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Title: Linking Spinal Cord Injury Rehabilitation Between Wars: The Deaver
McKenzie Legacy.

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INTRODUCTION

Military Medicine has had a major influence on the development of SCI Medicine and Physical Medicine and Rehabilitation (PM&R) dating back to WW I. Although its origins in Europe and North America may have differed by location and specialty, the organization of categorical centers required for the delivery of specialized services to the severely injured soldier especially to the neurological system had much in common. Patients were triaged from those requiring routine care to those in need of specialized comprehensive care with long term medical and rehabilitation services. Peripheral nerve injuries in Germany, England and the United States served as a model for categorical comprehensive care.^{1,2} While pioneers such as Munro, Guttman,³ Botterell and Jousse, Bors and Comarr are well recognized for their contribution to the restoration of function to the wounded in World War II (WW II), especially those with SCI, little recognition has been given to the origins of their comprehensive approach to SCI care.⁴ Foerster in Germany, Frazier in the US reported on large series of 3-4000 cases of peripheral nerve injuries requiring restorative services of physical treatment, training and vocational assessment.^{1,5,6} Sir Robert Jones from Great Britain is credited with the organization of special orthopedic centers, which provided integrated operative and restorative services. Jones placed a Canadian citizen, with the title of Professor of Physical Therapy in an American university in charge of inspecting the restorative care of the British centers, R. Tait McKenzie.⁶ McKenzie, gained recognition based on publications in leading British journals of his success in restoring the wounded to function with physical training. Realizing that military physicians were unprepared for dealing with mass casualties requiring rehabilitation in WW I, he wrote the Handbook of Physical Therapy, which became the reference manual for British, Canadian and United States Armed Forces.^{6,7,8} In 1917, he was recognized by the Canadian Government and invited to make recommendations to the Military Hospital Commission on the reeducation (rehabilitation) of wounded soldiers as regard to the staffing and equipment of Military Convalescent Hospitals from “Halifax to Victoria”.⁹ Today, we will recognize the contributions of this great Canadian physician and his role in the origins of comprehensive rehabilitation.^{8,10,11}

McKenzie’s early life at McGill

McKenzie and James Naismith had been close boyhood friends, who played sports together and continued this relationship when they entered college at McGill.¹² While Naismith excelled in

football, McKenzie won medals in track and field. It is Naismith, who had taken over gymnastic classes at McGill in 1889 and asked McKenzie to share the teaching responsibilities. Shortly thereafter Naismith would be recruited to Springfield College in Mass. by Luther H. Gullick and together they would invent the game of basketball.¹³ McKenzie would assume full responsibility for teaching under graduate gymnastics, thus launching his career in physical education.⁸ His interest in exercise and fitness continued following his entrance into medical school in 1890s and embraced an academic dimension as he taught anatomy and kinesiology. During two summer vacations, he studied under Paul Dudley Sargent, Anthropometrics or the quantitative measurements of men and women's response to exercise.⁸

“McKenzie attended courses for 2 summers, in 1889 to 1890, on the theory of systems in physical education, anthropometry, applied anatomy, and other sciences, which were applied in class drills that involved exercises with weights, vaulting with bars and horses, tumbling, and dancing. Sargent's systematic measurement of body proportions and research that involved thousands of male and female students and that included physiological studies of respiratory capacity and grip strength, established that training approaches must be scientifically based. This same scientific rigor is evident in McKenzie's future cardiac studies.

Many of the machines used in gymnasiums throughout the United States, such as rowing, pulley systems for specific muscle groups, and lifting, were developed by Sargent. However, Sargent faced opposition to his scientific approaches to the study of physical conditioning by the conservative elements of academe. Yet, McKenzie predicted that Sargent's place in the history of physical education would be as “pioneer, thinker, and scientist.”⁸

Sargent was not only a pioneer in gymnastics in medicine at Harvard but founded the future school of physical therapy in Boston, one of the oldest in the US and named in his honor.¹⁴ This introduction to the scientific metrics of exercise in health and later illness was to define McKenzie's career interest for the next 40 years.

Gullick, who pioneered physical fitness for the YMCA at Springfield College, would approach McKenzie after his graduation from medical school and attempt to recruit him to join him and Naismith. Although McKenzie declined for personal reasons, the two became friends and colleagues and each have been identified as pioneers in sports medicine.⁸ McKenzie helped train directors at Gullick's request for the YMCA in Montreal during those years.

Following his graduation from McGill in 1892, he served as an intern/surgeon to the Marquis of Aberdeen, Governor of Montreal and joined the faculty of the medical school in 1894. The same year, while Instructor in Gymnastics at McGill in 1893 the previous year, he published his first medical article “The Therapeutic Effects of Exercise”.¹⁵ He cites Hippocrates, Galen and Sir William Osler as advocates of exercise for health in contrast to reliance on medications alone and carries this theme to the introduction of his textbook “Exercise in Education and Medicine”.¹⁶

Academic career U of P and publications

In 1904 McKenzie visited with Sir William Osler at Johns Hopkins Medical School to seek his advice regarding McKenzie’s invitation to join the faculty at the University of Pennsylvania (UP). Osler, regarded as one of the greatest physicians of all time,¹⁷ had served on the faculty of UP (1884-1889) after leaving McGill (1874-1884) and before going to Hopkins (1889-1905) and was friendly with McKenzie over the years in Canada, the USA and England during WW I. They were both Canadians, had served on the faculty of McGill and UP and Osler had been complimentary of McKenzie’s first textbook on Exercise. McKenzie would be commissioned by the Historical Society of Johns Hopkins to create a memorial plaque of Osler in 1925.¹⁷

Table 1. Timeline of Sir William Osler and R. Tait McKenzie.^{8,17}

	Sir William Osler (1849-1919)	R. Tait McKenzie (1867-1938)
Country of origin	Canada	Canada
Father (profession)	Minister	Minister
University	University of Toronto	McGill University
Medical School	McGill (1872)	McGill (1892)
Faculty	McGill Univ. (1874-1884) Univ. Pennsylvania (1884-1889) Johns Hopkins (1889-1905) Oxford Medical (1905-1919)	McGill Univ. (1894-1904) Univ. Pennsylvania (1904-1931)
WW I	Osler’s son, Edward Reeves Osler was killed in action WW I 1917. Sir	Textbook on Physical Therapy used by British, Canadian and

	William mourned his loss and died 2 years later 1919.	US forces. Restoration of function in wounded soldiers (Rehabilitation) Pioneered in WW I
Distinctions	Pioneered Bedside Teaching Greatest physician of his time (perhaps all time) Founder Johns Hopkins Medical School	Pioneered Physical Education and Physical Medicine (Physiotherapy) Internationally acclaimed sculptor First Professor of Physical Therapy in USA
Textbook	“The Principles and Practice of Medicine” was the major text for over 40 years published from 1892-2011	“Exercise in Education and Medicine”. First textbook on Therapeutic Exercise in USA

McKenzie accepted the invitation by the University and served as Professor of Physical Education and Professor of Physical Therapy (Physical Medicine and Rehabilitation) from 1904 until 1930.¹⁸ Since most chairs/professors at UP wrote textbooks unique to their specialty at the time, McKenzie chose “Exercise in Education and Medicine”,¹⁶ which is likely the first textbook on therapeutic exercise in the US. He appreciated the need for accurate diagnosis to enable the physician to prescribe specific exercises to restore function. Based on his familiarity with the work of Frenkel in neurological disorders, he defined the physical training required for individuals with impaired walking balance to practice specific patterns of foot placement by painting the footsteps on the floor to be repeated until improved.¹⁶

As a strong advocate of fitness and sports, he initiated a program of mandatory medical examination for the students at the UP, with recommendations for remedial exercises. He taught the principles of physical medicine and rehabilitation to sophomore and junior medical students in the classroom and seniors on clinical rotation. This was likely the first effort in a North

American medical school to systematically expose students to the scientific benefit of physical treatment and exercise and predated the efforts of Coulter¹⁹ and Krusen by 20 years.

In the introduction to his most cited scientific publication, “Exercise in Education and Medicine”, he chides organized medicine at the time for its reliance on medication to the exclusion of exercise in medical education and practice.

Exercise and massage have been used as remedial agencies since the days of Aesculapius, but definite instruction in their use has seldom been given to medical students.

Perhaps a certain laziness which is inherent in both patient and physician tempts to the administration of a pill or draught to purge the system of what should be used in normal muscular activity, but there is a wide dearth of knowledge among the [medical] profession of the scope and application of exercise in pathologic conditions, and the necessity of care in the choice and accuracy of the dosage will be emphasized throughout the second part of this book.¹⁶

We will find these sentiments echoed 40 years later in the writing of PM&R pioneers, John Stanley Coulter, Frank Krusen and George Deaver.^{20,21,22}

WW I

One of the legacies of WW I, which inspired pioneers of SCI Medicine was the categorical Peripheral Nerve Injury (PNI) centers.² Charles H. Frazier, Professor of Neurosurgery at the University of Pennsylvania, who trained Donald Munro (1916), was credited with the establishment of the first PNI in the US, which coordinated specialized care, rehabilitation and research in 1918.^{5,6}

In the United Kingdom, Sir Robert Jones developed the concept of Military Orthopedic Centres, with coordinated specialized care and rehabilitation. Military appointments of neurologists and electrotherapists sharpened clinical diagnoses and examinations. Surgical techniques were introduced, then discarded or accepted as surgeons developed skills to meet the new conditions. The US Surgeon General, William Gorgas, and his consultant in neurosurgery, Charles Frazier, went a step further, with the organization of a research laboratory as well as the establishment of a Peripheral Nerve Commission and Registry.⁶

Figure 1

R. Tait McKenzie was hired at the University of Pennsylvania in 1904 during the tenure of Frazier as dean of the medical school (1901-1910). They knew each other well professionally, socially and influenced each other in the rehabilitation of injuries to the neurological system. McKenzie sculpted bas reliefs of Frazier's son and daughter as children in 1906.²³ Recently, Frazier and McKenzie were paired together "as Americans" in a history of "military medical care for peripheral nerve injuries during World War I",⁶ since both worked in reconstruction hospitals, Frazier in the US and McKenzie in the UK under Sir Robert Jones. It was McKenzie's Handbook of Physical Therapy (Physical Medicine and Rehabilitation) written for Physicians that was used by American, British and Canadian armed forces in WW I.^{6,8} Lessons learned in WW I from PNI were lost due to inadequate follow up and metrics for the course of recovery. The manual muscle test (MMT), developed by Lovett in 1917 for determining the course of recovery and treatment for poliomyelitis,²⁴ would not be introduced into military medicine until WW II based on the Medical Research Council Memorandum in 1942.²⁵ McKenzie, likely unaware of Lovett's contribution in 1917, recommended graded strengthening exercises in his paper on nerve and muscle injuries, which include isometric contraction of the limb in a splint, to be progressed as strength returned to functional activities.²⁶ He instructed that precise measurement of strength, range of motion, dosage of exercise be recorder and substitution patterns of muscle action be avoided.

"ACTIVE MOVEMENT

Active movements may be free, but as a muscle works better against a certain amount of resistance, apparatus is necessary to measure the amount of work done and the distance -the load is raised. Free movements are merely a rehearsal of the motions of which a joint is capable and need not be described in detail, but even if a limb is fixed by a splint, muscles can be twitched by it has been our endeavour to design machines that would fulfil the following conditions:

- 1. To isolate the movement and so prevent the mistaken idea of improvement when it is really another group that is doing*

the work.

2. To record the range of movement, so that both patient and the operator can follow the progress of improvement.

3. To measure the dose of work in terms of the number of contractions and- weight raised.”²⁷

McKenzie provides illustrations of the various devices and equipment used to rehabilitate disabled soldiers at Heaton Park Depot, England in his textbook on Physical Therapy: **Figure 2 and Figure 3**. After he returns to the US in 1917, he is invited to Canada to advise the Canadian Government and the Military Hospital Commission. In an editorial published in the Canadian Medical Association Journal⁹ entitled “The Physical Education [Rehabilitation] of Disabled Soldiers” he requested to make a survey of Canadian Military Convalescent Hospitals and recommend standardization so “that hospitals from Halifax to Victoria will soon have workers and equipment.”

Guttmann, who worked for years on peripheral nerve injuries, cited the categorical approach of specialized care and rehabilitation pioneered by Jones, Frazier and his mentor Foerster in 1942,²⁸ several years prior to assuming responsibilities for the famed SCI center at Stoke Mandeville. Silver^{2,4} identifies Guttmann’s experience in PNI as Guttmann’s inspiration for the development of the Spinal Cord Injury Center at Stoke Mandeville in 1944.

Legacy of WW II

Figure 4 and Figure 5

The role of Harry Botterell and Al Jousse in the founding of SCI medicine in Canada is appreciated in most historical works on this topic.^{4,29,30} Although, Botterell demonstrated an interest in the comprehensive care of person with SCI as early as the 1930s, it was not until after the war in Spring of 1945 that he was confronted with the challenge of several hundred veterans requiring his positive attitude and concept of coordinated medical and rehabilitative care.^{31,32} Within 18 months he and his colleague, Jousse, published their first report of their approach and experience.³³ In this report, the studies of Munro and Deaver are cited as the basis for the development of SCI medicine and centers in Canada,³³

“The work to be presented has developed from that of Munro and Deaver and Brown. During the summer of 1945 some 200 paraplegic patients were gathered into four centres strategically placed across Canada. During the period from February 3, 1945 to June 1, 1946, 103 post-traumatic paraplegic patients from the Armed Forces have been treated in Christie St. Hospital and Lyndhurst Lodge, Toronto.”³³

Figure 6

We may trace the origins of the Lyndhurst center concept of rehabilitation to R. Tait McKenzie. McKenzie had a direct impact on George Deaver during WW I and an indirect one on Donald Munro during Munro’s neurosurgical training in Philadelphia under Charles H. Frazier. Deaver was a medical student (1915-1918) at the University of Pennsylvania, taught by McKenzie, who was professor of Physical Medicine (Physical Therapy) and Professor of Physical Education.⁸ Deaver had been immersed in physical education at Springfield College, Mass., before medical school and served with the YMCA Expeditionary Force in WW I (1918-1920), where he rehabilitated thousands of US/British soldiers with physical therapy, occupational therapy, gymnastics and sports.³⁵

Figure 7

Both McKenzie and Deaver published back to back articles of their war experiences in the YMCA journal.^{37,38} Following the war Deaver continued with the YMCA until he was recruited to Northwestern University School of Physical Therapy by John Stanley Coulter in 1930.⁸ Deaver later moved to NYC, where he worked at the Hospital for the Crippled and Disabled and from 1935 to 1945 developed the classical metric “Activities of Daily Living (ADL)”, which documented gains in rehabilitation that remain the standard today.^{35,39}

Dr. Jousse was appointed Medical Director at Lyndhurst Lodge (1945-1975) in March of 1945. He immediately went to visit with Deaver for several months based on his publications on crutch walking.^{32,40}

“Between April and June 1945 Jousse travelled to the Institute for the Care of the Crippled in New York City to observe the work of Dr. Deaver a leading proponent of crutch walking”³²

Munro's residency training under Frazier exposed him to the concepts of rehabilitation. Frazier's recognition of the importance of physical treatment in the restoration of function of peripheral nerve injuries in WW I,⁵ is reflected by his specific mention of massage, electrical stimulation and graded exercises.

*"The after-treatment is a matter of vital consideration; massage, galvanism and later faradism, properly selected exercises, these must be continued faithfully and persistently until voluntary movement has returned."*⁵

Munro also had inherited one of the finest departments of PMR at BCH in 1929, which had been founded by another pioneer physiatrist, Frank B. Granger (Head of Physical Therapeutics 1907-1928). Granger had been in charge of physical therapy (physical medicine) of all reconstruction hospital of the US Army at Walter Reed Hospital in WW I and a nationally recognized expert.^{20,41} Although, Munro never cited McKenzie, Frazier or Granger, his training reflected the tradition of the categorical treatment of peripheral nerve injury centers of WW I, founded by Frazier, to include comprehensive rehabilitation and vocational retraining of veterans.

Jousse credits Botterell with creating the environment of a team approach of the neurosurgeon, orthopedic surgeon, urologist involved in the acute phase and one medical physician in charge of the care of the patient throughout rehabilitation and discharge from the hospital. In his article on the evolution of the treatment program of the paraplegic in Canada,³¹ Jousse emphasizes the need of one physician, a specialist in physical medicine and rehabilitation, to be involved as consultant to the surgeons in the acute hospital phase and to assume the total care of the patient through the rehabilitation and life-long follow up.

Although the tradition of McKenzie, Deaver, Munro and later Bors and Comarr would influence future SCI rehabilitation physicians in the US, particularly in the Veterans Administration (VA) hospitals, the Canadian model developed by Botterell, Jousse and later Geisler surpassed the US in scope of services for all age groups, gender, veterans and civilians.⁴ In Tremblay's excellent history of the "Canadian revolution of the management of SCI", she credits the trio of Botterell, Jousse and a WW II veteran John Counsell as responsible for this incredible achievement. Together they established the Canadian Paraplegic Association (CPA), which not only negotiated services for veterans but also for civilians.

Lessons Learned

Described as “intelligent self-interest” the CPA foresaw that following the war, veteran admissions to Lyndhurst Lodge and staffing would decline, but new civilian admission would justify continuation of the program.²⁷ The great lessons from WW I in the United States and Canada was that expert comprehensive centers established in response to the crisis of large number of severely injured soldiers disappeared due to a failure to anticipate future needs.⁶ McKenzie’s impact on the MHC in Canada is never mentioned in historical reviews and Frazier’s peripheral nerve clinical and research centers lacked qualified physicians to report on recovery of injury and rehabilitation following WW I.⁶ Disability historians,^{27,42} who accurately reflect the consumer’s perspective of rehabilitation services during and after war, rather than the glamorized image of the “supercrip” in WW I and the impressive reduction of mortality in WW II, keep us focused on future needs. Counsel and countless veterans and consumers of those who have benefitted from the the SCI rehabilitation center have helped preserve this attitude of the need to do better.²⁷

The pioneers of Lyndhurst Lodge published their results of 30 years of experience in their SCI center and concluded:

“1. Substantial as is the merit of the existing care, province wide, of patients with acute cord injury, there is great need for development of an improved system of total management of patients with acute spinal cord injuries, and for prevention of spinal injuries.

2. A new model is needed for the care of acute cord injuries.”⁴³

They listed 13 characteristics that ranged from defining regional SCI center for acute and rehabilitation services with expert staffing affiliated with university hospitals to medical care lead by a paraplegists revolving around the patient and finally modern communication and transport of patients to regional centers rather than local hospitals.

Conclusion

War creates mass casualties with loss of function due to injuries to the nervous system requiring long term rehabilitation services. Military medicine had responded to these challenges in WW I with categorical treatment centers for peripheral nerve injuries, which were well organized in Germany, England and North America. This model provided guidance for the development of similar services for SCI in WW II. Revolutionary gains in survival, functional restoration, and

return to a fuller life was made possible with advances in medicine/surgery and the pioneering efforts of physicians and consumers motivated to restore life with meaning. The lessons learned from WW I regarding failure to provide continuing systematic care resulted in veteran's programs led by consumers, who have identified their needs and aspirations. In North America, the Canadian model has led the effort that includes civilians, women and children, in addition to veterans in providing comprehensive long-term care for persons with SCI.

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Figure 1. Major McKenzie at Heaton Park Depot, England 1915. From the University Archives and Records Center, University of Pennsylvania.²³

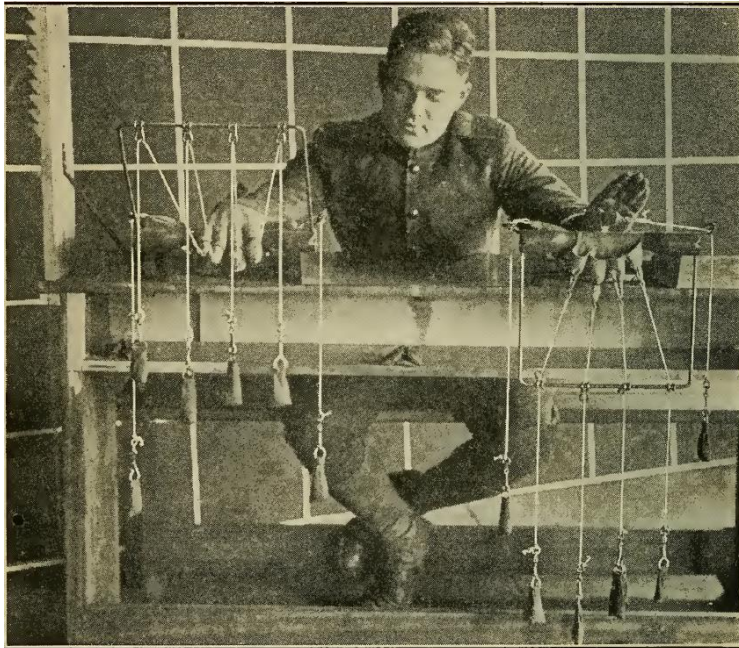


FIG. 53. — Pulley weights for exercising fingers in flexion and extension, right hand doing exercise 1, left hand with thumb attachment doing abduction.

Figure 2. Graded exercises with pulleys and weights to strengthen weakened muscle due to nerve injury.⁷



FIG. 1. — Bullet wound of the arm followed by ulnar paralysis with wasting.

Figure 3. Ulnar Nerve Injury.⁷

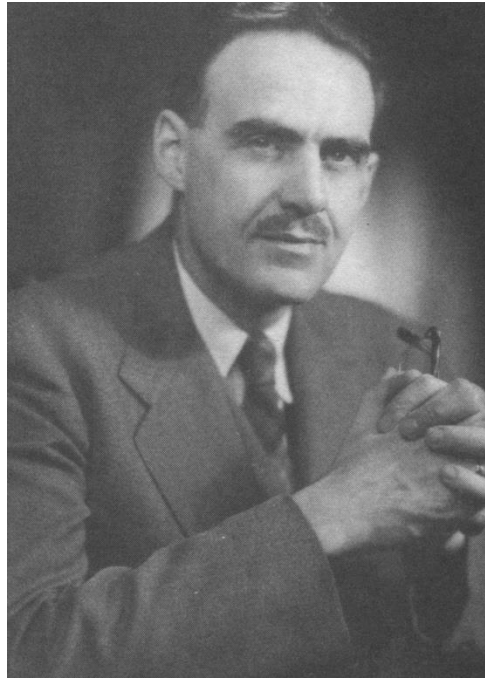
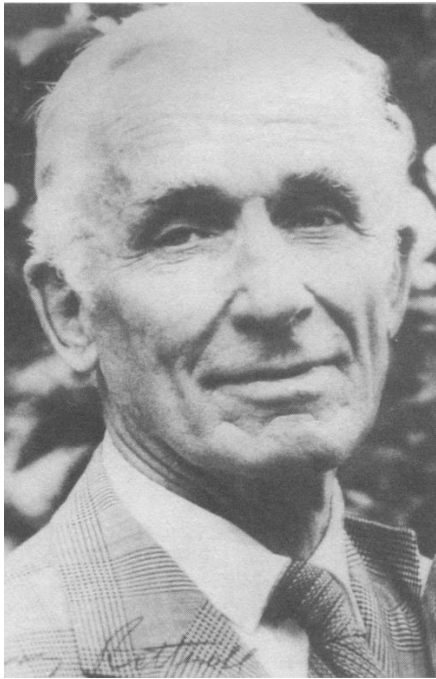


Figure 4 and Figure 5. Harry Botterell (left) and Al Jousse (right), founders of Lyndhurst Lodge.²⁷
(Pending approval from McGill-Queen's University Press)

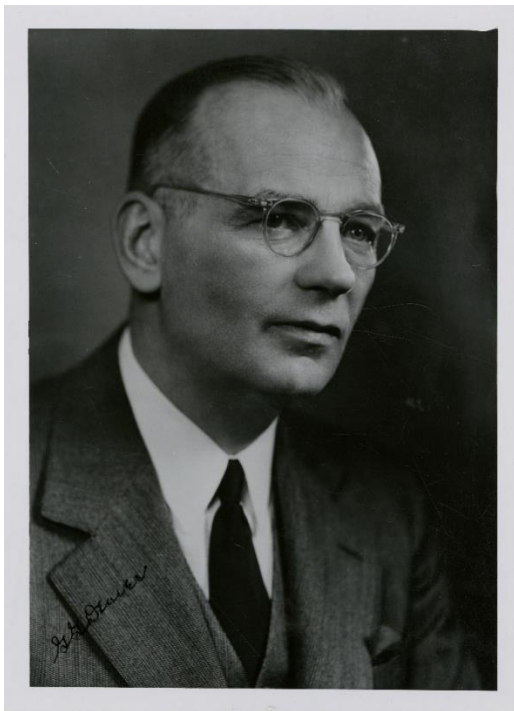


Figure 6. George G. Deaver.³⁴ Image courtesy of The Lillian and Clarence de la Chapelle Medical Archives of NYU.



Figure 7. Deaver passport photo, 1918³⁶

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