

MONITORING DURING CAESAREAN SECTION

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Recommendations for monitoring during Caesarean section (CS) have been developed by the American Board of Anesthesiologists and the Obstetric Anaesthetists Association (OAA) in the UK. The OAA's recommendations are reproduced in full in Box 1. Not all anaesthetists have access to complex equipment, but every anaesthetist should be aware of the potential problems that may be encountered and make appropriate use of the monitors they do have. The requirements for regional and general anaesthetics are different and so considered separately. **All obstetric patients undergoing CS should be positioned with left lateral tilt to avoid aorto-caval compression.** (See Update in Anaesthesia 1999).

Regional anaesthesia

Most of the monitoring is clinical since awake mothers are excellent monitors of their own physiology. The anaesthetist should be continuously present from the start of anaesthesia to the completion of surgery.

Assessment of analgesia

A major cause of maternal complaint is pain during CS under regional anaesthesia. For CS, a block should extend from S4 to the upper thoracic dermatomes. One common reason for inadequate pain relief is a failure of the block to spread to the sacral dermatomes. Although this happens more frequently with epidural than spinal anaesthesia,

whichever technique is used, always test the back of the legs (S2 and S3) to confirm that the sacral dermatomes are blocked before surgery starts.

How high a regional block must extend into the thoracic dermatomes to achieve intraoperative analgesia, remains controversial. Recommendations from T10 to T4 have been made, although the method of testing the block is often unspecified and the need for supplemental analgesics not mentioned. The three most commonly used methods of assessment are:

- loss of temperature sensation
- loss of pinprick sensation
- loss of light touch sensation.

These may differ by as much as 10 dermatomes, with temperature sensation lost first and light touch sensation last. Experimental data suggests that intraoperative analgesia is most reliably predicted by blocking light touch sensation (the hub of a needle lightly applied to the skin) to T5 (just beneath the nipples).

Haemodynamic consequences of regional anaesthesia

Extensive epidural and spinal blocks cause a temporary sympathectomy which makes the patient susceptible to hypotension. In pregnant women, this is made worse by the uterus compressing the aorta and inferior vena cava (aorto-caval occlusion). Hypotension may develop rapidly. Therefore, blood pressure should be measured at least every two minutes from starting a regional block until

delivery. Nausea during onset of a regional block is usually an indication of hypotension.

Blocks above T4 cause a loss of sympathetic innervation to the heart which may be associated with bradycardia particularly if aorto-caval occlusion is present. Because of this continuous monitoring of the pulse is essential.

Respiratory consequences of regional anaesthesia

Pregnant women are prone to hypoxia because of a reduction in functional residual capacity (FRC) of the lungs and an increased oxygen consumption. This is compounded during regional blocks by abdominal and intercostal muscle weakness which causes a further reduction in FRC. Pulse oximetry not only monitors the pulse but also provides a continuous non-invasive monitor of the saturation of arterial haemoglobin. It is simple and accurate; always use it if you can.

When the thoracic dermatomes are blocked, patients often complain of a strange sensation when breathing, usually as they realise that they cannot produce a forceful cough. This is normal and a result of intercostal paralysis and the patient can be reassured. However difficulty in speaking represents diaphragmatic paralysis developing and needs very careful assessment of the level of block. Further spread of local anaesthetic must be minimised. If hyperbaric local anaesthetic has been used, this can be done by careful elevation of the head and neck. However be prepared to intubate and support these patient's ventilation.

Unexpected high blocks

“Total spinal” or very high blocks may follow excessive spread of a deliberate intrathecal injection of local anaesthetic or be caused by an epidural catheter that is misplaced in the subarachnoid space. Misplaced epidural catheters can be detected by attempting to aspirate CSF through the catheter and carefully assessing the effect produced by a test dose. An appropriate test dose will produce detectable changes in sensory and motor function within five minutes of injection if the catheter is in the subarachnoid space and no significant effect if the catheter is in the epidural space.

The spread of deliberate intrathecal injections of hyperbaric (heavy) local anaesthetics can be controlled by keeping the upper thoracic and cervical spine elevated. As spinal blocks sometimes extend very rapidly, you must check the spread of the block within 4 minutes of injection and reposition the patient if necessary.

Box 1: Recommendations for monitoring during caesarean section

For operative delivery under regional block

Continuous pulse oximetry, non invasive blood pressure and continuous ECG during induction, maintenance and recovery.

The fetal heart rate should be recorded during initiation of regional block and until abdominal skin preparation in emergency caesarean section.

During general anaesthesia

Continuous inspired oxygen and end-tidal carbon dioxide concentration should be monitored, as well as pulse oximetry, non-invasive blood pressure and ECG.

Symptoms of high blocks are predictable. As the block extends the hands become warm and dry, then loss of hand and arm movement follows. Loss of abduction of the shoulder may be rapidly followed by diaphragmatic paralysis. At the same time sensation is lost over the upper chest, hands, arms, shoulder and neck. If the block extends further, consciousness may be lost and the pupils may become fixed and dilated. However all these signs will reverse provided cardiovascular and respiratory support are provided.

Regional blocks may continue to extend for at least 30 minutes after local anaesthetic has been injected, so the anaesthetist must remain vigilant for symptoms of high blocks even after surgery has started.

Monitoring the injection of local anaesthetic

Accidental intravenous injection of local anaesthetics may occur with epidural anaesthesia and although deaths are rare, convulsions occur in 1 in 500 - 9000 patients. This risk can be minimised by carefully aspirating before each injection, by assessing the effect of a small initial test dose of local anaesthetic and by splitting all large doses of local anaesthetics into several small portions. Every dose must be assessed for symptoms of intravenous injection (Table 1) even when previous doses have been uncomplicated.

Table 1: Symptoms of intravenous injection of local anaesthetic

Tingling around the mouth
Tinnitus (ringing in the ears)
Visual disturbance
Confusion
Slurred speech
Altered conscious state
Convulsions
Coma
Cardiovascular collapse
Cardiac arrhythmias

General anaesthesia

Patients undergoing CS performed under general anaesthesia should be monitored in the same way as with any general anaesthetic. The obstetric anaesthetist should be particularly aware of airway problems and episodes of hyper- or hypotension.

Monitors of intubation

Failure of intubation and oxygenation remains one of the commonest causes of anaesthetic related maternal deaths. Confirmation of the correct placement of an endotracheal (ET) tube is crucial. Various monitors are available to help the anaesthetist, but seeing the ET tube pass through the glottis remains the most valuable. However the presence of bilateral breath sounds should always be checked and, when possible, the presence of expired CO₂ confirmed. Figure 1 shows ten simple clinical tests of correct placement of a tracheal tube.

The oesophageal detection device is a useful additional monitor. It is cheap and easily constructed using a 50 ml syringe or a self inflating bulb. If a negative pressure is applied by the syringe to a correctly positioned endotracheal (ET) tube, gas can be aspirated because the trachea is supported by rigid cartilage. However if the ET tube is misplaced in the oesophagus and a negative pressure applied, the oesophagus will obstruct the tip of the ET tube and gas cannot be aspirated. (see Update number 1997;7)

Monitors of ventilation

As with regional anaesthesia the pregnant mother is vulnerable to hypoxia; look at the patient's colour and at movement of the chest wall. If you are ventilating by hand feel for any changes in resistance to ventilation - if you are using a lung ventilator look regularly at and make a note of the inflation pressure. Always use a pulse oximeter if you have one.

Haemodynamic consequences of general anaesthesia

Aorto-caval occlusion means that mothers are vulnerable to hypotension, while hypertension may occur with laryngoscopy and surgical stimulus. Pre-eclamptic mothers are particularly vulnerable to hypertension on laryngoscopy. So, as with regional anaesthesia, blood pressure must be measured at least every two minutes until delivery and the pulse continuously.

Monitors for awareness

To reduce fetal depression and uterine relaxation, anaesthetists have sometimes used low doses of anaesthetic agents in a paralysed mother during CS. This has resulted in some mothers being awake and in severe pain. No single monitor reliably predicts awareness, although signs of sympathetic stimulation - sweating, tachycardia, hypertension and pupillary dilation - should always be regarded with concern.

The most reliable method of ensuring the mother is asleep, is to give adequate doses of induction agents and an initial overpressure of inhalational agents (ie twice MAC for 5 min, 1.5 times MAC for the next 5 min and 0.8 times MAC thereafter).

Neuromuscular blockade

With modern short acting muscle relaxants, reversal of neuromuscular block at the end of caesarean section is rarely a problem. The exception is if the mother has been treated with magnesium sulphate. Magnesium enhances the action of non-depolarising muscle relaxants. So in these patients, assessing neuromuscular function is important, ideally with a nerve stimulator but alternatively clinical methods may be used, such as assessment of hand grip or head lift.

Fetal monitoring

Various monitors of fetal condition are available. Fetal heart rate (FHR) monitoring is the most common. The FHR may be recorded intermittently with a stethoscope, by abdominal ultrasound, or with a fetal scalp electrode. A normal FHR has a 95% association with good fetal condition, and a prolonged and continuing bradycardia is almost always associated with severe fetal distress.

During CS, the FHR should be monitored from the start of anaesthesia until abdominal skin preparation especially if the fetus is already distressed. Knowing that the FHR is not critical, may allow time for a regional technique to be used, when otherwise a general anaesthetic might have to be performed. Knowledge of the FHR is also useful if a failed intubation occurs during general anaesthesia. The FHR can influence the decision to either wake the mother

Figure 1. 10 Clinical tests of tracheal intubation

Test	Result	Significance	Reliability
Look with laryngoscope	Tube passes between cords	Correct tracheal intubation	Certain
Listen/feel	Breathing through tube	Correct tracheal intubation	Probable
Tap sternum	Air comes out through tracheal tube	Correct tracheal intubation	Probable
Inflate with SIB*	Chest rises & falls	Correct tracheal intubation	Probable
Inflate with SIB*	Gurgling noise	Oesophageal intubation (REMOVE TUBE)	Probable
Pass catheter down inside tube	Patient coughs (if not paralysed)	Correct tracheal intubation	Probable
Look	Patient remains pink after intubation	Correct tracheal intubation	Probable
Look	Patient becomes cyanosed after intubation	Oesophageal intubation (REMOVE TUBE)	Certain
Stethoscope	Air entry at both apices both axillae & both bases	Correct tracheal intubation	Probable
Stethoscope	Air entry over stomach	Oesophageal intubation (REMOVE TUBE)	Probable

* = self inflating bag.

The capnograph or an oesophageal detection device (see above) are the most useful pieces of equipment to confirm intubation

and perform a regional technique, or continue surgery with a face mask.

Special problems.

While the monitoring requirements for uncomplicated Caesarean deliveries are straight forward, additional monitors may be required if other pathologies are present. As haemorrhage, embolism, hypertensive disorders of pregnancy and maternal cardiac conditions are associated with more than 50% of maternal deaths in the UK, these conditions deserve special mention.

Major haemorrhage

Major haemorrhage may be life threatening. Whenever major haemorrhage occurs, invasive cardiovascular monitoring should be used if available. This should include hourly urine output measurement, temperature monitoring and central venous pressure and invasive arterial pressure monitoring.

Embolism

The triad of hypocapnia, hypoxia and hypotension should alert the anaesthetist to the possibility of an embolism. Air embolism, thromboembolism and amniotic fluid embolism may all occur. Minor air embolism can be detected in almost every caesarean section. However it is extremely unusual for this to have any clinical significance. Thromboembolism causes approximately 25% of UK maternal deaths, but rarely presents during surgery. Perioperatively, amniotic fluid embolism is the greatest risk. If embolism is suspected then invasive cardiovascular monitoring should be considered and the clotting cascade assessed. Amniotic fluid embolism is often associated with a coagulopathy.

Hypertensive disorders of pregnancy

Severe pre-eclampsia is associated with a reduced plasma volume, while total body water is increased. Laryngeal oedema may make intubation difficult and hypertensive responses to intubation may be greatly increased. Treatment with magnesium may prolong the action of muscle relaxants. (see Update in Anaesthesia 1998;9) Renal failure may be present. Monitoring should be tailored to detect these problems and particular consideration given to invasive monitoring of central venous pressure, arterial blood pressure and hourly urine output.

Maternal cardiac conditions

Pregnancy stresses the cardiovascular system, particularly at delivery, when large fluid shifts and rapid changes in the pre- and after-load of the heart occur. These changes may be compounded by anaesthesia. Patients with cardiac disease, especially significant shunts or stenotic valvular lesions, are vulnerable to these changes. Some patients will require invasive cardiac monitoring throughout the perioperative period.

Conclusions

Caesarean sections are so common that the risks are often ignored. However in a recent survey, 82% of anaesthetic related deaths occurred during Caesarean section. The obstetric anaesthetist can reduce the risk to his patients by careful monitoring. The monitors should be tailored to detecting the problems that may be encountered so that they can be corrected before mother or fetus are harmed.
