BJA Education, 20(3): 96–102 (2020)

doi: 10.1016/j.bjae.2019.11.006
Advance Access Publication Date: 27 January 2020

Neuraxial analgesia for labour

B. Shatil[1] and R. Smiley[2,*]

[1]Emory University, Atlanta, GA, USA and [2]Columbia University Medical Center, New York, NY, USA

*Corresponding author: rms7@cumc.columbia.edu

Learning objectives

By reading this article, you should be able to:

- Explain the advantages and disadvantages of various techniques for analgesia during labour.
- Select the most appropriate method for an individual patient from epidural, combined spinal–epidural, 'dural puncture epidural' and spinal analgesia procedures.
- Identify suitable drug combinations for analgesia for labour.
- Discuss several potential non-analgesic benefits of analgesia for labour.

Key points

- Contemporary analgesia for labour includes epidural, spinal, combined spinal–epidural (CSE) and 'dural puncture epidural' (DPE) techniques.
- Neuraxial labour analgesia is best performed with low concentrations of local anaesthetic agents and low-dose opioids.
- Labour analgesia upon request, rather than at a specific degree of cervical dilation, incurs no increased risk of Caesarean delivery.
- CSE and DPE techniques involve objective confirmation of needle placement by obtaining CSF. This typically results in more reliable analgesia
- Programmed intermittent epidural bolus (PIEB) administration, rather than continuous infusion, may result in better spread of drug and extent of analgesia.

Neuraxial analgesia for labour has become commonplace in developed countries. The increase over the past three to four decades has been driven by increasing attention to the care of women, by the availability of anaesthesia personnel in labour and delivery suites, and by significant improvements in the methods of analgesia available. However, even among developed countries, there are major differences in the percentage of women receiving neuraxial analgesia stemming from antiquated beliefs about obstetric analgesia, local customs and structure of medical practice and specifics of historical development. In the USA, epidural analgesia is used by about 65% of women, whereas in the UK it is about 33% prevalent and in Japan only about 5%. Even countries as geographically close and economically and culturally similar as Belgium (74% prevalence) and The Netherlands (5–38% prevalence with many home deliveries) may differ widely.

The purpose of this article is to present a review of contemporary labour analgesic techniques and practices. Commonly, all neuraxial analgesia procedures are referred to as 'epidurals,' although the word epidural is an adjective (e.g. 'epidural space,' 'epidural anaesthesia'), not a noun. In this review, the procedures discussed will be specified as spinal, epidural, dural puncture epidural (DPE), or combined spinal–epidural (CSE) techniques.

Richard Smiley *MD PhD is professor of anaesthesiology at Columbia University Medical Center and attending anaesthesiologist at the New York Presbyterian Hospital in New York. He was chief of the division of Obstetric Anaesthesia at Columbia from 1994 to 2018, and chair of the research committee of the Society for Obstetric Anesthesia and Perinatology from 2007 to 2017. His major research interests have included adrenergic receptor regulation in the perioperative period and during pregnancy, genetics and pharmacogenetics of pregnancy and anaesthesia and analgesia for labour and after Caesarean section.*

Ben Shatil *DO MPH completed a fellowship in obstetric anaesthesiology in 2019 at Columbia University and is now assistant professor of anaesthesiology at Emory University in Atlanta.*

Accepted: 18 November 2019

Anatomy of labour pain and analgesia

Labour is painful for almost all women. In the first stage of labour, uterine contraction and (probably more importantly) cervical dilation result in neural signalling via the cervical plexus that travels with the sympathetic chain, entering the spinal cord at T10–L1. This typically translates into severe, poorly localised visceral pain, which is treated with lumbar epidural local anaesthetic agents combined with low-dose opioids, as neuraxial opioids are effective for visceral pain. This understanding was one of the major advances in neuraxial analgesia in the 1990s, when the addition of fentanyl or sufentanil to local anaesthetic agents augmented epidural analgesia, allowing significant decreases (30–50% less) in the required dose of local anaesthetic, and superior analgesia with less motor and sensory blockade. Similarly, administration of intrathecal opioids, with or without local anaesthetics, was found to be effective for first-stage analgesia.

In the second stage, once cervical dilation is complete and the fetal head descends, much of the pain shifts to more somatic pain from vaginal and perineal stretching and actual tissue damage, transmitted via the pudendal nerve and entering the spinal cord at S2–S4. This pain frequently requires more local anaesthetic for successful relief, and depends on caudal spread of local anaesthetic from the lumbar epidural catheter. However, the dermatomal effects of epidural analgesia may be affected by the level of catheter placement, and caudal spread does not always occur, or takes a prolonged period of time, accounting for sometimes ineffective second stage analgesia. Subarachnoid administration of medication provides a more reliable sacral block, leading some practitioners to a strong preference for spinal or CSE procedures in women receiving analgesia late in labour.

Techniques and protocols

Neuraxial anaesthesia technique

Currently, four different neuraxial techniques for labour analgesia: epidural, CSE, spinal (single shot or continuous via catheter) and DPE techniques are defined. Classic epidural analgesia involves placement of a catheter in the epidural space with administration of an initial bolus dose followed by an infusion of a local anaesthetic agent with an opioid. In many institutions, the infusion is supplemented by patient-administered doses, which can improve analgesia and patient satisfaction, while decreasing the need for physician intervention.

The use of spinal analgesia is limited because of the fixed duration of a single-shot technique, and by the high risk of headache when a large-bore needle is used to place a catheter in the subarachnoid space. When a woman appears close to delivery, a single injection of local anaesthetic (e.g., bupivacaine or ropivacaine 2–4 mg) with opioid (fentanyl 10–15 μg or sufentanil 1–4 μg) using a 25 or 27 gauge (G) pencil-point spinal needle can provide analgesia for 1–2 h.

There are several significant advantages of CSE analgesia, and it is the predominant form of analgesia in our practice at Columbia University. In most studies, CSE has been shown to provide more rapid, more reliable and more effective analgesia than epidural analgesia, as a result of several factors (Table 1). Theoretically, the dural hole may allow some direct transport/entry of medication from the epidural space into the intrathecal space, providing a denser block, although this is more pronounced with a 25 G than a 27 G needle. In a randomised study, patients receiving CSE had mean pain scores of 1.4 compared with 1.9 in those receiving epidural analgesia ($P<0.001$), and perhaps more significantly, required less supplemental intrapartum dosing.[1] A study from an academic teaching hospital demonstrated lower pain scores at 30 min with CSE compared with epidural analgesia.[2] Furthermore, obtaining CSF via the spinal needle placed through the epidural needle provides anatomical confirmation of epidural placement, decreasing the incidence of incorrect catheter placement, with some evidence of a decreased incidence of unilateral blocks. In teaching institutions, obtaining CSF via the spinal needle provides the supervisor objective evidence that the loss of resistance (LOR) obtained by the trainee actually results from entry into the epidural space. Similarly, the spinal needle confirmation can be particularly helpful when performing procedures that are technically difficult and where false LOR is more common, such as in patients who are obese or have scoliosis. Although dural puncture could increase the incidence of post-dural puncture headache (PDPH), this has *not* been the case in practice. Actually, many studies suggest a lower incidence of

Table 1 Advantages and disadvantages of epidural, combined spinal–epidural, and dural puncture epidural analgesia. ? indicates some degree of uncertainty. FHR, fetal heart rate

Epidural	Combined spinal epidural (CSE)	Dural puncture epidural (DPE)
Advantages	**Advantages**	**Advantages**
Default technique/long history	'Anatomical' confirmation of epidural placement	'Anatomical' confirmation of epidural placement
Less equipment/less expensive	Faster analgesia	Stable haemodynamics
Stable haemodynamics	Improved analgesia?	Faster analgesia?
'Proven' catheter effect?	Better second stage analgesia ↓ Accidental dural punctures? Increased maternal satisfaction Useful in training environment ↓ Need for catheter replacement	Improved analgesia? Better second stage analgesia? ↓ Accidental dural punctures? Useful in training environment
Disadvantages	Disadvantages	Disadvantages
No objective determination of epidural space	↑ Paraesthesia (spinal needle)	Larger spinal needle (25G) needed?
Unreliable second-stage analgesia	↑ Pruritus ↑ FHR effects (hypotension, ↑ uterine tone)	↑ Paraesthesia (spinal needle) Dural puncture for no purpose?

dural puncture because the availability of and familiarity with the small gauge spinal needle allows its use to check for CSF in circumstances of questionable LOR, avoiding some situations where the epidural needle would potentially have been advanced too far.[3]

There is a common belief that CSE analgesia can result in delayed recognition of catheter failure or an increase in failure rate during attempted conversion to anaesthesia for Caesarean delivery (CD), because the initial spinal dose could mask a non-functioning epidural catheter, frequently referred to as the 'untested catheter.' However, studies have shown that the CSE technique leads to a significantly *lower* risk of overall epidural catheter failure and need for replacement than classic epidural placement, because of the anatomical confirmation inherent in the CSE procedure.[4]

The CSE technique has disadvantages as well. There is an increased incidence of mild maternal hypotension, and the spinal opioid administration leads to a significantly higher incidence of pruritus. Most concerning regarding the CSE technique is the increased incidence of abnormal fetal heart rate (FHR) patterns after analgesia, most likely related to the dose of spinal opioids. CSE techniques performed with high dose spinal opioid (20–25 μg fentanyl) and no local anaesthetic had a higher risk of FHR decelerations (24% compared with 12%) and of uterine hyperactivity (tachysystole) (12% compared with 2%) when compared to CSEs done with local anaesthetic and a lower dose of opioid (fentanyl 10–15 μg).[5] The CSE technique has also been shown to be associated with increased uterine tone after analgesia compared with epidural analgesia alone.[6] Decreases in circulating catecholamines from rapid analgesia have been suggested, because typical plasma concentrations of adrenaline (epinephrine) in pain would be expected to be mildly tocolytic via beta-adrenergic agonism, and thus a rapid cessation of adrenaline release could result in increased uterine contraction.[6] Fetal bradycardia resulting from a CSE procedure should be managed with maternal blood pressure management and occasionally tocolytic drugs (e.g. terbutaline, nitroglycerine) if tachysystole is suspected, and should rarely lead to emergency delivery. An existing poor FHR tracing is a reasonable factor to consider when deciding between CSE and epidural techniques.

DPE is a recently described technique that can be used when some potential effects of a spinal dose might be inappropriate or undesirable, such as in the case of significant maternal cardiovascular disease or a pre-existing poor fetal tracing. The same technique is used as with a CSE procedure, but no spinal medication is injected after observation of CSF. The backflow of CSF confirms midline epidural placement, one of the technical advantages of the CSE procedure, whereas the lack of spinal dose avoids adverse effects (pruritus, FHR effects, hypotension). Analgesia provided by the DPE technique is more reliable with fewer failed and unilateral blocks compared with an epidural technique. Analgesia, including sacral coverage, may also occur more rapidly because medications are injected into the epidural space translocating into the subarachnoid space via the dural hole.[7] However, this potential advantage of DPE may depend on the size of the dural hole, and there may be little or no benefit when using needles smaller than 26 G.[8]

A catheter may be placed into the intrathecal space and continuous spinal analgesia (CSA) provided by intermittent injection or continuous infusion via this intrathecal (spinal) catheter, analogous to the use of an epidural catheter. Most times CSA is used after inadvertent dural puncture during attempted epidural catheter placement, but some practitioners believe that CSA is more reliable than continuous epidural analgesia because the medication is entering the CSF directly, and the position of the catheter can be verified more objectively by aspiration of CSF. This route of analgesia is chosen occasionally for patients with difficult surface anatomical landmarks (e.g. morbid obesity) or when there is concern about medication spreading properly in the epidural space (e.g. previous spinal surgery) or perhaps repeated attempts at finding the epidural space or failure of proper spread of analgesia with an indwelling epidural catheter. CSA dosing is not well established, but spinal doses are roughly 10–15% of epidural doses. At our institution, we insert an intrathecal catheter and use CSA fairly commonly after inadvertent dural puncture. A reasonable starting bolus dose would be similar to a typical CSE dose, bupivacaine 2–3 mg with fentanyl 10 μg. Infusions of bupivacaine 0.0625% with fentanyl 2 μg ml^{-1} at a rate of 2–3 ml h^{-1} often provide analgesia comparable with epidural dosing of 12–20 ml h^{-1}. We do not allow patient-controlled dosing of spinal catheters because of safety concerns. Critically, care must be taken when programming any pump so as not to inadvertently set it up to deliver epidural dosing. If patients need additional medication to supplement the infusions, physicians manually inject a bolus dose containing bupivacaine 1–3 mg and fentanyl 10–20 μg. Because these catheters are in the intrathecal space, several safety issues are involved that are not as critical with epidural catheters. Infection may be more common and more devastating if there is contamination of the fluid path. If there is a disconnection, CSF may be lost, with serious consequences. Finally, communication is imperative so that all practitioners are aware of an intrathecal catheter in place on the labour floor, as an epidural bolus dose via the spinal catheter could be catastrophic. Labelling the catheter, pump and door to the patient's room well, and ensuring that the nurse or midwife and patient know that this is an 'unusual' catheter are advisable. There is a significant risk of PDPH whenever a large (17–18 G) needle is used to insert a typical 19 or 20 G catheter into the subarachnoid space.

Neuraxial dosing

Research into neuraxial labour analgesia has changed practice over time, demonstrating that less medication is required for effective epidural analgesia than previously thought (see Table 2 for common dosing strategies. In Europe, levobupivacaine may be used instead of racemic bupivacaine; the former drug is not available in the USA. This results partly from the growing understanding of and emphasis on the synergistic effect of low concentrations of local anaesthetic agents with opioids. A 40–50% dose reduction in local anaesthetic requirement can be expected from the presence of opioid compared with no opioid, at least for first-stage analgesia. A higher concentration of local anaesthetic (bupivacaine >0.125% or ropivacaine >0.2%) may increase motor block enough to affect the success of vaginal delivery, increasing instrumental delivery, CD, or both.

Although opioids have assumed an important place in neuraxial analgesia, the benefits of other adjuvants to local anaesthetics are less clear. Very low dose neostigmine has shown some analgesic benefit, but is not widely used.[9] Adrenaline in concentrations as low as 1:1,000,000 (1–2.2 μg ml^{-1}) may improve analgesia, either by local vasoconstriction maintaining higher concentration of analgesics, or via α_2

Table 2 Common dosing regimens for neuraxial analgesia in labour. In Europe, levobupivacaine (not available in the USA) may be substituted for bupivacaine at comparable doses. DPE, dural puncture epidural; PCEA, patient-controlled epidural analgesia; PIEB, programmed intermittent epidural bolus

Labour spinal dosing	
Local anaesthetic	Opioid
Bupivacaine 2.5 μg	Fentanyl 10–15 μg
Ropivacaine 2.5–3.5 μg	Sufentanil 1.5–5 μg
Epidural (DPE) loading dose	
Local anaesthestic	Opioid
10–15 ml bupivacaine 0.125%	Fentanyl 50–100 μg (50 μg probably enough)
10–15 ml ropivacaine 0.2%	Sufentanil 10 μg
Epidural infusion (10–15 ml h^{-1})	
Bupivacaine 0.0625–0.125% with fentanyl 2 μg ml^{-1} or sufentanil 0.2–0.5 μg ml^{-1}	
Ropivacaine 0.10–0.20% with fentanyl 2 μg ml^{-1} or sufentanil 0.2–0.5 μg ml^{-1}	
PCEA recipes (patient-controlled epidural analgesia)	
4–6 ml of infusion drug, lockout 5–10 min, maximum 30–35 ml h^{-1} total infusion plus boluses	
PIEB strategy (essentially replace 10–12 ml h^{-1} infusion with timed bolus, similar hourly dose, usually with additional PCEA doses)	
6–8 ml q 30 min	
9–10 ml q 45 min	
12 ml q 60 min	

adrenoceptor-mediated analgesia. Clonidine prolongs the effect of bupivacaine in the epidural space by 25–40% and provides additional analgesia via α_2 adrenoceptor agonism.[10] It can be particularly useful and effective in women with opioid tolerance, where the direct effect of neuraxial opioids or synergism with local anaesthetics may be blunted.[11] Clonidine can be substituted for fentanyl in similar doses, with similar effects. Preservative-free clonidine 25–100 μg added to an epidural bolus or at a concentration of 2–3 μg ml^{-1} in standard epidural infusions can supplement analgesia, decrease sacral nerve sparing, improve patients' satisfaction and reduce the dose of bupivacaine required over the duration of labour.[10] The most common adverse effect is mild sedation, which can be beneficial in some anxious patients.

Programmed intermittent epidural bolus

Since the 1990s, epidural analgesia has been typically maintained by an infusion, usually supplemented by patient-initiated boluses. Newer evidence suggests that slow, constant infusions may not allow spread of medication in the epidural space and larger volume intermittent boluses. Pumps that allow 'programmed intermittent epidural bolus (PIEB)' can be set to administer a bolus, for example 8–12 ml at a high rate over a few minutes every 40–60 min (Table 2), as opposed to a continuous infusion of 8–12 ml over an hour. Patient-administered boluses via patient-controlled epidural analgesia (PCEA) are still available with PIEB-capable pumps. The patient often receives the same hourly dose as with a standard infusion protocol; but, the administration of larger boluses in a shorter period is thought to improve the spread of the medication in the epidural space. When compared with continuous epidural infusions with PCEA, PIEB with PCEA has been shown to decrease total local anaesthetic usage, peak pain scores and the need for physician intervention. The optimal timing of PIEB seems to be boluses every 40–60 min, requiring the least amount of physician administered boluses and with a high rate of maternal satisfaction.[12]

Controversies, contraindications and concerns

Neuraxial analgesia for labour and CD rate

Multiple retrospective and a few prospective studies in the 1990s suggested that epidural analgesia increases the rate of CD. However, it is practically and ethically difficult to randomise women in a proper randomised study to receive neuraxial analgesia or no neuraxial analgesia, so the results of the available studies are controversial. It is now generally believed that with low-dose local anaesthetic approaches, epidural analgesia has little effect on the CD rate.

A related misconception was that patients receiving neuraxial analgesia early in labour compared with after some specific degree of cervical dilation (e.g. 4 or 5 cm) are at increased risk of CD or protracted labour, and this issue has been more amenable to being addressed with high-quality studies. Several studies have randomised hundreds to thousands of labouring women to receive epidural (or CSE) analgesia upon demand early in labour (<4 cm cervical dilation) compared with being required to wait until some specified degree of cervical dilation (~5 cm). No study has found an increase in rate of CD in the early analgesia group.[13,14] Hence, the 'early *vs* late' debate has been settled in favour of analgesia at the request of the patient, regardless of the cervical examination.

Thrombocytopenia and coagulopathy

A common concern before providing neuraxial labour analgesia is a low platelet count. Currently, asking history from the patient is the only routine screening recommended before neuraxial placement.[13] The 2016 ASA Practice Guidelines for Obstetric Anaesthesia state that 'a routine platelet count is not necessary in the healthy parturient'.[15] Routine laboratory screening for coagulation disorders or thrombocytopenia is not recommended unless the patient has a known history of bleeding, thrombocytopenia or a coagulation dysfunction, or a history of or suspicion for a hypertensive disorder of pregnancy, such as pre-eclampsia or HELLP (haemolysis, elevated liver enzymes and low platelet count) syndrome. Furthermore, although mild dilutional thrombocytopenia of pregnancy is a common occurrence, the platelet count rarely decreases below a level generally regarded as safe for neuraxial procedures. There is no universally recognised minimum platelet count for neuraxial procedures, although 70,000 platelets ml−1 has been cited as an acceptable limit in a recent Practice Bulletin of the American College of Obstetricians and Gynecologists.[16] It should be noted that there has never been a reported case of epidural haematoma related to thrombocytopenia in pregnancy.[17] With growing concerns about venous thromboembolism, there has been an increase in peripartum use of heparin and low molecular weight heparin. Management of neuraxial analgesia in the presence of

thromboprophylaxis is the subject of a recent consensus statement from the Society for Obstetric Anesthesia and Perinatology.[18]

Scoliosis and spinal surgery

Scoliosis, and the associated major corrective spinal surgery, is another concern encountered on the labour and delivery suite. Patients with previous spinal surgery are typically eligible for neuraxial procedures; but, they are at a higher risk for a patchy block because of irregular epidural spread, and neuraxial techniques may be more difficult. Parturients with scoliosis also have an increased incidence of instrumental vaginal deliveries and CD, so a reliable epidural catheter can be very beneficial. Ultrasound may be helpful to assess midline or location of the hardware, and a CSE or DPE procedure can confirm midline epidural space placement in these cases where the scarring from prior surgery may cause false LOR. A study of 41 women at an academic institution who had undergone corrective surgery for scoliosis demonstrated that ~90% of these patients received effective epidural analgesia, with minimal alterations in effectiveness or medication requirements compared with a control group.[19]

Breastfeeding

There have been several studies regarding the effects of labour analgesia on breastfeeding, with varied results. Much of this literature consists of non-randomised studies in which women who did not receive neuraxial analgesia were very different in terms of likelihood or history of breastfeeding from those who did receive neuraxial analgesia. One randomised study suggested that fentanyl in epidural infusions might be associated with breastfeeding failure; but subsequent studies have failed to confirm this association.[20]

Management of breakthrough pain

Epidural catheters may 'fail' because of initial misplacement outside the epidural space, intravascular entry, movement over time, poor distribution or spread of medication within the epidural space, or inadequate dose of medication. With contemporary low-dose neuraxial analgesia techniques, many women require 'top-up' doses in addition to the prescribed continuous infusions or PIEB boluses and patient-controlled doses. It is sometimes difficult to tell when the increased drug requirements reflect normal or slightly more painful labour than average, or a misplaced or 'failing' catheter.

A reasonable strategy when addressing 'breakthrough' pain despite a previously functional epidural catheter is to assess the stage of labour, as it is well established that pain increases later in labour, particularly in the second stage, determine if there is any sensory level of analgesia (change in sensation to cold or pin-prick) and administer additional medication. The dose of medication that should be given in such a 'top-up' is not well studied or established, but it can be helpful to assess how much the patient has received in the past hour or two, and give approximately that amount. This will typically be bupivacaine 0.125% 5–10 ml, perhaps with fentanyl 50 μg. If this does not significantly reduce pain in 10 min, a dose of lidocaine 2% 5–7 ml can be given. With a functioning catheter, this should lead to at least a mild motor block with lower extremity weakness, along with some pain relief, even in the second stage of labour. If it does not, it is likely that the catheter is not functioning, and strong consideration should be given to replacing it. Patients requiring repeated top-up doses are more likely to need intrapartum CD, and catheters that are not working well for labour are unlikely to work for operative delivery.

Non-analgesic beneficial effects

Although the main indication for neuraxial analgesia in labour is the appropriate relief of pain, neuraxial labour analgesia has other benefits for many women. Obesity is a growing epidemic in the developed world, and is associated with an increased CD rate. Obesity increases the risks of general anaesthesia and tracheal intubation, so the presence of an in-dwelling epidural catheter, placed early in labour and appropriately tested, may decrease maternal risks overall. The incidence of postpartum haemorrhage from uterine atony increases with obesity; the presence of an epidural catheter in women at high risk of haemorrhage may allow avoidance of sedation or general anaesthesia during postpartum examinations or procedures to limit and treat haemorrhage. The mild sympathectomy from neuraxial analgesia can help control maternal blood pressure and may improve uteroplacental perfusion in pre-eclampsia. Similarly, parturients with cardiac disease benefit from limiting the degree of tachycardia and associated cardiac stress. Finally, there have been a series of recent studies suggesting a role for labour analgesia in preventing postpartum depression. A protective role for analgesia is not proven, but uncontrolled labour pain may be a predictor for women at risk.[21] Epidural analgesia may even be beneficial for paternal mental health as well, as the presence of a labour epidural has been shown to decrease paternal anxiety and increase paternal feelings of helpfulness.[22]

Alternatives

There is a small number of patients with contraindications to neuraxial anaesthesia. True contraindications include coagulopathy (therapeutic or pathologic); difficult, dangerous or impossible/failed epidural technique owing to previous spinal surgery or anatomical abnormality; or a patient's refusal. The two most commonly used alternatives are inhaled nitrous oxide (N_2O) and systemic opioids. Neither provides analgesia comparable with neuraxial techniques. Remifentanil has a rapid onset and rapid metabolism that may limit maternal and neonatal adverse effects. Remifentanil is frequently used via patient-controlled boluses (0.2–0.5 μg kg^{-1}) to be timed with uterine contractions. However, because of pump delay and CNS onset, this attempt at timing is frequently, or even usually, ineffective. At Columbia University, remifentanil is administered as a continuous infusion (0.05–0.2 μg kg^{-1} min^{-1}) without any patient-controlled boluses. It has been shown to reduce pain scores by ~50% at initiation of the infusion and to be a more effective analgesic than N_2O.[23] As labour progresses, however, there may be rebound pain because of tachyphylaxis, hyperalgesia or increased pain closer to delivery. There have been multiple case reports of maternal respiratory arrest and the need for fetal

resuscitation or oxygenation needed shortly after delivery. Hence, a remifentanil infusion or PCA warrants one-to-one nursing care, education of all associated healthcare providers, continuous maternal pulse oximetry, consideration of end-tidal CO_2 monitoring and immediate availability of both maternal and neonatal resuscitation equipment.[24]

Many studies of N_2O for labour analgesia fail to demonstrate actual analgesia, yet parturients using N_2O sometimes demonstrate comparable satisfaction rates to those with neuraxial analgesia.[25] This is probably related to the pleasant euphoric effect of the drug and the increased sense of control experienced during labour as the mother herself applies the mask. The most common adverse effects of N_2O are nausea, vomiting, dizziness and drowsiness. There are no reports of any maternal cardiopulmonary arrest or need for neonatal resuscitation associated with N_2O. A proper scavenging system must be installed in each labour room to limit occupational exposure, and it should be noted that N_2O is also a 'greenhouse gas'. N_2O can cause reproductive toxicity in the first trimester, presumably because of its effects on DNA synthesis.

Conclusion

Obstetric anaesthesia is a highly researched and often controversial area, and is the subject of much (informed and uninformed) public opinion about our practices. It is critical for patients' satisfaction and safety for practitioners to be aware of current strategies and recommendations. This is made more difficult by the nature and distribution of obstetric practice, with deliveries in most hospitals, of all sizes, limiting the possibility of provision of anaesthetic care by subspecialists, as may be more possible in clinical areas such a cardiothoracic surgery, neurosurgery, paediatric surgery or even major orthopaedic surgery. Although labour analgesia is a major concern of patients, and the topic of this article, patient safety is always the top priority. As pregnant women become older and less healthy, as is happening in most of the developed world, the need for knowledgeable and engaged anaesthesia providers in labour and delivery suites will only increase.

Declaration of interest

The authors declare that they have no conflicts of interest.

MCQs

The associated MCQs (to support CME/CPD activity) will be accessible at www.bjaed.org/cme/home by subscribers to *BJA Education*.

References

1. Gambling D, Berkowitz J, Farrell TR, Pue A, Shay D. A randomized controlled comparison of epidural analgesia and combined spinal–epidural analgesia in a private practice setting: pain scores during first and second stages of labour and at delivery. *Anesth Analg* 2013; **116**: 636–43
2. Goodman SR, Smiley RM, Negron MA, Freedman PA, Landau R. A randomized trial of breakthrough pain during combined spinal–epidural versus epidural labour analgesia in parous women. *Anesth Analg* 2009; **108**: 246–51
3. Norris MC, Grieco WM, Borkowski M *et al*. Complications of labour analgesia: epidural versus combined spinal epidural techniques. *Anesth Analg* 1994; **79**: 529–37
4. Booth JM, Pan JC, Ross VH, Russell GB, Harris LC, Pan PH. Combined spinal epidural technique for labour analgesia does not delay recognition of epidural catheter failures: a single-center retrospective cohort survival analysis. *Anesthesiology* 2016; **125**: 516–24
5. Van de Velde M, Teunkens A, Hanssens M, Vandermeersch E, Verhaeghe J. Intrathecal sufentanil and fetal heart rate abnormalities: a double-blind, double placebo-controlled trial comparing two forms of combined spinal epidural analgesia with epidural analgesia in labour. *Anesth Analg* 2004; **98**: 1153–9. table of contents
6. Abrao KC, Francisco RP, Miyadahira S, Cicarelli DD, Zugaib M. Elevation of uterine basal tone and fetal heart rate abnormalities after labour analgesia: a randomized controlled trial. *Obstet Gynecol* 2009; **113**: 41–7
7. Chau A, Bibbo C, Huang CC *et al*. Dural puncture epidural technique improves labour analgesia quality with fewer side effects compared with epidural and combined spinal epidural techniques: a randomized clinical trial. *Anesth Analg* 2017; **124**: 560–9
8. Wilson SH, Wolf BJ, Bingham K *et al*. Labour analgesia onset with dural puncture epidural versus traditional epidural using a 26-gauge Whitacre needle and 0.125% bupivacaine bolus: a randomized clinical trial. *Anesth Analg* 2018; **126**: 545–51
9. Booth JL, Ross VH, Nelson KE, Harris L, Eisenach JC, Pan PH. Epidural neostigmine versus fentanyl to decrease bupivacaine use in patient-controlled epidural analgesia during labour: a randomized, double-blind, controlled study. *Anesthesiology* 2017; **127**: 50–7
10. Paech MJ, Pavy TJ, Orlikowski CE, Evans SF. Patient-controlled epidural analgesia in labour: the addition of clonidine to bupivacaine–fentanyl. *Reg Anesth Pain Med* 2000; **25**: 34–40
11. Hoyt MR, Shah U, Cooley J, Temple M. Use of epidural clonidine for the management of analgesia in the opioid addicted parturient on buprenorphine maintenance therapy: an observational study. *Int J Obstet Anesth* 2018; **34**: 67–72
12. George RB, Allen TK, Habib AS. Intermittent epidural bolus compared with continuous epidural infusions for labour analgesia: a systematic review and meta-analysis. *Anesth Analg* 2013; **116**: 133–44
13. Wang F, Shen X, Guo X, Peng Y, Gu X. Epidural analgesia in the latent phase of labour and the risk of caesarean delivery: a five-year randomized controlled trial. *Anesthesiology* 2009; **111**: 871–80
14. Wong CA, Scavone BM, Peaceman AM *et al*. The risk of caesarean delivery with neuraxial analgesia given early versus late in labour. *N Engl J Med* 2005; **352**: 655–65
15. Practice Guidelines for Obstetric Anaesthesia: an updated report by the american society of anesthesiologists task force on obstetric anaesthesia and the society for obstetric anaesthesia and perinatology. *Anesthesiology* 2016; **124**: 270–300
16. Anonymous, ACOG Practice Bulletin No. 207. Thrombocytopenia in pregnancy. *Obstet Gynecol* 2019; **133**: e181–93
17. Goodier CG, Lu JT, Hebbar L, Segal BS, Goetzl L. Neuraxial anaesthesia in parturients with thrombocytopenia: a multisite retrospective cohort study. *Anesth Analg* 2015; **121**: 988–91

18. Leffert L, Butwick A, Carvalho B *et al*. The Society for Obstetric Anaesthesia and Perinatology Consensus statement on the anaesthetic management of pregnant and postpartum women receiving thromboprophylaxis or higher dose anticoagulants. *Anesth Analg* 2018; **126**: 928–44
19. Bauchat JR, McCarthy RJ, Koski TR, Wong CA. Labour analgesia consumption and time to neuraxial catheter placement in women with a history of surgical correction for scoliosis: a case-matched study. *Anesth Analg* 2015; **121**: 981–7
20. Chestnut DH. Labour epidural analgesia and breastfeeding. *Anesthesiology* 2017; **127**: 593–5
21. Toledo P, Miller ES, Wisner KL. Looking beyond the pain: can effective labour analgesia prevent the development of postpartum depression? *Anesth Analg* 2018; **126**: 1448–50
22. Capogna G, Camorcia M, Stirparo S. Expectant fathers' experience during labour with or without epidural analgesia. *Int J Obstet Anesth* 2007; **16**: 110–5
23. Volmanen P, Akural E, Raudaskoski T, Ohtonen P, Alahuhta S. Comparison of remifentanil and nitrous oxide in labour analgesia. *Acta Anaesthesiol Scand* 2005; **49**: 453–8
24. Aaronson J, Abramovitz S, Smiley R, Tangel V, Landau R. A survey of intravenous remifentanil use for labour analgesia at academic medical centers in the United States. *Anesth Analg* 2017; **124**: 1208–10
25. Likis FE, Andrews JC, Collins MR *et al*. Nitrous oxide for the management of labour pain: a systematic review. *Anesth Analg* 2014; **118**: 153–67