

# Heart Rate Variability Measurements in Mobile Work

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**Abstract.** There are new complexity and workload factors related to mobile working mode. One main thing to be considered is the work-life balance, especially from the adequate recovery point of view. Heart rate variability (HRV) reflects the functioning of the autonomic nervous system (ANS). Thus stress and recovery of the ANS can be evaluated with HRV analyses. The objective of this study was to find out how the HRV measurement serves the aims of occupational health care. Ten globally mobile employees were measured by a HRV recording procedure. The experiences of the measurement execution were collected by semi-structured interviews. Through HRV measurement occupational health care professionals gain valid information on mobile employees' ANS stress and recovery reactions. When connecting the diary information entered by the employees to this, knowledge of working conditions could also be reached. However, the measurement procedure is time consuming and expensive to execute. Therefore the HRV measurement should target those mobile employees, who have difficulties on controlling their work-life balance.

**Keywords:** Mobile work, Stress, Recovery, Heart Rate Variability

## 1 Introduction

New developments in information and communication technology (ICT) have changed the way people approach their life and work. Mobile virtual work is no longer bound to fixed locations, as utilising ICT al-

allows people function freely in various environments. An employee is considered mobile when he/she works more than ten hours per week away from his/her primary workplace and uses ICT for collaboration [1, 2, 3]. One has to distinguish the concept of mobile work, mobile workers and mobile technology. In a stricter sense by mobile work we may mean documents and tasks that move. In this article the concept of mobile work is used in a wider sense i.e. referring to the work and working mode of an employee. Thus, mobile employees work at and move between different work places. [see 4.] According to Lilischkis [5], this type of working in many places could also be called 'multi-locational work'. The Fourth European Working Conditions Survey [6] shows that in 2005 only 50 per cent of the working population in the EU worked at their place of work all the time and that a total of 21 per cent never worked at their primary workplace. This shows indirectly the increased portion of mobile working in multiple locations. Furthermore, 9 per cent of workers always worked in locations outside the home and company premises.

The available research on mobile virtual work argues that there are new complexity and workload factors related to this kind of working [3, 4, 7, 8, 9]. One main thing to be considered in this "anytime and anywhere" work is the work-life balance, especially from the adequate recovery point of view. E.g. Vartiainen and Hyrkkänen [3, 7, 8] have reported how globally mobile employees synchronously working over time zones experience the effect of changing the hours and rhythm of their work and how this 'timeless' continuous working and collaboration is a very strongly negative mental workload factor. It breaks down the normal rhythms of working and rest periods. Mobile employees do not have uninterrupted working days starting at a particular time and ending at another, but instead altered rhythms of the days, as well as the weeks, according to the demands of their tasks. Working periods could take place early in the morning, in the afternoon, and in the evening. Work might be done to some extent every day of the week. All this causes an inclination towards unconventional working hours, also with evening and weekend work. The need to be constantly available also affects the experiences of strain.

Better understanding of the work load factors of mobile work is needed not only by employees, but managers, HR personnel and occupational health care professionals as well. They all need to cope more effectively with the work demands of mobile work to enhance well-being. However, it is difficult to gain understanding about the load of mobile work if the paths of the mobile employee and his/her superior cross

only occasionally. Occupational health care professionals meet the same contradiction: they should be able to analyse the load of mobile work as well as stress and strain of a mobile employee and to give adequate instructions for optimising and controlling the load.

Heart rate variability (HRV) reflects the functioning of the autonomic nervous system (ANS). Thus, stress and recovery of the ANS can be evaluated with HRV analyses [10, 11, 12, 13]. Measuring HRV has usually needed laboratory conditions, but lately new applications, which allow measurements in the field and analysis made by corporate health care professionals, have emerged. In this preliminary study, the usability of HRV was tested in assessing the stress and recovery of mobile employees. The usability assessment was made from the occupational health care practitioner's point of view.

## **2 Objectives**

The objective of this study was to find out how the HRV measurement serves as a tool for occupational health care professionals in analysing the stress and recovery reactions of ANS of the mobile employees during their business trips. According to the Finnish Occupational Health Care Act [14], occupational health care activities should be based on careful analysis of work and working conditions at work places of the organisations involved. The knowledge of work and working conditions should be gained through repeated workplace visits [14]. In mobile multi-local work it is impossible for occupational health care personnel to directly observe the working conditions and therefore the information should be gathered in an indirect way. HRV measurement producing information about the stress and recovery of ANS during business trips may be a valid tool for the purposes of occupational health care.

The research questions were:

1. What do the HRV measurement and the measurement related diary tell about the mobile employee's recovery during the business trip?
2. What are the demands of the HRV measurement procedure met by occupational health care practitioners?

### **3 Methods**

This pilot study with the HRV measurement procedure was carried out in collaboration with two occupational health care corporations (clinics). Ten globally mobile employees needing occupational health care services were measured by a First Beat HRV recording procedure. The selection of the measured employees was made purposively: occupational health care professionals were instructed to select the employees that they thought would benefit from this assessment. The other inclusion criteria were that the employee often has to travel abroad to meet the objectives of his/her work and the working mode is "mobile" [2, 3]. Of the selected employees 2 were female and 8 male; all were managerial employees.

Ten mobile testees were given a "body guard" heartbeat recording system which they carried for three business trip days. The flow of the days was not strictly defined beforehand and therefore there are three different travelling and working procedures: 1. the first day includes travelling and working, the second day working abroad, the third day working and travelling back; 2. the first day travelling and working and the second two days working abroad; 3. working abroad two days and then working and travelling back to home during the third day. Before starting the measurement, the testees were instructed on how to use the heartbeat recording system and how to carefully enter all their actions and the places they had been to into a diary. After recording the data, the variables of HRV were analysed using the FirstBeat programme. After the analysis, the stress and recovery chart was shown to the testee and his/her experiences of the results/findings were discussed in detail. This discussion was recorded and analysed with the help of the AtlasTi programme.

For assessing the demands of the HRV measurement procedure, the time used by occupational health care practitioners for one measured employee was counted and the problems met during the procedure were entered into the measurement diary. The experiences of the measurement procedures were collected also by interviewing (semi-structured interview) those (health care professionals, researchers) who conducted the measurement procedure.

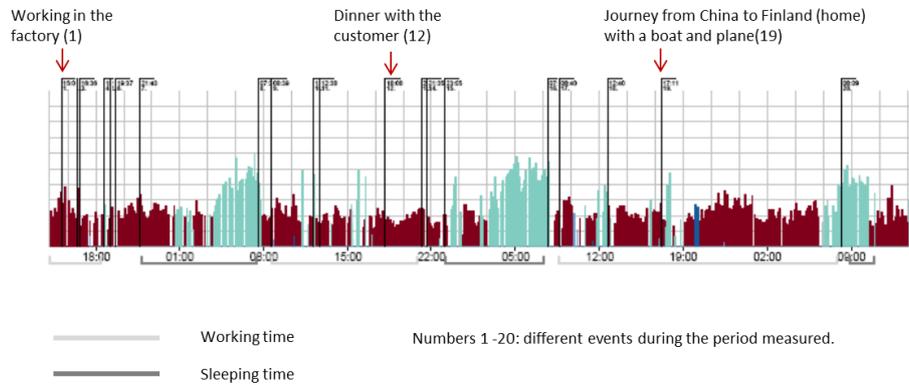
## **4 Results**

### **4.1 What does HRV measurement tell about the mobile employees' recovery during the business trip**

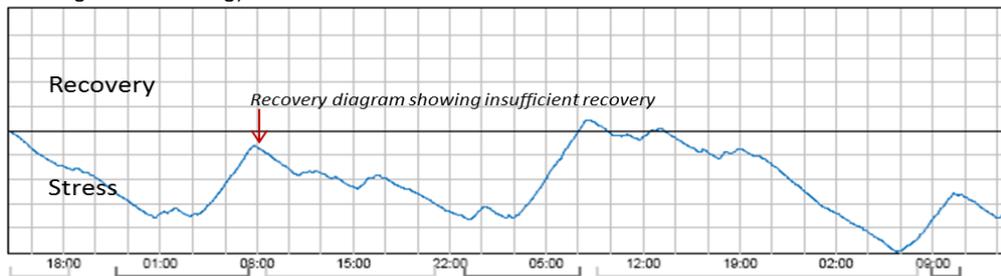
There are three main procedures in the First Beat application which could be used for the clinical assessing of recovery: the diagram of fluctuation of sympathetic and parasympathetic activation during the measured days (Fig 1.), the diagram of recovery (Fig 2.) and the diagram showing the root mean square of successive differences, i.e. RMSSD (Fig 3.). RMSSD is a measure of parasympathetic cardiac modulation, which could also be used for assessing the quality of sleep [e.g. 15]. The First Beat application produces estimations of the quality of sleep based on the analysis of RMSSD during sleeping time. These sleeping time related RMSSD averages were also used when analysing the recovery during the business trip.

The diagrams of fluctuation as well as the diagrams of recovery showed that during business trips, the mobile employees' sympathetic activation of the ANS dominates and parasympathetic activation phases remain relatively short (Fig. 1). Mobile working days were long and filled with sympathetic activation. Seldom during the working period were there breaks for recovery. Added to this, the evening times were usually spent in work related social events e.g. having dinner with a customer or colleague. That lengthened the period of sympathetic activation. In most cases the amount as well as the quality of sleep was inadequate for reaching sufficient recovery. The average sleeping time was 6.5 hours during the business trip nights and the average of RMSSD during sleep was 17.8 (sd 5.6) pointing out the bad quality of sleep.

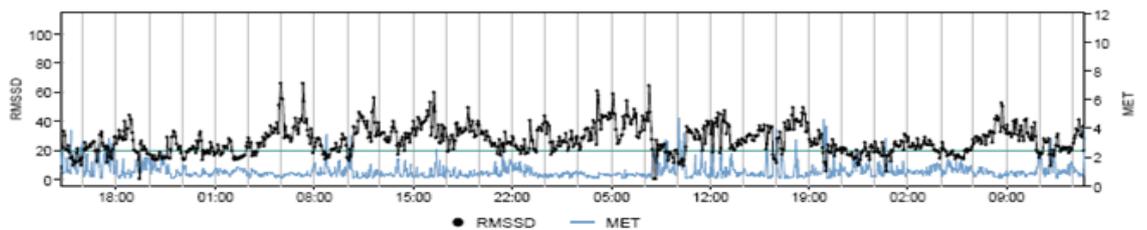
Of the ten followed people, only two exercised during the business trip days. Usually, the days were full of work activities only. The HRV shows also the minor physical activity periods of the day, i.e. climbing the stairs, running to a train or bus, walking from the work place to the hotel etc. However, according to the analysis, these periods were so few and so short that health enhancing physical activity levels were not achieved during the business trip days. In Figure 1 the blue part shows physical activity. In this example case, the employee was hurrying from the ferry to the airport.



**Fig. 1.** An example of the fluctuation of sympathetic and parasympathetic activation during a business trip (three days, testee 5, two days working abroad and the third working and travelling)



**Fig. 2.** The diagram of recovery – an example of the reduction and accumulation of a mobile employee's resources during a business trip, testee 5



**Fig. 3.** The diagram of RMSSD (testee 3)

#### 4.2 What are the demands of the HRV measurement procedure met by occupational health care practitioners?

For assessing the demands the HRV measurement procedure laid on

occupational health care practitioners, the time used for the employee measurement procedure was calculated by writing down the spent time per each employee step by step. The flow of actions and the average time spent on each step is presented in Figure 4.

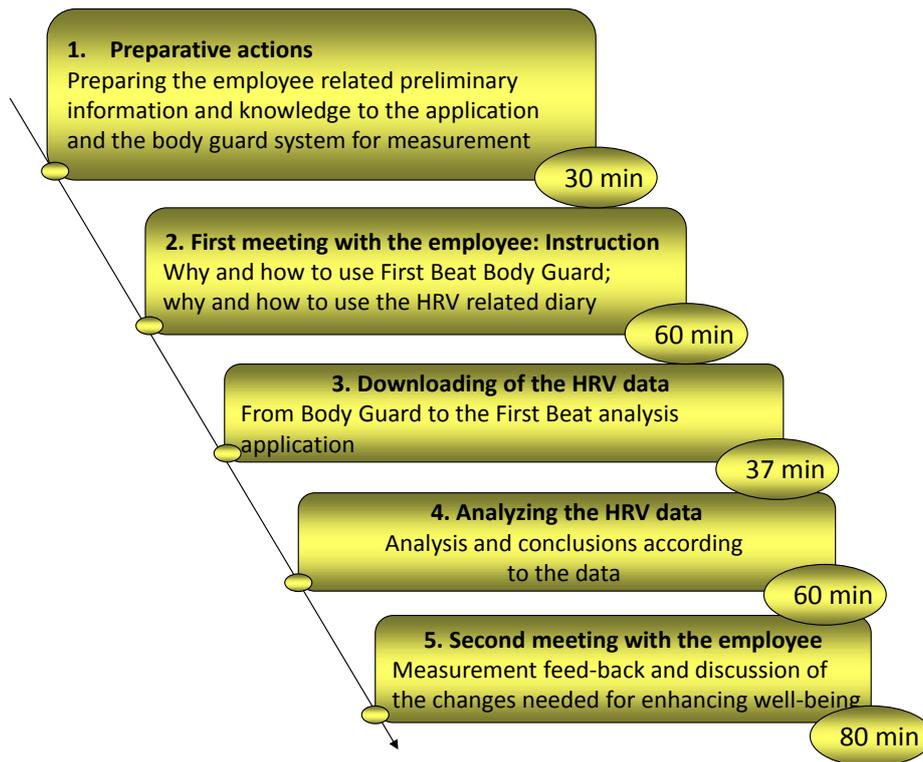


Fig. 4. The HRV measurement phases and used time

Except the time spent there are many other costs related to the measurement procedure: occupational health care organisations should invest in the tools and applications as well as in education of the professionals.

Concerning the measurement procedure, occupational health care practitioners should be able to motivate and instruct the mobile employees to use the measurement tools properly. The pilot showed that the mobile employees were very motivated to this kind of measurement and keen on knowing how their body reacted during the business trips. Because the pilot group members were used to using different

technical solutions for their work, they were not afraid to test this HRV solution and they quickly learned the main idea of using the body guard system and followed the measurement quite properly. The exception was the diary. Some of the testees made only a few entries in their diary (sleeping, working, travelling). Thus, the feed-back discussion was essential in order to complete the events of the business trip days and thus improve the validity, depth and quality of the analysis.

The occupational health care professionals find the analysis phase of the HRV data the most difficult. For adequate analysis not only the demographic parameters (age, gender) but also the health status related issues as well as the medication should be taken into account. How these factors affect the fluctuation of sympathetic and parasympathetic activation was not simple to conclude.

The feedback meeting was considered a beneficial learning situation for a mobile employee. At the sight of HRV results the mobile employees started to discern the demands of their work, the work–life balance as well as the recovery enhancing possibilities. As this feedback situation was significant to the measured mobile employee, it really was essential for the occupational health care professional for ensuring the clinical reasoning. The tables of the HRV parameters as well as the diary filled with work and other events act as a stimulus to health related discussions.

## **5 Conclusions**

An extensive amount of business travelling with a large area of operation embodies work load factors, which can be made visible for employees by the help of the HRV measurement procedure before they produce symptoms in mobile employees. Due to the long working days almost without rest periods and evening time filled with social events, the recovery phases with adequate parasympathetic activation may remain short during business trips. Not having enough time for recovery and relaxation may be a concern for those mobile workers whose job requires constant business trips.

HRV measurement is considered as a good tool for studying the physiological effects of work-related stress [16]. However many of these studies have been made in laboratory settings. It is essential for occupational health care practitioners to gain new and valid tools for as-

sessing the work stress and strain of those employees whose work is mobile and multi-local. Through HRV measurement, occupational health care practitioners gain valid information of mobile employee's ANS stress and recovery reactions. When connecting the diary information entered by each employee to this, knowledge of working conditions and work load factors may also be reached. However, the measurement procedure is time consuming and expensive to execute. Therefore it is not reasonable to assess the stress and recovery reactions of ANS of every mobile employee by the HRV procedure. Instead the HRV measurement target should be on those mobile employees, who have difficulties on controlling their work–life balance and who are suffering from symptoms assumed to be due to their mobile working mode. The other question to be considered came up with the studies, which e.g. point out the association between work stress and HRV to be the strongest in middle-aged workers and to be weaker in younger and older workers [12] or which argue that work stress might be associated with lowered HRV in women, but not in men [17]. As the tools of occupational health care professionals should be practical they should definitely guarantee ethically high-quality service: there is no room for conclusions that might mislead the customer.

There are many limitations in this study because of the very preliminary nature of it. Because the aim was very practical i.e. to test the HRV measurement procedure during a business trip and as a tool for occupational health care practitioners as well, we did not gather any baseline measurements or comparison material e.g. from “normal office days”. During the next phase of our study, we are going to collect data from three business trip days as well as from home office days. Because the measurement procedure will then take six days instead of three, many new challenges in executing the measurement will definitely rise. There is also a need to tighten up the measurement procedure, i.e. the definition of the ‘three-day business trip’ to gain accurate and comparable data for analysis.

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