OBSTETRICS

Intrapartum electronic fetal heart rate monitoring to predict acidemia at birth with the use of deep learning

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Background

Electronic fetal monitoring is used in most US hospital births but has significant limitations in achieving its intended goal of preventing intrapartum hypoxic-ischemic injury. Novel deep learning techniques can improve complex data processing and pattern recognition in medicine.

Objective

This study aimed to apply deep learning approaches to develop and validate a model to predict fetal acidemia from electronic fetal monitoring data.

Study Design

The database was created using intrapartum electronic fetal monitoring data from 2006 to 2020 from a large, multisite academic health system. Data were divided into training and testing sets with equal distribution of acidemic cases. Several different deep learning architectures were explored. The primary outcome was umbilical artery acidemia, which was investigated at 4 clinically meaningful thresholds: 7.20, 7.15, 7.10, and 7.05, along with base excess. The receiver operating characteristic curves were generated with the area under the receiver operating characteristic assessed to determine the performance of the models. External validation was performed using a publicly available Czech database of electronic fetal monitoring data.

Results

A total of 124,777 electronic fetal monitoring files were available, of which 77,132 had <30% missingness in the last 60 minutes of the electronic fetal monitoring tracing. Of these, 21,041 were matched to a corresponding umbilical cord gas result, of which 10,182 were time-stamped within 30 minutes of the last electronic fetal monitoring reading and composed the final dataset. The prevalence rates of the outcomes in the data were 20.9% with a pH of <7.2, 9.1% with a pH of <7.15, 3.3% with a pH of <7.10, and 1.3% with a pH of <7.05. The best performing model achieved an area under the receiver operating characteristic of 0.85 at a pH threshold of <7.05. When predicting the joint outcome of both pH of <7.05 and base excess of less than −10 meq/L, an area under the receiver operating characteristic of 0.89 was achieved. When predicting both pH of <7.20 and base excess of less than −10 meq/L, an area under the receiver operating characteristic of 0.87 was achieved. At a pH of <7.15 and a positive predictive value of 30%, the model achieved a sensitivity of 90% and a specificity of 48%.

Conclusion

The application of deep learning methods to intrapartum electronic fetal monitoring analysis achieves promising performance in predicting fetal acidemia. This technology could help improve the accuracy and consistency of electronic fetal monitoring interpretation (Figure).

Author and article information

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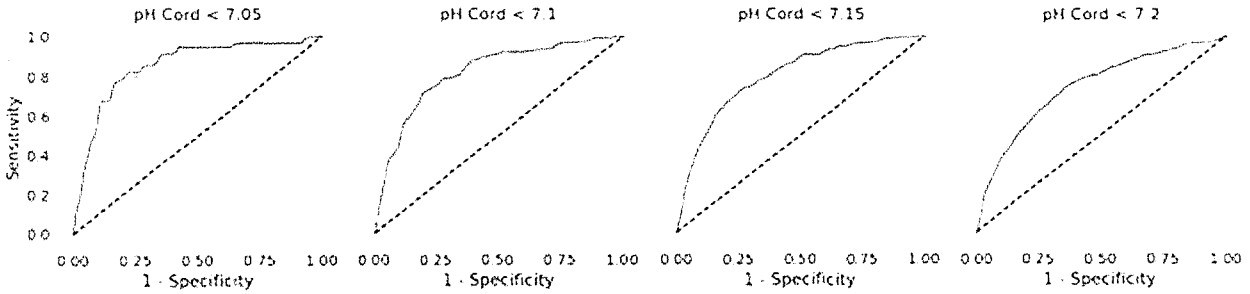
FIGURE
Receiver operating characteristic curves for the final deep learning models



From left to right, the pH threshold for classifying fetal acidemia increases from 7.05 to 7.10, 7.15, and 7.20. The *shaded area* indicates the 95% confidence interval.

McCoy. Deep learning to predict fetal acidemia. Am J Obstet Gynecol 2025.