Intrapartum Fetal Monitoring

A wide range of clinical techniques and investigations is available to healthcare professionals to survey the condition of a fetus in the womb. These may be deployed from early pregnancy to birth. They range from the use of traditional equipment such as a Pinard's stethoscope, which allows direct auscultation of the fetal heartbeat, to ultrasound imaging of the fetus, which gives an ever-increasing amount of morphological and functional data about the unborn child.

This article deals with those monitoring techniques that are used immediately preceding or during childbirth - known as intrapartum fetal monitoring. Current techniques rely predominantly on the use of electronic fetal monitoring through the use of cardiotocography (CTG). This technique records changes in the fetal heart rate (FHR) (via Doppler ultrasound or direct fetal ECG measurement with a fetal scalp electrode) and their temporal relationship to myometrial activity and uterine contractions. The interpretation of the data collected depends on the relationship between the two traces. The aim is to identify babies who may be hypoxic, so additional assessments of fetal well-being may be made, or the baby delivered by caesarean section or instrumental vaginal birth.

The technique became widely used from the 1960s onwards. Prior to this there was very little that could be discerned about the state of the fetus. The new technology was widely embraced as an undoubted ‘good thing’ which would lead to better outcomes and reduce the incidence of conditions such as cerebral palsy, which were postulated to be largely due to episodes of intrapartum cerebral ischaemia. Unfortunately, subsequent evidence has not borne out this optimism.

It seems unlikely that more than a small minority of cases of cerebral palsy is directly attributable to avoidable intrapartum fetal hypoxia:[1,2]

- Low gestational age (24-30 weeks) plus: postnatal dexamethasone use; patent ductus arteriosus; severe hyaline membrane disease; resuscitation in the delivery room; and intraventricular haemorrhage have all been shown to be associated with higher rates of cerebral palsy. Whereas antenatal corticosteroid use in very preterm infants is associated with a lower rate.[3]
- There appears to be at best a tenuous connection between cardiotocographic findings, what they signify about the fetal condition and any improvement in outcomes as a result of intervention based upon them.[4]

The widespread use of electronic fetal monitoring as part of the management of normal labour has been discarded, as a result of professional and public voices.[5,6]

A Cochrane meta-analysis showed that the routine use of intrapartum CTG had a minor beneficial effect on the incidence of neonatal seizures but no difference in rates of cerebral palsy or infant mortality. However, its use increased instrumental and caesarean deliveries significantly.[7]

Antenatal CTG: a Cochrane systematic review has found no evidence of the usefulness of CTG in antepartum fetal assessment, although computerised CTG may have advantages but further studied are needed.[8]

Criticisms of the routine use of electronic fetal monitoring

- Poor understanding of the pathophysiological background of the measurements collected.
- Indirect fetal monitoring treated by some as a direct monitor of fetal condition.
- Numerous technical problems that affect its usefulness.
- Variability in measurement and recording techniques.
- Qualitative nature of information obtained, requiring complex pattern recognition.
- An absence of agreed systems of classification.
- Confusion about the many influences on the fetal heart rhythm and rate.
- Significant intra- and inter-observer variation in interpretation of data.
- Low validity of findings and high false-positive finding rate.
- A screening investigation to detect the presence of fetal distress being misused as a diagnostic tool.
Inevitably leads to an increase in instrumental or surgical deliveries, due to the high false-positive rate.

No satisfactory criteria on how, when and whom to monitor.

Contributes significantly to medicolegal vulnerability of doctors who manage childbirth.

So what is cardiotocography useful for?[5]

It can be used as a fairly reliable screening test to indicate a normal condition of the fetus; if the FHR and pattern are normal, it is virtually certain that the fetus is not suffering hypoxia, acidemia or other causes of distress. It is this useful aspect of CTG that led to its widespread adoption. Unfortunately, its ubiquitous presence on labour wards has led to its overzealous use and overcomplicated interpretation, without a solid evidence-based grounding. CTG should no longer be performed routinely as part of the initial assessment of low-risk women and no decision about a woman's care in labour should be taken on the basis of CTG findings alone.

There are four features of a CTG that can be classified:

- **Baseline FHR**:
  - **Normal/reassuring**: 100-160 beats per minute (bpm) but FHR between 100-109 bpm is only reassuring if all other features are also reassuring.
  - **Non-reassuring**: 161-180 bpm.
  - **Abnormal**: <100 bpm or >180 bpm, although a stable baseline of 90-99 bpm with normal variability may be normal.

- **Baseline variability**:
  - **Reassuring**: if >5 bpm.
  - **Non-reassuring**: if reduced by <5 bpm for 30-90 minutes.
  - **Abnormal**: if reduced by <5 bpm for >90 minutes.

- **Decelerations**:
  - **Reassuring**: no or early decelerations.
  - **Non-reassuring** has either variable decelerations of ≤60 bpm and taking ≤60 seconds to recover, present for >90 minutes and occurring with >50% of contractions or variable decelerations of ≥60 bpm or taking ≥60 seconds to recover, present for up to 30 minutes and occurring with >50% of contractions or late decelerations present for up to 30 minutes and occurring with >50% of contractions.
  - **Abnormal** has either non-reassuring variable decelerations still observed 30 minutes after starting conservative measures with >50% of contractions or late decelerations not improving with conservative measures, present for over 30 minutes and occurring with >50% of contractions or a bradycardia or single prolonged deceleration for more than 3 minutes.

- **Accelerations**:
  - **Reassuring** has accelerations present. However, the absence of accelerations with otherwise normal trace does not indicate acidosis.

A **normal** CTG has all four features that are reassuring. A CTG is **non-reassuring** if it has one feature which is non-reassuring, but the others are reassuring. An **abnormal** CTG has two or more features which are non-reassuring, or any abnormal features.

Further information about classifying FHR traces:

- If repeated accelerations are present with reduced variability, the FHR trace should be regarded as reassuring.
- True early uniform decelerations are rare and benign, and therefore they are not significant.
- Most decelerations in labour are variable.
- If a bradycardia occurs in the baby for 3 minutes or more, urgent medical aid should be sought and preparations should be made urgently to expedite the birth of the baby. This could include moving the woman to theatre if the fetal heart has not recovered by 9 minutes. If the fetal heart recovers within 9 minutes the decision to deliver should be reconsidered, in conjunction with the woman.
A tachycardia in the baby of 160-180 bpm, where accelerations are present and no other adverse features appear, should not be regarded as abnormal. However, an increase in the baseline heart rate, even within the normal range, with other non-reassuring or abnormal features should increase concern.

Who should have electronic fetal monitoring?[^5]

The following table of antenatal and intrapartum risk factors should prompt the midwife or doctor to advise the use of continuous electronic fetal monitoring. The lists are not exhaustive and other risk factors may prompt the use of continuous monitoring.

<table>
<thead>
<tr>
<th>Antenatal maternal risk factors</th>
<th>Antenatal fetal risk factors</th>
<th>Intrapartum risk factors</th>
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<tbody>
<tr>
<td>Previous caesarean section</td>
<td>Suspected fetal growth restriction</td>
<td>Augmentation of labour using oxytocin</td>
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<tr>
<td>Pre-eclampsia or pregnancy-induced hypertension</td>
<td>Suspected oligohydramnios or polyhydramnios</td>
<td>Epidural analgesia</td>
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<tr>
<td>Recurrent antepartum haemorrhage</td>
<td>Abnormal presentation: breech, transverse or oblique</td>
<td>Fresh vaginal bleeding during labour</td>
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<tr>
<td>Prolonged membrane rupture (&gt;24 hours)</td>
<td>High or free head in a nulliparous woman</td>
<td>Maternal pyrexia ≥38°C, suspected chorioamnionitis or sepsis (or temp &gt;37.5°C twice, 1 hour apart)</td>
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<tr>
<td>Diabetes</td>
<td>Reduced fetal movements in the previous 24 hours</td>
<td>Significant fresh meconium-stained liquor</td>
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<tr>
<td>BMI at booking &gt;35 kg/m^2</td>
<td>Severe hypertension ≥160/ or /110 mm Hg (or ≥140/90 twice, 30 mins apart)</td>
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<td></td>
<td>BP ≥140/ or /90 mm Hg plus 2+ protein on urinalysis</td>
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<tr>
<td>Other significant maternal medical disease or risk factor requiring obstetric care, including prematurity and multiple pregnancies</td>
<td>Maternal tachycardia &gt;120 bpm twice, 30 minutes apart</td>
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<td></td>
<td>Pain different from normal contractions</td>
<td></td>
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<tr>
<td></td>
<td>Fetal heart rate &lt;110 bpm or &gt;160 bpm or fetal decelerations</td>
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<tr>
<td></td>
<td>Any 2 or more of: confirmed delay in first or second stage; non-significant meconium; and/or BP&gt;150-59/ or &gt;/100-109 mm Hg</td>
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All decisions to use continuous electronic fetal monitoring should be discussed with the woman and the reasons for offering it should be outlined. It is important to note that these criteria are only for the offering of continuous electronic fetal monitoring, not its mandatory use, and the pregnant mother is entitled to decline its use. Where it has been recommended and declined, this fact should be carefully documented in the partogram and clinical record.

All other patients having normal labour without associated risk factors should not have continuous electronic fetal monitoring. They should be monitored with normal partogram assessments and have FHR checked by auscultation for a full minute after uterine contractions and at least every 15 minutes in the first stage of labour, and every 5 minutes in the second stage of labour.

When continuous CTG is indicated, the use of a fetal scalp electrode to not only measure FHR but also allow automated computerised analysis of the fetal ECG waveforms avoids intra- and inter-observer variability. A Cochrane systematic review indicated that this results in a moderate reduction in the number of blood samples being taken from the baby’s scalp, fewer operative vaginal deliveries and fewer admissions to Special Care Baby Unit than CTG alone; its use did not, however, lead to any reduction in caesarean section rate or the numbers of babies with acidosis or neonatal encephalopathy.[^9]
What action is necessary if a cardiotocography is non-reassuring or abnormal?

For a non-reassuring CTG:

- If the CTG trace is of inadequate quality:
  - Check contact and connections of external transducer.
  - Check contact and connections of fetal scalp electrode (FSE), if being used.
  - Check maternal pulse and ensure not recording this in error.
  - Consider use of FSE if not currently being used.

And start conservative measures:

- Reduce contraction frequency:
  - Consider discontinuation of oxytocin, if being used.
  - Check whether vaginal prostaglandins have been utilised.
  - Consider use of tocolytic agents (subcutaneous terbutaline 0.25 mg).

- If FHR ≥160 bpm and/or there is maternal tachycardia and/or pyrexia:
  - Consider screening investigations and empirical treatment for infection.
  - Offer oral or intravenous fluids.
  - Offer paracetamol.
  - Consider the effect of tocolytics and discontinuing them if this may be causing the tachycardia.
  - Check maternal blood pressure (BP) and, if low, offer intravenous fluids if there are no contra-indications to this.
  - If FHR is raised and CTG otherwise reassuring, but FHR stays ≥180 bpm after conservative measures, offer fetal blood sampling.

- If there are other relevant maternal adverse factors:
  - Encourage the woman to mobilise or move into the left lateral position; avoid being supine.
  - Consider the effect of recent vaginal examination: an acceleration of FHR in response to fetal scalp stimulation is reassuring.
  - Consider the effect of recent bedpan use, recent vomiting or vasovagal episode.
  - Consider the effect of recent siting or topping-up of epidural analgesia infusion.

Inform the co-ordinating midwife and obstetrician whenever conservative measures are implemented.

Where a trace continues to be non-reassuring despite these conservative measures then observe for other suspicious FHR features, consider the whole clinical context and take appropriately experienced obstetric advice on how to proceed.

For an abnormal CTG (other than an isolated FHR ≥180 bpm prior to implementation of conservative measures - see above):

- If fetal blood sampling is feasible and not contra-indicated:
  - Encourage the mother to use the left lateral position and check BP, giving intravenous fluids if appropriate.
  - Proceed to fetal blood sampling with maternal consent.
  - Decide further course on the basis of fetal blood sampling results (see interpretation of fetal blood sampling below).

- If fetal blood sampling is not feasible or is contra-indicated:
  - Use the left lateral position and BP check with intravenous fluids as above.
  - Expedite delivery according to anaesthetic, paediatric and experienced obstetric opinion:
    - Speed of delivery should take into account the severity of FHR abnormalities and relevant maternal factors.
    - The current accepted standard is that expedited delivery should occur as quickly and safely as possible, and within 30 minutes if there is an immediate threat to life of either the mother or the fetus. However, this is not achieved in a substantial proportion of cases although it is uncertain how significant this is clinically.
    - There is some evidence that very short 'decision-to-incision' time (<20 minutes) may be inversely proportional to neonatal outcomes, i.e., lower umbilical blood pH and Apgar scores.
Following delivery, paired umbilical cord samples should be taken and 1- and 5-minute Apgar scores calculated and all results recorded in the mother’s and newborn’s notes.

Interpretation of fetal blood sampling

If available, measure lactate in preference to pH as the rate of failure of obtaining a sample is much less, as a smaller sample is required. Furthermore, the association between low pH and neonatal morbidity is also beginning to be questioned. The National Institute for Health and Care Excellence (NICE) classification of fetal blood sample results is:

<table>
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<tr>
<th>Lactate (mmol/L)</th>
<th>pH</th>
<th>Interpretation</th>
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<tbody>
<tr>
<td>≤4.1</td>
<td>≥7.25</td>
<td>Normal</td>
</tr>
<tr>
<td>4.2-4.8</td>
<td>7.21-7.24</td>
<td>Borderline</td>
</tr>
<tr>
<td>≥4.9</td>
<td>≤7.20</td>
<td>Abnormal</td>
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All fetal scalp blood estimations should be interpreted taking into account the previous measurement, the rate of progress in labour and the clinical features of the mother and baby.

- Normal: offer repeat fetal blood sample after at least 1 hour, if still indicated by CTG, or sooner if additional non-reassuring or abnormal features appear.
- Borderline: offer repeat fetal blood sample after 30 minutes, if still indicated by CTG, or sooner if additional non-reassuring or abnormal features appear.
- Abnormal: inform a consultant obstetrician, as delivery may need to be expedited.

Potential future developments in this field

- Vibroacoustic stimulation of the fetus via a device placed on the maternal abdomen has been proposed as an adjunct in the presence of a non-reassuring CTG, by reducing the incidence of nonreactivity (if, for example, the fetus is sleeping). However, a Cochrane systematic review has, to date, found insufficient evidence assessing its safety and efficacy to recommend its use.
- Fetal pulse oximetry has not been shown to improve the accuracy of fetal evaluation in the presence of non-reassuring CTG and does not contribute to a reduction in caesarean section rates in this situation.
- However, the use of computerised auto-analysis of fetal pulse oximetry in combination with CTG data has also been investigated with some evidence of usefulness.

Conclusion

Continuous electronic fetal monitoring is a useful intrapartum tool in experienced hands, if used selectively and according to evidence-based guidelines.

It should not be used routinely, as this is one of the factors that has pushed up the instrumental and caesarean delivery rates in the developed world. Its use should continue to be investigated by carefully designed randomised controlled trials to optimise its utility and compare outcomes with newer, potentially more accurate ways of evaluating fetal well-being in labour.

Further reading & references

- Intrapartum care; NICE Quality Standard, December 2015
5. Intrapartum care: care of healthy women and their babies during childbirth; NICE Clinical Guideline (Dec 2014)
10. Caesarean section; NICE Clinical Guideline (November 2011)
15. Quality standard for caesarean section; NICE, Jun 2013

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Current Version: Dr Jacqueline Payne
Peer Reviewer: Dr John Cox
Document ID: 1063 (v24)
Last Checked: 04/02/2015
Next Review: 03/02/2020

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