Neural Networks and the Intrapartum CTG

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Introduction:
In an ideal world methods to diagnose significant hypoxia should have high sensitivity, high specificity, be able to identify an intermediate state and provide a reliable estimate of time to deterioration. Because fetal monitoring has been around for a long time it is possible to review historical data and to characterize how various patterns over time are linked to outcome. We will present some results from work in progress using CTG traces, computerized measurement of fetal heart rate patterns and an artificial neural network to link these observations to 4 categories of newborn outcome.

Methods:
To measure the baseline of current clinical performance, 9 clinicians (from Canada, the US and UK) were sent binders containing the last 4 hours of fetal heart rates recording from approximately 24 different cases. The clinicians consisted of 8 certified obstetricians, 1 chief resident in Ob-Gyn and 1 RNC- PhD specializing in perinatal education. A total of 220 different cases were analyzed. The 4 group classification of newborn state was based on fetal functional response (presence or absence of newborn encephalopathy) and an accepted marker of asphyxia (base deficit from arterial cord blood). Clinical data and CTG recordings were collected from 4 Canadian centres. Only babies at gestational ages of 36 weeks or greater without evidence of congenital anomalies were included. All babies had arterial cord blood gas measurements. Detailed misclassifications grids will be presented.

Results:

Correct identification	Group A	Group B	Group C	Group D
	Encephalopathy & Base deficit over 12mmol/L	Encephalopathy & Base deficit under 12mmol/L	No Encephalopathy & Base deficit over 8 mmol/L	No Encephalopathy & Base deficit Under 8mmol/L
Clinicians	6/33 18.2%	1/6 16.7%	33/91 36.3%	68/90 75.6%
Neural Network	8/16 50.0%			39/48 81.3%
	20/38 52.6%		97/114 85.1%	

Summary:
Estimating the likelihood that a baby is in one of these 4 outcome states is indeed a challenge. The underlying physiology is complex, our ability to measure it the pertinent physiology is limited and the process evolves over time. Collecting the multicenter clinical information to conduct these experiments has been extremely difficult despite the importance of this clinical subject and its costs to society. More data is urgently required to ascertain the value of the ANN and to determine the stability and generalizabilty of the results. Moreover given that the interpretation of monitoring by newer technologies such as fetal oxygen saturation and fetal EKG ST segment changes depends upon an initial evaluation by CTG it is imperative to optimize CTG interpretation. At present it appears that the neural network can interpret tracings at a level comparable to our experts. We are continuing this work to determine its ability to discriminate between class C and D, and to analyze in detail the cases where the experts and the neural network have disagreed.

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