used to be, it can still occur frequently. Some children seem to be much more susceptible to this than others and this is quite unpredictable. I therefore think it is entirely reasonable that all the staff involved attributed Raychel's vomiting to normal post-operative vomiting, and there would have been no reason for any of them to consider any more serious diagnosis until much later.

8.c

Regarding the issue of whether she should have had a *naso-gastric tube* inserted, I agree with the witnesses who stated that this was not routine practice at the time. Even now it is still not routine practice to insert a naso-gastric tube in every child who vomits post-operatively.

8.d

It should be pointed out that the insertion of a naso-gastric tube is a thoroughly unpleasant experience at any age but particularly for a child. It also carries risks, such as inadvertent placement in the airway, or bleeding from the oesophagus or stomach. Vomiting for whatever cause normally settles without the need to do this. The advantage of a naso-gastric tube is that it is possible to monitor the amount of gastric secretions that are being retained in the stomach and also reduce the amount of actual vomiting by aspirating the stomach regularly, but this has to be balanced against the risks and the discomfort. Anti-emetic medications were given appropriately, and in the absence of any signs of a bowel obstruction (i.e. distended abdomen, absent bowel sounds, green bile stained vomit), a naso-gastric tube would not have been obligatory.

9. Protocols, procedures, policies, guidelines and standard practice

9.a

These terms are often used loosely and interchangeably to describe the ways in which patients are managed. In fact these terms carry different shades of meaning. 'Protocol' suggests rigid instructions on exactly how things should be done with little scope for variation. Procedures, policies and guidelines are less restrictive terms, with information, suggestions and guidance, but with the scope to do things differently according to individual circumstances. All these should be contained in a written document, on paper or electronic, which should be readily accessible to all concerned. 'Standard practice' refers to what has always been done, but which may or may not be written down anywhere. In practice it is often transmitted by word of mouth, or by instruction from a consultant. Since 2001, 'standard practice' has become increasingly unacceptable, and these days all medical practice should, where possible, be governed by protocols, policies or guidelines, which may be national or developed locally.

9.b

In this case, I have not been presented with any written document giving guidance on the prescription of IV fluids to staff at the time. I have assumed from the witness statements that the 'standard practice' regarding intravenous fluids was not in the form of a written document but rather 'word of mouth'. In this respect Altnagelvin would not have been any different to most NHS hospitals at the time. The development of these forms of guidance has seen huge strides in recent years, and what was commonplace then would be unacceptable now..

Response to specific questions contained in the supplementary brief of 17th January 2012

Question 2.1

- (a) Should Raychel have been referred to a more senior member of the team by Dr Devlin and/or Dr Curran?**

Response: This depend on to what extent these doctors were made aware of the severity and frequency of her vomiting. However if the nurses' account is accepted, that the she was relatively well and the vomiting was not severe, in my view Raychel should have been discussed with (not necessarily referred to) a more senior member of the surgical team at around about the time Dr Curran saw her at 21.00 hours, given that the paediatricians were not involved at that time. This is because it was approaching the point at which she had been on IV fluids for twenty-four hours, and in general terms of managing children, nine o'clock in the evening is quite a good time to get things sorted before the child settles down for the night. If the parents' account is accepted then Dr Devlin should have sought advice when he saw her at around 17.30. It appears that he was not made aware of this.

- (b) Should the surgical team have liaised with the anaesthetic team about whether the use of Cyclimorph and anaesthetic agents were the cause of the continued vomiting?**

Response: No. This long after the operation the anaesthetic team would usually not be involved, unless there was a new breathing or airway problem. Continued post-operative vomiting beyond a few hours would normally be considered the responsibility of the surgical team, not the anaesthetic team. Because of the way the body handles the drugs concerned, the anaesthetic drugs would have been largely cleared from the body although Cyclimorph may have continued to exert some effect for up to 24 hours..

Question 2.2

- (a) Why did many hospitals have a policy of checking electrolytes after twenty-four hours of intravenous fluids?**

Response: There is no scientific basis behind the twenty-four limit. It is simply an indication that a whole day is a significant length of time. The twenty-four hour limit should be, and normally is, interpreted flexibly. If the twenty-four limit falls in the middle of the night, it would be good practice to check the electrolytes a few hours before that, so as not to have to disturb a sleeping child during the night. On the other hand, if a child is close to tolerating adequate oral fluids when coming up to the twenty-four hour limit, it may be unnecessary to check the electrolytes at all. Clearly, if other symptoms intervened, such as protracted vomiting then that might prompt one to check the electrolytes earlier, as in this case. This guidance refers to patients who are not tolerating significant amounts of oral fluids or diet. Generally, as soon as the majority of the patient's fluid intake is by mouth, the electrolyte balance regulates itself by the body's natural regulatory mechanisms, and checking the electrolytes is less important. In other words it is almost impossible to become significantly hyponatraemic through normal voluntary oral hydration. This only happens with intravenous hydration.

Policies were designed to monitor blood electrolytes in these circumstances because even when correct and recognised fluid regimes are used, the way the body handles the intravenous fluids is unpredictable. Any of the measured electrolytes can be too high or too low and adjustments may

need to be made. Hyponatraemia is only one of a number of different electrolyte abnormalities that can result from a prolonged period on intravenous fluids.

Policies would be different for patients that had other underlying medical conditions, such as kidney disease, which do not apply in this case.

(b) What was the understanding of the medical profession in 2001 about the risks associated with the use of hypotonic fluids?

Response: This question is really impossible to answer meaningfully. One cannot generalise about the medical profession, with so many different grades of doctors being involved in different specialities in different types of hospitals and situations. I would expect a junior surgical doctor, in a district general hospital to have a very limited understanding, if any, of the risks of hyponatraemia. More experienced surgeons, and paediatricians, may be more familiar with it, but experience would be very limited. It has been acknowledged that there had been publications in medical journals long before this incident and there had been some discussion amongst professionals, but there was no generalised warning throughout the National Health Service, and as far as I am aware no such warning had been issued in other countries either.

In general terms, the process whereby new medical research is relayed to doctors on the ground, has caused a great deal of concern. In 2001 mechanisms for informing doctors of important developments were not as well developed as they are now.

It should be borne in mind that vast numbers of papers are published every year in a vast range of journals, and it is impossible for every doctor to remain up-to-date in every subject.

(c) Did the word 'assessment' in the initial report indicate a require to check blood electrolytes?

Response: Yes. The particular factors in Raychel's case which might have prompted an assessment of blood electrolytes were simply the continued vomiting, whatever the cause of the vomiting might have been. Also she had not started to take significant amounts of fluids by mouth. This should have prompted checking the electrolytes even if she otherwise appeared well and clinically adequately hydrated.

The lack of documented urine output is an important factor, but in practical terms because it is acknowledged that this is often poorly documented on children's wards, this in itself is not usually the main reason for checking electrolytes.

(d) Were there factors in the late afternoon or early evening on the 8th June 2001 which might have prompted Dr Devlin to check the blood electrolytes?

Response: In that Raychel had continued to vomit, it could be said that it should have prompted checking the electrolytes but as she was only just over twelve hours post-operative, and had not been on IV fluids for twenty-four hours at that stage, I think it was justifiable not to check the electrolytes. As discussed elsewhere (see 4.j), this decision would have been influenced by the extent of the amount and frequency of her vomiting. It would appear from the records and from the witness statements that Dr Devlin was not made aware of the extent of this.

(e) Should there have been a check of the electrolytes at 22.15 by Dr Curran and a plan made for a further review?

Response: Yes. As indicated above, by this time with the continued vomiting, the inability to tolerate oral fluids, and the continued administration of IV fluids then I believe electrolytes should have been

checked around about that time. Although a plan for further review during the night was not documented in the notes, I believe it would have been implicit that had the problem continued, the nurses would have again contacted Dr Curran or another member of the medical staff for advice. Even if there was no suspicion by the nursing staff at that time of a more serious diagnosis developing, simply to settle Raychel's distressing symptoms and allow her sleep during the night, some action by the medical staff might have been asked for. It was clear that two doses of different anti-emetics had not been effective.

Question 2.3

(a) Could Dr Johnston after attending Raychel following the seizure have made a diagnosis of hyponatraemia?

Response: As mentioned before, hyponatraemia is an extremely rare diagnosis even in children who have been kept on *hypotonic* fluids for long periods of time. I do not believe it would have been the top of the list of diagnostic possibilities by any of the doctors who attended her. It is not possible to diagnose hyponatraemia simply from clinical signs and symptoms without doing the blood tests. Hyponatraemia, i.e. a high blood sodium, can occur for a whole variety of reasons and given that Dr Johnston was called as an emergency and not familiar with the case, he would not have been able to exclude that. There could also have been a broad range of other causes for the seizure as mentioned before.

(b) Should Dr Johnston have taken immediate steps to lower the infusion rate or increase the sodium content of the intravenous fluid?

Response: No. As already mentioned, there are many other causes why Raychel could have continued to vomit or had a seizure, and from the information available to Dr Johnston at the time before the electrolyte result was known there was no indication to take any action. That would have run the risk of making the matters worse if the diagnosis had turned out to be different.

The issue of prescribing *Mannitol* is an interesting one: in my experience *Mannitol* for presumed cerebral oedema is virtually never prescribed until there is objective evidence of oedema occurring, usually as a result of the CT scan, and then it would almost never be given outside an intensive care unit. Any junior doctor giving it in these circumstances would most certainly have been expected to have discussed it with a senior paediatrician or an intensive care specialist beforehand. It would not have been expected practise to administer *Mannitol* in that acute situation without more information being available.

Question 2.4

(a) What are the parameters of 'normal' post-operative vomiting

As far as I am aware there is no definition of normal post-operative vomiting. I am not best placed to give an opinion on this as paediatricians do not normally manage post-operative vomiting. My impression would be that post-operative vomiting could occur up to twenty-four hours after an operation, but as noted previously (see 4.f) there are many other causes of vomiting in children that may be only indirectly related to the surgery or the condition for which the surgery was done. It is debatable whether one would term this post-operative vomiting or not. It is possible for post-operative vomiting to start some hours after surgery since the sedating effect of the anaesthetic drugs might prevent it until they have worn off.

(b) Was Raychel's case properly regarded by staff as normal post-operative vomiting?

Response: Yes. For most of the day on the 8th June 2001, it would have been reasonable for nursing and medical staff to regard this as normal post-operative vomiting. The point at which it became outside the bounds of normal is debatable, and depends on the credence given to the differing

accounts of the quantity and frequency of the vomiting, and whether staff were aware of Raychel's reported symptoms of listlessness.

(c) Regardless of whether Raychel's vomiting was considered 'normal' or not, what steps should have been taken to check her blood electrolytes?

This question is largely answered above.

- (i) As already stated, the factors which clinicians should have recognised as indicating a need to check her blood electrolytes include the fact that she had been on intravenous fluids for approaching twenty-four hours without tolerating oral fluids.
- (ii) The steps that should have been taken to investigate her blood electrolytes would involve taking a blood specimen and sending it to the laboratory to have it analysed.
- (iii) As stated above, the time from which it would have been recognised that there was a need to check Raychel's blood electrolytes would have been dependent on the extent and quantify of the vomiting but by 21.00 hours on the evening of the 8th June there was a need to check the electrolytes.

(d) Would the answer to the above questions have been different if the accounts of listlessness and unresponsiveness suggested in some of the witness statements were in fact the case?

Response: Yes. Quite irrespective of the intravenous fluid treatment and the vomiting itself, any child who unexpectedly becomes more unresponsive, listless or apathetic for no clear reason, requires some investigation. There are many reasons why this could happen, and in the first instance checking blood tests including electrolytes and for evidence of infection, would be the first line of investigation. Had Raychel shown signs of unresponsiveness, listlessness, etc in the afternoon or evening of the 8th June and had this been made clear to medical staff, I believe this would have warranted further investigation including blood tests. Junior surgical staff at that stage, had they appreciated this, should have referred it up the chain of command or asked for an opinion from a registrar grade paediatrician.

- (e) A 'more serious diagnosis' than normal post-operative vomiting should have been considered around about 21.00 hours.
- (f) As stated above the factors that should have prompted consideration of a more serious diagnosis were the continuation of the vomiting and if genuine, a decrease in conscious level and unresponsiveness.

Question 2.5

(a) What examinations or investigations should a doctor conduct before prescribing anti-emetic medication?

Response: If, as in this case, the doctor justifiably assumed that the vomiting was post-operative vomiting, a brief assessment of the child would have sufficed including checking the child was responsive and alert, and checking that the observations done by the nurses were within the normal ranges. The observations would include temperature, pulse, respiration and blood pressure. Most doctors would reasonably expect the nurses to bring it to their attention if the observations were outside the normal range, or if a child was abnormally drowsy. In a patient that has had abdominal surgery, it would have been best practice for the doctor also to examine the abdomen. This would have involved observing the abdomen for signs of distension, and placing a hand on the abdomen to see whether there was an area of tenderness in excess of what one might expect after an operation. Doctors will often use a stethoscope to listen to the abdomen for bowel sounds, although in my experience this is

generally unhelpful in children. It would not be considered normal practice to routinely check electrolytes or do any other investigations before prescribing an anti-emetic.

(b) Is it appropriate to administer an anti-emetic in the absence of a thorough assessment of the reasons for the vomiting?

Response: If the impression gained by the doctor, knowing the patient's recent history and the impression given by the nurses is that it was just post-operative vomiting, then a more thorough assessment would not have been warranted.

(c) What steps should be taken by staff if it became apparent that the vomiting had remained troublesome even after the administration of an anti-emetic?

Response: Anti-emetics are not always effective. Vomiting from whatever cause often does not respond to them and although sometimes they can relieve the subjective sensation of nausea, which can be unpleasant, they do not always actually stop the vomiting. This poor response can occur in many circumstances, and the lack of response to anti-emetic in itself is not diagnostic of a more serious cause for the vomiting.

In this case, the first anti-emetic given was Ondansetron (Zofran), which is generally considered to be a more powerful anti-emetic and evidently it did not work; then the second less powerful anti-emetic, Cyclizine (Valoid), also did not work some hours later. Action should have been taken not because the anti-emetics did not work, but because the vomiting continued whether or not they had been given.

(d) What action should Dr Devlin have taken before or at the time of prescribing an anti-emetic.

As stated above, when Dr Devlin saw Raychel in the late afternoon or early evening of the 8th June 2001 it would have been reasonable just to check the observations and do a brief assessment with a brief abdominal examination.

(e) What action should Dr Curran have taken before or at the time of prescribing an anti-emetic.

By later in the day, given that the vomiting had continued and developed into coffee grounds, as well as doing a physical examination as above, Dr Curran should have taken more senior advice or done investigations himself.

(f) Should either doctor have arranged investigations?

As already stated the prescribing of anti-emetics is not in itself a trigger for doing these investigations.

(g) Is there any indication that Dr Devlin or Dr Curran did the appropriate examinations or investigations before prescribing anti-emetics?

Response: In their witness statements both doctors suggested that they did assess the patient, although in neither case is this recorded in the casenotes. As already stated they did not do blood tests as the first electrolyte assessment wasn't done until after the seizure.

(h) What information would you expect Dr Devlin, Dr Curran and the nursing staff to record in the notes?

Response: Although it is not necessarily obligatory for every doctor to record in the notes every time an anti-emetic is prescribed, it would have been advisable to write a brief note giving the impression that this was continued post-operative vomiting, and saying that anti-emetic had been prescribed. In the early part of the day there would not have been a need for a more detailed list of diagnostic possibilities to have been recorded.

(i) Should Dr Devlin and Dr Curran made arrangements for follow-up examination after the administration of anti-emetic medication?

Response: The prescribing of an anti-emetic is not in itself a reason to arrange specific medical follow-up. Medical staff are dependent upon the nursing staff to inform them if any patient continues to have symptoms for which they have been treated, and which should have subsided by that time.

Given the sequence of events in this case, even if Dr Curran had returned to assess Raychel between 02.00 hours and 03.00 hours, according to the nursing records, she was sleeping peacefully and he is unlikely to have taken any further action at that time.

Question 2.6

(a) What is my position regarding whether Raychel was provided with appropriate care and treatment?

Response: My position with regard to whether Raychel was provided with appropriate care is detailed in the above statements. I have already made it clear that factors existed which ought to have prompted clinicians to check blood electrolytes.

Question 2.7

(a) Are issues relating to the impact of the seizure more properly the province of a consultant neurologist?

Response: Under these circumstances it would not have been normal practice to consult a paediatric neurologist as a matter of urgency. An acute deterioration such as this required immediate action, and there would be a delay in consulting a consultant paediatric neurologist. Moreover as Altnegalvin is a District General Hospital rather than a teaching hospital, there would not have been a consultant paediatric neurologist available locally. The immediate action to treat a seizure and to investigate it for its cause as detailed above, should be within the competency of any acute general paediatrician and would not need a tertiary paediatric neurology opinion. Subsequently, once the acute episode had settled, it may have been appropriate to consult a paediatric neurologist about underlying causes, but this would not have been appropriate during the night.

(b) The question relates to whether there were signs which ought to have prompted the clinicians to check blood electrolytes even in the absence of signs of raised intracranial pressure.

Response: As already stated, the diagnosis of hyponatraemia and other electrolyte abnormalities cannot be made on the symptoms and clinical signs only. A blood test is needed to do this. There would have been nothing in Raychel's findings on examination that would have caused clinicians to make the diagnosis of hyponatraemia until the result of the blood test was known.

Question 2.8

The question relates to the opinion I was asked to express in my initial report about what other specialists should be asked to comment on this case.

I should explain that the response I gave in my initial report to this question was a general response to the type of expertise which would be useful, and was in no way intended to reflect any inadequacies of the reports already given. In my non-specialist opinion these reports appear perfectly satisfactory.

- (a) My view expressed that a chemical pathologist or clinical biochemist should be involved was made in order that the inquiry should be informed by an expert of the nature of the way the body handles sodium and how the circumstances can arise where a low blood sodium occurs. If the inquiry feels that the report already made by Dr Loughrey is adequate (014-005-014), then I do not feel that any further reports are necessary.
- (b) Similarly, reports that have already been made by a paediatric pathologist and neuropathologist, (014-005-013) and if the inquiry feels that these are adequate, then I would concur.

Question 2.9

- (a) **The question relates to what time frame I was referring to when I used the phrase 'early evening'**

Response: This would indicate between 17.00 hours and 18.00 hours.

- (b) **The question asked what I meant by the term 'practice' in the context of 'I do not believe that the practice on the ward... was below... standard...'**

Response: This indicates the way in which the doctors and nurses carried out their duties. Please see para 9 above for explanation of terms like 'standard practice' etc.

- (c) **Clarification is requested of my use of the term 'marginal' in the conclusion of my initial report.**

Response: My meaning when I indicated that the indications for intervention were "marginal", was simply to say that different opinions might be given by different experts when asked this precise question.

- (d) **The question relates to an apparent inconsistency between my views expressed in different parts of my original report.**

Response: My views about the important issues of clinical management in this case have been clearly stated in this compendium report. Please see new conclusion below.

Incidence of Hyponatraemia

It is clear from the witness statements from many of the people involved, that they had never before experienced a case of hyponatraemia. I would concur with that, and say that this devastating complication is exceedingly rare. Very many children would have been treated exactly the same way as Raychel, and would have maintained a normal or only marginally low serum sodium level with no adverse effects.

As in many areas of medicine, we do not understand why certain individuals seem to react differently to interventions and there may be many reasons for this. This is of course entirely unpredictable.

Cause of Cerebral Oedema

In Raychel's case, it seems that things deteriorated particularly rapidly when she had the seizure. Although this is speculative, I would guess that the seizure itself caused a "vicious cycle" that hastened her deterioration. It is impossible to say how much of the vomiting that preceded the seizure was due to normal post-operative vomiting and how much was due to increasing cerebral oedema. There were no clearly diagnostic signs of raised intracranial pressure until after the seizure (i.e. reduced conscious level, slow pulse rate and high blood pressure). Any seizure can result in increased swelling of the brain, as the cerebral metabolic activity increases, and the blood supply is unable to keep up with the demand. The brain cells need more oxygen at a time when it is relatively lacking in the blood supply, and *hypoxic* brain cells can swell rapidly. Normally this recovers extremely quickly, but if the brain had already started to become oedematous because of the hyponatraemia, the seizure would have rapidly made it worse. The seizure would also have worsened the *inappropriate ADH secretion*, which is with hindsight assumed to be part of the cause of Raychel's hyponatraemia. The seizure could therefore have been both an effect and a cause of her rapid deterioration. Once cerebral oedema progressed beyond a certain level, "coning" i.e. forcing down and compression of the brain stem through the foramen magnum at the base of the skull, would have occurred and the situation would have become irrecoverable.

Conclusion

Had Raychel's electrolytes been checked in the early evening on the 8th June, it is likely that a very low sodium level would have been discovered and intervention by reducing her fluid and changing it to 0.9% Saline may well have prevented the later deterioration and her death

Implications of Post Operative Fluid Policy

It is now clear, following this and other Northern Ireland cases, that the policy that was in place at the time for giving intravenous fluids to post-operative children was presenting a risk. However it should be remembered that this risk was very small, and these cases are extremely rare. There are also some risks to using the alternative regime that is now in routine use, i.e. 0.9% Saline or Hartmann's Solution.

I do not consider that any blame should be attributed to any of the members of staff for prescribing or administering 0.18% Saline in the first place, as this was quite clearly routine ward policy at the time. Indeed it was the policy on most children's wards in the UK at that time. It was not until 2007 that the National Patient Safety Authority issued an alert advising all areas treating children to stop using 0.18% saline. (1) As late as 2003 standard paediatric textbooks were still recommending 0.18% saline as a possible choice of standard IV fluid management. (2) Regarding the choice of IV fluid treatment in this case, it is important to remember that the clinicians concerned would have treated very many children, as indeed I did myself, with his fluid regime with no adverse effects whatsoever.

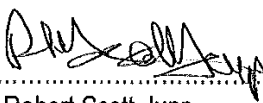
References:

- 1) National Patient Safety Authority (2007). Reducing the risk of hyponatraemia when administering intravenous infusions to children.
<http://www.nrls.npsa.nhs.uk/resources/?entryid45=59809> (Accessed 08/04/2011)
- 2) Nelson Textbook of Pediatrics (2004) 17th edition (Pub. Saunders) p. 242

Declaration:

I declare that the above is my own true opinion having studied all the relevant documents supplied to me, given to the best of my knowledge and ability. I have no personal interest in supporting any particular point of view, I do not personally know any of the clinicians involved in this case and I have never worked in Northern Ireland.

Signed:

 13/2/2012
.....
Dr Robert Scott-Jupp

Glossary

Analgisia: pain-relieving medication

Anti-emetic: medication given to prevent or treat nausea and vomiting. These drugs can be given orally, by injection or by suppository.

Bowel obstruction can occur for a number of reasons, including post-operatively. A physical obstruction to the intestine at any level can prevent the normal passage of stomach and intestinal secretions downwards, resulting in vomiting even if the patient has eaten or drunk nothing.

Cerebral oedema refers to the swelling of the soft tissues of the brain inside the skull. Because the skull is a rigid box and cannot expand, cerebral oedema inevitably leads to *raised intracranial pressure*, i.e. raised pressure inside the skull. Cerebral oedema has many causes, of which the most common in childhood are head injury and asphyxia. Hyponatraemia is rare cause.

Coffee grounds is the name given to material vomited that has the appearance of coffee grounds but is in fact blood that has been altered by the gastric acid, and produces a dark, almost black particulate material mixed up with the liquid vomit.

CT scan. A computerised X-ray scan which gives an immediate image of the brain.

Dilated and unreactive pupils. This refers to what is observed on shining a bright light into both pupils. Normally both pupils should constrict to an equal degree in response to light, even in an unconscious patient. When there is a severe problem with the brain, the normal mechanism controlling this ceases to function, and both pupils become widely dilated and fail to constrict in response to light.

Electrolytes refers to the various salts and other simple chemicals which are normally present in the blood plasma at levels which are closely regulated by the body. These are all easily measured in routine blood tests.

Fast bleeped. This refers to standard hospital communication systems whereby a doctor can be urgently summoned to attend. It usually involves a different tone to a standard bleep, with a voice message telling the doctor to attend the relevant area immediately without the need to make a phone call first. It differs from a 'crash bleep' in that just one individual, rather than a whole team, is summoned.

Fluid regime refers to the intravenous and/or oral fluids, both type and rate of administration, prescribed by the doctor.

Generalised seizure (or fit, convulsion) results from a burst of abnormal electrical activity in the brain resulting in involuntary twitching of all muscle groups in a characteristic, rhythmic fashion, and loss of consciousness.

Hartmann's solution. Also known as 'Ringer's lactate solution' or Compound Sodium Lactate solution'. This is an intravenous fluid which has traditionally been preferred by anaesthetists to be administered during and immediately after operations. It contains sodium chloride 0.6%,

sodium lactate 0.25%, potassium chloride 0.04%, calcium chloride 0.027%. For practical purposes it is very similar to normal saline solution (sodium chloride 0.9%) in that it is isotonic and contains no glucose. There are some theoretical benefits to adding small amounts of potassium, calcium and lactate which are not relevant to this case.

Histology. Microscopic laboratory analysis of tissue removed from the body.

Hypotonic refers to a fluid whose total concentration of solutes, in terms of millimoles per litre, is less than that of normal human serum. **Isotonic** fluids have the same concentration, and **hypertonic** fluids are more concentrated.

Hypoxic: lacking in adequate oxygen.

inappropriate ADH secretion or (SIADH) is an abnormal physiological state with many causes, whereby the pituitary gland at the base of the brain releases an excessive amount of anti-diuretic hormone (ADH) into the bloodstream. This has the effect of making the kidneys retain water, reducing urine output and increasing the degree of dilution of the blood. This dilution is usually manifested on blood tests as hyponatraemia.

Ileus refers to the phenomenon which often follows abdominal surgery whereby the entire intestine ceases to function in the absence of any physical obstruction. It can also produce vomiting.

Intubated. A plastic tube is inserted through the mouth or nose down into the lungs to allow the patient to be artificially ventilated.

IV cannula: Intravenous cannula. A small plastic tube inserted into a vein with a needle, usually into the arm. It can be used for giving both IV fluids and IV drugs.

Left lateral position, or 'coma' or 'recovery' position refers to positioning the patient lying on their left side in such a way that their airway can remain open during a seizure or unconsciousness

Localised indicates that the pain or tenderness started out covering all or most of the abdomen, and over time became restricted to a more limited area.

Mannitol is a drug given in the form of a rapid intravenous infusion which is used in some circumstances as an immediate treatment for cerebral oedema.

Naso-gastric tube: this is a soft plastic tube inserted through the nose so that the bottom end lies in the stomach. Its purpose is both to draw off (aspirate) liquid stomach contents to measure fluid loss and prevent vomiting, and to give fluids directly where appropriate. It is normally inserted by a skilled nurse.

Nil by mouth refers to the order given, usually by a doctor, that the patient should not be given anything to eat or drink until further notice. This is usually when a general anaesthetic is being planned. If a patient is anaesthetised with food or drink in the stomach, there is a risk that during the anaesthetic, the contents of the stomach may be vomited up and then breathed into the lungs which is harmful.

Nursing handover: this happens at each shift change (2 or 3 times a day depending on shift pattern). It is led by the senior nurse from the outgoing team, and each patient on the ward is discussed in turn, with a plan for their ongoing care. Patients are then allocated to members of the incoming team.

Peri-operative: immediately before, during and after the operation.

Petechiae refers to tiny, purple pinpoint spots visible in the skin. These are due to tiny skin blood vessels bleeding into the skin. There are many causes, but one is raised pressure in the veins due to vomiting.

Pre-op: pre-operative, before an operation.

Right iliac fossa. This is the anatomical description of the area of the abdomen below and to the right of the umbilicus (navel), extending as far down as the right iliac crest (hip bone). In the centre of this area is 'MacBurney's point', the point of maximum tenderness in a typical case of appendicitis.

0.18% Saline 4% Dextrose. This refers to the type of intravenous fluid used. This fluid is also known as 'Solution number 18' or '1/5th normal saline'. The numbers refer to the concentration of additives in the water of the fluid calculated as weight for volume; i.e. 0.18% Saline means that it contained 0.18 grams of sodium chloride for every 100 mls of water. 4% dextrose means that it contained 4 grams of dextrose (glucose) for every 100 mls of water. These concentrations have been used historically because they make an 'isotonic' solution, i.e. a solution with the same total concentration of solutes (mmols/litre) as normal human serum.

Symptoms refers to the actual problems that the patient or carer experiences and tells to the health professional.

Signs refers to the abnormalities that the health professional detects on examining the patient, whether or not they are aware of them.

Tenderness in the abdomen refers to the patient describing pain, or showing a facial expression indicating pain, when that area of the abdomen is pressed by the examiner's hand.

Ward round: this is a routine activity on most acute hospital wards. It usually occurs once a day in the morning, but on some wards may happen 2 or 3 times a day. It is usually led by medical staff, and nurses sometimes attend. The team move from bedside to bedside and discuss each patient under their care. This includes diagnosis, their progress to date and the plan for their ongoing treatment. Decisions are made by the most senior doctor present and usually recorded in the notes by the most junior. The most senior doctor should then speak to the patient or parent. One of the doctors should then communicate all decisions made to the nursing team.