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A CASE STUDY: RESTING, LOADING AND RECOVERY OF THE FLOORBALL PLAYER

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The purpose of this thesis was to clarify resting, loading and recovery of a floorball player with Firsbeat Lifestyle Assessment measurement device. In addition the possibility of using Firsbeat Lifestyle Assessment and possible problems were explored. The thesis is done in cooperation with FBT Pori floorball team. The aim is to give information for tested players and coaches of this team.

The research methods used in this thesis were quantitative research and case study. Whole practical part with measurements was done with Firsbeat Lifestyle Assessment devices. The data collection for the thesis took place in spring 2012. The measurements were executed in spring 2012. Analyzing was done during summer and autumn 2012. The results were given to tested players and coaches in late spring 2012.

The research results of this thesis found possibility to use Firsbeat Lifestyle Assessment device to test floorball players. Probably Firstbeat Sport device might be better for testing but it was possible to use Firsbeat Lifestyle Assessment as well. During this thesis there were four players tested but only one's results were used. Testing endured four days and before testing there was meeting where devices were introduced. Analyzing all material and giving results for players took more time than expected although testing itself was easy and quick.

As a conclusion it can be said that with Firsbeat Lifestyle Assessment measurement device it was possible to test and analyze resting, loading and recovery of a floorball player. In this case study there were noticed that periodization of training and especially loading of training was not insufficient with this one player in FBT Pori floorball team.

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1 INTRODUCTION

Floorball is nowadays one of the most popular sports in Finland. In terms of registered players, floorball holds the third place after football and ice hockey. Floorball is played throughout Finland. (Finnish Floorball Federation 2010). Floorball (also known as Innebandy, Salibandy or Unihockey) is an indoor team sport that originated in the 1970's in Sweden and Finland. Floorball is a fast-paced, low-contact type of floor hockey that has two teams of 3 to 5 players plus a goalie competing to score the most goals. (Floorball Nation nd., 2013.)

Playing floorball requires good physical condition. Floorball game includes quick running sprints, filibusters, turns and quick starts. These require sprint endurance and endurance, velocity, explosive power, balance, coordination, agility and muscle strength of quadriceps, gluteus and calf. Because of all these floorball can be called as speed skill sport. (Kulju & Sundqvist 2002, 107-109; Järvinen &Sipilä 1997, 59-60.)

A revolutionary analysis technology that provides comprehensive information about various functions and states of the human body on the basis of heartbeat measurement has developed by Firstbeat Technologies Ltd. The heart can give vast amount of information about the body. Heart rate is never constant and the variation of heart rate is called heart rate variability. Firstbeat's analysis technology is based on recognition of different bodily reactions from heart rate and heart rate variability. (Firstbeat Technologies, 2009.)

It is widely evidence-based that recovery from exercises and development of muscles happens during resting. Training programs are based on loading and recovery or heavy and light exercise variations. That is exercising in theory. In practice, relation between recovery and exercises can easily become distorted. This causes decreased amount of recovery. Full recovery requires almost that body is in unstressed situation. (Hakkarainen 2009, 170.)

This thesis approaches loading and resting in floorball by a case studies. Testing has been executed with Firstbeat measurements during four days for four floorball players. Background information has been collected by using Firstbeat background information form (see appendix 5). Players filled diary during measurement days so analyzing was easier.

2 PHYSICAL LOADING, STRESS AND RESOURCES

2.1 Physical loading and physical condition

Human is created for moving. This can be seen by thinking anatomy: the most of mass of human is muscles and different systems which keep muscles working. When talking about wellbeing and working order, one of the important parts is balanced physical loading of the body. Physical activity and loading has shown remarkable and positive effect inter alia density of bone mass, joint cartilage and structure of muscle cells. (Litmanen, Pesonen & Ryhänen 2000, 14–29.) Also especially endurance kind of training can improve on respiratory – and cardiovascular system. The intensity of physical loading is depending on person's age, sex and physical condition. (Borg et al. 2009, 51-57.)

Physical condition means validity, readiness or ability to carry out specific physical tasks (Litmanen et al. 2000, 46). Physical condition is not only sport and physical exercises but also everyday life activity as work, housework, social events and hobbies. (Aalto 2006, 40.) Good physical consists of many parts. Most important of these are condition of respiratory- and cardiovascular system, muscle condition and mobility, body composition, balance and coordination. (Aalto 2005, 9.) Good condition is combination of all of these parts which makes people to survive everyday life with the most optimal way. Physical loading happens always when some part of physical condition is loaded. In practice, the body is all the time under some physical loading but the intensity of loading differs highly depending on what the person is doing. (Aalto 2006, 40.)

2.1.1 Measuring physical loading

Physical loading can be measured with different numerical values. This thesis has been done with Firstbeat measurement which is based on measuring loading of respiratory- and cardiovascular system and that way definition of physical loading. Loading can be measured for example with MET and EPOC values. (Firstbeat Technologies, 2009.)

2.1.1.1 Maximal oxygen uptake

Maximal oxygen uptake (VO_{2max}) is defined as the highest rate at which oxygen can be taken up and utilized by the body during severe exercise. It is frequently used to indicate the cardiorespiratory fitness of an individual. In the scientific literature, an increase in VO_{2max} is the most common method of demonstrating a training effect. In addition, VO_{2max} is frequently used in the development of an exercise prescription. (Bassett et al. 2000, 70-72.)

Maximal Oxygen Uptake is predominately a function of cardiac output, or how much blood the heart can pump. VO_{2max} is expressed either as an absolute rate in liters of oxygen per minute (l/min) or as a relative rate in milliliters of oxygen per kilogram of bodyweight per minute (ml/kg/min). The later expression is often used to compare the performance of endurance sports athletes. (Bassett etc. 2000, 70-72.)

VO_{2max} of approximately 35-40 ml/kg/min is normal for the average untrained healthy male while the average untrained healthy female will have a VO_{2max} of approximately 27-31 ml/kg/min. These scores can decrease with age and improve with training, though the degree of trainability also varies very widely. As comparing, cross-country skier Bjørn Dæhlie measured at 96 ml/kg/min. (Bassett et al. 2000, 70-72.)

When clarifying intensity of physical loading, it can be determined by different percent of VO_{2max}: Moderate physical activity is 50 %, heavy physical activity is 70 %,

very heavy physical activity 85 % and maximal physical activity 95–100 %. (Borg et al. 2009, 63.)

VO_{2max} values can be measured either direct or indirect method. Due to fact that direct method requires laboratory circumstances, it has been used indirect method in this thesis as Firstbeat measurement device is using indirect method. (Borg et al. 2009, 63.)

2.1.1.2 MET

The metabolic equivalent of task (MET) is unit which defines energy consumption. It is a physiological measure expressing the energy cost of physical activities and is defined as the ratio of metabolic rate (and therefore the rate of energy consumption) during a specific physical activity to a reference metabolic rate, set by convention to 3.5 ml/kg/min or equivalently. Originally, 1 MET was considered as the Resting Metabolic Rate (RMR) obtained during quiet sitting. The 1 MET reference value of 1 ml/kg/min, is used by convention and refers to a typical metabolism at rest of an "average" individual. (Foss & Keteyian 1998, 91–92; Litmanen ym. 2000, 92.)

2.1.1.3 EPOC

Excess post-exercise oxygen consumption (EPOC) is a measurably increased rate of oxygen intake following strenuous activity intended to erase the body's "oxygen deficit". In recovery, oxygen is used in the processes that restore the body to a resting state and adapt it to the exercise just performed. These include: cellular repair, replenishment of fuel stores, hormone balancing, innervation and anabolism. Post-exercise oxygen consumption replenishes the phosphagen system. New Adenosinetriphosphate (ATP) is synthesized and some of this ATP donates phosphate groups to creatine until ATP and creatine levels are back to resting state levels again. Post-exercise oxygen is also used to oxidize lactic acid. Lactic acid is produced during exercise and then travels via the blood stream to the kidneys, cardiac muscle, and liver. An increased amount of oxygen is necessary to convert the lactic acid back to pyruvic acid at these locations. Another use of EPOC is to fuel the body’s increased

metabolism from the increase in body temperature which occurs during exercise. (McArdle et al. 2000, 137.)

The EPOC effect is greatest soon after the exercise is completed and decays to a lower level over time. One experiment found EPOC increasing metabolic rate to an excess level that decays to 13% three hours after exercise, and 4% after 16 hours. Another study, specifically designed to test whether the effect existed for more than 16 hours, conducted tests for 48 hours after the conclusion of the exercise and found measurable effects existed up to the 38 hour post-exercise measurement. (Rusko et al. 2003; Firstbeat web-pages 2012.)

2.2 Stress and resources

Stress reaction is increased level of activity in the body due to outside and inside factors. The body tries to adapt various demands with stress reactions. Short time stress reaction is normally positive resource and improves capacity. The body recovers quickly from short time stress reactions if there is rest after these reactions. Stress is harmful if it is long-lasting and is repeated too often. (Borg et al., 2009, 26.)

Factors that cause stress reactions are called stress factors. Stress factor can be physical, mental or social and it can be short time or long-lasting stress. Forcefulness of stress reaction is dependent on forcefulness of stress factor, duration and person's subjective handling of stress. Also person's ability to regulate and control stress is affecting on forcefulness and prolong of stress. Normally healthy people cope better with stress than people with decreased immunity. (Borg et al., 2009, 26.)

Stress can be divided positive and negative stress. Positive stress gives motivation and energy to do compulsory issues and reach maximal achievement. During positive stress person feels things exhilarating and motivational. During negative stress person feels unpleasant and negative feelings. (Borg etc., 2009, 27.) The ability of the body to react to outside and inside stress factors is called as resources. During resting and recovery these resources increase e.g. during relaxation. Instead of repetitive

stress reactions strain these resources. Overloading can be avoided with taking care of resources and recovery. (Borg et al. 2009, 27.)

2.3 Stress and sport

Training of athletes is based on stress theory which consists of the body's reaction of physical and mental stimulus, adaptation and counteraction of requirements of training and fatigue and exhaustion caused by training. Physical exercising is stimulus for athlete – a stress reaction. During that reaction the body is using energy supplies and defense mechanism. Hormone secretion increases and muscles are activated also. In that case the body aims at adapt requirements which stress reaction causes. (Rusko 2003, 62.) In case when stress reaction, caused by physical exercising, stays over there is just minor recovery. If stress caused by physical exercising is long-lasting it is called over training. (Martinmäki 2002, 9).

3 RECOVERY

Recovery is calming down the body when activity level decreases and outside and inside stress factors decrease or disappear. Parasympathetic nervous system activates and activation of target organs slows down e.g. heart rate lowers and digestion increases. (Borg et al., 81.)

Relaxation, rest, good time prioritize, regular exercises, healthy living habits and social contacts help the progress of recovery. (Stressi ja stressin mittaus 2005). Recovery has essential meaning while thinking management of life. Recovery enough makes sure that person is able to handle large amount of stress at times. Stress control requires that person has recovery periods instead of trying to eliminate fully all stress. The body needs recovery from time to time. (Stressi ja stressin mittaus 2005.)

3.1 Meaning of recovery and rest after loading

During physical activity the body is loaded and it has to adapt itself for new physiological situations. There are homeostatic mechanisms which help to adapt during physical activity. In that case, the body tries to reach the most suitable physiological balance, homeostasis, for that loading. Homeostasis is chemical equilibrium of whole body; under muscles it stands for that muscle cells get enough oxygen and nutrients. Homeostasis is kept up by autonomic nervous system and hormone secretion. (Sandström & Ahonen, 2011, 73.)

Recovery is correcting those changes that physical activity has produced with metabolism. All in all the basic idea of recovery is reaching homeostasis. (McArdle et al. 2009) During physical activity muscles are using oxygen and after activity there might be oxygen deficit. Oxygen deficit is the amount of oxygen that is used during physical activity – it is approximately 11 liters larger than in rest. (Sandström & Ahonen, 2011, 123.)

Nowadays it is not correct to have a word of oxygen deficit. It is more common to discuss about excess post-exercise oxygen consumption (EPOC) and it is not combined with lactate acid decomposition as oxygen deficit is. Extra oxygen is used for regeneration of creatine phosphate stores and completion of muscles' oxygen stores. Creatine phosphate is recurred almost fully after five to fifteen minutes. (Sandström & Ahonen, 2011, 128-129.)

According McArdle et al. there are different optimal recovery times from different exercises. An exercise performed below 55 to 60% of VO2max is steady rate exercise and they are performed with little blood lactate accumulation. Exercise elevates total metabolism and delays recovery which causes that passive procedures produces the most rapid recovery in such cases. Instead of optimal recovery time is different from non-steady-rate exercises. Although the precise mechanisms of fatigue during intense anaerobic exercise are not fully understood, there are evidences that the blood lactate level indicates the relative strenuousness of exercise and reflects the adequacy of the recovery. It is clear that moderate aerobic exercise in recovery facilitated lactate removal compared with passive recovery. Combining higher-intensity exercise

followed by lower-intensity exercise offered no greater benefit than a single exercise bout of moderate intensity. Recovery exercise above the lactate threshold might even prolong recovery by promoting lactate formation. (McArdle et al. 2009, 138-139.)

3.2 Monitoring recovery

Recovery after physical loading can be followed many different ways. With subjective variables it is possible to get information of athlete's own estimate of overall condition, readiness and physical & mental condition whereas with objective variables it is possible to keep an eye on recovery by medical ways by registering variables of heart, lungs and humoral system. (Weineck 1982, 238.) Lactate measurements, hormonal, immunological and chemical measurements, orthostatic tests and heart rate & heart rate variation monitoring are objective measurements. Subjective and objective monitoring can be used together or separately. (Heart beat based recovery analysis for athletic training by Firstbeat Technologies Ltd. 2009, 2.)

4 FIRSTBEAT MEASUREMENT

All the measurements were done with Firstbeat Bodyguard measurement. Firstbeat Bodyguard is device that records R- wave to R-wave interval (R-R interval). R-R interval is shown in figure 1. It is for short and long term measurements. "The device is attached directly to the skin with two chest electrodes. There is high quality and reliability with Bodyguard measurement as measurement errors and data breaks can be almost completely eliminated. User comfort has been significantly improved when compared to traditional heart rate belts allowing the person to collect crucial information on stress and recovery without disturbing the night sleep and leisure time." (Firstbeat Technologies, 2012.)

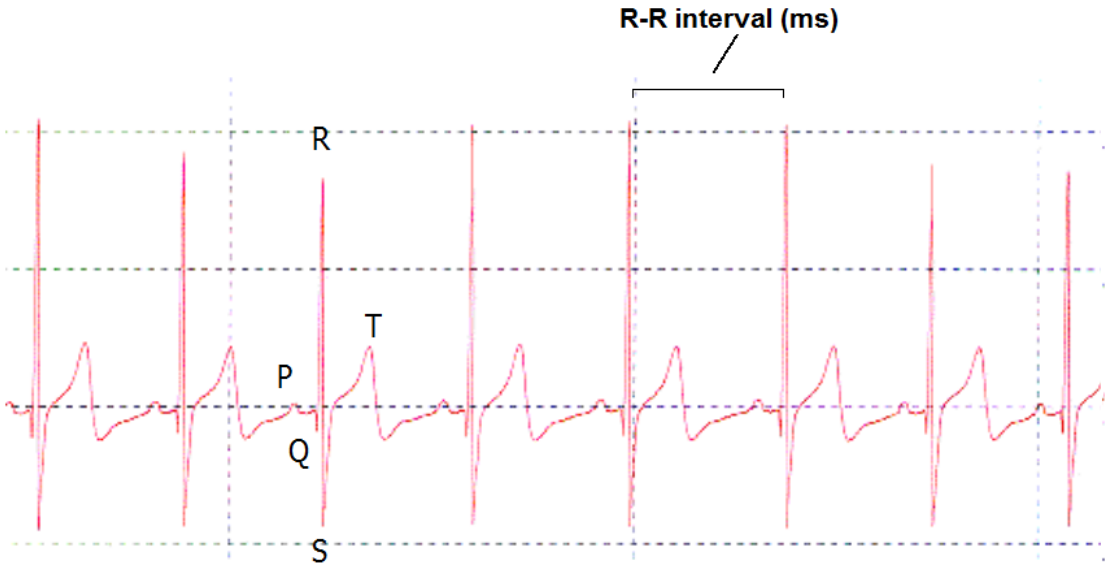

Figure 1. R-R interval (Sykeanalyysin perusta, 2010.) [1]

4.1 Autonomic nervous system

The autonomic nervous system (ANS) is the part of the peripheral nervous system that acts as a control system functioning largely below the level of consciousness, and controls visceral functions. It is involuntary nervous system which affects heart rate, digestion, respiratory rate, salivation, perspiration, pupillary dilation, micturition (urination), and sexual arousal. Regulation of ANS cannot be measured directly but it can be estimated by measuring heart rate and heart rate variation. (Borg et al. 2009, 19.)

[1] P = Activation of atriums (depolarization)
PQ = The time the electrical impulse takes to travel from the sinus node through the AV node and entering the ventricles
QRS = Contraction of ventricles (depolarization)
T = Recovery of ventricles (repolarization)
RR = The interval between an R wave and the next R wave

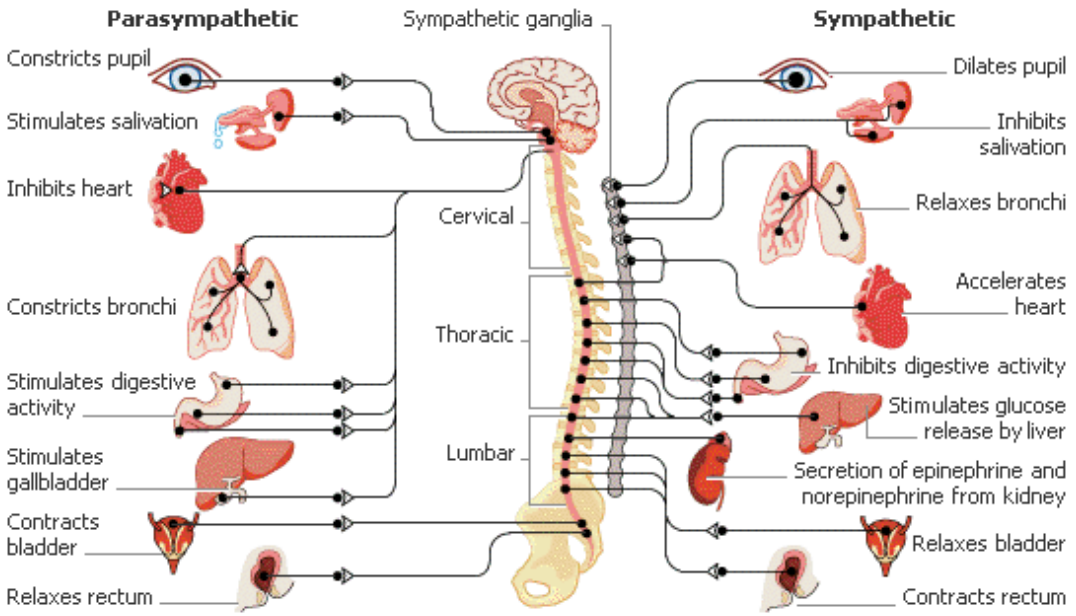

Figure 2. Autonomic Nervous System: System divides in two functional parts - sympathetic and parasympathetic system (Pinna, 2011.)

The ANS is divided into two subsystems: the parasympathetic nervous system and sympathetic nervous system (figure 2) which operate independently in some functions and interact co-operatively in others. Parasympathetic and sympathetic nerves start off central nervous system and travel to the body organs. In many cases parasympathetic and sympathetic systems have "opposite" actions where one activates a physiological response and the other inhibits it. (Borg et al. 2009, 19.) An older simplification of the sympathetic and parasympathetic nervous systems as "excitory" and "inhibitory" was overturned due to the many exceptions found. A more modern characterization is that the sympathetic nervous system is a "quick response mobilizing system" and the parasympathetic is a "more slowly activated dampening system", but even this has exceptions, such as in sexual arousal and orgasm where both play a role. The enteric nervous system is also sometimes considered part of the autonomic nervous system, and sometimes considered an independent system. (Nienstedt et al. 2004, 538-544.)

4.2 Heartbeat analysis and heart rate variability

As mentioned above, Firstbeat measurements are based on heartbeat analysis. The heart can provide a vast amount of information about the body because heart rate is constantly adjusting, from beat to beat, to meet the demands of everyday life. For this reason, heart rate is never constant - the time difference between two consecutive heartbeats changes from beat to beat. This variation is called heart rate variability, HRV. (Firstbeat Technologies, 2012.)

Firstbeat's analysis technology is based on recognition of different bodily reactions from heart rate and heart rate variability. For example inhalation and exhalation, control of breathing, hormonal reactions, metabolic processes and energy expenditure, autonomic nervous system adjustment, physical activity, exercise and recovery from physical activity, movement and changes in posture, cognitive processes and mental load and stress reactions, relaxation and emotional reactions can affect the heartbeat. (Firstbeat Technologies, 2012.)

Heart rate variability (HRV) is the physiological phenomenon of variation in the time interval between heartbeats. One way to measure it is measuring by the variation in the beat-to-beat interval. Several different inputs are received by the sinoatrial node. Either R-R interval and its variation or instantaneous heart rate is the results of these inputs. The main inputs are the sympathetic and the parasympathetic nervous system (PSNS) and humoral factors. (Bjålie et al. 1999, 233.)

HRV is related to emotional arousal. Under conditions of acute time pressure and emotional strain and elevated state anxiety, presumably related to focused attention and motor inhibition has noticed to decrease high-frequency activity. HRV has been shown to be reduced in individuals reporting duration and a greater frequency and of daily worry. (Martinmäki 2002, 21)

4.3 Firstbeat measurement in practice

FirstBeat Lifestyle Assessment is used in this thesis and it makes possible to produce statistical reports. Firstbeat Lifestyle Assessment is based on advanced analysis technology that analyzes heart rate and heart rate variability to recognize physiological changes in the body. The measurements are conducted during normal working and leisure days, rather than in a lab setting. This provides a concrete basis for feedback and actions in real life. (Firstbeat Technologies, 2009.) There are different reports, for example reports of physical workload, training effect, health promoting physical activity, lifestyle assessment, and stress & recovery. Some reports are able to get group reports instead of or with personal reports. (Borg et al. 2009, 16.) Because the idea of thesis is to clarify physical loading and recovery, it was used reports of physical workload, stress, resources and recovery.

4.3.1 Report of physical workload

Report of physical work load produced by Firstbeat Lifestyle Assessment gives information of person's physical loading, amount of loading and level of strain during measurement period. Information is collected as statistics and graphs of physical workload. (Firstbeat hyvinvointianalyysi. Raporttien tulkinta, 68.) Report of physical workload consists of four different graphs, a circle diagram and a table which are created by heart rate date of test subject during measurement period (see appendix 1). A graph of physical workload (figure 3) explains workload as a percent of test subject's maximal oxygen uptake and analyze of physical workload (figure 4) explains the most important time periods of loading e.g. the most physically loading 15 minutes and 60 minutes periods. Statistics of physical workload in table format present numerical values during physical workload which allows numerical analyses whereas index of heart rate variation (figure 5) explains function of parasympathetic nervous system and monitoring of physical workload explains division of all measurements during measurement period to different intensity levels.

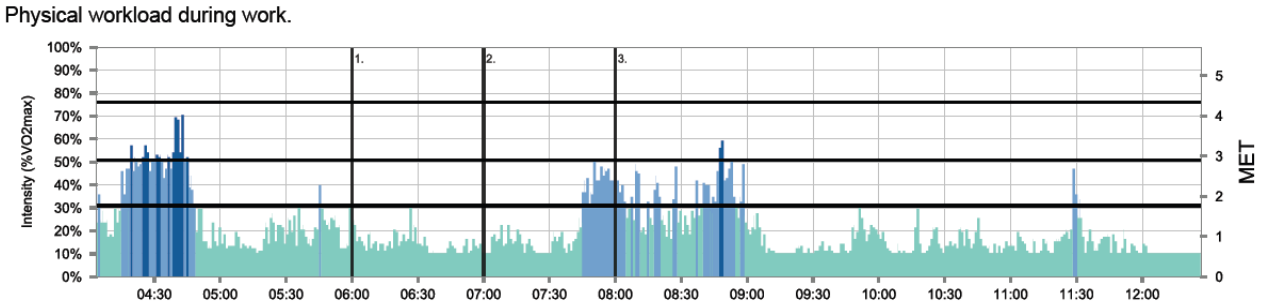

FIGURE 3. A graph of physical workload. (Firstbeat Technologies, 2010.)

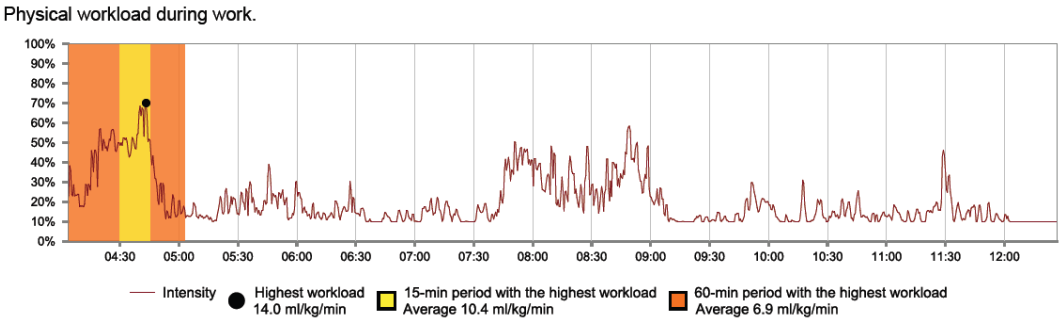

FIGURE 4. Analyze of physical workload. (Firstbeat Technologies, 2010.)

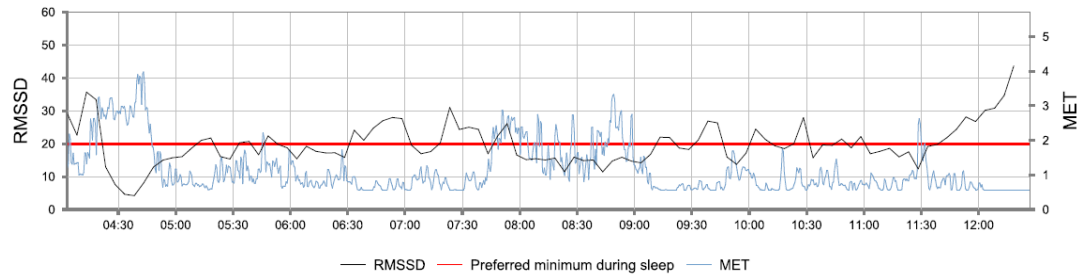

FIGURE 5. Index of heart rate variation. (Firstbeat Technologies, 2010.)

Firstbeat Technologies has defined that report of physical workload can be used i.e. estimating of physical loading of work and estimating strenuous of individual work tasks. Report can be used as well for recovery after physical loading. (Firstbeat hyvinvointianalyysi. Raporttien tulkinta, 68.)

Firstbeat Lifestyle Assessment measures physical loading via respiratory and cardiovascular system. Therefore all numerical values of report are based on body's respiratory and cardiovascular functions and their individual capacity. It is not possible to clarify local muscle loading. (Borg et al. 2009, 48.)

4.3.2 Report of stress

Report of stress produced by Firstbeat Lifestyle Assessment gives information about physiological reactions of stress and recovery of the test subject during measurement period. (Firstbeat hyvinvointianalyysi. Raporttien tulkinta, 51). Report of stress consists of four different graphs and a circle diagram (see appendix 2). Graph of stress and recovery (figure 6) shows stress, recovery, physical activity, light physical activity and other events during measurement period as function of time. It shows also their relative forcefulness. Analyze of stress period clarifies the most important time periods of stress e.g. the most stressful 15 minutes and 60 minutes periods and monitoring of stress reactions and recovery explains relative portions of all stress reactions and recovery during the whole monitoring period.

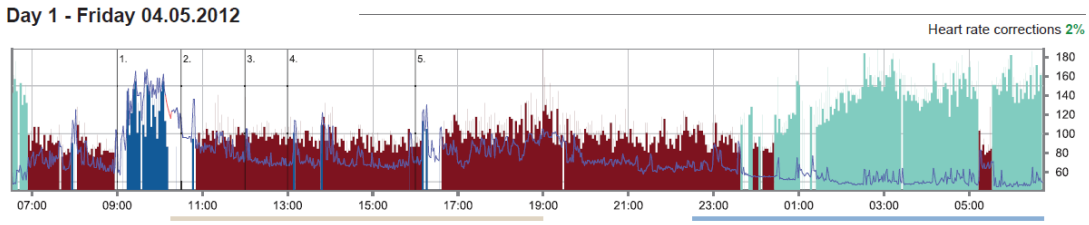

FIGURE 6. Graph of stress and recovery. (Firstbeat Technologies, 2010.)

Firstbeat Technologies has defined that report of stress can be used i.e. analyses of daily stress & recovery and mental loading of different work tasks. Report of stress can be used also while observing changes of stress and recovery during night time measurements. (Firstbeat hyvinvointianalyysi. Raporttien tulkinta, 51.)

Circle diagram of stress is used in results of this thesis. More closely percent of recovery is used. Percent clarifies recovery during night time vis-à-vis stress, physical activity and other events. (Firstbeat hyvinvointianalyysi. Raporttien tulkinta, 55)

4.3.3 Report of resources & recover

With Firstbeat Lifestyle Assessment it can be taken report of resources. This report gives information about changes of body's resources during measurement time. Physical and mental loading and amount & quality of recovery are affecting on re-

sources essentially. Report consists of five graphs (see appendix 3). Graph of resources (figure 7) explains changes of resources as function of time. Analyze of recovery periods clarifies the most important time periods of recovery e.g. the most recovery 15 minutes and 60 minutes periods. Portions of stress and recovery periodically shows relative portions of stress reactions and recovery in different time in measurement period and balance of resources graph gives ratio which explains average balance of stress and recovery during whole measurement period. (Firstbeat hyvinvointianalyysi. Raporttien tulkinta, 55)

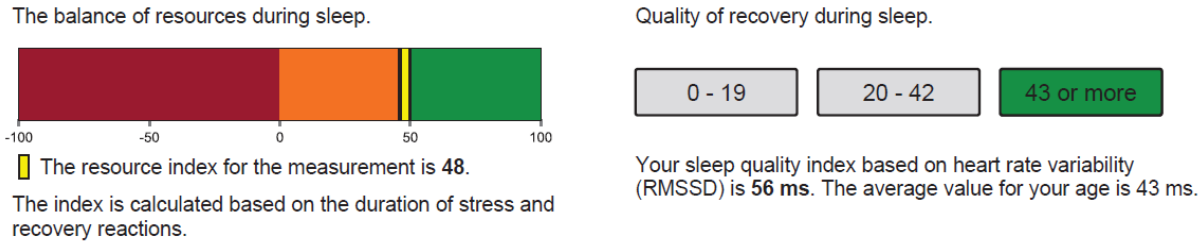

FIGURE 7. Graph of resources. (Firstbeat Technologies, 2010.)

In this thesis balance of resources graph has been used for clarifying relation between recovery and stress during night time. Also overall recovery and resources has been used in results part of thesis.

5 FLOORBALL AND LOADING

Floorball is nowadays one of the most popular sports in Finland. In terms of registered players, floorball holds the third place after football and ice hockey. Floorball is played throughout Finland. (Finnish Floorball Federation 2010). Floorball (also known as Innebandy, Salibandy or Unihockey) is an indoor team sports that originated in the 1970's in Sweden and Finland. Floorball is a fast-paced, low-contact type of floor hockey that has two teams of 5 players plus a goalie competing to score the most goals. (Floorball Nation nd. 2013.)

5.1 Requirements of floorball to player

In floorball, five players and one goalkeeper can be on the field at the same time. Each team can have a maximum of 15-20 players. The size of the field is 40 x 20 m and the field is surrounded by a rink that is 50 cm high. The playing surface is wood parquet, but more often removable or permanent synthetic material. The time of the match consists of 3 x 20 minutes (effective playing time) at men´s and women´s upper levels. The match time at lower and junior levels is either 3 x 15 or 2 x 15 minutes (three last minutes of the match effective playing time). (Finnish Floorball Federation 2010.)

Playing floorball requires good physical condition. Floorball game includes quick running sprints, filibusters, turns and quick starts. These require sprint endurance and endurance, velocity, explosive power, balance, coordination, agility and muscle strength of quadriceps, gluteus and calf. Because of all these floorball can be called as speed skill sport. (Kulju & Sundqvist 2002, 107-109; Järvinen &Sipilä 1997, 59-60.) Loading in the game situations is mainly interval type of. Player's heart rate is high, 160-180 beats per minute, during game situation. This means that there is also anaerobic work. (Kulju & Sundqvist 2002, 107-109; Järvinen & Sipilä 1997, 59-60.)

Speed endurance is trained with anaerobic exercises which mean that muscles start to build up lactic acid more and more and the body is unable to remove acid out of the body. Training speed endurance is preparing player to work heavily although there is lactic acid in muscles. Speed endurance exercises are short and rapid. They are done with maximal effort. (Kulju & Sundqvist 2002, 107–109; Järvinen & Sipilä 1997, 59–60; Seppänen et al. 2010, 76–77.)

During endurance training main idea is to develop aerobic fitness. Exercises are long and done with constant speed. These exercises should take at least one hour and heart rate should be 130-150 beats per minute. Endurance training is one of the bases of speed endurance training. (Kulju & Sundqvist 2002, 107-109; Järvinen & Sipilä 1997, 59-60; Seppänen etc. 2010, 76–77.)

Explosive strength is one part of speed endurance and it means extremely fast physical performance. Explosive strength is needed in floorball, especially quick changes of directions and starts. Best way to exercise explosive strength are jumps, leaps, explosive starts and strength training with 40-60 percent of maximum. (Kulju & Sundqvist 2002, 107-109; Järvinen & Sipilä 1997, 59-60.)

Readiness of nerve muscle system is effecting on the speed. In floorball explosive speed, motion speed, reaction speed and speed skills are part of speed. Maximal speed is needed for starts, changes of directions and shots on goal. These are very quick and short performances. Motion speed is maximal speed during performance. It can also be optimal speed of some performance. Reaction speed can be trained but it is also genetic. Reaction speed is time what person needs to react to the stimulus. In floorball reaction speed is needed for fast reactions to ball or opponent in a game. Speed skills are for example handling speed of floorball stick in the game situation. It is ability where nerve muscle system utilizes motion speed as effective way as possible. Every part of speed can be exercised separately. (Järvinen & Sipilä 1997, 61-63.)

Balance is sincerely important in floorball. It is needed in many different situations in motion as well as staying steady. Dekes, dodges, duels and changes of direction are situation in motion where balance is tested. This means that player needs dynamic balance. Static balance is required while staying still. These kinds of situations are for example face-offs. (Järvinen & Sipilä 1997, 63.)

5.2 Test floorball team

Test floorball team was one of the 14 teams of the Finnish Floorball League (Salibandy Liiga) during season 2011-2012. First time Salibandy Liiga was played 1986-1987. Salibandy Liiga is the highest level of floorball in Finland and it is highly respected in the world of floorball. Season is divided into regular season and playoff. Teams played against each other twice during regular season which makes 26 games per team. The last team of Salibandy Liiga falls into 1. Division and 12^{th} and 13^{th} teams are playing which on is staying in Salibandy Liiga. (Salibandyliiga, 2011.)

Eight best teams of Liiga play playoff. (Salibandyliiga, 2011.) Tested team was not playing playoff during the year when they were tested. In the tested team there were 26 players and 3 goalies. All of them got some playing time and the tested players were playing constantly and high amount.

6 THE PURPOSE OF THE THESIS

The thesis aims to clarify loading, recovery and meaning of resting in floorball in the highest level in Finland. The aim was to test players in one team to get enough data and then compare if there is some difference between junior players and adult players who both are playing in first team. Unfortunately enough data was not collected due to missing of participants. This made changes for aims and purpose of the thesis and changed the thesis case study type of thesis.

Additionally it aims to establish issues that affect recovery after game and training situation and clarify if there is wrong kind of periodization between training, games and recovery. The idea for this thesis was first discussed during planning thesis lessons. Teachers introduced Firstbeat measurement device and gave an idea to use that measurement as part of thesis. The subject was more closely discussed during the end of 2011 and the purpose of the study and the schedule for the thesis process were drafted during early spring 2012. Co-operation with floorball team was discussed and tests were done during spring 2012.

The thesis is a quantitative research and material is collected during spring 2012 with Firstbeat measurement device of the selected, appropriate target group. Target group included four players of the team and the main criteria were able to use measurement device, able to keep diary, able to take part for games and exercises during measurement period and keen to go through whole measurement period.

Thesis research questions are:

1. How Firstbeat measurement device can be used to measure recovery and loading in a floorball player?

2. What kind of periodization there is between exercising, games and resting times?
3. How loading floorball is for a chosen player?

7 RESEARCH METHODS

According Yin (1984, 23) the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used. (Yin, 1984, 23.) Basically, a case study is an in depth study of a particular situation rather than a sweeping statistical survey. A very broad field of research into one easily researchable topic is narrowed down with case study method. It will give some indications and allow further elaboration and hypothesis creation on a subject although it will not answer a question completely. (Shuttleworth 2008)

Research involving the collection of data in numerical form is called quantitative analysis. The numerical data can be durations, scores, counts of incidents, ratings, or scales. Quantitative data can be collected in either controlled or naturalistic environments, in laboratories or field studies, from special populations or from samples of the general population. (Jyväskylän yliopisto 2012.)

7.1 Case study as Research method

Research methods in this thesis were selected according to the quantitative & case study nature, and the aim of the research. Due to Firstbeat measurement device and way it gives results, this study is quantitative research. Quantitative studies provide data that can be expressed in numbers. Statistical analysis lets us derive important facts from research data, including preference trends, differences between groups, and demographics. (Madrigal & McClain, 2012.)

Eriksson and Koistinen (2005) explain that case study is not straightly submethod of quantitative research method, case study research is research method which considers one or more cases. Idea is to analyze, define and solve these cases. (Eriksson & Koistinen 2005.) According Henttonen (2008) case can be person, group, organization, product, process or event. Case study research can consist of both quantitative and qualitative methods and analyzes. Case study which benefits quantitative material is similar than all other quantitative research but it is specific due to definition of research object and analyzing as a case. (Henttonen 2008, 2.)

Also, Yin (1994) mentions that case studies can be single or multiple-case designs and when no other cases are available for replication, the researcher is limited to single-case designs. Yin (1994) pointed out that generalization of results, from either single or multiple designs, is made to theory and not to populations.

Yin listed several examples of cases done with case methodology in literature along with the appropriate research design in each case. There were suggestions for a general approach to designing case studies, and also recommendations for exploratory, explanatory, and descriptive case studies. (Yin 1993.)

Fieldwork and data collection may be undertaken prior to definition of the research questions and hypotheses in exploratory case studies. This type of study has been considered as a beginning to some social research. Explanatory cases are suitable for doing causal studies. The analysis can make use of pattern-matching techniques in very complex and multivariate cases. Descriptive cases require that the investigator begin with a descriptive theory, or face the possibility that problems will occur during the project. (Yin 1993.) In this thesis the case is descriptive case and as seen above, whole thesis is based on a descriptive theory.

7.2 Data collection for the Thesis

The thesis implementation was conducted in the beginning of spring 2012. The biggest part of the implementation was data collection with Firstbeat measurement devices from players. The other part of the implementation was analyzing all collected

data and diaries of players. Data collection took four days and there was the entire time person to answer to questions of players. Before data collection there was two meetings with players to explain how device works and what they should do during measurement period. After data collection there was feedback session in the late spring 2012.

Data was collected from four players and they had done what was asked. Every player had to keep diary during measurement period which included times of rest, eating, training and stressful situations. They also reported what kind of training they had: heavy, light et cetera.

7.2.1 Measurement

Measurements were carried out with Firstbeat Bodyguard measurement devices (see appendix 4). Every player had own device which saves beat-by-beat 24h heart rate and heart rate variability (HRV). Saved data was dissolved and analyzed with Lifestyle Assessment program. Firstbeat measurement devices were borrowed from Satakunta University of Applied Sciences. Firstbeat measurement devices are developed by Firstbeat Technologies Ltd which. It is 2002 founded enterprise that is specialized to develop programs for heart beat analyzes. Firstbeat Technologies Ltd. has developed a revolutionary analysis technology that provides comprehensive information about various functions and states of the human body on the basis of heartbeat measurement. (Firstbeat Technologies, 2009)

7.2.2 Test subjects

The preliminary idea was to test four players: two adult and two junior players who are playing in elite team. Due to lack of players, finally four players were tested – all adults playing in elite team.

There were couple limitations for players: they had to be able to take part to all training sessions and games. They also had to be able to keep diary and report all events

during measurement period. There were no age limitations and test subjects were age of 19 – 34. Players had to also be frame players of first team.

All players were playing in team which was playing in Salibandy Liiga, the highest level of floorball in Finland. All tested players were males. While starting to analyze collected data, this thesis was changed to case study. So there was used data of one player only.

Before measurement period tested players fulfilled predata form (see appendix 5) planned by Firstbeat Technologies Ltd. This was for getting enough information of their health condition, sport activity class & background of sports and amount of stress and rest. All tested players had quite high sport activity classes (8-10). Firstbeat Bodyguard device created numerical values (VO_{2max}, MET and EPOC) from reports of physical workload based on information of predata form.

8 RESULTS

It was chosen that VO_{2max}, MET and EPOC values are the ones to be used in results part of thesis. Except EPOC - value all the other values are reported as mean values of measurement period. EPOC – value in this case is the highest EPOC reading i.e. the peak of EPOC. As to stress and resources it has been examined percentage of recovery and resources. Terms used in results part are presented more thoroughly in section 2.

The main theme is to clarify loading of training sessions and game situation and how they differs. One theme is also observed if there is too much loading during morning training before game situation. Training sessions are examined with MET – values to get to know amount of loading. With MET – values it is possible to see total loading of the test subject during one training session via average energy expenditure whereas EPOC – values are telling the most loading moment of the training session.

8.1 Test subject

The tested player was 29 years old male who played in elite floorball team. This floorball team was playing Salibandy Liiga during season 2011-2012. There were no contraindications for testing or training at the time. He had no medication but the player reported on dose of alcohol (a drink) in last measurement day. Player is a non-smoker. His activity class is nine (9) which means training daily, 11-13 hours per week.

8.2 Daily routines

During these four measurement days player had two working days and two day offs. During first three days there were training session and in third day also game. Fourth day was entirely day off. Training sessions took 1, 5 – 2 hours and game took approximately three hours with warm-up and cool-down. During working days test subject was working nine hours per day. Every day there was some kind of recovery/relaxation session: stretching or just lying in the bed. Sleeping times differed due to work days: every night test subject went to bed approximately 00.30 but waking up time changed. Two nights were with ten hours sleep and two nights with seven hours sleep. Test subject reported that he slept well in every night. There was no mention of disturbance of the measurement device.

8.3 How Firstbeat measurement device can be used to measure recovery and loading

Firstbeat Lifestyle Assessment measurement device had plenty of ways to use to measure recovery and loading. Device gave plentiful amount of data with different values. As mentioned above, VO_{2max}, MET and EPOC values were used for analyzing. Because those values need some subvalues, also heart rate and balance of resources were used. The balance of resources value is representing level of recovery and its value varies from -100 (no recovery at all) to +100 (full recovery).

There was data from all four measurement days. The resting heart rate was 43 beats per minute and the highest heart rate was 192 beats per minute in the training situa-

tion. All the training sessions and game situation were done with high intensity: maximum heart rate increased every time in very high level and it stayed in high level throughout training session.

The balance of resources during sleep varied between measurement days, from +40 - +78 (mean +61). The balance of resources was every day positive and the lowest was + 40 while the highest was +78 (Figure 8).

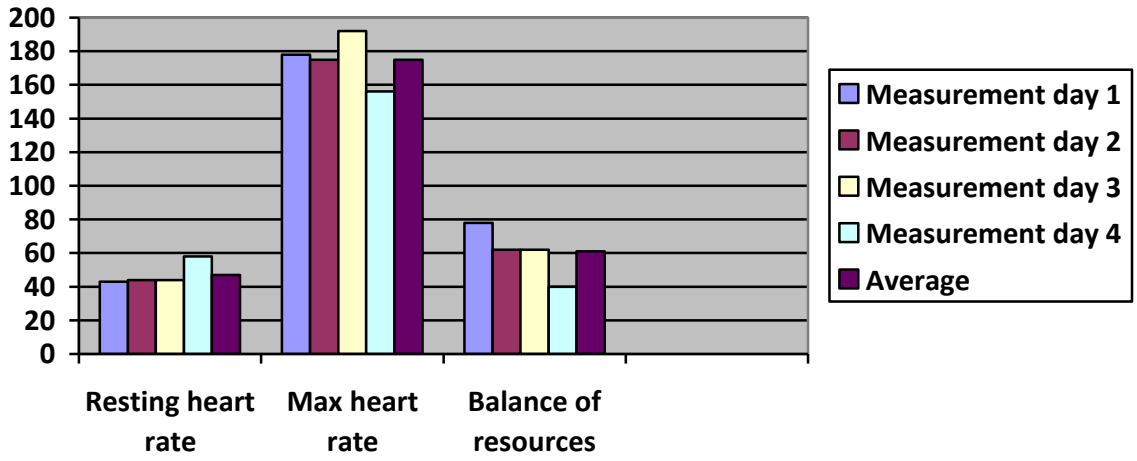

Figure 8. Maximal heart rate, resting heart rate and balance of resources of the test subject.

There were stress reactions 35% per day. The most stressful moments were always in the evening, after nine pm. The most stressful 60 minutes in first day 21.00 – 22.00, in second and third day 22.00-23.00 and the last day 23.00-24.00. While asking if there were some reason for that, test subject was not able to tell one except on second day when he was in restaurant with friends and there were some kind of unpleasant discussion. There was stress evenly in day time but during sleeping time there was no stress.

There was recovery 30% during the measurement. The 60 min period with the highest level of recovery was between 4.00 and 7.00.Recovery happened mainly during night time but there was also some recovery during day time as well. (Figure 9.)

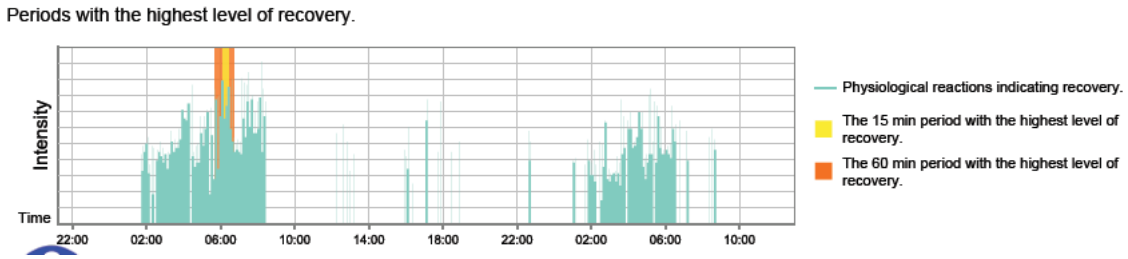

Figure 9. Periods with the highest level of recovery.

8.4 Periodization between exercising, games and resting times

There were training session on first, third and fourth day. On the third day there was also game. The ideal situation is that training session before game is kind of preparing training session for game. It should be light and mainly wake up muscles and body. Training session after game, normally on next day, should be also light, recovery training session. The idea of preparing training in this case did not go correctly; the 15 min period with the highest level of loading was at 11.00. Preparing training was more loading than the game situation. One clear sing of that is that EPOC peak was during preparing training session, not during game situation. EPOC was highest 49ml/kg. Highest EPOC value during game situation was 44 ml/kg.

Otherwise the periodization seemed to work suitable; there were enough recovery and not too much loading during training two days before game and one day after game. Due to vast amount of data from Firstbeat measurement device, it was easy to analyze periodization with Firstbeat Lifestyle Assessment device. As present below, all data is given results that “harder” training is two days before game, on game day there is preparing morning training and day after game there is recovery training. This seemed to be suitable periodization, except the loading of preparing morning training session.

8.5 How loading floorball is for a chosen player

During first and last measurement days there was training session. In the second day there were recovery day and in the third day there were training session (in the morn-

ing) and game (in the evening). Loading of training sessions and game is analyzed with MET-, EPOC and VO_{2max} and training effort values in this chapter.

8.5.1 First day

During first day there was two hours training session. First 30 minutes of that was warm-up and then there was 1, 5 hours of training. This training was quite light at least while checking numerical values from data. Training effort was 2.0 which is maintaining fitness kind of training. This workout maintains cardiorespiratory fitness and builds a foundation for better fitness and harder training in the future. EPOC value of that training was 27 ml/kg and the highest EPOC accumulation was at time 19.40. Heart rate varied from 61 to 175 beats per minute and the average heart rate was 108 beats per minute. Classification of the exercise to different endurance training types can be seen in figure 11. In that figure it can be seen that majority of exercises has been fast distance training and just 2 minutes has been VO_{2max} training. All those elements are telling that this training session was not very heavy and it is suitable if thinking that there will be game after two days. MET value was highest during exercise and the highest value was 10.1. It is halfway of MET values so it is also sign of not too loading training. VO_{2max} value has been in the highest 39.9 ml/kg/min.

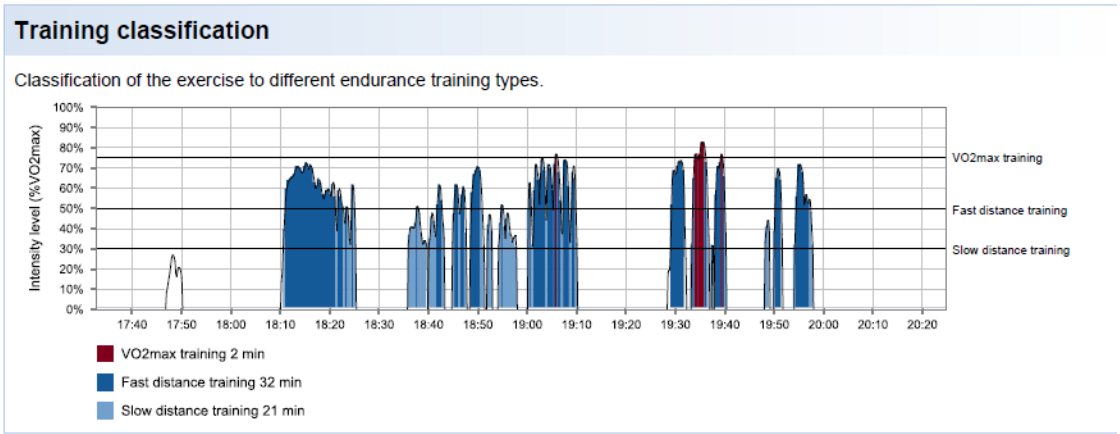

Figure 10. Training classification.

8.5.2 Third day

On the third day there were training session in the morning at 11.00 and it took 1 hour. It included light running and some exercises in the rink. Idea of that training should be preparing for game. In the evening there was game situation which started at 15.00 with palaver. Then there was warm-up, game (approximately 2hours) and cool-down. The idea of preparing training is to prepare for game and wake up muscles but in this case something did not go correctly; the 15 min period with the highest level of loading was at 11.00. Preparing training was more loading than the game situation. One clear sing of that is that EPOC peak was during preparing training session, not during game situation. EPOC was highest 49ml/kg. Highest EPOC value during game situation was 44 ml/kg. During game situation MET value was between 0,6 and 11,7 and the average was 3,9 which is quite low. VO_{2max} was highest 40.8 ml/kg/min but average stayed in 13.6 ml/kg/min. Heart rate changed from 69-178 beats per minute. During training session MET was 11,2 and highest heart rate was 168 beats per minute. This shows that heart rate has been higher in game situation than in training session, MET value has been higher in game situation but the EPOC value has been highest during preparing training. (See Figure 11.)

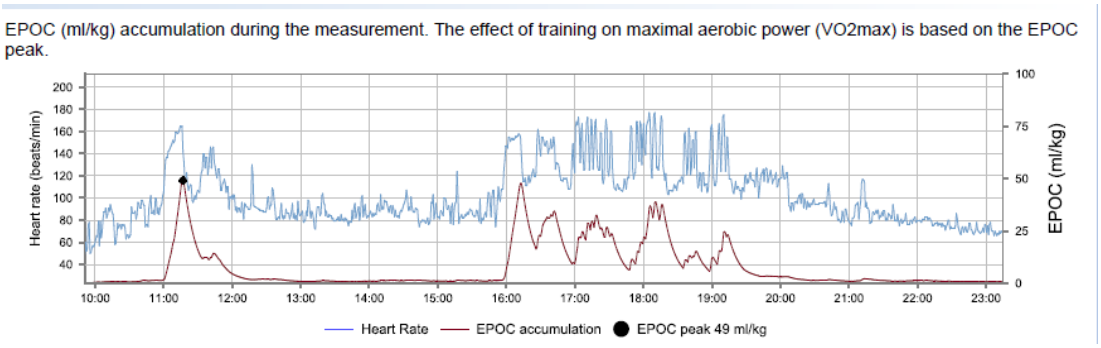

Figure 11. EPOC accumulation.

8.5.3 Fourth day

During fourth day there was 1, 5 hours training from 19.00 to 20.30. In the beginning there was light running 20 minutes and then light training indoors. At the end there were long stretches. Heart rate changed from 58 to 156 beats per minute and VO2 max was in the highest 35.4 ml/kg/min. Highest MET value was 10,1 and the aver-

age of MET value was 2.5. Training effort was 1, 9 which means easy recovery. EPOC value was 24 ml/kg in the highest. (Figure 12)

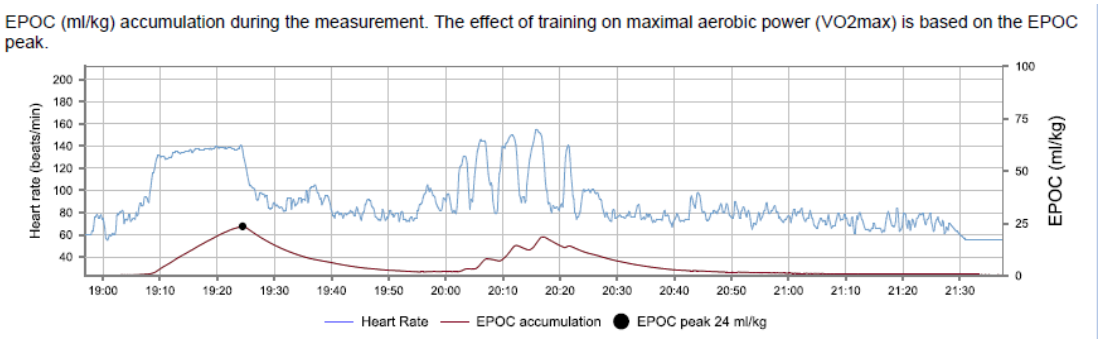

Figure 12. EPOC accumulation.

9 CONCLUSION

Research findings do not as such answer to the research questions; they only represent what was noticed from one floorball player. The research results are hidden in the research findings, and the research process aims to bring out those underlying phenomena. Analysis thus reveals the answers to the research questions. (Vilkka 2006, 12, 81) The following chapters present the answers to research questions.

9.1 Measuring recovery and loading in a floorball player with Firstbeat measurement device

Use of Firstbeat measurement was easy from research's point of view and also from tested players' point of view. Everybody mentioned that the device was light and it didn't disturb training or games. Using was easy, players just kept the device on and they hadn't done anything extra for the device. Preparing players for using was quick and effortless. No one mentioned any problems with the device. The most challenging part for players was to keep the diary. While thinking from research's point of view that was the difficult part – how to motivate players to document everything they were doing.

Floorball as a sport is not the easiest sport to measure with Firstbeat. It is difficult to find all values and clarify e.g. loading with this measurement device. The biggest challenge is with reliability. During floorball games there are quick swaps while the player is playing just under minute and then he is staying out of the game longer time. There are also breaks between rounds. With Firstbeat it is possible to sort out rounds and breaks but it is not easy so the reliability of values is not steady. Most of those values are lowering during breaks e.g. EPOC and MET values.

On the other hand, these tests were done with Firstbeat Lifestyle Assessment which is not fully meant for sports. There might not have problems with reliability while using Firstbeat Sports for tests. With Firstbeat Sports also realtime tests would be done and analyzing results might be easier. All in all, loading and recovery in a floorball players can be done with Firstbeat Lifestyle Assessment but it is not the easiest way to test them or the most reliable way.

9.2 Periodization between exercising, games and resting times

As mentioned above, there were some problems with periodization between preparing training and game. Clearly, if loading is higher in training than in game situation something has gone incorrectly. Due to case type of study it is not possible to clarify if the reason is coaching or style of preparing training or if it is player's own fault. It might be that something happening for player between training and game which made playing more difficult in game. Due to lack of knowledge researcher had not any information how many minutes player was playing – that might also affect to different values. The peak of heart rate has been higher during game situation than in training. MET values have been approximately 11 in training and in game which is a bit weird – competition kind of endurance sport should give MET value over 17. On the other hand, floorball is not endurance sport all the time; it is mix of anaerobic and aerobic sport, quick spurts and rest. (Floorball Nation nd., 2013.) Anyhow, there should be more clear difference between values in preparing training and game situation so that preparing training is just light training and is not taking energy from game situation.

With test subject between game and recovery training was successful. Recovery training next day was light and reversible. All values were lower than in game situation. Heart rate stayed under 156 beats per minute which is telling that training was light and not done with full speed or strength. Training effort was 1,9 which means easy recovery. This gives possibility to full recovery. Also recovery charts gives data of full recovery after game day. That shows that there has been enough resting time between game and next training as well as between training sessions.

As mentioned before, there is no possibility to do any generalization due to small amount of data and tested players. While thinking just this one player, periodization between exercising, games and resting times has been successful except periodization between preparing training and game. There has been enough recovery and resting times and heaviness of training sessions is mainly suitable. Still, he is just one player. Age, lifestyle, amount of relaxations and physical condition are affecting on recovery and numerical values of training effects. It is not possible to say that everyone in that floorball team would have same results as he has.

9.3 Amount of loading of a chosen player

The idea was to estimate loading of chosen player. Due to short measurement period, there were just three training sessions and one game. Amount of loading was not very high due to type of training – they were either preparing for game or recovery training after game. This situation made impossible to estimate amount of loading of a chosen player.

While verifying loading of training, the best way is to estimate different numerical values. In this thesis those values are training effort, VO2max and MET. Training effort values are values from one to five. One is no significant training effort and five is occasional overloading. All training efforts of training sessions were under three (improving training effort) so that is already telling that there was not high loading.

The maximum rate of Oxygen (O2) consumption (VO_{2max}) by the body during exercise is the criterion measure of aerobic endurance fitness. This value is the maximum

capacity of an individual's body to transport and use oxygen during exercise. The average untrained healthy male will have a VO2 max of approximately 35-40 ml/kg/min. The higher amount is the more loading exercise. In those three training sessions and game the VO2 max value changed from 35.4 ml/kg/min to 40.8 ml/kg/min which tell two things: player has quite good physical condition and he has trained not in very high level due to VO2 max level staying in low level.

The Metabolic Equivalent of Task (MET) is a physiological measure expressing the energy cost of physical activities and is defined as the ratio of metabolic rate (and therefore the rate of energy consumption) during a specific physical activity to a reference metabolic rate. There are values from one MET to 20 METs. One MET is sitting in stable and 20 METs is competition kind of endurance sport. Value during training sessions and game varied from 10,1 to 11,7 METs. Ten METs is running 10km/h which is already quite heavy exercises. This part is telling that there have been parts of training with more loading.

Due to fact that there were just four measurement days, there were just two days with working. It is very difficult to estimate if working is affecting on loading or not. There was also one free day, day when there was no working or training. After all those days although all of them were different, there was recovery and stress/recovery chart stayed in recovery part. All in all, there was not so much loading, at least no fear of overloading.

10 DISCUSSION

The idea of this thesis was to research and reflect if Firstbeat Lifestyle Assessment measurement can be used for measuring loading and recovery in a floorball player. Previously in this thesis in chapter 4, heart rate variation has been talked over in theory. Based on that information it can be said that heart rate analysis give many-sided and quite precise information of autonomic nervous system and especially parasympathetic system which is regulating rest and recovery.

The result of study is this thesis which is based on quantitative research. Heart rate analysis of Firstbeat has been used for athletes previously and the results have shown that heart rate variation gives reliable information about recovery of athletes. There has been some research done also with floorball but mainly so called well-known sports like ice-hockey and football are more popular.

10.1 Quality of Research

The quality of research material influences the quality of the overall research. Common for all studies is that the endeavor is to carry them out with as small amount of mistakes as possible. All the same, reliability and validity of researches vary dearly. Evaluation of reliability is important part of every study. (Hirsjärvi, Remes & Sajavaara 2004, 216.) There have happened mistakes also during this thesis what has effected on path of study and results.

Measurement period was just four days which was probably a bit short period while thinking that floorball season takes over six months. All measurements managed and there were no measurement mistakes or corrupted data. Due to short measurement period, tiredness and badly slept nights of test subjects were effecting on data. On the other hand, short measurement period gave more reliability that test subjects kept diary and reported all events during measurement period. There were enough motivation and the comments of measurement were positive. Still, longer measurement period would increase reliability more and there might be more data. On the other hand longer measurement period would require more sustainability from test subjects.

Test group consisted of four players which had been quite small sample for study. For that reason study was changed case study and only data from one player was used. Reasoning for choosing player was clear: chosen players has to be player who had played in every round of game, has took part every training sessions and has kept clear and proper diary during measurement period. Due to changed study type (case study) there was enough data. If study would have not been case study, higher amount of test subjects had been better. With higher amount of test subjects, reliability and validity would have been higher. Because this thesis were done by just one

person, this was not possible. All tested players were males but ages varied. Luckily that did not matter because just one person's data was used.

Tested person was working during measurement period so it was not clear if that increased need of recovery. Also type of work or heaviness was not clarified. This was clear mistake because heaviness of work might effect on results. There were not any questions of mood or liveliness which are clearly affecting on training and games.

For estimating recovery more reliable all kind of self-estimating might be useful e.g. estimating sleeping more subjectively. All in all, whole diary would have been done better and more guided. With that there might have been more data and more clear notes, now there were mainly physical activity times, eating times and trainings. Probably the instructions for diary were not thorough enough and there was missing of feedback and guidance during measurement period.

Probably the biggest mistake or missing was missing of playing times and duration of swaps. Because there was no information of that, it was very difficult to estimate how reliable result were, especially numerical values as MET, EPOC and VO2max. This mistake was noticed while starting to analyze data and players did not remember answer any more on that time.

10.2 Suggestions for Further Research

As this thesis focused on particular in one floorball team and more thoroughly in one player, a research on more general level could give some possibilities for generalization. Such research results could more easily used to improve floorball coaching and periodization of training and recover. Any qualitative part has not been included in this thesis so that might give some extra perspective.

Another interesting suggestion for research of related subject would concern how highly personal features are affecting on results. There is quantum difference for example in ages in one team – there some young players fewer than 18 years and same

time there might be players over 30 years. Age is clearly affecting on recovery and requirements of rest.

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APPENDIX 1

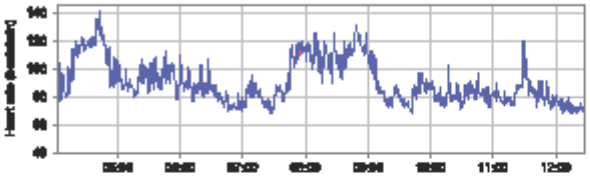
Measurement date
08.03.2011

PHYSICAL WORKLOAD REPORT

Page
1(2)

Practice 1 Nurse

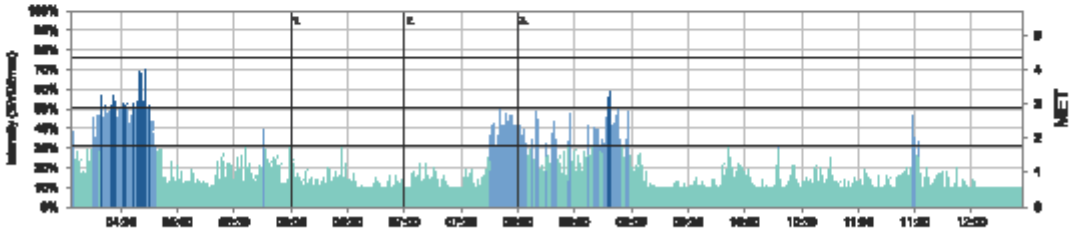
Age (yrs)	54
Height (cm)	153.0
Weight (kg)	66
Resting heart rate (beats/min)	41
Max heart rate (beats/min)	175
Body Mass Index (BMI)	28.2
Activity class	3.0



Duration (hr:min:sec)	08:23:56	Heart rate (low / average / high)	66 / 88 / 141
Start time (hr:min:sec)	04:03:24	Notes:	
End time (hr:min:sec)	12:27:20		

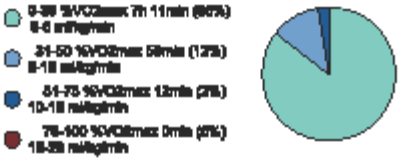
Physical Workload Chart

Physical workload during work.



Journal Markers (average and maximum %VO2max)

1. Rounds (12.9 %, 30.3 %)
2. Vastaanotto (19.2 %, 50.3 %)
3. Cleaning / washing (16.4 %, 58.3 %)



Physical Workload Analysis

Physical workload during work.

Provided by:

This report has been produced by Firstbeat Health (v 5.0.3.11)
18.03.2012 19:10
More information: www.firstbeat.fi/health

Analyzed by:
FIRSTBEAT

APPENDIX 2

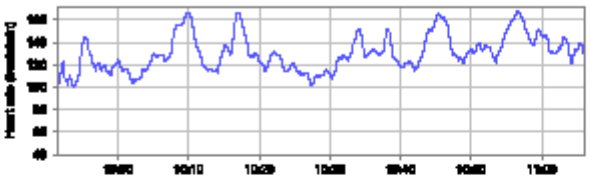
Measurement date
06.05.2012

TRAINING EFFECT REPORT

Page
1(1)

Eddie Example

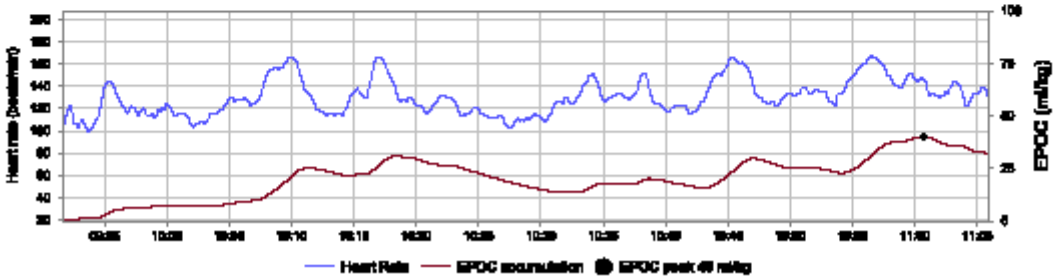
Age (yrs)	35
Height (cm)	183
Weight (kg)	93
Resting heart rate (beats/min)	39
Max heart rate (beats/min)	188
Body Mass Index (BMI)	27.8
Activity class	5.0



Duration (hr:min:sec)	01:14:15	Heart rate (low / average / high)	101 / 130 / 167
Start time (hr:min:sec)	09:51:37		
End time (hr:min:sec)	11:05:52		

EPOC and training effect chart

EPOC (ml/kg) accumulation during the measurement. The effect of training on maximal aerobic power (VO2max) is based on the EPOC peak.



Training Effect: Maintaining fitness

2.8

Benefits: This workout maintains cardiorespiratory fitness and builds a foundation for better fitness and harder training in the future.
Recommended: For all as an essential part of any training program.

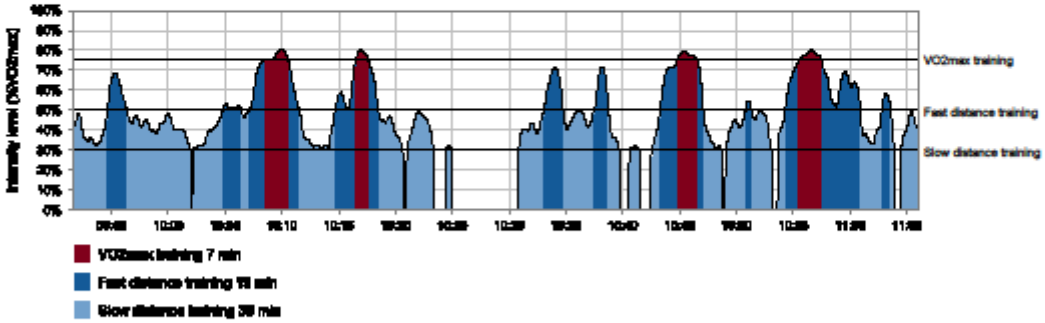
Exercise key figures

EPOC	40	ml/kg
TRIMP	100	TRIMP
Energy Expenditure	669	Kcal

***EPOC (Excess Post-exercise Oxygen Consumption)** is a physiological measure of training load. The amount of EPOC achieved during exercise is directly proportional to the training load and recovery required.*
***TRIMP (Training Impulse)** is a measure of quantifying training load and it accumulates during the workout as a function of time and intensity level.*

Training classification

Classification of the exercise to different endurance training types.



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23.08.2012 14:08
More information: www.firstbeat.fi/work-well-being

Analyzed by: FIRSTBEAT

APPENDIX 3

STRESS AND RECOVERY OVERVIEW

Eddie Example

Age (yrs)	35	Resting HR (beats/min)	39
Height (cm)	183	Max HR (beats/min)	188
Weight (kg)	93	Body Mass Index (BMI)	27.8
Activity class	5.0		

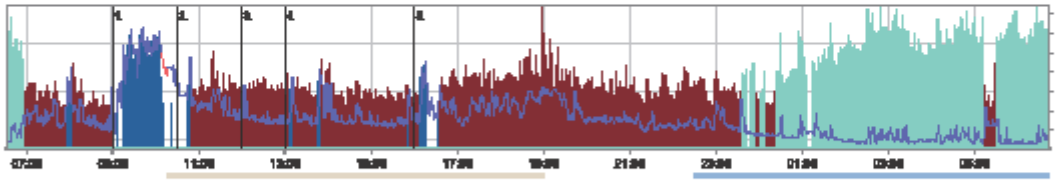
Measurement information:

Day 1	Day 2	Day 3
Start time:	Start time:	Start time:
04.05.2012 06:31:30	**05.05.2012 07:00:01**	**06.05.2012 08:45:00**
Duration: **24h 13min**	Duration: **25h 45min**	Duration: **23h 8min**
HR: (low/avg/high)	HR: (low/avg/high)	HR: (low/avg/high)
41 / 68 / 166	**39 / 56 / 135**	**43 / 70 / 167**

Stress and Recovery Charts

Day 1 - Friday 04.05.2012

Heart rate corrections 2%



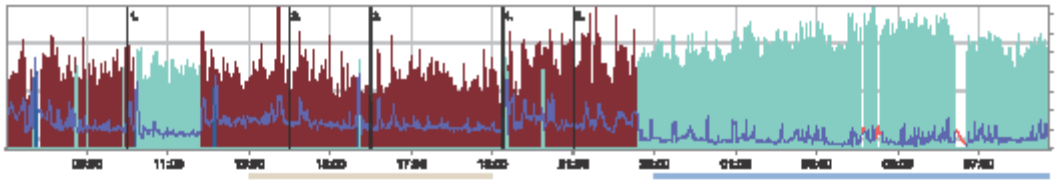
Journal Markers

1. Hard exercise
2. Computer
3. Eating
4. Meeting
5. Light exercise

Result	Recommendation
14h 46min (61%)	Less than 55%
5h 53min (24%)	More than 30%
60min (4%)	
2h 35min (11%)	

Day 2 - Saturday 05.05.2012

Heart rate corrections 3%



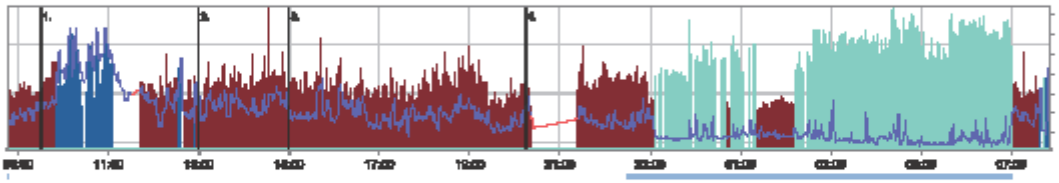
Journal Markers

1. Reading
2. Eating
3. Computer
4. Light exercise
5. Housework

Result	Recommendation
13h 23min (52%)	Less than 55%
10h 32min (41%)	More than 30%
5min (0%)	
1h 44min (7%)	

Day 3 - Sunday 06.05.2012

Heart rate corrections 6%



Journal Markers

1. Hard exercise
2. Eating
3. Housework
4. Shower/bath

Result	Recommendation
12h 46min (55%)	Less than 55%
5h 23min (23%)	More than 30%
1h 4min (5%)	
3h 56min (17%)	

Work period | Sleep period | Heart rate | Corrected heart rate
Stress reactions | Recovery | Physical activity | Other physiological states

Provided by: FIRSTBEAT

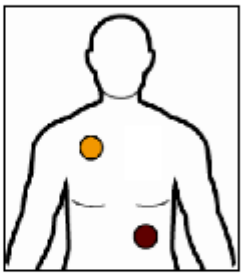
This report has been produced by Firstbeat Health (v 5.2.1.2)
07.09.2012 11:05
More information: www.firstbeat.fi/work-well-being

Analyzed by: FIRSTBEAT

APPENDIX 4

Firstbeat BODYGUARD Quick Guide

Attaching the electrodes



1. Clean the skin carefully on electrode sites. Shave off excess body hair, if needed.
2. Snap the electrodes to the device.
3. Place the electrodes on the skin as pictured; make sure they are snugly attached to the skin. The color in the picture describes the color of the snap that will attach there:
    a. Attach the yellow snap to the right side of the body, just below the collar bone.
    b. Attach the red snap to the left side of the body below the heart (on the rib cage).

Note!
The glue in the electrodes (or electrode paste) can irritate your skin. To avoid irritation, clean and dry the skin thoroughly after removing the electrodes.

Initiating a recording

4. Press the Firstbeat –switch on top of the unit until a green led is activated.
5. As a sign of successful recording, the green led starts to flash in sync with the heart rate.

Interrupting and ending a recording

6. You can **interrupt** a recording e.g. during a shower by de-attaching the monitor. Just unsnap the snaps from the electrodes. It is recommended to put on new electrodes after the shower. Do not press the Firstbeat –switch! The recording will continue automatically if you re-attach the snaps within an hour.

Note!
The electrodes are disposable! If you remove them from the skin, or if they start coming loose during the measurement, always replace them with new ones.

7. If the recording has turned off (green led is not on), restart the measurement as in step 4.
8. When you want to **stop** recording, unsnap the wires and press the Firstbeat –switch for a long time (app. 5 s), until the green led turns off.

Downloading data to the PC and recharging the Bodyguard

1. Turn off the Bodyguard by pressing the Firstbeat -switch for a long time. *Note!* The monitor goes into off-state automatically within one hour of ending a measurement.
2. **Unsnap the electrodes before plugging in the USB cable!** For electrical safety reasons, the USB cable must not be attached to a computer while the device is attached to a person.
3. Attach the Bodyguard to the USB cable and the cable to the computer's USB port so that the orange, blue and green leds are activated.

Note!
The monitor is not water-proof and must be removed during showers and swimming!
During the measurement, make sure that the protective cover to the USB port attachment site is closed!

APPENDIX 5

FIRSTBEAT

BACKROUND INFORMATION QUESTIONNAIRE

Measurement date ____ / ____ / _____ **Belt #** _____

Name (or ID code) _____

Phone number / e-mail _____

Group / Company _____

Contact person _____

Date of birth ____ / ____ 19_____

Gender ___ Female ___ Male

Smoking ___ No ___ Yes, over 10 cigarettes per day

Height _____cm Weight _____kg

Activity class _____ (select one number 0-10 from the list that's provided)

ADDITIONAL INFORMATION (optional):

If you have performed a maximal exercise test during the past year, or you know one or more of the following parameters, please fill the values below. If these parameters are not known, they will be estimated based on the information above!

Maximal heart rate [beats/min] _____ Resting heart rate [beats/min] _____

Maximal oxygen consumption [ml/kg/min] _____ *OR* METmax [l/min] _____

Vital capacity [l] _____