Insulin Sensitivity Profile as a Marker for Reduced Outcome in the Neonatal Intensive Care Unit

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Introduction

Hyperglycemia in neonatal intensive care units is associated with mortality and morbidity. This research aims to use machine learning methods to provide a prediction of outcomes in hyperglycemic neonates, based on model-based metabolic (glycemic control) data as a non-invasive marker.

Methods

Clinical Data

Glycemic control data from 44 patients (4499 hours) under the STAR-NICU or STAR-GRYPHON[3] model-based glycemic controllers from Christchurch Women's Hospital were used.

	Sepsis	IVH	Non-Survivors	Survivors
N patient (died)	12	8(2)	6	18
Mean BG (mmol/L)	7,31	7,80	9,15	7,72
Mean S_I (L/mU/min)	$7{,}51\times10^{-4}$	$5{,}47\times10^{-4}$	$2{,}42\times10^{-4}$	$7{,}50\times10^{-4}$
Mean S_I Variability	$1{,}00\times10^{-4}$	$4{,}99\times10^{-5}$	$4{,}22\times10^{-5}$	$9{,}09\times10^{-5}$

TABLE I. SEPSIS, IVH, SURVIVORS, AND NON-SURVIVORS SUB-COHORTS CLINICAL DATA

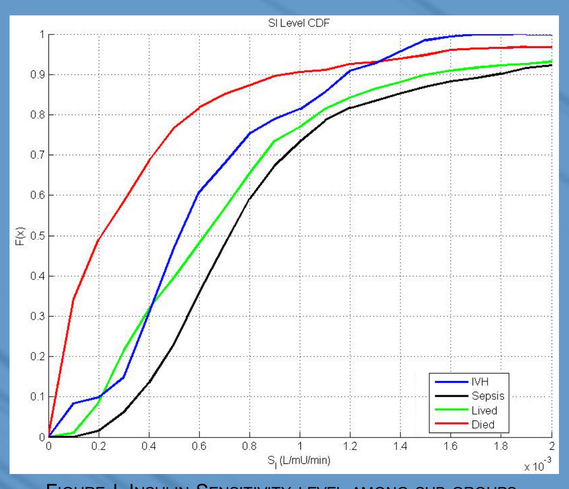


FIGURE I. INSULIN SENSITIVITY LEVEL AMONG SUB-GROUPS.

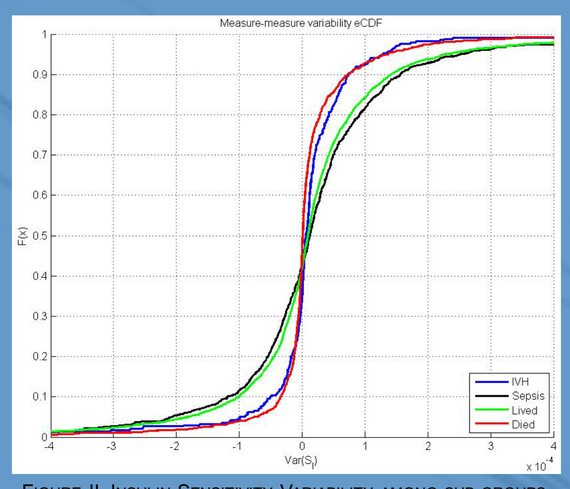
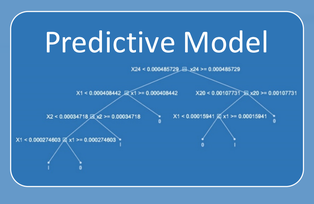


FIGURE II. INSULIN SENSITIVITY VARIABILITY AMONG SUB-GROUPS.

Predictive Models

Predictive models were built using attributes from hourly, patient-specific, model-based insulin sensitivity.

Patients Clinical Data (Insulin sensitivity times series) → → Mean hourly evolution of SI → Mean hourly SI variability → Predictive Model



The methods used were classification trees and K-nearest neighbors. The efficacy of the models was assessed evaluating sensitivity, specificity and accuracy.

Accuracy = overall correct classification.
Sensitivity = proportion of real positives properly identified.
Sensitivity = proportion of real negative properly identified.

New Patients entries → MODEL predicts outputs → → Accuracy? → Sensitivity? → Specificity?

Results

Mortality

It was possible to predict mortality with 85% accuracy and 60% sensitivity after the first 15 hours. Positive test is good at confirming death (Positive predictive value = 85%).

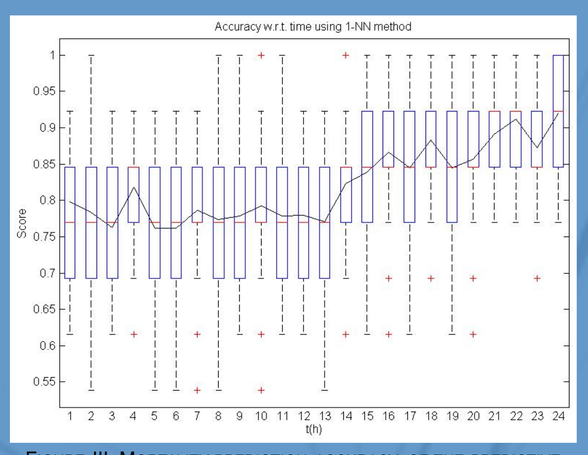


FIGURE III. MORTALITY PREDICTION ACCURACY OF THE PREDICTIVE MODEL W.R.T TIME.

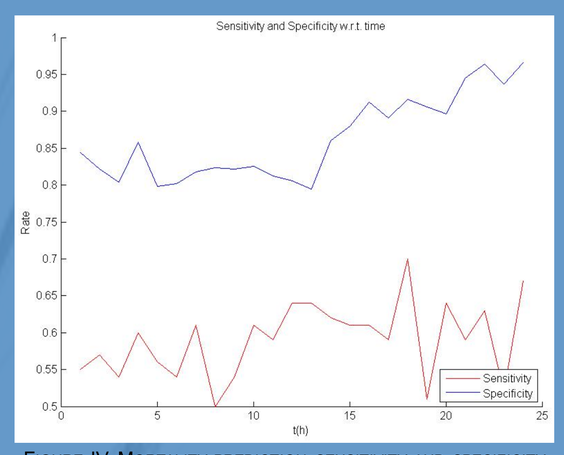


FIGURE IV. MORTALITY PREDICTION SENSITIVITY AND SPECIFICITY OF THE MODEL W.R.T TIME.

Sepsis

Septic patients were predicted with 70% accuracy and increasing sensitivity within 20 hours.

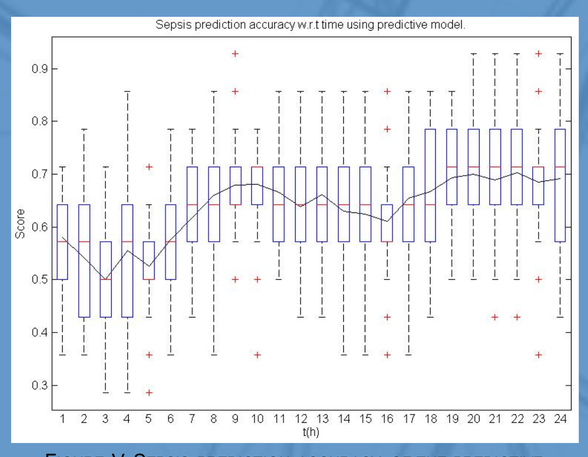


FIGURE V. SEPSIS PREDICTION ACCURACY OF THE PREDICTIVE MODEL W.R.T TIME.

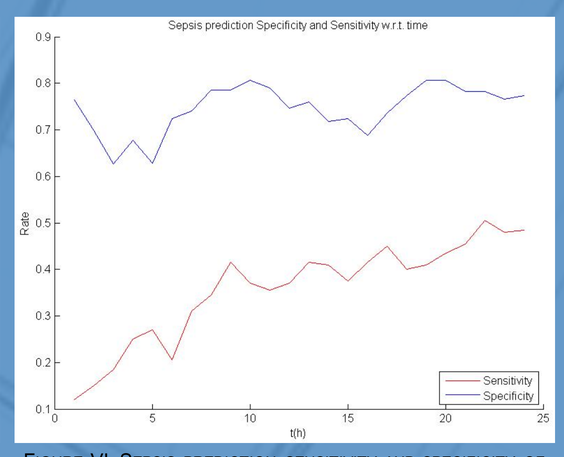


FIGURE VI. SEPSIS PREDICTION SENSITIVITY AND SPECIFICITY OF THE MODEL W.R.T TIME.

Conclusion

A clinically validated model-based insulin sensitivity measure and its variability, may provide information about patient condition and possible outcome, despite modeling limitations. This study emphasized the potential of machine learning to provide information on degrading patient condition and worsened outcome, as an alert to provide more intensive care.

Reference: 3. J. L. Dickson et al., "Development and optimisation of stochastic targeted (STAR) glycaemic control for preterm infants in neonatal intensive care," *Biomedical Signal Processing Control*, vol. 337, pp. 1–7, 2012.

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