The nurse needs to be able to monitor patients for adverse effects, and to report and respond to any abnormal findings in a timely manner.

**Epidural space**

Many textbooks provide complicated diagrams of the epidural space that can be difficult to interpret. In its simplest form, the spinal cord can be likened to a sausage with three skins or membranes called meninges. The epidural space lies between the outer membrane and the bony surround of the vertebrae.

The first membrane closest to the cord is called the pia mater, which means ‘soft mother’ in Greek. The second membrane is called the arachnoid mater, because of its cobweb-like appearance. The third membrane is known as the dura mater, which means ‘hard mother’ in Greek. The epidural space, which lies outside the dura, is a potential space, containing blood vessels, nerve roots, fat and connective tissue. Nerves, which enter and exit the spinal cord, travel through the epidural space. These nerves conduct impulses to the muscles for movement; relay information about sensations, including pain, temperature and touch; and send information via the sympathetic nervous system. The epidural space extends from the base of the skull to the sacrum, but the spinal cord stops at the level of the second lumbar vertebrae (Macintyre and Schug 2007).

Epidural catheters are usually inserted in theatre by an anaesthetist. A needle is inserted between the spinous processes of the vertebrae; patients are usually asked to bend forward to curve their spine to aid insertion. The needle is inserted until it reaches the hard ligamentum flavum and is then advanced carefully until the air or saline in the syringe attached to the needle can easily be inserted. This loss of resistance indicates
that the needle has entered the epidural space. A catheter is then threaded through the needle and secured in place to allow for either a continuous infusion or for repeat bolus injections to be administered. It is important that the needle is not inserted too far, puncturing the dura or the arachnoid mater, as the medication would enter directly into the cerebrospinal fluid (CSF). It is the anaesthetist’s responsibility to administer a test dose to ensure that the catheter is in the correct position (Parizkova and George 2009).

**Indications and contraindications**

The most common use of epidural analgesia is after surgery, usually following major thoracic or abdominal operations. It is frequently used for vascular surgery, as epidural analgesia has the added effect of dilating arteries, which helps to maintain the patency of new arterial grafts. It is often used during lower limb surgery, especially amputations.

Epidural analgesia is used commonly during childbirth. It can also be used for cancer patients in the end stages of life, where epidural catheters may be left in situ for weeks. There is a risk of developing an epidural abscess, but this risk is outweighed by the benefits of being pain free in the final weeks of life (Ruppen et al 2007). Circumstances where epidural analgesia should not be used are outlined in Table 1.

When an epidural catheter is inserted or removed, it is important that the patient’s clotting is normal. Patients can be anticoagulated while the epidural remains in situ. During insertion the anaesthetist may damage a blood vessel in the epidural space. If the patient’s clotting is normal this will not present a problem. However, if the patient is anticoagulated then the vessel may bleed profusely. The epidural space is encased by bone and will be compressed when the haematoma starts to expand vital structures, such as the spinal cord. Cord compression results in paraplegia if the clot is not removed.

When the epidural catheter is removed it is vital that the patient’s clotting is normal. If the anaesthetist has damaged a blood vessel on insertion, the catheter may be attached to the clot that has formed. On removal, the clot may be dislodged and the patient may bleed (Mitchell 2009).

Local policies may vary when it is deemed safe to remove the epidural catheter. Generally, catheters can be removed four hours after the administration of twice daily subcutaneous heparin and 12 hours after low molecular weight heparin, which is given daily. Patients receiving intravenous heparin must have had their infusion stopped for four hours and bloods should be taken to check their coagulation status. All patients who have been receiving heparin, by any route, for longer than four days must have their platelet levels checked before catheter removal (Macintyre et al 2010).

If a patient has an infection there is a risk that the infection could pass into the epidural space. Infection can enter the space from infected skin on insertion, therefore patients with infective skin conditions or pressure ulcers are not considered for this therapy. Patients who have systemic infection are considered ‘high risk’. If a blood vessel is damaged during insertion, this deposits infected blood into the epidural space and an abscess can form. A growing epidural abscess will compress the spinal cord and lead to paraplegia (Parizkova and George 2009).

Radiotherapy can damage the epidural space and even when catheters can be inserted, the local anaesthetic does not flow easily in the space. The block can be patchy, meaning that instead of a dense sensory block, there may be patches of skin where the patient feels some sensations, including pain.

**Advantages of an epidural infusion**

Epidural blockade can reduce the adverse responses to surgery, which are produced through activation of the sympathetic nervous system, such as stress on the cardiovascular system. Patients receiving epidural blockade have been found to have one third fewer myocardial infarctions than patients receiving conventional analgesia (Rodgers et al 2000). Improvement in pulmonary function and reduced risk of deep venous thrombosis, pulmonary embolism and pneumonia, have also been reported (Rodgers et al 2000).

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**TABLE 1**

<table>
<thead>
<tr>
<th>Circumstance</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clotting abnormalities</td>
<td>Increased risk of epidural haematoma</td>
</tr>
<tr>
<td>Infection</td>
<td>Increased risk of epidural abscess</td>
</tr>
<tr>
<td>Spinal deformity</td>
<td>Difficulty inserting the catheter</td>
</tr>
<tr>
<td>Previous radiotherapy to spine</td>
<td>Difficulty inserting the catheter</td>
</tr>
<tr>
<td>Raised intracranial pressure</td>
<td>Risk of entering the subarachnoid space</td>
</tr>
<tr>
<td>Uncorrected hypovolaemia</td>
<td>Risk of hypotension</td>
</tr>
<tr>
<td>Untrained staff</td>
<td>Risk that complications will not be recognised</td>
</tr>
<tr>
<td>Patient refusal</td>
<td>Patient must consent to therapy</td>
</tr>
</tbody>
</table>

(Adapted from Deschner et al 2007)
Requirements for effective analgesia

There are three requirements that need to be fulfilled for an epidural infusion to be effective, which are:

- Correct placement of the epidural catheter.
- A large enough volume of local anaesthetic to numb the area around the wound and drain sites.
- Use of appropriate medications.

Catheter placement

Spinal nerves enter and exit the cord at each vertebral level. As mentioned previously, these nerves convey information to the muscles and the sympathetic nervous system; they also send sensory information to the spinal cord. Each sensory spinal nerve supplies a specific skin segment called a dermatome. After surgery, it is important to block sensory information coming from all of the dermatomes that the skin incision crosses. Therefore the epidural catheter is placed at a level that corresponds with the middle dermatome of the incision (Sugden and Cox 2006). For example, a laparotomy wound may start at the thoracic (T7) dermatome and extend down to T11 or T12. The mid-point, T8, would be the optimum site to insert the catheter. If catheters are placed too low, then painful sensations from the wound will not be blocked.

Volume of local anaesthetic

The rate of the epidural infusion determines the spread of fluid within the epidural space. As the local anaesthetic spreads up and down, away from the catheter entry site, it will bathe sensory nerves roots as they pass through the epidural space and block pain signals (Dougherty and Lister 2004). The higher the rate, the bigger the spread; therefore more of the wound site will be pain free. If patients complain of pain at the top or bottom of the wound, it is an indication that the rate of infusion needs to be increased.

Appropriate medications

Two main classes of drugs are used for epidural infusions: opioids and local anaesthetics. The most commonly used opioids are fentanyl and diamorphine. Opioids work by attaching to receptors in the dorsal horn of the spinal cord, preventing pain signals from being transmitted to the brain, where they are perceived as a conscious experience. When opioids are given orally, they have to be absorbed by the stomach into the circulatory system. Much of the opioid is lost and excreted before it reaches its target (Cox 2010). With an epidural infusion, the opioid is deposited in the epidural space and it diffuses across the membranes to the dorsal horn of the spinal cord. Because no opioid is lost, much smaller doses can be administered. As opioid side effects are dose related, patients experience fewer adverse effects when opioids are given by this route, with the exception of pruritus (Dolin and Cashman 2005). Drugs such as fentanyl are lipid (fat) soluble. As the membranes of the spinal cord contain fat, fentanyl works much faster than diamorphine (Dougherty and Lister 2004). It is important to understand that even when the epidural infusion has been discontinued, there may be 12 hours of opioid waiting to be absorbed in the spinal tissues. Therefore patients can be at risk of opioid-related side effects for many hours after discontinuation (Macintyre and Schug 2007). Side effects may include respiratory depression, sedation, nausea and vomiting, pruritus, hallucinations and vivid dreams.

Respiratory depression is defined as a respiratory rate of fewer than eight or ten breaths per minute (Cashman and Dolin 2004). Sedation is normally a precursor to respiratory depression, so action should be taken at this point if the patient cannot be roused. The epidural infusion should be stopped and emergency assistance should be summoned. If possible, the patient should be sat upright to assist breathing. Oxygen should be applied and the patient encouraged to take deep breaths. Naloxone can be given to reverse the effects of the opioid, but care should be taken to give only enough naloxone to reverse respiratory depression, but not pain relief. This can be achieved by diluting naloxone and only giving 50mcg at a time. Naloxone will wear off after 60 minutes and therefore a naloxone infusion may be required (Macintyre and Schug 2007). If the patient is not breathing then basic life support should be commenced.

Nausea and vomiting are common side effects of opioids and anti-emetics should be administered as required (Dougherty and Lister 2004). Pruritus can also be distressing for patients. Treatments include the use of antihistamines (Dougherty and Lister 2004). Hallucinations and nightmares are more common when opioids are given by other routes, as the opioid dose used is higher than in epidural infusions. If the patient is troubled by adverse effects, the only alternative is to remove the opioid from the infusion and use local anaesthetics.

Constipation is usually a problem for patients taking opioids, but less so when given epidurally. The local anaesthetic has the effect of blocking sympathetic nerves to the gut (Macintyre et al 2010). This allows the parasympathetic nerves to stimulate the gut and increase peristalsis. Occasionally a patient may experience profuse diarrhoea.

The most commonly used local anaesthetics are bupivacaine, levobupivacaine and ropivacaine (Dougherty and Lister 2004, Macintyre and Schug 2007). Local anaesthetics work by blocking the sodium channels in the nerve, thereby preventing the generation and
conduction of impulses, which either slows or stops pain transmission (Scott 2009). Side effects of local anaesthetics include hypotension, bradycardia, motor block and urinary retention (Dougherty and Lister 2004).

Hypotension This is common and is caused by blocking of the sympathetic nerves, which causes vasodilatation of the peripheral arteries (Dougherty and Lister 2004). Sympathetic nerves act either to constrict or dilate the arteries to maintain blood pressure. When these nerves are blocked by local anaesthetic, the body loses this ability to compensate. Therefore, blood pressure can drop quickly in a patient who becomes dehydrated. The treatment is to replace circulating volume with intravenous fluid (Dougherty and Lister 2004, Macintyre and Schug 2007). The epidural infusion rate should not be decreased, as this will cause the patient to experience pain, though it may be stopped temporarily. Under no circumstances should patients be positioned with their head lower than their feet, to treat hypotension. This will cause the epidural fluid to travel into the cervical region where it can prevent the functioning of the vital centres. It is important to remember that a sudden drop in blood pressure post-operatively may be the result of haemorrhage. The medical team should be called to assess the patient.

Bradycardia If the local anaesthetic travels above the level of T4 (mid-nipple line), it can affect the sympathetic nervous system to the heart, which produces a bradycardia and may lower the patient’s blood pressure. In these circumstances, patients need to be sat upright to encourage the epidural fluid to fall with gravity. The rate of the epidural infusion will also need to be reduced.

Motor block Local anaesthetics can affect sensory, sympathetic and motor nerves. However, they affect small bore nerves first, thereby blocking sensory and sympathetic nerves in preference to the larger bore motor nerves. If higher concentrations or if higher volumes are used, motor nerves may be affected. Motor block produces a paralysis of the lower limbs which is distressing for the patient. The treatment is to reduce the rate of the infusion (Dougherty and Lister 2004, Macintyre and Schug 2007). Often a reduction of 0.5-1ml can reduce the motor block, but still maintain the sensory block.

It is common for patients to experience a motor block in the first few hours after surgery, as stronger concentrations of local anaesthetic are given routinely in theatre. The motor block should resolve within a few hours. If the motor block is not resolving, it could be a sign of cord compression or cord damage (Macintyre and Schug 2007). Following a recent audit, the Royal College of Anaesthetists (2009) produced an algorithm that nurses can follow to detect major complications such as abscess, haematoma or cord damage.

Urinary retention Local anaesthetic can also affect the nerve supply to the bladder, causing the patient to retain urine. This is more common when the epidural catheter is placed in the lumbar region. Most patients will return from surgery with a urinary catheter, but if they are not catheterised and have not passed urine within six hours of surgery, the medical team should be contacted.

Some patients have fibrous bands within the epidural space, which prevent an even spread of the infusate (Macintyre and Schug 2007). This can produce a patchy block, which is difficult to treat, as it is an anatomical anomaly. Simple analgesia, such as paracetamol and non-steroidal anti-inflammatory drugs can be used to enhance the block (Parizkova and George 2009).

Patients may experience pain relief only on one side; this is known as a unilateral block. The tip of the epidural catheter can get lodged on one side of the epidural space during insertion and preferentially bathe the nerve roots on that side (Macintyre and Schug 2007). This is more common if the anaesthetist has threaded too much of the epidural catheter into the epidural space.

The catheter can be pulled back carefully, to try to correct this, but this should not be attempted if the patient is anticoagulated (Macintyre and Schug 2007). Any correction of catheter placement is usually undertaken by the anaesthetist or staff from the pain service. Patients can be encouraged to lie on the unblocked side to enable better circulation of the infusate.

If the epidural is producing no discernable block, then the anaesthetist or pain service staff should be called to reassess the patient. If the catheter has become dislodged, then a new epidural catheter may need to be inserted. If there is a delay in inserting a new epidural catheter, then other forms of analgesia should be considered and administered.

Major complications of epidural therapy

There are a few major complications of epidural therapy, as shown in Table 2, but these are rare. As mentioned previously, epidural haematoma can occur during insertion or removal of the epidural catheter, but also if the catheter falls out inadvertently. It is essential to have normal clothing to prevent haematoma formation following these events. The signs and symptoms of epidural haematoma include increasing sensory and motor block from below the level of the epidural insertion site and possible loss of sphincter control. If a haematoma is suspected the on-call anaesthetist...
should be contacted immediately. It is a medical emergency and prompt action must be taken to prevent irreversible damage to the spinal cord, which results in paralysis. The anaesthetist will arrange an emergency magnetic resonance imaging (MRI) scan and the haematoma may need to be surgically removed.

An epidural abscess takes time to develop. Patients are more at risk the longer the epidural catheter remains in situ. The abscess takes time to grow and press on the spinal cord, so some patients may present with symptoms days after the catheter has been removed. The signs and symptoms are similar to those of an epidural haematoma, but in addition these patients are unwell and will have a raised temperature and white cell count. The treatment is the same; the patient needs an urgent MRI scan and surgery to remove the abscess.

Anaesthetic toxicity is a potentially fatal complication. It can occur when high volumes and high concentrations of local anaesthetic are administered to the patient over a prolonged period. It can also occur when an epidural infusion is inadvertently connected to an intravenous line. It is difficult to find an estimate of the incidence of anaesthetic toxicity. A survey of safe practice with intravenous colloids (to increase circulating volume) and a vasoconstrictor such as ephedrine (to raise blood pressure).

TABLE 2

<table>
<thead>
<tr>
<th>Complication</th>
<th>Incidence</th>
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<tbody>
<tr>
<td>Epidural haematoma</td>
<td>One in 12,000 patients (Macintyre et al 2010).</td>
</tr>
<tr>
<td>Epidural abscess</td>
<td>One in 145,000 patients (Macintyre et al 2010).</td>
</tr>
<tr>
<td>Catheter migration</td>
<td>Two in 707,425 patients (Royal College of Anaesthetists 2009).</td>
</tr>
<tr>
<td>Spinal cord damage</td>
<td>One in 5800 patients to one in 12,200 patients (Macintyre et al 2010).</td>
</tr>
</tbody>
</table>

Nursing care

Ideally, epidural analgesia should be a planned event. There are many factors to consider before accepting a patient back to the ward environment. There should be at least one registered nurse on each shift, who is trained and competent in caring for these patients (Royal College of Anaesthetists 2004). It is ideal if these patients can be nursed in an area where they can be easily observed for the first 24 hours, so that any deterioration in the patient’s condition can be detected immediately.

Patients must have patent intravenous access, in case emergency drugs need to be administered. Emergency equipment and medications should be readily available and these should include naloxone (for respiratory depression), intravenous colloids (to increase circulating volume) and a vasoconstrictor such as ephedrine (to raise blood pressure).

Patient assessment Most centres will have specific epidural assessment charts to record observations. Observations will include an assessment of pain, sedation, nausea, blood pressure, temperature, heart rate, the level of the sensory block, use of the Bromage scale measurement to measure motor function and the Bromage scale measurement to measure motor function, which do not circulate in the CSF. Once migration occurs the epidural infusion produces an effect similar to increasing the rate tenfold. The signs would include a rapidly rising sensory and motor block, which will cause bradycardia, respiratory distress, unconsciousness and finally cardiac arrest (Deschner et al 2007). As with anaesthetic toxicity, it is the nurse’s responsibility to summon emergency help and maintain airway, breathing and circulation.

Epidural insertion carries a small risk of damage to important underlying structures, as the anaesthetist may insert the needle too far and damage the spinal cord. Patients may present with a motor deficit, such as being unable to move one leg, which may be unilateral. Any unresolved motor deficit should be reported to the medical team.
block (Royal College of Anaesthetists 2009), the rate of the epidural infusion and regular inspection of pressure areas. As patients can have altered sensation in their sacrum and other pressure areas, they can be completely unaware that they are developing a problem.

Nurses should check their local policy and procedures to ascertain the frequency of observations. The epidural catheter site should be checked regularly to ensure that the catheter is securely fastened and there is no leakage, catheter dislodgement or local infection (Daykin and Cox 2003). Some centres will ask the nursing staff to assess the level of the sensory block to ensure that the wound area is numb and that the spread of the local anaesthetic has not risen above the level of the nipples (T4). As mentioned previously, this can cause bradycardia and hypotension.

Epidural catheters and infusions must be labelled and easily distinguished from other infusions by the use of yellow labels and giving sets. The bags of infusate should be stored separately from intravenous infusions and should be commercially prepared (NPSA 2007).

Stopping epidural infusions

Epidural infusions for pain relief are ideally continued for two to five days, depending on the type of surgery. By this point, the patient should be able to take oral preparations and the pain should have diminished to the extent that it can be easily managed with weak opioid analgesics.

Epidural catheters can only be removed when the patient’s clotting screen is normal and reference should be made to the times intervals stated earlier, to reduce the risk of epidural haematoma. Care should be taken when the catheter is removed to ensure that the tip of the catheter is intact and nothing has been left in the epidural space. Epidural observations should continue for 24 hours after the infusions has been stopped (Macintyre and Schug 2007).

Conclusion

Epidural analgesia is viewed as the ‘gold standard’ method of managing pain and can provide total pain relief for patients. There are some rare, but possibly fatal consequences of this form of therapy, and the nurse’s role is to monitor patients carefully and report any untoward events immediately NS

Acknowledgement

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