Uncovering Predictors of Neonatal Brain Injury Using Machine Learning

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Introduction

Hypoxic ischemic encephalopathy (HIE)

Brain injury occurring when the brain does not receive enough oxygen or blood flow for a period of time.

HIE accounts for 23% of neonatal deaths.

Therapeutic hypothermia (TH)
- Only intervention used today for neuroprotection of HIE infants
- Allows fetal brain time to heal and minimizes the spread of damage

Objectives

1. Create a prediction model based on prenatal, newborn, and maternal clinical data evaluating TH benefit.
   - Outcomes to be evaluated include:
     • Length of stay (LOS)
     • Time to full enteral feeds (FEFdays)
     • Abnormal MRI (AbnMR)

2. Evaluate feature importance with SHAP tests to identify features that have the greatest contribution to specific outcomes.

HYPOTHESIS: Identifying modifiable metrics (e.g., vasoactive drug delivery, oxygen delivery, hemoglobin/pH thresholds, etc.) will aid physicians in future interventional treatment of neonates with HIE.

Data Preprocessing

Inclusion/Exclusion criteria:

- 756 babies
- 155 babies with all the most relevant fields
- 275 babies big enough
- 275 babies NOT big enough
- 20 babies with important missing values
- 155 babies with all the most relevant fields
- 155 babies 18 features

Cohort description

Maximum Vasoactive Inotropic Score

Outcome distributions

Results - Feature importance in Outcomes

Length of stay (LOS)  Abnormal MRI (AbnMR)  Days to Full Enteral Feed (FEFdays)

Conclusions

Features that have a higher impact on the outcome of babies that underwent TH:
- Infant's first pH (stNpH)
- Maximum Vasoactive Inotropic Score (VIS_max)
- Race

Outcome Breakdown by Vasoactive Inotropic Score

Features correlated with VIS_max
- Gestational age
- Delivery method
- Lactate
- Nucleated RBCs

Features that have a higher impact on the outcome of babies that underwent TH:
- Seizures
- Non-reassuring fetal HR tracing
- Apgar 5 minute score
- Sarnat score
- Race

Feature and Model Assessment

Feature selection to address correlation between CordpH and CordBE

Evaluated scenarios:
- Dropping CordpH
- Dropping CordBE
- Maintaining both
- Dropping both and adding Badgas (A categorical feature that represents both CordBE and CordpH)

Model Performances vs Outcomes