HEART RATE VARIABILITY DURING ACTIVE AND QUIET SLEEP IN PRETERM NEONATES

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1 Introduction

During the last decade, studies using robust nonlinear detection techniques have provided some of the strongest support for the presence of chaos in HRV [1]. Specifically, the method of noise titration [2] provides a highly sensitive test for deterministic chaos and a relative measure for tracking chaos of a noise-contaminated signal in short data segments.

In the present study will be investigated if active sleep (AS) and quiet sleep (QS) periods can be distinguished – not only in general, but also in each of the neonate groups (see section 2.1) – using the Noise Limit (NL) value of the numerical noise titration technique. This could provide insight in the mechanisms causing periods of active or quiet sleep on the one hand and abnormal cardiorespiratory events on the other hand.

2 Methods

2.1 Data acquisiton

Polysomnographies (PSG) of 30 preterm neonates were recorded in the University Hospital Gasthuisberg (Leuven) and divided in three groups: NN, AN and AA. The first character refers to the PSG, while the second refers to the follow-up. N=normal, A=abnormal. Controlled RR interval series have mean duration of more than 8 hours, on average 75000 RR intervals.

2.2 Numerical noise titration

White (or linearly correlated) noise of increasing standard deviation (σ) is added to the RR interval series until its nonlinearity goes undetected by a particular indicator – here the Volterra-Wiener nonlinear identification method – at a limiting value of σ = Noise Limit (NL). NL>0 indicates chaos and the value of NL gives an estimate of its relative intensity. Conversely, if NL=0, then it may be inferred that the series either is not chaotic or the chaotic component is already neutralized by the background noise in the data, called “noise floor”. Therefore, the condition NL>0 provides a simple sufficient test for chaos. More details about the algorithm can be found in [2].

2.3 Data and statistical analysis

Numerical noise titration was applied on the resampled (2 Hz) RR interval series and even on all QS and AS periods separately, using a 300-second window and sliding the window every 30 seconds.

Statistical comparisons between QS, AS and complete recordings, were analysed by nonparametric Wilcoxon signed rank tests. $P < 0.05$ was considered statistically significant.

3 Results and Discussion

Periods of quiet sleep have lower noise limit values and can be distinguished significantly from periods of active sleep and from the whole recording. Several measures based on the NL value, reflect the same conclusions. The RR interval series during quiet sleep is less chaotic and in many cases NL is 0, which means that that signal part can be modeled sufficiently well in a linear way. The presence of abnormal cardiorespiratory events does not influence this finding.

4 Conclusion

The numerical noise titration technique led to statistically very significant differences. This original and new technique offers many possibilities for further studies since the NL parameter has a strong discriminating character for classification in different pathologies such as sudden infant death syndrome (SIDS) and asphyxia.

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References

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