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Multimodal Model for Predicting Fetal Acidosis in Delivery Room

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Abstract. In the delivery room, fetal well-being is evaluated through laboratory tests, biosignals like cardiotocography, and imaging techniques such as fetal echocardiography. We have developed a multimodal machine learning model that integrates medical records, biosignals, and imaging data to predict fetal acidosis, using a dataset from a tertiary hospital's delivery room (n=2,266). To achieve this, features were extracted from unstructured data sources, including biosignals and imaging, and then merged with structured data from medical records. The concatenated vectors formed the basis for training a classifier to predict post-delivery fetal acidosis. Our model achieved an Area Under the Receiver Operating Characteristic curve (AUROC) of 0.752 on the test dataset, demonstrating the potential of multimodal models in predicting various fetal outcomes.

Keywords. Artificial intelligence, Multimodal

1. Introduction

In the delivery room, data ranges from demographic information and medical histories to biosignals like cardiotocography and imaging studies such as fetal echocardiography. These multimodal data are integrated using methodologies like the Biophysical Profile for the monitoring of fetal distress. Current studies suggest using Fetal Heart Rate (FHR) to predict fetal acidosis, though they are limited to biosignal data.[1] We aim to develop a multimodal prediction model for fetal acidosis that integrates structured clinical, cardiotocography, fetal echography.

2. Methods

We obtained clinical data (Maternal age, underlying disease, gestational age), cardiotocography biosignal (2 Hz) and fetal ultrasonography from tertiary teaching

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hospital in South Korea(n=2,266). We used 70% patients for training, 10% for validation, 20% for internal testing. We defined the outcome, fetal acidosis, as pH<7.2 in first umbilical artery gas analysis after birth. Incidence of fetal acidosis was 7.3%(n=165).

We extracted features from cardiotocography and fetal ultrasonography data. Biosignals were processed as 1x100 vector representations with a variational autoencoder.[2] For fetal ultrasonography, we calculated the Systolic/Diastolic (S/D) ratio, Resistance Index (RI), and Pulsatility Index (PI) from umbilical artery images and extracted Peak Systolic Velocity (PSV) and End Diastolic Velocity (EDV) from notes. We combined these features with clinical data and applied the XGBoost algorithm to create the predictive model.

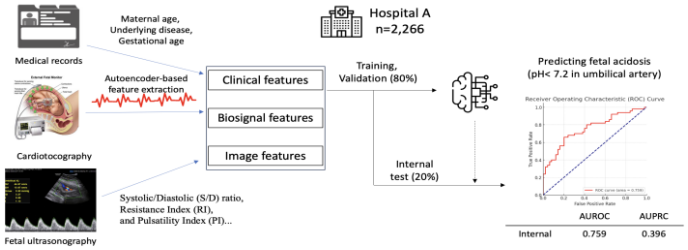

Figure 1. Overview of study.

3. Results

We developed a machine-learning model for predicting fetal acidosis using clinical data, biosignal, ultrasonography. In the test dataset, our model shows an area under the receiver operating characteristic curve (AUC) of 0.759, and an average precision (AP) of 0.396.

4. Discussion and Conclusions

We developed a machine-learning model for predicting fetal acidosis using clinical data, biosignals, and ultrasonography, demonstrating the potential of multimodal delivery room data. The model shows moderate performance with an AUROC of 0.759. The AP of 0.396 is relatively low due to the low incidence rate of fetal acidosis, making high precision challenging. Moreover, The study is limited by its single-institution data and simple feature extraction methods. Future work should employ advanced feature extraction techniques, expand to multi-institutional studies, and increase the number of fetal acidosis cases to improve precision and validate the model's effectiveness.

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