South Australian Perinatal Practice Guideline

Fetal Acid Base Balance Assessment

Note:

This guideline provides advice of a general nature. This statewide guideline has been prepared to promote and facilitate standardisation and consistency of practice, using a multidisciplinary approach. The guideline is based on a review of published evidence and expert opinion.

Information in this statewide guideline is current at the time of publication.

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Health practitioners in the South Australian public health sector are expected to review specific details of each patient and professionally assess the applicability of the relevant guideline to that clinical situation.

If for good clinical reasons, a decision is made to depart from the guideline, the responsible clinician must document in the patient's medical record, the decision made, by whom, and detailed reasons for the departure from the guideline.

This statewide guideline does not address all the elements of clinical practice and assumes that the individual clinicians are responsible for discussing care with consumers in an environment that is culturally appropriate and which enables respectful confidential discussion. This includes:

- The use of interpreter services where necessary,
- Advising consumers of their choice and ensuring informed consent is obtained,
- Providing care within scope of practice, meeting all legislative requirements and maintaining standards of professional conduct, and
- Documenting all care in accordance with mandatory and local requirements

Explanation of the aboriginal artwork:
The Aboriginal artwork used symbolises the connection to country and the circle shape shows the strong relationships amongst families and the Aboriginal culture. The horse shoe shape design shown in front of the generic statement symbolises a woman and those enclosing a smaller horse shoe shape depicts a pregnant woman. The smaller horse shoe shape in this instance represents the unborn child. The artwork shown before the specific statements within the document symbolises a footprint and demonstrates the need to move forward together in unison.

Australian Aboriginal Culture is the oldest living culture in the world yet Aboriginal people continue to experience the poorest health outcomes when compared to non-Aboriginal Australians. In South Australia, Aboriginal women are 2-5 times more likely to die in childbirth and their babies are 2-3 times more likely to be of low birth weight. The accumulative effects of stress, low socio economic status, exposure to violence, historical trauma, culturally unsafe and discriminatory health services and health systems are all major contributors to the disparities in Aboriginal maternal and birthing outcomes. Despite these unacceptable statistics the birth of an Aboriginal baby is a celebration of life and an important cultural event bringing family together in celebration, obligation and responsibility. The diversity between Aboriginal cultures, language and practices differ greatly and so it is imperative that perinatal services prepare to respectfully manage Aboriginal protocol and provide a culturally positive health care experience for Aboriginal people to ensure the best maternal, neonatal and child health outcomes.

Purpose and Scope of Perinatal Practice Guideline (PPG)

The purpose of this guideline is to give information about monitoring of fetal wellbeing in labour. It describes indications and contraindications for fetal scalp blood sampling as well as how to undertake the procedure. Similarly, information is provided about cord blood gas sampling as the best determinant of fetal metabolic condition at the moment of birth.

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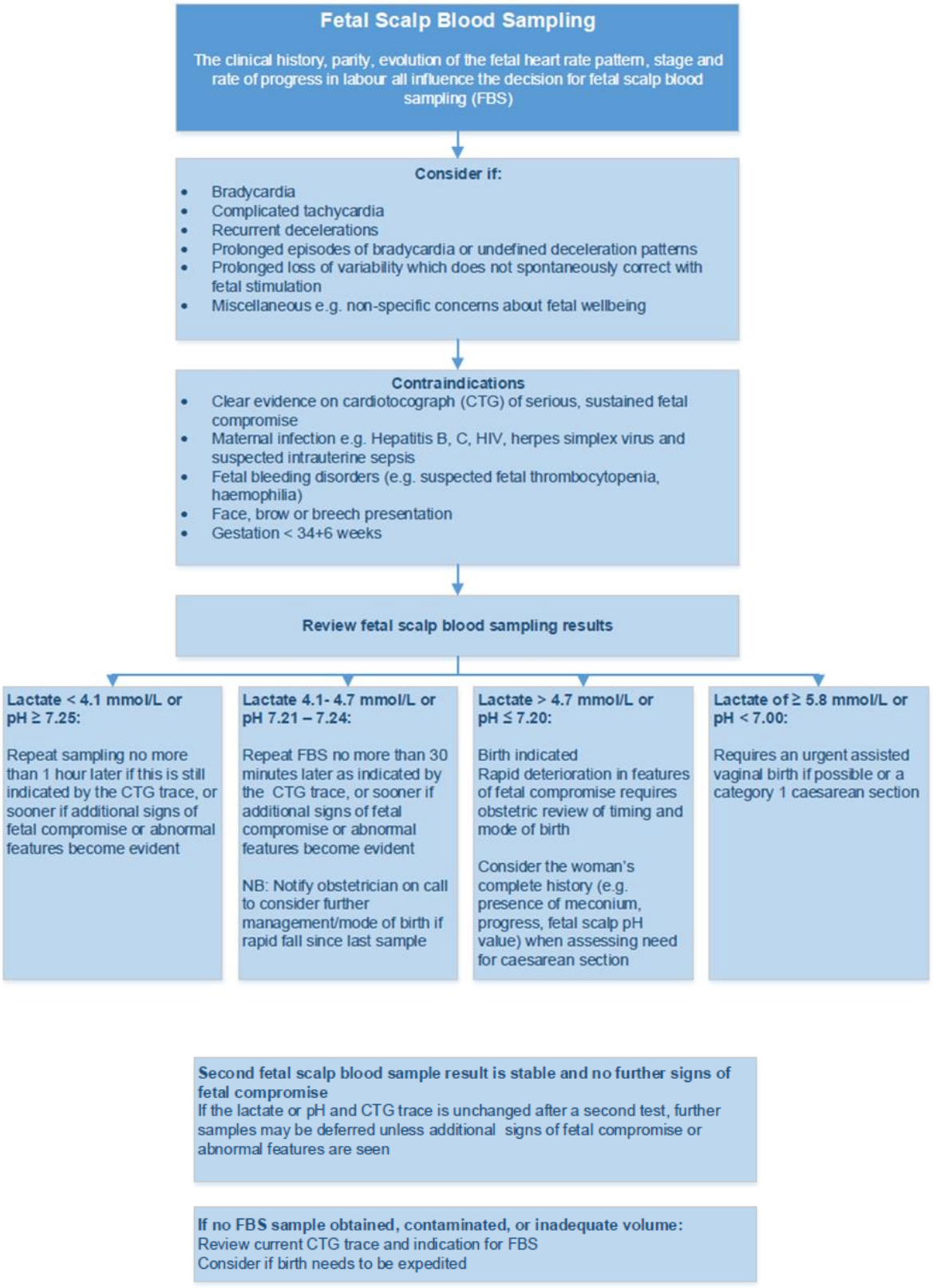
Flowchart: Fetal Scalp Blood Sampling



Fetal Acid Base Balance Assessment

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Summary of Practice Recommendations

In tertiary centres, fetal scalp blood sampling (FBS) should be considered part of routine care for the management team when indicated.

Interpretation of FBS results should take into account any previous scalp pH or lactate results, labour progress and the complete clinical picture.

FBS should not be undertaken in the presence of maternal infection, fetal bleeding disorders, malpresentation (e.g. breech, brow, face) or when there is clear evidence of sustained serious fetal compromise on CTG.

FBS is not recommended in pregnancies less than 35 weeks' gestation.

Scalp lactate rather than pH measurement may be easier to perform and more affordable.

Undertaking FBS may unnecessarily increase the decision to birth interval when expediting birth is indicated (e.g. evidence of serious fetal compromise).

Paired umbilical arterial and venous cord blood gases should be taken whenever fetal compromise is suspected (see Indications).

Once available, abnormal cord blood gas results should be discussed with the neonatal/ paediatric team.

Abbreviations

CTG	Cardiotocography
FHR	Fetal Heart Rate
ECG	Electrocardiography
cm	Centimetres
RANZCOG	Royal Australian and New Zealand College of Obstetricians and Gynaecologists
HIV	Human Immunodeficiency virus
mL	Millimetre(s)
e.g.	For example
%	Percentage
RCOG	Royal College of Obstetricians and Gynaecologists
i.e.	That is
C	Celsius
g	Gauge
mmol/L	Millimols per litre
pCO_2	Partial pressure of Carbon Dioxide
FBS	Fetal Blood Sampling

Introduction

Intrapartum fetal surveillance frequently involves the use of a cardiotocograph (CTG).[1] The CTG is an electronic method of simultaneously recording the fetal heart rate (FHR), fetal movements and uterine contractions to identify the probability of fetal hypoxia. In nearly half of all CTG tracings, an abnormal fetal heart rate is observed, but only a small proportion of these fetuses are actually hypoxic.[2] Cardiotocography has a high degree of sensitivity but a low level of specificity.[3] Fetal blood sampling is usually performed to better assess fetal acid-base status in the setting of an abnormal CTG.[3]

Tests to monitor fetal wellbeing in labour

Several ancillary tests to continuous fetal heart rate monitoring have been proposed to decrease the false positive rate, or even to replace it completely. These include:

- Fetal scalp blood sampling*
- Fetal scalp stimulation
- Fetal ECG ST analysis
- Fetal oximetry

The gaps in understanding of the precise pathophysiology of the development of metabolic acidosis during labour hinders the efficacy of ALL of the above fetal tests.[4]

*Fetal scalp blood sampling will be discussed in detail below

Fetal scalp stimulation

Fetal scalp stimulation during vaginal examination is a non-invasive assessment of the fetus that may provide assurance alongside continuous fetal heart rate monitoring and fetal scalp blood sampling in cases of suspected fetal compromise. The likelihood ratio of an acceleration following fetal scalp stimulation for having low scalp pH is 0.5.[7] If fetal scalp stimulation leads to an acceleration in the fetal heart rate, clinicians can regard this as a reassuring feature and take this into account whilst reviewing the whole clinical picture.[5]

Fetal electrocardiograph (ECG) ST analysis

Meta-analysis of randomised controlled trials has shown fetal ECG ST analysis reduces the need for fetal scalp blood sampling by about 40%. However, the trends to lower rates of low Apgar scores and acidosis were not statistically significant.[6] ST analysis of the fetal ECG in labour reduces the need for fetal blood sampling but has no other statistically significant benefit and does not reduce the caesarean section rate.[6]

Currently, RANZCOG states there is insufficient evidence to recommend routine fetal ECG ST analysis for use in intrapartum fetal surveillance.[1]

Fetal pulse oximetry

Currently, RANZCOG states there is insufficient evidence to recommend routine fetal pulse oximetry for use in intrapartum fetal surveillance.[1]

Fetal pulse oximetry results are affected by the presence of meconium and blood and a recent Cochrane review has concluded that fetal pulse oximetry is not associated with improvement in fetal outcomes.[7]

Fetal scalp blood sampling

A recent systematic review of intermittent auscultation versus continuous CTG in both low and high risk women reveals a significant increase in the caesarean section rate in the CTG group, whether fetal blood sampling was deployed in labour or not.[1,8] It is therefore possible that the availability of fetal blood sampling in labour will lessen the increase in the caesarean rate that comes as a consequence of using continuous CTG.[8]

Although fetal scalp blood sampling is generally considered to be a safe test, rare complications (e.g. haemorrhage, scalp abscess and drainage of cerebrospinal fluid) and questions regarding the accuracy of current, normal and abnormal values for fetal scalp pH (derived from two small studies) as well as the accuracy of pH levels obtained from a fetal scalp venous sample have led some medical experts to question if this procedure is clinically and scientifically acceptable.[4,8]

RANZCOG supports the practice of fetal scalp blood sampling, particularly in larger units that have ready access to operative delivery if required.[1] However, RANZCOG acknowledge that it is not practical for ALL Australian and New Zealand hospitals to provide fetal blood sampling. For example, in some hospitals, undertaking fetal blood sampling may delay a necessary birth and thereby worsen outcomes by lengthening the decision to birth interval for an emergency caesarean section.[1]

- In the past, some hospitals interested in providing fetal blood sampling were unable to because of the costs of maintaining the necessary hardware. More recently, the introduction and validation of scalp lactate measurement has provided an affordable alternative.1 If fetal scalp blood sampling is indicated, the use of scalp lactate rather than pH measurement will provide an easier and more affordable adjunct to electronic fetal heart rate monitoring for most units.[1,9]
- If fetal scalp blood sampling is performed, the scalp lactate or pH result should be interpreted taking into account any previous lactate or pH measurement, the rate of progress in labour and the clinical features of the woman and baby.[1,5]
- Inform the senior consultant obstetrician on call if any fetal scalp blood sample result is abnormal

In situations where fetal blood sampling is contraindicated (see below) or not possible, decisions regarding birth should take into account the severity of the fetal heart rate abnormality and the clinical situation. Birth should be expedited where:

- There is clear evidence of serious fetal compromise (fetal scalp blood sampling should not be undertaken)[1]
- CTG abnormalities are of a degree requiring further assessment, but fetal scalp blood sampling is contraindicated, clinically inappropriate or unobtainable[1]
- The decision to birth interval may be prolonged by virtue of location, clinical staff availability, patient factors or access to clinical services[1]

Fetal scalp lactate and pH levels

A randomised, controlled multicentre trial showed pH analysis and lactate analysis of fetal blood have comparable results in the management of intrapartum fetal compromise.[2] If fetal blood sampling is indicated, the use of scalp lactate rather than pH measurement is easier to perform for clinicians, is more affordable and requires a smaller volume of blood.[1]

Indications for fetal scalp blood sampling

Factors including clinical history, parity, evolution of the fetal heart rate pattern, stage and rate of progress in labour influence the decision for fetal scalp blood sampling.

Fetal scalp blood estimation may be of value in the following circumstances:

- Bradycardia
- Complicated tachycardia
- Recurrent decelerations
- Prolonged episodes of bradycardia or undefined deceleration patterns
- Prolonged loss of variability which does not spontaneously correct with fetal stimulation
- Miscellaneous e.g. non-specific concerns about fetal wellbeing

Contraindications to fetal scalp blood sampling

- Clear evidence on CTG of serious, sustained fetal compromise
- Maternal infection e.g. Hepatitis B, C, HIV, herpes simplex virus and suspected intrauterine sepsis
- Fetal bleeding disorders (e.g. suspected fetal thrombocytopenia, haemophilia)
- Face or brow presentation
- Fetal blood sampling is not generally recommended in pregnancies at less than 34^{+6} weeks of gestation because birth may be inappropriately delayed in a small “at risk” fetus that may sustain damage earlier than would be expected in a term fetus [1]
- If a fetus is in a breech presentation during labour and is exhibiting signs of fetal compromise that are not readily remediable, it would be more appropriate to deliver the baby by caesarean section than to undertake fetal blood sampling[1]

Management of fetal scalp blood sampling

In tertiary centres, fetal scalp blood sampling should be considered part of routine care for the management team when indicated, and a competency the resident medical officer or registrar should be able to fulfil. Ensure the blood gas analyser has been calibrated according to local hospital guidelines prior to the processing of samples.

Explain the following to the woman:[5]

- Why the test is being advised
- The blood sample will be used to measure the level of acid in the baby's blood, to see how well the baby is coping with labour
- The procedure will require her to have a vaginal examination using a small device similar to a speculum
- A sample of blood will be taken from the baby's head by making a small scratch on the baby's scalp. This will heal quickly after birth, but there is a small risk of infection
- The procedure can help to reduce the need for further, more serious interventions
- What the different outcomes of the test may be (normal, borderline and abnormal) and the actions that will follow each result
- There is a small chance that it will not be possible to obtain a blood sample (especially if the cervix is less than 4 cm dilated). If a sample cannot be obtained, a caesarean section or instrumental birth (forceps or ventouse) may be needed because otherwise it is not possible to find out how well the baby is tolerating labour

Procedure for fetal scalp blood sampling

Position:

The preferred maternal position is left-lateral position with hips well flexed and the lower leg extended. The upper leg should be flexed (held by an assistant or positioned in a stirrup) with the buttocks extending over the edge of the bed to allow the clinician to be positioned below the level of the maternal vagina. If lithotomy position is used, ensure a lateral wedge is used to prevent aortocaval compression.

Procedure:

- Disposable fetal scalp blood sampling kits should be available for clinician use
- Attach the fetal scalp blade (depth of 2 mm) to an introducer
- Under direct vision, insert the amnioscope with light source into the posterior fornix
- The clinician obtaining the scalp sample should aim to angle the amnioscope downward below the horizontal plane
- Once past the anterior lip of the cervix, angle the cone anteriorly into the cervix to visualise the presenting part
- Clean the fetal scalp surface with chlorhexidine / alcohol-soaked gauze
- Apply sterile liquid paraffin to the fetal scalp (forms a non-wettable surface and encourages beading of fetal scalp blood)
- Make a quick stab with the fetal scalp blade / introducer to achieve a clean incision on the fetal scalp
- As the fetal blood appears, insert the heparinised capillary tube to touch the drop of blood, and keeping the tube angled downward, the blood is allowed to flow by gravity
    - FBS for pH: Let the tube fill with at least 2 cm of blood (without air bubbles or liquor)
    - FBS for lactate: A minimum of 5 microlitres of blood is required (without air bubbles or liquor)
- Immediately pass the sample to an assistant for processing
- Obtain two samples
- Apply pressure with a swab to the fetal scalp over the next two contractions and observe to ensure the bleeding has stopped

Results

The following thresholds are suggested and clinicians should be aware that thresholds may vary between institutions:

Fetal scalp blood sampling	
Lactate and pH result	**Management**
Lactate < 4.1 mmol/L pH ≥ 7.25	**Fetal scalp blood sample is normal** Offer repeat sampling no more than 1 hour later if this is still indicated by the CTG trace, or sooner if additional signs of fetal compromise or abnormal features become evident[5]
Lactate 4.1- 4.7 mmol / L pH 7.21 – 7.24	**Fetal blood sample result is borderline** Offer repeat sampling no more than 30 minutes later if this is still indicated by the CTG trace, or sooner if additional signs of fetal compromise or abnormal features become evident[5] Take into account the time needed to take a fetal blood sample when planning repeat fetal sampling[5] **Note:** Notify obstetrician on call to consider further management/mode of birth if rapid fall since last sample
Second fetal scalp blood sample result is stable and no further signs of fetal compromise	If the CTG trace remains unchanged and the fetal scalp blood sample result is stable (that is lactate or pH is unchanged) after a second test, further samples may be deferred unless additional signs of fetal compromise or abnormal features are seen [5]
Lactate > 4.7 mmol / L pH ≤ 7.20:	Birth indicated Rapid deterioration in features of fetal compromise requires obstetric review of timing and mode of birth Consider the woman's complete history (e.g. presence of meconium, progress, fetal scalp lactate or pH value) when assessing need for caesarean section (category 1)
Lactate of ≥ 5.8 mmol / L pH < 7.00	Requires an urgent assisted vaginal birth if possible or a category 1 caesarean section

Discuss with the senior obstetrician if:

- A fetal blood sample cannot be obtained, OR
- A third fetal blood sample is thought to be needed

Fetal scalp blood sample cannot be obtained

If a fetal scalp blood sample is indicated and the sample cannot be obtained, but the associated scalp stimulation results in fetal heart rate accelerations, a decision whether to continue the labour or expedite the birth will be made in consideration of the clinical circumstances and in discussion with the consultant obstetrician on call and the woman.[5]

If a fetal scalp blood sample is indicated but a sample cannot be obtained and there is no improvement in the CTG trace, advise the woman that the birth should be expedited.[3]

- Notify the anaesthetist and paediatrician
- Urgency of birth should take into account the severity of fetal compromise and relevant maternal factors

No sample or one contaminated with liquor or inadequate volume sample obtained:

Review indication for fetal scalp blood sampling and current CTG trace. Consider the need for birth in consultation with the senior obstetrician on call.

Cord blood gases

Fetal arterial and venous cord gases (pH, base excess and lactate) are not required for uncomplicated term spontaneous vaginal births.

Even when paired samples are obtained it cannot always be assumed that one is from an artery and one from the vein. Fetal carbon dioxide is removed from the umbilical arterial blood in the placenta, umbilical venous blood should have a slightly higher pH and lower pCO_2 than umbilical arterial blood.[12]

Umbilical cord blood gas sampling is the most objective determinant of fetal metabolic condition at the moment of birth.[13]

Values from the umbilical cord artery provide the most accurate information regarding fetal and newborn acid-base status.[13] Information gained from umbilical cord blood sampling can be useful from a medical and medicolegal perspective.[14]

A cord base excess of 12 to 16 mmol/L is associated with encephalopathy in 10 % of neonates, and the rate increases to 40 % in neonates who have an umbilical arterial base deficit greater than 16 mmol/L.[13]

Indications

Where facilities are available, paired umbilical arterial and venous cord blood gas samples (pH, base excess and lactate) should be taken after birth in the following situations[1, 13, 14]:

- When the clinicians are concerned about a potential fetal metabolic abnormality
- Preterm gestation
- Meconium stained liquor
- Assisted emergency birth (i.e. ventouse, instrumental, emergency caesarean section)
- Vaginal breech birth
- Shoulder dystocia
- Intrapartum fever (≥ 38°C)
- Maternal thyroid disease
- Multiple pregnancy
- Small for gestational age baby
- Intrapartum haemorrhage
- Intrapartum fetal scalp pH performed
- Any significant intrapartum CTG abnormality
- Apgar ≤ 4 at 1 minute
- Apgar ≤ 7 at 5 minutes
- Planned neonatal nursery admission

Considerations

It is imperative to clamp the cord as soon as possible after the birth because a delay in clamping may significantly affect pH and gas values due to gaseous diffusion and continuing metabolism.[14] *However, clinicians should be aware of maternal requests regarding delayed cord clamping and the individual clinical scenarios.*

Most studies have determined that a cord blood sample is stable for assessment of both pH and base deficit for 60 minutes when collected in a syringe flushed with heparin and transported to the cord blood gas analysis machine on ice.[14]

Arterial pH, base excess and lactate at birth can be estimated from testing a blood sample obtained from a clamped umbilical cord kept at room temperature for up to 90 minutes after birth.[14]

If obtaining umbilical cord artery blood samples is difficult, the vessels on the fetal surface of the placenta can be used (arteries cross over veins) and will provide similar, but not necessarily equivalent results.[14]

If the baby is born in poor condition (the Apgar score at 1 minute is 5 or less), a 10-20cm segment of umbilical cord is doubly clamped as soon as possible after birth to allow paired cord blood gases to be taken.[14]

It is important to label the samples as either arterial or venous.

Where paired umbilical cord blood gas analysis is taken at birth as part of a clinical audit regimen, this process should not interfere with management of the third stage of labour.[1]

Ensure the time that the cord was clamped post birth is recorded in the baby's case notes.

Technique for obtaining umbilical cord blood gases

If acid-base analysis is planned, the cord should be clamped as soon as possible following the birth of the baby.

Technique One

1. A 10-20cm segment of umbilical cord is doubly clamped as soon as possible after birth and prior to the delivery of the placenta
2. Collect cord blood gases from the cord vessels above the bottom clamp prior to collecting routine cord blood samples

Technique Two

1. A 10-20cm section of umbilical cord can be double clamped prior to the delivery of the placenta. A third clamp can be placed above the isolated section. The isolated section can be detached and set aside in order to take arterial and venous paired samples
2. Cord blood gases can then be collected from the detached cord section. After the birth of the baby, clamp and cut the umbilical cord to separate the baby from the placenta as in normal vaginal birth. If the Apgar is less than 5 at one minute, clamp and cut the cord immediately

For all collections

- Use heparinised blood gas syringes (pre-packed if available) or attach a 21 g (green) needle to each heparinised blood gas syringe
- Identify one artery and vein separately
- Collect the arterial sample first
- Clean the segment of the cord that the sample will be collected from with a clean perineal pad to remove maternal blood or contaminants
- Insert the needle parallel to the vessel (less likely to go through the back of the artery into the vein) and withdraw a minimum of 0.2 mL from the artery
- Remove the needle with caution as blood may spray up from the puncture site, discard into the sharps receptacle, expel air from the syringe and cap with the stopper provided
- Invert tube to mix specimen and hand the specimen to the assistant to label appropriately with unique neonatal identification labels, date and time of collection and whether the source of the sample is arterial or venous
- Then collect the venous blood gas specimen in the same way

Facilitate timely analysis and reporting of cord blood gases per individual hospital policy Suggested levels for reporting to neonatologists include (if local hospital polices are not in place):

- pH < 7.15
- Base Excess > -10
- Lactate > 5
- Haemoglobin < 140
- Glucose < 3

Once available, abnormal results should be discussed with the neonatal team and documented in the baby's case notes, including the agreed plan. Normal results should also be documented in the case notes.

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