



## The current status of health informatics higher education in China

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There are likely to be many opportunities and challenges for health informatics and health informatics higher education in China following her acceptance as a member of the World Trade Organization (WTO). The purpose of the article is to review the current status and consider future directions for health informatics and health informatics higher education in China. Today, China's educators are viewing education in global terms. China is opening its markets and especially its educational system to the world. Developed countries should take this opportunity to export their advanced health ICT technology, management expertise and existing health information systems to China, and in particular to China's health informatics educational market.

### Keywords

China, Chinese education, health informatics in China

### Introduction

Health informatics is the study of how health data are collected, stored and communicated; how those data are processed into health information suitable for administrative and clinical decision making; and how computer and telecommunications technology can be applied to support those processes [1].

In order that the public health function can continue to be provided in an effective manner within this dispersed and devolved setting, it is essential that there should be proper communication between public health professionals. This implies the setting up of public health networks. Indeed the UK government has determined that there should be established 30 or so managed public health networks (MPHNs) covering the geographic

area of each Strategic Health Authority (SHA). Given that the healthcare infrastructure is becoming increasingly dependent upon an underpinning by information and communications technologies (ICT), the effective use of these technologies will be crucial to successful public health networking.

Health informatics education and research are still emerging disciplines and there are many opportunities for this field to have an impact upon healthcare planning, delivery and evaluation. There is a world-wide shortage of skilled and experienced health informatics practitioners to support national and commercial agendas for health information management. Currently, study and research in health informatics are still at a preliminary stage in China.

## **Health informatics in China**

At the end of 2002, severe acute respiratory syndrome (SARS) started to spread around the world. The initial cases of SARS appeared on 16 November 2002 in the Guangdong Province, South China [2]. As of 2 June 2003, a cumulative total of 8384 probable SARS cases with 770 deaths have been reported in 29 countries [3].

In its effort to fight SARS, China's government has recognized that a national health information network for disease control and prevention that covers public health organizations, research institutions, hospitals and clinics will facilitate processes and controls. Health informatics is playing a more and more important role in China's health care systems.

### *Overview of the Chinese healthcare sector*

In China, the healthcare system can be classified into rural and urban systems consisting of hospitals, urban street hospitals, rural township hospitals, sanatoriums, clinics, specialized healthcare stations including tuberculosis prevention stations and occupational diseases prevention stations, sanitation and disease control stations, maternity and childcare centres, medicines and chemical reagent test laboratories, and institutions of medical sciences. By the end of 2001, China's health care institutions totalled 324,380 (see Table 1).

Wang [5] reports that China's urban healthcare system is hierarchically structured into three tiers: (1) street health clinics and workplace clinics providing preventive and primary care; (2) district and enterprise hospitals and specialist clinics providing secondary care; and (3) provincial and municipal general hospitals and teaching hospitals providing tertiary inpatient care. In fact, there is another tier: national hospitals, which are governed directly by the Ministry of Health.

### *Introduction of ICT into the Chinese health sector*

The types of information systems used in healthcare by clinic health managers including the following [6]:

- operational information systems
- management information systems (MISs)
- decision support systems (DSSs)

**Table 1** China's healthcare institutions, 2001 [4]

<i>Type of healthcare institution</i>	<i>No.</i>
Hospitals:	
Hospitals at country level and above	15,451
Other hospitals	1330
Urban street hospitals	553
Rural township hospitals	48,090
Sanatoria	461
Clinics	248,061
Specialized healthcare stations	1783
Sanitation and disease control stations	4253
Maternity and childcare centres	2548
Medicines and chemical reagent test labs	1453
Institutions of medical sciences	397
Total institutions	324,380

- executive support systems (ESSs)
- expert systems (ESs)
- office information systems (OISs).

Currently China's health system has only benefited from ICT in the form of operational information systems, MISs and OISs. Effort has been put into developing electronic medical records but with few results. This is attributed to lack of funding and shortage of skills. Solutions to these problems are becoming ever more pressing. This crisis has drawn the attention of officials.

In April 2000, the Ministry of Health of the People's Republic of China published *Foundational Function Specifications for Health Information Systems* to drive the application of information and communication technology in health services, preventive medicine, research, training and education, and planning [7]. It is anticipated that the Chinese national health informatics standard will be established before 2010.

On 25 October 2002, the China Health Informatics Working Conference announced that the Chinese government is accelerating the establishment of standards and criteria for health informatics [8]. ICD-10, HL7 and DICOM3 have been translated and introduced into China. HL7 (Health Level 7) will become the Chinese national standard for health information system communication and interoperation [9].

### ***Current status of China's higher educational institutions in medicine***

By 1 January 2003 there were 1396 higher educational institutions including medical institutions in China [10]. At present, China's higher medical and educational institutions consist of the following five sectors:

- National Medical Academic Centre
- medical universities and medical colleges

- university medical colleges
- higher medical speciality institutions
- military higher medical and educational institutions.

China's National Medical Academic Centre consists of the Peking Union Medical College and the Chinese Academy of Medical Sciences. They are separate entities which combine to form the national institute. They offer only master and doctorate medical degree programmes.

By the end of 2002, there were 77 medical universities and medical colleges. Most of them offer bachelor and master degrees. Some of them offer doctorate programmes. University medical colleges offer bachelor, master and doctorate degrees in medicine. There are 48 such university medical colleges. There are 21 higher medical speciality institutions offering diploma degrees in medical programmes. In addition, there are a few military higher medical and educational institutions. In total, there are 147 higher medical and educational institutions (except military institutions).

In 1997, Auhui Medical University set up the first bachelor programme in health information technology and management [11]. However, by April 2003, only 29 higher educational institutions provided 53 programmes related to health informatics (Tables 2, 3, 4). This includes 28 bachelor, 21 master and 4 doctorate programmes.

## **The challenge**

Three recent events have great importance for China's future economic development. First, the World Trade Organization (WTO) successfully concluded negotiations of China's terms of membership on 17 September 2001 [12]. Second, the Games of the 29th Olympiad in 2008 were awarded to the city of Beijing, China [13]. Finally, Expo officials announced in Monaco that Shanghai would host the 2010 World Exposition after the city bid fiercely to organize an event expected to bring in millions of dollars of investment [14].

These events will have far-reaching influence on many areas of Chinese society, including economics, law, agriculture, retail, IT, finance, insurance, trade, real estate, entertainment, employment, health and education. These developments will have wide impacts across the economy.

### ***The challenges for the healthcare industry***

China's entry to the WTO, though only recent, has already brought significant changes. These changes are accelerating the readjustment of China's economic structure, social order and governance [15].

The healthcare industry is also under pressure from globalization and economic reform. These include efforts to improve work efficiency and service outcome. As an important facilitator for better health delivery, health informatics is increasingly recognized as an essential discipline by the health industry and health academia.

There are two key considerations essential to the successful implementation of health informatics in China. The first is how to develop and deploy new software that integrate current hospital communication systems [16]. The second is how to build up the capacity of the industry to cope with and manage health ICT projects efficiently and effectively.

**Table 2** Health informatics bachelor programmes in Chinese higher educational institutions, 2003

<i>Higher educational institution</i>	<i>Bachelor programme</i>
University of Medical Sciences	Diploma of Medical Information Management Capital
NanTong Medical College	Bachelor of Public Health Management (health informatics major)
China Pharmaceutical University	Bachelor of Information System Management
Guangzhou University of Traditional Chinese Medicine	Bachelor of Computer Science and Technology
Beijing University of Chinese Medicine	Bachelor of Public Health Management (informatics management major)
China Medical University	Bachelor of Information System Management in Health
Nanjing University of Traditional Chinese Medicine	Bachelor of Computer Science and Technology
WenZhou Medical College	Bachelor of Information Systems and Management
AnHui Medical University	Bachelor of Public Health Management in Health IT and Management
WanNan Medical College	Bachelor of Information Systems and Management in Health Information Management
HuaZhong University of Science	Bachelor of Information Systems and Management and Technology
Southeast University	Bachelor of Biomedical Engineering in Bio-Information Technology
Southeast University	Bachelor of Biomedical Engineering in Health Information
ChangZhi Medical College	Bachelor of Information Systems and Management
ShanXi Medical University	Bachelor of Information Systems and Management
Central South University	Bachelor of Health Informatics
HuBei College of Traditional Chinese Medicine	Bachelor of Information Systems and Management Chinese Medicine
ZheJiang College of Traditional Chinese Medicine	Bachelor of Computer Science and Technology Chinese Medicine
TaiShan Medical College	Bachelor of Computer Science and Technology
TaiShan Medical College	Bachelor of Information Systems and Management
TaiShan Medical College	Bachelor of Clinical Sciences and Bachelor of Computing
HuNan College of Traditional Chinese Medicine	Bachelor of Computer Science and Technology
JiNing Medical College	Bachelor of Information Systems and Management
JiangXi College of Traditional Chinese Medicine	Bachelor of Computer Science and Technology (medical software development)
YouJiang Medical College for Nationalities	Bachelor of Public Health Management (health and information management)
GuangDong Pharmaceutical College	Bachelor of Information Systems and Management
GuangDong Pharmaceutical College	Bachelor of Preventive Medicine (health information management)
ZhangJiaKou Medical College	Bachelor of Information Systems and Management

**Table 3** Health informatics master programmes in Chinese higher educational institutions, 2003

<i>Higher educational institution</i>	<i>Master programme</i>
Capital University of Medical Sciences	Master of Computing Processing and CAD in Medical Imaging
Shandong University of Traditional Medicine	Master of Biomedical Engineering in Information Technology
Shandong University of Traditional Medicine	Master of Biomedical Engineering in Medical Imaging
China Academy of Medicine and Science	Master of Biomedical Engineering in Biomedical Information
ShangHai Second Medical University	Master of Biomedical Engineering in Medical Imaging
ShangHai Second Medical University	Master of Biomedical Engineering in Image Databases
ZheJiang University	Master of Computer-Aided Technology in Pharmaceutical Analysis
HuaZhong University of Science and Technology	Master of Pharmaceutical Information Management
Southeast University	Master of Biomedical Engineering in Bio-Information Technology
Southeast University	Master of Biomedical Engineering in Health Information
Southeast University	Master of Biomedical Engineering in Biomedicine Information Visualizing and Imaging
Southeast University	Master of Biomedical Engineering in Biological System Modelling and Emulating
Southeast University	Master of Biomedical Engineering in Bio-Informatics
Central South University	Master of Biomedical Engineering (IT in clinical sciences)
Central South University	Master of Biomedical Engineering in Clinical Imaging
TaiShan Medical College	Master of Medical Imaging
TsingHua University	Master of Biomedical Engineering in Biomedicine Information
TsingHua University	Master of Biomedical Engineering in Microprocessing in Biomedical Instrumentation
TsingHua University	Master of Biomedical Engineering in Medical Imaging
TsingHua University	Master of Biomedical Engineering in Human Sporting Signal Detecting
TsingHua University	Master of Biomedical Engineering in Physiological System Modelling and Emulating

Currently, 85 percent of China's hospitals have developed hospital information systems [17], mainly hospital management information system (HMISs) that focus on accounting assessments. Moreover, 10 percent of China's hospitals are attempting to develop hospital clinical information systems (HCISs). However, 40 percent of HMISs developed have not fulfilled expectations.

**Table 4** Health informatics doctorate programmes in Chinese higher educational institutions, 2003

<i>Higher educational institution</i>	<i>Doctorate programme</i>
China Academy of Medicine and Science	Doctorate of Biomedical Engineering in Biomedical Information
TsingHua University	Doctorate of Biomedical Engineering in Human Signal Detecting and Emulating
TsingHua University	Doctorate of Biomedical Engineering in Remote Health and Health Informatics
TsingHua University	Doctorate of Biomedical Signalling and Imaging

An investigation by Zhang found that a few hospitals were exploring e-health based on clinical diagnosis, nursing, clinical examination, medical imaging and remote diagnosis [18]. The lack of medical and technological standards, and of skilled workers who understand both healthcare and computing, are the major problems for these initiatives.

At the 2002 China Health Informatics Working Conference [8], the following weaknesses were reported:

- lack of health informatics standards
- lack of uniform information exchange standards
- lack of specialized departments of health informatics: 80 percent of them are affiliated to other departments.

### *The challenges for medical education*

In the current age of economic globalization, China as a developing country faces a shortage of skilled human resources. This is especially evident in fields that combine high technology and new specializations. As a new academic discipline, health informatics requires the active participation of multiple experts with multidisciplinary skills and knowledge. Lack of relevant talent is the main reason why the development of information systems in the health industry is significantly lagging behind that of other industries.

On 17 December 2001, China published the *Chinese National Programme for Medical Educational Reform and Development* [19], which indicated that the following problems needed to be addressed as priority:

- lack of knowledge and understanding of the roles and rules of medical education under social and economic development
- readjustment of medical and educational institution systems
- improvement in the level of medical and educational institutions
- inability of present operating mechanisms to allow higher educational institutions to keep pace with development.

### China's educational doors open

The Ministry for Education of PR China has recognized that Chinese higher educational institutions have to reform curricula, teaching materials, teaching methods, and examination and assessment tools through incorporating international experience [11]. China specifically supports and encourages universities to collaborate with higher educational institutes in other countries. Some Chinese universities have been restructuring their curricula and actively seeking collaboration with overseas institutions [20].

In 2000, the official Xinhua Wenzhai reprinted an article written by Bao Guoqing [21]. The main point in the article is that China's entry to the WTO will inject the Olympic spirit into Chinese education, fostering new methods, improving ethos and introducing economic mechanisms. It will be a catalyst in bringing education in China up to international standards of achievement.

### The opportunities for higher education

Table 5 outlines the features of China's higher educational programmes in health informatics. It is apparent that the number and type of programmes offered is far behind the requirements of the market. This provides an opportunity for health informatics experts and consortia to provide consulting services.

The table shows that 31 IT programmes and one double programme (60.4% of programmes) were provided by institutions involved in developing medical software, health imaging, medical networking, CAD in medical imaging, clinical computing, bio-information technology, biological system modelling and emulating, health signal detecting and emulating, and remote health and health informatics; and 21 programmes (39.6%) were provided in health management information systems. A total of 29 institutions, representing 19.7 percent of the 147 higher medical and educational institutions, provided the 53 programmes in health informatics. In the context of 1396 higher educational institutions this represents only 0.2 percent, which is too low.

In order to meet the demands of the 21st century, the *Chinese National Programme for Medical Educational Reform and Development* identified the following challenges and opportunities for China's medical higher education [19]:

**Table 5** Features of China's higher educational programmes in health informatics [22]

	Programme major						Total
	MIS		IT		Double		
	No.	%	No.	%	No.	%	
<i>Health informatics</i>							
Bachelor programme	19	35.8	8	15.1	1	1.9	28
Master programme	2	3.8	19	35.8			21
Doctorate programme			4	7.6			4
Total	21	39.6	31	58.5	1	1.9	53

MIS majors include programmes in health information systems and management.

IT majors include programmes in computer science and technology in health areas.

Double major means a combined programme of medicine and IT.

- Medical education is becoming internationalized.
- China's entry into the WTO will accelerate the development and reform of medical education in many ways, such as the introduction of advanced educational models, management and operation practice.
- Life sciences will have increasing importance.
- The breakthrough of human genome research signals the next revolution in medicine. The associated rapid development of science and technology, and especially life sciences, will profoundly impact on medical education.
- There will be profound changes in healthcare service models and operation. Opportunities and challenges will arise in the reform of health education goals, modes, curriculum setup, content, delivery and benchmarking criteria, such as changes in medical practice, the development of community health services, population growth, the ageing trend, and imbalances in the ecological environment.

### *The opportunities for developed countries*

After joining the WTO, China will naturally have a much higher demand for qualified personnel [23]. With a more open market policy, China will also provide a tremendous opportunity and an immense market for higher education. Strong competition at the global level for creative talent will force China's higher education institutions to bring in innovative ideas and new operative models in order to stay competitive. This open market will be shared with the international educational enterprises.

Hu WenBin, education specialist of the World Bank, believes that higher education in China is making a transition from elite to popular education [24]. According to the plans of the Ministry for Education, higher education in China will expand so that the enrolment rate will reach 15 percent by the year 2010. This plan is both brave and timely. Assuming this goal is realized, China's higher education will be at the forefront of the world.

On 12 December 2001, the Ministry of Health of PR China published *China's National Programme for Health Development: Second Five-Year Plan and 2010 Long-Range Plan* [25], which indicated that the future goals include:

- create new cooperative channels and give impetus to international health scientific and technological cooperation and communication
- support China's scientific research institutions to cooperate with overseas counterparts
- widen communication channels with developed countries and international health academic organizations.

### **Future directions**

The majority of health information systems currently implemented in China are targeted at hospital level administrative system management. A patient-centred approach has yet to be taken. No health information strategy and development plan has been introduced at the national level. There is a need for Chinese health informatics to develop a national

strategy for health information system plans, health informatics curriculum development, and education and industry capacity building.

The future direction for healthcare in China will be towards e-health, which involves a multidisciplinary approach including informatics, communication, health, security, multimedia, marketing, advertising, management, finance, business, law, education and training including online, real-time, service collaborations and community perspectives [26, 27]. Mobile health, based upon China's rapid adoption of cellular technology, may be well suited to the vast size of China in terms of distance as well as dispersed population. All this needs multiple talents.

### *Health informatics*

The 2002 China Health Informatics Working Conference defined the mission for the coming 8 years as including [8]:

- developing health information systems to focus on clinical information systems, such as electronic clinical records, digital imaging, clinical diagnostic systems and nursing systems
- enhancing the training of the future health informatics workforce
- strengthening of health informatics research
- encouraging expert research into information modelling, work practice change, implementation strategies, legal issues, privacy and security
- predicting directions and constructing models for health information technology
- establishing educational programmes in informatics and information technology majors in health educational institutes
- training and skilling in compound knowledge of both information technology and health by importing overseas experts
- developing practical training materials and books for health informatics
- creating a modern open and distance learning centre to offer online resources for health informatics education.

In the meantime, work will be needed to establish a uniform health informatics index system, coding systems and information standards development [18].

It has been said that 80 percent of the 17,000 hospitals in China will implement a health information system over the next 5 years, providing a market of about AU\$2 billion [17]. Some large hospitals are planning to implement new health information systems in 2003. An IT planning and investment budget of over AU\$6 million has been allocated for the China–Japan Friendship Hospital, Peking Union Medical College Hospital, Peking Friendship Hospital, People Hospital of Peking University, Yunnan Tumor Hospital and The PLA 301st General Hospital [28].

### *Medical education*

The *Chinese National Programme for Medical Educational Reform and Development* [19] defines the medical educational mission by 2005 and 2015 as follows, to:

- Optimize the medical educational structure in levels, specialization, and layout.
- Reform training models, curriculum system, teaching content, teaching measure and method.
- Establish new training models and curriculum systems that combine arts, science and medicine to conform to the needs of the development of medical science and the change of healthcare service models by 2005.
- Adjust medical programme aims, reduce the quantity of medical programmes, and develop relative medical programmes through introducing the experience of other countries.

## Conclusion

After entry into the WTO, China will have to face the global system. China's healthcare system will have many challenges and opportunities. However, there will also be greater business opportunities for foreign organizations and enterprises.

Some foreign IT enterprises are actively seeking opportunities to enter the Chinese health market, such as CISCO, Oracle, IBM, Siemens, Cerner, and SeeBeyond. For example, a report entitled 'CISCO marches towards health informatics in China' has been published on the website of the China Center for Information Industry Development (CCID) [29]. However, different hospitals in China have different business models, management systems and work practices, which are very different from foreign methods in workflow processing. It would be very difficult and even impossible to try to impose a single solution onto different business and clinical models.

To date, no successful cases of foreign solutions in China have been reported [30]. There are two key reasons for this. The first is that there are still no uniform health informatics and information exchange standards in China. The second is the shortage of multi-skilled experts who understand IT, health and management. Lack of skilled human resources will limit the penetration of information technology into the health industry. Training and skilling of human resources are the critical requirements at present.

China's higher education plays a decisive role in this respect. The performance of this sector will relate directly to the building of the human resources of industry to enable its economic and social advancement. WTO entry will accelerate the reform of China's higher education to cope with the change.

Today, China's educators are viewing education in global terms. China is also opening its markets to the world, especially in education. Developed countries should take this opportunity to export their advanced health ICT technology, management expertise and existing health information system to China, especially China's health informatics educational market.

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