Spectral analysis of fetal heart rate variability for fetal surveillance: review of the literature
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CRD summary
The authors’ concluded that spectral analysis could be a promising method for foetal surveillance. The conclusions were supported by the data but should be interpreted with some caution due to the possibility of missed studies, lack of data on diagnostic accuracy and small size of the included studies.

Authors' objectives
To determine the value of spectral analysis for foetal surveillance.

Searching
PubMed, EMBASE and Cochrane Central Register of Controlled Trials (CENTRAL) were searched to May 2007. Search terms were reported. Reference lists of relevant studies were screened. The review was restricted to studies published in English.

Study selection
Studies that assessed spectral analysis of heart rate variability in antepartum or intrapartum foetuses and compared spectral energy in specific frequency bands with blood-gas values obtained by funipuncture or from the umbilical cord immediately post-partum were eligible for inclusion.

Antepartum studies were conducted at 20 to 38 weeks gestation. They used autoregression analysis of foetal heart rate measured using ultrasound and correlated these with blood gas measures from the umbilical vein. Intrapartum studies were conducted after 35 weeks gestation and used fast fourier transform or wavelet to analyse foetal heart rate measured using scalp electrodes or ultrasound and correlated these with blood gas measures from the umbilical artery. All studies provided data on spectral analysis at the low frequency (LF) band and all intrapartum studies also reported data at the high frequency (HF) band; some studies provided data at other bands, such as very low frequency (VLF), low low frequency (LLF) and medium frequency (MF). Thresholds for foetal distress varied between studies.

Two reviewers independently selected studies.

Assessment of study quality
Studies were assessed for methodological quality using the criteria: study design; description of inclusion/exclusion criteria; consecutive enrolment; prospective data collection; description of spectral analysis; valid outcome measure; whether foetal heart rate was obtained beat to beat; confounding variables; definition of foetal distress; availability of the same clinical data as in clinical practice; reporting of uninterpretable/missing results; and explanation of withdrawals.

The authors did not state how many reviewers performed the quality assessment.

Data extraction
Two reviewers independently extracted data.

Methods of synthesis
A narrative synthesis was reported.

Results of the review
Six prospective cohort studies (n=527, range three to 334) were included. None of the studies reported enrolling consecutive patients. All studies provided an adequate description of the spectral analysis and used valid outcome measures. All studies except one provided a clear definition of foetal distress. All studies reported that the same clinical data was available as would be available in practice. None of the studies explained reasons for withdrawals. Three
studies provided data on uninterpretable/missing results.

**Antepartum (two studies, n=29):**

Both studies found that a decrease in spectral energy in the low frequency band was significantly associated with foetal distress (pO$_2$ and pH in umbilical vein).

**Intrapartum (four studies, n=197):**

Three of the studies reported that spectral energy in the LF and HF bands decreased in the case of foetal distress (foetal hypoxia or acidaemia). Only one study provided sufficient data to calculate measures of diagnostic accuracy. This study reported a sensitivity of 97.5% and a specificity of 86.1% at an LF value of <0.0013 for the detection of foetal acidaemia.

**Authors’ conclusions**

Spectral analysis could be a promising method for foetal surveillance.

**CRD commentary**

The review addressed a clear objective supported by defined inclusion criteria. The literature search was adequate, but restriction of the review to published English-language studies raised possibilities of publication and language biases; these were not considered in the review. Details of the review process were not reported and so it was not possible to determine whether appropriate steps were taken to minimise bias and errors. Study quality was formally assessed and the results clearly reported, but some important biases for diagnostic studies (such as verification bias and review bias) were not considered. A narrative synthesis was appropriate given the differences between studies and format in which results data were available.

The authors’ cautious conclusions were supported by the data but should be interpreted with some caution due to the possibility of missed studies, lack of data on diagnostic accuracy and small size of the included studies.

**Implications of the review for practice and research**

**Practice:** The authors did not state any implications for practice.

**Research:** The authors stated that larger prospective studies were needed to determine the exact diagnostic value of spectral analysis. Standardisation of spectral analysis was recommended. Studies should focus on real-time monitoring.

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