

Photoplethysmography For Simultaneous Recording of Heart and Respiratory Rates in Newborn Infants

Olsson E, Ugnell H, Öberg P Å & Sedin G, Department of Paediatrics, Children's University Hospital, Uppsala and Department of Biomedical Engineering, University of Linköping, Linköping, Sweden

Abstract: A new non-invasive method for monitoring of heart rate and respiratory rate is presented.

INTRODUCTION

In infants with long-term lung disorders, apnoea of prematurity or convulsions, it may be necessary to monitor the heart and respiratory rates during a long period. It is then of advantage if the monitoring technique is easy to use by the parents and does not cause any disturbance to the infant.

When electromagnetic imaging is used as a diagnostic tool in infants it is also necessary to use other techniques than ECG and transthoracic impedance, as these techniques require ECG electrodes applied on the thoracic cage. Recently new techniques have been introduced, making it possible to record respiratory and heart rates using fibre-optic sensors (1, 2). In this study we have compared the heart and respiratory rates recorded by photoplethysmography with those recorded with the use of ECG and transthoracic impedance (3).

MATERIAL AND METHODS

Ten newborn infants nursed in a neonatal intensive care unit and in a neonatal intermediate care unit were studied. They were in stable condition and none of them needed mechanical ventilation at the time of the study. Some of the infants were fullterm and some preterm.

For the photoplethysmography (PPG;4) a photo detector (SFH 2030, Siemens, USA) was used. The photoplethysmographic signal was derived from the skin surface using an optical sensor which consists of a photo detector circumferenced by 6 light-emitting diodes (wavelength 940 nm). The PPG signal was offset-balanced and amplified and the heart and respiratory signals were extracted using specially designed digital filters.

The optical sensor was attached to the skin at three different measuring sites, the leg, the buttock and the interscapular region. For comparisons heart rates and respiratory rates were recorded with a Hewlett Packard Merlin System. All signals were recorded on a TEAC RD-101 Data Recorder.

EVALUATION OF DATA

The recordings with the two techniques were compared in order to determine which individual heart beats and respiratory cycles were recorded with one or both techniques.

RESULTS

Comparison between PPG and the traditional ECG and impedance signals revealed a high degree of correspondence between respiratory and heart rates recorded with the two different methods. In most subjects there was almost 100% correspondence. There was a higher agreement between the PPG and ECG/impedance signals when the PPG sensor was placed on the leg or on the buttock than when it was placed in the interscapular region, from which it was more difficult to distinguish individual heart beats.

DISCUSSION

To summarise, heart and respiratory rates in newborn infants can be monitored by photoplethysmography although the technique must be further investigated and developed so that it will be possible to eliminate all disturbances caused by movements. PPG will be of great value for monitoring during MRJ and during radiographic examinations when electrodes can not be applied on the thoracic cage.

CONCLUSION

Heart and respiratory rates in newborn infants can be monitored by photoplethysmography.

REFERENCES

- [1] L-G. Lindberg, H. Ugnell and P.Å. Öberg, Monitoring of Respiratory and Heart Rates Using a Fiber-Optic Sensor, *Med & Biol Eng & Comput*, vol. 30, pp. 533-537, 1992.
- [2] M. Vegfors, H. Ugnell, B. Hök, P.Å. Öberg and C. Lennmarken, Experimental Evaluation of two New Sensors for Respiratory Rate Monitoring, *Physiol Measurements*, vol. 14, pp. 171-181, 1993.
- [3] T. Olsson and L. Victorin, Transthoracic Impedance, with Special Reference to Newborn Infants and Ratio Air-To-Fluid in the Lungs, *Acta Paediatr Scand*, Suppl 207, 1970.
- [4] A.B. Hertzman, Photoelectric Plethysmography of the Fingers and Toes, *Man Proc Soc, Exp Biol Med*, vol. 37, pp. 529-534, 1937.