

Heart Rate Variability Analysis during Weaning from Mechanical Ventilation: Models for Prediction of the Weaning Trial Outcome

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This study estimates the activity of the autonomic cardiac control (ACC) in critically ill patients undergoing weaning from mechanical ventilation, aiming to predict the weaning outcome. Drawing the attention on the cardiovascular stress during ventilator discontinuation, we investigate the potential of heart rate variability (HRV) profiles to unmask existing abnormalities in the autonomic regulatory mechanisms at different weaning phases.

Data from 11 successfully and 12 unsuccessfully weaned patients were collected with AVEA ventilator system in the intensive care unit of the University Emergency Hospital 'Pirogov', Sofia. HRV profiles were estimated in non-sedated patients during 3 weaning phases: (1) PSV(0) – pressure support ventilation at zero back-up pressure; (2) PSV at 12-25 cmH₂O; (3) SBT – spontaneous breathing trial at 8 cmH₂O. HRV was analyzed on 5-min RR-interval episodes under stationary conditions during each weaning phase. Standardized HRV indices in the time-domain (calculated from RR-tachogram, dRR-tachogram) and frequency-domain (Fourier transform) were measured.

We found that weaning patients presented certain HRV profile differences than healthy subjects:

- increased low and very low frequency components (LF, VLF);
- reduced high frequency components (HF) and correlated time-domain indices (RMSSD, pNN50);
- reduced total power (TP) and correlated SDNN.

Our model for prediction of successful weaning outcome considers 3 basic mechanisms for adequate ACC response on the weaning cardio-respiratory stress: (1) preserved ACC ability to maintain physiological adaptation; (2) modulated ACC activity by the breathing model; (3) mostly neurohumoral regulation of the blood circulation. The successful group model exhibits reduced total activity (TP, SDNN) with increased sympathetic tone (VLF/TP, LF/TP, LF/HF>1) and reduced vagal tone (HF/TP, RMSSD, pNN50), the latter related to the respiratory rate and tidal volume. Deviations from this model are indicative for unsuccessful weaning detected with a decision tree rule with accuracy 92.5% (PSV(0), PSV) and 95.2% (SBT), better than other published studies.