15th Chapter of Surgeons Lecture: Surgeon of the New Millennium – Surgeon, Scientist and Scholar

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Abstract

The surgeon of the new millennium has come a long way from his humble beginnings in the Middle Ages as the lowly barber-surgeon. The skills and techniques developed by outstanding surgeons like Astley Cooper of the 19th century have withstood the test of time and have been refined by subsequent generations of surgical masters. The scientific basis of modern surgery was put on a firm footing in the early 19th century through the discovery of anaesthesia and micro-organisms as a cause of many diseases and surgical complications. The 20th century brought about rapid progress in medicine, information technology (IT) and the life sciences, and closed with a big bang with the completion of the sequencing of the human genome. For the surgeon of the 21st century to remain relevant, he must embrace the concept of the Total Surgeon. Not doing so will render him irrelevant in the course of time, for having good surgical technique alone is insufficient. He must also lead in scientific endeavours to push the frontiers of the life sciences in attempts to solve the insoluble, and be scholarly in thought, attitude and behaviour. In other words, he must be a Surgeon-Scientist-Scholar.

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Introduction

Next year, we celebrate a hundred years of medical education in Singapore. We have come a long way since 1821 – from a small, sleepy medical outpost catering to the British Armed Forces in the Far East, to an excellent state-of-the-art medical hub. Even as we move confidently into this new millennium, we, the surgical fraternity, should take stock and define our role and place in the new healthcare environment. This is all the more so in light of unprecedented developments taking place around us.

The rapid advances in technology and biomedical sciences have made obsolete many of the things we do and believe in. We operate in the environment of an enlightened and well-informed public. Expectations from patients, colleagues and society are much higher than before. Changing population demographics and disease trends dictate that we adjust the way we practise, lest we become irrelevant.

Hence, it is important that as surgeons, we should define for ourselves the role that we, or at least future generations, should play.

A Historical Perspective

Surgery has been practised for a long time. Evidence of this is ample. Trephined skulls, dating back to the Neolithic period, have been found, indicating that our ancestors had attempted to treat neurological diseases and head injuries through surgical intervention. The fact that patients survived those early surgical procedures is suggested by the smooth rounded edges of the trephine hole. Other archaeological evidence suggests that prehistoric man attempted to treat wounds and bone injuries by stitching them with tendon strips and needles of bones.

The "doctor" or medicine man often occupies a high position in the social order of a tribe or region. He is often the wise man, village elder, counsellor and judge – all rolled into one. He is highly regarded and often revered. Even in the ancient civilisations of China, India and Mesopotamia, the doctor occupied a high social standing.

The Greek physician Galen was perhaps one of the most influential practitioners in recorded medical history. His extensive and detailed descriptions of surgical anatomy,

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pathology, and physiological processes were from observations made in treating war wounds and from cadaveric dissections. However, many of his treatises were rather erroneous because they were translated from observations made from animal dissections. Furthermore, his attempts at trying to ascribe a reason to every single observation made during surgery were based on Aristotle's principle that "nature does nothing without a purpose". And this is not always correct.

Surgical interventions were also noted in the early civilisations of India and China. The famous Chinese physician Hua T'o was reported to have removed an arrow from the arm of a famous general by cutting the muscles and scraping the underlying bone while the general drank wine and played chess. It looked like the Chinese knew the anaesthetic effects of alcohol too!

In India, surgeons and physicians came predominantly from the Brahmins. They developed skills in the surgical treatment of cleft lips, hernias as well as amputations. Their surgical instruments were often made in the shape of animals. They were also particularly skilled in nose and ear reconstruction.

With such an illustrious and highly respected historical background for the medical profession as a whole, one would expect that surgeons who are, after all, members of this profession would have an equally distinguished historical standing. History, however, showed otherwise. Surgery as an art had more humble beginnings.

In the Middle Ages, surgery was separated from medicine as the Church – which included well-educated doctors amongst its clerics – discouraged surgical procedures in the treatment of illnesses and injuries. It was left to barber-surgeons and other lowly practitioners, who were often regarded as inferior to the physicians. Due to the riskier nature of surgery in those early days, without the benefit of aseptic techniques, antibiotics and anaesthesia, its outcomes were less predictable and favourable. As a result, it attracted even fewer men into the fraternity and this reinforced the inferior status of surgeons compared to their physician counterparts.

With the establishment of the scientific basis of modern medicine in the early 19th century, this trend was reversed and surgery began to take its proper place in the profession. This was brought about by two important developments – the use of anaesthesia in surgery and the discovery of micro-organisms as the cause of many diseases. Asepsis and antimicrobial treatment dramatically reduce post-surgical infection while anaesthesia allows surgeons to perform more extensive operations using careful surgical techniques. Coupled with a better understanding of surgical anatomy and pathophysiology, outcomes improved and many difficult clinical conditions were amenable to surgical intervention.

In addition, the physiological basis of many body functions both in health and diseases became well established by Claude Bernard in the early part of the 19th century. Although he was not a surgeon but a physiologist working with experimental animal models, Claude Bernard helped to make surgical procedures more rational and safer, and established the scientific basis for post-operative management.

One of the most outstanding surgeons in modern surgical history must be Astley Cooper. His careful examination and study of the human anatomy and disease processes through cadaveric dissections, and the application of such observations to meticulous surgery, brought about revolutionary changes in the way surgery was practised. Many of you will still remember the famous "Cooper's fascia" and "Cooper's hernia" from his works.

Another surgical giant is Albert Christian Theodor Billroth, whose major contributions helped place upper gastrointestinal surgery on a very firm footing. His works and writings were extensive, ranging from surgical pathology to the tenets of ideal medical education.

Surgery in the New Century

The last two world wars, tragic as they were for the lives lost and societies and nations destroyed, led to the better understanding of the human body's reaction to severe trauma, and our ability to aid the healing process. They also gave us greater insight into the pathophysiology of many diseases and helped in our planning of treatment strategies.

We have now travelled three years into the new millennium and there are already signs that 21st century surgery is going to be dramatically different from that of our forefathers. This has been brought about by many developments, principally:

- Rapid advances in the life sciences,
- Information technology (IT),
- Changing population demographics and disease trends,
- The environment (social and physical) under which we operate.

Will conventional surgery in the 21st century be largely anachronistic or will there still be a role for the surgeon in the healthcare team?

In spite of the quantum leaps made in the medical sciences, the surgeon of the 21st century, I believe, will still play a crucial role in medicine. However, to remain relevant, he must take cognisance of the shifting paradigms and the changing environment in which he operates (pardon the pun).

The Surgeon

Firstly, the basic tenet of good surgery remains having a

set of excellent surgical skills. There is no substitute for this, not even with the most advanced technology. A surgeon must continuously sharpen his clinical acumen and surgical skills to perfection. The only way to achieve this is to consistently hone his skills either through experiential surgery or psychomotor skills training via workshops and laboratory work. With few exceptions, most surgeons should be able to accomplish this in his or her specialty. The large number and variety of courses, workshops and skills training programmes we have today are more than adequate to ensure that our skills are continuously improved.

Patients today are well-informed, well-read and have much higher expectations. They expect their surgeons to be not just competent but excellent professionals at the cutting edge of their practice.

Secondly, the speed at which technology advances and influences our practice is unprecedented in the history of medicine. New technologies have made surgical interventions more precise, predictable and less traumatic; thus they carry lower morbidity and mortality. Examples of such technologies are the stenting of aortic aneurysms, robotic prostatectomy and minimally invasive surgery total knee replacement (MIS TKR) using navigational technology. Properly utilised and with good patient selection, they bring about improvement in outcomes for patients. Surgeons would do well to acquaint themselves with, and avail themselves to, these technologies.

The surgeon of this century must not only have excellent surgical skills, but also the ability to combine them with advanced technological equipment and instruments. This will require excellent hand and eye coordination, which can only come about through specialised training and constant practice, both in the laboratory and in clinical practice.

Thirdly, the surgeon of this millennium must be IT-savvy. IT has influenced practically every aspect of our daily activities and surgical practice is no exception. Apart from IT-incorporated hardware such as surgical tools and equipment, surgeons need to harness IT to work more efficiently, smartly and safely. The use of electronic records, imaging technology, video-conferencing, video-consultation and information sharing are just some of the applications that have been firmly established. The use of artificial intelligence in the medical field to assist in decision-making may sound like an interesting but ludicrous thought today – but it could be reality tomorrow.

The Scientist

The ideal surgeon of tomorrow must also be a scientist, exploring the frontiers of medicine, in search of better ways of overcoming old problems. Many of today's clinical conditions are difficult to overcome using current technologies and the solutions could lie at the cellular and molecular level. Surgical leadership is required to steer teams of research workers in exploring new directions for old problems. The latter will not yield to improvement or refinements in surgical techniques alone.

By being scientifically attuned, the surgeon should be able to critically assess new findings and developments to ensure that patients' outcomes are improved by evidence-based practice. Many exciting recent discoveries have been made at the cellular, genetic and molecular research level. They show tremendous promise in the treatment of difficult clinical conditions. An example can be seen in the interesting findings of two articles published in the journal *Science* in June 2004.[1-2] The authors of both articles found that the clinical condition called horizontal gaze palsy with progressive scoliosis and hindbrain dysplasia (HGPPS) is associated with mutations in the *ROBO3* gene.

During fetal development of the central nervous system, the growing axons of the corticospinal and somatosensory tracts need to cross the midline to reach their end destination synapses lower down the spinal cord in order for normal motor and sensory function to occur. The *ROBO3* gene is required to guide the midline crossing of these axons to reach their destination synapses. Mutations in this gene result in the failure of the guiding mechanism of the crossing. The resultant clinical condition includes severe progressive scoliosis caused by motor imbalance at the torso level.

The gold standard treatment of severe scoliosis today is surgical correction and mechanical stabilisation through implants and fusion. Perhaps orthopaedic surgeons should pause and take a look at this interesting finding. Could it be that the so-called idiopathic scoliosis they treat is related to this? The solution to this condition may lie at the genetic and cellular level.

Another example of how genomic research can potentially help to unravel perplexing clinical conditions and point the way to more effective treatment is seen in the condition known as ankylosing spondylitis. This crippling condition results in severe joint stiffness and ankylosis, and deformities of the cervical and thoracic spine.

A recent discovery at the Stanford University School of Medicine has excited orthopaedic surgeons and rheumatologists alike. A team of researchers in the Department of Developmental Biology found that in a mutant strain of mice known as *ank*, a mutation in chromosome 15 led to the development of a form of ankylosis, fairly similar to the severe debilitating human form of ankylosing spondylitis. On further probing, they zeroed it down to a 15,000-base pair stretch of the DNA in chromosome 15, containing 11 genes called the progressive ankylosis *ank* locus.

The human ankylosing spondylitis equivalent form is about 98% identical to this mutation in chromosome 15. What is more interesting is that this locus is absent in invertebrates, that is, animals that do not have a bony skeleton (hence no joints). When they drilled this down to the cell and molecular level, it was discovered that these mice exhibited a reduced ability of the chondrocytes in the articular cartilage of the joints to pump pyrophosphate into the extracellular compartment. This resulted in cartilage reduction, stiffening of the joints and formation of bony spurs known as osteophytes – all classical manifestation of the arthritis found in human ankylosing spondylitis. Such a discovery surely offers hope to human sufferers; perhaps the next step forward would be to genetically manipulate this locus in chromosome 15 of patients with ankylosing spondylitis.

The genetic basis of many surgical conditions has opened new possibilities and opportunities to revolutionise conventional treatment modalities. The discovery that a number of cancers are associated with genomic instability, telomere dysfunction and p53 gene inactivation offers hope for patients with cancers such as colonic carcinoma and osteosarcoma. Our ability in the future to contain such conditions through a combination of genetic manipulation, gene therapy, conventional surgery, immuno- and chemo-therapy holds the promise of better outcomes for patients.

In an interesting experiment, Jain et al[3] from Stanford University School of Medicine engineered a conditional transgenic mouse to over-express the *myc* oncogene (a multiple oncogene) that induced the formation of a highly malignant form of osteosarcoma. By briefly suppressing one of the oncogenes, they were able to cause the tumour cells to undergo either apoptosis (cell death) or transform themselves into mature osteocytes, leading to the formation of histologically normal bones. Subsequent reactivation of the oncogene did not reactivate the malignant process but continued to induce apoptosis. These findings have great potential treatment implications for osteosarcomas. It may hold the key to more effective outcomes for quite a number of similar tumours.

Other interesting developments are also found in many areas that can ultimately change the way a surgeon works. Progenitor cells in the olfactory organ are now being investigated to see whether they can be used to reverse the paralysis found in para- and tetraplegics. I believe the preliminary findings are encouraging.

The new millennium surgeon must be equally competent and adept at cellular, genetic and molecular manipulation in his quest for surgical cures.

The Scholar

A scholar is defined as a "learned" person in the Oxford Dictionary. The 21st century surgeon should be a learned surgeon, deeply schooled in both the arts and sciences, refined in culture and knowledgeable in the affairs of man. To be a wholesome and complete surgeon, he must not only be well-versed in the science of surgery but also in the art of healing, and of understanding the human mind in health and in illness.

Knowing and deeply appreciating the arts and culture will help in this, and enable the surgeon to see and appreciate beyond the operating theatre and ward. He must have the intellectual depth, breadth and capacity to operate beyond surgical knowledge and skills, and provide leadership to the fraternity and community. Only then can he achieve the objectives of the art and science of the healing profession. This was recognised by Sir William Osler, when he said:

> "*While Medicine is to be your vocation, or calling, see to it that you have also an avocation – some intellectual pastime which may serve to keep you in touch with the world of art, of science, or of letters.*"

The learned surgeon will be a complete healer, counsellor, and confidante to his patients and colleagues. His ability to see beyond the present and think outside of conventional wisdom will greatly enhance his standing and respectability. As a scholar surgeon, he should not only provide the surgical healing, but must also shape and develop professional direction, lead in community change for improvements and be a leader of thought in society.

To achieve this, he must maintain at all times the stature and standing of any learned man so as to win the respect of patients and the public alike. He must practise with professionalism and uphold the values and virtues expected of the profession. A proper sense of decorum in behaviour is expected of him at all times, both in public and private. And he should not bring himself or the profession into disrepute.

We should at all times seek to be the scholar surgeon, as the learned surgeon is the better surgeon.

Conclusion

The surgeon of this new millennium has come a long way from his humble beginnings in the Middle Ages as the lowly barber-surgeon. The skills and techniques developed by outstanding surgeons like Astley Cooper of the 19th century have withstood the test of time and have been further refined by subsequent generations of surgical masters. The 21st century surgeon must lead in the endeavour to prevent degradation of the body as a result of the ravages of time on an ever-increasing life expectancy. To do this, he must embrace the concept of the Total Surgeon. Not doing so will render him irrelevant in the course of time, for good surgical techniques alone are no longer sufficient. Besides

having excellent surgical skills, he must also lead in scientific endeavours to push the frontiers of the life sciences in attempts to solve the insoluble. And he must be scholarly in thought, attitude and behaviour. In fact, all these reflect the attributes of a great man in the eyes of Confucius, who said:

"To see beyond when he looks
To listen beyond what he hears
To be gentle in looks
To be respectful in manners
To be true in his word
To ask when in doubt."

I have no doubt that the ideal surgeon of this millennium will be a Surgeon-Scientist-Scholar who will provide leadership in the healthcare of the future.

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