Global Aspects of Cardiothoracic Surgery with Focus on Developing Countries
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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.

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
of cardiac surgery. Yet this growth, as well as the quality of cardiac surgery, have not been uniform.\textsuperscript{5} Weiser and colleagues\textsuperscript{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: ‘‘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.\textsuperscript{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 >55 million in 2005.\textsuperscript{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.\textsuperscript{10}

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.\textsuperscript{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\textsuperscript{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.\textsuperscript{13–16} Steger\textsuperscript{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.\textsuperscript{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.\textsuperscript{18,19} Notable exceptions include Costa Rica and Cuba where, despite low GDP, citizens enjoy both longevity and a high quality of healthcare.\textsuperscript{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. Gazzano 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 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.

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. 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 this. 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. 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.

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 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. 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. 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 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. Grover and colleagues 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
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). The growth of cardiac surgery parallels the growth of GDP, as does longevity. The types of cardiac surgery programs worldwide are summarized in Figure 3.

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

<table>
<thead>
<tr>
<th>Organization</th>
<th>Website</th>
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<tbody>
<tr>
<td>Bambini Cardiopatica nel Mondo</td>
<td><a href="http://www.bambinicardiopatici.it">www.bambinicardiopatici.it</a></td>
</tr>
<tr>
<td>Cardiostart</td>
<td><a href="http://www.cardiostart.com">www.cardiostart.com</a></td>
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<tr>
<td>Chain of Hope</td>
<td><a href="http://www.chainofhope.org">www.chainofhope.org</a></td>
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<tr>
<td>Children’s Heart Link</td>
<td><a href="http://www.childrensheartlink.org">www.childrensheartlink.org</a></td>
</tr>
<tr>
<td>Gift of Life, Inc.</td>
<td><a href="http://www.giftoflifeinc.com">www.giftoflifeinc.com</a></td>
</tr>
<tr>
<td>Frontier Lifeline</td>
<td><a href="http://www.frontierlifeline.com">www.frontierlifeline.com</a></td>
</tr>
<tr>
<td>Hearts for All</td>
<td><a href="http://www.cptg.ch/en/start.htm">www.cptg.ch/en/start.htm</a></td>
</tr>
<tr>
<td>International Children’s Heart</td>
<td><a href="http://www.ichfund.org">www.ichfund.org</a></td>
</tr>
<tr>
<td>Foundation</td>
<td></td>
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<tr>
<td>International Children’s Heart</td>
<td><a href="http://www.babyheart.org">www.babyheart.org</a></td>
</tr>
<tr>
<td>Foundation</td>
<td><a href="http://www.ichf.org">www.ichf.org</a></td>
</tr>
<tr>
<td>International Hospital for</td>
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</tr>
<tr>
<td>Children</td>
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<tr>
<td>La Chaine de L’Esper</td>
<td><a href="http://www.chainedeleesper.org">www.chainedeleesper.org</a></td>
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<tr>
<td>Project Hope</td>
<td><a href="http://www.projecthope.org">www.projecthope.org</a></td>
</tr>
<tr>
<td>Samaritan’s Purse-International</td>
<td><a href="http://www.samaritanspurse.org">www.samaritanspurse.org</a></td>
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<tr>
<td>Relief</td>
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<tr>
<td>Save a Child’s Heart</td>
<td><a href="http://www.saveachildsheart.com">www.saveachildsheart.com</a></td>
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<tr>
<td>Variety-The Children’s Lifeline</td>
<td><a href="http://www.varietychildrenslifeline.org">www.varietychildrenslifeline.org</a></td>
</tr>
<tr>
<td>World Heart Foundation</td>
<td><a href="http://www.world-heart.org">www.world-heart.org</a></td>
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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. 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.
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 carried 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.\(^7\),\(^29\) 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 CTnet has also promoted the humanitarian World Heart Foundation website (www.world-heart.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 non-profit 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.\(^3\) In the USA, the philosophy of training remains a non-pyramidal horizontal system, pioneered by Edward D Churchill,
with increasing responsibility, perioperative care, and performance of a standard number of surgical procedures both as first assistant and supervised primary surgeon. In recent years, modern technology has entered surgical training. Simulation, as pioneered by the airline industry, has been introduced into many training programs. Corporate participation has augmented this effort. 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. Many 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. 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. 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 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 (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”.

Figure 4. Types of cardiothoracic surgery training programs.
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.\(^5\) The goals of continuing medical education are to focus on both practice and evidence-based learning, and to preserve the concept of lifelong learning.\(^5\) 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.\(^5\) 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.\(^5\) 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.\(^5\) 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.\(^5\)

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.\(^6\) Prior to the invention of the movable printing press by Gutenberg in 1436, monks laborled 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.\(^6\) Open access is broadly defined as content that is freely available on the internet without the need for payment.\(^6\) 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.\(^6\) 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. Cox5 nicely outlined this approach. Turina66 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.57 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.59,70 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 Yacoub73 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
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.\textsuperscript{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.

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.\textsuperscript{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
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


