RESEARCH ON THE CHANGES OF THE RESCUERS HEART RATE DURING TRAINING

Daniel Pupazan, *Phd. Eng .,INCD INSEMEX Petrosani*
Artur George Gaman, *Phd. Eng .,INCD INSEMEX Petrosani*
Cosmin Ilie, *Phd. Eng., INCD INSEMEX Petrosani*
Alin Irimia, *Phd. Student, INCD INSEMEX Petrosani*

ABSTRACT: *Under conditions of intense effort, heart rate suffers significant changes that depend largely on the functional characteristics of the respiratory system, which in turn is in close correlation with the degree of the body training and physical exertion.*

Heart rate (pulse) is commonly used in remote monitoring of physiological parameter because it allows an assessment of the overall condition of the rescuer, heart rhythm disturbances being recorded promptly and variations can be easily differentiated from abnormal / normal. This parameter provides an indication of cardiovascular function. Pulse sampling is made by automatic devices which are frequently using photoelectric plethysmography method for measuring of peripheral arteries.

KEYWORDS: *Heart rate, rescue, respiratory system, intense effort.*

INTRODUCTION

Training is a preparatory psychophysiological process to obtain high efficiency to work, for rescuers. The maximum yield was obtained by raising the functional ability of the body to the highest degree. This requires the use of systematic and methodical exercise after pedagogical rules.

Intensity used during training exercises is given by:

- individual possibilities of rescuer;
- degree of readiness
- kinds of exercises;
- deployment external conditions.

Succession and their graduation are rigorously planned, providing a scientific training.

During training the following psychophysiological objectives are seen: learning motor skills, developing physical and mental qualities of the motor activity: speed, strength endurance, skill, will, perseverance, self-confidence, courage, determination, initiative.

Motor skill learning and development is done with the participation of the central nervous system which improves the body functions and thereby yield a high level of locomotor activity. It's also a "training of internal organs" that precedes the execution of exercise.[1]

Body functions have gradually driven to achieve the maximum mobilization conditions. The various processes of adaptation (blood circulation, respiratory metabolism, muscle activity, nervous system analyzer) that result in increased work output will conduct an similarly exercise in advance, but less intense.

Professional work requires a further application of biological adaptation, defined by notion of "professional effort."

Professional effort are all adaptive changes in the body during work (motor requests, sensorial and neuropsychological).

Professional effort are as follows: physical, sensorial, neuropsychiatric, with different weights in the work performed. By type of effort that prevails classified work into work with, work physical effort, sensorial effort and work with mentally effort.

Professional physical effort is defined as all motor applications required to maintain the position and movements during work.

Among the many vegetative adaptations own to physical exercise, the most important relates to the functions of the respiratory, circulatory and thermoregulation.[2]

For occupations with predominantly physical effort in which work involves large muscle groups, physiological assessment criteria relate to:

- the size of external mechanical work, the mechanical work done, expressed in kgm;

- oxygen consumption, exercise intensity and energy expenditure, expressed in kcal.

- changes of physiological indicators during or immediately after exercise, particularly the more intense systems and appliances required (cardiovascular, respiratory), compared with baseline values of these parameters at rest or basal conditions.

When analyzing labor regime, changing the work capacity is studied in dynamics from time to time.

The rational principle of achieving physiological research would continue observing telemetry methods.

Telemonitoring involves remote monitoring of vital functions of a rescuer by means of appropriate devices and techniques.

Monitoring involves conventional biomedical signals and the collection of physiological parameter over a longer period of time on the order of days, downloading and analysis on a computer system being made at the end of the monitoring period (off-line). Telemonitoring systems samples, store and transmitt remotely (through a communication network) biomedical signals or physiological parameters to a much shorter time, their analysis automatically (on-line) and can send alarms if values of monitored parameters exceed certain limits.

Physiological parameters can be extracted automatically via personal monitoring devices, devices that are usually portable and often used in monitoring of vital physiological parameters such as: blood pressure, heart rate, respiratory rate, blood oxygen saturation, etc.., which varies according to choice of pathologies, technical and financial possibilities.

Heart rate (pulse) is commonly used in remote monitoring physiological parameter because it allows an assessment of the overall condition of rescuer, heart rhythm disturbances recorded promptly and variations can be easily differentiated from abnormal / normal. Parameter provides guidance and on cardiovascular function. Sampling pulse is automatic devices frequently using photoelectric plethysmography method for measuring the level of peripheral arteries.

Measuring the pulse with - HRT-SYS telemetry

Equipment (Fig. 1) is used to measure rescuers pulse in training polygon and allows continuous monitoring throughout an exercise progress for six people.

Fig. 1 - Measuring the pulse - HRT SYS telemetry

The whole device is housed in a mobile kit, allowing its use in different locations.

The device is composed of:

- Pulse sensor - mounted on a strip of elastic material is fixed under the pectoral muscle (Fig. 2)

Fig. 2 - Pulse Sensor

- Transmitter - is connected in the vicinity of the sensor pulse at a distance of up to 15 cm. (fig. 3) and is designed to convert all information received from the sensor pulse to be sent to the central unit.

Fig. 3 – Transmitter

Each transmitter is identified by a number which is assigned to a channel for wireless communication with the main unit, which allows to view the monitorized wearer's pulse. On the front of the transmitter are two LEDs, one to indicate the connection between transmitter and main unit and the second indicates whether transmitter is loaded or not.

- The main unit - displays pulse per each wearer and connects to an IT system (fig. 4)

Fig. 4 - The main unit

The main unit includes:

- Device for receiving data from the transmitter with a capture radius of approx. 100 m. (Fig. 5)

Fig. 5 - Device for data reception

- Electronic pulse display device, allowing viewing each carrier and setting alarm thresholds (Fig. 6)

Fig. 6 - Electronic pulse display device

- Charger for transmitting devices (Fig. 7) - allows simultaneous charging of six transmitters.

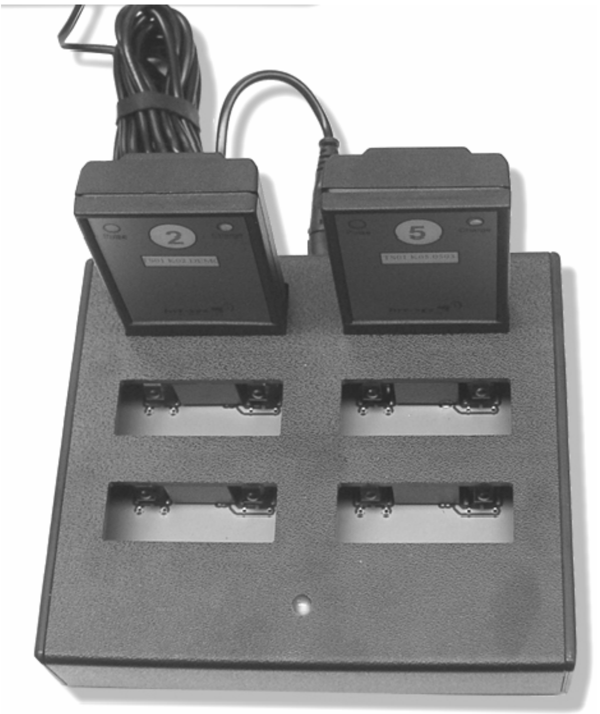

Fig. 7 - Charger for transmitting devices

Through a serial port - USB the main unit is connected to a computer system with a specialized installed software (Fig. 8).

Fig. 8 - Specialized software installed on a computer system

For each rescuer before installing pulse sensor will be introduced in the software as the primary data, name, age, sex, weight and height (Fig. 9).

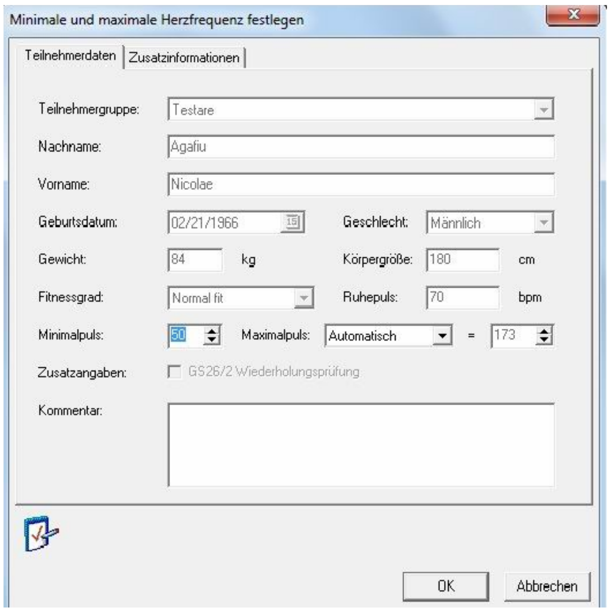

Fig. 9 - Introduction primary data per tested person

The software allows the formation of a database based on the carrier pulse sensor and their activities (fig. 10):

- Continuously monitors each rescuer's pulse, it is displayed in separate windows;
- Allows setting of maximum and minimum alarm thresholds, and highlights by beep;
- Recorded over a period of time fixed by the operator for each rescuer pulse;
- Indicates whether the connection is made between the central unit and system;
- Indicates if one transmitter does not work;
- Show workload of transmitters;
- Depending on the input data and pulse variation calculates burned calories during the conduct of certain activities carried by rescuer.

Fig. 10 - Program for pulse test

For each monitoring period of rescuer is drawn a graph that highlights all changes in heart rate depending on activity (Fig. 11)

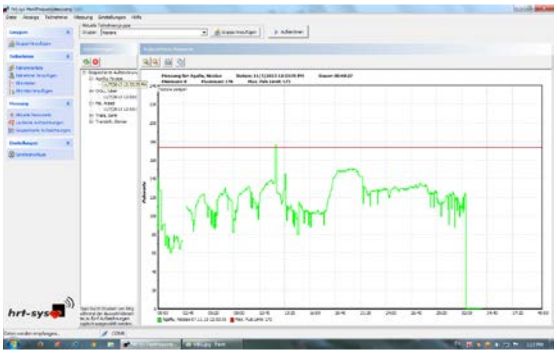

Fig. 11 - Graph for pulse

Pulse measurement using HRT-SYS telemetry system.

HRT-SYS telemetric system allows continuous monitoring of heart rate throughout the period of rescuers training.

Monitoring was conducted for a team of three rescuers under protection of protective breathing apparatus with open circuit based on compressed air with negative pressure [3].

Exercise activities included the following activities:

1 - traction on ergometers;

2 - displacement on ergometric treadmill;

3 - ladder displacement;

4 - moving in confined spaces.

Work quantities submitted by rescuers depending on the specific activity are:

Activity no. 1 - Traction on ergometers

In this activity rescuers performed 4 sessions of traction on on ergometers, each session with 100 pulls-up (Fig. 9). The amount of work done to lift a weight of 20 kg, at a height of 1.2 m, with 100 times repeat activity in 4 series is 9600 Kgm.

Fig. 9 - Pull-up on ergometers

Pulse monitoring was conducted prior to the start time of one minute and while rescuers were performing on ergometers.

The software generated two pulse monitoring reports for each rescuer.

The values measured before and after working are shown in Table. 1.

Table no. 1 - pulse values before and during pulls-up on ergometers.

No. Item	Subject	Before - bpm	On exercise - bpm	Variation in pulse- bpm
1	I	81	152	71
2	II	84	102	18
3	III	82	131	49

Activity no. 2 - Displacement on ergometric treadmill

In this activity rescuers simulated walking using treadmill ergometric, with the speed of 5 km / h, for 5 minutes (Fig. 10).

The amount of work performed for moving the ergometric treadmill, at the speed of 5 km / h for 5 minutes by a rescuer who weighs approximately with the apparatus 100 kg is 2200 Kgm.

Pulse monitoring was conducted prior to the start time of one minute and while rescuers were moving on ergometric treadmill.

The software generated two pulse monitoring reports for each rescuer.

The values measured before and after working are shown in Table. 2.

Fig. 10 - Walking using treadmill

Table no. 2 - Pulse values before and during walking using treadmill.

No. Item	Subject	Before treadmill - bpm	Walking on treadmill - bpm	Variation in pulse - bpm
1	I	102	144	42
2	II	84	115	31
3	III	102	128	26

Activity no. 3 – Ladder displacement

In this activity rescuers go up and down a ladder with 5 steps by repeating 40 times the activity (Fig. 11) .

The amount of work done by climbing and descending the ladder with 5 steps, by a rescuer with the insulation apparatus weighs approx. 100 kg, with repeat the activity 40 times is 2000 kgm.

Pulse monitoring was conducted prior to the start time of one minute and while rescuers were ascending and descending stairs.

The software generated two pulse monitoring reports for each rescuer.

The values measured before and after working are shown in Table. 3.

Table no. 3 - Values of heart rate before and during the ascent and descent of the ladder.

No.. Item	Subject	Before ladder - bpm	On ladder - bpm	Variation in pulse- bpm
1	I	112	144	32
2	II	91	112	21
3	III	102	118	16

Fig. 11 - Ladder displacement

Activity no. 4 – Moving in confined spaces

In this activity rescuers moving indoors, on 3 positions (crawl - in a section of 0.54 square meters, on palms and knees - in a section of 0.9 sq meters and a tilt in a section of 1.5 square meters) per a length of 12 meters by repeating 3 times the activity (fig. 12)

The amount of work done is 3150 kgm.

Pulse monitoring was conducted prior to the start time of one minute and while rescuers were moving indoors.

The software generated two pulse monitoring reports for each rescuer.

Fig. 12 - Moving in confined spaces

The values measured before and after working are shown in Table. 4.

Pulse increases were observed for all activities, the highest values being recorded for the activity which has the highest value amount of the work, respectively on ergometers.

Table no. 4 - Values of heart rate before and during movement in enclosed spaces.

No. Item	Subject	Before enclosed spaces - bpm	During moveme nt - bpm	Variation in pulse-bpm
1	I	112	156	44
2	II	93	138	45
3	III	102	140	38

CONCLUSIONS

Heart rate (pulse) is commonly used in remote monitoring physiological parameter because it allows an assessment of the overall condition of rescuer, heart rhythm disturbances recorded promptly and can be easily differentiated from abnormal / normal. Parameter provides an indication of cardiovascular function. Sampling pulse is automatic frequently using devices based on photoelectric plethysmography method for measuring the level of peripheral arteries.

Pulse measuring has made with telemetry system HRT-SYS, which is the only device which allows continuous monitoring of this parameter. The equipment uses specialized software that allows continuous recording of rescuers pulse via wireless technology to a distance of about 100 meters from the unit.

The tests were conducted in the polygon where the training was set a route made up of several activities (on ergometers, treadmill, ladder confined spaces.) for each of the job knowing work consumption.

Pulse determination was performed for a group of three rescuers. The measurements were performed at rest before the start of and during activities.

After analysis of these measurements it was observed that the pulse was increased for all activities, the highest values being recorded for the the activity which has the highest value amount of work, respectively on ergometers.

Telemonitoring in real time allows:

- Determining the degree of difficulty of training routes based on changes in heart rate;
- Alarm thresholds for achieving the minimum and maximum measured vital parameters;
- Real-time identification of rescuers whose vital parameters are exceeded during training exercises;
- Possibility for the instructor which supervises the exercises to stop this activity for those above the maximum or minimum, avoiding possible undesirable events;
- Data storage for each person and follow his evolution during the next workout.

REFERENCES

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