10. Fetal Monitoring

The idea that the technification of labour control should improve neonatal outcomes has led to fetal monitoring. The aim of fetal monitoring is to detect situations of fetal hypoxia during the labour and birth process in order to be able to intervene and prevent fetal deterioration.

This chapter examines which method is most appropriate for controlling fetal well-being in childbirth in healthy women, when and how to use fetal monitoring and how to interpret it. The following methods of fetal control will be assessed: intermittent auscultation (IA), intermittent electronic fetal monitoring (CEFM), analysis of the ST segment of the fetal ECG (STAN), fetal pulse oximetry, fetal blood sample (FBS) and fetal scalp stimulation.

10.1. Continuous electronic fetal monitoring (CEFM) versus intermittent fetal auscultation (IA)

- How effective are the following methods of fetal monitoring: continuous electronic fetal monitoring (CEFM) vs intermittent fetal auscultation (Pinard stethoscope or Doppler)?

Fetal heart rate can be monitored intermittently using a Pinard fetal stethoscope or a manual Doppler device. Continuous recording of fetal heart rate can also be obtained using cardiotocography equipment (CTG). This method is known as electronic Fetal monitoring (EFM) and provides a continuous recording of the fetal heat rate and uterine contractions during labour.

Although continuous CTG has certain advantages, such as providing a written recording that can be analysed at any moment during or after labour, which gives more quantifiable parameters in relation to fetal heart rate patterns, it also has certain drawbacks, amongst which are the difficulty of standardizing CTG interpretations due to the complex nature of fetal heart rate patterns, limitations with regard to mobility and the fact that the attention of nursing staff, the woman and the person accompanying her tends to be diverted towards the electronic fetal monitor during labour.

Furthermore, although it has been suggested that certain specific abnormalities in fetal heart rate patterns in the CTG are associated with a greater risk of cerebral palsy, the specificity of the CTG to predict cerebral palsy is low, with a false positive rate of up to 99.8%, even with multiple late decelerations or reduced variability (360).

These facts have led to concerns being expressed in relation to the efficacy and the routine use of continuous CTG in labour (361). The obvious contradiction between generalized use of continuous CTG and the recommendations to limit its habitual use (362) indicate that it is necessary to carry out a new assessment of this technique.

Scientific Evidence
To respond to the question of the effectiveness of continuous electronic fetal monitoring compared to intermittent auscultation, the NICE (10) guideline built on a good quality SR (363), LE=Ia that compared the effectiveness of CEFM during labour vs IA or vs IEFM.

In relation to the comparison of CEFM with intermittent auscultation, three of the 12 studies included 37,000 low-risk women; the studies were conducted in the USA, Ireland and Australia and their quality was between moderate and good.

The outcomes of all of the women as a whole were assessed and those of low-risk women were assessed separately. The data obtained from the high and low-risk subgroups were compatible with the general results.

In women with low-risk births evidence was found that women with CEFM had a greater possibility of requiring a caesarean section due to abnormal fetal heart rate: RR 2.31 [95% CI 1.49 to 3.59], operative vaginal delivery: RR 1.29 [95% CI 1.02 to 1.62] and any type of instrumental delivery (caesarean section, instrumental vaginal delivery): RR 1.35 [95% CI 1.09 to 1.67], compared to those who underwent intermittent auscultation.

No differences in perinatal mortality were observed between the two groups of women, RR 1.02 [95% CI 0.31 to 3.31]. However, it was observed that women with CEFM were less likely to have infants with neonatal seizures, RR 0.36 [95% CI 0.16 to 0.81] and more likely to have infants who have to be admitted to neonatal units, RR 1.37 [95% CI 1.01 to 1.87] in comparison with the intermittent auscultation group.

When the overall results of high and low-risk women are analysed, nine studies that included 32,386 women found that neonatal seizures were reduced by half with CEFM: RR 0.50 [95% CI 0.31 to 0.80] although in two studies with 13,252 women no significant differences in cerebral palsy were detected: RR 1.74 [95% CI 0.97 to 3.11].

The NICE (10) guideline also examines the use of Doppler ultrasoundography versus the Pinard stethoscope. It is a small study (364), conducted in 1994 in a low-income country with 1,255 high and low-risk women, in which it is observed that with the use of Doppler there are less spontaneous vaginal births: RR 0.83 [95% CI 0.76 to 0.91] and more caesarean sections: RR 1.95 [95% CI 1.47 to 2.60], less probability of the infant being admitted to a neonatal unit: RR 0.65 [95% CI 0.46 to 0.94] and/or of suffering hypoxic encephalopathy: RR 0.12 [95% CI 0.02 to 0.88]. The NICE (10) guideline development group considers that this evidence is not solid enough to allow a differentiation to be made between the two techniques.
In summary there is a high level of evidence that CEFM reduces the rate of neonatal seizures but it does not have an impact on the rates of cerebral palsy. There is a high level of evidence that it increases the number of caesarean sections and instrumental deliveries.

**Update (2006 to July 2008)**

No new studies have been located in the update but the CPB ICSI (Institute for Clinical Systems Improvement), 2007 (365) has been reviewed and classed as recommended after assessment with AGREE. It analyses the effectiveness of using CEFM compared to intermittent auscultation.

To respond to this question this guideline uses an SR with seven RCTs that included both high and low-risk women.

No differences were observed in fetal mortality and most of the studies showed an increase in the number of caesarean sections in the groups with CEFM. The most recently published RCT of those included in the review indicated a significant reduction in perinatal mortality due to asphyxia in the group with CEFM, although the reason for these differences in relation to the other RCTs is not clear.

The ICSI guideline considers that the presence of trained, motivated midwives who perform auscultations adds quality to healthcare process and improves outcomes.

See Appendix 3.1. Technique of intermittent auscultation of the fetal heart

**Summary of Evidence**

<table>
<thead>
<tr>
<th>Evidence</th>
<th>CEFM compared to IA reduces the rate of seizures but does not have an impact on the rates of cerebral palsy (363). CEFM increases the number of caesarean sections and instrumental deliveries (363).</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>There is not enough evidence to differentiate between the effectiveness of intermittent auscultation with a Doppler device or a Pinard stethoscope (364).</td>
<td>II</td>
</tr>
</tbody>
</table>

**Recommendations**

<table>
<thead>
<tr>
<th>Type</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Both CEFM and IA are valid and recommended methods for checking fetal well-being during labour.</td>
</tr>
<tr>
<td>√</td>
<td>IA can be performed using either Doppler ultrasound or a stethoscope.</td>
</tr>
</tbody>
</table>
10.2. CEFM versus Intermittent electronic fetal monitoring (IEFM)

- How effective are the following methods of fetal monitoring: CEFM vs intermittent electronic fetal monitoring (IEFM)?

IEFM has been suggested to try to obtain the best of each method. The aim is to keep the pregnant woman free of monitoring equipment for most of the time but to still be able to assess the variables given by the continuous cardiotocographic recording, such as variability or reactivity that are impossible to assess using auscultation procedures.

Scientific Evidence

The NICE (10) guideline does not answer this question but included in the SR that the NICE guideline (363) contains, is an RCT conducted in Sweden (366), with LE=Ib, CE (363) that addresses the comparison between CEFM and IEFM. This study includes 4,044 women in labour with a low risk of suffering loss of fetal well-being.

The group with intermittent electronic monitoring were monitorised for 10 to 30 minutes every 2 or 2 and a half hours during the first stage of labour and fetal heart rate was auscultated every 15-30 minutes between recording periods. If complications arose intermittent monitoring was changed to continuous monitoring. During the second stage of labour continuous monitoring was used in all of the cases.

No significant differences were observed between the two groups for any of the variables analysed: ominous or suspicious fetal heart rate, caesarean section due to suspected loss of fetal well-being, umbilical pH, Apgar values or admittance to Neonatal Intensive Care Units (NICU).

Use of electronic intermittent fetal monitoring at regular intervals (with intermittent auscultation between these intervals) seems to be as safe as continuous electronic fetal monitoring in low-risk childbirth.

Update (to May 2008)

No new studies were found in the update.

Summary of Evidence

The use of IEFM at regular intervals (with intermittent auscultation between intervals) seems to be as safe as continuous electronic fetal monitoring in low-risk childbirths (366).

Recommendations

A  Both CEFM and IEFM accompanied by IA are valid and recommended methods for checking fetal well-being during labour.
10.3. CEFM with or without pulse oximetry

- How effective are the following methods of fetal monitoring: CEFM with or without pulse oximetry when there are alterations in fetal hear rate?

Pulse oximetry is a continuous way of determining arterial oxygen saturation of fetal haemoglobin by optical means. Oxygen saturation values above 30% ensure a normal fetal acid-base balance. Arterial oxygen saturation would seem to have a relationship with cardiotocographic alterations and hence could improve the specificity of intrapartum fetal surveillance.

The aim is to discover if its use together with continuous monitoring can provide benefits in the event of pathological cardiotocographic recordings.

Scientific Evidence

The NICE (10) guideline does not respond to this question since this is not a technique used in the United Kingdom.

Update (to May 2008)

In the new search performed, a Cochrane review (367) published in 2007 has been recovered. The review comprised five RCTs with a total of 7,424 women. This review compared fetal pulse oximetry and CTG versus CTG alone or with the pulse oximetry values blinded.

Four of the five studies did not report any significant differences in the general rate of caesarean sections. In the remaining study with less population, a significant reduction in caesarean sections was observed in the group with pulse oximetry and CTG.

In two of the four studies it was observed that there was a significant reduction in caesarean sections due to risk of loss of fetal well-being in the group with pulse oximetry and CTG: Caesarean section rate in the cases without fetal blood sampling prior to inclusion in the study, RR 0.68 [95% CI 0.47 to 0.99] and, in the cases in which a fetal blood sample was required prior to inclusion in the study, RR 0.03 [95% CI 0.00 to 0.44].

No significant differences were observed in instrumental deliveries or caesarean sections in relation to dystocia when pulse oximetry and CTG are performed, nor were there any significant differences in neonatal results or maternal satisfaction.
In summary, evidence consistency for this question derives exclusively from this Cochrane SR in which it is observed that the data come from studies with limitations and provide a limited support for the use of fetal pulse oximetry when it is used in the presence of CTG, to reduce caesarean sections due to risk of loss of fetal well-being. It was also observed that adding fetal pulse oximetry to an abnormal CTG does not reduce the general rate of caesarean sections.

The guideline development group considers that the evidence provides only limited support for the use of pulse oximetry in the presence of a non-reassuring CTG for the routine use of fetal pulse oximetry to be recommended, and, given the limitations of the study methods, the strength of the recommendation is further reduced.

Summary of Evidence

| The evidence provides limited support for the use of fetal pulse oximetry in the presence of an abnormal CTG to reduce caesarean sections due to risk of loss of fetal well-being. However, the general caesarean section rate is not reduced (367). | Ia |

Recommendations

| A | Fetal pulse oximetry should not be used routinely |
10.4. CEFM with or without ST segment analysis (STAN) of the fetal ECG with a pathological CTG recording

- How effective are the following methods of fetal monitoring: CEFM with or without analysis of the ST (STAN) segment of the fetal ECG when there is an abnormal cardiotocography reading (CTGR)?

ST segment analysis (STAN) of the fetal ECG by means of an electrode attached to the Fetal scalp provides information on the capacity of the fetal myocardium to respond to hypoxia during labour. The aim is to assess the fetal myocardial function which represents an indirect measurement of the state of oxygenation of the foetus's brain.

During acute hypoxemia a mature foetus reacts physiologically with a rise in the ST segment and a progressive increase in the height of the T wave (T/QRS ratio). Depression of the ST segment and a negative T wave show a myocardium which does not respond adequately to hypoxic stress.

The purpose of this question is to determine whether or not the combined use of ST segment analysis (STAN) of the fetal ECG with continuous monitoring in the presence of pathological cardiotocographic recordings affords benefits compared to the use of cardiotocography alone.

Scientific Evidence

The NICE (10) guideline used a Cochrane SR (368) published 2005 and a randomised controlled clinical trial published in 2006 (369).

The SR compared the effectiveness of the ST segment analysis of the fetal ECG compared to other alternative methods of fetal monitoring during childbirth in high risk women and evaluated the use of fetal ECG associated with CEFM. The three studies included in the SR were of good quality. Two of them assessed the ST segment and in the other, the PR interval.

The RCT published in 2006 (369) was conducted in Finland and it assessed the effectiveness of ST segment analysis of the fetal ECG. The consistency between the two studies included in the SR and the new study enabled a meta-analysis to be performed to study the effectiveness of performing an ST segment analysis of the fetal ECG.

The meta-analysis showed evidence that ST segment analysis of the fetal ECG significantly reduced the rate of:

- Instrumental vaginal deliveries RR 0.87 [95% CI 0.78 to 0.96]
- Any type of instrumental delivery RR 0.89 [95% CI 0.82 to 0.96]
- Need for fetal blood samples RR 0.69 [95% CI 0.48 to 1.00]
• Number of neonates who develop neonatal encephalopathy RR 0.33 [95% CI 0.11 to 0.95]

• Acidosis in umbilical cord blood (pH less than 7.05, base excess less than −12 mmol/l), RR 0.53 [95% CI 0.33 to 0.85]

There was no evidence of differences in other neonatal outcomes such as perinatal mortality, RR 2.16 [95% CI 0.48 to 9.58], Apgar test scores <7 after 5 minutes, RR 0.80 [95% CI 0.56 to 1.14] or admittance to neonatal units, RR 0.90 [95% CI 0.75 to 1.08]. When perinatal mortality and neonatal encephalopathy were combined, no differences were found, RR 0.60 [95% CI 0.27 to 1.34].

The evidence is of good quality but these are studies conducted in high-risk women so that this must be taken into account when they are interpreted and applied to low-risk women.

**Update (2006 to May 2008)**

In the update search the studies detected were rejected for not fulfilling inclusion criteria but an SR (370) with LE=II, located in a literature search for another question, has been taken into consideration.

This SR includes four RCTs (2 of which are already included in the NICE (368) SR, three observational studies and a non-randomised prospective study. The aim of the SR is to evaluate the pathophysiology of the ST segment of the fetal ECG, its role in monitoring during labour and the practical use of this technology.

The SR (370) concludes that with the incorporation of the ST segment analysis of the fetal ECG in the CTG, there has been a reduction in the rates of neonatal metabolic acidosis and moderate and severe neonatal encephalopathy, which has led to an improvement in perinatal outcomes. This is achieved thanks to improved detection of fetal hypoxia which reduces the number of unnecessary interventions. There was also a significant reduction of instrumental deliveries due to fetal hypoxia.

This is indirect evidence as it comes from studies involving high and low risk women, undergoing a wide range of circumstances and interventions.
Summary of Evidence

The incorporation of ST segment analysis of the fetal ECG to the pathological CTG has been shown to reduce the need for fetal blood sampling FBS, instrumental vaginal deliveries, neonatal encephalopathy and metabolic acidosis in the studies that included low and high-risk women. Although there are no differences in the number of caesarean sections, in an Apgar score of less than seven after five minutes, nor in admissions to neonatal care units. (368-370)

Recommendations

<table>
<thead>
<tr>
<th></th>
<th>Routine analysis of the ST segment of fetal ECG is not recommended for normal labour.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>In hospital births when analysis of the ST segment of fetal ECG is available, it should only be used in women with an abnormal CTG.</td>
</tr>
</tbody>
</table>
10.5. CEFM with or without fetal scalp blood sampling (FBS)

- How effective are the following methods of fetal monitoring: CEFM with or without fetal scalp blood sampling (FBS)?

Fetal blood sampling is a procedure in which a small amount of the foetus's blood is taken, generally from the scalp. Fetal blood sampling and measuring of acid-base balance parameters (pH, base excess/deficit, etc) have been introduced for the purpose of identifying foetuses that are genuinely at risk and which must be delivered immediately from those that are not really at risk. It is important to underline the value of this test as a complement to CTG, to the extent that it has been recommended that cardiotocography should not be performed if this procedure is not available.

Scientific Evidence

To respond to the questions the NICE (10) guideline used an SR (363) that comprises 12 studies (37,000 women) in which CEFM was compared to IA, also evaluating the effect of FBS on a CEFM subgroup. It also uses the results of an observational cohort study with historic controls that compares the effectiveness of FBS and CEFM vs CEFM alone, (371) LE=II. The two studies were of reasonable quality although in the SR neither a statistical nor subgroup analysis was conducted and hence the findings are suggestive only.

The SR included high risk and low risk women, revealing an increase in instrumental vaginal deliveries in the CEFM and FBS group:

- CEFM and FBS versus IA: RR 1.47 [95% CI 1.11 to 1.93] CEFM
- CEFM without FBS versus IA: RR 1.10 [95% CI 0.87 to 1.40]

And a reduction in neonatal seizures:

- CEFM and FBS versus IA: RR 0.49 [95% CI 0.29 to 0.83]
- CEFM without FBS compared to IA: RR 0.54 [95% CI 0.20 to 1.44].

When low-risk women only were included in the meta-analysis, the results were consistent: there were less neonatal seizures in the CEFM and FBS groups when compared to IA: RR 0.37 [95% CI 0.15 to 0.87] and in the groups of CEFM without FBS compared to IA, the differences were not significant: RR 0.54 [95% CI 0.03 to 3.22]). No differences were found either in the results for other variables.
The cohort study (371) compared CEFM with CEFM and FBS and revealed evidence that the use of FBS reduces the incidence of instrumental deliveries due to fetal suffering: RR 0.33; (p=0.007), although no differences were observed in caesarean sections due to fetal suffering: RR 0.5; (p=0.5) nor in the Apgar test score of less than 7 at one minute: RR 0.50, (p=0.15) or at five minutes; (p=0.25).

The evidence provided by NICE (10) is limited due to the fact that there are no direct comparisons in randomised studies, but the evidence obtained from indirect comparisons suggests that FBS prevents some instrumental deliveries and caesarean sections.

The GDG of the NICE (10) guideline also highlights the contraindications to FBS:
- Maternal infection: HIV, hepatitis, herpes.
- Fetal blood disorders: haemophilia
- Prematurity: less than 34 weeks.

**Update (2006 to May 2008)**

In the update search no new studies were found meeting the criteria for inclusion.

See Appendix 3.2. Decision algorithm according to fetal pH results.

**Summary of Evidence**

Evidence coming from indirect comparisons suggests that FBS prevents some instrumental deliveries and caesarean sections. The procedure that has been shown to be most useful in reducing false positives of CEFM is FBS (363;371).

**Recommendations**

| B | FBM should be performed when there is an abnormal CTG reading. | Cohort study II |
10.6. CEFM with or without fetal scalp stimulation in the presence of FHR alterations

- How effective are the following methods of fetal monitoring: CEFM with or without fetal stimulation test when there are alterations in fetal hear rate?

Many sites have reduced the use of FBS to determine pH (372) and have not experienced a negative impact on neonatal morbidity-mortality. This has been possible thanks to an increase in the use of the Fetal stimulation test which is a technique that has arisen as a less invasive alternative, allowing less dependence on FBS.

Scientific Evidence

To respond to this question the NICE (10) guideline used an SR with a meta-analysis published in 2002 (373) that assessed the usefulness of the stimulation test in predicting fetal acidemia. The review assessed the predictive value of four fetal stimulation tests amongst which were puncture of fetal scalp (six studies) and digital stimulation (2 studies). The studies provide the results of the effectiveness of these methods separately and compared with FBS, the baseline test for determining fetal pH.

Reactivity of FHR after stimulation defines a negative result that predicts the absence of fetal acidemia. The meta-analysis that was re-published (374) after corrections were made to the magnitude of the estimates analysed, on the one hand, six studies that assessed *stimulation by puncture* of the fetal scalp, showing a combined likelihood ratio or a combined Lr for a negative acidemia test (Lr-) of: 0.22 [95% CI 0.05 to 1.05] and a combined likelihood ratio for a positive test (Lr+) of 2.3 [95% CI 1.53 to 3.48]. On the other hand, the combination of the two studies that assess *digital stimulation* of the fetal scalp resulted in Lr-:0.08 [95% CI 0.02 to 0.41] and Lr+: 1.93 [95% CI 1.48 to 2.52].

The very low value of negative Lr (<0.1) means that a negative test result practically rules out an acidemia diagnosis, and a positive Lr >1 increases the likelihood of acidemia existing.

In this meta-analysis the puncture results, with a statistically non-significant negative likelihood ratio, do not give confidence that the pre-test likelihood is altered after performing scalp puncture stimulation.
In relation to digital stimulation, an Lr- of 0.08 indicates that a negative result of said test would generate a considerable change in pre-test likelihood, reducing the likelihood of having acidemia and practically ruling out such a diagnosis. The Lr+ 1.93 only indicates a slight increase in post-test likelihood (in relation to the estimated 11% pre-test likelihood in the study) of having acidemia. Thus the evidence shows that digital stimulation of the fetal scalp has a high negative predictive value for the diagnosis of fetal acidemia.

Update (2006 to May 2008)

The search did not find any new studies that met the inclusion criteria.

Summary of Evidence

*Digital stimulation of the fetal scalp* has a poor positive predictive value but a high negative predictive value for the diagnosis of fetal acidemia (374).

Recommendations

* Digital fetal stimulation test should be used as an additional diagnostic method when there is an abnormal CTG reading.
10.7. Application of a CEFM categorisation system

- How does the use of a CEFM classification system influence neonatal outcomes?

There is a great disparity of criteria when classifying fetal heart rate patterns and, what is more, criteria are not applied across the board. It would be expected that the use of strict classification criteria would improve CTG monitoring capacities to obtain an appropriate indication for interventions.

Additionally, adopting uniform classification criteria for fetal heart rate recordings should afford benefits with regards to reproducibility of the research results.

**Scientific Evidence**

This question is not answered by the NICE (10) guideline.

**Update (2006 to May 2008)**

A literature search of systematic reviews, meta-analyses and assessment reports has been carried out to respond to this question.

The search has not found any review comparing the two interventions proposed: application of classification systems of continuous CTG recordings in different risk categories compared to assessment of the CTG recording without using these classifications.

Appendix 3.3 contains the classification of CTG recordings for each of the different risk categories. This table has been drawn up using two documents: the NICE (10) guideline and a review used in the update of one of the questions (370).

**Summary of Evidence**

| II | There are no categorisation systems, validated by trials, that demonstrate the effectiveness of applying a system for the classification of continuous CTG recordings in different risk categories (370). |

**Recommendations**

| ✓ | The CTG classification system shown in Appendix 3.3.2. is recommended. |