Prediction of Hypoxic-Ischemic Encephalopathy Using Events in Fetal Heart Rate and Uterine Pressure

Johann Vargas-Calixto[1*], Yvonne W. Wu[2], Michael Kuzniewicz[3], Marie-Coralie Cornet[2], Heather Forquer[3], Lawrence Gerstley[3], Emily Hamilton[1,4], Philip A. Warrick[1,4], Robert E. Kearney[1]

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

Aims: The objective of this work was to assess the potential of using features of intrapartum fetal heart rate (FHR) and uterine pressure (UP) events to detect infants at risk of developing hypoxic-ischemic encephalopathy (HIE).

Methods: We analyzed data from 40,976 term births from three groups: 374 infants that developed HIE, 3,056 that developed fetal acidosis without HIE, and 37,546 healthy infants. We counted the event transitions between FHR baseline, acceleration, and deceleration and the length of these events, uterine contractions, and resting intervals in the UP signal. These features were estimated in 20-minute-long epochs. Then, we trained a random forest classifier to discriminate between the healthy and the pathological groups comprised of acidosis and HIE cases. Finally, we looked at the predictions in consecutive epochs for each fetus and defined a decision rule to recommend clinical intervention if multiple consecutive epochs were classified as belonging to the pathological class comprised of cases of acidosis and HIE.

Results: Compared to the observed Caesarean delivery rates for each group, our system recommended interventions in 6.9% more infants in the HIE group (54.9% vs 61.8%, p<0.001) and in 10.7% more infants in the acidosis group (37.6% vs 48.3%, p<0.001), with no increase in the group with a healthy outcome (38.9% vs 38.8%, p=0.26). Furthermore, over 3/4 of the recommendations in the HIE group were made three hours or more before delivery.

Conclusions: Our results suggest that we could improve the detection of fetuses at risk of intrapartum HIE without adding unnecessary interventions to the healthy population. Importantly, most of the detections were made with enough lead time to permit clinical intervention to improve the outcome of birth.
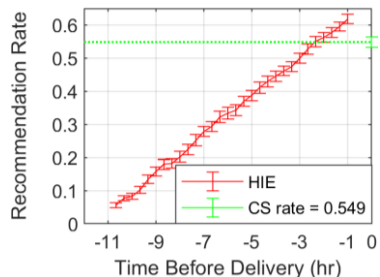
Figure 1: Median rate of recommending intervention in the HIE (red) group, compared to the Caesarean delivery rates (green) and its 95% confidence interval.