Audit of epidural analgesia in children undergoing thoracotomy for decortication of empyema

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Background. Uncertainty remains over the risk of epidural space infection after neuraxial blockade in the presence of systemic sepsis. For many years, we have provided epidural analgesia to children undergoing thoracotomy for the decortication of parapneumonic empyemas. Following recent publications asserting that epidural analgesia is absolutely contraindicated in this situation, we audited our management. The purpose of this audit was to document the effectiveness and the incidence of complications after epidural insertion in children with active sepsis from empyemas.

Methods. This is a retrospective single-centre audit over a 10-yr period.

Results. Forty-six epidurals were performed in children with empyema, and three children were treated with systemic opioids. We found no infective complications of the epidural space or insertion sites. The epidurals provided excellent analgesia. The incidence of moderate–severe pain was 18%, and 2% for severe pain in the first 24 h after surgery. Minor complications of epidural analgesia were uncommon. Two children receiving systemic opioids for pain relief suffered respiratory complications, one of which resulted in a prolonged admission to the intensive care unit.

Conclusions. Epidural analgesia provides excellent pain relief after thoracotomy in children with empyema, with a low complication rate. Until evidence to the contrary emerges, it remains our technique of choice for thoracotomy, even in the presence of empyema.


Keywords: complications, systemic sepsis; epidural analgesia, neuraxial blockade; pain relief, postoperative analgesia

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Provision of effective postoperative analgesia is an integral part of anaesthetic practice. Regional analgesia by continuous epidural infusion offers benefits over conventional opioid analgesia, particularly for thoracic surgery. However, the potential risk of epidural space infection has cautioned some authors to suggest that epidural analgesia is contraindicated in the presence of systemic sepsis.

The incidence of thoracic empyema in children has increased dramatically over the last decade. Although there is still some debate about the optimum management, there is no doubt that many children still require thoracotomy for decortication. Although these children are invariably receiving i.v. antibiotics at the time of surgery, they are toxic from intrathoracic sepsis. For many years, it has been our practice to offer epidural analgesia to these children undergoing thoracotomy. However, a recent review has suggested that epidural abscesses may be more common than previously thought. Furthermore, our colleagues from Birmingham and others have asserted that epidural analgesia is absolutely contraindicated in the presence of empyema. This led us to question our practice.

The purpose of this audit was to document the effectiveness and the incidence of complications after epidural insertion in children with active sepsis due to parapneumonic empyema.

Methods

Discussion with our local Research Ethics Committee confirmed that an audit of patients to whom we had a duty of care did not require formal ethical review. By definition, an audit is retrospective and uncontrolled.

Patients

We searched the hospital electronic patient administration system (PAS) and our theatre registers over the 10-yr
period from March 1996 to December 2005. We identified 49 children to include in the audit, none of whom was immunosuppressed (Table 1).

**Standards**

There are no published minimum standards for analgesic management specific to thoracotomy in children. However, for us to continue offering this potentially controversial procedure to our patients, we felt that the following conditions should be met.

(1) In a relatively small group, even one major complication should cause serious concern. There must therefore be no central nervous system infections or epidural haematomas in this group.

(2) The frequency of less serious complications should also be low, as it may indicate a level of risk. For example, a high rate of skin infection or accidental catheter dislodgement could suggest improper technique or inadequate vigilance of the insertion site.

(3) Our results must be better than those achievable by other means.

We decided to audit our management against the standards suggested by Dolin and colleagues\(^5\)\(^-\)\(^7\) in their reviews of acute pain management in adults. The authors extracted and averaged the efficacy and side-effects of epidural analgesia, patient-controlled opioids (PCA), and i.m. opioids from published trials involving nearly 20 000 patients. These averages are, of course, not directly applicable to our patients as they come from a mixed group of adult patients undergoing different surgical procedures. We have been unable to find a comparable report focusing on paediatric patients. Furthermore, many of the patients in the reviewed trials had less major procedures than thoracotomy, such as gynaecological and orthopaedic surgery. Achieving these standards for a complex, very painful procedure such as thoracotomy would therefore ‘set the bar high’. Any bias would therefore most probably be due to the standard being too high, rather than too low.

**Results**

Forty-nine children underwent decortication of empyema, 43 of which were provided with epidural analgesia. Three children in this group had epidural analgesia for two procedures. One child presented with bilateral empyema, and underwent two thoracotomies, separated by 2 weeks. A further two children had epidural analgesia for a more conservative thoracic procedure, subsequently followed by thoracotomy with a new epidural. Each of these 46 epidural ‘episodes’ was audited separately.

Three children did not have epidural analgesia and were treated with systemic opioids. The data were missing for three children.

The standard of record keeping was generally good. Children had hourly observations while receiving epidural infusions or systemic opioids. These included pain score, sedation score, and nausea score, on a scale from 0 (none) to 3 (severe).

**Epidural insertion**

Forty-three out of 46 epidurals were inserted by consultant anaesthetists, with the remaining three by specialist registrars (SpRs) in higher specialist training. All three epidurals inserted by SpRs were in patients over 3 yr of age, and none was complicated.

The level of insertion was documented in 44 cases. The majority were from T7 to T9 nerve root level, with 35 catheters. Two were inserted at T6, and six were inserted from T10 to T12. The youngest child in our series (33 days old) had a lumbar epidural catheter threaded upwards.

Complications at insertion were uncommon. There were two cases of a single bloody tap, followed by an uneventful second attempt. One (T11/12) epidural was re-sited at T7/8 in the recovery room, as it was ineffective. These were audited as single epidural episodes, that is, only the last epidural was audited in each case.

Most children had signs of systemic sepsis around the time of insertion: on 31/46 occasions, the child had a fever of greater than 38°C in the 12 h either side of thoracotomy, and in 23/46 a white cell count (WCC) of greater than 14 000 mm\(^{-3}\). Only two children had neither a fever nor a raised WCC. All were receiving broad-spectrum antibiotics around the time of insertion.

**Analgesic regimen and efficacy**

All children had epidural blockade established with either bupivacaine or levobupivacaine. In addition, 15 received epidural ketamine, and 18 received epidural fentanyl. No child had systemic morphine intraoperatively or in the recovery room.
The epidural maintenance regime reflects the change in our local protocols over the last 10 yr: before 1999, a variety of combinations of bupivacaine and fentanyl were used. Since then, all children have received an infusion of bupivacaine 0.1% with fentanyl 2 μg ml⁻¹. One child had this substituted for plain bupivacaine 0.15% to treat troublesome itching.

During the first 24 h after surgery, seven children experienced an episode of moderate pain, and one child experienced severe pain. Four children received a bolus down the epidural, which was effective in all cases. Two catheters were manipulated to treat unilateral block.

The incidence of moderate–severe pain in our patients was 18%, and 2% for severe pain. These are lower than the suggested standards of 20.9 and 7.8%. The results are also much better than the standards set for PCA, of 35.8% moderate–severe and 10.4% severe pain (Table 2).

Duration and catheter dislodgement

Our patients received epidural analgesia for a mean of 3 days, with five children receiving it for 4 days and one for 5 days. One child had the epidural removed on the first postoperative day, and two catheters became dislodged accidentally. This gives a catheter dislodgement rate of 4.7%, again less than the suggested standard.

Nausea, vomiting, and return to feeding

Three children receiving epidurals (3/43, 7%) experienced an episode of severe nausea, or vomited. Dolin and colleagues found the average incidence of emesis for all analgesic techniques to be 20.2%, and substantially higher with PCA, even when anti-emetics were routine. Our low nausea rates translated into a rapid return to feeding: 34 of 43 children on epidurals were eating solid food within 24 h of thoracotomy.

Other side-effects

Pruritis was troublesome in five cases, with four responding to oral chlorpheniramine. One child had her epidural prescription changed to an opioid-free solution. One child developed a Horner’s syndrome, which resolved once the epidural was removed.

Major morbidity from epidural analgesia

No child had an epidural catheter removed because of a suspicion of infection or haematoma. No child developed worrying neurological signs while in hospital.

Records of follow-up out-patient attendance at a chest clinic existed for 39 of the children who had epidurals inserted, at between 13 days and 3 yr after discharge. No neurological problems were recorded in these clinic notes. Our hospital provides the only referral centre for paediatric neurosurgery in the region. We also queried our hospital PAS against the original list of 49 children. None of these had a spinal neurosurgical procedure performed. The likelihood of a missed epidural space infection in one of the four children who did not attend follow-up is therefore low, since it would require both a late onset of symptoms (after discharge) and for the child to be treated outside our region.

Discussion

Poor analgesia after thoracotomy can lead to impaired coughing, reduced clearance of secretions, and respiratory failure. This is associated with a prolonged ITU stay and delay in discharge from hospital.

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Table 2: Analgesic management and outcomes.

<table>
<thead>
<tr>
<th>Analgesic technique</th>
<th>Number</th>
<th>Incidence (%)</th>
<th>Suggested standard (%)</th>
</tr>
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<tbody>
<tr>
<td>No epidural</td>
<td>3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>One epidural</td>
<td>40</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Two epidurals</td>
<td>3</td>
<td></td>
<td>30</td>
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<tr>
<td>Epidural inserted by Consultant</td>
<td>43</td>
<td>93</td>
<td>50</td>
</tr>
<tr>
<td>Sign of systemic sepsis</td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Local anaesthetic (bupivacaine/levobupivacaine) only</td>
<td>13</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Local anaesthetic + ketamine</td>
<td>15</td>
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<td>30</td>
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<td>Local anaesthetic + fentanyl</td>
<td>18</td>
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<tr>
<td>Postoperative</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Bupivacaine 0.1% + fentanyl 2 μg ml⁻¹</td>
<td>32</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Other bupivacaine/fentanyl combination</td>
<td>12</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Insertion complications</td>
<td></td>
<td></td>
<td>20</td>
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<tr>
<td>Bloody tap</td>
<td>2</td>
<td>4</td>
<td>50</td>
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<tr>
<td>Re-site: ineffective</td>
<td>1</td>
<td>2</td>
<td>20</td>
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<tr>
<td>Efficacy and interventions</td>
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<tr>
<td>Moderate–severe pain in first 24 h</td>
<td>7</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>Catheter manipulations (unilateral block)</td>
<td>2</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>Unintentional dislodgement</td>
<td>2</td>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>Nausea and vomiting</td>
<td>3</td>
<td>7</td>
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</tr>
<tr>
<td>Pruritis</td>
<td>5</td>
<td></td>
<td>20</td>
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<tr>
<td>Duration of epidural analgesia &lt;3 days</td>
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<td>3 days</td>
<td>32</td>
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<tr>
<td>4–5 days</td>
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Epidural analgesia in children undergoing thoracotomy

Children with empyema presenting for thoracotomy pose a complex analgesic problem. They will undergo a painful procedure that typically involves an incision over 3–6 dermatomes, muscle damage, and stripping out of the densely innervated parietal pleura. As thoracotomy is usually reserved for children with empyemas not responding to antibiotics and tube thoracotomy, they have generally been seriously ill for some time. As a consequence, they are at risk of major perioperative morbidity. A variety of analgesic strategies are possible to control post-thoracotomy pain in children, including patient- or nurse-controlled opioids, opioid infusions, paravertebral blocks, and neuraxial blockade.

Epidural analgesia has many advantages over opioid-based pain relief: reduced respiratory depression, improved coughing, less nausea and vomiting, and earlier return of bowel function. For these reasons, i.v. opioid analgesia is not the technique of choice for pain relief after thoracotomy in children.1

Paravertebral blockade has been shown to be superior to epidural analgesia for thoracotomy in adults.9 However, paravertebral blockade in the presence of empyema is problematic. The parietal pleura, which forms the anterior boundary of the paravertebral space, is stripped out at surgery. A paravertebral catheter would therefore lie directly in the infected cavity and, by definition, be colonized from the time of insertion. More importantly, pleurectomy at the time of decortication would preclude maintenance of the paravertebral block in the postoperative period.

Epidural abscess is a rare complication of epidural anaesthesia. A review of published series16 of epidurals in children found no epidural abscesses in 3397 patients. Other published results vary widely, but it is noteworthy that case series with a high (>1:1000) incidence have all been triggered by a local ‘cluster’ of cases, whereas prospective work has shown a lower incidence.3

Reihnsaus and colleagues11 have conducted an extensive literature analysis on spinal epidural abscess in adults, including those associated with neuraxial blockade. Risk factors include diabetes mellitus, drug and alcohol abuse, a distant source of infection, advanced age, compromised immunity, and spinal column disruption. Neuraxial anaesthesia or analgesia was associated with 5% of the epidural abscesses in this review. The literature on epidural abscesses in children is more limited. Auletta and John12 found that epidural abscesses in children were different from those in adults in a number of ways. The abscesses were less commonly associated with underlying disease and had better final outcomes (in terms of both mortality and neurological function) than abscesses in adults, despite generally being more extensive at diagnosis.

Epidural catheters may act as a focus of infection, either after spread from the insertion site or via the bloodstream. However, the majority of epidural abscesses that follow a distant infection are unrelated to spinal instrumentation.11 Catheter colonization also appears unrelated to overt infection: microbiological examination of 502 epidural catheters revealed 5.8% to be colonized at removal, with no instances of epidural abscess formation.13 Seventy-six per cent of these catheters were colonized by skin flora. Other authors have demonstrated catheter colonization rates of up to 22% in adults, and 32% in children, without abscess formation.14 15 The majority of local infections and catheter colonizations in critically ill patients are caused by skin flora.16

The above reports all suggest that the most important controllable factor in the prevention of catheter-related epidural abscesses is the sterility of the site and equipment. Meticulous aseptic technique can certainly make a difference: after experiencing a ‘cluster’ of epidural abscesses over 9 months, Jeffreys and colleagues17 made changes to their insertion technique. They have seen no further such complications in 4 yr. Gosavi and colleagues18 reported a similar experience.

Although neuraxial blockade is theoretically more risky in a patient with systemic infection, it seems likely that the magnitude of the increase in risk is small, and that it is less important than the insertion technique and breaks in the equipment as a risk factor. The children in our audit had their epidural analgesia established by experienced anaesthetists. Inserting the epidural at a dermatomal level approximating the site of surgery meant that very few catheters had to be manipulated, and few boluses were administered, so preserving a sterile infusion system in most cases.

Our experience has been that epidural analgesia in children with apparently normal immunity, established and managed by a specialist team, provides superb analgesia with few side-effects or complications. This analgesia enables seriously ill children to mobilize rapidly after decortication, decreasing their risk of respiratory complications. In our audit group, we have found no infections of either the epidural space or the insertion site.

Conclusions
This was an audit of practice in an area where the evidence base is sparse (and likely to remain so). An audit requires comparison with a published standard. We were unable to find paediatric data for comparison and therefore chose a recent comprehensive adult study.

Designing and implementing an ethical randomized controlled trial focusing on a rare complication of anaesthesia, for a relatively uncommon operation, would present great difficulty and would involve recruiting a large number of children. A more limited study, aimed only at defining the risk of epidural abscess formation, would also need to be large. Such a study would have to recruit at least 3000 children if it were to establish an ‘acceptable’ risk of less than 0.1%.16 Data from audits in other centres.
are needed to shed more light on the question of how best to manage postoperative pain in this group of complex patients. The ongoing Third National Anaesthesia Audit\textsuperscript{20} may also provide valuable insights.

At present, our view remains that epidural analgesia is not absolutely contraindicated solely because of the presence of thoracic sepsis. Moreover, we suggest that the quality of analgesia from a well-managed epidural makes this the technique of choice in children for thoracotomy in the presence of empyema.

References
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