Home Monitoring: Breathing Rate from PPG and ECG

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Objective: breathing rate is one of the vital signs that is most indicative of physiological deterioration (Hodgetts et al., 2002; Cretikos et al., 2007), and yet the majority of patients in hospital only have infrequent, manual measurements taken by clinical staff counting movements of the chest wall; the breathing rate of patients at home is typically not monitored. There is therefore a need for robust algorithms that can estimate respiration rate from the lightwave-sensors that can be worn by that majority of patients in hospital who are not connected to bedside monitors, and to patients in the home; such sensors include mobile pulse oximeter and a “smart sticking plaster”, which acquires single-lead ECG. All clinical investigations undertaken to date have been small studies (of typically around 20 subjects) of patients with healthy physiology. We undertook a large-scale clinical study to investigate the efficacy of estimating breathing rate from lightwave sensors, using a large cohort of patients undergoing haemodialysis. This group closely represents the “unwell” class of patients for whom automatic measurement of breathing rate is most necessary.

Results: the study resulted in 2,749 hours of monitoring from 500 sessions of dialysis (a cohort of 77 patients), each session of which was between 4 and 7 hours duration. Mean error in breathing-rate estimation (with error s.d.) over the whole dataset for methods 1, 2, 3, and 4, respectively, was 3.2 (4.7) bpm, 5.2 (8.4) bpm, 3.8 (4.3) bpm, and 2.0 (1.9) bpm, indicating that the new “fused” estimate was most successful.

We conclude that the difficulty of performing breathing-rate estimation in unwell, elderly patients is significant, and that previous-existing methods, which were trained and validated using data from small numbers of healthy patients, are not suitable for clinical use with “real” patient populations; our proposed method estimates breathing-rate sufficiently successfully that it can be used in clinical practice for monitoring home patients.

References: