

COMPUTERISING PULSE DIAGNOSTICS: APPROACHES, IMPLEMENTATION, PERSPECTIVE

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For more than three centuries Buryatia was the most northern region of the extension of Buddhism. All traditional Buddhist arts got their development here and especially medicine.

There are several periods in the history of traditional Buddhist medicine in Buryatia that could be distinguished.

1. It is impossible to determine the exact time of Tibetan Medicine (or Traditional Medicine, TM) penetration onto the territory of modern Buryatia, because historically it was the part of large Mongolian world and was influenced by all processes of social and spiritual life of Mongolia related with Buddhism. We can reliably state that by the end of 17 - the beginning of 18 centuries TM had strong roots with the formation of institutional (monastery) forms of Tibetan Buddhism.

2. The prime time of TM was in 19 - the beginning of 20 centuries when compilative and original works of Buryat authors appeared such as commentaries, medical reference books in Mongolian and Tibetan.

3. There was a decay of TM during the 30-50-s of 20 century related with Soviet anti-religious suppression.

4. New period began in the end of 60-s related with the beginning of academic investigation of TM at the Buryat Scientific Centre of the Siberian Division of Russian Academy of Science. The projects of translating and researching written sources, investigating remedies were worked out. In the late 80-s the work on computerisation of diagnostic methods was started.

5. The 90-s it is the period of the revival of old and formation of the new organisational forms of TM. It is the situation de-facto in the Buryat Republic today that TM coexists alongside with the European one and is implementing its own important social mission.

On this stage it is impossible to understate the role of modern science in further evolution of TM. Science today should promote spreading its approaches and methods, which could greatly influence the appearance of future medicine based on coexistence and co-operation of different medicinal traditions and science.

Among other attractive features of TM there can be distinguished the following ones:

1. TM is aimed at treating not external signs of diseases (symptoms and syndromes) but their internal causes. Any disease is considered as malfunction of general psycho-somatic patient's

status. Healing methods of TM are aimed at correction of vital forces, disposition, bringing harmony to patient.

2. Diagnostic and treating means of TM are relatively low expensive and therefore more democratic and accessible for people. All healing procedures are carried out under usual patient's life conditions. There is no need in hospitals and rehabilitation. Most acute and important this problem raises in Russia which is going through the severe crisis of Soviet public health system.

3. Ecological consistency. Remedies are made of natural raw materials, not synthetic. There is no great need in industrial production or other polluting factors to provide the sustenance of TM.

These factors provide the necessity of extensive academic investigation of TM which is conducted in Buryatia in the following directions:

1. Original Tibetan and Mongolian written sources study (translations, philosophic comprehension and popularisation).

2. Computerisation of diagnostic methods (pulse diagnostics, interrogation, visual examination).

3. Investigation of remedies.

4. Introduction of traditional healing methods (acupuncture, cauterisation, manual therapy) into wide clinical practice.

These works are carried out by several research groups at the different institutions of the Buryat Scientific Centre joined on collaborative basis.

The investigation of basic importance is computerisation of pulse diagnostics which is one of the main diagnostic methods of TM. This is conducted at the Laboratory of Radio-Biophysics of the Department of Physical Studies (LRB) of the Buryat Scientific Centre. Pulse diagnostics is a convenient object for scientific studying and computerisation due to following reasons:

1. It provides profound knowledge base for making diagnosis with well-structured categorical system.

2. It is simple to measure pulse by means of modern electronic devices

3. It is objective from the viewpoint of biophysics

The special feature of Tibetan pulse diagnostics is that six points on both wrists of a patient are palpated simultaneously, each point carrying information about one of six system of hollow-full organs of human body. Thus physician can make decision about patient's status as a whole and each functional system in particular.

Our work on computerisation is conducted on the following main directions:

1. Development of mathematical methods of multiparametrical description of pulse wave (the model of pulse)
2. Experts' work guiding to disclosure of common parameters of pulses of certain diseases.
3. Development of classifying rules based on mathematical methods and experts' evaluations.

Our main task is to determine fields of probability for different disease forms on the base of expert description of pulses and their computed parameters which could form required knowledge base to create an expert system for making diagnosis. Of special importance is the work with experts because traditional pulse descriptions don't coincide directly with categories of science and therefore it is almost impossible to determine direct categorical congruence only on the basis of textual analysis. Experts, being mediums between TM and scientists, create required layer of knowledge on the basis of which we can acquire a new quality.

A special feature of our work is to give the most adequate reproduction of traditional diagnostic procedure. For example, pulse sampling is undertaken by means of two specially constructed three-positional pulse transmitters placed on both wrists of a patient. Data through digital interface are transmitted to PC for further processing.

Mathematical methods we apply to process recorded signals can be divided into two groups.

1. Integral methods, which handle long signal samplings (up to several minutes). They permit to show common trends of the process and make qualitative estimation of a patient's functional status.
2. Single (or time-amplitude) ones which process single pulse wave, they allow to make more detailed decision on quantitative basis.

Composition of these methods gives required flexibility and provides more information for making decision and final diagnosis. Set of analysed parameters includes spectral, correlation, time-amplitude characteristics of pulse wave, etc.

Applied time-amplitude method is based on analysis of derivatives obtained using splines. For the purpose of acquiring derivatives in dependence of raw data quality and required accuracy of results we also use regularisation method and Fourier series. Using B-splines it is possible to perform real-time computing.

Subsequent process includes following steps: separation of single waves from arbitrary-length pulse samplings; single wave mark-up or typical points determination (*Fig. 1*); time-amplitude parameters calculation and analysis.

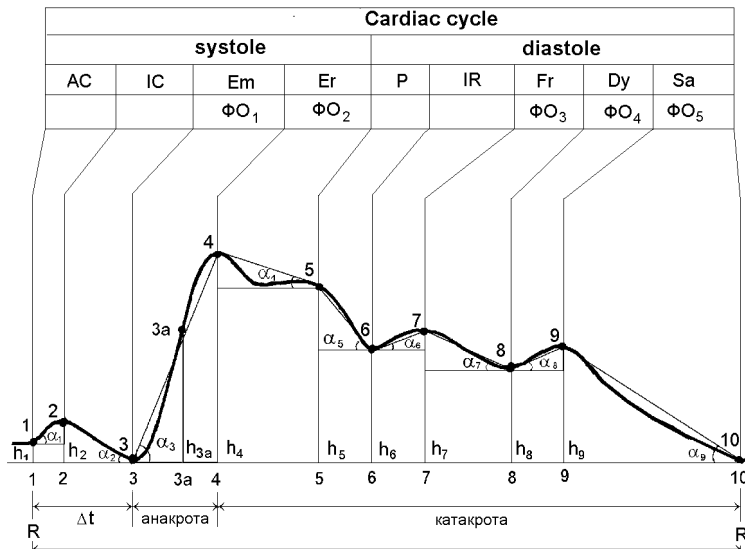


Fig. 1 Single pulse wave sample with mark-up. Phases of cardiac cycle are shown in the upper table of the figure.

Mark-up algorithm is based on a statistic model which includes several parameters such as average relative duration of cardiac phase (interval between two neighbouring typical points), defining the centre of searching area; average relative error of interval duration, defining the width of searching area; additional rules regarding the type of the curve being investigated and other features of typical point.

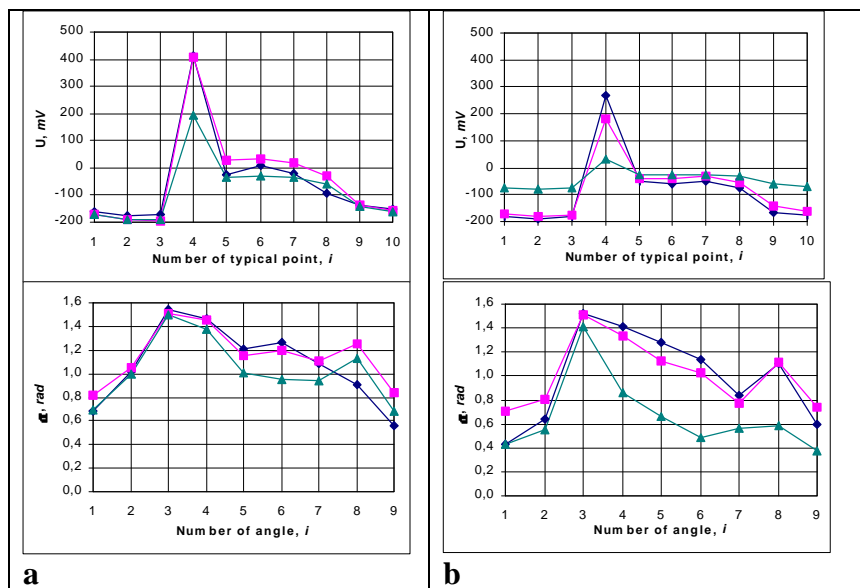


Fig.2 Time-amplitude parameters of *tson*, *kan*, *chag* pulses taken from the left hand of a patient calculated using mark-up algorithm: a. for healthy person; b. for diseased person

Software realisation of this algorithm permits automated pulse signal mark-up and time-amplitude parameters calculation. For analysis we chose following parameters: amplitudes of special points (h_1-h_{10} on the Fig. 1), cardiac phases, and values derived from these two types which could be estimated geometrically as angles of inclination of the segment of the pulse

contour to its zero line (a_1 - a_9 on the fig. 1). These parameters computed for healthy person and diseased one are shown on the *Fig. 2*.

Obtained results have been applied for the explanation of the main categories of TM, for example such as pulses of “heat” and “cool”, pulses of 5 prime elements, etc. But the most promising and responsible work is still progressing.

Our device has been introduced for conducting researches in several medical institutions. Some of the developed methods were adopted for clinical use by health governing organs. Created know-how has been partly patented especially pulse transmitters (two Russian Federation patents). Promising are researches related with expert systems realising interrogation, one more diagnostic method of TM, which are conducted at the LRB in a parallel way. All these works are open for every collaboration and support.

Computerised system of pulse diagnostics does not substitute physician, but is intended as his assistant. The personality of healer remains the determining factor of medicine.