Temporal Evolution of Intrapartum Fetal Heart-Rate Variability

Johann Vargas-Calixto[1], Emily Hamilton[1,2], Michael Kuzniewicz[3], Yvonne Wu[4], Philip Warrick[1,2], Robert Kearney[1]

[1]McGill University, Montreal, Canada, [2]PeriGen Inc., Montreal, Canada, [3]Kaiser Permanente, Northern California, USA [4]University of California, San Francisco, USA

Aims: Our research goal is to improve the intrapartum detection of severe fetal acidosis at birth and subsequent hypoxic-ischemic encephalopathy. The present study aims to examine the evolution of fetal heart rate variability (fHRV) over the course of labor.

Methods: We analyzed fetal heart rate (FHR) signals in the last six hours before delivery from 102,717 fetuses born at Kaiser Permanente Northern California. We divided these six hours into 18 nonoverlapping 20-minute epochs. For each subject, we analyzed the number of valid samples in each epoch and removed from analysis those with less than 80% valid samples. We estimated the power spectral density (PSD) of each epoch. The PSD was divided into three bands: low frequency (LF, 30–150 mHz), movement frequency (MF, 150–500 mHz), and high frequency (HF, 500–1000 mHz). The power in each band was normalized by the total power in the 30-1000 mHz band. We also estimated the LF/(MF+HF) ratio, and approximate entropy (ApEn). We assessed the time course of these features as delivery approached.

Results: Six hours before delivery, 59% of subjects had valid epochs. This number increased with time and peaked at 2 hours 20 minutes before delivery, when 66% of subjects had valid epochs. After this, the number of valid epochs decreased with time until only 10% of subjects had valid epochs at 20 minutes before delivery. Figure 1 shows differences in feature distributions of two epochs: LF decreased closer to delivery, while MF and HF increased. Also, the ratio LF/(MF+HF) and ApEn decreased with time.

Conclusions: This study demonstrates the temporal evolution of fHRV features that may be important in intrapartum fetal assessment. Future work will stratify the analysis by normal and pathological birth outcomes.
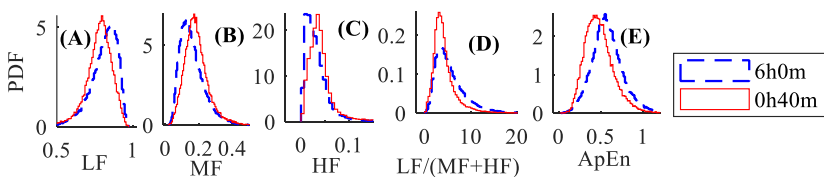

Figure 1: Distribution of fHRV features 6 hours (blue) and 40 minutes (red) before birth.