MEASURING ADEQUACY OF ANALGESIA WITH CARDIORESPIRATORY COHERENCE

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Introduction: An automated nociception monitor would be very useful in general anesthesia, providing anesthesiologists with real-time feedback about the adequacy of analgesia. We have developed an algorithm to measure nociception using respiratory sinus arrhythmia (RSA) in heart rate variability (HRV). We have previously shown that this algorithm can detect patient movement (strongly nociceptive events) during general anesthesia [1]. We will now attempt to determine if the algorithm responds to boluses of anesthetic drugs (strongly anti-nociceptive events).

Method: *Algorithm:* The algorithm estimates cardiorespiratory coherence, which is the strength of linear coupling between HR and respiration (one measure of RSA). It measures and combines the spectral power in both signals using wavelet analysis. Coherence is dimensionless, and ranges from 0 (no coherence, strong nociception) to 1 (perfect coherence, no nociception).

Data Analysis: Following ethics approval and informed consent, 60 drug bolus events (excluding induction of anesthesia) were recorded in 47 pediatric patients receiving general anesthesia during dental surgery. In post hoc analysis, coherence was averaged over the 60s immediately preceding the bolus dose of drug (nociceptive period). The bolus was given 30s to take effect, after which the coherence was averaged over the following 60s (anti-nociceptive period). The change in average coherence between the two periods was calculated. The change in average HR was also calculated, for comparison.

Results: Coherence increased by an average of 0.14 (32%) in response to the bolus dose of anesthetic drug. HR decreased by an average of 4.1 beats/min (3.9%).

Discussion: Cardiorespiratory coherence responded much more strongly to the anesthetic boluses than did HR alone. This result, combined with previous work showing that coherence is low during periods of nociception [1], demonstrates that cardiorespiratory coherence can be used to measure the adequacy of analgesia during general anesthesia. We are currently adapting the algorithm so that it can be used in real-time.

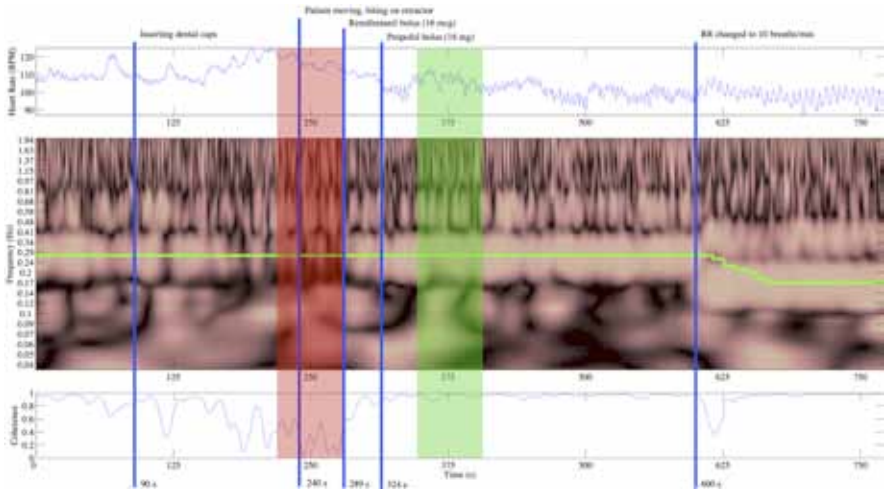

Figure 1: Example coherence analysis. Top plot: heart rate. Middle plot: coherence map in time/frequency. Bright areas indicate high coherence. Horizontal green line indicates the respiratory frequency. Bottom plot: coherence at the respiratory frequency. Vertical blue lines denote clinical events. Red box denotes nociceptive period, green box denotes anti-nociceptive period.

References

1. Brouse CJ et al., Conference Proceedings of the IEEE EMBS, 2011, pp. 6114-7.