CHAPTER 7

Anaesthesia for caesarean section

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Introduction

Anaesthesia for caesarean section can pose significant risk to the mother and the fetus. However, maternal deaths related to anaesthesia for caesarean section are uncommon in resource-rich countries. A recent report from the United Kingdom showed 261 maternal deaths for the 2006–2008 triennium, giving a maternal mortality rate of 11.7 per 100,000 [1, 2]. Of these, only 2.68% (7 deaths) were related to anaesthesia, giving a rate of 3.1 deaths due to anaesthesia per 1,000,000 maternities. Similarly, in the United States, only 1.6% of maternal deaths (which totalled 5375 deaths over the 12-year period) were related to anaesthesia over a 12-year period [3].

In resource-poor countries, however, there is undoubtedly a significantly higher risk of death from anaesthesia-related complications, compared to resource-rich countries. Though the numbers often are not recorded or reported, there are some clues in the literature. In South Africa, anaesthesia-related deaths accounted for 6% of all preventable deaths in 2008–2010 [4]. In one report from a teaching hospital in Nigeria, the death rate from anaesthesia was estimated to be 3.7 per 1000 [5]. In sub-Saharan Africa, the recorded death rate is as high as 1%–2% at caesarean section, with anaesthesia-related events contributing up to one-third of the observed mortality [6, 7].

These deaths in resource-poor countries largely have been attributed to a lack of resources, including the limited number of medically-qualified anaesthetists, and to deficiencies in training especially for the non-physician anaesthetic practitioner, leading to airway problems, inappropriate application of anaesthesia, and inability to recognise a sick or haemodynamically-compromised parturient.' Furthermore, a lack of essential monitoring equipment and drugs, combined with shortcomings in essential infrastructure, compound the issue and result in suboptimal care for a huge cohort of women.

Historically, the majority of anaesthesia-related deaths in the United Kingdom were due to airway problems (failed intubation and pulmonary aspiration) associated with general anaesthesia for emergency caesarean section, and many of these cases were staffed out-of-hours by poorly trained, poorly supported junior staff. Awareness of these issues has led to a widespread increase in the use of regional anaesthesia for caesarean section, and 2012 data show that only around 10% of caesarean section in the United Kingdom are now performed under general anaesthesia [8]. Reduction in the use of general anaesthesia, allied with improved training, monitoring, and support for anaesthetists has been instrumental in the significant decrease in anaesthesia-related mortality associated with caesarean section.

The purpose of this chapter is to highlight the important aspects of delivering safe anaesthesia for caesarean section in sometimes difficult circumstances.

Anaesthesia providers and standards

In resource-rich areas of the world, anaesthesia is most commonly provided by physician anaesthetists who have specialized after qualifying as a medical doctor. In the United States and some north European countries, nurse anaesthetists (usually under the supervision of a physician anaesthetist) provide a large proportion of the anaesthetics administered.

In contrast, in resource-poor areas of the world, and particularly outside of the major cities, medically qualified anaesthetists are a rare commodity, and it is usual for the vast majority of anaesthesia in surgical cases to be administered by non-physician anaesthetic technicians, often with very little or no supervision by physician anaesthetists.

Anaesthetic training

Adequate training in anaesthesia, whether for physician or non-physician providers, is crucial for providing an effective and efficient service where the focus is the safety of the mother and the fetus. Maternal mortality reports from the United Kingdom and South Africa have repeatedly highlighted the need for better healthcare worker training [1, 8]. Recommendations from the latest South African report suggest that anaesthetic providers who will care for pregnant women should complete a specific obstetric anaesthetic module, achieve competencies relevant to obstetric emergencies, and be able to use early warning scores [9].

An effective training programme requires:

1. A structured educational process;
2. Core competencies, knowledge and behavioural aspects required for the safe practice to have been identified and validated by a reputable organization (usually the regional college of anaesthesia); and
3. Competencies to be tested by examinations and while 'on the job'.

Good teamwork is a cornerstone of good care, and should be fostered and practised regularly in activities such as 'skills and drills' and simulation-based scenarios. Similarly, in emergency clinical situations, it is vital that the obstetrician and

Box 7.1 The World Federation of Societies of Anaesthesiologists' 'highly recommended' requirements to meet safe administration of anaesthesia for caesarean section

Preoperative

- Anaesthetic pre-assessment to tailor an appropriate and safe strategy;
- All anaesthetic equipment checked;
- Supplemental oxygen present and supply verified.

Intraoperative

- Continuous measurement of tissue oxygenation; pulse oximetry highly recommended;
- When pulse oximetry not available, dedicated personnel and adequate illumination to detect and manage hypoxia;
- Ventilation continually assessed by visual inspection;
- Capnography if intubated;
- Monitoring of the heart rate and rhythm is mandatory (ECG, pulse oximeter); continuous palpation of pulses and auscultation of the heart if monitoring is not available;
- Blood pressure at least every 5 minutes;
- Audible alarms turned on at all times.

Post-operative

- Presence of dedicated recovery with trained staff;
- Vital signs monitored; pulse oximetry highly recommended;
- Adequate analgesia prescribed and available;
- Every effort made to alleviate suffering.

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anaesthetist discuss the immediate management of the patient and agree a plan of action, underpinned by an understanding of and respect for each practitioner's priorities and concerns.

Standards for providing safe anaesthesia

The World Federation of Societies of Anaesthesiologists (WFSA) in 2010 has advised on the 'highly recommended' (meaning mandatory) requirements (Box 7.1) to meet safe administration of anaesthesia (including for caesarean section) worldwide [10].

While anaesthesia without the mandatory standards for elective procedures is deemed unacceptable, the WFSA recognizes that in resource-poor regions the mandated standards frequently cannot be met because of limitations of resources and organizational structure. In such situations, the WFSA strongly advises that anaesthesia only should be undertaken for life- or limb-threatening surgery.

Of note, is the current Lifebox® charitable project (established by the WFSA, the Association of Anaesthetists of Great Britain and Ireland, the Harvard School of Public Health, and the Brigham and Women's Hospital) which aims to provide simple pulse oximetry monitoring to every location worldwide in which anaesthetics are given (see http://www.lifebox.org) [11].

Technical considerations for anaesthesia during caesarean section

Pregnancy-related physiological changes pertinent for anaesthesia

The physiological changes associated with pregnancy are covered in other textbooks. Aspects particularly relevant to anaesthesia are listed in Table 7.1.

Reduction in the functional residual capacity of the lungs and increased oxygen consumption in the pregnant woman lead to rapid oxygen desaturation following induction of anaesthesia or apnoea. Airway changes can result in difficult or failed intubation (which is up to eight times more frequent in the term parturient than in the non-pregnant woman). Because of these issues, adequate preoxygenation before induction of general anaesthesia is very important.

The abdominal changes that occur during pregnancy increase the likelihood that gastric contents may be aspirated. To minimize acid-induced pneumonitis in such an event, it is accepted and expected practice in resource-rich countries to administer a histamine-receptor antagonist (e.g. ranitidine) and an oral antacid buffer (e.g. sodium citrate) prior to induction of general anaesthesia for caesarean

Table 7.1 Pregnancy-related changes relevant to the anaesthetist

	Issue	Risk
Airway	Engorged friable mucosa Enlarged breasts Oedema in pre-eclampsia	Easily bleeds Difficult laryngoscopy Failed intubation more likely
Lungs	Reduced functional residual lung capacity Increased oxygen requirement	Rapid desaturation
Abdomen	Increased gastric volumes Delayed gastric emptying after pain/opioids Passive regurgitation	Aspiration pneumonitis

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section. These reduce the acid content of the stomach and the risk of morbidity and mortality if pulmonary aspiration should occur.

From around 20 weeks gestation, the gravid uterus is of sufficient size to compress the inferior vena cava and the adjacent aortic segment when the mother is supine. This compression prevents venous return to the heart, resulting in reduced cardiac output and blood pressure. The drop in blood pressure is exacerbated by regional and general anaesthesia and may lead to cardiovascular collapse if aortocaval compression is not alleviated. Furthermore, aortocaval compression can also reduce uterine blood flow and cause non-reassuring fetal status. When the mother is supine, the uterus must be displaced laterally to the left, either by placing a wedge under the mother's back or by lateral tilting the table enough to see the gravid abdomen move off the midline.

Haematological changes during pregnancy include dilutional anaemia and mild thrombocytopaenia. Additionally, reduced albumin level lowers the oncotic pressure of the blood, making the pregnant woman liable to be tipped into pulmonary oedema with intravenous fluid therapy, particularly in pre-eclampsia.

Appreciation of these risks and adaptation of anaesthetic practice has led to a significant fall in anaesthesia-related deaths in the United Kingdom over the years [12].

Choice of anaesthesia for caesarean section

Anaesthesia for caesarean section can be achieved in a number of ways, and the approach should be dictated by the clinical situation and the resources available. The two main methods are general anaesthesia and regional anaesthesia (consisting of spinal, epidural, or combined spinal–epidural techniques), but local anaesthesia and ketamine anaesthesia also have a place in resource-poor settings (Table 7.2).

Regardless of the technique used, large-bore venous access should be used, and oxygen, relevant drugs, appropriate monitoring, and resuscitation equipment should all be immediately available. Aortocaval compression should be minimized by providing left lateral uterine tilt.

There is always a risk of vomiting and pulmonary aspiration associated with unexpected maternal collapse or the need for emergency general anaesthesia. Therefore, adequate measures to reduce the risk of aspiration pneumonia should be undertaken. Such measures may include premedication to reduce stomach acid production (e.g. ranitidine) and to enhance stomach emptying (e.g. metoclopramide). Neutralization of stomach acid with a buffer such as oral sodium citrate immediately prior to starting the procedure is also recommended.

Table 7.2 Contraindications to regional anaesthesia

Issue	Reason
Patient refusal	Poor cooperation, litigation
Haemorrhage	Hypotension, coagulopathy
Coagulopathy	Spinal haematoma
Hypovolaemia	Cardiovascular collapse
Generalized sepsis	Hypotension, epidural abscess
Infection at site of insertion	Meningitis, epidural abscess
Raised intracranial pressure	Coning
Spinal cord abnormalities (e.g. spina bifida)	Spinal cord damage
Allergy to local anaesthetics	Anaphylaxis
Extremely non-reassuring fetal status	General anaesthesia should be quicker

NB: Contraindications may be *relative* or *absolute*.

Regional anaesthesia (neuraxial techniques) for caesarean section

Regional anaesthesia has become the clearly preferred technique for caesarean section in resource-rich countries and also is being widely encouraged in resource-poor areas. It has distinct advantages over general anaesthesia, primarily because it avoids the adverse risks and side effects of general anaesthesia [13].

Neuraxial blocks can be achieved by the deposition of local anaesthetic with or without opioid into the subarachnoid space (spinal) or into the epidural space. In either case, the sensory block (often tested with cold sensation) ideally should be between the level of T4 (i.e. at the nipples) and the sacral roots. There is some evidence that testing the sensory block with light touch and ensuring a block to the T6 level (costal margin) prior to incision is more reliable than using cold sensation, but this method is not in widespread practice [14]. Achieving these levels is recommended so as to avoid pain during the procedure. Not only is pain during caesarean section extremely unpleasant for the mother, it is also a leading cause of litigation in obstetric anaesthesia in resource-rich countries. During the period 1995–2007 in the United Kingdom, inadequate anaesthesia accounted for 31% of litigation claims related to obstetric regional anaesthesia [15].

There are a number of contraindications to regional anaesthesia (Table 7.3), but the results of the third National Audit Project (NAP3) conducted by the Royal College of Anaesthetists in the United Kingdom has shown that regional anaesthesia in obstetric patients overall is extremely safe [16]. The risk of healthy patients developing the most feared of complications, a vertebral canal or epidural haematoma, following a neuraxial block was shown to be extremely small, with an incidence of 0.85 : 100,000 [16].

In patients with coagulopathy, it is generally accepted that the incidence of spinal haematoma would be higher than in patients without this condition. However, because of the rarity of spinal haematoma, definitive risk quantification is not possible. Consensus opinion suggests that the risk of this complication should be viewed as a continuum and be balanced against benefit [17].

Table 7.3 Core drugs for obstetric anaesthesia

Purpose	Drugs
Antacid prophylaxis	Sodium citrate Ranitidine Omeprazole
Induction agent	Thiopentone Propofol Etomidate Ketamine
Muscle relaxant	Suxamethonium Atracurium Vecuronium Rocuronium
Inhalational agent	Isoflurane Sevoflurane Desflurane (Halothane) (Ether)
Reversal	Neostigmine Glycopyrronium Atropine Sugammadex
Antiemetic	Ondansetron Metoclopramide Cyclizine
Analgesia	Opioids NSAIDs Paracetamol
Vasopressor	Ephedrine phenylephrine Metaraminol
Uterotonic	Oxytocin Ergometrine Carboprost

Timing of heparin is particularly relevant here, as the use of unfractionated and low molecular weight heparin (LMWH) to prevent thromboembolic events is commonplace in resource-rich countries and may increase the risk of developing a spinal haematoma after regional anaesthesia.

Guidelines from the Royal College of Obstetricians and Gynaecologists as well as wide consensus opinion recommend an interval of 12 or 24 hours after prophylactic or therapeutic LMWH administration, respectively, before performing neuraxial blockade [18], and LMWH should not be administered for 4 hours after a neuraxial procedure. There is no evidence that low-dose aspirin treatment (e.g. 75 mg per day) or truly prophylactic dosing of unfractionated heparin (e.g. 5000 U twice a day) is a contraindication for regional anaesthesia.

Thrombocytopaenia is a concern for anaesthetists when considering regional anaesthesia, because of the possibility of causing a spinal haematoma. There is still no reliable, easily available, test of platelet function, and obstetric anaesthetists therefore mostly rely on platelet count as a surrogate for platelet function. Correspondingly, anaesthetists generally consider regional anaesthesia safe if the platelet count is above 75–80 × 10^9/l. However, trends are considered as important as absolute values, as platelets may fall precipitously in situations such as severe pre-eclampsia or HELLP syndrome. Although platelet counts are not usually required in healthy women prior to neuraxial blockade, in those at risk of thrombocytopaenia, a platelet count should ideally be performed within the preceding 6 hours. It is appreciated that in rural or low-resourced settings, access to quick laboratory tests may not be available. In such circumstances, the low risk of a spinal haematoma should be weighed against the clinical situation. For example a spinal technique in the context of a borderline-low platelet count may be preferable to general anaesthesia for a parturient with a difficult airway and with an inexperienced anaesthesia provider.

Localized infection at the site of the neuraxial needle insertion carries with it a risk of seeding pathogens into the central nervous system and is hence a contraindication to neuraxial anaesthesia. In the case of systemic infection, or sepsis originating elsewhere, in women that have been treated with antibiotics *and where no overt signs of systemic sepsis (e.g. tachycardia, hypotension, and ongoing pyrexia) are manifest*, it is reasonable to consider regional anaesthesia.

Spinal anaesthesia for caesarean section

Single shot spinal anaesthesia (SSS) is the most common technique used worldwide for caesarean section. In skilled hands, it is safe, quick, and reliable. In this technique, local anaesthetic with or without a synergistic additive (usually opioid) is deposited into the intrathecal space by using a fine needle. The spinal cord ends at the L1 to L2 level in most individuals and hence the needle should be inserted below L2 to prevent inadvertent cord damage. Typically the L3–L4 or L4–L5 interspaces are recommended, since it is well recognized that anaesthetists often actually insert spinal needles at interspaces higher than expected [19, 20].

The most common potentially serious complication of spinal anaesthesia is post-dural-puncture headache due to continuing cerebrospinal fluid (CSF) leakage. This complication is dependent on the needle size and configuration of the needle tip. The short bevelled tip of the traditional Quincke needle cuts through the dural fibres but results in a relatively high incidence of post-dural-puncture headache, especially in pregnant women. The use of a 22-gauge Quincke needle for SSS has a post-dural-puncture headache rate of up to 36%. This rate can be reduced to less than 5% when the 27-gauge size is used. However, Quincke needles have been superseded in modern obstetric anaesthetic practice by pencil-point spinal needles (e.g. Whitacre, Sprotte), which incorporate a non-cutting needle tip. This tip separates the dural fibres instead of cutting them and is associated with significantly lower post-dural-puncture headache rates than Quincke needles are. Standard practice has therefore become to use a 25-gauge (or smaller) pencil-point needle for spinal anaesthesia in pregnant women. The use of 25- or 27-gauge needles has lowered the incidence of post-dural-puncture headache to less than 1% [21].

The most common local anaesthetic used for spinal anaesthesia is 0.5% hyperbaric bupivacaine. However, bupivacaine 0.75%, lidocaine 2% or 5%, and ropivacaine 0.5% or 0.75% are alternatives. Hyperbaric preparations (with added glucose to make the solution 'heavy') are popular, as

gravity helps direct the spread of local anaesthesia selectively and produces a more predictable block.

The addition of short-acting, lipid soluble opioids (e.g. fentanyl, sufentanil) improve the quality and success of the spinal block and reduces the total amount of local anaesthetic required. The latter effect is desirable as large local anaesthetic doses are associated with increased hypotension (see 'Hypotension'). Moreover, the addition of a long-acting opioid (e.g. morphine, diamorphine) provides excellent post-operative analgesia.

Other additives which may improve the quality or duration of the spinal block include epinephrine (adrenaline) and clonidine, although these are not used widely.

All the quantities of drugs used in spinal anaesthesia are small and hence there is insignificant amount of transfer to the fetus.

In experienced hands, spinal anaesthesia can be administered quickly, and there may be little difference between the time of decision to caesarean section and delivery when compared with general anaesthesia. The decision to delivery time in Category 1 sections has been shown to be prolonged by 7–8 minutes when SSS anaesthesia is used [22, 23]. There are insufficient data to suggest that this time difference causes adverse outcomes for the fetus, although there is evidence to show that excessive use of ephedrine to correct hypotension induced by spinal anaesthesia is associated with increased fetal acidosis [24].

The time from decision to delivery is dependent on the coordinated efforts of a number of individuals, including midwives, obstetricians, operating theatre staff, paediatricians, and anaesthetists. Attempts to shorten the anaesthetic time without addressing other contributing factors will very likely lead to an increased incidence of anaesthesia-related maternal complications. Certainly, some clinical scenarios, for example prolonged fetal bradycardia, will necessitate rapid delivery.

Despite the relatively small difference in speed between spinal and general anaesthesia, in extremely urgent situations it may be preferred to use general anaesthesia, since spinals are sometimes unexpectedly difficult to perform or slow in onset, irrespective of the experience of the anaesthetist. The decision to use general anaesthesia is best made by personnel (i.e., the anaesthetist and obstetrician) present at the time of the urgent situations (Category 1 caesarean section), as they must collectively balance the risks between general anaesthesia (i.e. mostly airway and intubation issues) and spinal anaesthesia (unexpected difficulty or slow onset of block).

Epidural anaesthesia for caesarean section

In epidural anaesthesia, local anaesthetic drugs are administered into the epidural space to inhibit sensory nerve roots, either via a one-shot technique, or more commonly via a catheter for multiple dosing. The epidural space is found by a 'loss-of-resistance' technique using air or saline in a special low-resistance syringe attached to a relatively large-bore (16- or 18-gauge) Tuohy (epidural) needle; the epidural catheter is then threaded into the epidural space through the epidural needle and can remain in situ throughout labour.

Epidural anaesthesia is rarely used de novo for elective caesarean section but, in resource-rich countries, epidurals are commonly used for analgesia in labour. If caesarean section becomes necessary, additional doses of anaesthetic solutions can be administered through the epidural catheter to achieve surgical anaesthesia for emergency caesarean section. However, a poorly functioning epidural in labour should alert the anaesthetist to the possibility of failure to produce surgical anaesthesia through the use of the epidural catheter, and alternative techniques should be considered.

Local anaesthetic agents such as bupivacaine, ropivacaine, lidocaine, and 2-chloroprocaine are used for epidural anaesthesia in caesarean section, with opioids and/or other supplemental drugs often added. The speed of onset of anaesthesia for these agents is variable, and a recent meta-analysis [25] suggested the fastest onset is achieved when 2% lidocaine with epinephrine is used; a block to T4 can be achieved within 10 minutes (mean). This time may be further reduced if fentanyl is added to the mixture, and it is not uncommon for anaesthetists to use complex mixtures including bupivacaine, lidocaine, epinephrine, opioid, and bicarbonate to create a rapid onset epidural mixture. However, if

this practice is used, anaesthetists should be aware of the risks of inadvertent drugs errors being made, particularly when complex mixtures are being used in an emergency situation.

Epidural anaesthesia offers an advantage over SSS in that it can be supplemented during surgery should the mother experience pain or if surgery is prolonged. In addition, if an epidural catheter is already present for labour analgesia, it is a relatively simple procedure to add additional medication for surgery.

Disadvantages of epidural anaesthesia include the fact that the volumes and doses administered via this route are up to *ten times* the amount used in spinal blocks, and hence there is possibility of systemic toxicity.

Insertion and management of epidural anaesthesia requires considerably more skill and training than the spinal technique, is more expensive, and carries with it additional inherent risks. In the low-resource setting, the lack of appropriately skilled professionals, coupled with the additional expense, may preclude the routine use of this technique.

Combined spinal–epidural anaesthesia for caesarean section

Here, the two techniques of spinal and epidural anaesthesia are combined and can be administered sequentially (spinal followed by epidural anaesthesia, or epidural followed by spinal anaesthesia), or more commonly performed via a needle-through-needle technique: the epidural space is located with a Tuohy needle through which a fine-bore spinal needle is introduced to penetrate the dura and deposit local anaesthetic mix into the subarachnoid space. A catheter is then threaded into the epidural space.

The combined spinal–epidural anaesthesia (CSE) technique remains a source of debate among obstetric anaesthetists. Advocates argue that it couples the speed of onset of SSS, with the option of intraoperative supplementation via the epidural catheter should it be required. Furthermore, the amount of local anaesthetic administered via the spinal component can be reduced, thus reducing the incidence of hypotension. Detractors note the increased degree of training and expertise that is required, the additional costs, and the data from the NAP3, conducted by the Royal College of Anaesthetists, which suggests there to be disproportionately greater risk of long-term neurological complications from CSE than from either spinal or epidural techniques alone [16].

Again, the requirements for additional training and expertise, and the added costs of equipment reduce the attractiveness of this technique in the low-resource setting.

Complications and side effects of regional anaesthesia

Data from the NAP3 have confirmed the overall relative safety of regional anaesthesia in obstetric patients and show that there is a lower rate of serious long-term complications from regional anaesthesia when used in obstetric patients than when used in non-obstetric patients [16].

Nevertheless, the anaesthetist must be trained to recognize and deal effectively with complications when they do occur. In South Africa, maternal death related to spinal anaesthesia has been on the rise. In the last National Committee on Confidential Enquiry into Maternal Deaths triennial report (2008–2010), two-thirds of the 93 deaths attributed to anaesthesia occurred in patients having spinal blockade. Farina and Rout have suggested that this high proportion may reflect the misconception that spinal anaesthesia is inherently safe and can be administered with minimal training [26]. Additionally, in seven of the cases, the patient had spinal anaesthesia administered by the surgeon and care handed over to non-medically qualified personnel while the surgeon proceeded with the operation. Though such practice may reflect under-resourcing and may be common in resource-poor areas, it cannot be considered typically acceptable or safe.

Hypotension

Spinal anaesthesia invariably produces a degree of sudden-onset sympathetic block resulting in peripheral vasodilatation and a fall in blood pressure. This condition is often accompanied by a compensatory tachycardia and, if the drop in pressure is severe, nausea and vomiting (posing an airway risk). On occasion, the sympathetic block may be of sufficient extent to inhibit the cardiac accelerator fibres (T1–T4) and thereby precipitate cardiovascular collapse. The incidence of hypotension may be lower with epidurals and also with CSEs if smaller spinal doses are used.

Thus, strategies to promptly recognize and treat hypotension should be in place. Positioning the patient in the left lateral tilt to alleviate aortocaval compression is mandatory and, if not done, will worsen the situation by impeding venous return to the right heart. On occasion, it may be necessary to manually displace the gravid uterus to recover blood pressure. Preloading with intravenous crystalloid fluids before spinal anaesthesia has not been shown to be beneficial, although coadministration of a crystalloid *during* the development of the block is effective in the short term and is an appropriate strategy [27]. Colloids have been shown to be of increased benefit but are relatively expensive, carry a low but important risk of anaphylaxis, and may not be readily available in low-resourced environments. Other techniques such as compression stockings applied to the legs have variable success.

Vasopressors are the cornerstone of blood pressure control, and regional anaesthesia should not be performed unless they are readily available. Ephedrine, metaraminol, and phenylephrine are the most commonly used agents. Recent evidence suggests that the pure alpha-1 adrenergic agonist, phenylephrine, is the agent of choice. Phenylephrine has been shown to result in a higher fetal pH when compared to ephedrine for intraoperative blood pressure control [24]. Phenylephrine can be administered as a bolus or by infusion. Again, familiarity with the agent is required for safe practice.

Phenylephrine may cause a reflex bradycardia which is associated with a fall in cardiac output and therefore may not be the most suitable vasopressor when heart rates are low to begin with. In such cases the alpha- and beta-adrenergic effects of ephedrine may be preferable, as would be the use of a vagolytic agent such as glycopyrronium or atropine. Meticulous attention to cardiovascular parameters is required to ensure safety of mother and child.

High block/total spinal block

High sensory-motor blocks occur when the spread of local anaesthetic extends above the desired level. Such spread can occur unexpectedly during spinal or epidural anaesthesia and may be more common in obese women and those of short stature than in others. However, this event also may be a result of poor management of patient position or excessive dosing of regional anaesthetic drugs. Typically, high blocks are accompanied by hypotension and bradycardia, paraesthesia and numbness of the arms, and shortness of breath as the intercostal muscles become paralysed.

Careful monitoring of the developing sensory and motor block in the first few minutes after giving the spinal or epidural drugs is necessary. In the event of a block spreading too high and too quickly, head-up tilt may prevent further cephalad spread.

Excessively high block of the C3, C4, or C5 nerve roots may impair diaphragmatic function and airway protective reflexes and, if severely compromised, the patient is likely to require intubation and ventilation.

'Total spinal' block is the extreme version of this situation and may occur suddenly when a large dose of additional epidural drug is given through an epidural catheter which has migrated intrathecally, producing a massive dose spinal anaesthetic. Total spinal block manifests itself as a rapid loss of consciousness associated with cardiorespiratory collapse. Management is supportive.

Inadequate block/failed spinal block

Although spinal anaesthesia is widely considered the most reliable and effective regional anaesthetic technique for caesarean section, the incidence of suboptimal sensory block is not infrequent, even in resource-rich countries. In the United Kingdom, conversion to general anaesthesia because

of inadequate spinal anaesthesia is required in approximately 0.5% of cases; however, in resource-poor countries, the prevalence may be as high as 6% [28]. Conversion rates for epidurals that had been used for caesarean section after being used for labour are higher than those for spinals. Hence, the anaesthesia provider relying on regional anaesthesia must also be able to deliver a safe general anaesthetic for the obstetric patient and to manage a potentially difficult airway.

Except in an emergency situation and with the patient's consent, surgery should not commence before adequate anaesthesia has been achieved. Testing of the sensory and motor block before allowing surgery to start will usually alert the anaesthetist to a suboptimal block, whereupon, if time allows, appropriate alternative strategies can be undertaken. Such strategies include repeating the spinal, adding additional medication through the epidural, or performing general anaesthesia if warranted by the clinical situation.

The difficulty for the anaesthetist arises when patients feel discomfort after the start of surgery, which occasionally happens despite an apparently adequate block at the outset. The reasons for inadequate blocks are multifactorial and include operator error, inadequate amounts of drugs, anatomical variation, and prolonged surgery. Strategies to deal with failed spinals should be in place, and failed spinal/epidural algorithms may be useful.

Effective communication between the anaesthetist and the obstetrician is important in addressing this scenario. If the patient experiences pain, surgery should stop immediately and, if the fetus has not yet been delivered, conversion to general anaesthesia is often the most appropriate response. If pain is experienced after delivery, administration of intravenous analgesics such as ketamine and/or opioids should be considered. Entonox (nitrous oxide/oxygen mixture) inhalation, if it is available, can be useful in this situation. Pain and discomfort also may be reduced if the surgeon can limit manipulation of the abdominal contents. At all times, the mother should be kept advised on the actions taken, and general anaesthesia should be offered if the pain is unresolved.

Post-dural-puncture headache

Even with smaller pencil-point needles, post-dural-puncture headache can occur after uneventful spinal anaesthesia. With epidurals, the risk of accidental dural puncture is generally considered to be in the region of 1% but, since epidural needles are of large calibre (16- to 18-gauge), there is a very high risk of consequently developing post-dural-puncture headache (70%).

The headache occurs because the continued CSF leak from the puncture site creates a state of low intracranial pressure. This low-pressure state is thought to induce traction on the intracranial meninges and veins, resulting in headache. The cardinal features are frontal and/or occipital headache worsened by standing or sitting, as gravity further enhances the traction. Additional features such as photo- or phonophobia, nausea, vomiting, or tinnitus may be present [21]. The headache presents within 48 hours in 90% of cases, although there can be a delay of up to 7 days, and usually resolves through natural healing of the dural hole in 1–2 weeks.

Management is dependent on the severity. Oral analgesics (e.g. paracetamol, NSAIDs, and/or simple opioids) may be useful in mild cases. It is important to keep the patient well hydrated. Various other therapies including caffeine have been trialled, but there is little evidence supporting their use. Caffeine may paradoxically make the clinical situation worse by keeping the mother awake.

The only potentially curative treatment for post-dural-puncture headache is epidural blood patch (EBP), and this procedure should be offered to patients with severe or prolonged post-dural-puncture headache symptoms. EBP should be performed by an anaesthetist experienced in epidural anaesthesia, to minimize the risk of further complications. The procedure involves locating the epidural space again with a Tuohy needle and giving approximately 20 ml of autologous blood into the epidural space. Resolution of the headache is often rapid, but the exact mechanism by which the blood patch has its desired effect is unknown; explanations suggesting it creates a physical plug over the offending hole may be overly simplistic.

Apart from the debilitating headache, a persistent CSF leak can cause sufficient traction on vessels to create subdural haematomas [29]. In such circumstances, the nature of the headache is likely to change and other neurological signs may present; thus, patients with unresolved post-dural-puncture headache should always be followed up.

Headaches following regional techniques should not automatically be attributed to post-dural-puncture headache. A careful history and examination should be performed to rule out other causes such as meningitis, pre-eclampsia, cortical vein thrombosis, and subarachnoid haemorrhage.

Neurological complications after neuraxial anaesthesia

The incidence of neurological deficit after delivery in the obstetric population approaches 1%. Most of these issues are transient, due mainly to the mechanics of pregnancy and delivery, and not related to neuraxial anaesthesia. Risk factors have been shown to be primiparity, prolonged second stage, and the use of forceps [30].

Neural injuries directly caused by regional anaesthesia techniques are rare in the obstetric population. The NAP3 has estimated that permanent nerve damage as a consequence of regional anaesthesia has an incidence of 0.2–1.2 : 100,000 [16]. Overall, there was evidence that the incidence of complications after neuraxial block for obstetric indications is extremely low. However, although the numbers were small, there appears to be a higher incidence of complications after combined spinal–epidural anaesthesia compared to spinal or epidural techniques alone.

The majority of obstetric-related injuries result in sensory loss, and a third involve motor fibres. The commonest lesions are areas of numbness or pain on the lateral and anterior aspects of the thigh. This is meralgia paraesthetica and is due to compression of the lateral cutaneous nerve of the thigh, sometimes with the femoral nerve, against the inguinal ligament. Risk factors include obesity, diabetes, and prolonged hip flexion. The common peroneal nerve may also be compressed while in stirrups, resulting in foot drop. Compression of the lumbosacral plexus by the descending fetal head can also result in foot drop. Other nerve palsies include obturator and femoral neuropathy.

Other common side effects of regional anaesthesia

Shivering and shaking is often seen and may interfere with monitoring and surgery, as well as cause distress to the patient. Though unpleasant, this condition usually resolves spontaneously. The cause is unknown and varies from patient to patient.

Nausea and vomiting is a common problem and can pose a risk to the airway. The cause is usually hypotension or vagal hyperactivity. Although appropriate management of hypotension will usually alleviate nausea, occasionally anti-emetics may be necessary.

Itch can also be problematic intra- or post-operatively when neuraxial opioids are used. It responds poorly to treatment with chlorpheniramine. Small doses of intramuscular naloxone (typically 2 μg/kg) may be more effective than chlorpheniramine would be.

Local anaesthetic infiltration

Local infiltration techniques may be useful when a surgeon is working alone, with no anaesthetic equipment or services, such as in low-resource areas [31]. This technique typically is not practised in resource-rich environments, and few surgeons/obstetricians are adequately trained in its use. The procedure involves the sequential infiltration of the skin, rectus sheath, peritoneum, and visceral peritoneum of the uterus with local anaesthetic (e.g. lidocaine). Epinephrine at a dilution of 1:200,000 is usually added

to the lidocaine to allow a large dose to be used safely. Furthermore, epinephrine can help curtail bleeding at the incision site and facilitate an improved surgical field. Patients should be warned of discomfort, and surgery should proceed, if possible, without the use of retractors or packs.

General anaesthesia for caesarean section

Over the decades, there has been a move away from general anaesthesia for caesarean section in resource-rich countries, as regional anaesthesia is generally considered safer and better than general anaesthesia in most circumstances. However, when there is immediate threat to life of mother or baby, or regional anaesthesia is contraindicated (see Table 7.3), general anaesthesia may be needed. With adequate training and cohesive teamwork, general anaesthesia can be established promptly.

Provision for general anaesthesia is usually more complicated and more expensive than for regional anaesthesia, since considerably more equipment and drugs are required. Such provision requires financial and infrastructure investment, maintenance of equipment, and a reliable supply of drugs and anaesthetic gases (see Table 7.4).

In the knowledge that oxygen saturations fall very quickly in pregnant women after induction of anaesthesia, it is absolutely necessary to pre-oxygenate the patient properly, that is, replace as much air in the lungs with oxygen as possible, such as through application of 100% oxygen via a tight-fitting mask (i.e. one with no leaks). Where time permits, this should be for 3 minutes but, in an emergency situation, 5 vital capacity breaths are almost as effective.

Thiopentone has long been the induction agent of choice but increasingly propofol is used. In haemodynamically unstable patients, etomidate or ketamine may be chosen to provide a more stable induction (i.e. less associated hypotension).

Because of the increased risk of pulmonary aspiration, tracheal intubation following rapid sequence induction with cricoid pressure is still considered obligatory when general anaesthesia is administered for caesarean section. Suxamethonium remains the primary relaxant of choice, having the fastest onset of all relaxants. Although supraglottic airway devices (e.g. laryngeal mask, I-Gel, LMA Proseal) have become the mainstay of elective non-obstetric anaesthesia, they have no place in routine general anaesthesia for caesarean section since they do not protect the airway from aspiration.

General anaesthesia is usually maintained with an inhalational agent such as sevoflurane or isoflurane but, in resource-poor areas, halothane or ether may still be in use. Nitrous oxide is often included in the gas mix because of its vapour-sparing and

Table 7.4 Anaesthesia for pre-eclampsia/eclampsia

Condition	Comments
Pre-eclampsia and eclampsia	Regional anaesthesia generally preferred (coagulation permitting) Spinal anaesthesia commonly used Regional anaesthesia induced hypotension less than expected Higher risk of pulmonary oedema Pressor response of general anaesthesia needs to be controlled to reduce risks of cerebral haemorrhage/cardiac ischaemia: opioids, beta blockers, $MgSO_4$ Risks of airway oedema/difficult intubation

analgesic properties, and a minimum of 50% oxygen is recommended before delivery of the baby to optimize fetal oxygenation in utero. Anaesthetic vapours cause relaxation of the uterus and may result in increased bleeding and, while a Cochrane review of over 1700 patients showed greater blood loss in caesarean sections under general compared to regional anaesthesia, there was no difference in transfusion requirements between the groups [32]. However, when uterine atony is present, it may be prudent to turn off the anaesthetic vapour and maintain anaesthesia with an intravenous agent instead (e.g. propofol).

An anaesthetic machine is required to provide anaesthetic vapours and ventilation; such machines range from the highly sophisticated to the simple-to-use, simple-to-maintain draw-over devices still in use in resource-poor areas (where there may be no reliable electricity or pressurized gas supplies).

There is always a balance to be drawn between giving the mother adequate anaesthesia to guarantee unconsciousness/prevent awareness and giving an excessively deep anaesthetic which then depresses the baby; for this reason, opioid analgesia is usually not given until after delivery of the baby. Ideally, a multimodal approach will be taken with respect to analgesia, incorporating opioid, non-steroidal analgesic agent, and paracetamol, as well as local anaesthesia infiltration to the wound. Recently, interest has been shown in the use of transversus abdominis plane (TAP) blocks, which can provide prolonged and effective post-operative analgesia after caesarean section (see 'Analgesia in the post-operative period following caesarean section').

At the end of the operation, residual muscle relaxant should be reversed, and the patient extubated fully awake (i.e. with good airway reflexes present) either head down on the side, or sitting upright. She should then be monitored in a monitored setting (i.e. a recovery room) until fully awake. Recent maternal mortality reports from the United Kingdom show that patients are still at risk of airway and respiratory compromise after the end of the operation and that they need close observation during this time [1]. The components of safe general anaesthesia are summarized in Box 7.2.

Box 7.2 Components of safe general anaesthesia

Components of safe general anaesthesia include:

- Antacid prophylaxis (ranitidine, sodium citrate);
- Preoxygenation (supply of oxygen);
- Anaesthetic machine;
- Monitoring equipment;
- Drugs (induction agent, muscle relaxants, inhalation agent, analgesia, reversal);
- Rapid sequence induction (training, suxamethonium);
- Tracheal intubation (laryngoscope, tracheal tubes, difficult airway equipment);
- Ventilation (ventilator or manual bag squeeze);
- Inhaled vapours to maintain anaesthesia (vaporizer, agent, nitrous oxide);
- Monitoring in immediate post-operative recovery period (training, staff).

Failed intubation

Failed intubation is one of the most stressful and acute of anaesthetic crises and, unless prompt and appropriate action is taken by the anaesthetist, the mother may die from hypoxia. An old adage is that 'women don't die from failed intubation, they die from failure to stop trying to intubate.' Thus, having failed to intubate, the main priority is to ventilate the patient to regain adequate oxygenation.

Achieving this end may mean bagging the patient with a face mask and airway. Increasingly anaesthetists are becoming familiar with supraglottic airways and may use one of these devices in order to maintain oxygenation, even though such devices do not protect against aspiration.

Assuming airway manoeuvres improve oxygenation, the anaesthetist may try to intubate again; but, if this attempt is unsuccessful, the anaesthetist will need to make a decision on whether to wake the mother up or to allow surgery to proceed with what will always be considered a suboptimal airway (and one which is unprotected from aspiration of gastric contents).

This decision will be based on the relative security of the airway, the clinical indications for caesarean

section, and the experience of the anaesthetist, but there is a strong argument which says anaesthetists should always wake a mother up after failed intubation rather than proceeding with a suboptimal unprotected airway *unless the caesarean section is being performed for maternal life-saving reasons (e.g. haemorrhage, collapse)*. The safety of the mother will be considered to outweigh any perceived risks to the baby, even in the case of non-reassuring fetal status.

In this situation, which is stressful not just for the anaesthetist but also for the obstetric team, good communication and collective understanding of relevant issues and needs are crucial.

If the lungs cannot be ventilated using routine rescue techniques, including the use of supraglottic airways, then cricothyroidotomy or tracheostomy is the next step. Anaesthetists can prepare for unexpected failed intubation by using simulation-based scenarios in training sessions.

Intravenous ketamine for caesarean section

Ketamine is commonly used in resource-poor countries as an induction agent and also as a sole anaesthetic agent without intubation and other aspects of traditional general anaesthesia. It causes a 'dissociative anaesthesia' by inhibiting the connections between thalamo-cortical and limbic systems, resulting in a trance-like state with profound anaesthesia. Importantly, cardiovascular stability and respiratory reflexes are maintained, and ketamine is popular in the low-resource setting, where it is sometimes used as the sole anaesthetic agent without airway control. There is still potential for aspiration of gastric contents, but the risk of this is not well quantified and probably low.

Ketamine stimulates salivary secretions, and an antisialogogue (e.g. atropine) is commonly used to control this side effect. Post-operative delirium is common and may be attenuated by a small dose of a benzodiazepine given after delivery of the baby. Ketamine does not provide optimal surgical conditions as there is no muscle relaxation, and tonic contraction of the uterus can make disengagement of the fetal head difficult in obstructed labour. Furthermore, patients under ketamine often have involuntary movements and phonate, which both surgeon and anaesthetist will need to handle.

This technique, although probably quite common in resource-poor settings, cannot be considered best practice. There is very little published data on the use of ketamine as sole anaesthetic agent for caesarean section, and the World Health Organization advises that this technique be reserved for situations when equipment and anaesthetic expertise are unavailable. However, there also is no evidence to suggest that it is any less safe than an inexperienced, poorly trained, unsupported anaesthetist trying to deliver a traditional intubation-based anaesthetic in a low-resource setting [33].

Anaesthesia for pre-eclampsia

Regional anaesthesia is the preferred technique for women presenting with pre-eclampsia or eclampsia and many may have epidural analgesia instigated in labour before presenting for caesarean section (see Table 7.5). Eclampsia is not in itself a contraindication to regional anaesthesia, providing coagulation status and level of consciousness are acceptable. Following an eclamptic convulsion, administration of $MgSO_4$ and blood pressure control should be considered a prerequisite before rushing to emergency caesarean section.

Spinal anaesthesia, which traditionally has been avoided in severe pre-eclampsia because of concerns about an increased risk of hypotension, is now considered a safe and appropriate technique to use [34].

The endothelial dysfunction in pre-eclampsia causes leaky capillaries, and patients with pre-eclampsia are at particular risk of developing pulmonary

Table 7.5 Summary of pros and cons of anaesthesia for caesarean section

	Comments	Pros	Cons
Local infiltration	'Squirt-and-cut' technique by surgeon	May be useful where no anaesthetic services are available	Few surgeons have the training to perform this now Relatively uncomfortable for patient Risk of local anaesthetic toxicity
Spinal anaesthesia	Probably commonest technique worldwide Simple, easy to learn technique Currently the commonest cause of anaesthesia-related mortality in South Africa	Quick to perform Reliable dense block Cheap Little airway risk (but NB: having an airway-competent practitioner present is essential) Generally considered very safe Mother awake, so mother–baby bonding can occur rapidly Neuraxial opioid may be given for post-op analgesia	Finite duration of block (~2 hours) Hypotension Vasopressors may be needed Fetal acidosis associated with high ephedrine use Low risk of post-dural-puncture headache
Epidural anaesthesia	Usually for women who already have an epidural for labour analgesia	Top-up is easy if epidural already in situ Duration of block may be extended ad infinitum by top-ups Mother awake, so mother–baby bonding can occur rapidly Neuraxial opioid may be given for post-op analgesia	May take longer than to work than spinal anaesthesia would Large-dose local anaesthesia More complicated than spinal anaesthesia Risk of local anaesthetic toxicity/total spinal block Risk of dural tap and post-dural-puncture headache
Combined spinal–epidural anaesthesia	Popular among a minority of enthusiasts Usually needle-thru-needle technique	Potential benefits of fast spinal with extendable titratable epidural block Mother awake, so mother–baby bonding can occur rapidly Neuraxial opioid may be given for post-op analgesia	Most complicated regional anaesthesia technique Requires additional equipment Requires a long learning curve Potential side effects/complications of both spinal and epidural anaesthesia Disproportionately high neurological complication rate compared to spinal or epidural anaesthesia alone
General anaesthesia	The default fall-back technique when regional anaesthesia not possible or contraindicated Intubation with rapid sequence induction expected Indicated for sick and unstable patients Indicated for very urgent caesarean section	Fast(est), most reliable technique Mother asleep Airway secure (once intubated) Can be used to manage unstable patients	Training required Complex equipment required Risks of failed intubation/aspiration Risk of uterine atony/increased blood loss Risk of awareness Post-op pain relief may be problematic Post-op nausea and vomiting Drug transfer to baby; neonatal depression Delayed mother–baby bonding
Ketamine (sole agent)	May be useful in resource-poor settings where no (or poorly trained/poorly equipped) anaesthetic practitioners are available Produces dissociative-type anaesthesia Frequency of use in resource-poor settings unclear, but little documentation in literature	Minimal equipment required Cheap Patients maintain their own airway Supports blood pressure	Patients may move during surgery Safety not established Small (unquantified) risk of aspiration Post-op delirium

oedema if excessive intravenous fluids are administered; correspondingly, intravenous fluid management should be prudent.

General anaesthesia is indicated in a minority of cases in which neuraxial techniques are contraindicated, most commonly when coagulopathy has developed. General anaesthesia provides particular challenges in this group of patients, compounding the usual problems of general anaesthesia with additional risks: the airway is likely to be oedematous, and visualization of the glottis may prove difficult or even impossible, leading to difficult or failed intubation [35, 36].

Importantly, the hypertensive response to laryngoscopy is exaggerated in pre-eclampsia and, unless attenuated in some way, this response may cause intracranial haemorrhage or cardiac ischaemia. Short-acting opioids (e.g. such alfentanil, fentanyl, and remifentanil), $MgSO_4$, and beta blockers all may be used. Since no single drug or combination has been shown to be superior, the drug(s) used to control the hypertensive response should be dictated by drug availability and familiarity to the anaesthetist. If opioids are used before delivery of the baby, it is prudent to be prepared for a degree of neonatal respiratory depression, since these drugs readily cross the placenta.

Emergence from anaesthesia is also a crucial period, as the blood pressure is likely to spike during extubation. Conscientious attention to prevent undue blood pressure rises is required. In this setting, opioids may delay emergence, and short-acting beta blockers may be more appropriate. Post-operatively, these patients require increased levels of monitoring and care.

Analgesia in the post-operative period following caesarean section

Immediate post-operative monitoring in a dedicated recovery unit by staff trained in recovery skills should follow all caesarean sections, regardless of the mode of anaesthesia. This approach is to ensure that early complications of surgery and anaesthesia can be quickly detected and managed. Vital signs, including the respiratory rate, oxygen saturations, temperature, blood pressure, heart rate, and heart rhythm, are normally assessed at short intervals. Additionally, pain scores, nausea scores, and the level of consciousness are all documented [1]. Patients who have received neuraxial anaesthesia should have the residual level of block, and its disappearance, recorded before discharge.

Pain following caesarean section is both somatic (form the skin, fascia, and muscles) and visceral (peritoneum, visceral structures) in origin. Adequate pain control enables mothers to mobilize earlier, thereby reducing the risk of thromboembolic events, and enhancing bonding with her baby [37].

When regional techniques are used, opioids (e.g. morphine, diamorphine) may be administered via the intrathecal (spinal) or epidural route to confer effective analgesia, which lasts between 12 and 24 hours. This technique is very much preferred in resource-rich countries, and the dose of opioids administered is sufficiently small that there is a very low concentration systematically and transfer to the breast milk is clinically insignificant.

Parenteral opioids are the mainstay of post-operative management in those who have had a general anaesthetic for caesarean section or in those for whom opioids given through a regional technique are contraindicated. Patient-controlled analgesia systems are widely used in resource-rich areas, although cost, complexity, and security issues limit their availability in resource-poor countries.

As part of the multimodal approach, paracetamol and NSAIDs (if not contraindicated) may also be given. While opioids in general are useful in controlling visceral pain, agents such as NSAIDs will reduce inflammation in the tissue and reduce somatic pain.

The use of local anaesthetics to infiltrate around the wound and to block afferent nerves is another useful adjunct. Wound infiltration with agents such as 0.5% bupivacaine can give a few hours of post-operative analgesia, but in general the effects

are relatively short-lived. Nerve blocks (e.g. ilioinguinal, hypogastric) and rectus sheath catheters may be useful in reducing opioid consumption.

Recently, there has been growing interest in the use of the TAP block, where local anaesthetics are deposited between the internal oblique and the transverse abdominis muscles, either under ultrasound guidance or blindly by using a landmark technique. TAP blocks have been shown to be effective and reduce both 24- and 48-hour opioid requirements [38, 39].

Key learning points

1. Regional anaesthesia (spinal, epidural, CSE) is the default technique for caesarean section unless contraindicated.
2. For Category 1 caesarean section (imminent threat to life of mother or baby), there should be discussion between the obstetrician and anaesthetist regarding whether there is time to attempt a regional technique or whether general anaesthesia is required.
3. Pain during caesarean section under ineffective regional anaesthesia is the commonest cause of obstetric anaesthesia-related litigation.
4. Serious long-term complications following regional anaesthesia are extremely rare.
5. The risk of aspiration of gastric contents mandates the use of rapid sequence induction and intubation when general anaesthesia is required for caesarean section.
6. In the event of failed intubation at general anaesthesia for caesarean section, consideration for the mother's life and well-being will take precedence over that of the fetus.
7. Effective team work and continual communication between anaesthetists, obstetricians, and midwives is mandatory for the safety of mother and baby.
8. Headaches after regional anaesthesia warrant full investigation and must not be solely attributed to dural puncture.
9. In women with pre-eclampsia, regional anaesthesia is preferred. General anaesthesia should only be conducted by experienced anaesthetists, and blood pressure control at induction and emergence is crucial.
10. Following a caesarean section, the mother must be observed in a dedicated recovery area by adequately trained staff prior to discharge to the ward.

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