Clinical Guideline
Fetal Acid Base Balance Assessment

Policy developed by: SA Maternal & Neonatal Community of Practice
Approved SA Health Safety & Quality Strategic Governance Committee on:
19 April 2016
Next review due: 19 April 2019

Summary
Clinical practice guideline on fetal acid base balance assessment.

Keywords
fetal acid base balance assessment, clinical guideline, Fetal pH, lactate, fetal scalp blood sampling, FBS, fetal scalp stimulation, fetal ECG ST analysis, fetal pulse oximetry, pH levels, fetal scalp lactate, fetal heart rate, hypoxic, metabolic acidosis, labour, cerebral palsy, abnormal, bradycardia, base deficit, fetal acidaemia, umbilical artery pH, amnioscope, abnormal features

Policy history
Is this a new policy? N
Does this policy amend or update an existing policy? Y 3.0
Does this policy replace an existing policy? N
If so, which policies?

Applies to
All SA Health Portfolio

Staff impact
All Staff, Management, Admin, Students, Volunteers
All Clinical, Medical, Nursing, Allied Health, Emergency, Dental, Mental Health, Pathology

PDS reference
CG233

Version control and change history

<table>
<thead>
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<th>Date to</th>
<th>Amendment</th>
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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 prior to the generic statement symbolises a woman and those enclosing a smaller horse shoe shape depicts a pregnant women. 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 respectively manage Aboriginal protocol and provide a culturally positive health care experience for Aboriginal people to ensure the best maternal, neonatal and child health outcomes.
Fetal acid base balance assessment

Fetal scalp blood sampling flow chart

- The clinical history, parity, evolution of the fetal heart rate pattern, stage and rate of progress in labour all influence the decision for fetal scalp blood sampling (FBS)

Consider if:
- 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
- Clear evidence on cardiotocograph 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
- Gestation < 34 + 6 weeks

Review fetal scalp blood sampling results

Lactate < 4.1 mmol/L or pH ≥ 7.25:
- Repeat sampling no more than 1 hour later if this is still indicated by the cardiotocograph trace, or sooner if additional signs of fetal compromise or abnormal features become evident

Lactate 4.1 - 4.7 mmol/L or pH 7.21 – 7.24:
- Repeat FBS no more than 30 minutes later as indicated by the cardiotocograph trace, or sooner if additional signs of fetal compromise or abnormal features become evident
- NB: Notify obstetrician on call to consider further management/mode of delivery if rapid fall since last sample

Lactate > 4.7 mmol/L or pH ≤ 7.20:
- Delivery indicated
- Rapid deterioration in features of fetal compromise requires obstetric review of timing and mode of delivery
- Consider the woman’s complete history (e.g. presence of meconium, progress, fetal scalp pH value) when assessing need for caesarean section

Lactate of ≥ 5.8 mmol/L or pH < 7.00:
- Requires an urgent assisted vaginal delivery if possible or a category 1 caesarean section to be called

Second fetal scalp blood sample result is stable and no further signs of fetal compromise
- If the lactate or pH and cardiotocograph trace is unchanged after a second test, further samples may be deferred unless additional signs of fetal compromise or abnormal features are seen

If no FBS sample obtained, contaminated, or inadequate volume:
- Review current cardiotocograph trace and indication for FBS
- Consider if delivery needs to be expedited
Introduction

- Intrapartum fetal surveillance frequently involves the use of a cardiotocograph (CTG)\(^1\)
- The CTG is an electronic method of simultaneously recording 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\(^3\). Metabolic acidaemia occurs in 2% of all births. Over 90% of these infants will not develop cerebral palsy\(^4\)

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\(^5\)*
- *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\(^7\). This means that, at low probabilities, the risk of fetal acidosis after an acceleration following stimulation reduces with 50%

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\(^8\)
- 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\(^6\)

Fetal scalp blood sampling

- A recent systematic review of intermittent auscultation versus continuous cardiotocograph in BOTH low and high risk women reveals a significant increase in the caesarean section rate, whether fetal blood sampling was deployed in labour or not\(^1,2,4\). 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\(^1\)
> 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\(^5,9\)

> RANZCOG supports the practise of fetal scalp blood sampling, particularly in larger units that have ready access to operative delivery if required. 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 delivery and thereby worsen outcomes by lengthening the decision to delivery 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\(^1,10\)

> 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\(^1,2\)

> In situations where fetal blood sampling is contraindicated (see below) or not possible, decisions regarding delivery should take into account the severity of the fetal heart rate abnormality and the clinical situation

**Delivery should be expedited where:**

> There is clear evidence of serious fetal compromise (fetal scalp blood sampling should not be undertaken)

> Cardiotocograph abnormalities are of a degree requiring further assessment, but fetal scalp blood sampling is contraindicated, clinically inappropriate or unobtainable

> The decision to delivery interval may be prolonged by virtue of location, clinical staff availability, patient factors or access to clinical services

> Inform the obstetrician on call if any fetal scalp blood sample result is abnormal

**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\(^3\)

> The average fetal scalp blood pH is 7.33 in normal labour

> pH > 7.25 and lactate < 4.1 mmol / L is considered normal

> pH < 7.25 and > 7.20 and lactate ≥ 4.1 to 4.7 mmol / L are borderline

> pH < 7.20 and lactate > 4.7 mmol / L indicative of fetal acidaemia requiring intervention

> pH < 7.00, or base deficit ≥ 12 mmol / L and lactate > 5.8 mmol / L indicates pathologic fetal acadaemia\(^11,12\)

> The mean umbilical artery pH after uncomplicated pregnancy and labour ranges from 7.25 to 7.31 in different studies\(^3\)

> Thresholds for lactate may vary between institutions. Institutions should have local guidelines for lactate thresholds\(^1\)
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 for fetal scalp blood sampling
> Clear evidence on cardiotocograph 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 delivery may be inappropriately delayed in a small “at risk” fetus that may sustain damage earlier than would be expected in a term fetus
> 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 scalp blood sampling

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

Explain the following to the woman:
> 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 coping
> Do not carry out fetal blood sampling if any contraindications are present (see below), including risk of maternal-to-fetal transmission of infection or risk of fetal bleeding disorders
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:
- Attach the fetal scalp blade (depth of 2 mm) to an introducer.
- Under direct vision, insert 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.
- **Note:** refer to individual midwifery standard for further information.
## Results

### Fetal scalp blood sampling

<table>
<thead>
<tr>
<th>Lactate and pH result</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactate &lt; 4.1 mmol/L, pH ≥ 7.25</td>
<td><strong>Fetal scalp blood sample is normal</strong></td>
</tr>
<tr>
<td></td>
<td>&gt; Offer repeat sampling no more than 1 hour later if this is still</td>
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<tr>
<td>Lactate 4.1 - 4.7 mmol / L, pH 7.21 – 7.24</td>
<td>indicated by the cardiotocograph trace, or sooner if additional signs of</td>
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<tr>
<td></td>
<td>fetal compromise or abnormal features become evident²</td>
</tr>
<tr>
<td></td>
<td>&gt; Take into account the time needed to take a fetal blood sample when planning</td>
</tr>
<tr>
<td></td>
<td>repeat fetal sampling²</td>
</tr>
<tr>
<td>Second fetal scalp blood sample result is stable and</td>
<td><strong>Fetal blood sample result is borderline</strong></td>
</tr>
<tr>
<td>no further signs of fetal compromise</td>
<td>&gt; Offer repeat sampling no more than 30 minutes later if this is still</td>
</tr>
<tr>
<td></td>
<td>indicated by the cardiotocograph trace, or sooner if additional signs of</td>
</tr>
<tr>
<td></td>
<td>fetal compromise or abnormal features become evident²</td>
</tr>
<tr>
<td>Lactate &gt; 4.7 mmol / L, pH ≤ 7.20:</td>
<td>&gt; If the cardiotocograph trace remains unchanged and the fetal scalp blood</td>
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<tr>
<td></td>
<td>sample result is stable (that is lactate or pH is unchanged) after a second</td>
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<td></td>
<td>test, further samples may be deferred unless additional signs of fetal</td>
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<td></td>
<td>compromise or abnormal features are seen²</td>
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<tr>
<td>Lactate of ≥ 5.8 mmol / L, pH &lt; 7.00</td>
<td>&gt; Delivery indicated</td>
</tr>
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<td></td>
<td>&gt; Rapid deterioration in features of fetal compromise requires obstetric</td>
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<td></td>
<td>review of timing and mode of delivery</td>
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<td></td>
<td>&gt; Consider the woman’s complete history (e.g. presence of meconium,</td>
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<td></td>
<td>progress, fetal scalp lactate or pH value) when assessing need for</td>
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<td></td>
<td>caesarean section (category 1)</td>
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<tr>
<td>No sample or one contaminated with</td>
<td>&gt; Requires an urgent assisted vaginal delivery if possible or a category 1</td>
</tr>
<tr>
<td>liquor or inadequate volume sample</td>
<td>caesarean section to be called</td>
</tr>
<tr>
<td>obtained:</td>
<td>&gt; Notify anaesthetist and paediatrician</td>
</tr>
<tr>
<td></td>
<td>&gt; Urgency of delivery should take into account the severity of fetal</td>
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<tr>
<td></td>
<td>compromise and relevant maternal factors</td>
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<tr>
<td>Discuss with the obstetrician if:</td>
<td>&gt; A fetal blood sample cannot be obtained OR</td>
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<td></td>
<td>&gt; A third fetal blood sample is thought to be needed</td>
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<td></td>
<td>&gt; Fetal scalp blood sample cannot be obtained</td>
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<td></td>
<td>&gt; If a fetal scalp blood sample is indicated and the sample cannot be</td>
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<tr>
<td></td>
<td>obtained, but the associated scalp stimulation results in fetal heart</td>
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<td>rate accelerations, a decision whether to continue the labour or expedite</td>
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<td>the birth will be made in consideration of the clinical circumstances and</td>
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<td></td>
<td>in discussion with the obstetrician on call and the woman²</td>
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<td></td>
<td>&gt; If a fetal scalp blood sample is indicated but a sample cannot be</td>
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<td></td>
<td>obtained and there is no improvement in the cardiotocograph trace,</td>
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<td></td>
<td>advise the woman that the birth should be expedited¹</td>
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<tr>
<td></td>
<td>&gt; Notify anaesthetist and paediatrician</td>
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<td></td>
<td>&gt; Urgency of delivery should take into account the severity of fetal</td>
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<tr>
<td></td>
<td>compromise and relevant maternal factors</td>
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### No sample or one contaminated with liquor or inadequate volume sample obtained:

> Review indication for fetal scalp blood sampling and current cardiotocograph trace. Consider need for delivery in consultation with obstetrician on call.
Categorisation of urgency for emergency caesarean section

- Categorisation of emergency Caesarean section facilitates communication and reduces misunderstanding between health care professionals.
- The Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) recommend that there be a four grade classification system for emergency caesarean section. These are:
  - Category 1: Immediate threat to the life of a woman or fetus
  - Category 2: Maternal or fetal compromise but not immediately life threatening
  - Category 3: Needing early birth but no maternal or fetal compromise
  - Category 4: At a time to suit the woman and the caesarean section team

- Whilst RANZCOG recommends that there should be no specific time attached to the various types of caesarean section, each case should be managed according to the clinical evidence of urgency, with every single case being considered on its merits. For more information, see ‘Standards for the Management of Category One Caesarean Section in South Australia’ in the section ‘Pregnancy policies and brochures’ at www.sahealth.sa.gov.au/perinatal.

- In major tertiary centres where staff and theatre facilities are available, delivery within 30 minutes is a debated standard for category 1 emergency Caesarean sections.
- A RCOG (2004) review of decision to delivery times found maternal and neonatal outcomes do not change for decision to delivery intervals of up to 75 minutes. However, delays to delivery of > 75 minutes were associated with poorer outcomes; the effect greater with pre-existing maternal or fetal compromise.

Cord blood gases

- Fetal arterial and venous cord gases (pH and base excess) are not required for uncomplicated term spontaneous vaginal births.
- Obtain fetal arterial and venous cord gases (pH and base excess) at time of birth where
  - Fetal scalp bloods have been taken
  - Operative vaginal delivery or caesarean section is required
  - Baby is less than 37th week of gestation
  - Multiple pregnancy
  - Breech vaginal birth
  - Baby’s condition is poor at birth
  - Meconium stained liquor is present

- It is generally accepted that arterial and venous pH should differ by 0.03 to be sure that the artery has been sampled.


References


5. Chandrarahan E. Fetal scalp blood sampling during labour: is it a useful diagnostic test or a historical test that no longer has a place in modern clinical obstetrics? BJOG 2014; 121: 1056-1062.


Abbreviations

<table>
<thead>
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<tbody>
<tr>
<td>cm</td>
<td>Centimetre(s)</td>
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<tr>
<td>CTG</td>
<td>Cardiotocograph</td>
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<td>ECG</td>
<td>Electrocardiograph</td>
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<td>EFM</td>
<td>External fetal monitoring</td>
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<td>e.g.</td>
<td>For example</td>
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<tr>
<td>et al.</td>
<td>And others</td>
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<tr>
<td>FBS</td>
<td>Fetal blood sampling</td>
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<tr>
<td>FHR</td>
<td>Fetal heart rate</td>
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<td>≥</td>
<td>Greater than or equal to</td>
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<tr>
<td>&gt;</td>
<td>Greater than</td>
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<tr>
<td>HIV</td>
<td>Human immunodeficiency virus</td>
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<tr>
<td>≤</td>
<td>Less than or equal to</td>
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<tr>
<td>&lt;</td>
<td>Less than</td>
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<tr>
<td>mmol/L</td>
<td>Millimoles per litre</td>
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<tr>
<td>mm</td>
<td>Millimetre(s)</td>
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<tr>
<td>NICE</td>
<td>National institute for health and care excellence</td>
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<tr>
<td>pH</td>
<td>A measure of the acidity or basicity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity</td>
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<td>RANZCOG</td>
<td>Royal Australian and New Zealand College of Obstetricians and Gynaecologists</td>
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