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Guidelines

Prevention and management of intra-operative pain during caesarean section under neuraxial anaesthesia: a technical and interpersonal approach

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Short title: Testing the block for caesarean section

Keywords: caesarean section; epidural; spinal; testing; pain.

Summary

A woman who experiences pain during caesarean section under neuraxial anaesthesia is at risk of adverse psychological sequelae. Litigation arising from pain during caesarean section under neuraxial anaesthesia has replaced accidental awareness under general anaesthesia as the most common successful medicolegal claim against obstetric anaesthetists. Generic guidelines on caesarean section exist, but they do not provide specific recommendations for this area of anaesthetic practice. This guidance aims to offer pragmatic advice to support anaesthetists in caring for women during caesarean section. It emphasises the importance of non-technical skills, offers advice on best practice and aims to encourage standardisation. The guidance results from a collaborative effort by anaesthetists, psychologists and patients and has been developed to support clinicians and promote standardisation of practice in this area.

Recommendations

1. Informed consent for anaesthesia for caesarean section requires an explanation of neuraxial techniques and general anaesthesia.
2. For neuraxial techniques, discuss the planned level of block and how it will be tested, the sensations that should be expected with an effective block, the possibility of pain, and the potential ways of treating it, including general anaesthesia.
3. For non-elective caesarean section, the discussion should include any potential fetal risks arising from the time taken to deliver the possible modes of anaesthesia.
4. Use a recognised technique for neuraxial block for caesarean delivery with sufficient doses of local anaesthetic and opioids.
5. Use light touch as the primary testing modality, aiming for a block to sensation to T5 or higher. A second, confirmatory sensory modality should be used if the level of block is in doubt.
6. Identify the block level as the first point at which sensation is first felt when moving from blocked to unblocked dermatomes between the mid-axillary and mid-clavicular lines bilaterally.
7. Test the lower limit of the block as well as the upper limit, using the back of the leg if necessary to avoid spraying near the genital area.
8. In addition, use straight-leg raising as a simple and reproducible test for motor block. An effective block is indicated by the inability to straight leg raise against gravity bilaterally.
9. Acknowledge any complaint of pain or distress and ask the surgeon to stop if safe, then use intravenous fast-acting opioids or ketamine in the first instance.
10. A request for general anaesthesia should be honoured if possible. It is good practice for the anaesthetist to recommend general anaesthesia if effective analgesia is unlikely to be achieved using other methods.
11. Any patient who feels pain during caesarean section should be followed up before they leave hospital by a senior anaesthetist, who should also contact the patient's general practitioner.

Why were these guidelines developed?

A woman who experiences pain during caesarean section under neuraxial anaesthesia is at risk of adverse psychological sequelae. Litigation arising from pain during caesarean section under neuraxial anaesthesia has replaced accidental awareness under general anaesthesia as the most common successful medicolegal claim against obstetric anaesthetists. These guidelines have been developed to support clinicians and promote standardisation of practice in this area.

How do these guidelines differ from other available guidelines?

There are no widely accepted guidelines available in this area. These guidelines have been produced by an Obstetric Anaesthetists' Association' (OAA) working group and approved by the OAA Executive Committee. Recommendations have been made to assist clinicians. They are not intended to dictate an exclusive course of management; rather, they should guide management to meet individual patient needs.

Introduction

Neuraxial anaesthesia is established as the preferred form of anaesthesia for caesarean section. In the UK, approximately 92% of caesarean sections are carried out under neuraxial anaesthesia [1]. Although generally reliable, neuraxial techniques can fail, either wholly or partially, and supplementation may be necessary. During caesarean section under neuraxial anaesthesia, pain has replaced accidental awareness under general anaesthesia as the most common successful medicolegal claim against obstetric anaesthetists [2,3].

Assessment of the block following neuraxial anaesthesia is essential to minimise the risk of an inadequate block, but objective assessment can be challenging [4]. There is a lack of consensus about what to test, how to test and what constitutes an adequate block. Surveys of neuraxial block assessment before caesarean section reveal significant variation in practice. There is currently no standardised approach to testing a neuraxial block before caesarean section, nor is there an algorithm for managing a neuraxial block that is inadequate for surgery. A recent systematic review of inadequate neuraxial anaesthesia in patients undergoing elective caesarean section has highlighted the absence of national guidance in this area [5].

These guidelines aim to support management in three of the thematic areas identified in a review examining a series of medicolegal claims of pain during caesarean section under neuraxial anaesthesia: consent, assessment of the neuraxial block and management of intra-operative pain [3]. Additionally, we make recommendations about communication and follow-up for women who experience pain and distress during caesarean section under neuraxial anaesthesia. Throughout the guideline, we have emphasised the importance of good communication with the patient.

Methods

A working party was formed comprising anaesthetists with varying experience levels and frequency of obstetric anaesthesia practice (weekly vs. occasional), a psychologist with expertise in psychological sequelae following medical intervention and patient representation. We performed an electronic literature search in Medline, Embase, CINAHL and PubMed for material published between 1980 and December 2020. This period was chosen since before 1980, general anaesthesia was the dominant technique for caesarean section with neuraxial techniques gaining rapidly in popularity from this time. The search terms used were: 'anaesthesia'; 'obstetrical'; 'methods'; 'spinal'; 'epidural'; 'cesarean section'; 'pain measurement'; 'drug effects'; 'cold temperature'; 'sensation'; 'drug effects'; 'physical stimulation'; 'Bromage'; and 'air'. The resulting 44 publications were

assessed for relevance by three authors (FP, DB, NL). Recommendations were developed on the basis of consensus opinion.

Definition, incidence, and risk factors for inadequate neuraxial anaesthesia

The incidence of inadequate neuraxial anaesthesia for caesarean section varies according to definition, neuraxial technique and urgency of caesarean section. The word 'failure' may be used to describe blocks that have entirely failed (no evident sensorimotor block), partial blocks, e.g. a unilateral block or inadequate block height, or the use of adjuvants or requirement for conversion to general anaesthesia. Spinal anaesthesia has a faster onset, fewer complications and lower intra-operative supplementation rates than epidural anaesthesia. In a prospective audit of 5080 caesarean sections from a single centre, the rate of failure to achieve a pain-free operation was 6% with spinal anaesthesia, 24% with epidural top-up and 18% with combined spinal-epidural [6].

The difficulties around the definition of 'failure' are illustrated by varying recommendations about acceptable conversion rates of neuraxial anaesthesia to general anaesthesia for emergency caesarean section, especially in time-critical situations. The Royal College of Anaesthetists suggests that where a general anaesthesia is given in the presence of a labour epidural which is not topped up, this is counted as a converted neuraxial technique, rather than primary general anaesthesia [7]. Using this definition, Kinsella found a general anaesthesia conversion rate of 4.9%, notably higher than the Royal College of Anaesthetists' target of 3%. However, if cases where there was no attempt to 'top-up' the epidural were excluded, the rate was 4.1% [5]. When no attempt was made to top-up an indwelling epidural, the proportion of cases was higher for category-1 caesarean section, which is unsurprising.

Identifying risk factors for inadequate neuraxial block also depends on the definition of failure used. In his case series, Kinsella defined 'failure' as either pre-operative failure to achieve a satisfactory block or intra-operative failure leading to pain. Factors associated with pre-operative failure included operative urgency, increased BMI, women having their first caesarean section and the indications for caesarean section of acute fetal distress or maternal medical condition. For intra-operative failure, the inadequacy of pre-operative anaesthetic block and duration of surgery were significant risk factors. When spinal anaesthesia was used, the use of a spinal opioid was associated with less pre-operative failure [6]. When a labour epidural was extended for caesarean section, lower epidural top-up volume was associated with less pre-operative failure, and use of adrenaline was associated with both less pre-operative and intra-operative failure [6]. A systematic review and

meta-analysis of observational trials for failed conversion of labour epidural analgesia to caesarean section anaesthesia identified risk factors including an increased number of clinician-administered boluses during labour, greater urgency of caesarean section, and increased epidural top-up volume required [8].

Regardless of how failure of neuraxial block is defined, the crucial element is that the anaesthetist recognises it is inadequate and can lead to pain and distress during surgery. Recognition and proactive management of failure are essential to mitigate this risk.

Height of block required for caesarean section and methods of assessment

The innervation of the uterus comes from sympathetic nerves from the inferior hypogastric plexus (T10–L1), and parasympathetic fibres of the uterus are derived from pelvic splanchnic nerves (S2–S4) [9]. Therefore, the level required for a lower transverse abdominal skin incision for caesarean section is the T10 dermatome. These innervations would suggest that a block height to low thoracic levels should be sufficient for caesarean section. However, several visceral organs send sympathetic afferent impulses to the thoracic spinal cord (T4–L2), and therefore a block height to higher thoracic dermatomes is required [10].

In a prospective study by Russell recording analgesic levels (loss of sharp pinprick sensation) and anaesthesia (loss of touch sensation) in 220 women during caesarean section, no woman with an anaesthetic level that remained above T5 experienced intra-operative pain [11]. This suggests that loss of touch sensation up to and including T5 is required to minimise the risk of pain during caesarean section, a finding which has been widely endorsed. However, the study predates modern obstetric anaesthetic practice in that it included 70 women who received de-novo epidural anaesthesia for caesarean section (now rarely used as a primary technique), and no patient received neuraxial opioids.

Although the T5 dermatome is the putative target for acceptable block height for caesarean section, several other factors add complexity to this superficially straightforward standard. An important finding of Russell's work, and confirmed by other studies, is that neuraxial anaesthesia is associated with a zone of differential sensory block at the cranial limits [12,13]. Other studies have confirmed an inconsistent relationship between cold, sharp pinprick and touch used to assess neuraxial block and height of block; thus, one cannot be predicted by assessing the other [14, 15]. Loss of cold sensation may be observed several dermatomes higher than the loss of sharp pinprick sensation,

and this, in turn, may be several dermatomes higher than the level at which touch is lost. Some authors have found that sharp pinprick and cold levels reversed, with loss of sharp pinprick sensation significantly higher than the loss of cold sensation, although the loss of touch sensation is still the lowest. For any modality, the effect does not change from total lack of sensation to completely normal sensation within a single dermatome, e.g. if using spraying ethyl chloride to assess block height to cold a woman may feel 'cold' at one dermatome but 'icy cold' at another dermatome. There is no evidence to guide which point between no sensation and completely normal sensation represents the height of the block.

These difficulties are compounded by the lack of consensus around the stimulus that should be used to test the sensory block. Kocarev et al. used various devices to assess block height after combined spinal–epidural anaesthesia in a group of women undergoing caesarean section [16]. Six tests were used in random order to measure four sensory modalities: ethyl chloride (cold), calibrated Neuropen (sharp), standardised monofilament 10 g (pressure), Neurotip stroking (light touch), monofilament stroking (light touch), cotton wool (light touch). The tests for light touch had the least dermatomal spread, and the more expensive tests did not confer any advantage over the least expensive test, cotton wool. Nor and Russell examined the effect of using different questions to assess the same stimulus in a group of women undergoing caesarean section under spinal anaesthesia [17]. The block height differed by a median value of two dermatomes depending on the question posed, suggesting that this is another variable to be defined. Finally, difficulties arise with the practical correlation of anatomical landmarks with specific dermatomes. Congreve et al. showed, in a study of 80 anaesthetists of all grades, that one in seven were at least two dermatomes outside the 'correct' demarcation of T5 [18].

Most textbooks state that a dense bilateral motor block in the lower limbs is essential when other aspects of the block are described. Inability to lift the legs against gravity demonstrates motor block of L1–4, but it does not provide information about the density of the block in the mid to upper thoracic segments. The Bromage scale and multiple modifications have been used to describe motor block [19,20]. An increasing proportion of anaesthetists use the straight leg raise test to avoid confusion [21].

The assessment of sympathetic block as a component of overall block assessment during neuraxial anaesthesia has received little attention. Lumbar neuraxial anaesthesia results in temporary sympathectomy of the lumbar sympathetic chain and can be evidenced by the presence of warm,

dry feet [22]. Autonomic fibres are the most vulnerable to local anaesthetic, and therefore the absence of sympathetic block suggests that the sensory nerve fibres are unlikely to be blocked [23]. A fall in blood pressure is not a reliable sign of sympathetic block as this can be caused by a multitude of factors and may be masked by the use of a vasopressor infusion.

The dilemma over the most effective way to assess and ensure an acceptable neuraxial block for caesarean section has, as already mentioned, led to considerable variation in practice. There is inconsistency in the sensory block height considered adequate, how the sensory block is tested, the reference point used, and even whether to test from blocked to unblocked areas or the other way round. A survey of obstetric anaesthetic practice published in 1997 found that 12% of anaesthetists did not routinely test the sensory block's upper level, and only 30% checked the lower level [24]. A comparison of practice between 2004 and 2010 showed that a block to T4 to cold remained the most commonly used standard for the sensory block, but an increasing number of anaesthetists were also evaluating block height to light touch [25]. In addition, there is a lack of consensus about which other modalities (motor block, sympathetic block), in addition to sensory block, to test.

Hoyle and Yentis undertook a literature review of methods to assess sensory and motor block (but not sympathetic block) for caesarean section under neuraxial anaesthesia from randomised clinical trials and recommendations in 45 editions of seven anaesthetic textbooks [20]. They also found wide variation but did detect a trend over time towards the use of light touch to achieve a block height to T5. The majority of trial manuscripts did not report whether motor block was tested. When motor block was mentioned, fewer than half described the actual method to use. If the method was specified, the majority referred to the 'Bromage scale', although only 5% of these matched Bromage's original description.

Seeking patient consent for neuraxial anaesthesia for caesarean section

The pre-operative obstetric anaesthetic consultation differs from other medical consultations in that the woman will likely be undergoing a surgical procedure for reasons other than her own health. Furthermore, in an emergency setting, the time frame is constrained, making it challenging to share information or address a woman's specific concerns [26,27]. This is another reason to make every effort to anticipate emergencies to enable adequate discussion with a woman. This requires close co-operation and communication between anaesthetists, obstetricians and midwives [28]. There is evidence that neuraxial anaesthesia is exclusively offered when discussing anaesthesia for caesarean

section [29]. General anaesthesia should be discussed as a primary alternative to neuraxial anaesthesia and not just as a rescue technique.

In the UK, ethical, professional and, more recently, legal standards, mandate that the information a patient requires to give informed consent should be based on what a reasonable patient would expect to be told, rather than what a reasonable practitioner would expect to explain [30,31]. In the words of the General Medical Council, doctors “*must try to find out what matters to patients so they can share relevant information about the benefits and harms of proposed options and reasonable alternatives.*” While formal signed consent for anaesthesia is not the norm in the UK, the anaesthetist should make a written record of the discussion, the information provided and the risks discussed.

A developing emergency may necessitate a more truncated and mechanistic approach to seeking consent for the sake of safety. However, this approach should be maintained for as short a time as possible as it can exacerbate feelings of loss of control, increasing the risk of adverse psychological outcomes [32].

The professional and legal requirement to seek consent may result in the anaesthetist’s agenda taking precedence over that of the woman. In the context of neuraxial anaesthesia for caesarean section, this can be counterproductive as active exploration of a woman’s needs and concerns has been shown to reduce anxiety and increases overall satisfaction [33]. It should be kept in mind that administering a neuraxial block might be routine for the anaesthetist, but having a neuraxial block and caesarean section is part of a significant life event for the woman [34]. Her perception of events and how she responds will depend on previous experience, or lack thereof, (mis)information she may have learned from other sources and whether this is an emergency.

Many women will be highly anxious regardless of urgency. From the outset, the anaesthetist needs to establish rapport with the woman to facilitate communication, vital to improving the assessment of the block. During the consultation, the anaesthetist needs to try to:

- Respond to verbal and non-verbal cues
- Use appropriate language
- Confirm understanding
- Demonstrate empathy
- Listen actively

- Provide verbal facilitation and non-verbal encouragement
- Legitimise the woman's concerns

Assessing neuraxial anaesthesia for caesarean section

Currently, there is no single, universally accepted method to test a neuraxial block before starting a caesarean section. The block required for caesarean section is no different if a spinal or epidural is used. However, the block from a spinal anaesthetic is more likely to be rapid, dense and easy to assess. The block from an epidural may be more challenging to assess, requiring careful and subtle evaluation. Multimodal testing should be used to assess the quality of a neuraxial block before commencing surgery, e.g. sensory block to light touch plus motor block.

Sensory block assessment

Light touch should be used as the primary testing modality, aiming for a block to sensation to T5 or higher. We consider that sensory testing, although essential, is more prone to error than testing of other modalities because it relies on accurate interpretation by the woman of what the anaesthetist is asking. When sensory testing alone is used, especially when the language used by the anaesthetist is not the first language of the woman, the risk of intra-operative pain may be increased. It is essential to allow sufficient time for the woman to respond when assessing a block. i.e., moving too rapidly along dermatomes. If ethyl chloride is used as an adjunct, the accuracy of determining a dermatomal level may be affected by the variation in the distribution of the spray of different commercial preparations, potentially covering more than one dermatome [35].

Motor block assessment

The dense sensory block required for caesarean section is associated with dense motor block of the lumbosacral plexus. If the mother can straight leg raise, no matter how high the loss of sensation, the block is unlikely to be suitable for anaesthesia for caesarean section [36]. Complete motor block of S1 (plantar-flexion) is characteristic of spinal anaesthesia but unusual with an epidural. Normal ankle motor function during epidural anaesthesia may indicate absent or inadequate sacral anaesthesia, which will likely result in pain during surgery.

Autonomic block assessment

Although favoured as a strategy to determine block quality, there is no objective evidence suggesting that sympathetic block should be part of routine practice when assessing a block before caesarean section. However, it can be a helpful adjunct to sensory and motor testing to confirm

bilateral spread. A sympathetic block of the feet does not develop until there is a well-defined sensory block to T10. It can be assessed by feeling the temperature on the underside of the toes bilaterally. Differences in foot temperature or the dampness of the feet indicate an asymmetrical or unilateral block. Even if sensory testing does not demonstrate a difference, the quality of the block is unlikely to be as good on the cooler side.

There is no evidence to guide when and how often a block should be assessed after neuraxial anaesthesia. The onset time will depend on the neuraxial technique, and drugs used [37]. Early demonstration of some effect is likely to encourage patient confidence but testing too soon can have the opposite effect. Testing the block multiple times may increase patient anxiety. If testing is repeated multiple times, the woman may feel under increasing pressure to say that the block is working [34]. Before starting to test the block, it is essential to emphasise to the woman that she is the best judge of the block, and that everyone understands the importance of waiting until she is ready. While the practice of asking the surgeon to test the block with forceps before skin incision has been described, the responsibility for block assessment remains with the anaesthetist. Some useful tips to aid block assessment are shown in Box 1.

It is essential that the assessment of the neuraxial block is comprehensively and accurately documented. This should include:

- The precise modalities that were used to test the block; the time of testing in relation to the administration of the neuraxial block or when the epidural top-up was completed.
- When extension of labour epidural analgesia is used, the pre-operative block height should also be documented.

Due to the variability in clinicians' interpretation of dermatomes, it has been suggested that the most reproducible way of documenting the height of the sensory block is using a dermatome map on the anaesthetic chart or a similar figure [4].

Communication

In addition to the practical aspects of block assessment, it is essential to consider communication between the anaesthetist and woman. A good rapport between the woman and anaesthetist may improve the accuracy of sensory assessment. Testing the sensory block depends on the woman understanding what the anaesthetist wants to know and being able to communicate what she is experiencing. The reliability of the test will depend on the accuracy of a woman's responses, which in turn can be affected by several factors, including:

- Distress and distraction: the woman's focus is the safe delivery of her baby. This may be overwhelming in emergencies where there are heightened concerns about the baby.
- Previous trauma can increase the woman's anxiety and affect her ability to respond to questions. This can include an inadequate neuraxial block in a previous pregnancy or domestic abuse (more common in pregnancy) [38].
- Power of suggestion: it is essential to avoid what in a legal context would be called 'leading the witness', e.g. 'I don't think you can feel that?'. Women can be vulnerable to suggestion, and this is increased by anxiety, distress and pain [32]. Questions should be open and neutral.
- Hierarchy: from necessity, women need to trust their anaesthetist. The nature of the clinical situation means that it is unrealistic to expect the woman to behave as an 'equal partner' [36]. Although clinicians' confidence and professionalism are reassuring to patients, it is crucial to remain aware that they may also inhibit a woman from speaking out if she is concerned.
- Time pressure: for anaesthetists, a time-pressured environment is commonplace; it is easy to forget that this pressure will be obvious to the woman and can be intimidating.
- Anaesthetic confirmation bias: on the vast majority of occasions, the block, especially if intrathecal, will be successful. Confirmation bias means the anaesthetist may unwittingly pay attention to the information that fits prior experience. The anaesthetist should make a conscious effort to look for signs of an inadequate block.

Managing pain and distress during caesarean section under neuraxial anaesthesia

In the event of an inadequate neuraxial block for caesarean section, the response will be determined by the urgency of the caesarean section, the stage of caesarean section at which a woman experiences pain or discomfort and the primary neuraxial technique. The anaesthetist must maintain situational awareness and recognise that a 'perfect' block can fail, and there are no infallible tests [39]. Moreover, the effectiveness of a block may change over time and during a caesarean section. The woman is the principal source of information regarding the block's efficacy and should be listened to carefully. It is not necessarily the neuraxial block's failure but the inadequate or delayed management that causes the most distress to patients [34,40]. If a clinician disregards the woman's experience, it may compound her distress, which can contribute to psychological trauma; subjective birth experience is the strongest predictor of postnatal trauma [41, 42].

The anaesthetist should establish the nature of the woman's pain, reassure her that she is being heard and that they will endeavour to make her more comfortable. Appropriate support can offer the best prospect of mitigating the long-term adverse impacts of block failure.

Management will depend on the urgency of surgery, stage of procedure and severity of the pain.

The following steps should be taken:

- Acknowledge the patient's distress and inform the operating theatre team.
- Ask the surgeon to stop surgery as soon as it is safe to do so. If the pain is severe and the woman's and the baby's lives are not in danger, surgery should immediately be halted except between uterine incision and delivery. If at this stage, the obstetrician should be asked to achieve delivery as quickly as possible.
- Reassure the woman and her partner that you will manage the pain.
- If pain occurs early on, especially before delivery, analgesic adjuvants are unlikely to be fully effective. If the urgency of surgery permits, consideration should be given to a second neuraxial technique (in the case of spinal anaesthesia) or extending the neuraxial technique (in the case of combined spinal–epidural or epidural extension anaesthesia). If these options are not possible, general anaesthesia should be recommended.
- Nitrous oxide and oxygen alone are unlikely to be sufficient. If the woman chooses to continue with neuraxial anaesthesia, consider repeated boluses of fast-acting opioids (fentanyl 25-50 µg, alfentanil 250-500 µg) or ketamine (10 mg boluses). Ensure the woman is pain-free before allowing surgery to restart. Watch for sedation and respiratory rate, with early recourse to facial oxygen.
- Do not treat pain with anxiolytics.
- If there is an indwelling epidural catheter and time, check the block. Additional top-ups could be considered. Alkalinised lidocaine with adrenaline is likely to achieve the most rapid effect. Do not allow surgery to restart without re-checking the block.
- Ask the surgeon to try to minimise surgical stimuli, e.g. exteriorisation of the uterus is not recommended because it is associated with a higher incidence of intra-operative nausea and vomiting, increased postoperative pain and does not improve operative outcomes such as haemorrhage and infection [43].
- Make a detailed record of events on the anaesthetic chart. Include what treatment was offered, the patient's response and any recommendation of general anaesthesia.
- If other strategies have failed and the woman requests it, provide general anaesthesia.

The anaesthetist should use their knowledge and expertise to decide when general anaesthesia should be offered and when it should be recommended. The woman should, if possible, be included in the discussion about how to proceed.

Follow-up for women who experience pain and distress during caesarean section under neuraxial anaesthesia

Follow-up is essential to minimise the development of long-term psychological sequelae [41]. Ensure that everyone caring for the woman before and following discharge is aware of intra-operative events. Follow-up should be prompt and, if possible, undertaken by the anaesthetist who cared for her (in the case of a trainee anaesthetist supported by a senior colleague). Occasionally the woman will feel unable to see the same anaesthetist, and a senior colleague should instead take over this role. A woman must be listened to and her accounts of events accepted as their genuine experience.

An explanation as to the possible reasons for intra-operative pain should be offered. Any questions or concerns the woman has should be addressed as fully as possible. Further follow-up by senior staff may be appropriate if the woman remains distressed. Lack of or insensitive postoperative management can exacerbate longer-term psychological consequences. A written record should be sent to the woman's general practitioner and the community midwifery service.

The woman should be advised to contact the anaesthetic department if she has ongoing concerns and should be assured that she has access to support should she need it. Women may delay reporting pain during surgery; the issue may only be raised if she becomes pregnant again. All women should be told they can ask for an appointment to see an anaesthetist to discuss events again, and to plan anaesthetic management for their next delivery. The strategy for follow-up and psychological support developed following the 5th National Audit into accidental awareness during general anaesthesia provides a framework that could be adapted for women who experience pain and distress during caesarean section under neuraxial anaesthesia [44].

The adverse impact on anaesthetists should not be overlooked. Irrespective of seniority, the clinician should have the opportunity to discuss events with another clinician. If the anaesthetist providing care was a trainee, a senior colleague should support them and accompany them when speaking to the woman.

Application of these guidelines in resource-limited settings

The principles outlined in these guidelines are both applicable and accessible in resource-limited settings. Concerns relating to inadequate spinal block remain relevant in any environment. However, contextual factors may influence local practice and make it difficult to achieve the same standards in differing clinical settings, e.g. in many resource-limited countries, opioid drugs suitable for neuraxial anaesthesia will not be available. As a result, spinal and epidural anaesthesia will rely predominantly on local anaesthetic drugs, making intra-operative pain more likely and a dense block more necessary.

Maternal mortality may be 50 times higher in resource-limited settings than in high-income countries [45]. Anaesthesia contributes disproportionately to this mortality: one in seven deaths are due to anaesthesia in resource-limited settings [42]. Maternal discomfort during caesarean section may thus be perceived as a less important outcome. In some areas, anaesthetists are required to perform both surgery and anaesthesia (up to 7% of maternal deaths were single-physician caesarean sections in South Africa) [46]. These factors make the management of pain problematic and reduce the amount of attention clinicians can provide. Anaesthetic providers are often less experienced and qualified, and in some areas there is only one physician anaesthetist per million women [47]. Exposure to general anaesthesia and non-physician anaesthetists is associated with increased risk to mothers in low-and middle-income countries. Increased risk due to general anaesthesia may be linked to poor maternal condition (such as in obstetric haemorrhage), but in one South African report, 10 out of 92 anaesthetic deaths were during general anaesthesia conducted for an inadequate spinal block [48,49]. There may therefore be reluctance to convert a failed spinal block to general anaesthesia, given the maternal risk in the hands of an inexperienced anaesthetic provider.

There are few data on the incidence of failed spinal in resource-limited settings, but it is likely to be higher, approaching 1 in 10 cases in one study [50]. A South African study suggested that only 56% of anaesthetic providers routinely test the spinal block [48]. Further, there was no agreement on an acceptable block height, or the optimal way to test the block. In response to an inadequate block, non-specialist anaesthetists were more likely to repeat the spinal and less likely to convert to general anaesthesia. More than a third felt that they were not competent to provide general anaesthesia for caesarean section, despite more than 95% being expected to do so.

These factors mean that adequate pre-operative counselling and assessment of the spinal block are of vital importance in resource-limited settings. Where language barriers exist, novel techniques

such as information videos on smartphones may minimise anxiety and ensure the mother receives the information in a consistent manner in her first language [51]. Management of pain during caesarean section follows similar principles to those outlined in these guidelines, although the acceptable threshold of pain requiring conversion to general anaesthesia may need to be balanced against the associated maternal risk in resource-limited settings. In addition to techniques mentioned earlier, the use of local anaesthetic infiltration by the surgeon may prove invaluable in providing safe and effective supplemental analgesia. Ultimately adequate assessment of the block pre-incision is the key component in preventing an unsatisfactory block that requires conversion to general anaesthesia in a high-risk setting.

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Box 1 Top tips for testing a neuraxial block [4,36]

- Wait for evidence of motor block before testing the sensory block for the first time.
- Check the block at relatively fixed time intervals, thus gaining experience of what to expect at those intervals.
- If the block is denser on one side than the other (noted by more motor block), start the sensory testing on that side. The mother will then appreciate if there are differences, and this will help you determine subtle changes.
- Perform the first check early enough to allow positional changes before fixing of intrathecal local anaesthetic.
- Continue testing past the initial level of change to seek possible further change at a higher level. This is most commonly noted when testing with an ice cube. The mother will first register cool touching, followed by cold, then icy cold as the ice cube is moved cephalad.