Part II: Reformers in medical education and practice

Martin A Entin MD FRCSC FACS

Plastic and Reconstructive Surgery, Royal Victoria Hospital, Montreal, Quebec

MA Entin. Part II: Reformers in medical education and practice. Can J Plast Surg 2001;9(2):59-68.

BACKGROUND: Part I was published in *Can J Plast Surg* 2000;8(1):25-29. It established that standards of professional practice shift constantly. When a standard falls short of professional expectation or when a physician becomes more concerned with financial gain rather than patient care, society needs the action of a reformer.

Part II continues the study and begins with the contribution of reformer John Hunter (1728-1793), and follows with the contributions of seven other reformers, concluding with Wilder Penfield (1891-1976).

STUDY DESIGN: The reformers were physicians and scientists who were selected throughout the history of medicine: they conformed to our definition of reformers, namely, a person whose action changed the structure or ideology of medical practice.

RESULTS: The present historical article shows that reforms are produced by people possessing critical judgement and analytical quality who influenced the direction of medical practice.

CONCLUSION: Reforms have been achieved through intuitive leaps, alterations of conventional practice, painstaking research or administrative restructuring.

Key Words: *Historical perspective; Medical reformers*

Les réformateurs de l'enseignement et de l'exercice de la médecine : 2^e partie

CONTEXTE : La première partie de l'étude, publiée dans *Can J Plast Surg* 2000;8(1):25-29, avait conclu que les normes professionnelles évoluent constamment. Lorsqu'une norme ne répond plus aux attentes professionnelles ou lorsqu'un médecin se préoccupe plus de ses profits que des soins aux patients, la société a besoin de l'intervention d'un réformateur. La deuxième partie poursuit la réflexion en soulignant la contribution du réformateur John Hunter (1728-1793) et celle de sept autres réformateurs, dont Wilder Penfield (1891-1976).

PLAN D'ÉTUDE : Les réformateurs étaient des médecins et des scientifiques qui ont été choisis au fil de l'histoire de la médecine; ils correspondaient tous à notre définition de « réformateur », soit une personne dont l'intervention a modifié la structure ou l'idéologie de l'exercice de la médecine.

RÉSULTATS : Il ressort du présent article rétrospectif que les réformes ont été mises en œuvre par des personnes qui possédaient un jugement critique et le sens de l'analyse et qui ont modifié le cours de l'exercice de la médecine.

CONCLUSION : Les réformes ont été le fruit d'entreprises intuitives, de modifications apportées à l'exercice traditionnel, de recherches laborieuses ou d'une réorganisation administrative.

The “reformer” is defined as an individual or group who consciously or unconsciously changed the structure or ideology of any facet of the medical profession, significantly affecting the life and health of our society. The reformers who were selected throughout the history of medicine were usually talented persons who introduced innovation in medical research or medical philosophy. Their discoveries or innovations produced profound changes in the theoretical and

practical study of medicine and human diseases. The following is an account of their reforms.

JOHN HUNTER (1728-1793)

Great researchers possess an insatiable curiosity, an ability to recognize what is significant and a compulsion to explain to others the puzzle that they have set before them. Reformers, on the other hand, try to improve the status of medical teach-

ing and practice through their discoveries. Reformers possess great powers of observation, together with a genius for experimentation, and the two are so finely blended that one can not be readily separated from the other. John Hunter displayed a sense of that fine union.

Hunter disliked books and hated school. His early years were spent in the unsupervised and haphazard study of nature (1). However, through meticulous and concentrated observation, he taught himself the very important scientific principle of deductive reasoning: starting from a general principle, one is able to derive or extrapolate a specific phenomenon (1). At 20 years of age, John joined his brother, William, who was an established obstetrician in London. John was put in charge of the dissecting room, thereby providing him with a different object upon which he focused his sharpened powers of observation. John's progress assumed the purpose of a mission: before long, he had developed great skill at dissection. He excelled in this field and he became a pupil of Percival Pott at Saint Bartholomew's Hospital, London, United Kingdom (2).

Hunter's medical apprenticeship began at St George Hospital, London in 1754. His study of comparative anatomy became a lifetime passion, and from 1765, he concentrated on human physiology, stressing the processes of healing and inflammation (3).

Hunter inoculated himself with a venereal disease from one of his patients, unaware that the patient was infected with both gonorrhea and syphilis (4,5). He then meticulously studied the progress and effect of those two diseases on his body. He observed the advancement of inflammation, not only in this particular case, but also in other diseases such as osteomyelitis, peritonitis and phlebitis. His fundamental study of inflammation and wound-healing laid the foundation for surgical science.

The basic principles that Hunter acquired through his many experiments permitted him to successfully transplant autogenous tissue from one part to another in the same individual. He was also reported to have successfully initiated artificial insemination in a woman whose husband had hypospadias (a congenital deformity on the ventrum of the penis).

Although Hunter was an excellent teacher, he was a poor lecturer. In childhood, he was deprived of a formal education that would have provided him with the basics of grammar and syntax; consequently, he lacked the ability to communicate eloquently. Notwithstanding this limitation, he was made Surgeon Extraordinary to the King in 1776 and appointed Surgeon General to the army in 1788. He left 14,000 specimens of comparative anatomy in his museum, most of which he had dissected (6).

Already in a poor state of health, suffering from advanced syphilis, Hunter was further agitated by an unnecessary argument with a colleague at a hospital meeting. He collapsed and died that afternoon, October 16, 1793 (7). Contemporaries considered Hunter to be the grandest figure in medicine with the exception of Hippocrates. Using scientific principles, Hunter transformed the process of dissection into 'surgery'.

Sir James Paget stated that "Hunter did more than anyone to try to make us gentlemen" (8).

KING GEORGE IV (1762-1830)

At the end of the 18th century there were no medical schools training doctors in Canada and only a few in the United States. The type of training that individual doctors received before they started their practice varied tremendously, but the majority of aspiring doctors began by apprenticing to established, practising physicians. Some evidence of formal medical training was required before a doctor was permitted by the authorities to practise medicine. A graduating certificate from a medical school was accepted at that time as a sufficient licence to practise. Edinburgh Medical College, Edinburgh, United Kingdom, had an excellent reputation during the 18th and early 19th centuries. Students were taught the current theories as well as the traditional concepts of medical practice.

During the last quarter of the 18th century, an average of 12 American students per year enrolled in Edinburgh Medical College. A number of students, descendants of Scottish immigrants, came from the Southern states. The tradition of attending Edinburgh Medical College extended to three generations (9). The usual procedure for becoming a doctor at this time was to take up an apprenticeship with a respectable local medical practitioner after completion of high school and then to enrol in a medical college. A degree from Edinburgh Medical College gave a distinct advantage to young graduates and assured them a successful career. On return to their own country, the Edinburgh Medical College graduates were often influential in establishing private institutions for the training of aspiring doctors, using methods learned at Edinburgh Medical College and establishing high standards of practice.

At Edinburgh Medical College, the following subjects had to be covered during the four years of medical training: anatomy, physiology, botany, chemistry, theory of medicine, materia medica and pharmacy, midwifery, surgery and a few elective courses. During the final year, students wrote a dissertation on a subject approved by the Dean and presented themselves for a series of final examinations, conducted in Latin, covering the whole field of medical science.

Edinburgh Medical College's curriculum had not changed in the early part of the 18th century, but there were some advances in several disciplines introduced at London University, London, United Kingdom and at Oxford Medical School, Oxford, United Kingdom. It was suggested to King George IV that improvement in the curriculum was necessary to compete with British schools. On July 23, 1826, King George IV appointed a special commission that visited the universities of Scotland and interviewed the medical faculty to hear suggestions for improving medical teaching (10).

The commission's recommendations dealt with the educational preparation of premedical students, the defined role of the medical faculty, whether surgical training should be separate from the teaching of anatomy and whether Latin should be retained in lecturing and in examinations, and it

weighed the merits of oral compared with written examination. The commission also wondered whether too many doctors were being trained in Scotland (10).

Edinburgh Medical College's excellent reputation was reinforced by the commission's report. Edinburgh Medical College's faculty expressed their opinion freely, aware that their views would be presented to Parliament. Their objective was the improvement of the medical curriculum and of the teaching atmosphere at the medical college.

The commission's report resembles, in miniature, Flexner's report of 1910. The faculty members of Edinburgh Medical College were not as critical of clinical training as their American counterparts would later be, and they did not recommend the introduction of courses in the basic sciences.

JOSEPH LISTER (1827-1912)

The middle of the 19th century, during which the germ theory of disease was propounded by Louis Pasteur, was an active period in the development of medicine. British hospitals were filled with patients plagued by a condition that surgeons were finding extremely difficult to treat – putrefying wounds. The mortality rate was very high. Patients with acute fractures often refused to be taken to the hospital because of a fear of dying from 'putrefaction'. A Scottish surgeon, Joseph Lister, at the University of Edinburgh was confounded with the same problems affecting his surgical patients. Purulent discharge from wounds occurred frequently. Surgeons called this discharge 'laudable pus' because it occasionally portended recovery.

In France, Pasteur (11), who was investigating why beer and wine would turn 'sour' and unsuitable for human consumption, discovered that in addition to yeast, there were other small living organisms that he called 'bacteria'. Heat could destroy the organisms in a flask and the solution would remain sterile if the bottle were corked. When it was left open, the bacteria multiplied in the fluid. Pasteur concluded that the small bacteria invaded beer and wine from the air and were responsible for the altered taste. In a paper published in 1865, Pasteur announced that fermentation and putrefaction were due to invasion by germs (11).

Lister read Pasteur's paper with great excitement. He verified Pasteur's observation by boiling contaminated fluids in a flask until the organisms were destroyed and he found that the fluids remained sterile when corked.

Lister, who had done some research in inflammation and blood clotting, surmised that putrefaction after injurious wounds or postoperative surgery could have been transmitted through the contaminated hands of the surgeons and nurses, the instruments, the dressing and the physicians' clothing. His next step was to find a substance that would destroy the germs in the wound but not damage the human tissue. Pasteur remarked, when referring to the creative process, that "chance favours the prepared mind". Lister's search for that substance alerted him to the chemical, carbolic acid, that farmers were using to control the stench of city refuse. It could be the substance he needed. Trying it first on a patient with a compound fracture, he soaked square dressings in car-

bolic acid and applied them directly to the exposed bone and wound, and wrapped a bandage over it. The dressings were changed frequently. The wound healed in a couple of weeks and the bone knitted in six weeks (12). Encouraged by this result, he began to treat all wounds, fresh and old, with applications of carbolic acid, which surgeons and nurses also used to wash their hands and clean their instruments. There was an obvious improvement in the patients' healing. Although he did not have sufficient statistical corroboration, Lister nevertheless began advocating the antiseptic method for the treatment of putrefaction (13).

The medical world had still not accepted the 'germ theory' of disease as shown by Pasteur's work on wine fermentation. The controversy still had not diminished after Koch discovered that anthrax is caused by bacteria (1876), nor after Pasteur had used the attenuated anthrax bacillus to successfully immunize diseased animals. Lister was the ideal person to reform the conception or apprehension of disease in favour of the germ theory. He was brought up in the Quaker religion, which encourages attitudes of patience to achieve a desired end. He had microscopically studied blood clotting and inflammation, which had some bearing on antiseptics. The immediate clinical benefits of the use of carbolic acid gave impetus to his mission.

Several types of infections had been found among hospital patients: staphylococcal infection resulting in laudable pus and streptococcal infection that spread quickly through the tissues, sending the toxic substance into the blood stream producing high fever and chills (erysipelas). A patient with tuberculosis frequently developed abscesses in the lungs or deep muscles. Hospital gangrene, a mixed infection that killed everything in its path, produced a wet, putrid odour. If any infection entered the blood stream, it would produce pyemia and septicemia.

Before the use of carbolic acid, many patients with these infections did not survive. Lister also employed the antiseptic method in the treatment of amputated limbs that, when untreated in the past, proved to be fatal. Encouraged by his preliminary observations, Lister published his results (1870) showing that before the use of antiseptics, 16 deaths occurred in 35 cases, but when antiseptics were employed, only six deaths occurred in 40 cases (14,15).

In spite of these favourable results, British surgeons were sceptical about the existence of bacteria and few used Lister's antiseptic method. The controversy ranged over the next eight years. The situation in the United States was no different from that in the United Kingdom (16).

Lister was appointed Professor of Surgery at the University of Edinburgh, replacing Professor James Syme. In 1869 he was invited to take the post of Professor of Surgery at the University of Glasgow, where he became quite popular with the students and was invited to lecture to various learned societies.

While British surgeons were slow to accept his antiseptic technique, European surgeons were showing great interest. In 1875, Lister was invited to Philadelphia to chair a conference session on surgery. His address on the technique of anti-

sepsis did not create many converts. His antiseptic technique found greater support in Europe. That same year, he visited several German hospitals and clinics and was congratulated on his success. Two years later, Lister was offered the position of Chair of Surgery at the Medical School of King's College, London, United Kingdom. Initially, he was reluctant to leave the warm atmosphere of the University of Glasgow but he accepted the post to promote the germ theory within the sceptical environment of London. Undeterred, Lister was heartened by a line from the Book of Proverbs: "let not mercy and truth forsake thee; bind them about thy neck". Lister held fast to his belief that in time the public would recognize its merit.

Today, it is difficult to understand the general reluctance to accept the germ theory of disease. However, several explanations have been offered, including that the theory was discovered by a French chemist, that established, old-guard surgeons are reluctant to change, and that Lister's method was quite simple in its concept but was rather cumbersome in the technique of application of dressings and the use of carbolic spray.

It was stated that Lister was unique in that he gave joy to surgery. However, he did much more, "he made both experimental surgery and human surgery safe. Lister found surgery an art; he left it both art and science" (17).

JOHNS HOPKINS: WELCH, OSLER, HALSTED AND KELLY

The boom in mercantilism and industry in the late 19th century created an unprecedented accumulation of wealth. There was an attendant rise in the standard of living among the general population. Several new medical colleges were founded with little concern for the academic preparation of its new students or for the quality of academic instruction. German medical science and research had surged so far ahead of the United States that German centres specializing in post-graduate training had begun to attract American physicians.

Johns Hopkins, a Quaker merchant from Baltimore, accumulated substantial funds that he dedicated to medical education. Aware of German advances in medical science, Hopkins stipulated in his will (1870) that 'The Johns Hopkins University' and 'The Johns Hopkins Hospital' be established (18), and in his letter of instructions to the trustees, he specified that,

In all your arrangements in relation to this hospital, you will bear constantly in mind that it is my wish and purpose that the institution should ultimately form a part of the medical school of that university for which I have made ample provision by my will. (19)

The success of Johns Hopkins University, Baltimore, Maryland was due to the choice of an inspiring director, Daniel Colt Gilman, and a skilful advisor, Dr John Shaw Billings. Its reputation was based on the appointment of four outstanding faculty members from different universities who had been active in educational reform long before their term at Johns Hopkins University. Together they formed a unique

symbiosis forging a method of teaching and training through progressive clinical laboratory advancement.

One of the Johns Hopkins University reformers was William Welch, a graduate of Yale Medical School, New Haven, Connecticut who received his training in pathology at German medical centres. He acquired research and laboratory experience while on staff at the Bellevue Hospital, Bellevue, Washington and his interest in medical curriculum reform was greatly influenced by his education in Germany. Welch was considered for appointment to Johns Hopkins University long before the university was built because he was well equipped to offer advice in the planning of the laboratories and the establishment of the research facilities (20).

Another individual who joined Johns Hopkins University (1889) was William Osler, a graduate of McGill University, Montreal, Quebec who showed great interest in laboratory facilities and in pathology. When he graduated with honours in 1874, he was appointed Professor of Medicine at McGill University. His two years of graduate studies at various European institutions brought him into contact with the pathologist Rudolf Ludwig Karl Virchow (1821-1902). He purchased eight microscopes with his own funds and brought them to McGill University for the purpose of instructing medical students in microscopic work and in histology. He was of the firm conviction that pathology must be the foundation of medical clinical science (21). While practising medicine at the Montreal General Hospital, he personally completed 1000 autopsies on his patients. This expertise gave tremendous authority to his teaching of internal medicine. Osler held that medical students must learn at the patient's bedside, supported by laboratory findings and verification at autopsy. His primary purpose in teaching was to remove institutional restrictions in the teaching and learning process.

By the time Osler was appointed to Johns Hopkins University in 1889, he had published his *Principles and Practice of Medicine*, which, because of its objectivity and candour, became a highly successful medical textbook (22). Although his primary objective was to understand the disease process, Osler was a consummate physician who was interested in the whole person. His personal charm and charisma caused students to flock to his lectures and rounds.

The third reformer, William Halsted, was delayed somewhat in assuming his post at Johns Hopkins Hospital, because he developed a cocaine habit during his medical experiments at Bellevue Hospital where he was a staff surgeon (23). Welch, a colleague and pathologist at Bellevue Hospital at that time, became aware of Halsted's addiction and tried to help him. Treatments for addictive behaviour were crude in the latter part of the 19th century, and Welch hoped that mere abstinence from cocaine would stop the addiction. Without Halsted's consent, Welch and a couple of seamen restrained him and kept him isolated aboard a schooner in New York Harbour. After a couple of weeks, Halsted's mental condition deteriorated so much that he had to be admitted to the psychiatric hospital in Providence. For a time, he lost interest in surgery, was withdrawn and spoke little (24).

Welch, now at Johns Hopkins' Hospital, suggested to Halsted that informal work in the laboratory might be therapeutic. In time, under Welch's supervision, Halsted regained complete control of himself. He renewed his interest in surgical research, practice and teaching. His addiction was known only to a few friends. Halsted was meticulous at dissection, careful in the handling of tissues and deliberate in the choice of procedures. Osler did not hesitate to recommend him to the position of Professor of Surgery, whereupon Halsted introduced a new program and procedure for the training of residents and master surgeons, a method that was soon recognized as the most advanced in the United States (25).

The fourth reformer, Howard Atwood Kelly, joined the group as Associate Professor of obstetrics and gynecology in 1889. Within a short period of time he was recognized as a specialist in women's diseases, advancing procedures in abdominal surgery and developing a new technique for the diagnosis of kidney and bladder diseases (26).

It is said that the essence of a successful undertaking is the thought that precedes it. The founder of Johns Hopkins University and Hospital had a vision of promoting health, teaching and research for the benefit of mankind. A new university and hospital provided the faculty with an opportunity to free itself from traditional methods and practices and to introduce new approaches and techniques in teaching and research. Within a few years, substantial contributions were made in the fields of basic and clinical science. The new university complex became a model for contemporary medical education (27).

Within 20 years of its founding (1896) over 60 American colleges had three or more Johns Hopkins University graduates in important academic positions (28).

ABRAHAM FLEXNER (1866-1959)

The most notable obstacles to efficient and effective medical treatment had been the lack of the means to control severe pain, the problem of containing infections, the lack of diagnostic aids for internal diseases, and the inability to control bleeding and replace lost blood. However, by the turn of the century, many of these obstacles would have been overcome. The introduction of the use of ether and chloroform anesthesia in the 1840s helped to control pain. Platelets were recognized as an important factor in the coagulation of blood, and Landsteiner's discovery of blood groups made human blood transfusion possible almost two decades later.

Toward the end of the 19th century there was an increased demand for physicians in the United States that, in turn, necessitated more medical colleges in North America. However, acute administrative disorganization had left many medical colleges in the United States in a deplorable state. The clinical departments were often staffed by nonresident, part-time physicians using old fashioned teaching methods (29). Some were proprietary schools offering instruction that was substandard and were no better than 'diploma factories'. By the end of the 19th century, some American medical universities were inferior to those in Europe. As indicated above, great developments had occurred in medical science and practice, yet these advances were being neglected in America.

The ferment of change in the United States began at the end of the 19th century. The American Medical Association believed that the medical colleges required reform to incorporate the latest developments in science but were unable to implement these reforms. The Association of American Medical Colleges, established in 1890, had similar objectives, but the American Medical Association failed in its attempt to gain the members' cooperation. However, Johns Hopkins University, as stated earlier, provided a well needed beacon of possibility.

Two philanthropic organizations, the Carnegie Foundation and the Rockefeller Foundation, which dedicated much of their funds to the improvement of medical teaching and practice, were agents of American medical reform. In 1908, the American Medical Association appealed to the Carnegie Foundation for help in evaluating medical college education. The Foundation's President, HS Pritchett, subsequently engaged Abraham Flexner, a 42-year-old high school teacher, to assess the state of medical education in the United States and Canada.

Flexner was born in Louisville, Kentucky, on November 13, 1866. He was educated at Johns Hopkins University, Harvard University, Cambridge, Massachusetts and Berlin University, Germany. His highschool teaching career of 19 years was considered to be ample qualification for the task set by the Carnegie Foundation, which in 1908 was to inspect medical colleges to evaluate the quality of medical training (30).

In preparation, Flexner consulted the work of Thomas Bond, who with Benjamin Franklin cofounded the Pennsylvania Hospital, Philadelphia, Pennsylvania in 1753. Bond advocated bedside teaching and recommended that medical schools be "organic" parts of a university. Furthermore, the teaching should be done by practising physicians in public hospitals. Bond also suggested that students acquire "a competent knowledge of Latin, mathematics, natural and experimental philosophy and a sufficient apprenticeship to some reputable practitioner in physic" (31). With that preparation they would then have a final year of study at Pennsylvania Hospital consisting of lectures and "attendance upon practice" (31).

Aware that Carnegie millions were backing Mr Flexner's project, all the universities cooperated in giving him free access to records. Without overtly stating his purpose, Flexner visited 155 North American medical schools and found that the standards of admission were low, the training of the faculty was below standard, the laboratories were inadequately equipped and few of the universities were affiliated with a hospital of high calibre (32).

Flexner's report was a meticulous document that named names and institutions, and it became a powerful testimonial for reform. It contained two parts: the first part reviewed the history of medical education in the United States, assessed its present condition and recommended reform based on the Johns Hopkins model – more stringent admission requirements, graded four-year curriculum, full-time faculty for basic sciences and high calibre clinical teaching. The second

part reported on how the individual schools measured up against the proposed standards.

Flexner summarized the effect of his report as follows:

Schools collapsed to the right and left without a murmur. A number of them pooled their resources ... The fifteen schools in Chicago which I have called "the plague spot of the country in respect to medical education" were shortly consolidated into three. (33)

The effect of the final recommendations culminated in what became known as the 'Flexner Revolution' and the standardization of medical education in North America.

It is intriguing to note that the medical school faculties and their administrators respected and accepted the findings of a highschool teacher of 19 years' experience. There were few protests, demands for recount or court suits (34).

Another American foundation that had exercised a reforming influence on medical education in North America was the Rockefeller Foundation, New York. Founded in 1902, its objective was to ameliorate medical standing by promoting excellence in teaching and research and to encourage full-time appointments of qualified personnel.

Flexner was invited to become a member of the Rockefeller Education Board in 1913 and disbursed funds to improve the medical schools. He used the Johns Hopkins Medical School and its hospital as a model. The following institutions and universities were the recipients of generous funds: University of Chicago (Chicago, Illinois), University of Colorado (Boulder, Colorado), University of Iowa (Iowa, Iowa), University of Oregon (Eugene, Oregon), University of Rochester (Rochester, New York), University of Virginia (Charlottesville, Virginia), University of Washington (Seattle, Washington), Columbia University (New York), Cornell University (Ithaca, New York), Duke University (Durham, North Carolina), Harvard University, McGill University, Tulane University (New Orleans, Louisiana), Vanderbilt University (Nashville, Tennessee), Case Western Reserve University (Cleveland, Ohio) and Yale University (New Haven, Connecticut) (35). These philanthropic contributions helped alter the standard of American medical education and set a pattern for the future.

Canadian universities were also swept up by the wave of reform unleashed by Flexner's report. McGill University, which had attracted outstanding teachers and researchers, had not taken the opportunity to build on this talent but was content to settle on its reputation.

CHARLES MARTIN (1868-1953)

McGill University's period of growth was waning toward the end of the 19th century. William Osler had left to accept a post as head of the newly founded Johns Hopkins Hospital. Early in the century, while other Canadian universities were installing new research facilities and appointing full-time faculty, McGill University lagged behind (36). The enlistment of faculty into the armed forces in 1914 seriously depleted McGill University's ranks (37). By the spring of 1916, the lack of leadership in the field of research gained public at-

tention during the Faculty of Medicine's graduation exercises.

Harry Goldblatt, a brilliant medical student in his final year, was selected to be valedictorian. Dr Harold Segall, a freshman, attended the convocation and recalled the proceedings. After the graduates received their diplomas, Goldblatt delivered the valedictory address. He recalled the great men in the medical faculty who created McGill University's reputation as one of the leading medical schools. Then, changing his tone, he stated that this recognition was threatened and implored that measures be taken to preserve McGill University's stature (38). Palmer Howard, William Osler, Francis Sheperd and Thomas George Roddick had left. He intimated that other Canadian medical schools were forging ahead, establishing departments of research and appointing full-time faculty. Dr Segall reported a feeling of dismay and embarrassment among the members of the medical faculty. Charlie Martin rose to address the audience and stated, in response to Goldblatt, that measures to rectify McGill University's situation were in the planning stages and would be implemented in the near future. Martin had taken great interest in advancing teaching and clinical research at McGill University and its associate hospitals and was seeking some financial assistance that would help the Royal Victoria Hospital (RVH), Montreal, and McGill University to regain the leadership that they had enjoyed at the end of the 19th century and the beginning of the 20th century.

He devised some tentative plans and was eager to discuss them with William Osler. The opportunity came when Martin was assigned to military duties in England in 1918. Enthusiastic about the project for McGill University, Osler alluded to the innovations that he had introduced at the London teaching hospitals, one of which was full-time clinical appointments allowing time for research (39). Osler may well have suggested to Martin that similar arrangements would be required at McGill University to attract distinguished researchers and research grants.

It is likely that William Osler was encouraged to send an open letter to McGill University Principal, Herbert Stanley Birkett, the Medical Boards of the Montreal General Hospital and the RVH, advising them to introduce facilities that would help McGill University to maintain its leadership (40). Osler also sent a letter to the Rockefeller Foundation commending them for their past generosity in the United States and pointing out the need for research support and medical training in Canada (41).

Osler's death in 1919 impelled Martin to assume the leading role in that project. He was subtle, far-sighted and persuasive; he saw the importance of bringing distinguished researchers and clinicians to the RVH and providing them adequate financial support. Martin had taken advantage of Rockefeller Foundation grants and received funds to upgrade the pathology department. He also knew that there had been recent changes in the granting policy: the Foundation would provide about one of three funds requested on the condition that these funds be matched from the institution and the community.

Understanding that McGill University students required clinical and research training, Martin hoped for a sufficiently large grant to establish a research institute at the RVH. The institute would conduct research in the basic sciences and offer the opportunity to do clinical research in the various medical disciplines. He had helped to lure Jonathan Meakins, who had a great deal of research experience in respiratory medicine. Meakins was the professor of research medicine at Edinburgh Medical College, a position that he obtained as soon as he was demobilized from his war duties. He had graduated from McGill University, having completed early postgraduate training under Martin, and was eager to return to McGill University and Montreal (42).

Martin recognized the advantage of the Johns Hopkins School of Medicine's program of hiring full time faculty, but he bided his time until he was appointed Dean of Medicine in 1923 (43). By carefully choreographing his persuasive encounters, Martin was able to obtain conditional commitments from the Principal of McGill University and the RVH's Board of Governors to provide matching funds when the Rockefeller Foundation had agreed to support a university clinic (43).

Jonathan Meakins, having returned to McGill University as Director of the clinic, created an atmosphere that encouraged the free exchange of ideas among basic and clinical scientists. The result was a "contagious atmosphere of excellence" that engendered cooperative publications. New interdisciplinary departments have since been established, such as the departments of metabolism, endocrinology, female fertility and others (44).

Under the dynamic direction of Dr Meakins, who was also appointed Physician-in-Chief, the symbiosis between skilled biological scientists and ambitious clinical investigators continued for years and resulted in 1800 original publications within 20 years.

EDWARD ARCHIBALD (1872-1945)

Martin was not content to rest on his laurels following the successful reform of the medical department. His next long range plan for McGill University was the rehabilitation of the Department of Surgery, which suffered a retrograde period with the appointment of Sir Henry Grey as Chief in 1923.

The tuberculosis epidemic in 19th century North America destroyed many lives, frequently young adults in their prime. Robert Koch (1843-1910) had discovered that the cause of tuberculosis was bacterial infection. The spread of 'consumption' within crowds or densely populated areas was effected through tiny globules of secretion containing live bacteria expelled from the lung cavities. Obligatory isolation of patients was instituted only in the 20th century.

Canadian surgeon Edward Archibald graduated in medicine from McGill University in 1896 and completed postgraduate training in Breslau, Ontario with Johann von Mikulicz-Radecki, who believed that surgery must be founded on the basic sciences.

The incidence of tuberculosis in 1921 was very high in Quebec. Overcrowding and the lack of obligatory milk pas-

teurization helped to create the highest mortality in North America (123.2/100,000 people) (45). Archibald contracted tuberculosis after his trip to Europe and was treated for one year at the Saranac Lake Sanatorium. He observed that many patients with tuberculosis recovered through natural resistance. The majority of the patients, however, were at the mercy of the advancing disease. Before the discovery of antibiotics and of surgical intervention, patients with advancing disease merely languished, awaiting death (46).

Archibald became a consultant to the Trudeau Sanatorium in Saranac Lake, New York, and saw little hope of recovery in many of his patients. There were reports from Europe about the promising surgical treatment for tuberculosis; German chest surgeon Ferdinand Sauerbruch (1875-1951), a pupil of Johann von Mikulicz-Radecki (1850-1905) with whom Archibald had studied in 1900, devised a method of putting the affected lung at rest when all other treatment failed. The method involved collapsing the rib cage by removing portions of the upper ribs on one side, and causing the afflicted lung to collapse. The procedure was called extrapleural thoracoplasty (47).

When Archibald returned from his military service in World War I, he began an intensive study of thoracoplasty using animals in his experiments. He later developed a significantly improved technique that offered the chance to arrest the disease in carefully selected patients. The technique involved adjusting the length of the portion of the rib to the specific needs of the patient; he effected this procedure in two or three stages. The technique also involved the use of a special endotracheal tube to prevent spilling of infected material into the healthy lung. Furthermore, the apex of the lung had to be freed and an insertion made of a 'living pedicle' of pectoralis muscles to fill the empty space (48).

Archibald was the first surgeon in North America to use a modified Sauerbruch thoracoplasty in the treatment of advanced tuberculosis. This improved method offered some hope for the young afflicted individual. The prevalence of tuberculosis in Quebec prompted Archibald to establish the Thoraco-Pulmonary Division at the RVH to train chest specialists in the surgical treatment of advanced disease.

In addition to tuberculosis, Archibald conducted extensive research on acute pancreatitis. He was the only member of the RVH who had done continuous investigative work since his appointment to the staff in 1904.

In 1923, the position of Surgeon-in-Chief at the RVH became available; however, the President of the RVH Board of Governors disqualified Archibald because he was showing signs of deafness and he had a reputation for chronic tardiness. Instead, he imported the Scottish surgeon Sir Henry Grey. This created a very difficult situation in the hospital for the staff and for Archibald who had been appointed Professor of Surgery at McGill University.

Ultimately, Sir Henry Grey was forced to resign, and for the next five years, Archibald carried on as Surgeon-in-Chief without formal recognition.

Charles Martin, who had great respect for Archibald's ability and recognized his international standing, decided to

use a strategy similar to that employed in effecting the establishment of the medical research clinic in 1924. In order for the Rockefeller Foundation to support the establishment of a sorely needed surgical research facility, Martin adopted the following strategy: he collected testimonials of support from the departments of physiology, nephrology and experimental medicine, he obtained conditional financial support from the Principal of McGill University providing an amount equal to that which the Rockefeller Foundation would offer, and he obtained similar conditional support from the RVH Board of Directors.

By submitting these carefully prepared documents in support of badly needed surgical research facilities at McGill University, Martin revealed to the Rockefeller Foundation that a surgeon of international stature was available to head this new facility (49). In addition, Martin had made several reconnaissance trips to the Rockefeller office in New York City sounding out the chances of obtaining support.

The Rockefeller Foundation assured Martin that as soon as McGill and the RVH held to their commitment, the establishment of the surgical facility would be guaranteed. Martin had only a few days before the Christmas holiday to secure the RVH Medical Board's recommendation of Dr Edward Archibald as Director of the new surgical research unit. He posted a personal message to Archibald to obtain his agreement and summoned a special meeting of the executive members of the Board of Governors on December 24, 1928 in order to approve the appointment.

WILDER PENFIELD (1891-1976)

Wilder Penfield, born in the American West, was raised by a strong-willed, devout mother. His father had left the family during Penfield's boyhood. His mother instilled in him the desire to excel academically and physically. She encouraged him to aim for a Rhodes Scholarship to Oxford University (50).

Penfield did not disappoint his mother and subsequently spent two years at Oxford University (1915-1916) studying with renowned physiologist Charles Sherrington, achieving a bachelor of arts in physiology. On his return to the United States, the ship was torpedoed by the Germans and he sustained a fractured hip while convalescing at Sir William Osler's home at Oxford. During that period he would occasionally visit the Pathology Department. One day, the prosector who was doing a complete autopsy casually asked Penfield if he would like to take out the brain. Dr Osler came in just as he was awkwardly trying to saw the skull. "Wilder", said Sir William, "it is always best to do the thing wrong, the first time". Then he took off his jacket, rolled up his sleeves and within five minutes showed Penfield the correct procedure. This episode so strongly influenced Penfield that he decided to pursue neurosurgery as his profession (51).

Penfield returned to the United States and completed his medical degree at Johns Hopkins University in 1918. He spent three years of specialized training in neurosurgery. In 1921, he settled in New York City, practising neurosurgery at the Presbyterian Hospital and at Columbia University. A

short time later, Dr William Cone joined him from Iowa; their association lasted until 1959.

The chances for advancement in New York were not encouraging and Penfield sought an academic environment where he could study the broad aspects of neurological diseases with emphasis on brain surgery.

In 1927, he received an invitation from McGill University. In order to keep up with the demand for surgical treatments of tuberculosis, Dr Edward Archibald, Professor of Surgery at McGill University and Surgeon-in-Charge at the RVH, was developing a thoraco-pulmonary division to train young chest surgeons. Being involved in this new enterprise left Archibald little time to attend to the demands of his practice. Because neurosurgical specialty did not exist when Archibald started practice in Montreal in 1904, he was encouraged by his Chief Surgeon to attend to patients with acute head injuries. The increased incidence of such injuries was due to the increased use of the motorcar. In 1907, Archibald spent several months studying neurosurgery with Professor Victor Horsley at Oxford. This encouraged him to accumulate and analyze the cases of his patients with head injuries and he subsequently contributed a chapter on head wounds in *American Practice of Surgery* (52). Archibald carried on with this subspecialty until 1927 when he started looking for a young promising surgeon to take over his neurosurgical practice at McGill University and at the RVH.

It was brought to his attention that Wilder Penfield was at the Presbyterian Hospital in New York and he arranged a visit to observe him operating. Archibald subsequently invited Penfield to come to Montreal to see whether he would be interested in the academic position. The facilities that were allotted to Dr Penfield and Dr Cone at the RVH were somewhat limited, but Penfield saw the potential for developing a successful neurosurgical practice as well as the possibility for comprehensive study of neurological diseases (53).

Archibald could not provide the funds to accommodate Penfield's research dream, which included the construction of a neurosurgical institute benefiting both McGill University and Montreal. Meanwhile, Penfield elaborated his ideas and set down the extensive studies in neurological diseases, sending them to the Rockefeller Foundation in 1929 in the hope of securing a grant. He was not successful because McGill University had already received a large grant from the Rockefeller Foundation that year. Penfield persevered despite this disappointment (Minutes of the Rockefeller Foundations, 22 January 1929, unpublished).

In 1931, a new director was appointed at the Medical Science Department of the Rockefeller Foundation. It was Alan Gregg, Penfield's old friend whom he had encountered in Europe. There had been plans for the construction of neurosurgical institutes at several American universities. In fact, Penfield had been invited to relocate to the University of Pennsylvania. Although no decision had been made by Penfield and Cone, rumours began to spread. Archibald, who wanted to keep Penfield at McGill University, discussed this matter with Charles Martin, the Dean of McGill University Medical School. Martin realized the tremendous importance

of such an institute and felt that every effort should be made to keep the institute and Penfield in Montreal. He reassured Penfield that McGill University could finance a neurological institute and shortly thereafter he telephoned Max Mason, President of the Rockefeller Foundation, requesting a grant to build the Montreal Neurological Institute. The foundation replied that Alan Gregg would be in Montreal in October (1931) to discuss this matter. Penfield invited Gregg to stay with him, and during their first breakfast, Gregg assured Penfield that the Foundation was interested in Penfield's plan (54).

The Rockefeller Foundation agreed to support the Montreal Neurological Institute with a one million dollar grant, provided that equal financial support would be made by McGill University, and the provincial and municipal governments. Archibald was pleased with the news and congratulated Penfield on achieving the first stage toward his important project. Charles Martin sought McGill University's participation from the Principal, Arthur Currie, and discussed the matter with the Board of Governors of the RVH. Martin also convinced Montreal Mayor Camillien Houde of the prestigious importance of the neurological institute for Montreal and acknowledged the brilliance and skill of its projected head, Dr Wilder Penfield. Mayor Camillien Houde had no difficulty convincing his aldermen to extend the city's financial support. Martin's great charm and diplomatic manoeuvres attracted additional private and public support for the project.

By the fall of 1932, sufficient funds had been committed to initiate a contract with the builders. On September 17, 1934 the Montreal Neurological Institute opened with great celebration. Archibald gave the opening address:

The nervous system is one of the most difficult parts of man's frame to understand. Few subjects in medicine have demanded of investigators as great an intellectual capacity or as arduous a labour. (55)

And then Archibald added a statement that is really his own credo:

To gather knowledge and to find out new knowledge is the noblest occupation of the physician. To apply that knowledge with understanding ... to the relief of human suffering is his loveliest occupation; and to do both with an unassuming faithfulness sets the seal on the whole. This is part of those who will work here. (55)

Archibald was delighted that Penfield's project, meticulously planned by him, was taking off with the help of such generous support.

Penfield envisioned a comprehensive study of neurological diseases requiring the establishment of a substantial institute with advanced technology. He believed that the project should be an integral part of the hospital and of the research clinic, combining clinical care with basic research, and probing the origin, treatment and cure of neurological diseases.

Penfield's exploration of the brain was conceived as a grand adventure. The study and analysis of the cortex and the

mapping of the brain were initiated during his treatment of epilepsy patients. As a surgical resident, I assisted in these operations and remember that the mapping of a specific area of the cortex was not unlike a journey into unknown territory except that the patient's consciousness and the electrochemical processes of the brain played a major role in the search. The brain mapping and the exploration of cortical functioning was a heuristic discipline for Penfield and his staff in those early days of research into the physiology of the brain and of the treatment of epilepsy (56).

The Institute has since earned an international reputation as a centre for the treatment of epilepsy. The Montreal Neurological Institute performs as many operations for the treatment of epilepsy as any other institution in the world. Penfield's mission for the Institute was to understand the nervous system and to alleviate suffering, extending this research in an effort to understand the functioning of the brain.

To understand the mechanism of consciousness, Penfield suggested that the subcortical region must be accessible from both hemispheres of the brain. He persisted in the search for the highest level of neurological integration of the brain's capacity allowing for conscious awareness.

Herbert Jasper, the neurophysiologist who collaborated with Penfield in the interpretation of electroencephalogram as a guide to the operations for patients with epilepsy, stated:

Penfield's life-time search for better understanding of the function and organization of the brain and its disorders during epileptic seizures is symbolized in a way by his hypothesis of the central integrating system. It is a sort of conceptual bridge he has built between brain and the mind. He concluded that we should probably never be able to cross that bridge. (57)

However, in anticipation of crossing that bridge, Penfield seized upon a bold vision of combining clinical treatment of neurological and neurosurgical diseases with a simultaneous search for the understanding of the cause of the disease. The pursuit of this vision resulted in the founding of the Montreal Neurological Institute, which today fulfills all his aspirations.

CONCLUSIONS

The analysis of the reformers who were selected for parts I and II shows that they have been men of vision with penetrating interest and analytical skills for medical education and practice.

Part II presents contributions of medical reformers starting with John Hunter in the mid-18th century and concludes with Wilder Penfield in the mid-20th century.

Some reformers, following their own mission or by invitation, helped to advance the medical sciences when they faltered. Others attempted to correct the distorted problems of medical practice by putting it back on track.

As we continue to chronicle the contributions of the reformers in the contemporary periods, we note that their role is becoming more essential. As the study continues into the

21st century, newer influences will create different problems for them to solve. The emerging reformers will present their challenges for our future studies.

REFERENCES

1. Beekman F. The self-education of young John Hunter. *J Hist Med* 1951;6:506-15.
2. Dobson J. John Hunter. Edinburgh: E & S Livingstone, 1969:33-4.
3. Jarcho S. John Hunter on inflammation. *Am J Cardiol* 1970;26:615-8.
4. Qvist G. John Hunter's alleged syphilis. *Ann R Coll Surg* 1977;59:205-9.
5. Hunter I. Syphilis in the illness of John Hunter. *J Hist Med* 1953;8:249-62.
6. Kobler J. The Reluctant Surgeon: A Biography of John Hunter. New York: Doubleday, 1960:232-8.
7. Brain R. The neurology of John Hunter's last illness. *BMJ* 1952;ii:1371-3.
8. Paget J. Memoires and Letters. London: Longman, 1902:286.
9. Randall J. The influence of Edinburgh Medical School in America in the 18th century. *Edinb Med J* 1923;30:95-124.
10. Great Britain. Evidence, Oral and Documentary. Commission appointed by His Majesty George IV, July 23, 1826 for the visiting of the universities of Scotland. London: W Clowes and Sons, 1837.
11. Pasteur L. Dépôts qui se forment dans les vins. *Acad Sci (Paris) C R* 1865;60:1109-13.
12. Fisher R. Joseph Lister, 1827-1912. London: Macdonald and Jane's, 1977:135-6.
13. Fisher R. Joseph Lister, 1827-1912. London: Macdonald and Jane's, 1977:146.
14. Lister J. On the effects of the antiseptic system upon the general salubrity of a surgical hospital. *Lancet* 1870;i:4-6,40-2.
15. Lister J. Further evidence regarding the effects of the antiseptic treatment upon the salubrity of a surgical hospital. *Lancet* 1870;ii:287-9.
16. Fischer R. Joseph Lister, 1827-1912. London: Macdonald and Jane's, 1977:273.
17. Archibald, E. The mind and character of Lister. *Can Med Assoc J* 1936;35:489.
18. Thom HH. Johns Hopkins: A Silhouette. Baltimore: The Johns Hopkins Press, 1929:102-3. (The full test of Hopkins' last will and testament is herein reproduced).
19. Thom HH. Johns Hopkins: A Silhouette. Baltimore: The Johns Hopkins Press, 1929:90.
20. Flexner S, Flexner JT. William Henry Welch and the Heroic Age of American Medicine. New York: The Viking Press, 1941:92-3.
21. Osler W. The evolution of internal medicine. In: McGovern JP, Roland CG, eds. The Collected Essays of Sir William Osler, vol 2. The Educational Essays. Alabama: The Classics of Medicine Library, 1985:303-22.
22. Osler W. The Principles and Practice of Medicine Designed for the Use of Practitioners and Students of Medicine. New York: D Appleton & Co, 1892.
23. Crowe SJ. Halsted of Johns Hopkins: The Man and His Men. Illinois: Charles C Thomas, 1957:29.
24. Whipple AO. Halsted's New York period. *Surgery* 1952;32:548.
25. Crowe SJ. Halsted of Johns Hopkins: The Man and His Men. Illinois: Charles C Thomas, 1957:37-59.
26. Curtis FB. Howard A Kelly. *Johns Hopkins Med Bull* 1943;73:1-22.
27. Flexner A. I Remember; The Autobiography of Abraham Flexner. New York: Simon and Schuster, 1940:65.
28. Shryock RH. The Unique Influence of the Johns Hopkins University on American Medicine. Copenhagen: Ejnar Munksgaard, 1953:10.
29. Norwood WF. Medical education in the United States before 1900. In: O'Malley CD, ed. The History of Medical Education. California: University of California Press, 1970:484-92.
30. Flexner A. I Remember; The Autobiography of Abraham Flexner. New York: Simon and Schuster, 1940:115.
31. Jacobson, TC. Making Medical Doctors: Science and Medicine at Vanderbilt Since Flexner. Alabama: University of Alabama Press, 1987:37.
32. Flexner A. Medical Education in the United States and Canada, 1910:28-51.
33. Flexner A. I Remember; The Autobiography of Abraham Flexner. New York: Simon and Schuster, 1940:131.
34. Hudson RP. Abraham Flexner in Perspective: American Medical Education 1865-1910. *Bull Hist Med* 1972;46:545-61.
35. Nuland SB. Doctors: the Biography of Medicine. New York: Random House, 1989:427.
36. Osler W. Brief Description of the Physiological Laboratory, McGill College. *Canada Med Surg J* 1880-81;9:198-201.
37. Macmillan C. McGill and its Story 1821-1921. London: John Lane, 1921:262.
38. Segall HN. The four G's of the class of McGill medicine, class of 1916. *Can Jew Hosp Soc J* 1982;6:17-32.
39. Fye WB. The origin of the full-time faculty system. *JAMA* 1991;265:1555-62.
40. Letter from William Osler to Herbert Stanley Birkett, Dean of Medical Faculty, McGill University, 29 July 1919. (Osler Library Acc 326/1.6/Birkett)
41. Cushing H. The Life of Sir William Osler. Oxford: Clarendon Press, 1925:2:664.
42. Segall H. Taped Interview with Dr Martin Entin, Royal Victoria Hospital, Montreal, 26 November 1986.
43. Lewis DS. Royal Victoria Hospital 1887-1947. Montreal: McGill University Press, 1969:171.
44. Entin M. The dynamics of research at the Royal Victoria Hospital, Montreal. *Can J Surg* 1987;30:449-50.
45. Wherrett GJ. The Miracle of the Empty Beds: A History of Tuberculosis in Canada. Toronto: University of Toronto Press, 1977.
46. Archibald E. The present status of surgery in pulmonary tuberculosis. *Can Med Assoc J* 1913;3:1087.
47. Archibald E. Recent advances in thoracic surgery. *Can Med J* 1924;14:240.
48. Entin M. Romance and tragedy of tuberculosis: Edward Archibald's contribution to the surgical treatment of pulmonary tuberculosis. *Can J Plast Surg* 1995;3:213-6.
49. Martin C. Letter to RM Pearce of Rockefeller Foundation, 7 December, 1928.
50. Penfield W. No Man Alone; A Neurosurgeon's Life. Boston: Little, Brown & Co, 1977:3.
51. Penfield W. A medical student's memories of the Regius Professor. Bulletin of the International Association of Medical Museums and journal of technical methods. No 9. Sir William Osler Memorial Number. Montreal (Privately issued), 1926:387.
52. Joseph D, ed. American Practice of Surgery; A Complete System of the Science and Art of Surgery. New York: W Wood & Co, 1906-1911.
53. Meakins JC. William Archibald Edward. *Can Med Assoc J* 1946;54:194-7.
54. Penfield W. No Man Alone; A Neurosurgeon's Life. Boston: Little, Brown & Co, 1977:295-6.
55. Penfield W. No Man Alone; A Neurosurgeon's Life. Boston: Little, Brown & Co, 1977:383.
56. Feindel W. The Montreal Neurological Institute. *J Neurosurg* 1991;75:821-2.
57. Feindel W. Wilder Penfield (1891-1976); The man and his work. *Neurosurg* 1977;1:98.