

Validity of ecgMove R-peak detection

Sarah Bachis, Jörg Ottenbacher¹
¹ movisens GmbH, Karlsruhe, Germany



Figure 1: ecgMove Device

Introduction

This report evaluates the ECG-signal monitoring performance of the movisens product ecgMove. The evaluation assesses the R-wave detection validity of the ecgMove in comparison to the SOMNOscreen plus from SOMNOmedics, a medical standard measurement system. The movisens ecgMove is a psycho physiologic ambulatory measurement system designed and optimized for research applications. The sensor acquires and records the raw data of a single channel ECG, 3D acceleration, air pressure and temperature for a measurement lasting up to 2 weeks. The data can be transferred to a PC via USB after the measurement or via Bluetooth in real-time. The sensor can be used with a dry electrode chest strap or with single use electrodes. From the raw data, secondary parameter like heart rate, heart rate variability, steps, activity classes, and energy expenditure can be calculated with the movisens DataAnalyzer

software. Meaningful reports in PDF or tables in Excel can be generated by this software.

Methods

We assessed the validity of the ecgMove by creating situations similar to those found under free-living conditions, but with an increased share of situations in which detection errors appear due to movement artefacts. Ten participants completed a test protocol involving activities of different durations: lying (3 min), sitting (2 min), standing (2 min), walking (4 min), arm circling (1 min), cleaning up the desk (2 min), walking fast (4 min), walking up and down stairs (4 min), jumping (1 min), jogging (4 min) and cycling on an ergometer (2 min). The researcher was always behind the subject to not influence their pace or behaviour. The participants (c.f. Table 1) were male and female, aged between 24 and 52 with moderate to good fitness levels. During the exercises, the participants wore the ecgMove and the SOMNOscreen plus system. After the data collection, the R-waves in the ECG signal were annotated manually to set a reference level. Regions of the ECG signal in which a manual annotation was not possible were excluded from further analysis. Then we used the OSEA algorithm² to automatically detect the R-waves on both systems. To assess validity, the results were compared to the reference described in DIN 60601-2-47¹ and the true positive (TP), false negative (FN) and false positive (FP) beats were detected. From these parameters the sensitivity (Se) and the positive predictive value (pP) can be calculated. Thus, Se and pP were estimated to demonstrate the validity of the R-wave detection of the ecgMove in comparison to the SOMNOscreen.

Table 1: Physical characteristics of participants

	Males (N=5)	Females (N=5)	All subjects (N=10)
Age (yrs.)	35.2 ± 10.0	31.6 ± 10.0	33.4 ± 9.6
Height (m)	1.8 ± 0.1	1.7 ± 0.1	1.8 ± 0.1
Weight (kg)	75.2 ± 8.3	64.4 ± 8.3	69.8 ± 9.7

Table 2: Absolute detected R-waves and mean results of pP and Se

R-wave	Tp [absolute]	Fp [absolute]	Fn [absolute]	Mean Se [%]	Mean pP [%]
SOMNOscreen	29552	522	147	99.47	98,06
ecgMove	29373	854	326	98.89	96.86

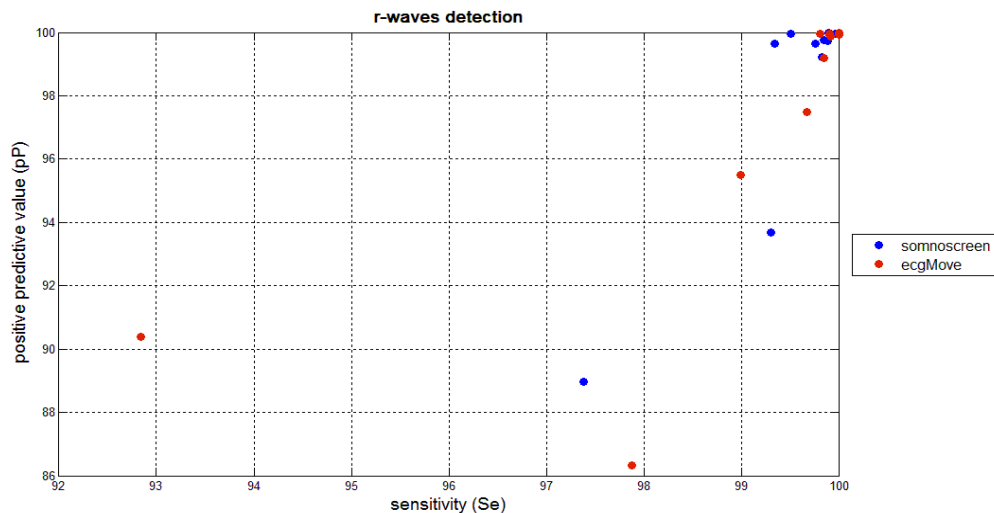


Figure 2: Results of R-waves of the SOMNOscreen (blue points) and ecgMove (red points) regarding the sensitivity (Se) and the positive predictive value (pP).

Results & Discussion

Table 2 shows the results of the absolute detected R-waves for both systems as well as the mean sensitivity and positive predictive value of all subjects. The ecgMove detected $98.89\% \pm 2.23\%$ of R-waves in which $96.86\% \pm 4.81\%$ of the detected R-waves have been true R-waves. The SOMNOscreen has detected $99.47\% \pm 0.77\%$ of R-waves in which $98.06\% \pm 3.72\%$ of these detected R-waves have been true. Figure 2 shows the results of R-waves of the SOMNOscreen and ecgMove for all subjects.

Due to the uniform size of the chest belt (only Large was available at that time), for two of the subjects during exercise it was sometimes sliding out of position. That caused movement artefacts that did not allow an exact detection of R-waves in these situations. Therefore the results note two outliers. Based on this knowledge chest belts in sizes S-XL have been made available for further studies. However it should also be noted in real life situations the artefacts which are caused by motion are much lower than in the study during the exercises.

Conclusion

In the current study two ECG measurement systems were compared for showing the accuracy of the ecgMove signal in detecting R-waves. Taking the high degree of Se and pP, as well as the low SD into account, the ecgMove is a suitable psycho physiological measurement system.

References

1. EN 60601-2-47: Medizinische elektrische Geräte - Teil 2-47: Besondere Festlegungen für die Sicherheit einschließlich der wesentlichen Leistungsmerkmale von ambulanten elektrokardiographischen Systemen.
2. Hamilton, S. (2002). Open Source ECG Analysis Software Documentation, E.P. Limited. <http://www.eplimited.com>: Abruf 11 2011