Review Article

Academician Kai-Xian Chen Talks about the Development of Traditional Chinese Medicine and Global Medicine

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Abstract

Following the spirit of Central Committee about the Opinions on Promoting the Inheritance, Innovation, and Development of Traditional Chinese Medicine, Academician Chen Kai-Xian, from Shanghai University of Traditional Chinese Medicine, made a wonderful report on the development of traditional Chinese medicine (TCM) and global medicine. The report deeply elaborated on five aspects: the characteristics and advantages of TCM, the challenges faced by contemporary medicine, the status and role of TCM in the contemporary era, the inheritance and innovation of TCM, and the cooperation and development of “Belt and Road.”

Keywords: “Belt and Road”, characteristics and advantages of TCM, contemporary medicine, global medicine, inheritance and innovation of TCM, TCM, traditional chinese medicine

Introduction

On October 26, 2019, the Central Committee of the Communist Party of China and the State Council issued the Opinions on Promoting the Inheritance, Innovation, and Development of Traditional Chinese Medicine, which called for the effective inheritance, development, and utilization of the precious wealth left by our ancestors to us. Academician Kai-Xian Chen, from Shanghai University of Traditional Chinese Medicine, followed the spirit of Central Committee and made a wonderful theme report on the development of traditional Chinese medicine (TCM) and world medicine. The report deeply elaborated on five aspects: the characteristics and advantages of TCM, the challenges faced by contemporary medicine, the status and role of TCM in the contemporary era, the inheritance and innovation of TCM, and the cooperation and development of “Belt and Road.”

Characteristics and Advantages of Traditional Chinese Medicine

Academician Chen Kai-Xian pointed out that there are two different medical systems in contemporary society. One is a modern medical system that originated in the West and has a history of thousands of years. These two medical systems have different ways of thinking, theoretical systems, and medical models.

In the past several thousand years, TCM has made an indelible contribution to the healthcare of the Chinese nation. Huangdi’s Internal Classic in the Qin and Han Dynasties laid the theoretical foundation of TCM; Treatise on Cold Damage Diseases established the principle of syndrome differentiation and treatment of TCM; Shennong’s Classic of Materia Medica established the foundation of Chinese Materia Medica. During the Tang and Song Dynasties, TCM began to take shape. During the Tang Dynasty, Newly Revised Materia Medica was the first Pharmacopeia issued by the government; Essential Recipes for Emergent Use Worth A Thousand Gold promoted traditional medical system that has originated in the East and has a history of thousands of years. These two medical systems have different ways of thinking, theoretical systems, and medical models.

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the development of clinical medicine. In the Song Dynasty, Prescriptions of the Bureau of Taiping People’s Welfare Pharmacy promoted the development of clinical prescription medicine. During the Jin and Yuan Dynasties, the academic debates of the four medical schools promoted the development of clinical medicine. The Ming and Qing Dynasties were the heyday of the development of TCM. Compendium of Materia Medica promoted the great development of TCM; Standards for Diagnosis and Treatment and Jing-Yue’s Complete Works promoted the systematization of TCM; Detailed Analysis of Epidemic Warm Diseases and Correcting the Errors in the Forest of Medicine have formed a new academic thought and development; Medical Department Full Record and Ancient and Modern Book Integration have gathered the research of medical literature; The Five Kinds of Chinese and Western Medicine Communication is the bud of Chinese and western medical thoughts communication. These works have gathered the essence of the minds of countless great TCM practitioners and still play an important role until now.

“The world’s first” created by traditional Chinese medicine

Hua Tuo (about 145–208) in the late Eastern Han Dynasty

He performed laparotomy after anesthesia with “MaFei Powder,” which became the earliest record of surgical treatment with general anesthesia in the history of medical science in the world.

Ge Hong (283–363) in the Jin Dynasty

The treatment of goiter with seaweed in the Handbook of Prescriptions for Emergency is the world’s first thyroid disease treatment with iodine-containing food; the brain tissue of mad dog was used to treat rabies bites by external application, which created the application of immunotherapy for rabies. In the West, it was not until 1885 that Pasteur of France used rabies vaccine for the first time in humans.

Sun Simiao (about 560–682) in the Tang Dynasty

The technique rectifying the dislocation of the mandibular joint in Essential Recipes for Emergent Use Worth A Thousand Gold is similar to the manual reduction of modern western medicine; Chinese onion tube was used for urinary catheterization to treat urinary retention, which was over 1200 years earlier than rubber tube catheterization in 1860 invented by French.

Wei Yilin (1277–1347) during the Jin and Yuan Dynasties

Effective Formulae Handed Down for Generations made a significant contribution to the development of the traumatology. He proposed a suspension reduction method for spinal fractures, which was over 600 years earlier than the suspension reduction method proposed by British medical scientist Daris in 1927.

The invention of human pox vaccination began during the Longqing Regime Period of Ming Dynasty (1567–1572) and was widely promoted in the 17th century. In the early Qing Dynasty, Zhang Lu reviewed the various vaccination methods, such as pox liquid, drought seeding, and pox cloths in Zhang’s Medical Collection. It is a major contribution to the artificial specific immunity method. In the middle of the 18th century, vaccination against human pox was spreading from all over Europe and Asia. In 1796, the Englishman E. Jenner was inspired by the experiment and tried to breed cowpox. Thus, the French enlightenment thinker Voltaire in the 18th century wrote: “I have heard that the Chinese have always had this habit for more than 100 years. This is considered to be the great precedents and role models of the most intelligent and polite nationality of the world.”

The emergence and development of modern western medicine

The medieval period and the time before that was the founding period of western medicine. During the time when Hippocrates lived, who was honored as the “Father of Medicine” by the West, he laid the fundamental thinking for later study of physiopathology and anatomy by his Hippocratic Corpus. Then, in ancient Roman times, the medical scientist Galen has written On the Anatomy Process and On the Function of Body Organs to study the physiological function on the basis of human anatomy.

After the Renaissance, western medicine entered a rising period. The founder of modern human anatomy, Vesari, through his book Human Tectonic, established the human anatomy discipline. After Vesari, the famous 17th-century British physiologist and doctor, Harvey found blood circulation, which helped life sciences become more scientific. The Morgagni, Giovanni Battista (1682–1771) established pathological anatomy, which opened the way for studying the biological causes of diseases. In the 19th century, diagnostics and surgery developed rapidly, and drug synthesis began to rise.

Until the 21st century, western medicine has ushered in its booming period, with the emergence of gene therapy, embryonic stem cell therapy, a large number of synthetic and natural extractions of new drugs, nanotherapy technology, and other disciplines and technologies. The development of modern western medicine has made a significant contribution to human health. Modern medicine has made many valuable new discoveries due to the use of scientific research and analysis methods.

Disciplinary characteristics of Chinese and western medicine

Overall, TCM emerged in the era of empirical medicine, focusing on the whole, but has insufficient analytical methods; modern medicine emerged in the era of experimental medicine, with the advantages of analytical methods, but its overall synthesis is insufficient.

Comparing the eastern medicine and the western medicine, TCM is “holism” and “plain systematology,” whose theoretical source is the compound medical model of the Chinese philosophical thinking of “harmony of man with nature,” which belongs to the multiple thinking of nonlinear philosophy; while the western medicine inclines to the mechanical reductionism, which stems from the pure biomedical model.
of its “physical–chemical” response, which belongs to the unit thinking of linear science.

The holism of TCM is embodied in the spiritual level, the whole level, and the dynamic level of life, attaching great importance to the common pathogenic role of the patient’s constitution and the psychological, social, and environmental factors; however, western medicine regards the human body as a combination of tissues and organs, attaching great importance to the pathogenic role of biological factors.

TCM uses accumulation of experience and analogy reasoning to induce syndrome types through syndrome representation reasoning during patient visits; western medicine emphasizes experimental evidence and finds abnormal biomarkers or image changes through physicochemical and imaging examinations.

TCM emphasizes the whole and the interconnection of multiple factors, such as focusing on dialectical thinking; treating sick people, syndrome differentiation, and treatment; and paying attention to the doctor’s experience and the overall change and individual heterogeneity of patients, and is also good at comprehensive consideration of problems from the perspective of transection; western medicine prefers form and local medicine, emphasizing direct cause and effect, analyzing the disease, and treating diseases, paying attention to the changes in the etiology, pathophysiology, and local structure and function of lesions and group evidence, and paying attention to the vertical occurrence and development and evolution of the disease.

In the Chinese Materia Medica and formula of TCM, a variety of effective components exert a comprehensive regulatory effects on the body in a multi-system, multi-pathway, and multi-target manner to achieve the purpose of disease elimination and health preservation. While western medicine mostly emphasizes the effect of a single-active compound on the body’s target, the drugs used are usually highly selective and obviously antagonistic.

TCM attaches importance to the overall efficacy, and the mechanism explanation is rich in philosophical thinking. The quantitative evaluation of curative effect is difficult, with a lack of repeatability and less basic research, resulting in many cases that the disease can be cured but not be explained. While western medicine attaches importance to the direct effect, the components, targets, and pathways are relatively clear. The treatment method is easy to be quantifiably evaluated, repeated, and popularized, and the basic research develops rapidly. Many diseases have clear etiology but still lack effective treatment methods.

**Challenges in Contemporary Medicine**

**Major contemporary health challenges**

**The first challenge – Severe infectious disease**

The greatest threat to human health and life in history has been severe infectious disease, which has caused great disaster to humanity. Apart from war, natural disasters, and political factors, great changes in population in history also relate to the prevalence of the plague. In the middle of the last century, humanity has made great achievements in combating severe infectious diseases, such as plague, smallpox, and diphtheria, which have been gradually controlled. The discovery of antibiotics has increased the average human life expectancy by at least a decade. In today’s society, although new infectious diseases continue to occur, in general, the threat of infectious diseases to human society has also been greatly reduced. The health revolution of humanity for the first time got a big victory, which is the great progress of human civilization.

**The second challenge – Noncommunicable chronic diseases**

The current global health challenges facing humanity are mainly noncommunicable chronic diseases (NCDs), including complex disease with no defined pathogens and caused by multiple factors, disease with multiple genes, multiple-target pathways (e.g., tumors and neurodegenerative diseases), and other diseases affecting multiple tissues or cell (e.g., diabetes and immune disorders). These diseases involve multiple genes, multiple-target pathways, and network regulation, so traditional, single-target-specific approaches have been difficult to adapt to the study of therapeutic drugs. The challenges brought by these complex diseases indicate that contemporary medicine needs to move from analysis to synthesis, from narrowing the cause to looking at the whole, from single target to network regulation. Clinically, effective drugs usually exert their pharmacodynamic properties by modulating multiple-target proteins rather than only acting on a single target; multiple diseases can share the same target, more than 40% of targets appear in multiple diseases, and drugs with a molecular weight of 300 Da can combine with more than 10 proteins on average. All these facts show that the drug-target mode of action is not simply attributed to a “one-to-one” relationship, but rather to a “one-to-many, many-to-one” complex nonlinear regulatory mode.

**The predicament facing the contemporary medical model**

In the 21st century, medicine is undergoing major changes. As early as the 1990s, it was stated that modern medicine “has entered a new era characterized by personalized medicine” (R. McIntire, ALEA Lecture, 1992). Pressure for fundamental change in contemporary healthcare models comes from two sides:

One is the obstruction of the second sanitary revolution aimed at conquering NCDs such as cardiovascular and cerebrovascular diseases and cancer, which inspired people’s reflection on the modern medical model, biological (therapeutic) medicine. A study conducted an epidemiological survey, which was about the large sample of pathogenic factors of the top 10 diseases with mortality ranking. The subjects of the survey were people over 1 year old in the United States. The results showed that: for the occurrence of NCD, the role of life style and behavior is far greater than biological factors. Take heart disease, cancer, and cerebrovascular disease as an example, and the results are shown in Table 1.
In the 1990s, a global survey conducted by the World Health Organization showed that lifestyle plays a leading role in people's health and life span, as shown in Table 2.

Clearly, the effective control of NCD requires a fundamental change in the medical model, that is, from biomedicine to a new medical model (human medicine) that combines physiological, psychological, social, and environmental factors.

Second, the global medical crisis caused by the vicious expansion of medical expenses has forced people to deeply reflect on the goal of medicine (GOM) and the core value of medicine. In 1992, WHO organized the GOM International Research Group, which in November 1996 clearly stated in its final report that “the current development of medicine is to make an unjust medicine that people cannot afford in the world” and “many countries have now reached the brink of availability in medicine.” Take the United States as an example, which is the most developed economy, with the most advanced technology, and the highest per capita health investment in the world: from 1950 to 1976, per capita medical expenses rose by 302.6% (in constant dollars), while the average life expectancy did not increase significantly; from 1980 to 1990, medical expenses rose from 1.2% to 11.5% GDP; from 1992 to 2002, US medical expenses doubled and then expected to be doubled again in 2002–2012 (GAO, USA); in 2004, US medical expenses accounted for 15% of GDP, which was approximately equivalent to national defense expenditures and social insurance.

“The root cause of this looming crisis is that the GOM, not the means, is wrong.” And, “The wrong medical goal necessarily leads to the misuse of medical knowledge and technology,” “which is especially the case when considering that medical services can be highly profitable.” To solve this global medical crisis, it is necessary to radically adjust the GOM and shift the strategic priority of medical development from “the pursuit of high technology for the purpose of curing diseases” to “the prevention of diseases and injuries and the maintenance and promotion of health.” Only the medicine, with the primary aim of “preventing disease and promoting health,” “is the affordable and therefore sustainable medicine,” and “is likely to be ‘fair’ and ‘just’ medicine.” (GOM International Study Group General Report, 1996, 11).

### Status and Function of Traditional Chinese Medicine in Contemporary Period

In response to the huge challenges faced by the development of modern medicine, the status and role of TCM in the contemporary world are increasingly receiving attention and attention from the medical community in various countries. In general, TCM will play an important role in the following three areas:

**Exploring life sciences**

The 19th and 20th centuries is the century of physics that explores the scientific laws of the physical world. During this period, two major scientific achievements, relativity and quantum mechanics, laid the scientific and technological foundation of modern industrialization and information society. The 21st century is the century of life science that explores the mystery of life and human itself.

In the middle of the 20th century, a landmark and epoch-making important discovery, namely the discovery of the double helix structure of nucleic acids, gradually moved the life science to the center of the whole scientific field. Life sciences have developed very rapidly since the 1980s and 1990s, and their achievements have become the most exciting achievements in the scientific field. The sequencing of the human genome, the application of genetic engineering, and a deeper understanding of many human life phenomena have been constantly widening our horizon. In the 21st century, the development of modern science turns to a deeper understanding of the phenomena of life and the mysteries of the human body itself. Life science has become the most important field in the whole process of scientific development. TCM is long-lasting and new. Many of its ideas, theories, and practices can bring profound inspiration to the frontier research of contemporary life sciences.

**Systematic biomedicine: A bridge between traditional medicine and modern science and technology**

System biomedicine is an important direction for the development of contemporary medicine. TCM has profound system theory and effective comprehensive methods (such as holistic concepts, syndrome differentiation, and treatment, meridian, and viscera theory). Through systems’ biology methods (such as genomics, proteomics, metabolomics, and transcriptomics) as a bridge, it can effectively promote the development of systematic biomedicine. The studies on characteristics of TCM kidney yang deficiency syndrome and

| Factors                        | Ratio (%) | Effect             |
|--------------------------------|-----------|--------------------|
| Lifestyle and behavior         | 60        | Played a leading role |
| Environmental factors          | 17        | Followed by        |
| Genetic factors                | 15        |                    |
| Medical service conditions     | 8         |                    |

### Table 1: Results of a large sample epidemiological survey of risk factors for heart disease, cancer, and cerebrovascular disease (population over 1 year old, USA)

| Proportion                          | Heart disease (%) | Cancer (%) | Cerebrovascular disease (%) |
|-------------------------------------|-------------------|------------|-----------------------------|
| Biological factors (including heredity) | 25                | 29         | 21                          |
| Lifestyle and behavior              | 54                | 37         | 50                          |
| Environmental factors               | 9                 | 24         | 22                          |

### Table 2: Influence of different factors on health and life span - A survey from World Health Organization in the 1990s

In the 1990s, a global survey conducted by the World Health Organization showed that lifestyle plays a leading role in people's health and life span, as shown in Table 2.
the Chinese Materia Medica *Herba Cistanches* interfering with kidney yang deficiency syndrome are the good examples.

**Chemical biology**

The discovery of the mechanism of berberine regulating blood lipids was based on the active ingredient in Chinese Materia Medica *Rhizoma Coptidis*, berberine, as a probe, revealing a new regulatory pathway for regulating blood lipids in humans. The research results were published in *Nature Medicine*.[2]

**Stem cell research**

For example, evidence was found that warming kidney yang drugs promote stem cell proliferation and migration. Icariin promotes the proliferation of neural stem cells and synergizes with epidermal growth factor and fibroblast growth factor to promote proliferation. The total flavonoids of epimedium promote the medial migration of proliferating cells from stem cells in the lateral region of the adrenal cortex.[2]

**Addressing contemporary global health challenges**

In the second health revolution, the progress of western medicine was not ideal and did not make a major breakthrough as quickly and effectively as one would hope to cope with infectious diseases. The incidence of chronic diseases is rising rapidly and alarmingly. Chen Zhu has pointed out that if there is no effective control, China will experience a serious situation of chronic disease “breaking out” in the next 30 years. Chronic diseases are difficult to treat and have become a major threat to health and life. At present, the death rate of chronic diseases in China accounts for 70%-80% of the major death diseases in different regions; by 2030, the mortality of chronic diseases in China will reach 85.9%.

These diseases involve multiple genes, multiple-target pathways, and network regulation. The medical pattern with the goal of “treating diseases” is not sufficient to curb the trend of the spread of chronic diseases; the treatment idea with the guidance of “reductionism” and for a single target is not sufficient to overcome the complex diseases caused by multiple factors. TCM not only has made great contributions to human health but also enriches the development of modern medicine. For example:

1. Effects of and dredging interior and purgation method on the emergency of abdominal surgery
2. Efficacy of prescription for promoting blood circulation by removing blood stasis on ischemic cardio–cerebrovascular disease and peripheral vascular disease
3. Combination of TCM reinforcing healthy Qi and modern cancer therapy in the treatment of cancer
4. Elucidation of the principle of acupuncture-assisted anesthesia and acupuncture analgesia
5. Innovation of medical concept of orthopedics and trauma diseases in integrated TCM and western medicine
6. Study on burn and detoxification with TCM
7. Theoretical study on viscera, Qi, and blood and the Eight Principles
8. Study on pharmacodynamic mechanism of Chinese Materia Medica and its compound

9. Various innovations in experimental methodology, etc.
10. A number of achievements have been made in the research of new TCMs: Since the implementation of the Measures for the Approval of New Drugs in 1985, more than 1000 varieties of TCMs have been researched and developed, such as artemisinin, a new antimalarial drug, and As$_2$O$_3$ for the treatment of acute promyelocytic leukemia (APL).

Here are some typical examples.

**Study on promoting blood circulation by removing blood stasis**

Academician Chen Keji carried out the study on the secondary prevention of cardiovascular disease by Xuezhikang and the related study on the prevention of restenosis after coronary intervention using the recipe for promoting blood circulation by removing blood stasis. It is the first time since the founding of the People’s Republic of China to conduct a large-scale, prospective, multicenter, double-blind, randomized controlled study in the Eastern population using the international evidence-based medicine method. For the first time, Xuezhikang’s evidence-based medicine research has proved that the efficacy of TCM can stand the test. At the same time, a large number of studies on Xuezhikang have been carried out in Norway, the United States, Singapore and Chinese Taiwan, all of which have achieved good results. Xuezhikang is not only praised by Chinese doctors but also recognized by overseas experts.

**Treatment of leukemia with As$_2$O$_3$**

Prof. Zhang Tingdong and Academician Chen Zhu carried out the clinical and basic research on the treatment of leukemia with As$_2$O$_3$ and made a major breakthrough, which has become the most representative model for the treatment of APL in the world by the Chinese oncology community and the gold standard protocol for the treatment of APL in the world, and As$_2$O$_3$ has been widely used to treat relapsed APL in the world.

**Artemisinin – A new antimalarial drug discovered from Chinese herbal medicine**

*Artemisia annua* was first recorded in the *Elbow Reserve Emergency Formula* for the treatment of malaria; Prof. Tu Youyou successfully extracted antimalarial active ingredient artemisinin according to that record,[3] and through the cooperation of many scientific and technical workers, he developed a new antimalarial drug of artemisinin and won the Nobel Prize in Physiology or Medicine in 2015.

**Fuzheng Huayu Recipe – An antiliver fibrosis drug based on Chinese herbal compound**

Prof. Liu Ping, from Shanghai University of Traditional Chinese Medicine, led the team to carry out the research of TCM compound in treating liver fibrosis.[4,5].

- Prescription: *Salvia miltiorrhiza, Semen Persicae, Cordyceps mycelium*, etc.
- Action: promoting blood circulation to remove blood stasis, nourishing essence, and nourishing liver
- Indications: Chronic hepatitis B liver fibrosis
- Some active ingredients/components of the compound
have been found: salvianolic acid B, amygdalin, and *Cordyceps sinensis* fraction A.

- Salvianolic acid B down-regulates the type I collagen gene expression of cells by inhibiting TGF-beta/SMADS intracellular signal transduction in hepatic stellate cells.
- Study on the clinical effects of Fuzheng Huayu Recipe: effects on liver fibrosis in chronic hepatitis B
- Phase II clinical study: multicenter, randomized, double-blind, positive control 222 cases
- Efficacy assessment: liver tissue punctures before and after treatment
- Fibrosis markers in serum (HA, LN, PIIP, IV-C)
- Results
  - Reversal rate of fibrosis: 58.3%.
  - Effects on liver fibrosis in cirrhosis: improving liver fibrosis, liver function, and immune function.

Fuzheng Huayu tablets have launched a Phase II clinical study in the United States, and the results confirm the safety and effectiveness of the medicine. This is the first Chinese medicine for liver disease approved by the Food and Drug Administration (FDA) to carry out Phase II clinical trials in the United States. The results were reported at the American International Conference on Liver Diseases, which attracted the attention of peer experts. Prof. Hassanein of the University of California, San Diego, said that the study not only yielded important results but also marked a milestone in the development of Chinese–Western communication in the United States.

**Combined treatment of Chinese and western medicine significantly prolonged the median survival of lung cancer**

Prof. Liu Jiaxiang, from Longhua Hospital of Shanghai University of Traditional Chinese Medicine, led the team to carry out “Demonstration Study of Integrated Traditional Chinese and Western Medicine for Advanced Non-Small Cell Lung Cancer.” The results showed that integrated TCM and western medicine in the treatment of patients with advanced lung cancer prolonged median survival time of 5.27 months compared with chemotherapy alone, of which patients with lung adenocarcinoma could prolong by 8.67 months. Moreover, the cost of treatment is substantially lower than the cost of current cancer targeted therapy.

**Promoting the transformation of contemporary medical model**

TCM can promote the transformation of contemporary medical model: from treating diseases to preventive treatment of diseases, from allopathic medicine to collaborative medicine, and from local medicine to holistic medicine.

**Preventive treatment of disease**

TCM has a very deep thinking on the purpose and mode of medicine, such as the quotation from *Inner Canon of Huangdi·uangd Questions*: “The sage prevents patients from being sick before they get sick and settles the chaos before it breaks out.” The supreme concept of “preventive treatment of disease” in Chinese traditional medicine embodies the core value of medical purpose adjustment and medical model transformation.

**Collaborative medicine**

In modern medicine, diseases exist as enemies of human life and health, and the two are conquering and being conquered relationships, hence the name Allopathic Medicine. The patient’s body and mind are the “battlefield” of confrontation as the remnants of war, medical, or drug-induced diseases are inevitable. In TCM, human life, health, disease, etc., are the results of physical and mental adjustment and internal and external environment interaction. The role of medicine or doctor is to act as a “natural assistant” to improve and enhance the function of the human body and mind system. Disease elimination is the natural result of the improvement of whole functions. Therefore, the risk of medical or drug-induced diseases is expected to be reduced.

In line with the change of core concept (from “treating disease” to “preventive treatment of disease”), the overall thinking of disease prevention and treatment is bound to shift from confrontation to synergy, that is, from allopathic medicine to collaborative (balanced) medicine.

**Holistic medicine**

That is, medicine from analysis to synthesis, from reductionism to holism. For the contemporary health problems, modern medical thinking must be adjusted with systematic thinking. In such cases, the overall, multi-target, multi-level role and regulation of TCM show important value and significance. TCM provides the core idea and theoretical basis for the establishment of a new medical model combining physiology–psychology–society–environment.

At the end of the 20th century, the then French President Mitterrand invited 75 Nobel laureates to gather in Paris on the theme of “Challenges and Hopes of the 21st Century” and issued the *Paris Declaration* after the meeting. “A good doctor should be a doctor who makes people not sick, not a doctor who can cure the disease;” and “Medicine should be a science not only about diseases but also about health.” This is exactly the modern global version of “superior doctors to prevent disease” advocated by Chinese philosophers, 2000 years ago. Obviously, the medicine of “preventive treatment of disease” is exactly “the science of health,” which requires the integration of natural science and humanities.

**“Preventive treatment of disease” guides the development of health medicine**

Lifestyle, behavior, and nutrition become important factors affecting health. Health services and healthcare are becoming increasingly important for maintaining health. “Preventive treatment of disease” – the identification and intervention process of health status: first, identify the health status through instruments and equipment, identification index system,
data information software, etc.; then conduct quantitative assessment; perform onset, transition, recurrence risk warning, whole-process monitoring, and dynamic analysis; finally, intervene through food, medication, lifestyle, and TCM healthcare exercises.

**Inheritance and Innovation of Traditional Chinese Medicine**

**Trends in traditional Chinese medicine research**
In recent years, TCM research has gradually shown some new trends: research topics have increasingly attached importance to follow the concept of translational medicine, and the research process has increasingly emphasized the adoption and adherence to standard norms. On the whole, there are three characteristics worth noting:

- In-depth research, quantification, and systematization.

**Study on the progress and achievements of traditional Chinese medicine heritage innovation and mechanism of action of Chinese herbal formula**

Case 1 – Study on the mechanism of APL treated by Chinese herbal formula compound Huangdai tablets.\(^6\)

This is an exemplary study carried out by Academician Chen Zhu. Huangdai tablet is composed of Realgar, Radix Salvia miltiorrhiza, and Indigo naturalis. A large scale of clinical trials has proved it effective, and the treatment effect was recognized internationally. Its major active components are tetraarsenic tetrarsulfide (A), indirubin (I), and tanshinone IIA (T). Orthogonal design is the main method of experimental design model. Three compounds are in one group, and eight compatibility groups are selected because this is the easiest way to clarify the compatibility. At the same time, the combination index method was used to analyze the interaction of each component. The experiment was comprehensively observed at the level of “integral–organ–cell–molecular–gene” using internationally recognized methods and indicators:

- Animal integrity – Mouse model (10 iv, 50 ig, 50 ig mg/kg)
- Organ – Liver index, spleen index
- Cells – Three cell lines NB4, NB4-R2, and leukemia cells
- Gene – PML-RARa fusion protein represents the expression of leukemogenic genes
- Molecule – The molecular pathogenesis links and regulatory mechanisms were clear, and about 50 kinds of regulatory factors and metabolic markers involved were measured.

Case 2 – Intestinal flora – An important target for traditional Chinese herbs. The intestinal flora system repair in the human body caused by Chinese herbal medicine plays a great role in the recovery of host pathological conditions.

**Study on drug metabolism of Chinese Materia Medica**
Pharmacokinetics is a subject that reveals the characteristics of the process of drug changes in vivo from four aspects: absorption, distribution, metabolism, and excretion, as well as the study of related mechanisms. The research on the metabolism of Chinese Materia Medica is mainly divided into three directions: to prove and ensure the effectiveness of Chinese Materia Medica; to reveal the scientific connotation of the characteristics of Chinese Materia Medica such as formula compatibility, medicinal properties of Chinese Materia Medica, and processing of Chinese Materia Medica; and to develop modern new Chinese medicinals.

TCM holds the view that “drugs have the specialty of property, and prescriptions have the wonderful use of compatibility.” The compatibility of prescriptions is not only the superposition of the efficacy of a single herb but may also produce greater pharmacodynamic effects than simple superposition through the synergy between single herbs. The processing can not only change the medicinal properties of Chinese Materia Medica but also reduce the toxic side effects of Chinese Materia Medica, making them cleaner and more usable.

The study of pharmacokinetics of Chinese Materia Medica is very complicated and difficult. In recent years, many new methods, techniques, and strategies have been explored and developed to promote the development of drug metabolism in Chinese Materia Medica. For example, the use of liquid chromatography-electrolyte effect plus gradient chromatography technology can improve the detectability of liquid-mass spectrometry analysis of trace Chinese Materia Medica substances in complex biological samples and improve the usability of the analytical method in multi-component pharmacokinetic studies of Chinese Materia Medica.\(^7-9\)

**Study on the nature of meridian and acupuncture effect**

Through continuous exploration, the study on the nature of meridians and collaterals and acupuncture effects has achieved some new progress and founding, which can be roughly divided into the following four categories: School of Neurophysiology – the theory of nerve conduction, School of Physiology and Biochemistry – the theory of body fluid circulation, Holistic Gap School – the theory of fascial connective tissue, and School of Biophysics – biological field theory.

**Example: Discovering the phenomenon of transmission in loose connective tissue and its structural basis**
According to the transmission phenomenon in some loose connective tissue, the anatomical structure characteristics of its tissues and organs are studied by means of modern imaging and characterization, and at the same time, the coupling relationship between structure and function is clarified. The research results showed that in addition to the vascular circulation system composed of blood vessels and lymphatic vessels in animals, there is also a long-range transmission phenomenon of fluid in fibrous connective tissues throughout the body.

**Research on informatization and intellectualization of “Four Diagnostic Methods” in traditional Chinese medicine**
Physical condition is determined in TCM mainly by the
information obtained by inspection, listening and smelling, inquiry, as well as pulse-taking and palpation. The modernization of techniques of TCM physical condition identification has realized the objectification, digitization, and standardization of TCM syndrome differentiation and laid a foundation for the development of health service industry. Physical condition is identified through a large-sample database (including data of TCM, mathematics, bioinformatics, tissue engineering, and computer science), comprehensive detection system of TCM four diagnostic methods, portable equipment (such as acquisition system of tongue and pulse information), and wearable equipment (such as TCM health bracelet) for dynamical regulations of health risks.

The informatization and intellectualization research of TCM four diagnostic methods overcome the technical difficulties of quantity–effect evaluation of color constancy model of face and tongue and of information collecting of face and tongue diagnosis from special light source to common light source. For example, quantity–effect evaluation of color constancy model of face and tongue (the dynamic vector model of tongue image feature - the vector changes of signals of tongue image features before and after the intervention - technology transfer and industrialization) and the acquisition and analysis of information by observation and tongue inspection based on machine vision are used to carry out the research on the identification and evaluation of the physical condition of TCM features for the application of TCM health services, with the use of data mining and decision support algorithm. The key technology of nanoflexible material sensor enables the breakthrough of pulse diagnosis sensor from single-point to multi-point and to array technology. Moreover, the combination with visualization and audio technology makes the acquisition environment friendlier.

On the basis of overcoming key technologies, a series of four TCM diagnostic instruments have been gradually developed:

1. Tongue image acquisition terminal: industry-leading light source environment system (standardization: spectrum closest to natural light, color rendering index ≥92%; intellectualization: intelligent correction of light source environment); rich tongue image parameters (more than 500 kinds of quantification parameters of RGB, HSV, LAB color, and spatial and tongue image feature); advanced image intelligent algorithm (comprehensive use of in-depth learning and significance detection technology for intelligent analysis of 25 tongue image features)

2. Pulse acquisition terminal: leading high-precision sensor in the industry, rich pulse diagram, and parameters (48 analysis parameters, such as parameters of optimal pulse diagram, P-H trend diagram, and pulse force); authoritative analysis algorithm (using time–frequency domain, cepstrum, and other algorithms to achieve accurate interpretation of eight elements).

**Study on traditional Chinese medicine syndrome differentiation of human body in Mars500 long-term closed environment**

From June 3, 2010, to November 4, 2011, “Simulated Manned Flight Test of Mars 500,” organized by the Institute of Biomedical Problems of the Russian Academy of Sciences, was the first and longest test of fully simulated human-crewed Martian flight and landing ground simulation in human history, which lasts 520 days. China also participated in the 106 projects involving more than 40 countries, and “TCM Syndrome Differentiation of Human Body in Mars500 Long-term Closed Environment” is one of them.

Research methods: 6 volunteers (including 1 Chinese volunteer), all male, aged from 26 to 38 years; information collection period of four diagnostic methods: a total of 37 times of data collection, 1 time of data collection 3 days before entering the cabin, and once in every 2 weeks after entering the cabin (a total of 35 times), and 1 time of data collection on the 2nd day after leaving the cabin. The study obtained a large amount of data on the physical condition of astronauts in a long-term confined environment. The results of the study were collated and reported at the International Astronautical Conference and attracted attention from all sides.

**Information system of physical condition identification went from Shanghai to Milan**

At the Milan International Fair, a health information identification system of TCM was displayed. This system realizes dynamic and constant monitoring of physical condition and transmission of health data. It also identifies and evaluates individual physical condition according to the independently developed human physical condition identification function and provides personalized health services.

**Innovative development of traditional Chinese medicine toward “precise medicine”**

Precise medicine focuses on two major issues: “precise diagnosis” and “precise treatment”

**Precise diagnosis**

Precise medicine requires to realize highly personalized disease syndrome classification and disease staging. Accurate diagnosis should have the characteristics of traditional Chinese medicine. We need to think about how to transform the concept of molecular typing and molecular staging in modern medicine into syndrome typing and syndrome staging in TCM diagnosis. Efforts should be made to explore and establish biomarkers with the characteristics and advantages of traditional Chinese medicine. Finally, it makes the dialectics of traditional Chinese medicine from the current macro dialectics to the combination of macro dialectics and micro dialectics. At the same time, the determination of TCM syndrome gradually moves from subjective experience judgment to objectification, refinement and moderate quantification.

**Precise treatment**

To achieve accurate treatment, traditional Chinese medicine needs to strengthen one of its advantages, that is, different treatment for the same disease, the same treatment for different diseases, treatment varying from person to person and treatment varying from disease courses. We should strive
to explore the model of disease syndrome combination and develop personalized comprehensive programs for different physical types, climate, environment and lifestyle. It is necessary to strengthen the precise research and application of traditional Chinese medicine, especially compound medicine.

**Study on biological markers of traditional Chinese medicine syndrome efficacy**

The effects of TCM were realized usually in a multicomponent manner acting on multiple targets and are characterized by the comprehensive changes, which are different from the single efficacy index of modern medicine. The curative effects of TCM are comprehensive, which often result from the accumulation of the scores of patients’ symptoms and physical signs. At present, some symptoms of TCM syndrome efficacy are often lack of specificity. Their biological basis is not clear, and the index is not sensitive enough, therefore it is difficult to carry out precise medication, resulting in the treatment results difficult to be recognized. Therefore, it is necessary to develop biological markers for TCM syndrome efficacy. Urine, blood (neuro-endocrine-immune network), and other changes involving a large number of endogenous substances may fully reflect the overall state of patients and present the body’s comprehensive health or disease state, which, in some cases, is expected to be used as syndrome efficacy indicators or biomarkers and is worthy of exploration.

**Case 1: Study on kidney essence and kidney yang deficiency syndrome**

For the first time, Academician Shen Ziyin confirmed the specific material basis of kidney yang deficiency syndrome internationally with modern scientific methods. In the 1950s, he pioneered the study of kidney yang, which is also called “fire of the life gate” in TCM and found that patients with kidney yang deficiency had significantly lower values of urinary 17-hydroxycorticosteroid that could return to normal after treatment with kidney-tonifying herbs. The results were repeated and recognized by several research institutes in China and Japan. This suggests that urinary 17-hydroxycorticosteroids may serve as a biomarker for kidney yang deficiency syndrome.

**Case 2: Syndrome efficacy marker of chronic hepatitis B**

According to TCM syndrome differentiation, chronic hepatitis B patients can be divided into different syndromes: dampness-heat in the liver and gallbladder syndrome, stagnation of liver Qi and deficiency in the spleen syndrome, yin deficiency of the liver and kidney syndrome, as well as insidious syndrome. Through metabolome, genome, and transcriptome studies, researchers, from Institute of Liver Diseases, Shanghai University of Traditional Chinese Medicine, found a variety of marker substances and differential expression profiles that can be used to diagnose and evaluate the syndromes and also established biological markers that can basically and accurately identify and predict the TCM syndromes of chronic hepatitis B, which can guide precise syndrome differentiation and precise treatment of chronic hepatitis B patients.

**Vigorously strengthening the research of new drugs of traditional Chinese medicine**

Mr. Zhao Yuhuang (1883–1960), a senior scientist of China Academy of Chinese Medical Sciences, became one of the four researchers in the former Institute of Chemistry of Shanghai Academy of Central Studies in 1929. In more than 5 years, he had carried out a series of studies on herbolgy and pharmacognosy and compiled and published the *New Collections of Herbals*. He used to work in Peking University School of Medicine and Institute of Traditional Chinese Medicine, Ministry of Health. Academician Lou Zhichen evaluated Zhao Yuhuang’s *Modern Herbology and Pharmacognosy* as the earliest pharmacognosy work in China. Pharmacologist Zhang Changshao respectfully addressed Zhao Yuhuang as the pharmacognosist who contributed most to China. In 1953, he wrote and published *New Annotation of Herbals* of more than 380,000 words, which systematically introduced 78 important works of Materia Medica in China. He has collected more than 80 reliable books and nearly 1000 rare editions on Materia Medica of all generations, and his family donated all to the Institute of Traditional Chinese Medicine according to his will.

Mr. Zhao believes that Chinese Materia Medica is like the unmined mineral resources in China, which should be excavated and improved by modern scientific methods. “The drugs recorded in *Compendium of Materia Medica* contain many undiscovered chemical components, and with the advancement of science in the future, it can be predicted that a *Compendium of Materia Medica* will become the experimental field of pharmaceutical scholars in the world.” (general idea).

**Key directions of modernization of Chinese Materia Medica**

In the past decades, the research on the modernization of Chinese Materia Medica has achieved remarkable results. At present, in response to the urgent needs and major issues facing the modernization of Chinese Materia Medica, the following six key research directions need to be strengthened:

- Conservation and sustainable utilization of Chinese Materia Medica resources: resource survey, research and improvement of genuine regional drugs, protection of endangered and rare medicinal materials, planting of commonly used Chinese medicinal materials, sustainable utilization of Chinese Materia Medica resources (for medicine and health care)
- Study on the material basis and mechanism of Chinese Materia Medica: systems biology and network pharmacology study (biomarkers), drug metabolism process internally (serum pharmacology, intestinal microbiota)
- Study on standardization and quality control technology of Chinese Materia Medica: modernization and internationalization of quality standards, modernization of quality control technology (fingerprint, gene coding), safety evaluation
Research on new compound drugs: research on compound drugs for major diseases, identification and efficacy correlation – evaluation technology of effective component groups, quantitative design and optimization of effective component groups, quality control and metabolism research

Efficacy evaluation and clinical research of new drugs: study on the evaluation system and research of evidence-based medicine

Research on the modernization of industry technology of Chinese Materia Medica: study on the economic and efficient preparation technology and research on the modernization of Chinese Materia Medica preparations.

**“Belt and Road” Cooperative Development**

**Historical trends of medical development**

From the aspect of history, the formation and development of medicine has gone through the era of empirical medicine and experimental medicine, and is now moving towards the era of holistic medicine (system medicine). The model of medicine also experienced the model of theism medicine - the model of natural philosophy medicine - the model of mechanistic medicine - the model of biomedicine, and now, it is going to biological–psychological–social–environment–engineering medical model. This is the historical trend of medical development.

**Trends in contemporary science and medicine**

Trends in contemporary science and medicine show the following very significant features:

1. Equal attention is paid to the whole and the part, the synthesis and the analysis, and the experience and the experiment
2. The transition from the era of experimental medicine to the era of holistic medicine:

The object of medicine has expanded from disease to paying more attention to and maintaining health. Under the guidance of this concept, the goals of medicine are also gradually moving toward the 3P: prevention, prediction, and personalization.

**Traditional medicine going to the world: An inevitable trend in the development of contemporary medicine**

In the face of contemporary health challenges, it is an inevitable trend for the development of contemporary medicine that traditional medicine will go global. Dr. Joseph, a leading British expert in the History of Science, pointed out that, “It is unfair to say that there are no quantitative data in Chinese medical works. In fact, Chinese medical books, like certain western works, have quantitative data… It is difficult to assume that a medical treatment that many people have experienced over the years has only a purely psychological effect, but no physiological or pathological basis.” Former Director-General of the WHO, Margaret Chan Fung Fu-Chun also emphasized, “Traditional medical culture is a treasure of China and it needs to be carried forward.”

**Internationalization of traditional Chinese medicine**

In recent years, the internationalization of TCM has been accelerating:

- In 2009, the World Health Assembly passed a resolution on traditional medicine (WHA62.13)
- In June 2014, the WHO developed traditional medicine strategy (2014–2023)
- In August 2015, the WHO held the International Forum on Traditional Medicine in Macau with the theme “Integrating Traditional Medicine into the Mainstream Medical System”
- In May 2019, the WHO officially included traditional medicine in the International Classification of Diseases (ICD-11)
- At present, 183 countries and regions have been using TCM; China has signed 86 intergovernmental agreements on TCM cooperation with other countries; 17 overseas TCM centers have been established; 11 TCM Confucius institutes have been established; there are 150,000 TCM institutions with nearly 1 million practitioners.

**Current situation of acupuncture and moxibustion dissemination abroad**

Application and promotion of acupuncture in various countries are shown in Table 3.

There are more than 50,000 relevant institutions of acupuncture and more than 100,000 moxibustion employees overseas, as shown in Table 4.

All the above data show that medical globalization of resource allocation based on modern medicine and complemented by traditional medicine has become the general trend.

**“Belt and Road” cooperation**

With the implementation of the *Vision and Action for Promoting the Co-construction of the Silk Road Economic Belt and the 21st Century Maritime Silk Road*, the exchange and cooperation with the countries along the “Belt and Road” initiative in the field of TCM (including ethnic medicine) are continuously strengthened and create a new pattern of comprehensive opening of TCM.

The National Administration of Traditional Chinese Medicine and the National Development and Reform Commission issued the Development Plan for the “Belt and Road” for Traditional Chinese Medicine (2016–2020) in December 2016. There are five major tasks: (1) policy communication – improving the inter-governmental exchange and cooperation mechanism, (2) resource exchange – sharing TCM services with countries along the line, (3) people connection – strengthening talent exchange with countries along the line, (4) sharing science and technology – promoting the inheritance and innovation of TCM, as well as (5) unimpeded trade – developing the TCM health service industry.

It is believed that with the in-depth implementation of the “Belt and Road” cooperation initiative, the internationalization of TCM will continue to advance, make due contributions to meet the health challenges faced by contemporary humanity, and improve the health and well-being of people around the world!
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