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FORMATION EN CHIRURGIE CARDIO-VASCULAIRE ET THORACIQUE /
TRAINING PROGRAM FOR CARDIO-VASCULAR AND THORACIC SURGERY

INITIATION OF A MODEL SIX YEAR CARDIOTHORACIC SURGERY RESIDENCY PROGRAM IN SHANGHAI, CHINA

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SUMMARY

China has witnessed an accelerated growth in its economic, demographic, social, and political development. The population of China is over 1.3 billion people, in comparison with the world population of >6.5 billion. Healthcare is evolving from a totally socialized government funded system to a hybrid of government and privatization, and a slowly increasing number of private "for profit" systems with domestic and foreign support. The medical education system beyond medical school, i.e. graduate medical education (GME), is not centrally organized or controlled in China. It is estimated there are 8 million Chinese citizens in need of cardiac surgery. There are presently approximately 100,000 operations performed in over 170 centers annually, with <20 centers doing more than 1,000 per year. The exact number of cardiac surgeons is unknown, but estimated at over 1,000. The individual larger centers have developed their own "in-house" residency programs, with no oversight authority, or transparency. There is no formal specialty or subspecialty board certification or credentialing process. In August 2005, a formal six year cardiothoracic residency program was initiated at Shanghai Chest Hospital, Shanghai, China, in cooperation with the World Heart Foundation. Modeled after the current USA program, and modified for China, this system is designed to provide a defined period of cardiothoracic residency training with graduated responsibility, subsequent written/practical/oral examination, and certification by the local Shanghai Health Bureau, Shanghai Chest Hospital, and the World Heart Foundation. A review of the planning, initiation, implementation, and early experience with this effort is presented.

Key words : China – Cardiothoracic residency training

RESUME

La Chine connait une croissance accélérée dans son développement économique, démographique, social et politique. La population de Chine est à plus de 1.3 milliards de personnes, en comparaison de la population mondiale de plus de 6.5 milliards. Les Services médicaux totalement sociaux initialement sont passés à un système hybride voire privé avec un nombre croissant progressif de privés au bénéfice du système avec une assistance personnelle et étrangère. Le système d'enseignement médical au-delà de la faculté de médecine, n'est pas organisé ou contrôlé en Chine. I y a 8 millions de citoyens chinois qui ont besoin de chirurgie cardiaque. Il y a actuellement environ 100,000 opérations exécutées dans plus de 170 centres annuellement, avec moins de 20 centres faisant plus de 1,000 par an. Le nombre exact de chirurgiens cardiaques est inconnu, mais évalué à plus de 1,000. Les plus grands centres individuels ont développé leurs propres programmes de résidence, sans autorité de l'Etat, ou sans transparence.

Il n'y a aucune structure formelle de certification ou de suivi des formations qualifiantes. En août 2005, un programme de formation de 6 ans en Chirurgie Cardio-Thoracique a été amorcé à l'Hôpital pneumologique de Shanghai, (Shanghai, Chine) en coopération avec la Fondation Mondiale du Cœur. Cette résidence, modelée sur le programme des USA et modifiée pour la Chine, est ponctuée d'un diplôme après un examen écrit/pratique/oral et certifiée par le Bureau local de la Santé de Shanghai, l'Hôpital pneumologique de Shanghai et la Fondation Mondiale du Cœur. Une revue de la planification, de l'initiation et de la mise en œuvre de ces efforts consentis est présentée dans ce travail.

Mots clés :*Formation-Résidence en Chirurgie Cardio-Thoracique*

Introduction

The global burden of cardiovascular and chronic diseases has been well documented (figures 1,2) (table 1)[1,2,3]. The Chinese experience parallels this burden[4,5]. Of interest to cardiothoracic surgeons are the global incidence, prevalence, mortality, morbidity, and long-term results of cardiac and thoracic diseases, and subsequent surgical management. Unfortunately, there is no international database to exact these statistics[6,7]. Global cardiothoracic surgery statistics are extrapolated from unofficial sources that include corporate data e.g. annual sales of cardiopulmonary oxygenators, perfusion packs, heart valves, or disposable mechanical stapler devices, as well as data from the West, e.g. the Society of Thoracic Surgery, and European Association of Cardiothoracic Surgery annual database systems. Disposable items, like cannulas or OPCAB devices give inaccurate statistics, since they are reused multiple times in many developing countries and emerging economies.

Table 1 : Deaths by Major Causes, estimates for 2002

Source: World Health Report 2004

Total Deaths	**57,029,000**
Communicable	*18,324,000*
Respiratory Infections	3,963,000
HIV/AIDS	2,777,000
Perinatal Conditions	2,462,000
Diarrheal	1,798,000
Tuberculosis	1,566,000
Malaria	1,272,000
Non-communicable	
Cardiovascular Disease	16,733,000
Malignant Neoplasms	7,121,000
Injuries	5,168,000

http://www.who.int/whr
http://www.who.int/whr/2004/annex/topic/en/annex_2_en.pdf
and Comment : Injury- Surveillance is Key to Preventing Injuries. Lancet 2004, 364:1564.

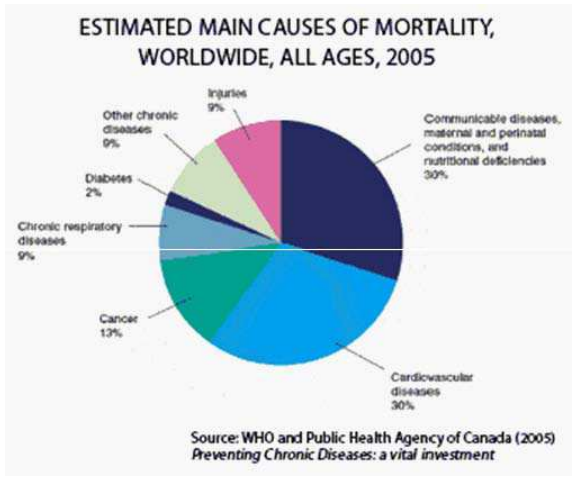

Figure 1: Estimated main causes of mortality, worldwide, all ages, and 2005

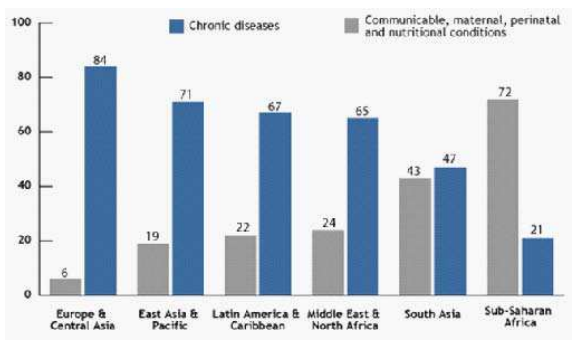

Figure 2* : Global Incidence of Chronic Disease

**Source: Ref. #1. Deaths by Cause. http://www.prb.org/images07/Dths-ByCause.gif. (Accessed 8/3/08).*

The annual Chinese mortality for ischemic heart disease, lung and esophageal cancer, and tuberculosis exceeded 14% of total annual deaths in China in 2001(table 2)[4,5]. The incidence of chronic disease is rising, in the face of lingering infectious diseases that include rheumatic fever, HIV/AIDS, and tuberculosis. This double burden of disease is not seen in the West. The access of cardiothoracic services worldwide remains a challenge. This has been reasonably studied and documented[1,2,3]. Access to Cardiothoracic (CT) surgical services remains a greater challenge in China, given the population of 1.3 billion people, an estimated backlog of 8 million patients, a growing incidence of diseases that includes >150,000 neonates with congenital heart disease, and the imbalance of healthcare access and delivery systems between the urban and rural population[8].

Historically, a number of international voluntary and humanitarian efforts in cardiothoracic surgical services have and continue to be made in emerging economies[9]. This has included a variety of initiatives. Both paying and non-paying patients, especially congenital, have been transferred and treated in the developed/industrial countries with gratifying results and outcomes. Yet, aside from marketing and good will, this has not been a cost-effective strategy, in terms of reducing the global backlog, or promulgating the "teaching to fish" concept. Ironically, the reverse course of surgical tourism has expanded recently to include patients from developed countries going to emerging countries for surgery at lower prices[10]. Large state of the art "for profit" centers in these countries cater to the global market, as well as the privileged or financially capable native population. Visiting surgeons, either solo, or with non-government organizations (NGO's) or medical center sponsored teams, have and continue to go to these countries for short term visits to offer assistance from a clinical, educational, and training perspective. When done on a continuing basis to build capacity in the surgical team in a specific host country and program, this yields gratifying results[11]. Non-sequential or inconsistent, sporadic voluntary short term efforts, often categorized as "surgical tourism", have generally been unsuccessful.

Foreign trained CT surgeons, as well as foreign medical school graduates, have and continue to go abroad to obtain accredited and non-accredited training, as well as those coming for short 1-6 month observational training/education experiences[12]. In the USA, the procedural aspects of obtaining fellowship training are complex. Obtaining a J1 visa is a requirement for acceptance to USA training programs (www.ecfmg.org/). This involves completion of the USML steps one and two, as well as English language proficiency. Some of those who have qualified and completed their USA fellowship training attempt to remain beyond their J1 or HI USA visa status to obtain permanent resident status (green card). This is substantiated by the percentage of foreign medical graduate (FMG) physicians practicing in the USA[13]. Other western programs (e.g. USA, Western Europe), as well as regional centers (e.g. Hong Kong, Singapore, Australia, New Zealand, Taiwan, Japan) have and continue to offer both short term, and long term

support with education/training , and research opportunities. The major societies offer visiting fellowships, and ongoing review courses, e.g. the Bergamo School *(http://school.eacts.org/)*. For China, the major difficulty continues to be language and unfamiliarity with either the USA or other country qualifying systems.

Most of these efforts still fall short of the global challenge to increase the quality and quantity of cardiothoracic surgical services in any particular country or region (figure 3)[14].

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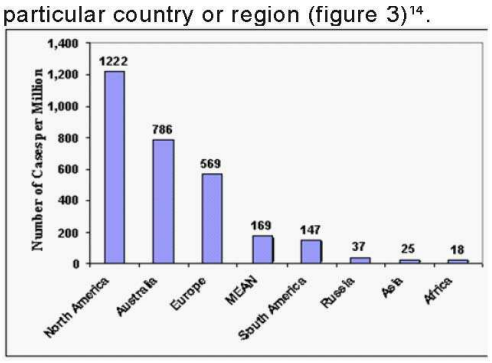

Figure 3* : Number of Cases per Million in several continents.

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** Source: Unger, F. Worldwide Survey on Cardiac Interventions 19995. Cor Europaeum. 1999;7:128-146.*

A practical and, probably more lasting and durable initiative is to establish effective long-lasting "in situ" relationships with a host program or country, thus decreasing emigration, diaspora, or "poaching" of physicians and healthcare workers, and providing a continuous increase in capacity with upgrading of clinical care, services, education/training, and clinical/basic research within their native country[15]. For the larger populated countries, like China and India, this is a practical and more effective approach, especially with regards to education and training. Unfortunately, the glamour, distraction, or emphasis on acquiring high tech operations, e.g. transplantation and robotic surgery, in developing or emerging countries, and the greed of some Western centers and individuals eager for commercial success, have overshadowed the basic need of providing basic CT surgery to the larger patient population base, as well as providing accredited centers with well trained personnel, especially CT surgeons and teams, to handle the backlog and increasing incidence of CT surgical problems.

This is especially important in China where the graduate medical education (GME) system is still evolving. There is no national or central based Graduate Medical Education (GME) system in China. The National Ministry Health Authority controls medical education, but has not been proactive in initiating national norms, standards, or directives. The Chinese Academy of Medical Sciences, the Chinese Medical Doctors Association (CMDA), and the Chinese Association of Thoracic and Cardiovascular Surgery offer broad based recommendations, but have no official authority or mandate re. education/ training directives or standards. In fact, broad based international recommendations and standards regarding graduate medical education/training programs remain non-existent worldwide[16]. Funding for GME in China is provided by the individual large training hospitals, with little or no financial or administrative support from central or local government health agencies. In addition, most hospitals must subsidize their budget with financial revenues from billing patients for supplies, drugs, and high tech diagnostic and therapeutic services. The larger national training centers, like FuWai and Anzhen hospitals in Beijing, Shanghai Chest Hospital, and Shanghai Childrens Medical Center, though well established and experienced with education/training and clinical care, cannot meet the accelerated demand. It is necessary and imperative to reform the present education/training scheme in China. To address this challenge, the World Heart Foundation has embarked on a collaborative effort with Shanghai Chest Hospital and the local Shanghai Health Bureau to initiate a standardized, model six year cardiothoracic residency program at Shanghai Chest Hospital. Hopefully, this model will serve as a template for other programs to study and adopt, or integrate into their own system. The ultimate goal is to accelerate the formation of a centrally organized and administered graduate medical education system in China. The present report highlights the initiation and first three years experience with this project.

Background

a. History of China

The Chinese culture and civilization is one of the oldest in the world, with humanoid fossils dating back 1.7 million years[17]. The first Chinese dynasty dates back to the 22nd century BC. Table three gives an abbreviated summary of the dynasty chronology[18]. The Zhou dynasty (11th century-256 BC) saw the emergence of the four social classes – scholar, farmer, laborer, and merchant. This was the era of Confucius (551-479 BC), who established the philosophical base of Chinese thought, characterized by "ren" or benevolence. The Great Wall emerged in the Qin dynasty (221-206 BC). During the "golden era" or Han dynasty (206 BC -220 AD) the economy flourished, and paper was invented. The legacy of other Chinese inventions include movable type, the compass, firearms, paper money, and gunpowder[17]. China was also one of the first countries to navigate the world[19].

Though traditional Chinese medicine (TCM) began during the earlier Zhou dynasty or Spring-Autumn Period (772-481 BC), it advanced during the Han dynasty[20]. Hua Tuo and other Chinese doctors developed the notion of holistic medicine, as opposed to the western system of curing specific illnesses. Chinese herbal medicines, along with acupuncture, and exercises like Tai Chi, became the basis of traditional Chinese medicine. The Compendium of Materia Medicu became the authoritative text that listed and described the pharmacology of thousands of herbal medicines. In the modern era the Chinese or Sinic civilization remains the oldest and most robust of the 8 remaining major global civilizations (Sinic, Japanese, Hindu, Islamic, Western, Latin America, African, and Orthodox)[21].

Surprisingly, it was drugs, namely opium, that brought China into open conflict with the Western powers, especially Great Britain during the last half of the 19th century[17,18]. The 20th century was a defining period for China as it emerged from the Qing dynasty (1616-1911 AD). The Boxer rebellion of 1899 saw the beginning of separation from western power influence, the end of emperor rule, and the start of a democratic process. Most westerners, especially faith based groups were expelled from China. Educational efforts, including the American John Dewey's two year project in China to demonstrate the American educational system, were rejected[22]. Foreigners like Pearl Buck and Edgar and Lois Snow have documented the plight of the Chinese people during this tumultuous period[23]. This has had a far reaching effect as the present educational system in China is still somewhat devoid of creative and analytical skills. Yet China has recently increased its political and economic support of indigenous research and development[22].

The conflict between the nationalists and communist political factions abated during World War II, where a united China, in alliance with the west, opposed Japanese aggression and courageously defeated over one-half of the total Japanese military effort in the Pacific theater of conflict.

Following the war, the hostility between the nationalists and communists re-emerged with the ultimate establishment of a Chinese communist state in 1949. Three subsequent movements occurred. The Peoples Communes and the Korean War gave way to the cultural revolution from 1966 to 1978, with its hard line socialistic constraints and suppression of individual expression and growth, but which eventually saw the emergence of a modified traditional Chinese culture, ultimately overshadowing the remnants of the Chairman Mao Ze Dong sponsored rigid communistic structured society[24]. However, during the cultural revolution the effect on education was profound. There was the attempt to define a modern educational system that tried to eliminate the "three distinction": town vs. country; industry vs. agriculture; and mental vs. manual labor. This virtually halted academic and creative intellectual activity[25]. All foreign influence was suppressed, as well as the native Confucian and Taoist philosophy.

China gradually opened to the west following the "ping pong diplomacy" and President Richard Nixon's visit to China in 1972. By 1978, with the inspired leadership of the moderate hard liner Deng Xiaoping, China re-emerged as a balanced society that embraced both the elements of state controlled socialism, and the foreign style elements of capitalism or economic free enterprise[24]. This has evolved dramatically with China becoming a major international force both economic growth and geopolitical influence (table 4,5).

Table 4 : China Statistics

Area – 9,560,900 sq km
Population – 1.313 billion
GDP – 1.417 trillion
Annual GDP – 9.1% (1994-2004)
Health care – 5.6% GDP (USA-15.2%) + Education spending – 5.7% of GDP
Human Development Index – 75.5 * (HDI)

* HDI – measures income levels, adult literacy, and life expectancy
(>80 high; 50-79 medium; <50 low)

** The Economist, Pocket World in Figures, 2007 edition. Profile Books LTD. London, UK. 2007.

Country	Doctors
USA	321
Malawi	000
China	

China is the 3rd largest country, with the largest population, and the fastest growing economy.

Table 5 *: Country, China

Population estimates	
Total population (000), 2003	1,311,709
Percentage of population aged 60+ years, 2003	10.5
Total fertility rate, 2003	1.8
Health indicators	
Life expectancy at birth (years) 2003	
Total population	71.0
Males	70.0
Females	73.0
Child mortality (probability of dying under age 5 years) (per 1000) 2003	
Males	32
Females	43
Adult mortality (probability of dying between 15 and 59) (per 1000) 2003	
Males	164
Females	103
Healthy life expectancy at age 60 (years) 2002	
Total population	64.1
Males	63.1
Females	65.2
Healthy life expectancy at age 60 (years) 2002	
Males at age 60	13.1
Females at age 60	14.7

However, there remains economic and social imbalance in China. Despite the average GDP of 9.1% from 1994-2004, the 3 major regions of China have grown disproportionately. The eastern coastal region of 482 million people boasts 58% of this annual GDP, whereas the inner region of 710 million people has a 38% share, and the western region of 83 million has only 4%[26]. The Chinese communist party has become aware of this imbalance, and during the 11th meeting of the party in November, 2005, the theme of the new 5 year plan was the creation of a "harmonious society". Elimination of the farm tax was a bold step in that direction, along with harsher punishment for political fraud in the higher economic zones, like Shanghai. China remains open to growth and development, as witnessed by the assimilation of Western technology, yet mindful of its proud history and heritage (figure 4).

Figure 4 : The Old and New Shanghai, China (photo, courtesy of Dr AT Pezzella)

Figure 5 : (A) Dr Gu, Dr Wu, Dr Huang

b. Healthcare in China

As in most countries, education and healthcare are low priority, given the fact that neither generates immediate revenue or tangible results. Qizhi[20] gives a very detailed history of traditional Chinese medicine (TCM) and the

incorporation of foreign medical thought and technology.

Healthcare, as measured in life expectancy or number of surgeons, parallels economic imbalance (figures 6,7)[27,28]. Despite the average annual growth of GDP in China, the gap between the 3 populations regions of China remain apparent, with the eastern coastal region receiving the larger percentage of healthcare benefits[26]. At the hospital level, the complexity and number of surgical specialties and beds available remain the method of categorization. Hospital levels range from 1 A,B,C to 2 A,B,C to 3A,B, C, with 3A being the "best" or most sophisticated[29]. Patients can choose their doctors at the hospital. The names and photos of the attending doctors available are portrayed in the hospital lobby entrances for perusal and selection. Direct referrals from other physicians are not the norm. Though physicians are hospital employees, the "red envelop" courtesy payment by patients to desired surgeons and staff is commonly practiced[30]. In many cases, the patient must also pay the hospital for expensive devices, e.g. heart valves, mechanical staplers, and expensive drugs.

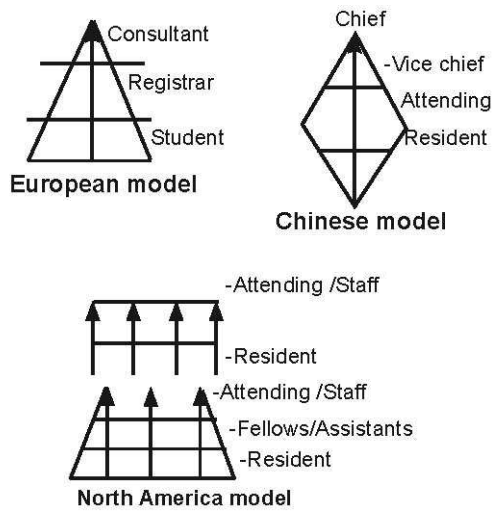

Figure 6 : Training Models in CI Surgery.

Historically, healthcare in China has evolved in China since 1949[31]. In the early era from 1949 to early sixties prevention and universal access to healthcare were the priority. The barefoot doctors (estimated at 1 million) were basically farmers with basic medical training. They were sent to rural areas to fill the void when urban doctors were not available. The average life expectancy improved dramatically from 32 years in 1950 to 69 years by 1985[30]. Infant mortality decreased from 200 to 34 per 1000 live births[31,32]. However, by 1987, the economic reforms saw a gradual transition to market based approaches and a breakdown of universal healthcare coverage, especially in the rural areas and western provinces. The barefoot doctors gradually disappeared or evolved into non-effective administrative positions. This resulted in more concentration of resources into the urban areas, leaving the rural majority neglected or ignored. This disparity has been highlighted in recent epidemiological problems, including HIV/AIDS in 1985, SARS in 2002, the Avian Flu Virus (H5N1) in 2005, and the recent earthquake in 2008[25].

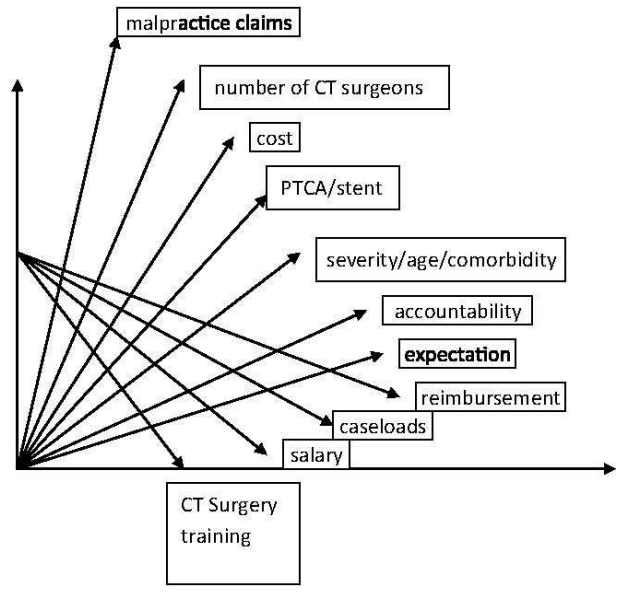

Figure 7 : The Challenges for Cardiothoracic Surgery – USA/Developed Countries/Economies

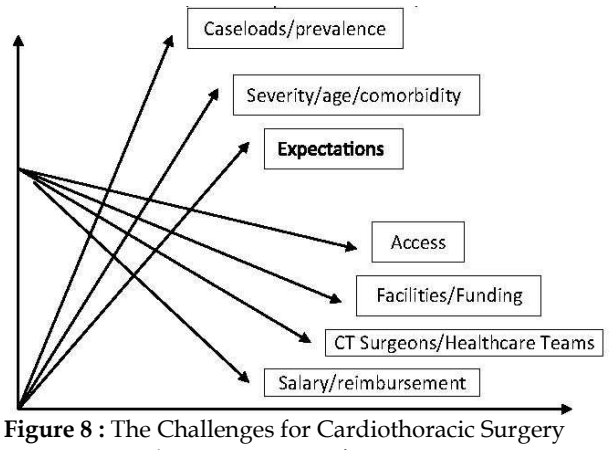

Figure 8 : The Challenges for Cardiothoracic Surgery – Developing Countries/Emerging Economies

Overall healthcare spending in China is 5.7% of GDP. Central government funding of national healthcare has decreased from 32 to 15%[31-34]. At present <29% of Chinese people have health insurance, and >58% of healthcare spending is personal out-of-pocket. The disparity is witnessed further with >80% of rural residents having no insurance or public coverage. The average Chinese has little disposable income, given the fact that savings are sequestered to finance personal healthcare and education. At the hospital level, there is minimal central or local government financial support. As noted, over 90% of hospital revenue comes from the patients' medical care expenditures[31-34]. As an example, patients requiring a lung resection can have mechanical staples if they pay for the device, otherwise they get silk ligation of the bronchus, and the "Chinese GIA" (i.e. horizontal silk mattress closure of incomplete fissures).

Unfortunately, the USA healthcare system is not be a perfect model or system for China. The USA is the only developed country without a universal health care system. In 1990, the USA ranked 10th in a 10 nation survey on level of healthcare satisfaction[35]. The poor pay 18% of their disposable income on health, verses 3% for the rich. More than 46 million Americans (including both employed and unemployed) are uninsured[35].

Cardiothoracic Surgery in China

a. History of CT Surgery in China

The growth and development of CT surgery has been slow yet progressive in China. The history is well documented in the excellent monograph by Wan and Yim[36]. Yet reference or elaboration of CT surgical training in China is lacking. The major historical CT operative procedures performed in China are summarized in (table 6)[36]. Despite limited exposure to the West from 1949-1966, and intellectual suppression during the Cultural Revolution from 1966-1976, the ingenuity, persistence, and determination of the early pioneers is evident. Four pioneers stand out: Ying-Kai Wu, Jia-Si Huang, Kai-Shi Gu, and Mei-Hsin Shih (figure 5 A,B). Dr Wu received training further training in the USA. He returned to China in 1943, after 10 months with Dr. Evarts Graham at Barnes hospital in St Louis, Missouri. He eventually became an honorary member of the American Association of Thoracic Surgery (AATS)[37]). Dr Huang also trained in the USA with Dr John Alexander at Ann Arbor, Michigan. Dr Huang was, in fact one of the founders group of the American Board of Thoracic Surgery (certificate # 229) in 1951. Foregoing the opportunity to remain in the USA, he returned to Shanghai, China[38]. Both surgeons were instrumental in fostering not only developments in CT surgery, but also formulating the basics of education and training for future Chinese CT surgeons. Huang's textbook of surgery continues in its 7th edition[39]. Dr Gu become the vice president and chief of cardiac surgery at Shanghai Chest Hospital in 1957[40]. He pioneered the early growth of cardiac surgery, performing the first open-heart operation in China utilizing a Chinese made heart/lung machine in 1958. Dr Shih trained with Dr Huang[39]. He performed the first Blalock-Taussig shunt in China in 1944. He also corrected an ASD in 1958 utilizing surface cooling.

Table 6 : [36]Chronology of Significant First Successful Cardiothoracic procedures in China

Year	Surgeon	Procedure
1937-	Da-Tong Wang	Lobectomy for bronchiectasis
1940-	Ying- Kai Wu-	Esophagectomy for carcinoma
1941-	Ji-Sheng Zhang-	Pneumonectomy for carcinoma
1944-	Ying- Kai Wu-	Ligation of patent ductus arteriosus
1953-	Mei-Shin Shih-	Blalock-Taussig shunt
1954	Xi-Chun Lan-	Closed Mitral
1958	(June)-Hong-Xi Su-	First CPB procedure (VSD repair)
1958	(July) Kai-Shi Gu-	Correction of RVOTO with Chinese made CPB
1974-	Jia-Qiang Guo-	machine at Shanghai Chest Hospital CABG
1974-	Wen-Xiang Ding-	Pediatric (<2 years) cardiac surgery

The contributions from the West can be divided into 4 eras: the first era was the Western missionaries who ventured to China over 100 years ago as volunteers or missionaries to establish churches, schools, and hospitals[41]. One example is the Peking University Medical Center (PUMC) in Beijing. In 1917, the Chinese Medical Board of the Rockefeller Foundation established PUMC to foster the spiritual, physical, and mental well-being of the Chinese people[38]. The second era involved a few Chinese surgeons, like Drs Huang and Wu, receiving formal training in the West.[42]. The third era saw prominent foreign surgeons returning to China. Leo Eloesser came to China following World War II and spent 4 years living and working there[43]. Following WW II there was an increase in the number of notable first CT

surgical procedures performed in China. Norman Bethune from Canada, having previously worked in Spain during the Spanish civil war preceding World War II, came to China as a zealous socialist and participated in the Communist Great March following World War II[44,45]. He died in China from septicemia and became a national hero. The fourth era occurred after 1978 and the 10 year cultural revolution, when China progressively opened to the West. Prominent western surgeons, including Michael DeBakey and Denton Cooley came to China to teach and operate. At the same time, many Chinese surgeons came to the West for short and long term training. A notable example is the number of Chinese surgeons receiving non-accredited 1-2 year " hands on" clinical fellowship training with Dr Albert Starr's program in Portland, Oregon[18] Chinese CT surgeons completed non-accredited clinical CT surgery fellowships in Dr Starr's program)[46]. Other surgeons ventured to Japan, Australia, and New Zealand.

The international "break out" event for CT surgery in China came in 1981 with the International Cardiothoracic Surgery Beijing Symposium[29]. Participation by the international cardiac surgery community accelerated subsequent exchange .Since then a number of international meetings have been held in China, including the 1986 conference, and the recent Beijing International Heart Forum in 2005[29].

This era continues today with the current generation of foreign surgeons, as well as NGO's, and foreign companies bringing new technology, as well as clinical expertise in establishing or upgrading CT surgery centers and programs throughout China. At the same time, the indigenous development of Chinese devices, like heart valves, oxygenators, and medical equipment, continues to grow.

Foreign surgeons, like Drs.Carlos-A Mestras from Spain, Roland Hetzler from Germany, Ray Chu-Jeng Chiu, Jean Deslauriers, and Ren-KE Li all from Canada, are notable examples of dedicated international volunteers who have donated their time and services to help their Chinese colleagues. Native Chinese surgeons abroad have also been involved in this effort. Hong Kong, after returning to mainland Chinese control in 1997, Taiwan, and Singapore CT surgeons have all been especially helpful in offering training and research opportunities to mainland China medical students, residents, and faculty[42,47]. A few Chinese medical schools have expanded to accept foreign medical students, as well as develop international alliances in education and research.

The annual growth of CT surgical procedures in China continues to grow. In 1982, 6,444 open heart procedures were performed in China[48]. This grew to 15,000 cases in 1990, 59,886 cases in 2003, 74,840 in 2004, and > 100,000 cases in 2007[49] .The number of centers in 1999 totaled >600. Presently, the number of centers exceeds 700 (>170 is the more realistic number), with >75% of the centers performing < 100 cases/ year. Fu Wai hospital in Beijing performs the largest number of cases, estimated at > 7,500 procedures/year. There are at least 20 hospitals in China performing >1,000 cases per year in Beijing, Shanghai, Wuhan, Guangzhou, and Chengdu[29]. From 1997-2004, the breakdown of specific procedures was 60% congenital, <25% valvular, 10-15% CABG, and < 5% aortic procedures[29,49]. In a national survey in 2005 there were 1,225 cardiac and 3,405 CT surgeons in China[49]. Thoracic surgery continues to grow with increases in lung cancer, as well as a large incidence of esophageal cancer. At Shanghai Chest Hospital > 2,500 major chest procedures are done annually, including > 250 esophageal resections for carcinoma.

At present, the estimated backlog of patients requiring cardiac surgery in China is >8 million[8]. The annual incidence of congenital cardiac disease exceeds 150,000 , with a rate of 6.7/1,000 live births[50]. Of these > 100,000 need surgical or interventional procedures. Less than 80 centers are capable of treating CHD, with < 10 centers having expertise for complex neonatal problems[50].

Clearly, the need for more centers and CT surgeons is apparent. This is a global problem. The overall number of healthcare workers in Asia is 2.3/1,000 population, compared with 10.1/1,000 in the USA, and the 4.0/1,000 global average[51].

As noted, the incidence of coronary artery disease and degenerative valve disease will increase as the population ages. In 2000, 7% of the population was >65 years old. This will rise to 20% by the year 2040 (5). This alone will increase annual deaths 200% from CV

diseases[5].

b. CT Surgical Education/ Training

It must be kept in mind that only 3% of Chinese have a college education, versus 22% in the USA, and, in general, tuition is free. Newer private medical schools now charge expensive tuitions[22]. At present, following graduation in 5.5 to 6 years at 23-24 years of age from an accredited Chinese medical school with a bachelor of medicine degree (171 medical schools in China)[52], the future CT surgeon can apply for a job vacancy at a hospital with an active CT surgery service, and an “in house” training program. He/she is accepted as a hospital employee. The number of residents is limited by the number of employee vacancies. A second route is to pursue a masters degree in medicine, combined with a residency. Others can pursue this tract to gain the doctor of medicine degree as well. More than 15 centers in China offer the masters or doctorate in medicine program[50]. At present 15 medical universities are approved by the government as teaching centers for masters and doctorate programs[50]. Over 50% of the present Chinese CT surgeons have a masters degree, and about 30% have a doctorate degree. Though long and arduous, this pathway offers the best chance to secure an attractive academic position. A small number of graduates do not pursue clinical medicine but enter industry or sales of pharmaceuticals or medical devices. The training hospitals receive no formal financial assistance for medical training from the central or local governments.

In contrast, in the USA, all Graduate Medical Education (GME) is financed by the federal government through the Medicare program (53,54). In 2004, Direct- GME funding was 2.7 billion dollars, and Indirect- GME funding 5.8 billion dollars. Medicare controls the total number of resident positions in accredited residency programs. This has become a debated area since the number of residency positions accedes the annual number of medical school graduates. Given the need of doctors in primary care, as well as selected specialty areas, the shortfall has been filled by foreign medical graduates.

In China, once accepted into the designated training hospital, there is a basic first year of general medical training in order to qualify for medical licensure by the local health bureau. Then there is 1-2 years of basic surgical training. This culminates in qualifying for an attending examination and credentialing. This examination is a general national attending certification test administered by the National Ministry of Health. Thereafter, the candidate is a hospital employee, and can pursue further training at that hospital, if it is available, and assuming the candidate is qualified and accepted. This aspect is very subjective, relying on recommendations of senior staff, chiefs, and vice-chiefs. Traditionally, cardiovascular and thoracic training are separate pathways. As stressed, there is no centrally controlled or administered graduate medical education system, nor specialty credentialing process in China.

In comparison, in the USA, the non-profit independent Accreditation Council for Graduate Medical Education (ACGME), established in 1981, controls and coordinates the 8,355 ACGME residency programs, covering 126 specialties and subspecialties, and 106,245 residents[55]. Each specialty board, like the American Board of Thoracic Surgery (ABTS), coordinates the criteria, selection, residency programs, and certification processes.

Presently, in China, after 2-3 more years of specialty training, the attending is granted privileges to perform surgery at that hospital. Yet the attending is under the direction of the chief and vice-chief of that team. He cannot admit his own patients, assume primary responsibility, or operate independently. He/she basically remains a vassal for varying lengths of time, with only graduated levels of operative independence. Basically, it is a master/apprentice system, somewhat similar to the Kung fu (Wu Shu) system of teaching the martial arts! Historically, this is the familiar old European triangle system, the difference being the varying number of accepted candidates, depending on job vacancies in that particular hospital (figure 6).

Historically, the German triangle or pyramid system was brought to the USA by Dr William Halsted to Johns Hopkins Hospital in Baltimore, Maryland in 1889[56]. This system produced a number of gifted surgeons who became chiefs at many academic centers, but failed to satisfy the need of more qualified surgeons to meet the rising demand. It was basically a modification of the master/apprentice philosophy. In 1931 Dr Edward Churchill

redesigned the system to a more horizontal system that increased the overall number of qualified and capable surgeons. The model was based on the creation of a group of masters with a institutional team approach to education and teaching. This system persists to the present day.

The triangular or pyramid system is doomed to failure, since there are only a limited number of vacancies in the hospitals, with the best candidates competing for the few positions in the larger centers. In addition, attractive candidates will be dissuaded from pursuing a long and arduous career in favor of more lucrative and promising careers in other areas. To use the airline example, as China airlines increases its flights and routes, buying more Boeing and Airbus planes, they urgently need more trained pilots. This mandates quantity and quality in a shorter time period. Foreign pilots are a short term measure. Native Chinese pilots are needed. CT surgery is growing in China, given the increase in centers, and the ability of more patients able to pay for services. This mandates an increase in qualified Chinese CT surgeons. This is the grid lock situation for CT surgery in China. China has well trained and capable mentors and teachers. Convincing them to change their philosophy of training is a major challenge. A paradigm shift to accelerating the experience and responsibility of the aspiring Chinese CT surgery residents will help alleviate the problem. If this doesn't occur, then fewer candidates will pursue a career that is low in salary, long in training, and not professionally satisfying. In interviewing a number of Chinese medical students and residents, the three major wants or needs included opportunity to do what they were trained to do, a secure job with decent salary, and personal time for family and other interests. This is being seen to some extent in the American system. The differences between the Western and Chinese system are summarized in figures 7,8. A major difference is the increasing caseloads and demand in the emerging economies and developing countries. A disturbing trend in the American system is the declining number of candidates applying for CT surgery residency positions. The number of CT surgery resident candidates have decreased an average of 10% per year in recent years[57]. Long training periods (7-9 years post medical school---mean age 35+/- 3years), large debt (mean of $51,000), decreasing jobs and salary are given as major reasons for this trend[57,58].

As highlighted, China was sheltered from the West from 1949-1978, with few Chinese CT surgeons receiving formal training abroad. Not surprisingly, the pioneers of CT surgery in China advanced on their own, given their innate talents and abilities. Language and visa requirements have, and still remain major barriers to Chinese surgeons seeking training abroad. Canada, USA, Australia, New Zealand, and Japan have been the major countries for both short term, and long term "hands on" accredited and non-accredited training. At present, the visa restrictions and requirements for both the H1 research visa and the J1 clinical visa have decreased the overall number of foreign trainees in the USA. The ECFMG remains the organization that administers the qualifying USML examinations that qualify the candidate for visa approval[59,60]. Few Chinese surgeons presently have availed themselves of the international opportunities, given the language, political, and logistical challenges and constraints.

Model/ Standardized Program

" There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new order of things" Niccolo Machiavelli[61].

The need for improvement in residency training was highlighted in 1995 at a National Chinese conference However, no firm recommendations were made or implemented[42]. In 1997 David Cheung from Hong Kong proposed a project to formally train mainland Chinese surgeons in Hong Kong[62]. Despite hard work and diplomacy the project never materialized. A second attempt was made by Baxter Ltd to develop centers of excellence in both China and India. Again that program never materialized[63]. A notable exception was the Shanghai Children's Medical Center. In cooperation with Project Hope and Boston Children's Hospital, and under the direction and leadership of Dr Richard Jonas, a modern, state of the art pediatric cardiac surgery program was established in the late 1980's[64]. This program has grown to > 2,000 open heart operations/ year. An in house Pediatric Cardiac surgery residency program was established as well, along Western standards, though elements of

the master/apprentice system still remain. Younger attendings still advance slowly in operative experience and responsibility.

In 2002, at the annual meeting of the Asian Society of Cardiovascular Surgery in JeJu, South Korea, a proposal was made by the World Heart Foundation to Professor Yingze Li, Vice President and Chief of Cardiac Surgery, Shanghai Chest Hospital (SCH) to initiate a formal standardized 6 year CT surgery residency program, modeled after the USA system. Following a series of meetings in the USA and China, a memorandum of understanding was fashioned. A formal proposal and business plan was accepted by the World Heart Foundation, Shanghai Chest Hospital, and the Shanghai Health bureau (table 7). Two additional Shanghai centers were invited to participate in a cooperative collaborative endeavor, but declined, as well as Fu Wai hospital in Beijing.

Table 7 : Shanghai Chest Hospital Model Cardiothoracic Residency Program

Introduction
Formation Correspondence/Letters Goals/Business Plan Outline of program Approval; Initiation (SCH/SHB/WHF) Application/Selection Process
Program requirements:
Caseload; Operative Log Rotations/Call schedules/Vacations Evaluations – Resident/Rotations Certification requirements Conferences – Core Lecture/M & M/VP Clinical Core lectures- one academic year cycle with lectures prepared/given by resident Monthly morbidity/mortality conference alternating between cardiac and general thoracic Visiting professor every 3-4 months Weekly preoperative case discussions to include indications, contraindications, timing of procedure, knowledge of operative technique, and early/late complications of operation
Certification:
Clinical competency-approval of program committee Operative minimum requirements Successful completion of 3 part examination process

Shanghai Chest Hospital deserves special recognition. Started in 1880 as Hongren Hospital by the Protestant Episcopal Church, it was converted to SCH in 1957 by the Shanghai Health Bureau[40]. Under the pioneering efforts of Professor KS Gu it became a national training base for CT surgery and training (figure 9). The first Chinese heart lung machine was developed at SCH (figure 10). Yet it should be stressed that other major centers, especially Fu Wai hospital, remain a major source for trained surgeons, as well as a base for development of satellite programs in northeastern China. Fu Wai developed the Chinese Technical Cooperation and Training Center of Cardiovascular Disease. Through 1998, 98 centers have been supported. This involved the re-establishment of cardiac surgery activity in 28, upgrading in 25, and de novo centers in 44[65]. The satellite concept of major centers developing and supporting smaller programs in outlying cities and regions is a practical and effective strategy for China.

Criteria to be a designated center were established. The clinical activity at SCH included >800 adult open heart procedures, > 200 pediatric open heart procedures, and >2,200 major thoracic procedures (>200 esophageal resections. The majority of the teaching staff had academic appointments at Jai Tung Medical School. The clinical research was active with peer reviewed publications in both Chinese and Western journals. The residents had access to the internet, as well as currents texts and journals in an established medical library. Adequate conference and audiovisual capability were in place. The major deficit was “in house” medical and surgical specialty consultant services. Consultants were available from affiliate institutions.

The initial phase one plan includes acceptance of residents who have successfully completed a three year general surgery residency. Phase two will require 2 years of general surgery, and subsequently four years of CT training, of which one year would include rotations on cardiology, pulmonary medicine, and oncology. Three pathways would be offered: adult cardiac, pediatric cardiac, and general thoracic. The pediatric cardiac pathway would also involve an additional year of training in a designated Chinese pediatric cardiac surgery program.

All rotations include preoperative, operative, and postoperative exposure and involvement, with incremental increases in clinical and operative responsibility. A monthly morbidity/ mortality conference alternates between cardiac and thoracic surgery. A core curriculum was fashioned from the Thoracic Surgery

Directors Association Bluebook (http://www.tsda.org/documents/PDF/Blue_Book_Curriculum_2004.pdf). A one year core lecture series was initiated with weekly resident prepared power point presentations and faculty participation/evaluation. The EACTS cardiac and thoracic outline was utilized (http://school.eacts.org/sections/Cardiac/CarCur/index.html) (http://school.eacts.org/sections/Thoracic/ThorComp/index.html).

Evaluations were submitted after each rotation by both residents and faculty. This provides valuable information, not only for resident performance, but for faculty assessment insofar as participation and willingness to advance the education and training of the individual resident. An annual in training examination will be implemented in the phase two update.

In August, 2005, 4 residents, having successfully completed 3 years of general surgery residency, began the phase one 3 year CT surgery residency (figure 11A,B). The framework for the program was adapted from the American Board of Thoracic Surgery residency system (66). The author (ATP) spent one year (July 2005-July 2006) coordinating the program, along with co-director Professor Ying Ze Li. Three residents successfully completed the program in August, 2008. The 4th resident will complete his final year following a 2 year program in Hong Kong to obtain his Master of Medicine degree. Presently seven more residents are in the program.

In summary, candidates for certification must complete a minimum of 36 months of residency training in thoracic and cardiovascular surgery in the program. This includes 12 months of continuous senior responsibility. The director and program committee of the thoracic training program must approve the resident and signify that he/she has satisfactorily completed the residency in thoracic surgery. The resident was also encouraged, but not required, to write a paper (a case study or review paper) for submission to a peer reviewed Chinese or foreign journal. This will be mandatory in the phase two update. The resident then qualifies to take the 3 part certifying examination (written/oral/practical).

Figure 9 : The new Shanghai Chest Hospital, Shanghai, China--2006

Education and adequate operative experience in both general thoracic and cardiac surgery are essential parts of the thoracic surgery residency program, no matter what pathway the resident chooses to follow

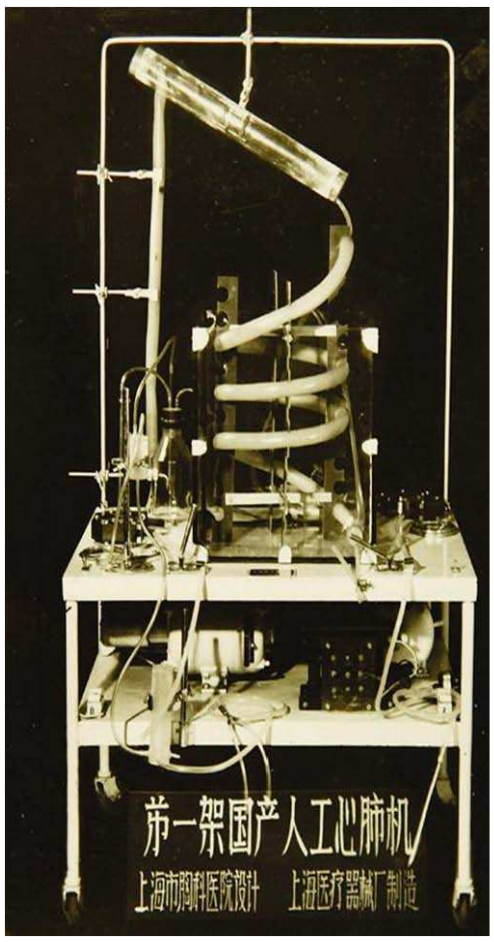

Figure 10 : First Chinese made Heart/Lung machine in Shanghai, China. (photo, courtesy of Prof Yingze Li)

Figure 11 A : First group of Chinese CT surgery residents at Shanghai Chest Hospital (photo, courtesy cof Dr. AT Pessella).

Figure 11 B : Atending assisting Chinese resident perform CT surgical procedure, Shanghai Chest Hospital, 2006.

The approved candidate must satisfy the minimum operative experience requirements (table 8).

Table 8* : Log Boolk

Cardiothoracic Pathway USA	China		Requirements	General Thoracic Pathway USA	China
20	20		Congenital Heart Disease	10*	10*
10	10	P	rimary		
10	10		First Assistant	*All cases can be as First Assistant	
150	65	A	dult Cardiac	75	65
50	45	A	cquired Valvular Heart	20	45
80	10		Myocardial Revascularization	40	10
15	5	R	e-Operations	5	5
5			Aorta	0	0
15	10		Other	15	0
50	50		Lung, Pleura, Chest Wall	100	100
30	30		Pneumonectomy, lobectomy,	50	50
20	20	S	egmentectomy Other	50	50
5			Mediastinum (resection)	10	10
15	8	E	sophagus	30	30
10	4	E	sophagectomy/Resection	20	20
0	0		Benign Esophageal Disease	5	0
5	4		Other	5	5
15			VATS	30	
255			**Total**	**255**	
40		E	ndoscopy	90	30
20			Bronchoscopy	40	10
10		E	sophagoscopy	25	10
10			Mediastinoscopy	25	10
100		C	onsultative Experience	100	-
50			New patients	50	-
50			Follow-up	50	-

*Source:ABTS:http://www.abts.org/sections/Certification/Operative_Requiremen/index.html

The major challenges for the future of CT surgery education/ training in China include: training the trainer to accept the roles of mentor, advisor, coach, and instructor of the new generation of Chinese doctors; permitting and fostering increasing responsibility, as well as operative experience of the residents; accepting the value and necessity of core lectures, ward rounds, preoperative conferences, morbidity/mortality conferences; and the

ultimate acceptance of the trained certified young CT surgery attending as a functional member of the CT surgery team with independent operative privileges, and appropriate proctoring and supervision.

The issue of allowing residents perform surgical procedures is a basic challenge not only in China, but globally. It has been demonstrated in the USA that allowing supervised resident performance of surgical procedures does not have a negative impact on patient outcomes[67-69]. To help bridge the transition in China, corporate involvement, (e.g. Ethicon and Tycos), has been helpful in allowing the residents to perform both basic and newer operations in their wet lab facilities in Shanghai.

On a larger scale, embracing the entire Chinese healthcare team, proficiency in spoken and written English, as a second language, is crucial to professional growth and global involvement. This has been adequately addressed by Benfield[70]. The level of English language proficiency in China is very low. There are many examples that can simplify the transition, (e.g. composing hospital records and charting in bilingual formats) (figure 12).

Faculty growth and development, and retention of both faculty and staff in the government hospitals in China will have to compete with the lure of private practice initiatives and opportunities. The future training programs will also have to include cooperative arrangements for rotations in affiliate hospitals to provide training in deficient areas. In Shanghai, a three month rotation in pediatric cardiac surgery at Shanghai Childrens Medical Center was a major step in that direction.

Clinical and basic research and development is an essential component of any major academic training program. Those Chinese residents who choose to go the route of obtaining their masters and doctorate in medicine will form the core group of the next generation of academic Chinese CT surgeons[50].

An interesting aspect of CT surgery in China is that, in the future, many foreign residents may desire to come to China for further fellowship training, given the large caseloads and spectrum of pathology. Cooperative affiliations are already emerging between leading centers in China and the West.

Open access to the medical literature, especially journals, remains a formidable challenge, not only in China, but throughout the world[71,72]. The CTSnet remains an essential link for the global CT surgical community. For this audience, the CTSnet remains a major, and sometimes the only source of continuing medical education (CME). Because of financial, language, and visa difficulties, it is difficult for many Chinese surgeons to attend international meetings or subscribe to major journals. Corporate sponsorship has been somewhat helpful in this regard. Already, many societies and organizations are hosting meetings in China. This trend will certainly continue. The Beijing Olympics is but the start of China embracing international participation.

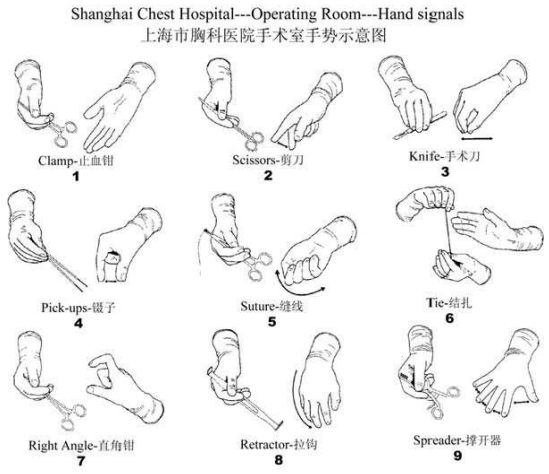

Figure 12 : Practical initiative to overcome the language barrier

Future issues to be discussed, debated, developed, and implemented in China include: maximum working hours (80 hours in USA)[73], job placement[58], newer methodology to teach operative procedures[74-76], and compliance with the newly developed American ACGME core competencies system (table 9).

Table 9*: Accreditation Council for Graduate Medical Education (ACGME) Core Competencies

Patient Care
Medical Knowledge
Practice-Based Learning and Improvement
Interpersonal/Communication Skills
Professionalism
Systems-Based Practice

*Source: ACGME.http:/www.acgme.org/outcome/comp/compFull.asp. Accessed 8/17/08

Remarkably, the Chinese display the admirable quality of assimilation. They have become the benefactors and not the victims of the resurrected educational philosophy of

Confucius, as well as embracing varying aspects of Western thought and educational methodology[20,42] (table 10)[77,78].

Table 10[20] **:**Confucian Influence on Education

• Respect teachers and love students--------- "harmony"
• Elicitation and guidance----------active response and cooperation
• Teaching students in accordance with their attitude----- individualized, personal approach
• Proceed step by step in an orderly way------ organizational and managerial approach
• Integrating learning with thinking----balance between objective and subjective or facts vs. creativity
• Specialized knowledge needs a base------fundamentals are building blocks
• Gaining new insights through reviewing old material---- -judgment, experience, maturity is evolutionary
• Learning through practice-----aligning ethics with practical ,objective application
• Teaching and learning complement and support each other---- the mentor, coach, instructor welcomes his teacher (student)

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