Since Singapore became an independent nation about 50 years ago, remarkable progress has been made in the development and organization of the health care system, specialty services, graduate training, and medical research. The primitive health care service under the British colonial service before the Second World War which was further ravaged in the 1940s by the Japanese occupation has been radically transformed in a short period. Singapore has a modern health care service, excellent hospital facilities, an affordable health financing system, adequate medical manpower including specialists, and a postgraduate organization for the training of medical specialists. The advancement in surgical services has reached a high level where all forms of modern surgery, including laparoscopic and endoscopic operations, are routine and major bone and joint replacements, heart and liver transplantations, and complex neurosurgical and craniofacial operations are frequently carried out.

**HISTORY**

Singapore is a small island city-state at the southern tip of peninsular Malaysia just 1° north of the equator (Figure). The climate is warm and humid throughout the year with temperatures ranging between 23°C and 33°C. It has a land mass of about 683 km², a population of about 4 million people, and a resident population of 3.26 million. The multiracial mixture of the local population includes 76.5% Chinese, 13.8% Malays, 8.1% Indians, and 1.6% other races. Despite its small size, the island republic has a reputation as an international hub for commerce, communications, and financial services. Singapore was named in the 13th century from 2 Sanskrit words singa and pura or Lion City. In 1819 it was an obscure island of sparsely populated villages with a small population of 200 Malays and Chinese when Sir Stamford Raffles acquired it for the East India Company. Seven years after its founding, Singapore together with Malacca and Penang, became the Straits Settlements and later a crown colony under the British Empire. It was invaded and occupied by the Japanese from 1942 to 1945. In 1959 Singapore became a self-governing state and 6 years later it became an independent republic.¹

**MEDICAL EDUCATION**

Medical education dates back to 1891 when a proposal to start a medical school was made by leading Chinese and other non-European communities. The colonial government expressed serious reservations initially but finally relented after obtaining support from the public in the form of an $800,000 donation. The medical school known as the Straits Settlements and Federated Malay States Government Medical School was formally opened in 1905 with 23 students of whom 12 were graduated in 1910 as Licentiates in Medicine and Surgery (LMS). The diploma was highly regarded and was recognized by the General Medical Council of the United Kingdom. Most of the teaching was done by part-time teachers with only the principal being employed full time. In 1922 full-time professors were appointed in anatomy, surgery, medicine,
and midwifery. By then a total of 137 licentiates had graduated from the school. The school was renamed the King Edward VII College of Medicine that later became the Faculty of Medicine in the University of Malaya and, after independence, became the National University of Singapore. The licentiate diploma course was changed to a full-degree program offering an MBBS (Bachelor of Medicine and Bachelor of Surgery) degree.

The medical undergraduate curriculum was composed of 5 years of study and modeled closely to that of the United Kingdom. The stringent criteria for admission included top-level passes in advanced-level examinations in chemistry, physics, mathematics, and the biological sciences in addition to a successful interview. The first 2 years of the preclinical course were followed by 3 years of clinical study that emphasized the current practice of medicine, surgery, pediatrics, orthopedic surgery, and obstetrics and gynecology. A student after graduation had to complete 1 year of supervised clinical training as an intern to get registered with the Singapore Medical Council for practice rights.

Following the worldwide trend in medical education, the university introduced a major revision of medical curriculum. There is less emphasis on didactic teaching and detailed factual information and more emphasis on understanding principles, concepts, and self-directed learning including the use of problem-based learning. Clinical exposure starts from the first year with integrated learning of basic science in a clinically relevant context. There is also an increasing use of information technology and computer-based learning with an emphasis on communication skills, medical ethics, and medical social sciences. Students are encouraged to undertake research at an early stage and those with a keen interest are offered a combined medical and research degree (MBBS/PhD) program.

**HEALTH CARE**

Singapore has one of the highest standards of health care in the Asian-Pacific region. Rising standards of living, high standards of education, good housing, a safe water supply, good sanitation, a high level of medical services, and the active promotion of preventive medicine have all helped to boost the health of Singaporeans. The infant mortality rate is 2.5 per 1000 live births and the maternal mortality rate is 1.5 per 10,000 live births. The average life expectancy is 78 years—76 years for men and 80 years for women. Singapore has a young population with only 11% of the population older than 60 years. However, the percentage of the population older than 60 years is expected to increase to 20% in 2020 and 27% by 2030. The leading causes of morbidity and mortality are the major noncommunicable diseases such as cancer, coronary heart diseases, stroke, diabetes mellitus, hypertension, and injuries. Cancer and cardiovascular diseases combined account for about 62% of the total causes of death.

Singapore has a dual system of health care with a private system provided by private hospitals and general practitioners and a public system managed by the government. The private sector plays a larger role in primary health care providing 80% of the primary health care and 20% of the hospital care services, while the public sector provides 80% of the more costly secondary and tertiary care and 20% of the primary care through government-run polyclinics. There are 21 hospitals and 6 specialty centers in the country, providing 11798 beds or 1 bed to every 341 individuals in the population in 2000. The 14 public institutions account for 81% (9556) of hospital beds and provide treatment spanning 32 specialties, while the remaining 19% (2242) are distributed in 13 private hospitals. In 1999, the public health care delivery system was reorganized into 2 vertically integrated networks, the National Health Care Group and the Singhealth Services. They are operated as a corporation with their own boards of management with financial and fiduciary responsibilities.

**HEALTH CARE FINANCING**

The advances in medical sciences, greater use of medical technology, and an aging population have resulted in the rising cost of health care. The national health care expenditure has increased from $4.4 billion in 1999 to $4.7 billion in 2000 and is about 3% of the gross domestic product.

Singapore’s health care financing philosophy is based on individual responsibility coupled with government subsidies to keep basic health care affordable. While community and state help are available to the needy, all patients have to pay part of the cost of medical service depending on the class of hospital ward accommodation they choose. Patients in an A class ward pay the full cost and receive no subsidy, while those in a C class ward pay 20% and are subsidized 80% by the government. The government has 3 schemes in place to help Singaporeans pay their share of health care expenses.

Medisave is a compulsory saving plan introduced in 1984 in which 6% to 8% of their monthly income from their Central Provident Fund account is put into a per-
The development of postgraduate surgical training is a postwar phenomenon and has closely followed the models in Britain and Australia. Before the war, there were no opportunities for surgical training in Singapore. A local physician with any interest in further studies had to proceed to the United Kingdom but was actively discouraged by the colonial administration. However, following the war, the colonial administration became more responsive to the local needs and introduced a plan for sending a limited number of physicians on scholarship to the United Kingdom. This arrangement continued until 1960 and produced some 40 physicians with postgraduate qualifications.

In the 1950s, the Royal Australian College of Surgeons offered to conduct postgraduate courses in Singapore under the Colombo Plan. The first course in basic sciences and primary fellowship examination were conducted in 1957. The 11 successful candidates were later sent to Australia for further training and final examinations for the fellowship of the college. The courses and examinations continued on a biennial basis until the local postgraduate training system was established. The first advanced surgery course and final fellowship examination was held by the college in 1970.5

THE ACADEMY OF MEDICINE AND THE SCHOOL OF POSTGRADUATE MEDICAL STUDIES

In 1957 a specialist body known as the Academy of Medicine was formed with its main objectives being to promote postgraduate training and to maintain the highest standard of professional and ethical practice. After organizing postgraduate lectures and courses for many years, the Academy of Medicine together with the National University of Singapore and the Ministry of Health formed the School of Postgraduate Medical Studies in 1968. Since then, the school has been responsible for conducting training courses and regular professional examinations in various disciplines for the degree of master of medicine (MMed). The first course in basic sciences and examination for MMed (Surgery) were held in 1970. The MMed examination from the start has had the participation of external examiners from the Royal Colleges of the United Kingdom and Australia and had been similar in content and comparable in standards to the fellowship examinations of the Royal College of Surgeons (FRCS). It was in recognition of the good standing that the Royal College of Surgeons of Edinburgh, Edinburgh, Scotland, decided to jointly hold their examination for fellowship with the local MMed examination in 1986. The candidates who pass the joint final examination are awarded both the MMed Singapore and FRCS Edinburgh.5,6 The training requirements and examinations were restructured in 1989 and again in 1992 in keeping with the worldwide trend in specialty training and assessment.

The training of a surgical specialist is divided into 2 parts. The basic training starts after the completion of the intern year and full medical registration and lasts for 3 years. The clinical training during this period includes mandatory posting of 6 months each in general surgery and orthopedics and 2 postings (of 6 months each) in other surgical specialties as well as participation in basic surgical skills, advanced trauma life support, and critical care courses; satisfactory progress reports; and a logbook of surgical experience. After the trainee has passed the joint part 1 MMed/MRCS Edinburgh examination, the trainee may complete part 2 MMed by submitting a dissertation. The dissertation should be based on 10 cases with acute major surgical problems, the management of which involved the application of basic science principles and that were comanaged by the trainee. The advanced surgical specialty training is normally for 3 to 4 years after completion of basic training. It includes supervised surgical posting in an accredited specialty department, the first 2 years being in the main specialty and the next year or 2 in the chosen subspecialty. The period may be longer for those who spend additional years in national service or in basic research. Relevant clinical research and supervised training in accredited overseas centers may be accepted as part of the training. The advanced trainees are required to maintain a record of their clinical activities in a logbook with details of major operations performed and assisted; attendance at surgical workshops, courses, lectures, and conferences; scientific presentations; teaching; and publications. On completion of 3 years of training, the trainee may sit for an assessment examination that for the specialty of general surgery includes 2 clinical and 3 structured oral examinations and is similar to the format of the intercollegiate examination in the United Kingdom. Those who pass the examination are certified by the Specialty Accreditation Board and are eligible to be registered as a specialist by the Singapore Medical Council.

CONTINUING MEDICAL EDUCATION

Continuing medical education (CME) has been recognized as an essential part of maintaining professional competence. The voluntary CME scheme that had been in
The Second World War and the Japanese occupation that followed until 1945 acted as a watershed in the evolution of Singapore and Singapore surgery. With the reopening of the medical school, the General Hospital resumed its role as the main teaching hospital where most major surgery was done. The volume of surgical work increased rapidly at the rate of 10% a year and by 1949 the 3 surgical units together performed 6000 operations, including many major operations such as stomach and lung resections. The patients were less skeptical of surgery and surgery became an acceptable form of treatment. As the volume of work began to increase, the need to expand the hospital services was recognized. A 5-year plan to double the clinical facilities was recommended by a Ministry of Health review committee. By the 1950s the specialties of ophthalmology, orthopedics, and otolaryngology were established. In the 1960s the general and orthopedic units were started in the peripheral hospitals following by the founding of specialty units in cardiothoracic, plastic, pediatric, urological, and colorectal surgery and neurosurgery. In 1985, a new university hospital was built on the campus of the National University. All the clinical academic departments that were located in the Singapore General Hospital were moved to the new hospital. However, most of the clinical teaching remains in the associated hospitals that have a large patient volume and many tertiary services. The 5 acute general hospitals together with 2 specialty hospitals and 6 national centers offer a comprehensive range of clinical specialty services.

The range of operations done in the specialty departments of the public hospitals is similar to that in any advanced medical center. Among the many successful landmark procedures done recently are forearm attachment to shoulder blade, bilateral maxillomandibular advancement, divided liver transplantation, lung transplantation, unicompartamental arthroplasty, and separation of a pair of conjoined twins. While the common elective operations done in general surgery continue to be cholecystectomy, colorectal resections, breast and thyroid resections, and vascular reconstruction procedures, more and more operations are performed using laparoscopic and minimally invasive techniques. The common emergency operations done are for appendicitis, intestinal obstruction, peritonitis, intra-abdominal infections, and gastrointestinal bleeding and remain unchanged in the last 10 years.

MEDICAL MANPOWER

There are about 6029 physicians practicing in Singapore. The physician-population ratio has been steadily increasing over the last decade from 1.840 in 1981 to 1.690 in 2002. There are 2088 physicians registered as specialists who form 34.6% of all medical practitioners registered with the Singapore Medical Council. Almost half of all physicians are employed in the public sector. There are 35 recognized specialties. About 25% of the specialists are in surgical specialties, 34% in medical specialties, and the rest in other specialties (Table).

MEDICAL RESEARCH

Medical research in Singapore is still at an early stage of development. Until recently there has been a lack of re-
search culture as the academic institutions placed emphasis mainly in training physicians in clinical medicine. In 1994 the National Medical Research Council was established to oversee, coordinate, and fund medical research. The National Medical Research Council provides individual research grants for deserving projects and for a protected time for researchers as well as institutional block grants for operational expenditure. From fewer than 50 applications in 1994 the number of individual applications has increased 6-fold in 2000. Research is carried out at the National University Medical Institute, national centers, research institutes, the Institute of Molecular and Cell Biology, and in the major hospitals.

More recently, since the founding of the Agency for Science Technology and Research (A*STAR) by the Economic Development Board and its major division of the Bio Medical Research Council, there has been an increasing push for research partnerships involving government agencies and industry players in life sciences. A major initiative undertaken is training clinician researchers for the biomedical industry that remains strong and grew 3.2% to $6.6 billion in 2001. There are 89 biomedical establishments including several big international companies such as Baxter Healthcare Corp, Novartis International AG, Pfizer Inc, GlaxoSmithKline, Wyeth-Ayerst Laboratories, Avantis, Schering-Plough Inc, Merck Sharp & Dhome, and Eli Lily & Co that make drugs for world markets. The Medical Clinical Research Committee is responsible for overseeing the conduction of clinical drug trials in Singapore in compliance with regulations and good clinical practice. About 81% of clinical trials certificate issued were for premarketing phase 1, 2, and 3 trials and 19% for postmarketing trials.

The Clinical Trials and Epidemiology Research Unit, established in 1996, provides the necessary infrastructure for the conduction of clinical trials and epidemiology studies and supports the National Disease Registry Office for coordinating and managing data collection and quality. The Clinical Trials and Epidemiology Research Unit also has formed a systematic review group to focus on aspects of evidence-based medicine. Singapore has 2 well-established medical journals listed in Index Medicus, namely, the Singapore Medical Journal for the generalists and the Annals of the Academy of Medicine for the specialists.

Accepted for publication April 27, 2003.

Corresponding address: Postgraduate Medical Institute, Singapore General Hospital, Block 6, Level 1, Outram Rd, Singapore 169608 (e-mail: gteraj@sgh.com.sg).

REFERENCES

2. Lee YK. The Medical History of Early Singapore. Tokyo, Japan: South East Asia Medical Centre; 1978.