



Human biological rhythm in traditional Chinese medicine

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Received 20 July 2016; accepted 29 August 2016

Available online 8 February 2017

KEYWORDS

Biological rhythm;
Traditional Chinese
medicine;
Circadian rhythm;
Seasonal rhythm;
Annual rhythm

Abstract Traditional Chinese medicine (TCM) has a comprehensive and thorough understanding of biological rhythm. Biological rhythm is an inherent connotation of “harmony between human and nature”, one of the thoughts in TCM. TCM discusses emphatically circadian rhythm, syzygial rhythm and seasonal rhythm, and particularly circadian and seasonal rhythms. Theories of Yin Yang and Five Elements are the principles and methods, with which TCM understands biological rhythms. Based on theories in TCM, biological rhythm in essence is a continuous variation of the human body state synchronized with natural rhythms, and theories of Yin Yang and Five Elements are both language tools to describe this continuous variation and theoretical tools for its investigation and application. The understandings of biological rhythm in TCM can be applied to etiology, health care, disease control and treatment. Many understandings in TCM have been confirmed by modern research and clinical reports, but there are still some pending issues. TCM is distinguished for its holistic viewpoint on biological rhythms.

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Biological rhythm, the phenomenon of temporal rhythm observed in vital activities of living creatures, is an inherent function endowing them with the capability to adapt themselves to environment and often synchronized with natural rhythms. During recent decades, biological rhythm has become a focus under investigation. Along with

constantly deepened understanding of biological rhythm in modern medicine and biology, fruitful results have been achieved through a great deal of researches on rhythm from the individualized level to the molecular one, providing important references in respect of recognition of etiology and therapeutic idea for diseases, and promoting the progression of medicine powerfully.

Despite the absence of the term of biological rhythm, traditional Chinese medicine (TCM) theory elucidates profoundly the rhythmic phenomenon of human being, including circadian rhythm (daily rhythm) that has been

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Peer review under responsibility of Beijing University of Chinese Medicine.

studied most, as well as syzygial rhythm (lunar rhythm) and seasonal rhythm (annual rhythm), and has the developed theory to elucidate the rationale and application of biological rhythm. This work aims to elucidate the understanding of human biological rhythm in TCM, and provide probable materials and ideas for modern research.

Biological rhythm – the inherent connotation of the TCM thought of “harmony between human and nature”

The thought of “harmony between human and nature” is rooted in traditional Chinese philosophy and a conclusion about the relationship between people and the nature, highly generalized by ancient Chinese. In TCM, this thought is the logical basis for understanding human biology and pathology and contains three connotations. Firstly it is the isomorphism between human and nature, i.e., their compatibility on structure and composition. It was stated in *Keqi of Spiritual Pivot* that five Zang organs of human compatible with five musical scales of heaven, six Fu organs of human compatible with six tunes of heaven, 365 acupoints of human compatible with 365 days a year; knees and shoulders of human compatible with mountains on the land; axilla and popliteal spaces of human compatible with valleys on land; 12 meridians of man compatible with 12 rivers on the land, etc. Similarly, the rhythm of nature can be also observed in human body. Therefore, isomorphism between human and nature is a TCM explanation of the presence of biological rhythms. Secondly there are same virtues between human and nature, i.e., there are similar and comparable functions and phenomenon between human and nature. It was stated in *Tianyuanji Article of Plain Questions* that human has five Zang organs that can metabolize five Qi to generate happiness, anger, thoughts, sorrow and dread, just like the heaven has Five Elements that can drive Five Positions to generate coldness, heat, dryness, wetness and wind. Visceral manifestation theory in TCM is centered on the understanding of functions of heart, liver, spleen, lung and kidney of human body via natural phenomenon of generation, growth, metabolism, collection and storage, relating temporal factors like day, night and four seasons to biological and pathological variations. Same virtues between human and the heaven, therefore, are the main theoretical basis and main approaches in investigation on biological rhythms in TCM. Thirdly it is interaction between human and heaven, i.e., as the individual system of its own, human and nature are open but not closed, with mutual exchange of information and energy and mutual influences. It was stated in *Yinyangyingxiang Article of Plain Questions* that Heaven Qi is communicated to Lung, Earth Qi to throat, Wind Qi to Liver, Thunder Qi to Heart, Grain Qi to Spleen and Rain Qi to Kidney. It is also a prerequisite of explaining human pathological rhythms in TCM, as stated in *Zangqifashi Article of Plain Questions* that a patient with liver diseases feels fresh in the morning, but the disease tends to be aggravated in the evening and then relieved at midnight. It is also a basic foundation for TCM health care, as stated in *Siqitiaoshen Article of Plain Questions* that the sage cultivates his Yang during spring and summer and his Yin during autumn and winter. Interaction between human and heaven is the

theoretical foundation and approaches to apply biological rhythm to practice.

In summary, based on the point of views in TCM, biological rhythms are inherent biological functions analogous to natural rhythms, and can be intervened through some positive approaches.

Biological rhythms in TCM theory

Given the fact of harmony between human and the heaven, all rhythms in the nature should be found in human body! In fact, in comparison with modern medicine scrutinizing circadian rhythms but neglecting other rhythms, *Huangdi's Canon of Medicine* description about circadian rhythm, syzygial rhythm and seasonal rhythm is of great reference value in details.

Human circadian rhythm is embodied in the operation of *Ying Qi* and *Wei Qi*, as stated in *Yingweishenghui Article of Spiritual Pivot* that *Ying Qi* circulates within pulse and *Wei Qi* circulates out of pulse, and they circulate continuously, *Ying Qi* has the circulating rule of fifty cycles along the body within one day and one night, *Wei Qi* has the rule of circulating along yang (the external body) during daytime for 25 circles and yin (the internal body) during night for 25 circles, the circulation of *Wei-qi* dominates human sleeping/awake cycle. Moreover, it is put forward by *Shunqiyirifenweisishi Article of Spiritual Pivot* the rhythm division method imitating four seasons that one day is divided into four seasons with morning as the spring, noon as the summer, sunset as the fall and midnight as the winter. Similarly, human also has the biological rhythm that qi emerges in the morning, grows at the noon, declines in the evening and enters organs at midnight, which is analogous to seasonal rhythms with its significance listed as following.

Human syzygial rhythm is embodied in prosperity-decline variation of qi and blood. It is stated in *Bazhengshenming Article of Plain Questions* that accumulation of blood qi and circulation of *Wei Qi* start from crescent; at the full moon, blood qi are substantiated and muscles strengthened; at the wane, muscles and meridians are weakened, *Wei Qi* is gone and figure exists alone without essence. It is stated in *Suilu Article of Spiritual Pivot* that at the full moon sea water flushes to the west and human qi and blood are accumulated with strengthened muscles, tight skin, strong hair and compact texture, but at the wane sea water flushes to the east and human qi and blood are weak, with *Wei Qi* gone, figure alone (without essence), shrunk muscles, flabby skin, open texture, sparse hair and thin muscle texture. So phase of the moon is synchronized with the prosperity-decline of human blood and qi.

Human seasonal rhythms are the biological rhythm that is discussed most in *Huangdi's Canon of Medicine*, and is embodied in rotated duties of Five Zang organs. Liver is on duty in spring, heart in summer, lung in autumn and kidney in winter. Due to Five Zang organs taking turns to be on duty, pulse manifestation also shows periodical changes including pulse in spring like string, summer flood, autumn hair and winter stone; based on which human also show corresponding vulnerability to certain diseases. The rhythm that Five Zang organs take turn on duty is the most important idea concerning rhythm in TCM. It should be

pointed out that human seasonal rhythm contains a group of complex causalities, is fulfilled through highly orderly cooperation between multiple function of creatures, and is hard to understand if a single causality is isolated. That's probably why few modern biological researches aim at the seasonal rhythm.

Concerning human seasonal rhythm, there are many other patterns of rhythms in *Huangdi's Canon of Medicine* besides the rule of Five Zang taking turns to be on duty. For example, it is stated in *Zhenyaojingzhong Article of Plain Questions* that human qi is in liver at lunar month 1 and 2, in spleen at lunar month 3 and 4, at heart at lunar month 5 and 6, at lung at lunar month 7 and 8, at heart at lunar month 9 and 10, and at kidney at lunar month 11 and 12. It is stated in *Yinyangxiriyue Article of Spiritual Pivot* a rhythm model that twelve meridians in feet correspond to the 12 months. Moreover, besides the significant biological rhythms of day, month and year, 10-day rhythm is also recorded in *Huangdi's Canon of Medicine*. Despite fewer articles are for this rhythm, it can be applied to prognosis and evaluation of diseases.

Among all these three rhythms, circadian rhythm and seasonal rhythm are especially focused on by TCM, and discussion and application of Syzygial rhythm seem fewer.

Yin-yang and Five Elements are the theories and methods for investigation on biological rhythm in TCM

Yin-yang and Five Elements Theory, based on Theory of qi monism, is the most important theoretical utensil for TCM. Yin Yang and Five Elements Theory is still applied generally to understanding of the phenomena of biological rhythm.

Yin-yang is used in *Huangdi's Canon of Medicine* to understand circadian rhythm. It is stated in *Jinhuizhenyan Article of Plain Questions* that one day consists of day (yang) and night (yin), and the day and night could also be divided into two periods, yang and yin. The period from early morning to noon is "yang (the first half) of yang (day)", from noon to evening is "yin of yang", from evening to dawn is "yin of yin" and from dawn to early morning is "yang of yin". Four periods during one day and one night have their yin and yang features respectively. Instantly after yin and yang of a nature day is discussed, it is followed by a statement of "therefore human should comply with it". How should human being comply with the nature? It lies in yin yang profile endowed to Five Zang organs including heart as the Yang of Yang, lung as the Yin of Yang, kidney as Yin of Yin, liver as Yang of Yin, and spleen as the utmost Yin of Yin.

A certain correlation can be established between a period and an organ with the same features. Due to the similarity in locations and functions in subject of their own, human circadian rhythm can be divided into four stages including "yang of yin, to yang of yang, to yin of yang, and to yin of yin" also named as "Shaoyang, Taiyang, Taiyin and Shaoyin". We can utilize yin yang features to carry out research and applications.

Take the heart as the example, heart takes its turn on duty from early morning to noon. Research reveal that blood pressure and heart rate reach to the peaks during this

period in a day, and so does the incidence of heart diseases such as myocardial infarction, arrhythmia, angina pectoris and sudden cardiac death.¹ From the point of view in TCM, the whole body is in a state of "yang of yang" during the natural state of "yang of yang". Heart is the executor of this state, so the requirement on heart by body seems most urgent, cardiac burden rises to the highest point, and risks of exhausted heart qi seems the highest with the highest incidence of morbidity.

Taking turn on duty by "liver–heart–lung–kidney" is the essence of quartation of day–night rhythm, it can be inferred that lung diseases most likely occur on the afternoon with risk of aggravation and death; kidney diseases from evening to midnight, and liver diseases from midnight to sun rise. It has been confirmed that severe liver disease (including severe viral hepatitis, decompensated liver cirrhosis and hepatocellular carcinoma) has the highest mortality during the latter half of the night,² and the period from 15 to 19 o'clock (Shenyou Period) witnesses the highest death rate of lung cancer patient,³ which seems consistent with conclusion in TCM, reflecting the accuracy of understanding of biological circadian rhythm in TCM.

TCM uses mainly Five Element Theory to understand seasonal rhythm, and each season has its "Five-Element feature" of its own, such as spring corresponding to wood, summer to fire, long summer to soil, autumn to gold, and winter to water. Similarly, Five Zang organs also have their "Five-Element features" respectively, such as liver belonging to wood, heart to fire, spleen to earth, lung to metal and kidney to water. Therefore, human body appears a seasonal rhythm of rotating duty by "liver–heart–spleen–lung–kidney" similar to the natural rhythm, as stated in *Zangqifashi Article of Plain Questions* that liver dominates spring, heart summer, spleen long summer, lung autumn and kidney winter. Therefore, we can use Five Element Theory to investigate and apply human seasonal rhythm.

How can human seasonal rhythm be expressed? The accurate expression is variation in pulse manifestation. In *Yujizhenyao Article of Plain Questions*, a periodic variation of "spring pulse like string", "summer pulse like hook", "autumn pulse like floats" and "winter pulse like stone", which reflect the state of qi and blood, and therefore human blood and qi during four seasons also appear periodic variation.

Unfortunately, qi blood is hard to visualize, and activity of qi is difficult to normalize and standardize, so the biological seasonal rhythms are hard to represent with symbolic events. However, it does not mean that it is unknowable. Indeed the seasonal rhythms of onset of diseases can reflect from the side view the biological seasonal rhythms. For example, spring is the season of high incidence of depression. This can be elucidated based on syndrome differentiation of Zang-Fu organs, in that the syndrome differentiated in TCM is positioned at liver with a deficiency feature in the depression patient, spring belongs to wood and orders of genesis and growth dominate, then the whole body needs to enter "wood" state relying on the genesis and growth function of liver. Therefore, in the case of liver deficiency, body requirement can not be satisfied and exterior requirement may in turn aggravate exhaustion of liver qi, resulting in depression state with the failure of body's entry into "genesis and growth" rhythm.

Additional research have confirmed that incidence of liver cancer in spring is higher than that in other seasons.⁴ It can be inferred that rhythm of disease onset can be adopted as the indirect proof for presence of human biological rhythms. It should be noted that human rhythm of “liver–heart–spleen–lung–kidney” is absolutely not a sequential prosperity-decline cycle of a single organ in turn, but a rhythm with successive appearance of states of “wood–fire–soil–gold–water” in whole body, “a certain organ is on duty” is only a description because a specific organ is needed during a specific period to exert the function to accomplish the changes of rhythm.

In summary, the connotation of rhythm either circadian or seasonal is a continuous variation in functional state of human body during a day or a year. During a specific period human body may be in a specific state, and there should be transition and continuity between different stages. Theories of Yin Yang and Five Elements are both the language tools to describe the state and theoretical tools applied to investigation of the states. Five Zang organs play an important role in the conversion and realization of functional stages. If this connotation is understood, it is easy to comprehend the difference between dichotomy, quartation and five-equal partition, and it is the most reasonable method as long as it describes accurately the feature in that stage, just like multiple expressions are used for a same stage in *Huangdi's Canon of Medicine*, sometimes with Yin Yang and sometimes with Five Elements.

Destruction of biological rhythm is in the scope of etiology in TCM

Biological rhythm is one of human biological functions, and failure of fulfillment of this function may cause disease. It is stated in *Tiaojing Article of Plain Questions* that the genesis of evil is from yin (internal factors) or yang (external factors), that from yang is caused by wind, rain, cold and heat, while that from yin is caused by food, domicile, and extreme emotion like happiness and anger. It points out that food intake without abstention and regular time and non-regular daily lives are some reasons for genesis of disease evils, with the mechanism that abnormal intake and living habits destroy normal rhythms of human being, thereby causing imbalance between yin and yang, bias in Five Elements, and finally, the morbidity.

It is proved by research that destruction of biological rhythm may induce or accelerate onset of multiple diseases, broken wake-sleeping rhythm is an important factor inducing Alzheimer's disease,⁵ disturbance of circadian rhythm caused by light pollution during night or shift work may induce disorder in metabolism and therefore cause multiple diseases such as obesity, diabetes and metabolic syndromes,⁶ and is a risk factor for breast cancer.^{7,8} Moreover, the stability in human biological rhythm may decrease along with the increase in age.⁵ Still other research have confirmed that destroyed human rhythm is a factor that can not be ignored during the pathogenesis of cardiovascular diseases and chronic diseases such as cancers.⁹ Therefore, more and more attention is being paid to working patterns or systems contradicted to human rhythms in modern society, as one of pathogens. A new

round of revolution is being triggered in some of the fields to conform to human biological rhythms.

Modern medicine prioritizes the physical changes happening firstly and then inducing functional abnormality, and attributes the latter to the former, resulting in an explanation of diseases in a more and more microscopic point of view. On the contrary, TCM emphasizes the invisible destruction of functions inducing physical lesion and attributes physical alteration to disorder in human qi activity. Therefore, TCM adopts a comprehensive point-of-view of “time–space–human” to elucidate diseases, and thereby having much more advantages in understanding biological rhythms in a whole point of view.

Maintenance of biological rhythms is the important part in TCM health care

Biological rhythm is the biological function of human body, and it is considered in TCM that physical fitness with longevity can be realized as long as this function is maintained at the normal level. *Shanggutianzhen Article of Plain Questions* argues that ancients who knew the truth imitating yin yang and being consistent with the fluctuation of yin and yang, with good habit in food intake and living, without over working, so he could live his full span of one hundred years after termination of both figure and essence, and would not die until 100 years old. This article emphasizes especially the significance of good habit in food intake and living. It is recorded in *Shengqitongtian Article of Plain Questions* that stopping work in the twilight without disturbance of bones and muscles, avoid external evils as fog or dew, which can be adopted as commandment in maintenance of circadian rhythm. *Siqitiaoshen Article of Plain Questions* argues the guideline on living during four seasons, with spring as the example, one should sleep and gets up early, walk around within the park with hair disheveled to generate ambition. This also contains guidelines managing one's emotion.

The statement of “The alternation of day and night, and the circle of four seasons, are the laws that everything must obey, and the fundamental of life activity, the revolt against it should result in disasters, and obedience to it prevent from diseases” expresses emphasis on biological rhythm in TCM and its application, which is one of vital theories in TCM. Under the style of “future medicine”, new glories will be shined by the health care principle in TCM centered on maintaining biological rhythms.

The application of biological rhythm to treatments in TCM

In TCM treatment, the theory of biological rhythms is put into effect thoroughly. The usage of acupuncture emphasizes the “simulation of time”, the acupoint-selection principle is different in different seasons, Xing acupoints are taken in spring, Shu acupoints in summer, He acupoints in autumn and Jing acupoints and Shu acupoints in winter. That is the acupoint-selection principle based on seasonal rhythms.

It is stated in *Bazhengshenming Article of Plain Questions* that no reducing therapy should be used at the

crescent, no supplement at the full moon, and no treatment at the wane, which is an acupuncture principle based on Syzygial rhythm. The application of human biological rhythm is also embodied in method of acupoint selection according to theory of midnight-noon and ebb-flow.¹⁰

Attention is also paid to obedience to human rhythm when using TCM prescription. For example, it is stated in *Distinguish between Vomiting of Treatise on Cold-Induced Disease* that the truth is that emetic therapy is suitable for spring, that is to say, it yields twice the result with half the effort if emetic therapy is used to treat disease in obedience to the qi activities in spring. In modern medicine, biological rhythm has also been considered when a regimen is being established,¹¹ for example, treatment for high blood pressure based on the principle to re-establish circadian rhythm of blood pressure, and usage of chemotherapy for tumors based on rhythm of tumor growth. TCM is the pioneer in this regard.

Difficulties in understandings of biological rhythms in TCM

Still, some difficulties exist in understandings of biological rhythms in TCM. Firstly, there is no a unified pattern correlating time division to organs. In day–night division pattern of Tai Shao Yin Yang, spleen is not referred to but only liver, heart, lung and kidney, and there are two different patterns in seasonal division: that of four seasons and that of five seasons, corresponding to two different opinions in Five Organs Theory of that “spleen dominates last 18 days of four seasons” (spleen does not dominate a certain season) and of “spleen dominates the long summer”. Therefore, the effect of spleen in biological rhythm seems relatively vague.

Secondly, there are different concepts of disease rhythms in *Huangdi's Canon of Medicine*, and the applicable scope of various concepts and their accuracy seem inexact. There is an Article about “healing, aggravation, elimination and persistence” on five organ diseases in *Zangqifashi Article of Plain Questions*, take kidney as the example, “for the disease of kidney, healing is in spring; if not healed in spring, it aggravates in long summer; it is not eliminated in long summer, persists in hidden state during autumn, and ameliorates in winter”; “for kidney disease, it is relieved at midnight, aggravates during the hours of Chen, Xu, Chou and Wei (12 h timing method in ancient China), but persists on afternoon. For example, research have suggested that spring, summer and autumn are the seasons with high incidence of IgA nephropathy in Sichuan Province, with peak of average rate of admission is on June 12th while winter is the season with low incidence,¹² which is consistent with the description in TCM that kidney disease is severe during long summer and ameliorates in winter. However, the epidemiology of mortality in lung cancer reported by Wei Wang et al.³ seems not consistent with the statement in the *Zangqifashi Article of Plain Questions* that lung disease is eliminated in summer, ameliorates in autumn, ameliorates on afternoon and aggravates at noon, but consistent with corresponding theories stated in *Truth Theory of Golden Chamber*. Therefore, the different theories found in *Huangdi's Canon of Medicine* need further elucidation and clarification.

Moreover, the connotation of some rhythms remains unclear. For example, the rhythm of “ten days” is often used in *Huangdi's Canon of Medicine* to anticipate the outcome of the disease. However, the ten-day rhythm has no support from more adequate materials except for the statement in *Yinyangxiriyue Article of Spiritual Pivot* that ten fingers corresponding to ten days, and the essence and biological manifestation of ten-day rhythm remain unknown.

Summary and expectation

Based on these analysis, we can make a summary that in the point of view in TCM, the essence of biological rhythm is a continuous variation in human body synchronized with natural rhythms. The difference in TCM theory compared with modern medicine is that biological rhythm in TCM refers to the rhythm observed in the whole human body, and any isolated phenomena in rhythm is just a silhouette of the integrated rhythm of whole human body, either in the individual level or in the molecular level. It is like that spring, summer, autumn and winter are all a part of the rhythm of nature, and the prosperity and decline of trees are just a detail. The detail can reflect the ensemble but can not replace the ensemble. TCM focuses on the ensemble, which is similar to the recent viewpoint that the peripheral tissue has its spontaneous rhythm and forms a web with central oscillator, achieving the regulation upon biological rhythms.¹³ The fore-said circadian rhythm in operation of *ying qi* is a part of integrated circadian rhythm of human. Moreover, TCM emphasizes the regulation on rhythm centered on Five Zang organs, which realize regulation on human rhythms through qi transformation, representing a culture difference compared with western understanding as “central oscillator” and “guidance by SCN”.

Biological rhythm is an appropriate window for TCM and biomedicine to see each other. In researches in future, the understandings of biological rhythms in TCM will be tested due to the development in modern medicine. The connotation in TCM theory will be elucidated along with the progression in science. Meanwhile, the understandings in TCM help broaden the ideas in modern research, and contribute to the new breakthroughs in studying the essence of biological rhythms.

Conflict of interest

The authors declare that there is no conflict of interest.

Acknowledgment

This work is supported by a grant from National Science Foundation of China (No. 81574098).

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