

Background

- Growth failure (GF) among preterm infants is associated with clinical disorders and has been shown to adversely affect neurodevelopmental outcomes.
- Machine Learning (ML) methods can be used to integrate and analyze clinical observations, over time, in order to predict the likelihood of GF for preterm infants.
- Goal: Identify those infants that are most at risk for GF and identify changes in the treatment and interventions that could potentially improve the outcome for those at risk.

Objective

- We hypothesized that we could identify infants at risk for GF in the first few weeks of life based on their clinical and feeding data.
- We are interested in deploying and testing ML methods that can both, predict such outcome early on and identify nutritional interventions that could lead to better outcomes.
- Our classification ML models aim to predict GF at discharge, defined as a birth-to-discharge z-score decline of ≥ 1.2 .
- We trained three models that differ in the duration of the data they use in order to determine tradeoffs between accuracy and time of predictions: 1) *Birth*, 2) *Two weeks*, and 3) *One month*.

Clinical Data and Classifiers

Figure 1: Overview of Methods

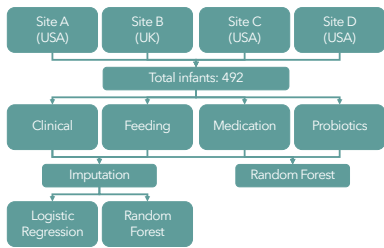


Table 2: List of Features

Feature Name	Weekly?	A	B	C	D
Gestational age		✓	✓	✓	✓
Birth z-score		✓	✓	✓	✓
Gender		✓	✓	✓	✓
Mode of delivery		✓	✓	✓	✓
Multiple gestation?		✓	✓	✓	✓
Maternal age		✓	✓	✓	✓
Post-menstrual age (PMA)		✓	✓	✓	✓
Body weight		✓	✓	✓	✓
Received any medication?		✓	✓	✓	✓
Quantity of Ampicillin/Gentamicin		✓	✓	✓	✓
Quantity of other antibiotics		✓	✓	✓	✓
# of days received breastmilk	✓	✓	✓	✓	✓
Quantity of breastmilk	✓	✓	✓	✓	✓
# of days received donated milk	✓	✓	✓	✓	✓
Quantity of donated milk	✓	✓	✓	✓	✓
# of days received formula	✓	✓	✓	✓	✓
Quantity of formula	✓	✓	✓	✓	✓
Received any probiotics?		✓	✓		
Quantity of Infloran		✓	✓		
Quantity of LB2		✓	✓		

Table 1: Summary of Data Sets

Dataset	# of Infants	
	GF	GN
Training (Sites A,B,C)	91	195
Test (Sites A,B,C)	20	51
Validation (Site D)	81	54

Results

Table 3: Summary of Best Model Performance Across Data Sets

Dataset	Performance Metrics								
	Sensitivity			Accuracy			AUC-ROC		
	Birth	Two weeks	One month	Birth	Two weeks	One month	Birth	Two weeks	One month
Training	0.68	0.72	0.71	0.61	0.66	0.62	0.64	0.72	0.68
Test	0.70	0.80	0.80	0.70	0.66	0.68	0.75	0.72	0.76
Validation	0.59	0.46	0.76	0.62	0.58	0.66	0.71	0.68	0.70

Table 4: Top 5 Features based on Pearson Correlation Analysis (GF as Positive Label & GN as Negative Label)

Feature Name	Correlation Coefficient (p-value)
# of days received donated milk (week 1)	-0.31 (8.3E-08)
# of days received breastmilk (week 1)	0.25 (2.1E-05)
Quantity of donated milk (week 1)	-0.21 (2.8E-04)
Body weight (Day 29)	-0.16 (6.6E-03)
Birth z-score	0.16 (7.7E-03)

Figure 2: Top 5 Selected Features Across Each Period

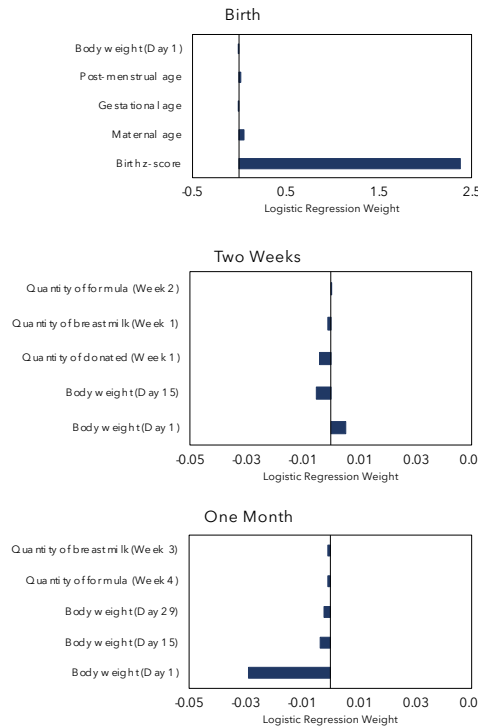
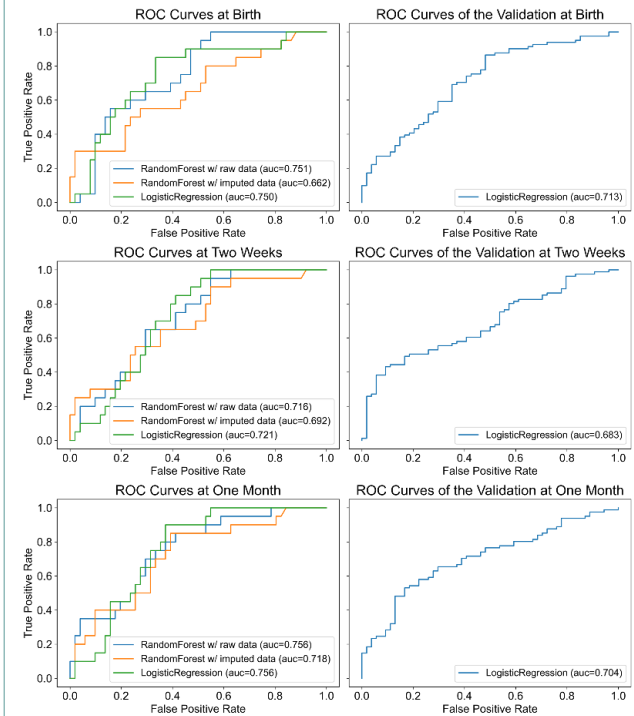


Figure 3: ROC Curves for Test Set and Validation Across Each Period



Conclusions

- We performed a systematic evaluation of ML classifiers to predict GF in preterm infants within the first month of life; Logistic Regression (LR) with imputation performs best and a subset of the features provides adequate accuracy.
- Features related to infant body weight and diet significantly affected the likelihood of GF at discharge.
- To determine generalizability to other preterm patient populations and clinical sites, models were validated on an independent cohort, demonstrating applicability to naïve datasets and patients.

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