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Neurocardiological anamnesis: development from complementarities with syndrome differentiation of Traditional Chinese Medicine

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Abstract. Cardiologists that are examining patients with ECG monitoring devices for years may get clinical experience from which they are sometimes able to closely evaluate type of autonomic nervous system (ANS) in patients, not just through overview of ECG parameters, but even before: during introduction conversation with patients, from their symptoms, will, mood, voice gesticulations. All of them are possible to be differentiated in two types: hyperactive versus phlegmatic behavioral manners. These energetic types are often matching with sympathetic and parasympathetic ANS predomination, respectively. This is very similar to diagnostic methods of observation 望诊(wàngzhěn) and auscultation 闻诊(wénzhěn) in Traditional Chinese Medicine (TCM). From specific patterns in the voice, tong, mimics of the face, eyes, gesticulation and history of patient, TCM physicians are obtaining syndrome 证 (zhèng), a generalized clinical result of health status; briefly, it is characterization of the state of 气 (qì) in patient. Very sophisticated and complex zhèng is basis for successful administration of therapy. After drawing complementary analogies of yang and yin excess/ deficit with sANS and pANS predomination/failure, and extracting main principles of TCM diagnostic procedures we can use it for development of algorithm for neurocardiological anamnesis in the form of simple expert system. Its purpose would be the software support to cardiologist in order to get synoptic health report of patient useful in further ANS analysis and recommendation of therapy. In other words, it would do mimetic of expert knowledge of experienced neurocardiologist. That could be a basis in neurocardiology for greater and fruitful personalized medical approach, that is otherwise practiced for centuries in TCM.

1 Introduction

As it is well known, autonomic nervous system (ANS) represents neural structures and neural cells that are innervating all internal organs [1]. Through neural interplay they are enabling correct physiological functions, for example, blood vessels (blood

pressure), respiratory roads (breathing), heart (pulse), sweating glands (sweating and thermoregulation), intestines and urogenital organs (contraction, secretion and absorption) [2] etc. Work of these organs, these functions are performed involuntary [3]. Usually, sympathetic ANS (sANS) is increasing physiological functions (heart rate, blood pressure), whereas parasympathetic ANS (pANS) is decreasing it. As a rule, sANS and pANS are always acting antagonistic, synchronous, synergetic; they never act independently, action of one is always fallowed with inhibition of other [4]. Since invention of monitoring instrumentation these ANS system regulation concepts have started to be taken into account as significant assumptions for health status and administration of therapy. Autonomic imbalance, in which typically the sympathetic system is hyperactive and the parasympathetic system is hypoactive, is often associated with various pathological conditions [5]. Changes in the HRV patterns could be an indicator of health status. High heart rate variability (HRV) is a signal of good adaptation and characterizes a healthy person with efficient autonomic mechanisms. Whilst lower HRV is frequently an indicator of abnormal and insufficient adaptation of the autonomic nervous system, causing the subject low physiological function, this decrease is consistent with a dysfunctional vagus [6]. Aging and disease are accompanied with a *reduction of complex variability* in the temporal patterns of heart rate [7]. According to literature, disease is normally characterized by reduced complex variability in the temporal patterns of HR. It has been shown that attenuation of HRV complexity characterizes, among others, cardiovascular and metabolic diseases [8]. All of it is field of research in new interdisciplinary science called Neurocardiology. In general, Neurocardiology is dealing with cardiac ANS patterns that are determinate and characterized after ECG and blood pressure parameter analyze. Cardiac ANS patters are evaluated in various medical conditions and diseases, for example as risk predictors, and as mentioned they are used for administration of optimal drug therapy.

2 Complementary analogies between Neurocardiology and Traditional Chinese medicine (TCM)

Beside obtaining by ECG monitoring devices, ANS patterns are all the time reflected through facial expressions of inner feelings, subjective experience, vocalization [9]. Facial expressions and vocalization are mainly regulated by cranial nerves that are connected with vagus (a part of the pANS). Cranial nerves and vagus regulate stratial muscles of the face, larynx and pharynx [10]. They also regulate heart and they are significantly influenced by self-regulation of emotions, outside environment, social interconnections [11], exchange of energy. Based on this observation we are able to conjecture a hypothesis that physicians in Traditional Chinese Medicine (TCM) with their methods of anamnesis are detecting mainly these ANS patterns in facial expressions, vocalization, gestures, mood, social

behavior etc. During ages of life experience, they remarked the significance of ANS patterns for health and quality of life. Their insights are just expressed in different medical terminology. Now, if we study etymology of TCM concepts, obvious similarities with concepts of Neurocardiology could be found. It is remarkable that neurocardiac concepts (ANS patterns and ANS regulation principles) are consistent with explanations of Zhang Fu 脏腑 (zàngfǔ) theory of inner organs in TCM [12, p. 23]. It is giving insights about physiological functions, inner relationships and pathologies of internal organs by observation of manifestations that are reflected outside on the body. It is important to know that organ in TCM is not the same thing as in biomedicine. Organ in TCM is identified with function and symptoms. Zàngfǔ organs could be considered as complex functional systems. 脏 (zàng) organs are „solid" organs that performe main functions like production, transformation, regulation of vital substances: qi 气 , blood 血 (xuè), body liquids 津液 (jīnyè) and essence 精 (jīng). There are 5 zàng organs: heart, lungs, kidneys, liver and spleen. 腑 (fǔ) organs are „hollow" organs; they are functionaly connected and have roles in processes of digestion, absorption and secretion. There are 6 fǔ organs: small intestine, big intestine, gall-bladder, stomach, triple wormer (regulates qi in body, its circulation and activity). These internal organs have their own separate functions, but they are connected with all other organs by means of acupuncture meridians. Every zàng organ is connected with certain fǔ organ. Beside them, atypical fǔ organs exist as well: uterus, brain, medula oblongata, bones, blood vessels, gall-blader, again. They are „hollow" like fǔ organs, but their function is collecting vital substance in the same manner as zàng organs. Every pair of zàngfǔ organs are relating to each other in agreement with 阴 (yīn) and 阳 (yáng) shifting. They are balancing each other and together they are influencing on general health status. Usually TCM physicians can detect disbalans between two organs, in other words yīn - yáng local relationship [12, p. 22]. Thus, sANS and pANS are suitable to be modeled as yīn and yáng. In the same way that TCM physicians interpret diseases and health problems as yin and yang excess/deficit, in Neurocardiology we can also determine sympathetic and parasympathetic predominance by means of HRV signal analysis. This is especially notable in power spectral analysis of HRV. Thus, translated to language of Neurocardiology, TCM principles could have the following explanation:

- organic dysfunctions and syndromes 证 (zhèng) are related to impairment of ANS control over involuntary functions;
- qi vitality (energy) could be represented by means of total power (TP) in HRV spectrum;
- qi congestion could mean impairment of autonomic regulation (very low value of TP in HRV spectrum);
- yang excess can be regarded as sympathetic predominance (high value of low frequency band in TP spectrum of HRV);

- yin excess as parasympathetic predominance (high value of high frequency band in TP spectrum of HRV) [13].

HRV analysis that we obtain with ECG monitor recording, TCM physicians are doing through pulse palpation. Thus, fingers of TCM physicians have the same function as sensors and electrodes in Neurocardiology. By means of the pulse palpation, TCM physicians are able to detect 28 types of pulse all of which possess diagnostic indices.

3 Establishing neurocardiac anamnesis

We have to point out that in Neurocardiology anamnesis there is something not yet defined. It might have great significance just as in TCM it has. First off all, neurocardiac anamnesis could and should be systematized because of great diagnostic potential it possesses. In that aim, process of neurocardiac anamnesis of several physicians should be fallowed and noted.[1] Afterwards, their questions, insights and conclusion should be well documented. The most significant relationships in context of diagnostic assuming and prescription of therapy are needed to be valued. Then, noted insights of physicians can be generalized for getting simple rules that lead to conclusion about autonomic patterns in concrete person. More simplified, these clues can be scored. For notion of specific autonomic pattern physician needs several signs in mimics, gestures, vocalization, facial expressions. Besides, testifying about way of life should be taken into account: for example, early getting up, dynamics, speed, multiple activities, meeting, joining with many people, stress etc, versus late getting up, slow rhythm of life, long preparation for getting out from home etc. These two ways of life could be generalized as hyperactive and phlegmatic manners. They correspond to sympathetic and parasympathetic type of ANS predomination [14]. Thus, physician may obtain confirmation about autonomic patterns through observation and conversation about usual daily activities and social circumstances of patient. Accordingly, it would be great achievement to create neurocardiac anamnesis through original insights in neurocardiac clinical practice, but more elegant is to borrow some principles from TCM. Their physicians do diagnostics by means of 4 methods:

1) 望诊望诊 (wàngzhěn), visual inspection of tong, outside look, behaving of patient etc;
2) 闻诊 (wénzhěn), auscultation (listening of the patient);
3) 问诊 (wènhěn), verbal inspection (interview);
4) 切诊 (qièzhěn), Palpation (pulse detection by fingers).

[1] In this paper we have insights of one neurocardiologist that he shared with us during our research. But, we need more like that, for better generalization.

In general, they use these techniques to observe systematic or regional changes in *vitality* of qi. It is reflected through observation of eyes, consciousness, color of the skin, movements, sweating, hearing of the voice, breathing, cough, smell. Then they perform detailed conversation with patient about his/her social circumstances, natural environment etc. In this way they collect signs, "diagnostic parameters" about state of qì, blood and organs. In the end all symptoms, signs, details from history of patient are forming clinical result (pattern) of the disease (health status) that is called 证 (zhèng) [12, p. 22-23]. Correct differentiation of zhèng is most important for further recommendation of therapy. Mainly TCM distinguishes two types of zhèng:

- ***cold zhèng***: Cold (chill, coldness); cold pain; tastelessness; clear abundant urine (clear urine in large amounts); loose stool; pale tongue; white fur (white moss); *tight pulse (stringy pulse)* and
- ***hot zhèng***: Fever; heat (hot); diaphoresis; flushed face; burning pain; deep-coloured urine; red eyes; thirst; desire for drinking; constipation; red tongue; dry tongue; thin fur (thin moss); yellow fur (yellow moss); *rapid pulse*.

Zhèng is not a name for the disease. It is rather used for disease classification and then for recommendation of therapy. Some disease may be characterised by different zhèngs in different patients and some certain zhèng may be present in different diseases [15]. However, according to TCM, diseases might be arbitrarily classified as yīn or yáng diseases. Also, we can make complementary analogous classification on diseases with sympathetic or parasympathetic type of ANS predomination. In both classifications there are exceptions. It happens that those are people with atypical ANS regulation. Therefore, with ANS predomination patterns we can introduce hypothetic concept of neurocardiac zhèng analogous with zhèng in TCM therapy.

3 Establishing neurocardiac anamnesis

Even if neurocardiac anamnesis would already been invented, its application in clinical practice seems hard to fulfill. Just like in TCM, much time of training for learning anamnesis procedure would be needed and afterwards it would consume time for making report for anamnesis. As well known, time in cardiological cabinets is often a lacking resource. Without effective and simple way to perform neurocardiac anamnesis, it would be predisposed to stay a theoretical ideal. Thus, it is very suitable to employ computer technology for development of an expert system for neurocardiac anamnesis. Its designation would be mimicking expert knowledge of neurocardiologists. However, in any situation, role of neurocardiologist is not meant to be replaced with this computer technology. More precise, purpose of neurocardiac expert system would be supporting assistance to neurocardiologist in making clinical decisions. Despite of that, sometimes physicians may get impression that such technology reduces direct relationship with

patients. But in contrary, one of main goals of neurocardiac expert system is to support personalized medical approach of neurocardiologist. It might be accomplished with development of neurocardiac anamnesis procedure analogous with TCM methods of it that are fully personally oriented. Before it, for better clearance in algorithm expert mimesis we need to get introduced with expert systems that have already been developed for neurocardiac analysis.

4 Expert systems for neurocardiology and Traditional Chinese medicine

The basic idea of expert system (ES) is to transfer expert knowledge of human to computer system. It is then manipulated by certain algorithms aided by artificial intelligence aiming to mimic process of making decision of human, an expert in some field [16]. Thus, ES in medical application should help physician to get diagnosis or prescribe therapy significantly more effective, precise and faster or to get useful information for concrete cases in own medical practice. In that way, ES is serving to physician in process of (fast) making medical decision that is based on starting symptomatic (for example cardiological problems, hypertension, pain in chest, arrhythmia etc) suggesting the most relevant questions related with type of a health problem. Then, from the answers which can be effectively inputted and evaluated, it gives the clues on diagnostic hypothesis. After that, for final diagnosis, from expert dataset ES suggests possible therapeutic solutions. To develop such system engineering strategy of defining ES structure and algorithm functions is needed.

In that purpose, some classifiers with use of neurocardiac parameters were designed. Here we are suggesting an overview of these machines:

Lee HG et al used LFnu, HFnu, LF/HF, SDRR, SDSD (linear parameters), SD2/SD1, SD1SD2, ApEn (nonlinear parameters (HRV complexity)) for classification of coronary artery disease. After trial of several classification techniques they found that Support Vector Machine had the best accuracy of 90 % [17].

Heitmann A et al were using 17 HRV indices (TD: sdNN, rmssd, pNN50, pNNL10, renyi4; FD: LF/HF, HF/TP; DFA: α1; CE: $H_c^{3,3}$; PPA: SD1, SD/SD2; SD: SDShannon, Forbword, wpsum2; STSD: arpf, ppf, plpf) for classification of healthy participants from heart disease patients (Myocardial infarction (MI), Heart failure with peripheral arterial disease (PAD), Heart failure without PAD (HeF)). They made 4 tests in which was shown that there is great dependance of gender and age on classification results (20 % diference) [18].

Acharya UR et al performed classification of ischemic/dilated cardiomyopathy, complete heart block, sick sinus syndrome, atrial fibrilation (AF), ectopics and normal subjects by using ANN and fuzzu equivalence relation. They fed ANN with: average heart rate, Ener 1 [energy content in the band (33.3–100 Hz)]/[energy

content in the band (0–33Hz)], Ener 2 [energy content in the band (66.7–100 Hz]/[energy content in the band (0–66.7 Hz)], correlation dimension factor (HRx-axis(k) vs HRy-axis(k+m)). They obtained mean accuracy (for diseases and normal) of 86 % [19].

Noh K et al conducted an experiment for the associative classifier (with multiple rules and pruning and biased confidence) to classify coronary artery disease from normal coronary arteries in total of 670 participants. For inputs they used: TP, VLF, LF, HF, LFnu, HFnu, LF/HF, SDNN [20].

Pecchia L et al designed and realized algorithm for recognising heart failure (HF) based on classification and regression tree (CART) method. For detection of HF they extracted more excerpts of 5 minute HRV. Each excerpt was classified as normal or abnormal basing on HRV features: SDNN, LF/HF, RMSSD. The subjects were considered as suffering from HF if more than 30 % of the excerpts were classified as abnormal. And they developed and trained several classification trees using LF/HF, TP and RMSSD to get diference betveen mild from severe HF. The patients were considered as suffering from severe HF if 40 % of the excerpts were classified as severe. The system developed achieved accuracy and a precision respectively of 96.39 % and 100.00 % in detecting HF and of 79.31 % and 82.35 % in distinguish severe versus mild HF [21].

Bilgin et al presented 32 new sub-bands of LF and HF that can be used for classification and evaluation of some diseases. They verified their findings with successful classification of ventricular tachyarrhythmia dataset by means of multilayer perception neural networks [22].

Hosseini GH et al made artificial neural network (ANN) classifiers for distiguising 6 diseases (premature ventricular contraction, paced beats, right bundle branch block, atria premature beat, fusion of paced and normal beats). They used 12 feature parameters of ECG for inputs in ANN: 12 ECG features: ST-segment area (STA), R-S interval (RSI), ST-slope (STS), R-T interval (RTI), QRS area (QRSA), Q-T interval (QTI), R-wave amplitude (RWA), heart beat rate (HBR), QRS energy (QRSE), mean of the power spectral density (MPSD), auto-correlation coefficient (ACC), and signal histogram (SH) and 13 compressed ECG sample parameters (52-sample interval centered at the QRS complex compressed with a compression ratio of 4). It had average classification accurasy of 93 % for all desaases [23].

Chazal P et al created algorithm of ANN automatic classification of normal beats, ventricular ectopic beat (VEB), supraventricular ectopic beat, fusion of a normal and a VEB, or unknown beat tipe. The best results of 79 % accuracy showed classifier with next inputs: pre-RR interval, post-RR interval, average RR-interval, local avg. RR-interval; QRS duration, T-wave duration, P-wave presence or absence, amplitude values of samples of ECG signal (for QRS segment – 10 samples, QRS-T wave segment – 9 samples) [24]. Two years latter they combined this type of classifier with certain local classifier (it involves adaptation stage in which previous classiffication of beats is validated and corrected if wrong output is determined, and then these corrected results are used for testing). This classifier

reached high accuracy of 95,7 % [25]. *Gonin JM et al* found correlation between corrected Q-T interval (Q-Tc) prolongation and presence and severity of cardiac autonomic neuropathy (CAN) in diabetic patients: 92 % (23 of 25) patients with a Q-Tc>433 ms had evidence of CAN [26].

We had intention to make an overview of TCM expert systems like it was done for classifying systems for neurocardiology. But, because of the lack of space, it was skipped. Traditional Chinese medicine represents wide area with great amount of expert knowledge and information. If someone wants to practice TCM he/she needs many years of learning old Chinese theoretical concepts and practical procedures. In other words, whole life dedication in TCM is preferred. Alternative solution is special systematization of TCM knowledge and making it available by means of information technologies.

5 Neurocardiac algorithms

Considering diversity of health issues and unique responses of every organism and personality on health conditions and medication, software should be oriented on personal healthcare approach. Technically, it means that it has to consist electronic questionnaire about patient health circumstances. In other words, it should help physician to get patient anamnesis. Beside general health information, electronic questionnaire needs to incorporate data about cardiological health issues, basic psycho-emotive state, habits like smoking, drinking, physical activities, taking medication and all factors that might affect autonomic nervous system (ANS) and cardiovascular system. In the same line, reasoning is leading to suggestion that it should have a certain subunit for evaluation of weather person is sympathetic, balanced or parasympathetic oriented from innate nature. So, there should be defined as much as possible precise markers and patterns of it in behavior and human character (hyperactive or phlegmatic manners). This may be important for distinguishing disturbed ANS from natural predomination and also for adjustment of therapy and recommendations for synchronization with native life rhythms (it could be also added as an option in software recommendation algorithm). Collected information should be than evaluated with prediction algorithm to give eventual predisposition for pathological development. These predisposition data are suitable for combination with clinical information in order to give notion of current health state and factors of risk for disease development and undesired events like stroke, heart failure, sudden death etc. Also, it might give evaluation of how much important factor is state of ANS in noncardiological diseases. It is necessary that software is user friendly and intuitive. For that purpose, there should be done certain observation of few experienced cardiologists during patient anamnesis. Thus, in that manner designed software could mimic physicians experience and methodology. It is possible to realise by using new “deep learning algorithm”. After that comes the challenge how this information technology can improve cardiologic examination.

Briefly, this software should enable advanced cardiac ANS expertise that is easy to use in any clinical environment. All the mentioned information could be formed, stored and transmitted wireless as a part of electronic cardiac health records. That is for a long time a worldwide trend in healthcare systems. From our research we derived two parallel algorithms for neurocardiac analysis that are congruent with TCM expert systems. They are conceptual frameworks for development of machines with ANN based classifications. In processing we are presenting resume of them.

Algorithm I

1. Initiatory inputs:
- basic information, family and personal disease history;
- marking and scoring of symptom/s.
2. Import of ECG data from ECG recorder.
3. Processing of ECG data:
    - Artifacts removal:

- automatic cleaning (filtering) and/or
- visual representation of signals.
    - Erratic rhythm removal (for autonomic predominance classification).
    - Extraction of time, frequent, nonlinear ECG features (Fourier transformation or Wavelet transformation).

2. Determination of health status:
    - increased/decreased HRV, loss of HRV complexity (SDNN or α1 and α2) → health/disease.

3. Multivariable scoring I – determination of disease class (cardiovascular, pulmonary, oncology, other, etc.):
    - Time domain parameters:

SDNN, rmssd, pNN50, pNNL10;
PR duration, QRS duration, QT duration, QTc duration, T-wave duration.
    - Frequency domain parameters:

LF, HF, VLF, LF/HF, TP, LFnu, HFnu, LFnu/HFnu;
    - Nonlinear parameters:

power-law slope (β), short-term scaling exponent (α1), intermediate scaling exponent (α2); HRT: turbulence onset (TO), turbulence slope (TS); CE: $H_c^{3,3}$; PPA: SD1, SD/SD2; SD: SDShannon, Forbword, wpsum2; STSD: arpf, ppf, plpf).
3. Multivariable scoring II - determination of disease with minimal combination of parameters that gives highest prognostic accuracy.
4. Risk stratification for myocardial infarction and sudden cardiac death.
5. Recommendation of therapy according to belonging to autonomic predominance group.

Algorithm II

1. Determination of type of ANS regulatory domination (using LFnu):

- sympathetic predominance,
- parasympathetic predominance.

2. Determination of autonomic patterns:
    - Level of autonomic predominance or/and ANS damage:

- 2, 4, 8, 16 and 3, 9 groups of ANS predominance (using LFnu)
    - Autonomic disturbance (related to disease):

- combination of LFnu and TP: 4, 16 groups,
- combination of other parameters: LFnu, TP, BRS, QRS, HR…: 4, 16, 32 groups.

3. Cardiovascular risk:
    - Summation of factors for cardiovascular risk: obesity, smoking, hypertension, lack of physical activities, pollution,
    - Evaluation of autonomic patterns for cardiac death (based on statistical significance and dependence of parameter combinations and ranges with mortality/survival).

4. Evaluation and recommendation of therapy:
    - *if/then* algorithmic rule

if part:
- previously determinate diagnosis,
- evaluated dependence of drug effect from autonomic patterns;

then part:
- recommendation of exact drug that has the best effect for each patient.
    - Inference engine:

- user interface (intuitive and fast representation of results and decision recommendations),
- learning machine (mimetic of cardiologist expertise),
- expert database (database of all drugs for each disease, indications, contraindications, dosages).

5 Conclusion

Analogies suggested in previous sections are signs that TCM and Neurocardiology have similar systematic approaches. It can further be confirmed by visual presentation and analysis of neurocardiac signals that it will be showed in our presentation for conference Speech and Language 2017. But, these are not just conceptual coincidences. It might have clinical and scientific significance in the sense of practical integrative approach of Neurocardiology and TCM. After recognizing mentioned analogies, more attention should be paid on anamnesis, especially to closely relate it with clinical results from ECG and HRV reports. Insights that physicians usually perceive as result of their intuition, practical experience and expertise, could be stored in electronic records and be easily available for any visit of patient for examination. That might probably enable possibility that physician, instead of several changes of therapy, give one precise

drug and advice to patient to get more rest, recreation, deep breathing, take mint tea in order to turn back to his/her natural autonomic patterns.

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Неурокардиолошка анамнеза: базирана на комплементарности са диференцијацијом синдрома у Традиционалној кинеској медицини – Кардиолози који током више година прегледају пацијенте помоћу ЕКГ мониторинг уређаја умеју стећи клиничко искуство из којег су понекад у могућности да процене тип аутономног нервног система (АНС) код пацијената, не само кроз преглед параметара ЕКГ-а, већ и пре тога: током уводног разговора са пацијентом, из њених/његових симптома, воље, расположења, гласовних гестикулација. Сви они се могу диференцирати у два типа: хиперактивне и флегматичне. Ови енергетски типове се често поклапају са симпатичком и парасимпатичком АНС предоминацијом, следствено. То је веома слично дијагностичким методама посматрања 望诊 (wàngzhěn) и ослушкивања 闻诊 (wénzhěn) у Традиционалној кинеској медицини (ТКМ). Из специфичних образаца у говору, језику, мимике лица, очију, гестикулације и историје пацијента, ТКМ лекари сачињавају тзв. синдром 证 (zhèng), уопштени клинички резултат здравственог стања;

укратко, у питању је карактеризација стања 气 (qì) код пацијента. Веома софистициран и комплексан zhèng је основа за успешну примену терапије. Након изналажења комплементарних аналогија екцеса/ дефицита јина и јанга са сАНС и пАНС предоминацијом/дисфункцијом и извлачења главних принципа ТКМ дијагностичких процедура, можемо их искористити за развој алгоритма неурокардиолошке анамнезе у форми простог експертског система. Његова сврха може да буде софтверска подршка кардиолозима у циљу добијања прегледног здравственог извештаја пацијента корисног у даљој АНС анализи и препоруци терапије. Другим речима, вршио би опонашање експертског знања искусног кардиолога. То може бити основа у Неурокардиологији за виши и плодотворнији персонализовани медицински приступ, који се с друге стране примењује већ вековима у ТКМ.