

MONITORIZATION AND EVALUATION OF HPNS (HIGH PRESSURE NERVOUS SYNDROME)

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Abstract— HPNS (High Pressure Nervous Syndrome) is medical disorder connected with the diving activity. This syndrome occurs when a diver descent very fast below 150 m depth, in a breathing environment represented by a helium – oxygen mixture. The disorder consist in psychomotor and neurology type effects which represents in fact, the deep diving upper limit above which the human body decreases in performance.

When a diver is selected to perform a deep diving course, he has to pass an evaluation stage in order to prove his ability to tolerate the compression speed accompanied by the helium - oxygen breathing mixture without encountering the HPNS effects.

The deep diving test consists in postural tremor and the EEG (electroencephalography) registration, in both conditions: at the atmospheric pressure and at 180 m deep too. Then the results obtained at the surface percentage limits are fixed for the maximum deflection agreed between the values registration made under pressure and the atmospheric pressure (surface) values.

Keywords— EEG (electroencephalography) waves, HPNS (High Pressure Nervous Syndrome), postural tremor.

I. SYMPTOMATHOLOGIE OF DEEP DIVING ACTIVITY

DIVING activity below 60 m, presumes the utilization of the synthetic breathing mixtures. These are made by oxygen diluted with an inert gas. The atmospheric air contains 21% of oxygen and 79% of nitrogen. The narcotic effect of the nitrogen, which appears deeper 60 m, imposes to use another inert gaseous and the most appropriate is helium, due to his properties. This forms with the oxygen in various concentrations, the synthetic breathing mixture helium - oxygen, which has an indistinguishable narcotic effect.

At diving below 150 m depth, have been observed in humans signs and symptoms by disturbances of the central nervous system (dizziness, nausea, vomiting, postural tremors, fatigue and somnolence, decrements in intellectual and psychomotor performance, increasing and decreasing of wave activity of the brain, as measured by an electroencephalogram). These symptoms are known as the HPNS (High Pressure Nervous Syndrome) and begin at different profounder for various subjects, depending of

our resistance. It is necessary to establish scales of aptitude to perform a deep diving course.

The symptoms are divided in two categories:

- 1) clinical symptoms: tremor, dissymmetry, muscle convulsions, somnolence;
- 2) EEG symptoms: EEG (electroencephalography) modifications, increase of Theta waves activity, depression of Alpha and Beta waves activity, sleeping perturbations [1].

Pathology HPNS (High Pressure Nervous Syndrome) is explicated by Hunter and Bennett through a series of factors indirect, like oxygen and carbon dioxide (both the minor role) and the temperature, especially hyperthermia and osmotic phenomenon [2].

II. MEASURING PROCEDURES

Since 1965, a comparative study of hydrostatic and gaseous breathing mixtures (helium, hydrogen, nitrogen) effects on animals first and then on humans, has significantly contributed to understanding causes, mechanism of production and prevention of HPNS (High Pressure Nervous Syndrome).

Also amazing progress in the movement of the depth limits to diving has led first to the description of important HPNS symptoms, followed by preventive measures and finally by clarification and understanding of variable causes which they give rise.

Very important roles in phenomenon study have Peter Bennet [2], [3].

The compressing of the diver with helium - oxygen to depth below 150 m, causes HPNS (High Pressure Nervous Syndrome). This syndrome is translated by:

- 1) psychomotor disorders: tremor and dissymmetry, imprecision and gestures without coordination;
- 2) decrease of the vigilance, decrements in intellectual performance fatigue and somnolence;
- 3) modifications by increase of slow wave and decrease of fast wave activity of the brain, as measured by an electroencephalogram.

In general, it noted that tremor appears at diving below 150 m and it is characteristic at the extremities (hand fingers) and heightens with the profounder. It was called "helium tremor", but appears in deep diving, with

breathing helium - oxygen breathing mixture and hydrogen - oxygen too [4], [5].

The studies of this phenomenon have been made to Diving Center too, on hyperbaric complex, serviced by its team of qualified technicians (see Fig. 1).



Fig. 1. Hyperbaric complex: two dry hyperbaric chambers and one wet hyperbaric chamber

Two dive teams, by 3 divers selected for deep diving course, participated to the experiment.

The hydrostatic pressure effects and the helium - oxygen effects at the divers were verified by HPNS (High Pressure Nervous Syndrome), according to NODAS (Normative for preparation, organization and labour protection) [6].

The test was made in a dry chamber, with 3 divers, without the tender diver. Before compression, were recorded the electroencephalography of the divers, in supine position, without luminous stimulus and postural tremor.

Electroencephalography represents the recorder of the electrical potential of the spontaneous activity of the cortical neurons, adding the electrodes fixed on the scalp [7].

Postural tremor represents the anomalous movement of the hand fingers, characterised by rhythmic and involuntary oscillations.

Pathology of the phenomenon isn't knower. Tremor is considered a sensitive symptom, determined by the hyperbaric stress, which may interfere with the nervous conduction and the metabolism too [8].

Realisation of Electroencephalography procedure

TABLE I
 FIRST TEAM – FEATURES OF SUBJECTS

S	Corporeal Pound (kg)	Hig (cm)	Thorax circumference (cm)	Age
1	94	180	115	45
2	93	173	121	30
3	128	194	125	40

Two diver teams with divers selected to perform a deep diving course have participated at the experiment. Every team was compound by three subjects.

First is made the test at the surface, into the hyperbaric dry chamber.

TABLE II
 SECOND TEAM – FEATURES OF SUBJECTS

S	Corporeal Pound (kg)	High (cm)	Thorax circumference (cm)	Age
4	84	178	110	42
5	68	168	92	39
6	94	191	115	39

The neurologist made the electroencephalogram for first team, at surface, in the following conditions:

- 1) open eyes;
- 2) close eyes;
- 3) at hyperventilation;
- 4) after hyperventilation;
- 5) in supine position;
- 6) without luminous stimulus.

The discus silver electrodes were attached by the scalp with the conductive and adhesive paste. The electrical stimuli from different regions of the skull vault were take over and digital reproduced. Were recorded the Alpha rhythms, the Beta rhythms and the slow Delta activity.

After finish of the surface recorders, the subjects were compressed at depth 180 m, in the dry chamber of the Hyperbaric Laboratory, with helium – oxygen over the existing atmospheric gas and which has the following diving characteristics:

- 1) compressing mixture - HeO2 5/95 %;
- 2) respiratory mixture at life level - HeO2 5/95 %;
- 3) maximum depth – 180 m;
- 4) compression time - 18 minutes;
- 5) compression speed - 10 m/min;
- 6) stationary time at 180 m – 60 minutes maximal;
- 7) decompression time - 38,2 hours;
- 8) decompression table used is OXY - HELIUM DIVING DECOMPRESSION TABLES.

After 10 minutes pause, the tests were resumed at 180 m depth, in the same conditions.

Realisation of the recording procedure of postural tremor

After EEG test, the six subjects were tested at postural tremor, at surface and after very fast descent at 180 m.

The transducer for postural tremor was fixed on the median finger of the right hand, tensed on horizontal and were recorded the signals into a computer, during 20 seconds, 20 seconds pause and 20 seconds with the hand suspended near the body. For each subject were made by tow such recording: first amplitude A1 and second amplitude A2.

After 10 minutes pause at 180 m depth, were resumed same EEG and postural tremor records like at atmospheric pressure. The total bottom diving time don't was over 60 minutes. At finalizing of the recordings was started decompression.

III. CALCULATION RELATIONSHIPS FOR PARTIAL PRESSURES

For the variation of the partial pressure's gaseous from the mixture, relationships have been determined, depending on entire respiratory gas pressure, due to the

