

# Computerised intrapartum diagnosis of fetal hypoxia based on fetal heart rate monitoring and fetal pulse oximetry utilising wavelet analysis and SOM neural networks

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**Objective:** The development of an automated computerised system that will assist the early intrapartum diagnosis of fetal hypoxia. The proposed method is based on 1) a signal processing method named wavelet transform in order to estimate the power in different frequency ranges in various fetal states 2) the analysis of the continuous fetal pulse oximetry recordings (FSpO<sub>2</sub>) and 3) the utilisation of the Self-Organising Map (SOM) neural network in order to categorise different fetal heart rate (FHR) patterns.

**Methods.** Data collection: Data were collected from 61 women during labor in the 2<sup>nd</sup> University Clinic of Obstetrics & Gynaecology, "Aretaeion" Hospital, University of Athens. Fourteen cases, with pH < 7.2 were the risk group. The Cardiotocogram (CTG) and the FSpO<sub>2</sub> have been recorded during labour, using the Corometrics series 120 cardiotocograph combined with fetal pulse oximeter.

Wavelet based analysis: For each 10-minute period we applied wavelet multi-resolution analysis in order to address the problem of long-term non-stationary behaviour of the fetal heart rate tracings and to estimate the power in different frequency ranges. The estimated power corresponds to the variations of the FHR in a given frequency range.

Statistical analysis of the FSpO<sub>2</sub>: For each 10-minute period we calculated the percentage of time in which the SpO<sub>2</sub> was less than 30%.

Classification: In order to categorize different 10-minute fetal heart rate patterns we used the SOM neural network with unsupervised training. Such network consists of two layers: an input layer and a two-dimensional output layer. The characteristic of this neural network is to learn to recognize groups of similar input vectors, in such a way that units near to each other in the output layer respond to similar input vectors. In this way, a mapping process takes place and input data vectors with similar features are mapped into the same area of the SOM.

**Results:** For each 10-minute fetal heart rate pattern we estimated the power in the frequency ranges between 0.03 to 0.06 Hz and 0.06 to 0.09 Hz respectively and the percentage of time in which the SpO<sub>2</sub> was less than 30%. These three parameters formed the input vectors of the SOM neural network. After training of the neural network and mapping, the two-dimensional output topology showed an area characterized by high power values and very low oxygen saturation. We have noticed that when one or two 10-minute period patterns were located in this area, the pH value was below 7.2

**Conclusions:** We believe that computerised analysis of the FHR monitoring and pulse oximetry based on the combination of wavelet analysis and neural networks is a very promising technique in objective intrapartum diagnosis of fetal hypoxia.