Global Aspects of Cardiothoracic Surgery with Focus on Developing Countries

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INVITED REVIEW

Global Aspects of Cardiothoracic Surgery with Focus on Developing Countries

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ABSTRACT

The incidence and prevalence of cardiothoracic disease continue to increase globally, especially in emerging economies and developing countries. Cardiothoracic surgery is also growing despite limited access, availability of surgical centers, political and cost issues. The increase in atherosclerotic coronary artery disease, rheumatic heart disease, congenital heart disease, trauma, and thoracic malignancies is a more urgent problem than realized in these emerging economies and developing countries, or low- and middle-income countries. A determined focus and cooperation between the preventive and curative elements of care is warranted. This represents a paradigm shift to develop a consensus that fosters a multi-integrated disease-specific approach that includes prevention, promotion, diagnosis, treatment, and rehabilitation. In addition, the concept or acceptance of surgery as a necessary component of public health policy is critical to improving overall global healthcare.

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KEYWORDS: Developing Countries, Economics, Internationality, Thoracic Surgery

''*If you would not be forgotten as soon as you are dead, either write something worth reading or do things worth writing.*'' Benjamin Franklin

''*Have you ever started a path? No one seems willing to do this. We don't mind using existing paths, but we rarely start new ones. Do it today. Start a path. Even if it doesn't lead anywhere.*'' George Carlin

INTRODUCTION

Cardiothoracic (CT) surgery has evolved remarkably over the past 100 years. From World War II to the present, several events have accelerated the development of this specialty in the USA. The establishment of separate American military thoracic surgery units during World War II allowed specialized treatment of thoracic wounds, as evidenced by Dwight Harkin's dramatic series of surgery for penetrating heart wounds.[1] The tradition of surgical training at Johns Hopkins Hospital, initiated by William Halsted in 1889 and continued under Alfred Blalock, prepared a seminal group of dedicated CT surgeons.[2] The early initiation of a formal thoracic surgery training program by John Alexander at the University of Michigan in 1928, and subsequent establishment of the American Board of Thoracic Surgery in 1948 accelerated the quantity and quality of CT surgeons in the USA.[3] The reemergence of CT surgery in Europe and Asia in the aftermath of World War II also led to significant developments. With the end of the Cold War in the early 1990s and exposure of Russia and Eastern Europe to the West, the world was reintroduced to the contributions of its eastern neighbors.[4]

The successful introduction of the heart-lung machine and cardiopulmonary bypass in 1953 ushered in the modern era of open heart surgery. However, it was the introduction of coronary artery bypass grafting in the late 1960s that accelerated the worldwide growth

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of cardiac surgery. Yet this growth, as well as the quality of cardiac surgery, have not been uniform.[5] Weiser and colleagues[6] noted that of the annual volume of 234 million surgical procedures of all types, only 26% were performed in >70% of the global population. In low- and middle-income countries, ready access to CT surgery is proportional to the economic status of the patient. Let us examine CT surgery from clinical, education and training, research and development, administrative, political, and logistic viewpoints. This discussion will be offered from the perspective of an American CT surgeon who has spent the past 6.5 years doing voluntary CT surgery projects in a number of countries and a variety of scenarios. It may be biased somewhat by the American principles of pragmatic philosophy as espoused by Charles Pierce and William James:[7] ''beliefs, in short, are really rules for action; and the whole function of thinking is but one step in the production of habits of action. If there were any part of a thought that made no difference in the thought's practical consequences, then that part would be no proper element of the thought's significance.''

BACKGROUND

Over 6.8 billion people live on the 4.5-billion-year-old planet earth. Politically, it is composed of 244 entities (192 countries in the United Nations, the Vatican State, 9 countries not in the UN, 38 inhabited dependent territories, and 4 special entities). Our global society has evolved from hunter-gatherers to agrarian domestication, then industrial, and now a mushrooming technological community.[8] The social, political, economic, environmental, and demographic imbalances are real and factual, yet beyond the scope of this discussion. The annual global mortality was >58 million in 2005.[9] Cardiovascular disease, cancer, trauma, and tuberculosis were significant contributors to this mortality (Table 1). It is important to stress that chronic noncommunicable diseases including trauma are increasing worldwide, especially in low- and middle-income countries.[10]

Table 1. **Selected deaths by cause in WHO regions for 2002***

Causes of Death	No. of Deaths
All	57,029,000
Cardiovascular diseases	16,733,000
Rheumatic heart disease	327,000
Ischemic heart disease	7,208,000
Congenital heart abnormalities	281,751
Tuberculosis	1,566,000
Trachea/bronchus/lung cancers	1,243,000
Road traffic accidents	1,192,000
Esophageal cancer	446,000

*Based on World Health Report 2004 (www.who.int/whr/2004/en/report04_en.pdf).

Access to CT surgery, cost, and availability of trained individuals and centers are significant issues for CT surgeons worldwide. There are 1,222 open heart operations per million population in North America, and 18 per million in Africa, which translates into 1 center per 120,000 people in the USA and 1 center per 33 million people in Africa.[5,11]

Finding international data is a challenge. It is estimated that >10,000 CT surgeons in >6,000 centers globally perform more than 2 million open heart operations per year. This is based on poorly referenced data from the internet, CT surgery societies, the literature, corporate resources, and personal contacts. An accurate updated voluntary global database would certainly have value in projecting results and trends. Wyse and Taylor[12] proposed an international surgical registry in 1999. Designed to collect voluntary data on adult cardiac, pediatric cardiac, and general thoracic surgery, the goal was to allow surgeons and centers to conduct a variety of analyses so as to benchmark themselves, based on demographics and risk factors. Unfortunately, there has been no recent progress in this early initiative.

GLOBALIZATION

Globalization is not a new phenomenon.[13–16] Steger[13] offered a reasonable definition: ''Globalization refers to a multidimensional set of social processes that create, multiply, stretch, and intensify worldwide social interdependencies and exchanges while at the same time fostering in people a growing awareness of deepening connections between the local and the distant.'' Historically, with the appearance of large sea-going vessels, trade routes were established and the world saw an explosion in the exchange of goods, services, and people. China halted its globalization movement in the 15th century, and remained reclusive throughout its exploitation in the 19th century by foreign powers.[17] Having tasted the rewards of an open free economy in the 1980s, China has now become an economic superpower, progressive and assimilating, blending old concepts and philosophy with new ideas and technology to meet the needs and of its growing population of 1.3 billion.

With regards to healthcare and education, most countries follow a similar political and economic pattern of relegation to low priority, except during elections or times of crisis. Yet the quality and quantity of healthcare generally parallels GDP.[18,19] Notable exceptions include Costa Rica and Cuba where, despite low GDP, citizens enjoy both longevity and a high quality of healthcare.[19] Imbalance of healthcare is noted both within and amongst most countries; the uninsured ranks of >40 million Americans are but one example. In addition,

developing countries are challenged by the double burden of chronic noncommunicable diseases and the risk factors of hypertension, obesity, smoking, and urbanization, along with the lingering communicable diseases, especially tuberculosis, HIV/AIDS, and malaria.[20,21] Gaziano[8] described the epidemiological transitions as the age of pestilence and famine, the age of receding pandemics, the age of degenerative and man-made diseases, and the delayed degenerative diseases. The later 2 include cardiovascular diseases and cancer, whereas the former 2 include malnutrition and infectious diseases. All 4 ages remain prevalent today in double-burden countries. Yusuf and colleagues[22] recently added a 5th age of health regression and social upheaval, as seen in Russia. As well as lower life expectancy (<64.4 years average global lifespan), disability-adjusted life years (the sum of years lost from premature death combined and years lost from disability, adjusted for severity) have become a benchmark to evaluate the impact of both communicable and noncommunicable diseases.[23]

It is an accepted fact that the world stage has become smaller, closer, and more open regarding global events and activities. Yet the world is not flat despite Friedman's proposition.[14] It remains round, as most events continue to evolve in a continuous 24-h cycle. The 24/7 free media coverage of world news and events, especially recent economic cycles, testifies to that. Within our specialty, the explosion of literature, be it textbooks, monographs, journals, websites, corporate literature, meetings, or personal contacts, has made global availability and transfer of information, ideas, knowledge, skills, and technology extremely helpful; yet at times overwhelming, confusing, and frightening. The international community is not only accessing CT journal articles, but significantly contributing to them.[24,25] This alone warrants a global perspective. Just as the blind Buddhist monks were tasked to touch a portion of the elephant and give their picture of the entire elephant, and different versions of what the entire elephant looked like emerged, so too the scope of CT surgery has at times become blinded, depending on where one lives and works in the world.[16]

In summary, globalization encompasses the notion of transfer of people, product including money, and communicated data (ideas, knowledge, information, and skills). With regard to CT surgery, this includes the transfer of people locally, regionally, nationally, or internationally. These people include patients, families, doctors, and healthcare personnel. The sensitive area of medical tourism arises here. For years, paying or insured patients traveled to developed countries for surgery and services not available in their own country. Now the same groups are going to centers of excellence in the emerging economies for services of similar quality but markedly reduced cost, including cardiac surgery and transplantation. India has become attractive for high-quality low-cost procedures. Reed[26] noted that 150,000 medical tourists went to India in 2005. This accounted for >22 billion US dollars, and is projected to rise to 40–60 billion US dollars by 2012. Other countries actively involved in this enterprise include Singapore, Malaysia, and Thailand. Unfortunately, the profits go to the investors and do not trickle down to subsidize or alleviate the backlog of poor patients in need of cardiac surgery in their own country. Many of these private hospitals have enhanced their value by certification from the Joint Commission International.[27] Crone[28] pointed out some concerns including how to choose a center, pretreatment screening, the actual accepted indications for surgery, follow-up or continuity of care, and liability issues. National and international private or governmental insurance companies or agencies will be looking critically at these issues as they consider future outsourcing strategies.

Clinical Aspects

The international aspects of CT surgery, especially cardiac surgery, show marked differences in the developed and developing nations.[5,29] In the USA, cardiac surgery has leveled off, and in some regions decreased with increasing use of angioplasty and stenting for coronary artery disease. Grover and colleagues[30] noted a 28% decrease in coronary artery bypass operations between 1997 and 2005, and a 121% increase in stent procedures over the same period. The variables of age, comorbidity, cost, patient/society expectations, complexity, and the present oversupply of CT surgeons in the USA seem to be going in the wrong direction from a business model point of view (Figures 1, 2). However, the aging USA baby-boomer population along with the results of the Syntax CABG vs. Stents Trial, and the future decrease in CT surgeons due to retirement and falling number of trainees will change these variables.[30–32] Grover and colleagues[30] stress a future need for CT surgeons: by 2025, a shortage of 1,500 CT surgeons is predicted in the USA. Of the 4,734 active CT surgeons in 2005, >54% will retire within the next 12 years. This is compounded by a decrease in new trainees. Foreign medical graduates are more often being trained at home, as there are now more opportunities at home.

In contrast, there is a backlog of CT surgical candidates in the developing world. The backlog of congenital heart and rheumatic heart disease patients is compounded by the emerging chronic diseases, especially coronary artery and degenerative heart diseases. Yet there have been significant increases in annual caseloads in many

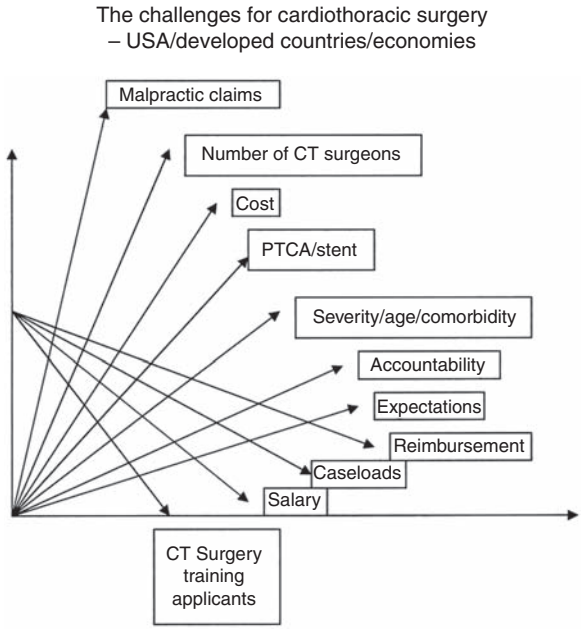

Figure 1. The challenges for cardiothoracic (CT) surgery in the USA and developed countries.

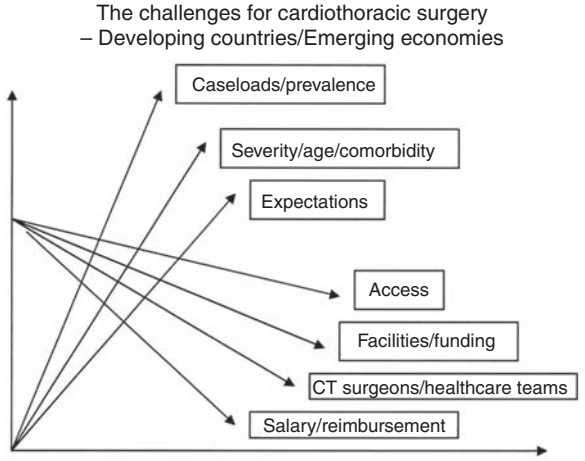

Figure 2. The challenges for cardiothoracic (CT) surgery in developing countries.

countries, especially China and India where annual caseloads have doubled over the past 10 years. This is due in part to increased access, an improved economy, and more cardiac surgery centers. Yet, waiting lists and poor access, especially in government and charitable trust hospitals, high cost, availability of services, and imbalance in urban/rural areas remain, especially in low- and middle-income regions of the world (e.g., Africa with 18 operations per million people vs. the global mean of 169 cases per million).[5] The growth of cardiac surgery parallels the growth of GDP, as does longevity.[19] The types of cardiac surgery programs worldwide are summarized in Figure 3.

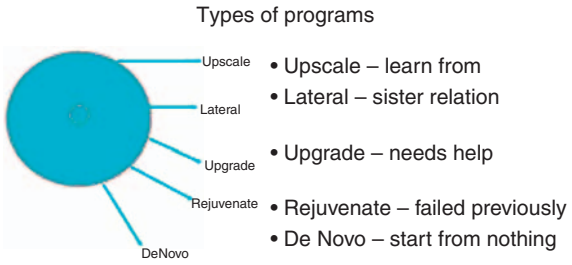

Figure 3. Types of cardiothoracic surgery programs.

Table 2. **Sample of international voluntary/humanitarian non-government organizations**

Bambini Cardiopatica nel Mondo	www.bambinicardiopatici.it
Cardiostart	www.cardiostart.com
Chain of Hope	www.chainofhope.org
Children's Heart Link	www.childrensheartlink.org
Gift of Life, Inc.	www.giftoflifeinc.com
Frontier Lifeline	www.frontierlifeline.com
Hearts for All	www.cptg.ch/en/start.htm
International Children's Heart Fund	www.ichfund.org
International Children's Heart Foundation	www.ichf.org www.babyheart.org
International Hospital for Children	www.healachild.org
La Chaine de L'Espoir	www.chainedelespoir.org
Project Hope	www.projecthope.org
Samaritan's Purse-International Relief	www.samaritanspurse.org
Save a Child's Heart	www.saveachildsheart.com
Variety-The Children's Lifeline	www.varietychildrenslifeline.org
World Heart Foundation	www.world-heart.org

The majority of voluntary humanitarian efforts from North America, Western Europe, and developed countries including South Korea, Singapore, Australia, New Zealand, have focused on congenital cardiac surgery (Table 2). There is now a transition from the starfish approach of bringing selected patients to developed countries. Aside from helping a select few, raising awareness, and marketing, this effort has not been cost effective. This has given way to more in-country strategies, establishing a host-donor relationship or a twinning concept. A 3–5-year relationship is a practical time frame to achieve desired goals. Examples include Richard Jonas's work with Boston Children's Hospital and Project Hope in establishing a center of excellence in Shanghai, China.[33] Over the past 10 years, the annual caseload has risen from <200 to >3,000 open heart procedures per year at Shanghai Children's Medical Center. Alain Carpentier's work in Ho Chi Minh City, Vietnam, is a similar story with >1,500 cases per year.[34]

With a different strategy, Novick and colleagues[35] have achieved a notable goal of increasing both the quantity and quality of pediatric cardiac surgery in a number of countries over a 10-year period: a non-government organization (NGO) utilizes voluntary teams spending 10–14 days in the host country, combining clinical surgery with teaching as well as building transparency, sustainability, and accountability. Larrazabal and colleagues[36] reported the Guatemala experience. Aldo Castaneda retired from Boston Children's Hospital and returned to his native Guatemala to build a center of excellence in pediatric cardiac surgery. From 1997 to 2004, 1,215 surgical procedures were carries out with increasingly good results: the overall mortality of 10.7% reduced to 5.7% during 2003–2004.

Collaboration amongst the NGOs continues to increase. This is an improvement from prior disjointed efforts.[5,29] The European Union countries are reaching out to Eastern Europe as well as their former colonies.[37,38] South Africa is challenging local social and political constraints to reach out to neighboring countries, which is a major challenge given the burden of HIV/AIDS, tuberculosis, and malaria. China and India have developed satellite programs in rural areas. The same is happening in Mexico, Brazil, and Russia. The process is slow but progressive. Until such time as the local economic and political climate becomes more favorable, the voluntary humanitarian efforts along with donated local support will be needed and fostered. There is a wealth of experience with the initiation or development of CT surgery programs along with models to study.[29] It is important to have a donor-host relationship of at least 3–5 years. The focus should be continuity and collaboration of clinical, education, and future research efforts. In addition, building capacity, sustainability, transparency, and accountability are vital aspects of the project. Whereas most efforts have centered around congenital heart surgery, there is increased need for help with other major CT problems including coronary artery disease, rheumatic heart disease, tuberculosis, CT trauma, lung and esophageal cancer. The major CT surgery societies have also contributed to increasing awareness of these issues with symposia and special lectures at their annual meetings, which have been well attended. The CTSnet has also promoted the humanitarian World Heart Foundation website (www.worldheart.org) as a vehicle to disseminate more insight and information on voluntary humanitarian efforts.

Education and Training Aspects

In the USA, after 9 years of primary school and 4 years of high school, the aspiring doctor enters a 4-year premedical phase. A subsequent 4-year medical school course culminates in the medical degree. This differs from many countries where medical school is 5–6 years following high school. Many international doctors complete medical school 2–3 years earlier than their American counterparts. It is difficult to ascertain the drop-out rate in countries where there is early commitment to a medical career. The 4 premedical and first 2 years of medical school are mainly structured around scheduled lectures and laboratory work. The final 2 clinical years are less structured, with education and training consisting of lectures, conferences, clinical ward rounds, and operative participation as observer or second assistant. It is in this phase that the medical student comes to realize that they are now in charge of their continuing education. Assessments following each clinical rotation only sample the basic knowledge and potential of the student; enthusiasm, interest, and determination then become the mainstay of further education and training. The graduate education phase includes a 1-year internship that is required for medical licensure, followed by a residency in the desired specialty. The Accreditation Council for Graduate Education, a nonprofit private organization, regulates the number of residency positions and the quality of the programs.[39] Accreditation and certification of residency programs are conducted by the Residency Review Committee, a sub-entity of the Accreditation Council for Graduate Education.[40] The residency program is funded directly and indirectly by the US Medicare and Medicaid services.[41] The American Board of Medical Specialties (9 of 24 boards are surgical) is responsible for examination and board certification. There are >16,000 medical graduates per year, and >1,000 surgery residency positions in 250 surgery teaching programs in the USA, but there are now <100 approved CT surgery residency programs.[42,43] With fewer American applicants (present applicant/position ratio is 0.7), the number of international graduate applicants has increased from 20% to 25%.[43]

Much has been debated about the North American system for education and training of CT surgeons.[42,43] It has evolved slowly but progressively since 1948, and serves as an international model to study, evaluate, compare, adapt, and adopt. The European Association of Cardiothoracic Surgery has also made great strides in formulating a cohesive training and certifying system.[44] The basic format of both systems is a structured standardized program over a fixed period (6–8 years). Debatable issues in existing training programs include the number and quality of programs, the minimum number of index cases, length and scope of training, work hours (now 80 hours per week in USA programs), and subsequent job opportunities. The basic historic and current systems are illustrated in Figure 4.[2] In the USA, the philosophy of training remains a non-pyramidal horizontal system, pioneered by Edward D Churchill,

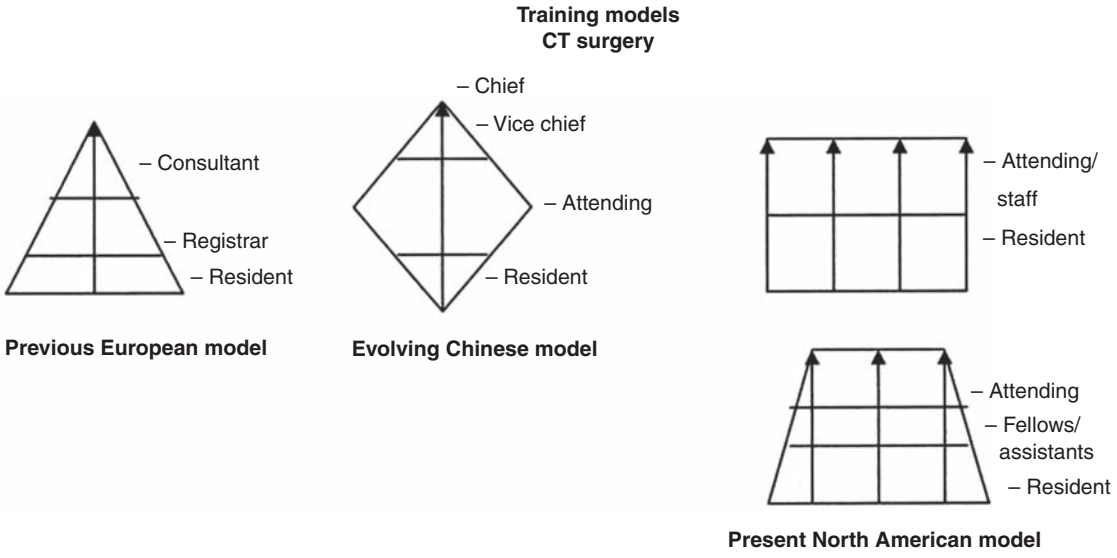

Figure 4. Types of cardiothoracic surgery training programs.

with increasing responsibility, perioperative care, and performance of a standard number of surgical procedures both as first assistant and supervised primary surgeon.[2] In recent years, modern technology has entered surgical training. Simulation, as pioneered by the airline industry, has been introduced into many training programs.[45,46] Corporate participation has augmented this effort.[47] The ultimate goal is to produce an independent CT surgeon, granted that continuing experience, knowledge, skill, and maturity are built into the process, along with re-certification at 10 years. Character, personality, and competence remain essential in a CT surgeon. The general competencies in surgical residency programs, now mandated by the Accreditation Council for Graduate Education, stress patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice.[48] Most international programs are not structured and remain pyramidal in structure, and follow the medieval apprentice model with the chief as the ultimate decision maker who controls everything without being challenged (Figure 4). Surely, this creates an atmosphere of fear, sometimes respect, and certainly does not focus on the welfare of the resident or patient. Most residents feel that quality training, a reasonable salary, secure job, and time for personal activity are the desired goals for a successful career in CT surgery.

It has become increasingly difficult for international medical graduates to train abroad, especially in the USA and Western Europe. The non-accredited USA CT surgery fellowship programs have suffered due to visa restrictions and the changing Educational Commission for Foreign Medical Graduates requirements (www.ecfmg.org).[49–51] Many of these graduates are training at home, where job opportunities are increasing. There remains a proud legacy of graduates from American and European programs, such as the Texas Heart Institute, Mayo Clinic, Albert Starr's program, and Great Ormond St. Hospital. Recently, Robert Replogle suggested an international certification process in CT Surgery.[52] This bold attempt to standardize international training systems has aroused interest and debate. We may one day see this happen, but for now, it may well be a bridge too far, and international guidelines derived from consensus may be the first step.

With the expected increase in number of retired CT surgeons, there is greater opportunity for taping the knowledge and experience of this group. Mentoring is perhaps of greatest value. Floyd Loop[53] has nicely summarized this concept. He divides our professional life into 3 phases: education, achievement, and payback. Mentoring is unique to the last phase, since it requires maturity, self-confidence, and a willingness to commit time and energy beyond that required for teaching. John W Kirklin[54] (a true pioneer of CT surgery) characterized the persona of the truly well-trained, intuitive, and qualified CT surgeon, maintaining the 3 core characteristics of character, personality, competence: ''There is no substitute for the technically competent, well-informed, thoughtful, and intuitive cardiac surgeon. Even when these optimal circumstances are present, and particularly when they are not present in their totality, appropriate and well-supported inferences and implications can be useful. In addition, they aid in organizing and preserving knowledge''.

Beyond residency, continuing local sources for general structured education include independent study of textbooks, monographs, journals, and the internet. Conferences, workshops, daily rounds, and discussions are additional sources of information. The continuing medical education phase, be it academic or nonacademic, has become the main means of updating clinical practice. Medical licensure mandates an annual minimum number of documented continuing medical education hours. Home schooling is a phrase now being used to illustrate this phase.[55] The goals of continuing medical education are to focus on both practice and evidence-based learning, and to preserve the concept of lifelong learning.[56] Printed material, texts, monographs, manuals, journals, corporate information, personal notes as well as the internet, complement the knowledge base. The traditional approach to the acquisition of knowledge in CT surgery has been via printed information. Primary sources include textbooks and monographs devoted to adult cardiac, pediatric cardiac and general thoracic surgery. Journals devoted to CT surgery and related disciplines are available by individual subscription, medical library, and the internet with either free or abstract access. Internet proliferation has introduced a new means to disseminate knowledge and skills. It has been over 50 years since a 22-inch spherical aluminum Russian Sputnik communications satellite was launched. It ushered in the space age, accelerated the cold war, and initiated the global communications era.[57] Communication has evolved dramatically over the past 200 years, from beating drums and smoke signals to wireless microchip technology, and soon nanotechnology. With the explosive growth in use of computers and mobile phones, the world continues to shrink in real time. We are constantly connected by the global media. The recent introduction of the $100 computer by Negroponte and scientists at the Massachusetts Institute of Technology will make information technology impact even more as education spreads to the low- and middle-income children of the world.[58] Telemedicine and telecommunication has become a cost-effective and readily available modality.

Nowhere is the growth more apparent than on the CTSnet. With a global membership of 33,188 from 165 countries and 375,374.53 average hits per day, the CTSnet has evolved into a global hub for those seeking access to the world of CT surgery. The groundwork for the CTSnet began in earnest with the vision, persistence, and pioneering efforts of Robert Replogle and colleagues.[59,60] The guidance and intensive efforts of Peter Greene and colleagues gave birth to the CTSnet in May 1997, and the website has blossomed under the direction of the senior editor, Thomas Ferguson, and his able executive editor, Carol Blasberg. The original goals of information, knowledge, ideas, skills, and technology transfer remain intact, and will continue under the new editor, Marko Turina. Robert Replogle's vision of ''a calm oasis where the cardiothoracic surgeon can go to avoid wandering aimlessly around the Internet, searching soulfully for pertinent information about the specialty'' remains.[59]

Complementing the CTSnet is the global expansion of regional, national, and international meetings, be they general or specialized. These meetings provide interaction that initiates, renews, and strengthens interpersonal relationships, as well as a venue to exchange personal experiences, views, common concerns, and out-of-the-box ideas. Historically, one can go back to another seminal event in the recording and transmission of knowledge in Western civilization.[61] Prior to the invention of the movable printing press by Gutenberg in 1436, monks labored in monasteries hand-writing copies of sacred texts. The resistance by the Catholic church to the printing press was short lived. In the 21st century, a similar seminal event is taking place with the internet. Virtually all printed and visual information is, or will be, available on the web. Will the resistance by publishing companies be as short lived? Two major issues have been raised in this regard. The first is open access to current or archived journal articles. The other is a web-based encyclopedia that covers adult cardiac, pediatric cardiac, and general thoracic surgery.[5] At present, access to full journal articles is limited. Recently, the major CT surgery journal publishers have offered free full text access to their content after one year. Pubmed or Old Pubmed (back to 1964) give access to citations or abstracts only. Outside the USA, the availability of medical library sources for free full texts is limited. Medical libraries have to pay large sums for access to archived journals. The access principle argues that since knowledge conveyed in publications is a public good, access should be broadened as far as possible.[62–64] Open access is broadly defined as content that is freely available on the internet without the need for payment.[63] Financial and legal issues will continue to be debated: publishers worry about loss of autonomy or revenue; authors and companies argue over copyright issues. For those with access to a medical library, a valuable ally is the librarian who is extremely knowledgeable, willing, and able to assist with literature searches and manuscript preparation.[65] A significant impact of the CTSnet has been in the area of education and training. This has been especially valuable to CT surgeons in developing countries without ready access to current textbooks, monographs, current or archived journals, or meeting proceedings.

Textbooks and monographs remain essential as a basis for CT surgical knowledge. The increasing costs of these texts make it harder for many to purchase. In fact, in

developing countries, the texts are easily copied at low cost. The average number of purchased CT surgery texts approaches 5,000. Beyond that, there is little profit. New editions appear every 3–5 years. This is a static method of learning. A primary web-based text is the solution. This can be free access or subscription. Multi-authored texts can be written directly to electronic publication, and updated anytime. Printed versions can be made available. Cox[5] nicely outlined this approach. Turina[66] has developed a free multimedia text of CT surgical procedures available on the CTSnet. This is the prototype of the future. The present generation of CT surgeons need easy access to the CT surgery disciplines. Downloading to a portable device makes the information readily available for referencing. The introduction of home schooling or obtaining continuing education credits from the CT surgery journals or the CTSnet is a valuable asset. Perhaps, in the near future, we might see a free or discounted internet-based SESATS IX (www.sesats.org) that is available on line internationally.

English has become the international language of science.[67] Non-native-English speaking surgeons use the internet almost exclusively for information, and a major challenge remains in helping them prepare and deliver presentations, as well as language editing of manuscripts.[68] John Benfield has been an advocate of promoting English as the global language of CT surgery.[25] He points out that 60% of articles in the Annals of Thoracic Surgery and the Journal of Thoracic and Cardiovascular Surgery are now from non-native-English speaking authors, and proposes the development of editing teams. CTSnet could act as a conduit to bring together authors and volunteer editing teams to help with language and preparation of manuscripts. This can be difficult, given the constraints of time and finances involved. Yet there are potential willing volunteers, especially among the increasing cohort of retired CT surgeons. Another area of innovation and growth includes outsourcing, videoconferences, and telemedicine.[69,70] Outsourcing involves utilization of distant sites to interpret diagnostic studies or provide medical consultations. Telemedicine has become a useful cost-effective modality to provide real-time education and transfer of audio/visual information.

Research and Development

Clinical and basic research in developing countries or emerging economies is challenging.[71,72] Ethical recruiting of clinical subjects for randomized prospective studies is a major challenge. Yet, large multinational prospective clinical studies are of immense value. Performing ''bush, bench, or bedside'' research favors those areas where the pathology is sited. Sir Magdhi Yacoub[73] has given a beautiful presentation on the value of research closer to the pathology, especially in developing countries. He argues for a global culture of science. This empowers the local community to gain dignity as well as participate in a global cooperative effort, and also brings recent advances directly back to the local areas. Clinical research in developing programs continues to grow.[24,25,74] This includes case reports, techniques, reviews, retrospective and prospective studies, editorials, and comments. Multinational collaborative studies combine the availability of expertise and clinical caseloads.

Financial, Administrative, Political, and Logistical Concerns

There is a large disparity of GDP for healthcare in emerging economies or developing countries.[18,19] There is social and healthcare inequality both within and between countries.[75] International assistance varies. Multilateral agencies (UN, WHO) are eager to develop collaborative strategies. Bilateral agencies, such as the United States Agency for International Development, are working more with private voluntary agencies rather than giving direct financial help to governments. Debt relief for emerging economies will provide needed short-term relief, but healthcare is a low financial priority for most. NGOs have been a major source of support, yet this is short-term (3–5 years) and has declined in recent years. As noted, the private sector has enjoyed healthy growth in some emerging economies, especially India.[26,28] This is due largely to a growing middle income group that can acquire private insurance or self-pay, as well as surgical tourism.

The United Nations established the Millennium Project in 2000 and issued the millennium development goals.[76] Unfortunately direct aid or goals for noncommunicable diseases are not addressed. This project remains bogged down in strategy development, with loss of time and money highlighted by poor results at the 5-year assessment. As with many initiatives, more is accomplished with less financing by smaller local organizations. Targeting focused financial aid to these projects, with benchmarks and accountability, has been more effective.

In CT surgery, strategic administrative and political issues flow from top down or bottom up. This means that governments, major societies/organizations, or NGOs make decisions that affect those involved in the efforts. This top-down approach usually revolves around collaboration, compromise, and consensus. The bottom-up approach is where individuals or groups lobby for change. This political process is somewhat democratic, but at times erratic and disorganized. In low- and

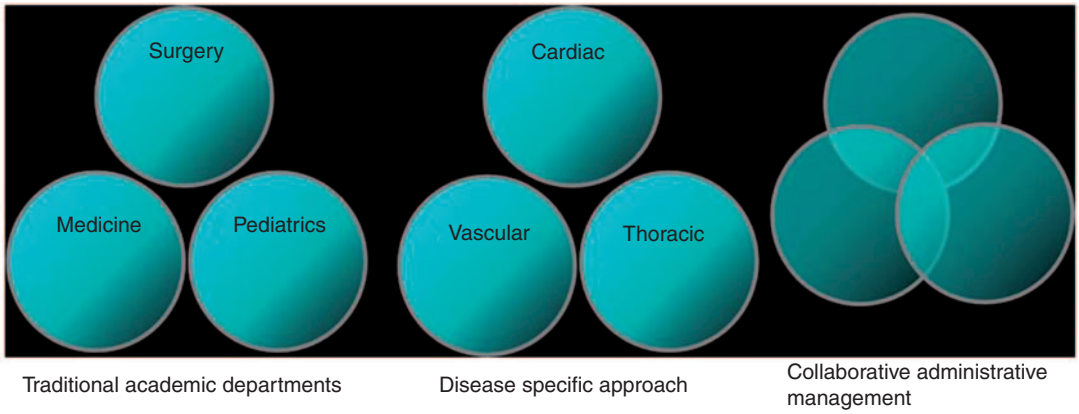

Figure 5. Product line outline.

middle-income countries, and even developed countries, selfish interests, corruption, and incompetence can have dire consequences. The migration or ''poaching'' of healthcare workers has raised international concern.[77–80] There has been a continuous exodus of healthcare workers from developing countries to the developed countries. Needless to say, nurses are in short supply. USA nursing schools need to expand and increase the number of capable trained teachers. The developing countries need to look at strategies to improve both the financial and work environment for both medical and non-medical staff. There has been a decrease in migration of CT surgeons, partly related to decreasing training opportunities and clinical caseloads, as well as a current oversupply of CT surgeons in developed countries. It may well be that future USA-trained CT surgeons find employment abroad. There will also be an increase in need as fewer individuals seek a CT surgery career and more CT surgeons retire. There may also be an increase in young USA CT surgeons going abroad for further practical training opportunities. Hands-on experience and lifestyle changes will be major drawing factors. An important area of interest is the transition to product lines or disease-specific pathways (Figures 5, 6).[81–83] The traditional approaches of preventive and curative strategies, though productive in the developed economies, have not had a major impact on reversing the overall trend. In fact, the incidence of cardiovascular disease continues to rise in emerging economies. Clearly a new strategy is warranted. This mandates increased cooperation between the preventive public health sector and the curative patient-oriented sector. The product line or cardiovascular disease-specific approach encompasses prevention, promotion, diagnosis, treatment, and rehabilitation. Strategic or organizational elements combine with tactical or managerial elements to build a consensus that is collaborative and not competitive or adversarial. The horizontal concept is nothing more than turning the flow of prevention or care from the pyramidal or vertical flow to a more practical mode where all aspects of healthcare are handled at the same time. All 5 elements are approached concomitantly.

Logistically, there is interest in the imbalance in procurement of equipment and supplies in developed and underdeveloped programs. There is continued waste, especially of disposables. Although cognizant of corporate concerns, there is value in helping developing or emerging programs with donated product. It creates future markets, as donated product evolves into discounted product via distributors, and ultimately to fair market value. Also of interest is the increasing quality and quantity of low-cost indigenously produced equipment/supplies in emerging economies. There is ultimate opportunity where all parties benefit, especially the patients served.

Finally, an important concept to accept is that surgery is an integral component of public health or preventive medicine. The cost and allocation of health resources for surgery must be weighed against the cost of no surgery and resultant increased mortality, morbidity, and disability-adjusted life years.[6,84–86] Of the 234 million operations per year globally, the operative mortality approaches 1 million. It is unknown what the predicted mortality or morbidity would be without surgery. There are >500 types of surgical operation, but no international guidelines regarding indications, timing, type of operation, or priority of surgery. Issues of access, cost, availability of services, and institutional capability remain topics of discussion and debate.

SUMMARY

The international community is watching and evaluating CT surgery in the developed countries, especially the USA, Western Europe, and the Pacific Rim. Duration, content and scope of training, licensure/credentialing, job opportunities, salary structure/benefits, job satisfaction and security, continuing medical education, and personal time for family and non-medical activities are

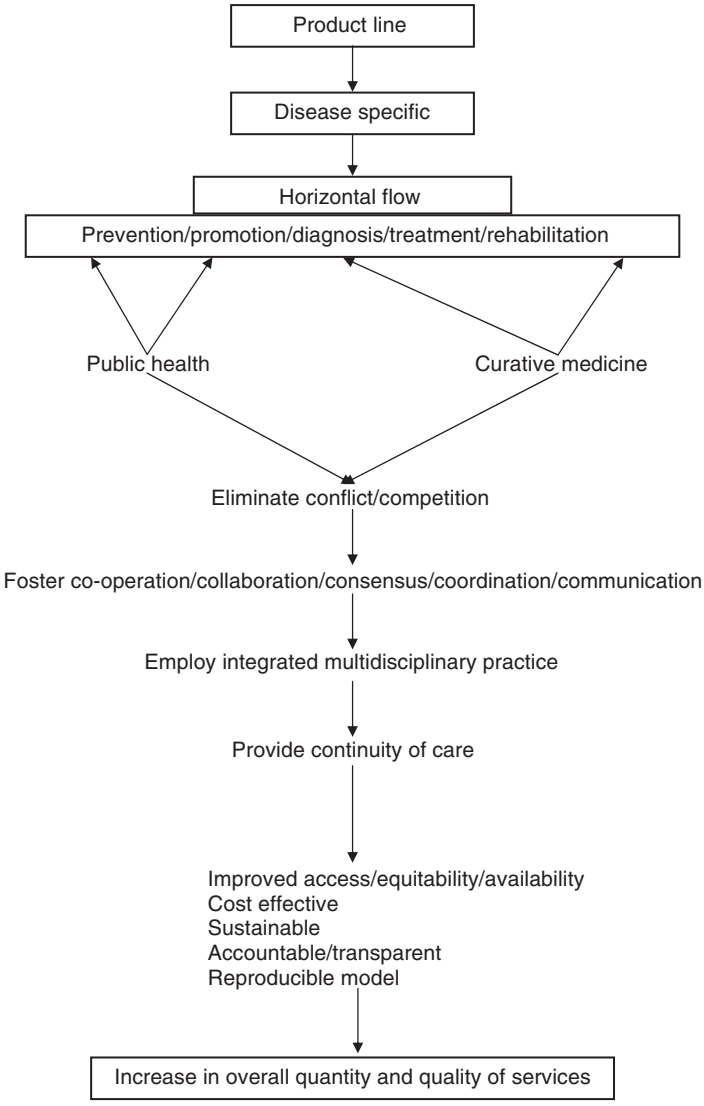

Figure 6. Flow diagram of product line.

but a few of the areas of interest. Dr Replogle has nicely brought to our attention a valued quote by Theodore Roosevelt, former president of the USA, that Denton Cooley had posted on his operating room door.[87] Hopefully, this brief offering will arouse interest, discussion, debate, and response. Such is the nature of the CT surgeon.

It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood, who strives valiantly; who errs and comes short again and again; because there is not effort without error and shortcomings; but who does actually strive to do the deed; who knows the great enthusiasm, the great devotion, who spends himself in a worthy cause, who at the best knows in the end the triumph of high achievement and who at the worst, if he fails, at least he fails while daring greatly. So that his place shall never be with those cold and timid souls who know neither victory nor defeat. Theodore Roosevelt, ''Man In The Arena'' Speech Given April 23, 1910.

References

1. Hurt R. The History of Cardiothoracic Surgery—From Early Times. Parthenon Publishing, New York, 1996:25–7; 406–7.
2. Grillo HC, Edward D. Churchill and the ''rectangular'' surgical residency. Surgery 2004;136:947–52.
3. Sloan H, Kirsh MM, Orringer MB. Thoracic surgery training at the University of Michigan. Chest Surg Clin N Amer 2000;10:201–11.
4. Bockeria LA, editor. History of Cardiovascular Surgery. Bakoulev Scientific Center for Cardiovascular Surgery, Moscow, 1998.
5. Cox JL. Presidential address: changing boundaries. J Thorac Cardiovasc Surg 2001;122:413–18.

6. Weiser TG, Regenbogen SE, Thompson KD, Haynes AB, Lipsitz SR, Berry WR, et al. An estimation of the global volume of surgery: a modeling strategy based on available data. Lancet 2008;372:139–44.
7. James W. Philosophical Conceptions and Practical Results. University Press, Berkeley, CA, 1898.
8. Gaziano JM. Global burden of cardiovascular disease. In: Zipes DP, Libby P, Bonow RO, Braunwald E, editors. Braunwald's Heart Disease. A textbook of cardiovascular medicine, 7th ed. Elsevier-Saunders, Philadelphia, 2005:1–19.
9. WHO Global Report. Preventing chronic diseases: a vital investment. Available at: www.who.int/chp/chronic_disease_report/contents/en/index.html. Accessed January 26, 2010.
10. Quam L, Smith R, Yach D. Rising to the global challenge of the chronic disease epidemic. Lancet 2006;368:1221–3.
11. World Heart Foundation. Our Approach to Improving Cardiac Surgical Services in Developing Countries. Available at: www.world-heart.org/doc/8862. Accessed November 28, 2009.
12. Wyse RK, Taylor KM. The development of an international surgical registry: the ECSUR project. The European Cardiac Surgical Registry. Eur J Cardiothorac Surg 1999;16:2–8.
13. Steger MB. Globalization—a very short introduction. Oxford University Press, Oxford, 2003.
14. Friedman TL. The World is Flat: a Brief History of the Twenty-First Century. Farrar, Strauss, and Giroux, New York, 2006.
15. Stiglitz JE. Making Globalization Work. WW Norton and Company, New York, 2006.
16. Diamond J. Guns, Germs, Steel: the Fates of Human Societies. WW Norton and Company, New York, 1999.
17. Menzies G. 1421—the Year China Discovered America. Harper Collins, New York, 2003.
18. Marmot M. Health in an unequal world. Lancet 2006;368:2081–94.
19. Leirner AA. The health and wealth of nations—coping with limited resources. Artif Organs 2006;30:493–7.
20. Strong K, Mathers C, Leeder S, Beaglehole R. Preventing chronic diseases: how many lives can we save. Lancet 2005;366:1578–82.
21. Abegunde DO, Mathers CD, Adam T, Ortegon M, Strong K. The burden and costs of chronic diseases in low-income and middle-income countries. Lancet 2007;370:1929–38.
22. Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases: part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. Circulation 2001;104:2746–53.
23. Anderson GF, Chu E. Expanding priorities: confronting chronic disease in countries with low incomes. N Engl J Med 2007;356:209–11.
24. Tompkins RK, Ko CY, Donovan AJ. Internationalization of general surgical journals: origin and content of articles published in North America and Great Britain from 1983 to 1998. Arch Surg 2001;136:1345–52.
25. Benfield JR. Cardiothoracic surgeons divided by a second language [Editorial]. Ann Thorac Surg 2007;84:363–4.
26. Reed CM. Medical tourism. Med Clin N Am 2008;92:1433–46.
27. Joint Commission International. Available at: www.jointcommissioninternational.org. Accessed November 28, 2009.
28. Crone RK. Flat medicine? Exploring trends in the globalization of health care. Acad Med 2008;83:117–21.
29. Pezzella AT. International cardiac surgery: a global perspective. Sem Thorac Cardiovasc Surg 2002;14:293–320.
30. Grover A, Gorman K, Dall TM, Jonas R, Lytle B, Shemin R, et al. Shortage of cardiothoracic surgeons is likely by 2020. Circulation 2009;120:488–94.
31. Serruys PW, Morice MC, Kappetein AP, Colombo A, Holmes DR, Mack MJ, et al. Percutaneous coronary intervention versus coronary artery bypass grafting for severe coronary artery disease. N Engl J Med 2009;360:961–72.
32. Lee TH, Hillis LD, Nabel EG. CABG vs. stenting—clinical implications of the SYNTAX trial. N Engl J Med 2009;360:e10.
33. Jonas RA. Evolving healthcare for congenital heart disease in China. Asian Cardiovasc Thorac Ann 1998;6:151–2.
34. L'Institute du Coeur de Ho Chi Minh-Ville, un etablissement unique au Vietnam. Available at: http://patrick.guenin2.free.fr/cantho/infovn/coeur.htm. Accessed November 28, 2009.
35. Novick WM, Stidham GL, Karl TR, Guillory KL, Ivancan V, Malcic I, et al. Are we improving after 10 years of humanitarian paediatric cardiac assistance. Cardiol Young 2005;15:379–84.
36. Larrazabal LA, Jenkins KJ, Gauvreau K, Vida VL, Benavidez OJ, Gaitan GA, et al. Improvement in congenital heart surgery in a developing country: the Guatemalan experience. Circulation 2007;116:1882–7.
37. Borst HG, Ralph D. Alley lecture. The hammer, the sickle, and the scalpel: a cardiac surgeon's view of Eastern Europe. Ann Thorac Surg 2000;69:1655–62.
38. Velebit V, Montessuit M, Bednarkiewicz M, Khatchatourian G, Mueller X, Neidhart P. The development of cardiac surgery in an emerging country: a completed project. Tex Heart Inst J 2008;35:301–6.
39. Bell Jr RH. Graduate education in general surgery and its related specialties and subspecialties in the United States. World J Surg 2008;32:2178–84.
40. Accreditation Council for Graduate Education. Available at: www.cms.hhs.gov. Accessed November 28, 2009.
41. Iglehart JK. Medicare, graduate medical education, and new policy directions. N Engl J Med 2008;359:643–50.
42. Wood DE, Farjah F. Global differences in the training, practice, and interrelationship of cardiac and thoracic surgeons. Ann Thorac Surg 2009;88:515–22.
43. Mathisen DJ. 2008 Midwest Surgical Association Harridge Lecture. Am J Surg 2009;197:275–8.
44. European Board of Thoracic and Cardiovascular Surgeons. Available at: www.ebtcs.org. Accessed November 28, 2009.
45. Reznick RK, MacRae H. Teaching surgical skills—changes in the wind. N Engl J Med 2006;355:2664–9.
46. Satava RM. Historical review of surgical simulation—a personal perspective. World J Surg 2008;32:141–8.
47. Relman AS. Industry support of medical education. JAMA 2008;300:1071–3.
48. Ponsky JL. Addressing the ''general competencies'': what is this all about? Surgery 2004;135:1–3.
49. Jonas RA. New visa limits for foreign medical graduates: crisis in subspecialty care in USA. Asian Cardiovasc Thorac Ann 2001;9:250–1. Available at: http://asianannals.ctsnetjournals.org/cgi/content/full/9/3/250?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&author1=jonas&searchid=1&FIRSTINDEX=0&sortspec=relevance&resourcetype=HWCIT.
50. Adebonojo SA, Mabogunje OA, Pezzella AT. Residency training in the United States: what foreign medical graduates should know. West Afr J Med 2003;22:79–87.
51. Itani KM. Presidential address: international medical graduates in the surgical workforce and the Veterans Affairs hospital: where are we coming from? Where are we going? Am J Surg 2008;196:315–22.
52. Replogle RL. A proposal for international certification in cardiothoracic surgery. Asian Cardiovasc Thorac Ann 2004;12:187–8.
53. Loop F. Mentoring. J Thorac Cardiovasc Surg 2000;119:S45–8.

54. Kirklin JW. Ventricular to pulmonary artery connections: generalizations. Sem Thorac Cardiovasc Surg 1995;7:168–71.
55. Edmunds Jr LH. Home schooling. Ann Thorac Surg 2005;80:1985–7.
56. Woollard RF. Continuing medical education in the 21st century. BMJ 2008;337:469–70.
57. Sputnik and the Dawn of the Space Age. Available at: http://history.nasa.gov/sputnik. Accessed August 5, 2007.
58. Ricciuti M. The $100 laptop moves closer to reality. Available at: http://news.com.com/The+100+laptop+noves+closer+to+reality/2100-1044_3-5884863.html. Accessed August 5, 2007.
59. Replogle RL. In my opinion: it's a wonderful world. Available at: www.ctsnet.org/sections/newsand views/inmyopinion/articles/article-0.html Accessed August 2, 2007.
60. Sergeant PT. Organizational reengineering using CTSNet. Ann Thorac Surg 1998;65:594–5.
61. Man J. Gutenberg: How One Man Remade the World with Words. MJF Books, New York, 2002.
62. Frank M. Access to the scientific literature- a difficult balance. N Engl J Med 2006;354:1552–5.
63. Clarke MT. Open sesame ? Increasing access to medical literature. Pediatrics 2004;114:265–8.
64. Matsubayashi M, Kurata K, Sakai Y, Morioka T, Mine S, Ueda S. Status of open access in the biomedical field in 2005. J Med Libr Assoc 2009;97:4–11.
65. Lindberg DA, Humphreys BL. 2015—the future of medical libraries. N Engl J Med 2005;352:1067–70.
66. Turina M. Multimedia Manual of Cardiothoracic Surgery: the internet-based educational tool. Eur J Cardiothorac Surg 2008;33:1–3.
67. Benfield JR, Howard KM. The language of science. Eur J Cardiothorac Surg 2000;18:642–8.
68. Edmunds Jr LH. Writing in a borrowed tongue. Ann Thorac Surg 2002;73:15–6.
69. Augestad KM, Lindsetmo RO. Overcoming distance: video-conferencing as a clinical and educational tool among surgeons. World J Surg 2009;33:1356–65.
70. Singh SN, Wachter RM. Perspectives on medical outsourcing and telemedicine- rough edges in a flat world. N Engl J Med 2008;358:1622–7.
71. Shapiro HT, Meslin EM. Ethical issues in the design and conduct of clinical trials in developing countries. N Engl J Med 2001;345:139–42.
72. Nundy S, Gulhati CM. A new colonialism?—Conducting clinical trials in India. N Engl J Med 2005;352:1633–6.
73. Yacoub M. The importance of research at the local level in developing countries. Symposium: 83rd Annual Meeting of American Association of Thoracic Surgery, May 7, 2003. Available at: www.aats.org/webcast/aats1o/index.html. Accessed July 31, 2007.
74. Bakshi KD, Vaidyanathan B, Sundaram KR, Roth SJ, Shivaprakasha K, Rao SG, et al. Determinants of early outcome after neonatal cardiac surgery in a developing country. J Thorac Cardiovasc Surg 2007;134:765–71.
75. Marmot M. Social determinants of health inequalities. Lancet 2005;365:1089–104.
76. Sachs JD, McArthur JW. The Millennium Project: a plan for meeting the Millennium Development Goals. Lancet 2005;365:347–53.
77. Sheldon GF. Globalization and the health workforce shortage. Surgery 2006;140:354–8.
78. Migration of health workers: an unmanaged crisis [Editorial]. Lancet 2005;365:1825.
79. Poaching nurses from the developing world [Editorial]. Lancet 2006;367:1791.
80. Kuehn BM. Global shortage of health workers, brain drain stress developing countries. JAMA 2007;298:1853–5.
81. Pryor AD. Surgical evolution: collaboration is the key. Arch Surg 2005;140:237–40.
82. Turnipseed WD, Lund DP, Sollenberger D. Product line development: a strategy for clinical success in academic centers. Ann Surg 2007;246:585–92.
83. Pellegrini CA, Warshaw AL, Debas HT. Residency training in surgery in the 21st century: a new paradigm. Surgery 2004;136:953–65.
84. Farmer PE, Kim JY. Surgery and global health: a view from beyond the OR. World J Surg 2008;32:533–6.
85. Taira BR, Kelly McQueen KA, Burkle Jr FM. Burden of surgical disease: does the literature reflect the scope of the international crisis? World J Surg 2009;33:893–8.
86. Ozgediz D, Hsia R, Weiser T, Gosselin R, Spiegel D, Bickler S, et al. Population health metrics for surgery: effective coverage of surgical services in low-income and middle-income countries. World J Surg 2009;33:1–5.
87. Replogle RL. Cardiac surgery in the age of the dinosaurs. Perfusion 2003;18:171–7.