Update in
Anaesthesia

BRIEF COMMUNICATION

Management of infantile hypertrophic pyloric stenosis

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Summary

Objective. To collect details of common UK management practices for infantile hypertrophic pyloric stenosis (IHPS) and compare this to our practice at the Royal Cornwall Hospital Trust (RCHT).

Aim. To compare local with national practice and published evidence, leading to a local guideline for the perioperative management of IHPS.

Results. Although there was inevitable variability in some of the above areas, our audit at RCHT was generally consistent with practices identified in the survey.

Conclusions. Our perioperative management of IHPS at RCHT is reasonably concordant with national practice and published evidence.

INTRODUCTION

Infantile hypertrophic pyloric stenosis (IHPS) is a common disease with an incidence of between two and five per thousand live births. It characteristically presents between the third and eighth week after birth and there is a male to female preponderance of four to five times.[1] The aetiology is unclear, although abnormalities in both the innervation of, and nitric oxide synthesis in, pyloric musculature have been implicated.[2] Hypertrophy and hyperplasia creates a pyloric channel which gradually becomes elongated and narrowed.

Patients typically present with non-bilious vomiting after feeding, which can be difficult to distinguish from feed intolerance and gastro-oesophageal reflux. High serum bicarbonate may be helpful, although sensitivity is low.[3] There may be inadequate weight gain or weight loss since birth. Although the late signs of projectile vomiting, visible peristalsis and a palpable 'olive-sized mass' in the right upper quadrant (RUQ) of the abdomen are fairly specific for IHPS (up to 0.9), overall clinical examination has a specificity of less than 0.5.[4] Ultrasonography is now established as the imaging modality of choice and is both highly sensitive and specific for IHPS.[5] Once considered the gold standard, the upper gastrointestinal series involves exposure to ionising radiation and is now reserved for equivocal cases.[6]

Ongoing vomiting causes dehydration and a hypochloraemic, hypokalaemic metabolic alkalosis.[7] There may be a deficit of sodium and occasionally there is renal impairment or an unconjugated hyperbilirubinaemia. Urine is paradoxically acidic due to secondary hyperaldosteronism, which further exacerbates the metabolic alkalosis. Acid-base balance should be restored prior to surgery, as untreated alkalaemia may result in apnoea during the recovery period.[7] The degree of dehydration is estimated and appropriate intravenous fluids are given for resuscitation, maintenance and replacement of ongoing nasogastric (NG) losses.

Pyloromyotomy is curative, well established and survival approaches 100%.[8] It should be carried out during the normal working day once the biochemical abnormalities and dehydration have been corrected. It can either be performed as an open (OP) or laparoscopic (LP) procedure and involves making a small cut in the musculature of the pylorus whilst leaving the mucosa intact. There are two possible OP approaches, umbilical and RUQ.[8]

Guidelines produced by the Association of Paediatric Anaesthetists of Great Britain and Ireland (APAGBI) include recommendations for the perioperative fluid management and correction of biochemistry.[9] However, until recently, there were no agreed approved guidelines at the Royal Cornwall Hospital Trust (RCHT), nor indeed in the South-Western region of England, encompassing the perioperative management of these cases.

We aimed to collect details of common practice in the UK, compare this to our practice and to publish local guidelines for the perioperative management of IHPS at RCHT.

METHODS

Local audit

We completed a retrospective notes-based audit of our practice at RCHT between December 2006 and September 2008, specifically focusing on the factors listed in Table 1.

Survey

We then conducted an email survey of 32 anaesthetic departments across England, Wales and Scotland. We directed our questionnaire either to the designated lead paediatric anaesthetist, or to those who most frequently anaesthetise patients of this age group within each department. We asked them to provide answers they felt to be representative of their department and concentrated on key areas to maximise compliance. We specifically focused on the factors listed in Table 1.

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Table 1. *Specific areas of focus in the local audit and survey*

	Local audit	Survey
Demographics	Gender Gestational age Age at presentation Birth weight Presentation weight	
Biochemistry	Admission bicarbonate Preoperative bicarbonate	Preoperative bicarbonate
Fluid	Maintenance NG losses Postoperative	Preoperative Intraoperative Postoperative
Anaesthetic Technique	Premedication NG tube suck out Pre-oxygenation Airway Circuit Induction Maintenance Muscle relaxants Reversal of muscle relaxants	Premedication NG tube suck out Pre-oxygenation Airway Circuit Induction Maintenance Muscle relaxants Reversal of muscle relaxants
Analgesia	Local anaesthetic infiltration Paracetamol Opiates NSAIDs	Local anaesthetic infiltration Paracetamol Opiates NSAIDs
Surgical Factors	Operative approach Length of stay Surgical timing	Operative Approach Estimated usual length of stay
Numbers	Number of cases over study period Number of anaesthetists Number of surgeons	Estimated number of cases per year Number of anaesthetists Number of surgeons

Comparison and implementation of guideline

The survey was analysed to identify common aspects of perioperative care. The management of our cases was then compared to the most common national practices identified in the survey. A guideline was published within RCHT in April 2009 (see Appendix 1 for summary) and also circulated to those centres that responded to the survey.

RESULTS

Surveyed centres

Of the 32 centres surveyed, 17 replied (53%). Five of these were District General Hospitals (DGHs) that either never, or very rarely, operated on patients with IHPS and were therefore excluded. 12 provided answers to our questions (37.5%). Of these four were DGHs and eight were tertiary referral regional centres.

Patient demographics

Our audited case patients had a mean gestation of 39.9 weeks and a mean age at presentation of 4.7 weeks. The mean birth weight (BW) was 3.78kg and the mean weight gain from BW to presentation was 0.19kg (range -0.23 to +0.95kg).

There were 12 males and two females.

Biochemistry

In our audit, the mean pre-operative serum bicarbonate concentration was 25.3mmol.L^{-1} and the highest instance was 30mmol.L^{-1}.

Our national survey revealed a range of 26-34mmol.L^{-1} as a prerequisite for anaesthesia, but the mode of 28mmol.L^{-1} was quoted by 50% of respondents (Figure 1).

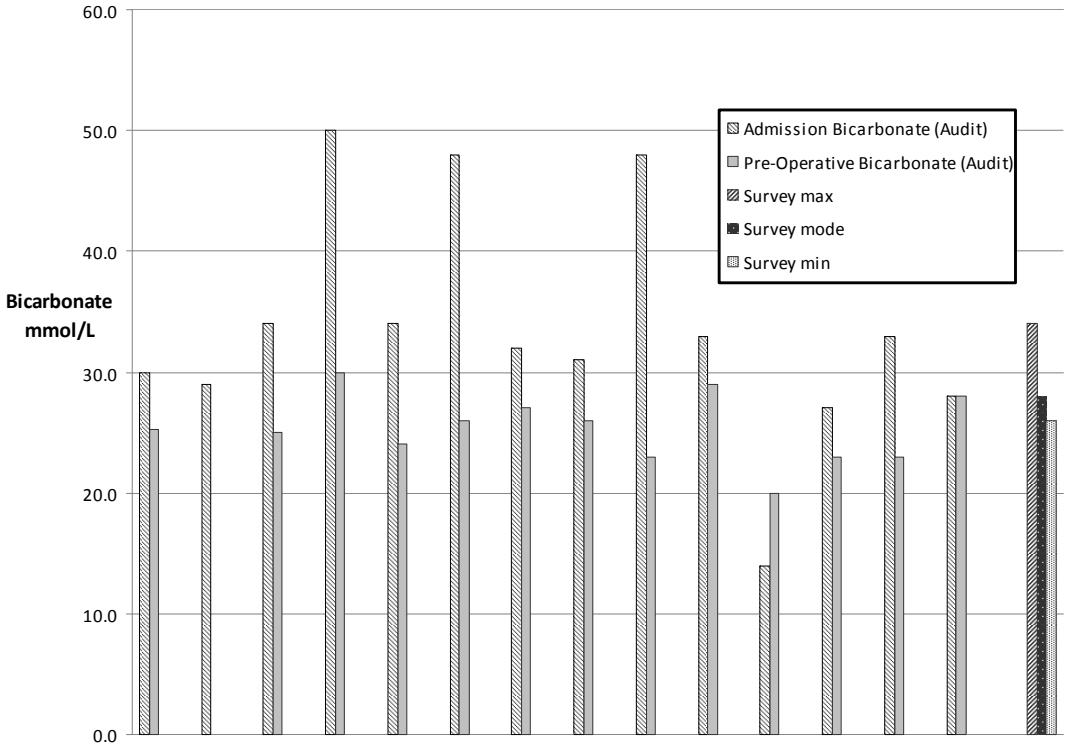

Figure 1. *Admission and pre-operative serum bicarbonate (Audit), with survey minimum, mode and maximum values also shown*

Fluid

In our Trust we used two different maintenance fluid regimes; both consisted of 0.45% saline in 5% glucose with 10mmol potassium chloride added to each 500ml bag. In seven cases this was infused at $100ml.kg^{-1}.day^{-1}$ and in the other seven at $150ml.kg^{-1}.day^{-1}$. Replacement of NG losses with an equal volume of 0.9% saline occurred in 12 cases. There was variability from our survey, but the most common (six centres) fluid used was 0.45% saline in 5% dextrose, with or without additional potassium. All but one centre stated that they continue preoperative or 'maintenance' fluids until tolerating feeds. All of our audited cases were normoglycaemic.

Anaesthetic technique

None of the surveyed centres or our patients received premedication. All of our cases and all centres surveyed used nasogastric tubes (NGTs), all of which were aspirated prior to anaesthesia. In two surveyed centres but none of our audited cases, a 3600 suck-out technique was employed. All of our cases and all but one centre reported performing preoxygenation. Trachea intubation was routine in all cases in our audit and those surveyed. All of our audited cases and 3/12 surveyed centres used an Ayre's T-piece. Of the remaining nine centres, five used a circle system and four used a T-Piece for induction in the anaesthetic room, changing to a circle once in theatre. Both the survey (5/12 inhalational, 5/12 variable) and audit (11/14 inhalational) favoured inhalational inductions. The remaining inductions were either intravenous (IV) or rapid sequence inductions (RSI) (Table 2).

Anaesthesia was maintained with sevoflurane in all of our cases, in addition to nitrous oxide (N_20) in 5/14. Of those surveyed all used volatile, with additional N_20 in 4/12 and remifentanil in 1/12

Table 2. *Methods of induction of anaesthesia*

Induction technique	Our practice (14 cases)	Survey (12 centres)
Inhalational	11 (79%)	5 (42%)
IV	2 (14%)	2 (16%)
RSI / Modified RSI	1 (7%)	0
Variable (Inhalational, IV or RSI)	0	5 (42%)

Table 3. *Technique for maintenance of anaesthesia*

	Our practice (14 cases)	Survey (12 centres)
Sevoflurane	14 (100%)	2 (17%)
Isoflurane	0	1 (8%)
Desflurane	0	1 (8%)
Volatile (not specified)	0	8 (67%)
TIVA	0	1 (8%) (occasionally)
+ Nitrous Oxide	5 (36%)	4 (33%)
+ Remifentanil	0	1 (8%)

centres. One centre reported 'occasionally' using total intravenous anaesthesia (TIVA) (Table 3). Excluding suxamethonium (which was used in all of our RSIs), non-depolarising neuromuscular blockers (NDNBs) were given in all of our cases; 8/14 received atracurium and 6/14 vecuronium. 11/12 centres surveyed used atracurium but one centre did not routinely give NDNBs at all. Regarding reversal

of NDNB with neostigmine and glycopyrrolate, seven centres always, three sometimes and two never did. From our audit, none of our cases appear to have received reversal (Table 4).

Table 4. *Reversal of neuromuscular blockade*

	Our practice (14 cases)	Survey (12 centres)
Atracurium	8 (57%)	11 (92%)
Vecuronium	6 (43%)	0
Reversal	None or N/S	7 (58%) 3 (25%) 'sometimes' 2 (17%) 'not'

Analgesia

All of our cases and those surveyed use local anaesthetic infiltration by the surgeons and paracetamol. Additional analgesic requirements (usually codeine) were minimal, both in our audit and the survey. Only 1/12 centres and 3/14 of our cases reported prescribing non-steroidal anti-inflammatory drugs (NSAIDs) post-operatively. One centre 'sometimes' inserted rectus sheath blocks (Table 5).

Table 5. *Analgesia*

	Our practice (14 cases)	Survey (12 centres)
Paracetamol	14 (100%)	12 (100%)
Codeine	2 (14%)	2 (17%)
NSAIDS	3 (21%)	1 (8%)
Local Anaesthetic Infiltration	14 (100%)	12 (100%)
Rectus Sheath Block		1 (8%)

Surgical factors

All of our audited cases had an OP technique. Of our two surgeons, one performed all umbilical and the other all RUQ. Only two of the centres surveyed used the RUQ approach, both DGHs. The remaining centres (two DGHs and all the regional centres) used either the umbilical approach or a combination of umbilical and LP.

The median post operative stay from our audit was three days, as compared to estimates of 24 - 48 hours from the survey.

After diagnosis the maximum time to surgery in all of our cases was 48 hours, reflecting time for adequate resuscitation. There were three cases with a delayed diagnosis, resulting in four, seven and 12 day delays from presentation to surgery respectively.

Incidence

14 cases of IHPS were identified during the defined study period of 22 months at RCHT, a DGH serving a population of nearly 500 000. This compares to survey means of 22.0 estimated cases per year (range 3-40) for the 4 DGHs and 61.7 (range 50-80) for the regional centres that gave estimates.

Our workload was evenly spread between two consultant surgeons and 5 consultant anaesthetists. This compares with survey means of 2.8 and 5.3 for the four DGHs, and 5.4 and 9.4 for the eight regional centres respectively.

DISCUSSION

Patient demographics

Although a well recognised feature of IHPS is a failure to gain weight, this is not always the case as demonstrated by our figures. The relationship between incidence of IHPS and low birth weight is also unclear, with studies reporting both positive[10] and negative associations.[11]

Biochemistry

Both our audit and survey demonstrated that anaesthetists generally ensure that metabolic alkalosis has normalised before pyloromyotomy, although there is variability in the absolute threshold used. The most frequently quoted figure was a serum bicarbonate of <28mmol.L^{-1} (50% of respondents). This is consistent with the above-mentioned APAGBI guidelines which suggest the following as a prerequisite for anaesthesia: bicarbonate <28mmol.L^{-1}, chloride >100mmol.L^{-1} and BE <+2.9

Fluid

Our audited maintenance rates were evenly split between 100ml.kg^{-1}.day^{-1} and 150ml.kg^{-1}.day^{-1}. The APAGBI guideline, which was published during our audit period, suggests that in the specific case of IHPS maintenance fluids should be given at 1.5 times the normal rate, calculated using the formula as described by Holliday and Segar.[12] Although several of our cases fell into the neonatal category, there is no clear relationship between which regime was followed and post-conceptual age, admission weight, or date of admission.

The constitutions of our intravenous fluid regimes for maintenance (0.45% saline in 5% dextrose) and replacement of NG losses (0.9% saline) were consistent with the APAGBI guideline for infants (>44 weeks post-conception age). No consensus was reached within this document regarding neonates (≤44 weeks post-conception age), although 0.18% saline in 10% dextrose was suggested. Our survey found that the most frequently (6/12 centres) used maintenance fluid was 0.45% saline in 5% dextrose. Only one (a large tertiary referral centre) reported using 0.18% saline. This may be in part due to a National Patient Safety Agency (NPSA) safety alert regarding the use of 0.18% saline in children,13 also published during the study period.

Anaesthetic technique

Premedication was universally not felt to be necessary. Aspirated NGTs were used in all cases, although a 360^0 suck-out technique was infrequently used. There was a broad consensus about pre-oxygenating and all agreed upon tracheal intubation.

All of our audited cases used a T-Piece circuit throughout. This contrasts to the survey, in which most centres reported using a circle, either throughout or after transfer into theatre for maintenence. A recently published postal survey of APAGBI members[14] found that despite improvements to paediatric circle systems the Ayre T-Piece remains popular, but also that the practice of switching to a circle system is gaining in popularity due to its practical advantages.

Analysis of the type of induction for pyloromyotomy reveals interesting changes over time; in the late 1970s inhalational induction was more common than intravenous (IV) (85% and 15% respectively), but by 1984 this trend had completely reversed (15% and 85% respectively).[15] In 1994 another postal survey of APAGBI members[16] found that 60% of anaesthetists use a RSI or modified RSI, but both our survey and audit suggested that inhalational inductions are once again gaining in popularity.

The near universal use of volatile for maintenance of anaesthesia and NDNBs was as expected. Most centres reported the routine use of neostigmine with glycopyrrolate for the reversal of neuromuscular blockade. This does not appear to have been given to any of our audited cases, however this does not mean that reversal was not administered and may represent a failure of documentation.

Analgesia

The use of paracetamol and local anaesthetic infiltration was universal, and analgesic requirements in addition to this were minimal in both our audit and survey. This is consistent with previously published series.[17]

Surgical factors

The commonest approaches from our survey were umbilical OP and LP. LP confers shorter recovery times, but may result in higher complication rates and lower efficacy when compared to OP.[8] Both LP and umbilical OP are associated with a superior cosmetic result when compared with RUQ OP.[18]

After diagnosis, our maximum delay to surgery of 48 hours is reasonable, given the need for pre-operative optimisation in these cases as discussed above. Our median post-operative stay of three days is longer than that from the survey, in which all quoted less than 48 hours as standard. This could however represent aspiration rather than reality, as a survey of anaesthetists is perhaps not the best way to investigate post-operative length of stay.

Incidence

We performed fewer than average when compared to other DGHs (14 in 22 months, versus the survey estimated average of 22 per year), although we were not the least frequent operators in the group. We have a comparable number of consultant surgeons and anesthetists performing pyloromyotomies to the four other DGHs surveyed. This reflects an appropriate concentration of expertise given the fewer numbers performed.

Study limitations

The number of audited cases was relatively small; we are currently undertaking a re-audit of further cases after implementation of the guideline. There are potential problems in comparing the results of a local audit to a survey and then extrapolating to the wider population. The survey is potentially biased; for practical reasons we targeted one representative per department and many of the responses were estimates; there is a tendency to report good more than bad practice; what people report they do is not necessarily what they actually do, or what they document they do. This is highlighted by the example of reversal of NDNBs; in our audit it was not documented for any case, but in the survey most respondents said they use it.

CONCLUSION

Our practice at RCHT demonstrates reasonable concordance with national practice. Despite the trend towards centralizing services, there is a balance between the need to protect capacity for local care in remote areas such as Truro and the need for sufficient exposure to maintain skills, as set out by the Care Quality Commission.[19] There is, as always, a range of anaesthetic practice but the most important factors are probably experience and the use of familiar techniques.

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Competing interests

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