



## Holistic integrative pharmacy, a new era of pharmaceutical education

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**[Abstract]** This study reviews the historical development process of the pharmacy in China and other countries. It furthermore introduces the concept of "Holistic Integrative Pharmacy" (HIP), interprets its connotation while integrating the knowledge of different fields, and analyzes the present pharmaceutical education of several nations. Moreover, the necessity and farsightedness of establishing the HIP education system are elaborated in an attempt to find a progression path of pharmacy that is more attuned to the current demands of human health and social development.

**[Key words]** Holistic integrative pharmacy; Pharmaceutical education; Qualified graduates; Healthy China

### 1 Introduction

At the National Hygiene and Health Conference held in 2016, China's President Xi Jinping emphasized that, "China cannot achieve its developmental goal of realizing a prosperous society in all respects before bringing health to all of its citizens!" A healthy population is a key mark of a prosperous nation and a strong country, and this can help to achieve the great rejuvenation of the Chinese nation. The "Healthy China" initiative proposed in this conference has been included in China's "13th Five-Year" Plan. It embodies China's outlook, "We develop for the good of our people, and whatever we achieve from that development is shared by the people."

Meanwhile, the Communist Party of China (CPC) will implement the Healthy China initiative by improving the national health policy and providing comprehensive lifelong health services for the people, as indicated in the report delivered at the 19th National Congress of the CPC. Against such a backdrop, medicine and healthcare services have been placed at the forefront of development strategies. The academician Fan Daiming put forward "holistic integrative medicine" as the solution to numerous challenges currently faced by the medicine and healthcare communities. Holistic integrative medicine has provided solid support for the implementation of the Healthy China initiative. A broad consensus exists in holistic integrative medicine, which has been the focused area in China's medical community. Therefore, this consensus has allowed the development of a concept known as "holistic integrative pharmacy"

(HIP). However, what is HIP? Why is HIP needed? How do we use HIP? In this study, we illuminate the past and present of HIP and attempt to outline its development blueprint to inspire pharmaceutical education.

## 2 History of Pharmacy

Where do we come from, and where are we going? These are the eternal philosophical questions of mankind. Where does pharmacy come from, and where is it going? A remarkable breadth of vision will be shown only by means of understanding history. To indicate the clear trend of pharmacy, this study outlines its development vertically (from ancient times until now) and horizontally (at home and abroad).

### 2.1 Pharmacy of ancient times

In ancient times, human beings accumulated experience from long-term daily activities such as distinguishing and choosing food during the process of foraging to avoid poisoning or to treat illness. Medicines thus emerged. The ancient Egyptians acquired a vast knowledge of pharmacy. The first known pharmaceutical record originated in Tutankhamun's time period. The Babylonians and, later, the Assyrians used multiple dosage forms. Medicines were also mentioned in the Babylon Code of Hammurabi. Hippocrates, a well-known ancient Greek physician, is the first recorded expert in food therapy. He is also the first to use the Greek word "pharmakon" as the term to interpret "pharmacy." Since then, a theoretical system of pharmacy was gradually developed. *De materia medica*, written by the ancient Roman pharmacologist Dioscorides, provides highly accurate descriptions of medicines. It is considered a foremost classical source of materia medica and the first pharmacological text in the Western world. Another pharmacologist, Galen, enunciated an extensive knowledge of pharmacy in his work *On the Therapeutic Method*. It influenced the

Western pharmacy for over 1,000 years and laid a solid foundation for pharmacy<sup>[1]</sup>. In ancient China, medical knowledge was initially recorded on oracle bones during the Shang dynasty and on wooden and bamboo slips in subsequent time periods. Hundreds of medicines are described in the *Book of Songs* (Shi Jing) and the *Classic of Mountains and Seas* (Shan Hai Jing), both of which are sources of herbal materia medica documentation. The *Herbal Classic of Shennong* (Shennong Bencao Jing) reveals medicine knowledge acquired before the Qin and Han Dynasties in a systematic manner. It represents the establishment of the theoretical system of pharmacy.

### 2.2 Pharmacy of the middle ages

The *Materia Medica* of Tang Dynasty (Xinxu Bencao), China's first pharmacopeia, was published around the 5th century AD. It is a comprehensive summary of medicine knowledge and marks a new phase in the development of Chinese pharmacy. Since the advent of *Materia Medica* of Tang Dynasty, Chinese pharmacy, originally as an integrative discipline of herbal materia medica, was gradually separated into multiple subjects, such as herb gathering, herb planting, medicine processing, and food therapy, which were all investigated in monographs<sup>[1]</sup>. However, Western pharmacy stagnated during the same age since the cultures of ancient Greece and Rome had been destroyed. The Renaissance witnessed a rapid advancement of science and culture. Pharmacy was subsumed under natural science by Western pharmaceutical researchers with the use of experiment-based empirical approaches as well as techniques and well-established study procedures used in various disciplines of natural science. In the same period, Li Shizhen, a medical scientist of the Ming Dynasty, compiled and wrote *Compendium of Materia Medica* (Bencao Gangmu). As an overall collection of materia medica, it epitomizes all the pharmaceutical achievements and developments

of China before the 16th century and considerably influences world medical science.

### **2.3 Modern Pharmacy**

In the modern era, with Western pharmacy progressively infiltrating China, traditional Chinese medicine (TCM) and Western medicine therefore coexisted in China. Some Chinese scholars learned from their Western counterparts by examining the nature of TCM using physical and chemical methods or by investigating TCM mechanisms of action based on pharmacology. These attempts laid a foundation for TCM study with scientific approaches developed in the modern era. Meanwhile, inorganic and organic chemistry became the basis of drug discovery and development with the advent of chemistry, physics, biology, physiology, and other disciplines. Since then, an era of "chemical medicine" began.

### **2.4 Contemporary Pharmacy**

Three leaps were made throughout the 20th century. The first leap was marked by the discovery and mass production of sulfonamides and antibiotics, with an emphasis on curing infectious diseases. The discovery of sulfonamides set a precedent for developing new drugs with drug metabolic products as the lead compound. The second leap was marked by receptor antagonists and enzyme inhibitors, which represents a focus shift of the pharmacy to drugs against non-infectious diseases. The third leap was made when macromolecular drugs became widely used in clinical practice with the advent of genetic engineering and cell engineering drugs; biologic therapy was then initiated to fight refractory illnesses, genetic diseases, and malignant neoplasms. Thus far in the 21st century, pharmacy researchers have learned from the fruits of other disciplines. Chiral drugs, biotech drugs, and directional drug design has been the focus of pharmaceutical research. Emerging therapy

techniques include gene editing, PD-1/PDL-1 tumor immunotherapy, chimeric antigen receptor (CAR) T cell-mediated immunity, and targeted agents.

The pharmacy industry has progressed by leaps and bounds in the past thousands of years, especially in the most recent century. It has contributed enormously to human health. In contrast to the continuous development of contemporary pharmacy and the increasingly detailed classification of disciplines, pharmacy graduates only understand a single aspect of medical science and cannot consider or address problems from a broader perspective due to a gap in their knowledge and a lack of innovation capability. They find it difficult to adapt to new trends in which health issues are more complex, integrated knowledge is required for application, and innovation is routine.

## **3 Definition and connotation of HIP**

With growing needs for quality of life and health improvement, the disciplines of pharmaceutical science and relevant majors have been overly subdivided. The knowledge has thus been fragmented, which is a double-edged sword for this discipline. An unprecedented challenge is to be solved in the development of pharmacy. Integration is the great weapon against major problems in our era, and it has an irresistible momentum. Just as the old Chinese proverb says, "Everything will disintegrate after long-term integration, and vice versa," and "everything rises upward in spiral paths and advances forward in wave modes," as revealed throughout the development of human society, now is the time for integration<sup>[4-5]</sup>.

### **3.1 Definition of HIP**

The authors of this study believe that HIP should put people first on the basis of integrating medicine holistically. With a core emphasis on

"make good drugs, make good use of drugs," methods and knowledge of all relevant disciplines are blended by integrating pharmacy with TCM, contemporary medicine, contemporary emerging techniques, basic research and application development, and humanities. Barriers between disciplines are thus broken down to build a new system of pharmaceutical theory and practice to better cater to people's health needs.

### **3.2 Connotation of HIP**

HIP does not reject the subdivision of pharmacy, segmented majors, and sophisticated techniques but instead calls for integration of these subdivided processes. This approach is used to properly organize theories and practices of pharmacy-related subjects into a whole, adding more in-depth content to each layer of integration. Its connotation can be interpreted from the following five aspects.

#### **3.2.1 Integration between Pharmacy and TCM**

The core concept of TCM is to treat patients by taking the whole human system as an integrated unit and to prescribe therapies in an individualized and dynamic manner. TCM accentuates general effects and interprets mechanisms of treatment with philosophy. Integration between pharmacy and TCM is intended to combine syndrome differentiation-based therapy and the idea of "harmony between human and nature" into contemporary pharmacy. In this way, a "people-oriented" system of HIP can be shaped, where patients' benefits are valued. Both are interconnected in theory and practice. One is complementary to and improved by the other. In the circumstances, more efficient public health service can be provided.

#### **3.2.2 Integration between Pharmacy and contemporary Medicine**

Both contemporary medicine and pharmacy

are guided by systematic thinking. Following long-term explorations and accumulation of experience, a systematic knowledge network of life science as well as disease diagnosis and treatment has arisen. It is a combination of nature and humanities with a systematic and non-linear science. Moreover, thanks to the engagement of a broad community, combination of many disciplines, and application of advanced techniques, the corresponding technological equipment and therapies have been well developed. Integration between pharmacy and contemporary medicine keeps pace with the times, ensuring that the combination of pharmacy and medical treatment is science-based and continually updated.

#### **3.2.3 Integration between Pharmacy and contemporary emerging techniques**

Contemporary emerging techniques such as cloud computing, big data, artificial intelligence, and 3D printing technology support and benefit pharmacy. For example, living tissue and organs produced by 3D printing technology have been used in drug screening and experiments<sup>[6]</sup>. This may prevent the failure of drug clinical trials in later stages due to differences between animal models and human organisms and is expected to eventually replace animal testing<sup>[7]</sup>. Integration between these techniques and pharmacy will undoubtedly be the new development trend. Hence, with disciplinary integration as a guideline, it is feasible to rapidly integrate the latest information of pharmacy and the most practical experience of drug development by blending disciplines (e.g., TCM, chemical medicines, and biologic medicines) with the use of novel key techniques.

#### **3.2.4 Integration between basic pharmaceutical research and application**

In the context of collaborative innovation, HIP may achieve a breakthrough by integrating basic research and applied research, which are

conventionally separated. It will open up further possibilities for interactive integration between science and technology. Moreover, HIP may help to construct an innovative environment in which basic and applied research overlap and combine. Ideally, basic research would be inspired by applied research, and these would work together to facilitate scientific discoveries and technical innovation. To this end, close industry-academia-research collaboration should be encouraged and accelerated. Effective technical innovation can be realized when function, funding, process, and assessment are provided.

### **3.2.5 Integration between Pharmacy and Humanities**

Humans not only exist in the physiological sense but also in the psychological and sociological sense; disease not only "finds its way in by the mouth" but also "originates from heart, ears, and eyes." Drugs alone are far from sufficient for therapy and prophylaxis. A patient's physical and mental condition should be taken into consideration. Therefore, pharmacy should be seen as a combination of humanities and natural science rather than just a single natural science. Instead, of a technical discipline, it is also a "people-oriented" discipline that is full of human spirit. As stressed in HIP, we should not only care for the effectiveness of a drug when it is used as a biological therapy but also care for the patients. In other words, the human itself should be respected.

## **4 Necessity and farsightedness of HIP**

Human talents are the most important resources in the evolution of medical and healthcare services. Medical reforms and Healthy China is impossible without pharmacy professionals. The pharmaceutical education staff has the mission of preparing qualified graduates for the rapid development of China's innovative

drug development system, medical industry, and healthcare services.

### **4.1 Status and challenges of Pharmaceutical education in China**

Focusing on how to prepare qualified pharmacy graduates, this study compared China with developed countries including the UK, Germany, France, the USA, and Japan from five perspectives: curriculum design, years of schooling, practice, employment, and schooling characteristics<sup>[8-9]</sup>. The findings are revealed in Table 1.

China's pharmaceutical education has a history of over 100 years. A growing population has been recruited into pharmacy across China, and a trend of diversification has been noticed in pharmaceutical education design. A well-established mode of higher vocational education, undergraduate education, master and doctorate education, and continuing education has taken shape. Although we have achieved considerable progress to date, enormous challenges still exist in the training of pharmacy professionals in China, which can be noted in four aspects. (1) Although the number of universities and colleges offering pharmacy courses and their enrollment increase rapidly, the curriculum designs are overlapped, and increased enrollment seems to be irrational. (2) It is true that the strategy of China's medical industry has changed from copying other countries' drug formulations to implementing independent innovation in drug development, but graduates are incapable of making innovations with the obsolete curriculum system and assessment methods. (3) Pharmacy teaching materials are out of tune with the actual needs of medical treatment and health care, and thus students cannot put what they have learned into practice because their training overemphasizes theories but neglects the importance of practice and values knowledge learning but overlooks the capability of practice. (4) In developed countries, pharmaceutical

**Table 1 Comparison between China and Western developed countries in preparation of qualified pharmacy graduates**

Country	UK	Germany	France	USA	Japan	China
Curriculum design	Foundation disciplines; specialized courses; drug design; and elective courses; continue to study upon completion of subject research	Two-year acquisition of basic knowledge + 8-week internship (Students must pass the first national exam); 2-year acquisition of specialized knowledge (the second national exam) + 1-year traineeship; the third national exam	Foundation disciplines; biology, pharmacy, and clinical disciplines; elective courses	Bio-medicine; pharmacy; behavioristics, sociology, and administration management; pharmacy practice	Foundation courses; specialized foundation courses; specialized courses; experiments	Foundation courses; specialized foundation courses; specialized courses; pharmacy practice
Years of schooling	Four-year successive undergraduate and postgraduate program	Assessment via national exams. No bachelor degree available	Three + 5–8 years' study for doctorate	Undergraduate education (2–4 years) + 4-year pharmaceutical education. Graduates receive Pharm. D	Newly specified 4 years or 6 years	Three-year vocational education or 4-year undergraduate education Three-year master education + 3-year doctoral education
Practice	1 year	Eight-week internship + 1-year traineeship	2–6 years	1 year (a total of 44 weeks)	Unavailable in 4-year schooling and 6-month internship in 6-year schooling	Generally 3–6 months
Employment	Pharmacy; scientific research; schooling; pharmaceutical factory; and government	Pharmacy; pharmaceutical company, industrial organization, professional institution, and R&D faculty	Pharmacy; pharmaceutical company; teaching and research; chemical engineering; and food	Drug research, production, and clinical use	Pharmaceutical company; chemical industry; pharmacy, clinic, and food and drug administration	Pharmaceutical company; pharmacy; teaching and scientific research
Schooling characteristics	Curricula are designed from the following six perspectives: patient care, drug action, pharmaceutical raw materials, medicinal products, medical system and responsibilities of pharmacy professionals, and knowledge extension. The primary teaching method is theory explanation, case study, and practice	Courses are arranged to build capability. Schools develop and complete the curricula with enterprises so that what students have learned can be mostly applied in clinical practice	Prolonged years of schooling and useful courses creatively designed; long cycle of practice; curriculum design conforms with employment requirements	Less chemistry-related courses and more biological and medical subjects; teaching of integrative disciplines and an emphasis on practice	"Biased toward theory and practice," standardized internship programs, and humanistic quality education emphasized in daily courses	More focus on chemistry and less on clinical practice

educational philosophy has transformed from "drug-oriented" to "patient-oriented," whereas China's pharmaceutical education is still "drug-oriented," failing to keep up with social needs; it is a deviation from the core objective and value of pharmaceutical education.

## **4.2 Necessity of HIP education**

The structure, layout, quality, and capability of pharmacy professionals in today's China can barely keep up with the technical innovation of contemporary pharmacy and people's ever-growing needs for a better life. Thus, education reform with HIP is exceedingly urgent.

### **4.2.1 Addressing needs of prophylaxis and treatment**

The human body is in a constant state of change, and the causes of illnesses also keep changing. The body and disease etiologies may interfere with or cooperate with each other, which significantly complicates the occurrence and development of illnesses. Thus, highly complex and consistent changes in illnesses require higher levels of drug-based prevention and therapies. A dosing regimen should be prescribed based on different populations. Individual features, stages, and pathogenesis of diseases should be considered. Drug therapy and regimens should be modified based on the specific person, time, and place. It is therefore necessary to develop and upgrade the existing pharmacy and pharmaceutical education and to build up the HIP education system that can keep up with the development of diseases and combine seamlessly with the existing pharmacy,

### **4.2.2 Open the way to "make good drugs"**

At present, it is difficult to develop effective drugs. Drug innovation has entered a period of stagnation. Since China lacks a strong ability to develop new drugs, the generic drugs take up more market share than new drugs. Drug development is

an integrated project requiring extensive expertise, advanced techniques, and close combinations of multiple disciplines. Researchers should not only comprehend the chemical construction and synthesis of drugs but also have a thorough knowledge of many disciplines involving patents, administrative protection, pharmacology, and efficacy of examined drugs. Furthermore, breakthrough is usually achieved through an interdisciplinary approach, as integration enables effective interactions between disciplines, which in turn accelerates progress. Therefore, knowledge and methods can be well organized by HIP education, which may lay a sound foundation to "make good drugs" and accelerate new drug development.

### **4.2.3 Meeting clinical needs: "make good use of drugs"**

On one hand, progress in pharmaceutical science presents more approaches to treat illnesses; irrational drug use, on the other hand, causes a surge in drug-induced diseases. In today's world, the trend of "drug-oriented" pharmacy has progressively transitioned to "people-oriented for the purpose of rational drug use." However, China lags behind as it is still at the stage of "drug-oriented" pharmacy. In these circumstances, the people-oriented education system of HIP is needed to change the long-time situation of prioritizing the objects (drugs) but neglecting the importance of people (patients) in China's pharmacy field. Education focus should be altered from drugs to clinical application to fulfill the clinical needs of "make good use of drugs."

### **4.2.4 Providing health service for a better life**

Health, as the foundation of one's life and the cornerstone of a nation, is a pivotal aspect of building a well-off society in an all-round way, and it is the relentless pursuit of human wellbeing. The "Healthy China 2030" Blueprint released by the

Central Committee of CPC and the State Council puts "working together to construct the healthcare system and bringing health to all Chinese citizens" as the principal method and central aim of the Health China action. As stated in the report delivered at the 19th National Congress of the CPC, "As socialism with Chinese characteristics has entered a new era, the principal contradiction in our society in the new era has been transformed into the contradiction between the people's growing need for a better life and unbalanced and inadequate development." Appreciably, pharmacy is still in the phase of unbalanced and inadequate development, far from satisfying the people's needs for a healthy life. HIP education conforms to the national strategy of "Healthy China." If we begin the reform in education by putting an emphasis on "make good drugs, make good use of drugs," we may pave the way for satisfying people's ever-growing needs for a better life.

### 4.3 HIP as the trend of Pharmaceutical education

Pharmaceutical education must be provided to develop the medical industry in light of demands for professionals, majors, and employment. As China's economy has entered a period of a new normal and new era, the Chinese are pursuing an increasingly higher quality of life. Within the fundamental rules of higher education, pharmaceutical education, based on its features and existing advantages, should modify its approach to prepare qualified graduates who keep pace with the times, follow the trends of the times, and adhere to the requirements of the times. The mode of pharmaceutical education should have Chinese characteristics based on China's Conditions.

HIP education emphasizes a holistic view, extending the limits of disciplines, majors, and knowledge. Students should be encouraged to become independent learners and to solve "fragmented" problems at the present and

in the future. "Integration" manifests itself in four aspects<sup>[10]</sup>: (1) integrate courses that are interconnected in underlying logic and core values but separated from one another, (2) encourage students to grasp "holographic theory" with a world vision, (3) profoundly understand and address actual problems using flexibly methods of integration, and (4) delete overlapped sections of courses and associate one course with one another. Only the "integration" application in pharmaceutical education can achieve the transition of a training model from chemistry to a combination of chemistry, biology, medicine, and management, thus blending usefulness, application, and innovation. Integration is biased toward the preparation of graduates who can solve practical problems of pharmaceutical engineering, offer pharmacy services, control drug quality, ensure the safe and rational use of drugs. It aims to train individuals who take responsibility for drug management departments, make sensible decisions, and operate pharmaceutical firms by organizing and coordinating all levels of activity. Hence, we should make proper modifications in major setup as well as the teaching materials and approaches, abandon current teaching methodology involving different systems and specificities, and integrate existing courses<sup>[11]</sup>. Besides this, the number of courses and class hours pertinent to biology, psychology, and social medicine should be increased. In this way, pharmaceutical education will be provided in a more integrative and systematic way. The education system of HIP will be the new trend of pharmaceutical education.

## 5 Conclusion

With integrated concepts, ideas, and methods, patient-oriented HIP always places people first when meeting public needs. It represents tomorrow's pharmacy industry. A new era of pharmacy, from micro to macro and from subdivision to integration, is about to begin. Guangdong Pharmaceutical University will never



forget its original intention and always keep the mission in mind. With the idea of "putting forward a hypothesis boldly while proving it conscientiously and carefully" as its scholarly philosophy, the university introduces constant innovations and significant reforms by initiating pilot programs to translate HIP into practice. We expect to work with other Chinese universities and colleges and make concerted attempts to push HIP to new heights. We should work hard to open up a route of pharmacy development in a new era by taking a results-oriented, innovative approach.

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