Recurrent Neural Networks for Early Detection of Late Onset Sepsis in Premature Infants Using Heart Rate Variability

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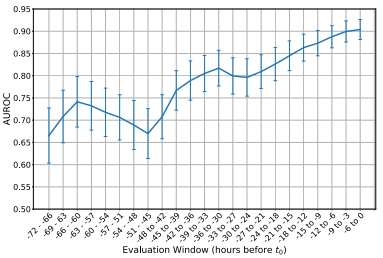
This study proposes a machine learning model based on recurrent neural networks (RNN) for the early detection of late onset sepsis (LOS) in premature infants, using heart rate variability (HRV) as input. The proposed model was designed with the objective of it being suitable for use as a decision support system (DSS) in neonatal intensive care units (NICU).

Methods: ECG data was acquired from infants born prematurely in six University Hospitals in France. Infants in the population were retrospectively classified into a control group, and a group of infants who developed LOS. The ECG signal was processed to obtain the R-R interval time series, from which 28 time-domain, frequency-domain, non-linear, and visibility graph features were extracted in order to characterize the HRV. These features were used in a machine learning model based on RNN architecture, which combines gated recurrent units and long short-term memory units. The output of the model is the probability of the patient having LOS, which is calculated in time-steps of 30 minutes. To train and test the model, the control and LOS groups were split into training and testing set (75% and 25% of each group, respectively). The performance of the model was measured using the area under the receiver operating characteristics curve (AUROC) as main metric.

Results: The model achieved an AUROC of more than 80% for the 24 hours before the onset of LOS, reaching a maximum of 90.4% (95% CI [8.1%, 92.6%]) six hours before the time of infection onset.

Conclusion: The proposed method has the potential to be easily implemented as a DSS for real-time LOS detection in NICU, as it uses only data which is continuously and automatically available in such settings, and can produce an updated probability of LOS every 30 minutes.



Progress of the AUROC achieved by model, evaluated on a sliding time window of six hours, with 50% overlap. Error bars represent the 95% CI.