



# Tu Youyou winning the Nobel Prize: Ethical research on the value and safety of traditional Chinese medicine

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## Abstract

In 2015, the Chinese pharmacologist, Tu Youyou, was awarded the Nobel Prize for Physiology or Medicine for the discovery of artemisinin. Traditional Chinese medicine (TCM) was the source of inspiration for Tu's discovery and provides an opportunity for the world to know more about TCM as a source of medical knowledge and practice. In this article, the value of TCM is evaluated from an ethical perspective. The characteristics of 'jian, bian, yan, lian' are explored in the way they promote accessibility and economic efficiency for TCM. The article also examines how the increased use and prevalence of TCM reflects the scientific, cultural, and ethical values of TCM and their increasing attraction in meeting major challenges to medicine and health systems currently and in the future. The article discusses safety issues within TCM, which is a controversial area, and also comments on some shortcomings and challenges which pose difficulties for more widespread and greater uptake of TCM-derived clinical or therapeutic interventions. The article concludes that TCM is generally safe if it is used according to TCM theory and where such applications are cognizant of the strengths and weaknesses of TCM. TCM has important bioethical values which may inform potential measures for meeting challenges facing global health care systems and the article argues that it can have an increasing role in improving human health.

## KEYWORDS

Chinese traditional medicine, ethical value, Nobel Prize for Physiology or Medicine, safety, Tu Youyou

## 1 | GENERAL INTRODUCTION

The Chinese pharmacologist, Tu Youyou, was awarded the 2015 Nobel Prize for Physiology or Medicine for the discovery of artemisinin. The main contribution, which led to the award for Tu Youyou, was the 'discovery of artemisinin, a drug which can significantly reduce the mortality rate of patients suffering from malaria, in addition to its unprecedented therapeutic effect in severe malaria treatment.'<sup>1</sup> A speech, 'Discovery of artemisinin – a gift from traditional Chinese medicine to the world' was delivered by Tu at the Karolinska Institute on December 7, 2015, in which she introduced the discovery process of

artemisinin and how it was inspired by traditional Chinese medicine (TCM). The discovery process was a result of the combination of TCM and modern Western medicine in matching scientific analysis with historical treatises containing TCM treatments and observations on therapeutic uses. Tu Youyou's award provides us, especially researchers of TCM, an opportune time to further rethink the value of TCM and the societal, cultural, and ethical issues for TCM, to make the best use of it for continuing improvements in human health care.

## 2 | TCM'S VALUE AND SCIENTIFIC, CULTURAL, AND ETHICAL ISSUES

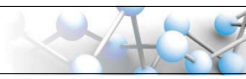
TCM, also called Chinese medicine, on a theoretical basis, originates and is derived from the Chinese philosophical principles of Yin and

<sup>1</sup>Wang, J., Liu, Z., & Wu, Y. (2015). A new window opened by Tu Youyou. *People's Daily*, 10(6), 4.

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Yang, five elements, and the relationship between man and the universe. 'Looking, listening, questioning, and feeling the pulse' are the four diagnostic methods of TCM, which aim to determine the cause, the character, the location, and the pathogenetic type of a disease. After diagnosis, therapeutic approaches are chosen for patients based on the principle of syndrome differentiation. The therapeutic approaches utilized by TCM include, for example, Chinese herbology, acupuncture, manipulation, massage, cupping, scraping, qigong, Chinese dietary therapy, and musicotherapy, amongst others.

## 2.1 | Tu Youyou discovers artemisinin with the assistance of TCM literature

In the early 1960s, a strain of malaria emerged worldwide which had high resistance to existing antimalarial drugs, such as chloroquine and quinine. In 1967, the Chinese government launched the 523 Project to work on antimalarial drug research, aiming to discover new antimalarial drugs. In 1969, Tu Youyou officially joined the 523 Project, and was appointed as the team leader. Tu reviewed classical TCM literature with the aim of finding antimalarial herbs or prescriptions. She finally discovered that the extractive from *Artemisia apiacea* had a significant antimalarial effect, with a high inhibition rate (60–80%) in mice with malaria. At that time, it was difficult to ascertain the therapeutic effect of extractive from *Artemisia apiacea* as a potent antimalaria drug because of varying outcomes.

In 1971, Tu was inspired by one sentence in *Zhou Hou Bei Ji Fan*, a handbook of TCM prescriptions for emergencies. It stated that '[Patients were asked to] steep a hold of *Artemisia* in 2 litres of water, twist the *Artemisia*, take the juice and drink it up.' Tu then realized that the application of high temperature during the extraction process may cause damage to the active ingredients of *Artemisia*. That was the reason that Tu chose to use ether instead of ethanol for extraction, because ether has a lower boiling point. After doing this, she found the extractive from *Artemisia* achieved a satisfactory antimalarial effect in 100% of the mouse and monkey models. After subsequent clinical trials and further studies, Tu and her colleagues discovered a new antimalarial drug, artemisinin, for clinical use.<sup>2</sup>

Tu's success in developing this treatment comes from two key points: the first is that *Artemisia* was correctly chosen as a potential source for treatment, and the second was the selection of ether, which has a low boiling point, being used for extraction. However, both of these points were only discovered by Tu's analysis of classical TCM literature. Tu was correct in her approach in retrospect, by being able to draw on the extensive herbal knowledge contained in the texts, and the exposition of how treatment should proceed, which gave her insight into the negative impact on treatment that might be caused by the application of high temperatures during the extraction process. This combination of drawing on TCM knowledge and history and modern medicine's scientific methods and clinical approach continues to

**TABLE 1** The increase of TCM hospitals, practitioners and beds in China

Year	Number of TCM hospitals	Number of TCM practitioners	Number of TCM beds
1957	257	337,022	5,684
1980	678	262,185	49,977
2000	2,654	417,037	27,1231
2013	3,590	801,408	68,6793

TCM, traditional Chinese medicine. Data from Ministry of Public Health of China and Bureau of TCM of China.

serve as inspiration for the identification of other novel treatments and therapies that might be found through analysis of TCM literature.

## 2.2 | Characters of jian, bian, yan, and lian in TCM

TCM is increasingly popular in China, as shown in Table 1. This may be due to the four key characteristics of TCM which are 'jian', 'bian', 'yan', and 'lian'.

'Jian' means simple. Here it refers to the observation that TCM practitioners can make a diagnosis at any time and place just by use of the four classical methods mentioned before: 'looking, listening, questioning, and feeling the pulse'. The process of diagnosis rarely depends on complicated medical equipment or costly procedures.

'Bian' means convenience, reflecting the accessibility and availability of Chinese herbal medicine. TCM advocates making the best use of local materials for diagnosis and treatment. Local plants, animals, minerals, and other resources can all be used as drugs. Furthermore, the processing techniques used in Chinese herbal medicine are also convenient and cheap from an economic perspective. This is different from Western medicine, which normally requires expensive or complex chemical equipment and where development and production of drugs and treatments have high costs. In addition, TCM therapies such as acupuncture, scraping, cupping, and traction are convenient in terms of ease in deploying them as clinical treatments, and generally have no side effects when utilized correctly.

'Yan' means validation. TCM has a reliable and significant documented history of more than 2,000 years. There is a large amount of solid evidence, from literature and practice, which supports the validation and efficacy of diagnosis and treatments prescribed within TCM. A large number of classical and empirical prescriptions recorded in classical TCM literatures are still used today with clinical effectiveness in TCM settings across China.

'Lian' means cheap; it means that the materials TCM uses are usually inexpensive. Animals, plants, and minerals used in Chinese herbal medicine are normally affordable for patients.

The characteristics associated with jian, bian, yan, and lian are focused on demonstrating and reflecting the availability and economics of TCM, from the perspective of patients, practitioners, and society. We suggest that both the availability and economics of TCM are important bioethical issues for modern medicine, given the array of challenges facing global health care, such as increased costs and

<sup>2</sup>Tu, Y. Countless injustice and suffering on the way of artemisinin discovery. <http://news.hexun.com/2015-10-15/179845070.html>.



restricted availability of health care for individuals globally. The ways in which TCM deals with these issues are key drivers in the expansion and growing popularity of TCM in China and potentially globally.

### 2.3 | The valid curative effect of TCM

TCM has faced serious challenges and questions, regarding its efficacy and approaches, from Western medicine since the early 20th century, and these persist today. Proposals to abolish TCM arose many times in China as there were proposals to supplant TCM with Western medical science and practices. However, TCM has gained an important role in Chinese health care, due to its demonstrated efficacy, its economic benefits, and as a viable alternative to treating diseases and conditions. Coexistence between TCM and modern medical practices is now the established norm in China. This coexistence and the benefits of it are captured in Chairman Jinping Xi's statement, made in 2014, which stated that:

TCM embodies the profound philosophical wisdom and the health preservation concept and practice in Chinese people for thousands of years. It is the great treasure from Chinese ancient science, and the key to the treasure house of Chinese civilization. In-depth studies and scientific summary of TCM is of vital significance in promoting global health development and life science research.

There are more and more TCM studies demonstrating the curative effects of TCM, which further reinforce and support the value of TCM and its coexistence with modern medicine. For example, in the treatment of leukemia, Zhang Tingdong et al. used TCM as their research starting point and then combined the advantages of both Chinese medicine and Western medicine, to develop an innovative leukemia arsenic therapy. This therapy increased the clinical cure rate of acute promyelocytic leukemia to 91% by use of an arsenic trioxide injection.<sup>3</sup> Another example is the use of TCM in cancer treatment: research has shown TCM can effectively control the development of tumors and improve patients' tolerance during surgery, radiation, and chemotherapy treatment. When TCM is used as an adjuvant treatment to Western medicine, it enhances the attenuation effect in achieving long-term survival rates for patients and allowing a better quality of life. This is seen especially in middle- to late- stage cancer patients, unable to achieve positive therapy outcomes with standardized Western treatment or when they are not suitable for surgery, where TCM treatment can be used to prolong their survival time, decrease the size of the tumor, improve their symptoms, or indeed, in some instances, cause remission.<sup>4</sup> TCM is

<sup>3</sup>Shikui, C. (2017) Integrative research of Chinese and Western medicine initiated in China and its inspiration(9)\_\_. Professor Zhang Tingdong and other traditional Chinese medicines in the treatment of acute promyelocytic leukemia. *Chinese Journal of Integrative Medicine*, 37(11), 1292-1296.

<sup>4</sup>Wang, S. (2013) The anti-cancer experience of Wang Sanhu. *The Fourth Military Medical University Press*, 4, 7.

therefore considered to be the fourth therapy for cancer treatment in China alongside surgery, radiotherapy, and chemotherapy.

In infectious disease treatment, TCM is used in AIDS treatment, which can greatly improve the quality of patients' life and prolong their survival. TCM has more significant impact on the patient's quality of life when patients and the virus coexist.<sup>5</sup> Compared to modern medicine, TCM showed a superior curative effect in the treatment of infectious disease during the SARS epidemic in 2003. The death rate in mainland China was 7%, which was far less than the world mortality level of 11%, as a result of the use of TCM in conjunction with modern medical treatments.<sup>6</sup> TCM is also being used for treatment of heart and cerebrovascular disease. One of the problems in the management of coronary heart disease patients is restenosis after stent placement. Chen Keji, an academician of Chinese Academy of Sciences, used Chinese herbal medicine to make a drug, xiongshao, which can reduce the rate of restenosis and angina by 50%, and reduce the incidence of 'final events' by 49%.<sup>7</sup>

### 2.4 | The scientific nature of TCM

TCM is an ancient science of China, and is different from modern science. However, in recent years, research on the scientific basis of TCM has achieved a number of satisfactory results.

Syndrome differentiation treatment is the core of TCM's theory. 'Zheng' in TCM, also called 'zhenghou', means 'syndrome', and is the central concept of the theory; it is an essential reflection of the cause, position, and nature of disease in a stage of its development. It is believed that syndrome is expressed in the pulse, tongue, shape, color, facial, and other related symptoms presented by patients. For a considerable time, Chinese medical scientists unanimously agreed on the existence of 'zheng' but were unable to expound on its scientific basis. In recent years, with the development and the application of genomics and metabonomics to TCM, its scientific basis has been partially revealed.

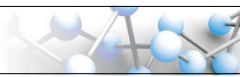
Genomics studies at the level of the whole genome to clarify the location and structure of genes, the function of the gene products, and the relationship between genes. Yang Huanmin, an academician of the China Engineering Academy, points out that the process of TCM syndrome differentiation treatment is similar to that of genomics, and that the research method of studying the human genome possesses a lot of similarities with the concept of holism and differentiation within TCM.<sup>8</sup> According to research focused on studying the curative effect of Yuping-feng powder on Qi deficiency syndrome, the decoction of the herbal medicine illustrated the presence of many active tiny genes, which can complement and repair the damaged or faulty genes of the human body

<sup>5</sup>Liu, J., Hou, Z. (2009). TCM in the World. *Beijing Science and Technology Press*, 9, 247.

<sup>6</sup>Jinsheng, L., & Zemin, H. (2009) *Traditional Chinese medicine in the world: The path to Chinese medicine in the 60 years since the founding of the PRC*. Beijing: Beijing Science and Technology Press.

<sup>7</sup>Li, E. (2011) To make the overall life quality and satisfaction of patients as the two main pursuits of medicine. *Chinese Medical Ethics*, 24, 3.

<sup>8</sup>Yang, H. (2008) Genomics – an entry point of TCM modernization. *Medicine World*, 8, 5–7.



to treat the deficiency syndrome of fatigue and cold etc. This research also suggested that TCM can treat human disease by gene repair.<sup>9</sup>

Metabonomics aims to determine the physiological and pathological state of organisms, through an analysis of the comprehensive changes of low-molecular metabolites after stimulation. There are several studies which have confirmed its similarity to the concepts of TCM's syndrome.<sup>10</sup> For example, research done by Tao Xiumei observed the animal model of kidney-yang deficiency and urine metabolites of chronic renal failure patients and chronic cardiac failure patients with kidney-yang deficiency, showing a significant rise in the tyrosine content and significant changes in metabolites. The same two changes were found: oleic acid decreases and tyrosine increases. The research preliminarily concluded that the kidney-yang deficiency syndrome mainly leads to tyrosine increase and metabolic disorders.<sup>11</sup>

Research by Yan Bei studied metabonomics characterization and identification of a myocardial ischemia rat model with stagnation of the heart blood and deficiency of both Qi and Yin, and found that the common characteristic of these two kinds of myocardial ischemia syndrome is that they are related to abnormalities of energy metabolism, oxidation of emergency response, amino acid metabolism, and other metabolic pathways. The relationship is caused by the changes and interactions of overall system function, but the two syndromes have different metabolic characteristics. These studies indicate that the theory of TCM syndrome and metabonomics have a kind of consistency, which provides a scientific proof for the existence of TCM syndrome.

## 2.5 | Worldwide recognition and popularization of TCM

TCM has been recognized and promoted by the World Health Organization and other international organizations. Since the 1970s, the WHO and United Nations Educational Scientific and Cultural Organization (UNESCO) have recommended more than 40 methods of acupuncture therapy for disease treatment. In 1987, the World Federation of Acupuncture-Moxibustion Societies was founded, and acupuncture terms were formulated and approved, and codified into a set of international standards. Since the 1990s, TCM cooperation centers have been founded by the WHO in Beijing, Shanghai, Hong Kong, Macau and elsewhere. In 2008, the WHO congress on traditional medicine approved the Beijing Declaration, in which it was proposed that traditional medicine, its treatment and practical knowledge, and its sustainable and indispensable natural resources should be maintained and protected, and the safety, efficacy, and reliability of traditional medicine practice should be guaranteed. Governments in countries around the world have the responsibility of ensuring citizens' health, therefore,

<sup>9</sup>Lin, X. (2015). 'Black box': Mechanism of Chinese traditional medicine in genetic decoding. *China's Traditional Chinese Medicine*, 11(6), 1.

<sup>10</sup>Zhao, S., Wang, P.-C., Feng, J., Chen, Z.-L., Wang, Q.-H., & Kuang, H.-X. (2015) Metabonomics technology and its application in the research of traditional Chinese medicine. *Chinese Herbal Medicine*, 46(5), 756–761.

<sup>11</sup>Tao, X. (2009). *Metabolomics research on the model and symptom of kidney-yang deficiency*. Shanghai: Shanghai Jiaotong University, p. 105.

traditional medicine should be treated as a part of a national comprehensive health care system; national policies, norms, and standards should be regulated to ensure the safety and efficacy of traditional medicine.<sup>12</sup>

Furthermore, TCM has spread to the United States, the U.K., and elsewhere in the world. Since the 1970s, the influence of TCM has gradually expanded to more than 140 countries across the world. The spread of TCM in the United States and the U.K. is representative of the manner in which TCM has expanded in use internationally. In the United States, at the beginning of the 1970s, James Reston, a journalist with the New York Times, introduced acupuncture to America by reflecting on his own experience of appendicitis treated by acupuncture therapy.<sup>13</sup> At that time, the U.S. government did not allow acupuncture and refused to issue medical licenses to practitioners. As such, traditional Chinese physicians were forbidden from practicing.

Through a long-term endeavour to highlight and test the clinical effects of TCM, the U.S. government finally published a medical policy report in 2002, in which the value of complementary and alternative medicine was affirmed, and TCM was recognized as an independent medical system and its legitimacy was established. In the U.K., TCM experienced a slow development before 1980 and rapidly expanded thereafter. Nowadays, the particular curative effects of TCM and its advantages have been accepted by British people. The number of Chinese medicine clinics has increased, since 2000, from a very small number located in London's Chinatown to their presence all over the U.K.<sup>14</sup> In recent years, TCM has been included in mainstream medical systems and medical insurance provision in some states in the United States along with Australia and Switzerland.

However, the spread and acceptance of TCM internationally is not problem-free. In Europe, for instance, the European Union formally implemented Instructions on Registration of Traditional Herbal Drugs in 2011, which created a dilemma for the import and sale of Chinese herbal medicines and Chinese patent medicines. It also made TCM practitioners face the problem of illegitimacy and proof as to efficacy. However, it is expected that the award of the Nobel Prize to Tu Youyou will provide further opportunities to promote and support the development of TCM in Europe.<sup>15</sup>

## 3 | SAFETY AND OTHER KEY ETHICAL ISSUES OF TCM

### 3.1 | TCM safety

TCM arose in ancient China and its limitations and problems have been well-documented internally and externally by TCM practitioners, Chinese society, and Western medicine. The safety of TCM has been an issue of increasing concern in recent years, especially as TCM has

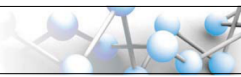
<sup>12</sup>Liu & Hou, *op. cit.* note 5.

<sup>13</sup>Liu & Hou, *op. cit.* note 5.

<sup>14</sup>Shen, H. (2013) The 12 years history and outcome of TCM legislation in UK. <http://eic.tjutcm.edu.cn/info/1005/1150.htm>, 2013-4-19.

<sup>15</sup>Liu, J. (2015, October 20) European Chinese medicine is looking forward to relaxing control by the "Tu Youyou effect". *Lanzhou Daily*, R12 edition.





spread internationally. Compared with relatively safe and less negative or invasive TCM therapies such as acupuncture, massage, cupping, scraping etc., Chinese herbal medicine has been severely doubted due to safety problems. This has been compounded by some toxic reactions in patients caused by the abuse of Chinese herbal medicine. However, this article holds the view that Chinese herbal medicine is generally very safe if it is used correctly. Nevertheless, the factors leading to safety issues with Chinese herbal medicine are discussed below.

### 3.1.1 | Incorrect use of Chinese herbal medicines

For thousands of years, knowledge of and familiarity with the side effects of each herbal medicine has been an important issue in TCM. The level of toxicity, side effects, and toxicity when mixed with other drugs for Chinese herbal medicine and other kinds of medicine have been extensively documented in both ancient and modern TCM literature. When used correctly and based on this collated evidence and compared with modern drugs, Chinese herbal medicine is arguably relatively safe. For example, China's National Center for Adverse Drug Reaction Monitoring documented and reported on 36,852 adverse reactions to drugs in 2003, of which only 10% were deemed to be caused by Chinese herbal medicine.<sup>16</sup>

The principle of Chinese herbal medicine uses the theory of TCM syndrome differentiation and there are strict limitations on the amounts of each medicine used in TCM. Indeed, medicines with severe side effects are recorded in TCM literature and it is suggested they should not be used due to potential damage to certain visceral functions. Therefore, it is the responsibility of TCM doctors or patients to ensure that treatments are used in the correct manner. If patients, for example, do not follow the prescription for taking the medicine, or take the medicine without differentiation on syndrome, using medicines for an effect that is not noted in the literature or mixing the medicine improperly, they risk having toxic side effects; likewise use of medicine for longer than the prescribed time can result in side effects. For example, in the case of the 'Bolus of gentian for purging liver-fire incident', some patients had taken bolus of gentian for purging liver-fire for a long time with the aim of losing weight, and this ultimately resulted in kidney damage. However, according to TCM theory, this medicine should have been used to treat the syndrome of liver and gallbladder damp-heat and should have been used for short periods of time.<sup>17</sup>

### 3.1.2 | Non-standard processing of TCM decoction pieces

The processing of TCM decoction pieces is an important step in making the original herb into usable medicine pieces according to certain procedures, which is called *paozhi* in Chinese. These procedures not only reduce the toxicity and chance of side effects, but can also increase the curative effect of some medicines. For example, after *paozhi*, the toxicity of *Ligusticum wallichii* and radix *Aconiti kusnezoffii*, which contain the double ester aconitine, can be reduced to 1/2,000, and the curative effect for heart and kidney treatment is also improved. However, in

recent years, some manufacturers of TCM decoction pieces have ignored or reduced the requirements of processing, or have processed ingredients incorrectly, which can increase the possibility of adverse reactions and toxicity.

### 3.1.3 | Confusion and misuse of some Chinese herbal medicines with similar names

Due to the vast geographic area of China, there is a diverse range of Chinese herbal medicine and it is common to see some different medicines having the same name. A study has pointed out that there are more than 8,000 different kinds of basic resources for Chinese herbal medicines, and some medicines contain more than 10 basic resources. Medicines may share the same name, but may have different curative effects and toxicities, and this can have a significant impact on the safety of TCM due to possible misuse. For example, in the case of the aristolochic acid incident, a foreign weightwatchers' institution used caulis *Aristolochiae manshuriensis* instead of *Akebiaquinata*, and *Aristolochia fangchi* instead of *Stephania tetrandra*, and this resulted in acute renal failure caused by aristolochic acid in a number of individuals taking the preparation.<sup>18</sup>

### 3.1.4 | Non-standard clinical use of TCM injections

As a new preparation, TCM injections are more concentrated in adverse reactions. Some studies found that among 392 adverse reactions, 302 were from injections, accounting for 77.04%, 81 were from Chinese patent drug, accounting for 20.66%, 7 were from Herb medicines, accounting for 1.79%, and 2 were external use, accounting for 0.51%.<sup>19</sup> Another study found that among 1,292 cases of adverse reactions reported in China during the period 1990 to 1999, 718 cases were caused by injection, accounting for 55.6% of all cases.<sup>20</sup> According to a safety monitoring report conducted by the State Food and Drug Administration, besides the issue of the quality of TCM materials and preparation technology, the safety risks of TCM injection are mainly related to clinics mixing TCM treatments using other drugs. It is a result of failure to adhere to the regulations of the national *Basic Principles of Clinic Use of Chinese Medicine Injection*.<sup>21</sup>

### 3.1.5 | Misleading publicity for TCM

There is considerable misleading publicity and advertising by a number of businesses, in China and elsewhere, saying, for example, that 'TCM is natural and without any toxicity or side effects'. This has led to some people having poor awareness of the safety issues of using TCM. For example, some people have taken Chinese medicine for a long time as a kind of food or health care product, leading to safety incidents. A

<sup>16</sup>Zhang, B., & Xu, G. (2005) *Introduction to adverse reaction of Chinese medicine*. Beijing: Beijing University Press, p. 5.

<sup>17</sup>Gan-sheng, Z. (2014) *Chinese Materia Medica* (pp. 200-201). Beijing: China Traditional Chinese Medicine Publishing House.

<sup>18</sup>Mei, Q., Zeng, C. (2007). Discussion on safety of Chinese medicine. *China Pharmacy*, 18(12), 882.

<sup>19</sup>Yan M., Li X. (2005) Analysis of 392 cases of major adverse reactions. *Chinese Journal of Hospital Pharmacy*, 25(11), 1100.

<sup>20</sup>Wang, Q., Zhang, Y., Xie, L. (2000). Literature analysis of major adverse reactions in China from the year 1990 to 1999. *Chinese Prescription*, 11(5), 226.

<sup>21</sup>State Food and Drug Administration. *The Annual National Report of Monitoring of Drug Adverse (2014)*. <http://www.sda.gov.cn/WS01/CL0078/124407.html>.



report showed that a patient with acute renal failure had taken a large amount of medicine, which was 20 to 50 times the correct amount according to *Chinese Pharmacopoeia*. A patient who was poisoned in Belgium took *Aristolochia fangchi* for 12 months, and a Chinese patient took the bolus of gentian for purging liver-fire for 20 years.<sup>22</sup> Long-term toxicity through prolonged use of these treatments is noted in the TCM literature as having serious side effects. It is therefore critical that publicity and advertising of TCM treatments are of a high standard to ensure that the public are aware of any risks.

### 3.2 | Shortcomings and challenges for TCM

There are some shortcomings and challenges for TCM. First, a disease in TCM is commonly named after the symptom and lacks a pathophysiological factor, for example, cough, stomach pain, headache, etc. Second, a doctor-dependent diagnosis is required because there are no objective and quantitative diagnosis indices. In TCM, a diagnosis is made mainly based on the patient's signs and the interrogation of reported and observable conditions, like the color of patient's face or tongue, or the features of the patient's pulse. As such the experience and ability of the doctor is vital for a correct diagnosis in TCM settings. The third challenge is the theoretical system of TCM, such as Yin and Yang, the ancient theory of five elements, and six kinds of natural factors; these are difficult for young students to understand and integrate into practice, so it often takes a long time, sometimes 20 years, to develop a qualified TCM doctor.

Identifying the scientific nature and basis of TCM using modern science, to enable the scientific community to better understand TCM, is a challenge. In recent years, there have been more and more important scientific research projects on TCM in China and some significant progress has been made. The Nobel Prize awarded to Tu will no doubt further encourage and improve the quality of these TCM studies.

## 4 | CONCLUSION

Tu Youyou winning the Nobel Prize provides an opportunity for the world to know more about TCM, which created the inspiration for Tu's discovery of artemisinin. TCM's characteristics of *jian*, *bian*, *yan*, and *lian* afford an opportunity for an alternative set of medical treatments with high value in international health care settings. The valid curative effect on many refractory diseases, progress on the scientific nature of TCM, and its international recognition and popularity continue to

reflect and shape the scientific, cultural, and ethical values of TCM. Although safety is a closely watched and important issue, TCM is generally safe if correctly used. Some shortcomings and challenges in TCM may also be addressed with more work and continued research in the future. Finally, TCM may have potential in the treatment of complicated and challenging diseases such as cancer, cardiovascular disease, and AIDS. It is also a field worthy of further studies, exploring the 'treasure house' of TCM knowledge, positing the potential for these other diseases of a revelation as dramatic as artemisinin for the treatment of malaria.

### CONFLICT OF INTEREST

The authors declare no conflict of interest.

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<sup>22</sup>Mei, Q. (2011). There is still a long way to go to popularize knowledge of safety of Chinese medicine. *China's Modern Distance Education of Chinese Medicine*, 9(2), 1–3.