CLINICAL NEURO-SURGERY

CONGRESS OF
NEUROLOGICAL SURGEONS

VOLUME 20

CLINICAL NEUROSURGERY

Proceedings

OF THE

CONGRESS OF NEUROLOGICAL SURGEONS

Denver, Colorado

1972

BALTIMORE
THE WILLIAMS & WILKINS COMPANY
1973

Made in the United States of America

Library of Congress
Catalog Card Number 54-12666
SBN 683-02016-1

COMPOSED AND PRINTED AT
WAVERLY PRESS, INC.
Mt. Royal and Guilford Aves.
BALTIMORE, MD. 21202, U.S.A.

Preface

We dedicate this twentieth volume to DR. FRANCIS MURPHEY, honored guest and principal speaker at the 22nd Annual Meeting of the Congress of Neurological Surgeons, October 16 through 20, 1972, Denver, Colorado. Dr. Murphey's accomplishments are reviewed in a biographical sketch by his colleague, Dr. Richard DeSaussure, and he himself then summarizes his current thoughts about two areas in which he has made pioneering contributions—the surgical management of ruptured lumbar discs, and the surgical management of ruptured cervical discs. Dr. Murphey's third paper is of historical interest, since it was he and his associates who first described the myelographic picture associated with cervical nerve root avulsion in 1947.

The other presentations reproduced in the volume were prepared by a number of experts from various disciplines, each of whom focused his attention on some aspect of the development, structure, function, and malfunction of the spine and spinal cord. Dr. Perry Black organized the scientific program that included all of these papers, with the Seminar in Fundamental Neurological Surgery (Chapters 4 through 7) under the direction of Dr. James Barnes, and the Pediatric Neurosurgical Symposium (Chapters 8 through 11) under the direction of Dr. John Shillito.

In addition to thanking Drs. Black, Barnes, and Shillito for their contributions, the editor would like to thank the individual authors for preparing their manuscripts and his associate editors for collecting the manuscripts and editing the references. He would also like to acknowledge the excellent cooperation of the publisher, with special thanks to Mrs. Ruby Richardson and Mr. Richard P. Griffin. Finally, the editor thanks his secretary, Mrs. Dottie Hightower, for all her valuable contributions.

ROBERT H. WILKINS, M.D.
Editor-in-Chief

Associate Editors:
ELLIS B. KEENER, M.D.
GLENN A. MEYER, M.D.
W. ROBERT HUDGINS, M.D.
DAVID G. KLINE, M.D.
PHILIP L. GILDENBERG, M.D.

Honored Guests

1952—Professor Herbert Olivecrona, Stockholm, Sweden
1953—Sir Geoffrey Jefferson, Manchester, England
1954—Dr. Kenneth McKenzie, Toronto, Canada
1955—Dr. Carl Rand, Los Angeles, California
1956—Dr. Wilder Penfield, Montreal, Canada
1957—Dr. Francis C. Grant, Philadelphia, Pennsylvania
1958—Dr. A. Earl Walker, Baltimore, Maryland
1959—Dr. William J. German, New Haven, Connecticut
1960—Dr. Paul C. Bucy, Chicago, Illinois
1961—Professor Eduard A. V. Busch, Copenhagen, Denmark
1962—Dr. Bronson S. Ray, New York, New York
1963—Dr. James L. Poppen, Boston, Massachusetts
1964—Dr. Edgar A. Kahn, Ann Arbor, Michigan
1965—Dr. James C. White, Boston, Massachusetts
1966—Dr. Hugo A. Krayenbühl, Zurich, Switzerland
1967—Dr. W. James Gardner, Cleveland, Ohio
1968—Professor Norman M. Dott, Edinburgh, Scotland
1969—Dr. Wallace B. Hamby, Cleveland, Ohio
1970—Dr. Barnes Woodhall, Durham, North Carolina
1971—Dr. Elisha S. Gurdjian, Detroit, Michigan
1972—Dr. Francis Murphey, Memphis, Tennessee

Officers of the Congress of Neurological Surgeons 1972

JOHN N. MEAGHER
President

BERNARD S. PATRICK
President-Elect

GEORGE L. BECKER, JR.
Vice-President

ROBERT G. OJEMANN
Secretary

JAMES T. ROBERTSON
Treasurer

Executive Committee

DONALD F. DOHN
BARTON A. BROWN
J. F. ROSS FLEMING
DAVID L. KELLY, JR.
ALBERT L. RHOTON, JR.
KENNETH R. SMITH, JR.
BRUCE F. SORENSEN
GEORGE T. TINDALL

BRUCE F. SORENSEN, *Chairman, Annual Meeting Committee*
PERRY BLACK, *Chairman, Scientific Program Committee*

Contributors

Jay B. Angevine, Jr., Ph.D., Professor of Anatomy, College of Medicine, University of Arizona, Tucson, Arizona (*Chapter 7*).

Neal I. Aronson, M.D., Assistant Professor of Neurological Surgery, Johns Hopkins University, Baltimore, Maryland (*Chapter 21*).

Gilles Bertrand, M.D., Professor of Neurosurgery, McGill University, and Neurosurgeon-in-Chief, Montreal Neurological Hospital, Montreal, Canada (*Chapter 26*).

Walter P. Bobechko, M.D., Associate in Surgery, University of Toronto, and Associate in Orthopaedic Surgery, Hospital for Sick Children, Toronto, Canada (*Chapter 11*).

Saul Boyarsky, M.D., Professor and Head, Genitourinary Surgery, Washington University School of Medicine, and Urologist in Chief, Barnes and Allied Hospitals, St. Louis, Missouri (*Chapter 31*).

Alf Breig, M.D., Associate Professor of Neurosurgery, Karolinska Hospital, Stockholm, Sweden (*Chapter 6*).

Bruce Brunson, M.D., Former Resident in Neurosurgery, University of Tennessee College of Medicine, Memphis, Tennessee (*Chapter 2*).

Benjamin Calesnick, M.D., Professor of Pharmacology, and Director, Division of Human Pharmacology, Hahnemann Medical College, Philadelphia, Pennsylvania (*Chapter 29*).

Shelley N. Chou, M.D., Ph.D., Professor of Neurosurgery, University of Minnesota Medical School, Minneapolis, Minnesota (*Chapter 25*).

Elizabeth C. Crosby, Ph.D., Sc.D., Professor Emeritus of Anatomy, University of Michigan and University of Alabama, and Consultant in Neurosurgery, University of Michigan Medical Center, Ann Arbor, Michigan (*Chapter 32*).

Richard L. DeSaussure, Jr., M.D., Clinical Professor of Neurosurgery, University of Tennessee College of Medicine, Memphis, Tennessee (*Biography of Dr. Murphey*).

J. F. Ross Fleming, M.D., Assistant Professor of Surgery, University of Toronto, and Head, Division of Neurosurgery, Toronto Western Hospital, Toronto, Ontario, Canada (*Chapter 20*).

Eldon L. Foltz, M.D., Professor and Chairman, Division of Neurological Surgery, University of California, Irvine, California (*Chapter 10*).

John M. Freeman, M.D., Associate Professor of Pediatrics, and Associate Professor of Neurology, Director of Birth Defects Treatment Center, The Johns Hopkins Hospital, Baltimore, Maryland (*Chapter 9*).

Hank H. Gosch, M.D., Former Assistant Professor of Surgery, Section of Neurosurgery, University of Michigan Medical Center, Ann Arbor, Michigan. Currently in private practice in Clearwater, Florida (*Chapter 32*).

John E. Hall, M.D., Professor of Orthopedic Surgery, Harvard Medical School, and Chief of Clinical Services, Department of Orthopedic Surgery, Children's Hospital Medical Center, Boston, Massachusetts (*Chapter 11*).

John D. Irvin, B.S., Graduate Student, Department of Physiology and Biophysics, Hahnemann Medical College, Philadelphia, Pennsylvania (*Chapter 29*).

John Kirklin, M.D., Professor and Chairman, Department of Surgery, University of Alabama School of Medicine, Birmingham, Alabama (*Chapter 3*).

Ian Macnab, M. B., Chief of Division of Orthopaedic Surgery, The Wellesley Hospital, Toronto, Ontario, Canada (*Chapters 13, 14, and 19*).

George J. Mathews, M.B., Assistant Professor of Surgery (Neurosurgery), Division of Neurosurgery, Department of Surgery, Hahnemann Medical College, Philadelphia, Pennsylvania (*Chapter 29*).

John N. Meagher, M.D., Clinical Associate Professor, Division of Neurological Surgery, Ohio State University Hospitals, and Senior Attending Neurosurgeon, Riverside Methodist Hospital, Columbus, Ohio (*Presidential Address*).

Francis Murphey, M.D., Professor Emeritus, Department of Neurosurgery, University of Tennessee College of Medicine, Memphis, Tennessee (*Chapters 1, 2, and 3*).

Jewell L. Osterholm, M.D., Professor of Surgery (Neurosurgery), and Director, Division of Neurosurgery, Department of Surgery, Hahnemann Medical College, Philadelphia, Pennsylvania (*Chapter 29*).

Phanor L. Perot, Jr., M.D., Ph.D. Professor and Chairman, Division of Neurosurgery, Medical College of South Carolina, Charleston, South Carolina (*Chapter 28*).

James T. Robertson, M.D., Associate Professor of Neurosurgery, University of Tennessee College of Medicine, Memphis, Tennessee (*Chapter 22*).

Richard H. Rothman, M.D., Ph.D., Director of Orthopedic Surgery, The Pennsylvania Hospital, Philadelphia, Pennsylvania (*Chapters 12 and 17*).

R. Harris Russo, M.D., Resident in Surgery, Section of Neurosurgery, University of Michigan Medical Center, Ann Arbor, Michigan (*Chapter 32*).

Richard C. Schneider, M.D., Professor of Surgery, and Head, Section of Neurosurgery, University of Michigan Medical Center, Ann Arbor, Michigan (*Chapter 32*).

Edward L. Seljeskog, M.D., Ph.D., Associate Professor of Neurosurgery, University of Minnesota Medical School, Minneapolis, Minnesota (*Chapter 25*).

John Shillito, Jr., M.D., Associate Professor of Surgery, Harvard Medical School, Senior Associate in Neurosurgery, Children's Hospital Medical Center, and Senior Associate in Surgery (Neurosurgery), Peter Bent Brigham Hospital, Boston, Massachusetts (*Chapter 8*).

David B. Shurtleff, M.D., Professor and Head, Division of Congenital Defects, Department of Pediatrics, University of Washington, Seattle, Washington (*Chapter 10*).

James C. H. Simmons, M.D., Associate Professor of Neurosurgery, University of Tennessee College of Medicine, Memphis, Tennessee (*Chapter 2*).

Raymond C. Truex, Ph.D., Professor of Anatomy, Temple University School of Medicine, Philadelphia, Pennsylvania (*Chapter 4*).

Ian M. Turnbull, M.D., Assistant Professor, Division of Neurosurgery, University of British Columbia, Vancouver, B. C., Canada (*Chapter 5*).

Henk Verbiest, M.D., Professor of Neurosurgery and Director of the Neurosurgical Department, Utrecht State University, Utrecht, The Netherlands (*Chapters 15, 16, 23, 24, and 27*).

Robert J. White, M.D., Ph.D., Director, Department of Neurosurgery, Cleveland Metropolitan General Hospital, and Professor of Neurosurgery, Case Western Reserve University School of Medicine, Cleveland, Ohio (*Chapter 30*).

Lawrence H. Zingesser, M.D., Associate Professor of Radiology, Albert Einstein College of Medicine, Bronx, New York (*Chapter 18*).

Biography of Dr. Francis Murphey

Richard L. DeSaussure, Jr., M.D.

Francis Murphey was born on the 24th of December, 1906, in Macon, Mississippi, the son of Edwin Mason Murphey and Clara Virginia Boggess. He attended school in Macon, and then graduated with an A.B. degree from Vanderbilt University. He received his M.D. degree from the Harvard Medical School. Dr. Murphey served a surgical internship at the University of Chicago Hospitals in Chicago, Illinois during 1933 and 1934. While he was in Chicago, Dr. Paul Bucy suggested to him the possibility of associating with Dr. Eustace Semmes in Memphis, Tennessee. Dr. Murphey joined Dr. Semmes in 1934, and completed a residency in neurological surgery at the University of Tennessee Medical Center with Dr. Semmes. Dr. Murphey sequentially held every academic rank in the Department of Neurosurgery at the University of Tennessee, culminating in his appointment as Professor and Chairman in 1956. In addition to his duties at the University of Tennessee, he was able to direct an active service at the Baptist Memorial Hospital and has been Chief of Service of the Department of Neurosurgery there since 1956.

With the outbreak of World War II, Dr. Murphey entered the Armed Services. He was Chief of the Neurosurgical Service at O'Reilly General Hospital in Springfield, Missouri, a center for peripheral nerve injuries, from 1942 to 1946. This offered an unusual opportunity for Dr. Murphey, and with his characteristic astuteness and energy he made the most of the opportunity, becoming a leading authority on the diagnosis and treatment of injuries of the peripheral nerves. In 1947 he became the first to demonstrate the myelographic picture of cervical nerve root avulsion. His chapter on peripheral nerve injuries that appeared in *Campbell's Operative Orthopaedics* is one of the most lucid works on this subject. Dr. Murphey still maintains an intense interest in injuries to peripheral nerves and enjoys demonstrating the clinical diagnosis of these injuries to medical students and residents.

Another disorder that attracted Dr. Murphey's attention was ruptured lumbar and cervical discs, and the subsequent work of Dr. Murphey and Dr. Semmes in this field has become legend. Dr. Murphey will share some of his experiences with the members of the Congress of Neurological Surgeons at the present meeting.

Dr. Murphey has also had a particular interest in cerebrovascular problems. He is the Director of the University of Tennessee Cerebrovascular Research Center, and has contributed to the cooperative studies that have

investigated subarachnoid hemorrhage and extracranial occlusive disease. He has directed research on these problems for a number of years, with a special emphasis on profound hypothermia and its application toward the treatment of aneurysms and other vascular lesions of the brain.

His talents were recognized early by the many neurosurgical organizations of which he has been a member. He was President of the American Academy of Neurological Surgery in 1942, President of The Southern Neurosurgical Society in 1964, and President of The American Association of Neurological Surgeons in 1966. In addition, he has served on The American Board of Neurological Surgery and was its Chairman in 1964. He has been President and Chief of Staff of the Baptist Memorial Hospital, and a consultant to the National Institutes of Health since 1962.

Dr. Murphey is the author of many scientific papers and chapters in books. However, he has still found time to pursue his avid fascination with hunting, fishing, gin rummy, and golf. He approaches these with the same thoroughness that he does neurosurgery. On one occasion, he took some of his friends for breakfast in a small cafe prior to a duck hunt. When the proprietor regretted that he had no eggs to serve for their breakfast, Dr. Murphey remarked, "I thought this might happen," and produced the eggs which he had brought with him as a precaution.

Dr. Murphey has a reputation as an astute clinician and he is an extremely thorough examiner. He has a remarkable memory for unusual cases. He never makes a snap diagnosis, although it sometimes appears that he arrives at the diagnosis very quickly. His diagnosis is always based on a very careful analysis of the patient's history, physical findings, and all related information.

He is outspoken on those subjects with which he is familiar, and he is always able to back his opinions with facts. He is never afraid to take a stand, even though this stand may be unpopular, and it usually develops that the unpopular stand is the correct one.

Dr. Murphey is married to Roder Trigg of Memphis. They have one daughter, Elizabeth Coulon Murphey Ranson, and two grandchildren, Beth and Jennifer. Dr. Murphey is convinced that he is the only grandfather who will have two Miss Americas as grandchildren.

It is a privilege to have been associated with Dr. Murphey over the past 20 years. He has inspired those who have been associated with him to be thorough in their clinical approach, to be certain of their facts when they make statements, and to consider all the factors involved, whether it be treating a patient, conducting a scientific meeting, or arranging for a duck hunt.

Bibliography of Dr. Francis Murphey

1. Murphey, F. Hypersensitive carotid sinus reflex—cause of vertigo, syncope, convulsions and sudden death. Memphis Med. J., *14:* 84–86, 1939.
2. Semmes, R. E., and Murphey, F. Syndrome of unilateral rupture of sixth cervical intervertebral disk with compression of seventh cervical nerve root; report of four cases with symptoms simulating coronary disease. J. A. M. A., *121:* 1209–1214, 1943.
3. Whiteleather, J. E., Semmes, R. E., and Murphey, F. Roentgenographic signs of herniation of cervical intervertebral disk. Radiology, *46:* 213–219, 1946.
4. Josey, A. I., and Murphey, F. Ruptured intervertebral disk simulating angina pectoris. J. A. M. A., *131:* 581–587, 1946.
5. Murphey, F., Pascucci, L. M., Meade, W. H., and Van Zwaluwenburg, B. R. Myelography in patients with ruptured cervical intervertebral discs. Amer. J. Roentgen., *56:* 27–42, 1946.
6. Murphey, F., Kirklin, J. W., and Finlayson, A. I. Anomalous innervation of the intrinsic muscles of the hand. Surg. Gynec. Obstet., *83:* 15–23, 1946.
7. Murphey, F., and Meade, W. H. Unilateral ruptures of lower cervical intervertebral discs. J. Omaha Mid-West. Clin. Soc., *7:* 69–72, 1946.
8. Watson, C. W., Murphey, F., and Little, S. C. Schistosomiasis of brain due to Schistosoma japonicum; report of a case. Arch. Neurol. Psychiat. *57:* 199–210, 1947.
9. Kirklin, J. W., Chenoweth, A. I., and Murphey, F. Causalgia; a review of its characteristics, diagnosis and treatment. Surgery, *21:* 321–342, 1947.
10. Murphey, F., Hartung, W., and Kirklin, J. W. Myelographic demonstration of avulsing injury of the brachial plexus. Amer. J. Roentgen., *58:* 102–105, 1947.
11. Murphey, F. Surgical treatment of hypertension. Memphis Med. J., *23:* 42–44, 1948.
12. Kirklin, J. W., Murphey, F., and Berkson, J. Suture of peripheral nerves; factors affecting prognosis. Surg. Gynec. Obstet., *88:* 719–730, 1949.
13. Murphey, F. Peripheral nerve injuries. *In* Campbell's Operative Orthopaedics, edited by J. S. Speed and H. Smith, Ed. 2, Vol. 1, pp. 735–786, C. V. Mosby, St. Louis, 1949; edited by J. S. Speed and R. A. Knight, Ed. 3, Vol. 1, pp. 947–1014, C. V. Mosby, St. Louis, 1956; edited by A. H. Crenshaw, Ed. 4, Vol. 2, pp. 1538–1582, C. V. Mosby, St. Louis, 1963.
14. Murphey, F. Rupture of intervertebral discs. *In* Campbell's Operative Orthopaedics, edited by J. S. Speed and H. Smith, Ed. 2, Vol. 2, pp. 867–877, C. V. Mosby, St. Louis, 1949; edited by J. S. Speed and R. A. Knight, Ed. 3, Vol. 2, pp. 1145–1165, C. V. Mosby, St. Louis, 1956; edited by A. H. Crenshaw, Ed. 4, Vol. 2, pp. 894–914, C. V. Mosby, St. Louis, 1963.
15. Semmes, R. E., and Murphey, F. Symposium on neurological surgery. Ruptured intervertebral disks: cervical, thoracic and lumbar, lateral and central. Surg. Clin. N. Amer., *34:* 1095–1111, 1954.
16. Rychener, R. O., and Murphey, F. Periorbital fibrous dysplasia. Trans. Amer. Ophthal. Soc., *53:* 155–174, 1956.
17. Murphey, F. Ruptured intervertebral discs in the lower lumbar region. *In* Current Therapy, edited by H. F. Conn, pp. 608–610, W. B. Saunders, Philadelphia, 1958.

18. Murphey, F., and Miller, J. Carotid insufficiency: diagnosis and surgical treatment; a report of twenty-one cases. J. Neurosurg., *16:* 1–23, 1959.
19. Murphey, F., and Shillito, J., Jr. Avoidance of false angiographic localization of the site of internal carotid occlusion. J. Neurosurg., *16:* 24–31, 1959.
20. Murphey, F., and Simmons, J. C. H. Initial management of athletic injuries to the head and neck. Amer. J. Surg., *98:* 379–383, 1959.
21. Murphey, F. Acute peripheral nerve injury. *In* Current Therapy, edited by H. F. Conn, pp. 559–560, W. B. Saunders, Philadelphia, 1959.
22. Murphey, F. Extracranial occlusive disease of the carotid arteries. *In* Current Therapy, edited by H. F. Conn, pp. 507–509, W. B. Saunders, Philadephia, 1961; edited by H. F. Conn, pp. 495–497, W. B. Saunders, Philadelphia, 1962.
23. Murphey, F. Surgical treatment of carotid insufficiency. J. Mississippi Med. Ass., *3:* 1–5, 1962.
24. Nofzinger, J. D., Britt, L. G., Murphey, F., and Pate, J. W. Unusual treatment of an intracranial aneurysm contralateral to a previous common carotid ligation. A case report. J. Neurosurg., *22:* 182–184, 1965.
25. Murphey, F., and Maccubbin, D. A. Carotid endarterectomy. A long-term follow-up study. J. Neurosurg., *23:* 156–168, 1965; Clin. Neurosurg., *13:* 291–311, 1966.
26. Sundt, T. M., Nofzinger, J. D., and Murphey, F. Arteriotomy patching by means of intraluminal pressure sealing venous autografts. A preliminary technical report. J. Neurosurg., *23:* 452–454, 1965.
27. Murphey, F. Extracranial carotid ligation: technical aspects. *In* Intracranial Aneurysms and Subarachnoid Hemorrhage, edited by W. S. Fields and A. L. Sahs, pp. 315–323, Charles C Thomas, Publishers, Springfield, Ill., 1965.
28. Murphey, F., and Simmons, J. C. H. Ruptured cervical disc. Experience with 250 cases. Amer. Surg., *32:* 83–88, 1966.
29. Sundt, T. M., Nofzinger, J. D., and Murphey, F. Hypothermic cerebral perfusion with nonheparinized blood. Experimental technic. Amer. Surg., *32:* 131–133, 1966.
30. Sundt, T. M., Nofzinger, J. D., and Murphey, F. Arteriotomy patching—a new technic. Amer. Surg., *32:* 207–212, 1966.
31. Dugdale, M., Nofzinger, J. D., and Murphey, F. Some effects of low molecular weight dextran on coagulation. Thromb. Diath. Haemorrh., *15:* 118–130, 1966.
32. Murphey, F. Neurosurgery in American medical schools. Presidential address. J. Neurosurg., *26:* 289–296, 1967.
33. Murphey, F., Sundt, T. M., Jr., and Nofzinger, J. D. Hemodilution in cerebral ischemia: a report of 24 cases. Presented at the Birthday Celebration of Dr. A. Earl Walker, Johns Hopkins Hospital, April 8, 1967.
34. Murphey, F. Sources and patterns of pain in disc disease. Clin. Neurosurg., *15:* 343–350, 1968.
35. Wood, M. W., and Murphey, F. Obstructive hydrocephalus due to infarction of a cerebellar hemisphere. J. Neurosurg., *30:* 260–263, 1969.
36. Sundt, T. M., and Murphey, F. Clip-grafts for aneurysm and small vessel surgery. 3. Clinical experience in intracranial internal carotid artery aneurysms. J. Neurosurg., *31:* 59–71, 1969.

Presidential Address: What a Neurosurgeon Ought to Be

JOHN N. MEAGHER, M.D.

It is with a certain degree of humility and a high degree of temerity that I embark upon this Presidential Address at this assembled gathering of distinguished people at the 22nd Annual Meeting of the Congress of Neurological Surgeons. It was following many painful weeks, nay months, that I finally arrived at the title and substance of this address. The title may appear somewhat awesome and certainly presumptuous, but in no way do I wish to inflict upon any of you either sensation. More so, I would hope to stimulate each and all of you to reflect upon your careers as neurological surgeons in relation to the past, the present, and possibly a somewhat kaleidoscopic view of what the future should hold for each of us.

The era of modern neurosurgery has been said by many to have begun with Macewen, following his treatise on "Pyogenic Infective Diseases of the Brain and Spinal Cord" in 1893 (2), and with the appointment of Sir Victor Horsley as surgeon to the National Hospital for the Paralysed and Epileptic in Queen Square in 1896. Following this, great strides were made, and during those early formative years of the specialty, many reflective thoughts were issued by the giants of the emerging specialty, notably Cushing, Dandy, Stookey, and Sachs to name but a few. In those early years the neurosurgeons more or less were delivered from the bellies of the general surgeons. Training was by preceptorship and not by formally structured residency programs. Advances in techniques and diagnostic methods were slow and painful, and certainly, in the earliest years, were guided primarily by the medical neurologist. The surgeon then was, in effect, but a tool in the hands of the neurologist. As the budding specialty progressed, neurosurgeons rapidly developed neurological skills which led them naturally to the development of their own departments. This fostered the development of the more surgical types of diagnostic tests such as ventriculography, pneumoencephalography, and angiography to supplement the classic neurological examinations.

Cushing, in his Presidential Address at the 49th Annual Meeting of the American Neurological Association in Boston in May, 1923, said: "Unquestionably, if the future neurologic surgeon is to do the thing properly, his training will demand a longer preparation than that needed for any medical speciality—and not many will have the industry, the patience, or the intellectual gifts combined with the manual dexterity, necessary to

see it through" (1). This then, was the first foundation upon which future generations of neurosurgeons were to build their experience and their maturity. Formal residency programs began to replace preceptorships in the late thirties in order to better allow for this formally structured training.

Just what kind of a person is the present day neurological surgeon? First, he must be a physician who has been attracted by the disciplines relating to the nervous system in its broadest sense. Secondly, he must be a physician who feels the need for a continuing inquiry into the surgical treatment of diseases of the nervous system. The cut of his jib must be bent to the demanding disciplines of the most complicated body system.

Cushing, in that same Presidential Address before the American Neurological Association in 1923, said: "Traditionally the surgeon is cut from a different piece of cloth than the physician and, because of the time-consuming and fatiguing nature of the manual work he is called on to perform, his intellectual attitude toward his activities tends to be on a lower plane than the physician's; so at least they give us to understand. Admittedly such an attitude is likely to be held by those who either do their work to order or who largely limit themselves to the cut and dried procedures of an established sort, which require little preliminary study and have a fairly certain outcome. But in a new and difficult field like ours this is an impossible attitude if we are to make any significant advances and are to hold the confidence of our fellows" (1).

What has brought us to the field of neurological surgery and disorders of the nervous system? It has not necessarily been the glory or the shortness of the work day nor the financial renumeration, for all of us might have achieved greater heights in other fields of endeavor not necessarily related to medicine and at less cost in energy and time. What then has lured us to this special area? Obviously the basic substrate has been an intense interest and curiosity regarding the nervous system, a complex but singly functioning unit. There are those among us who originally felt that medical neurology was their area of preference, but who at some point in their training period felt that perhaps the surgeon's hand could effect more direct remedies upon many of the disorders of the nervous system. All of us have been stimulated by a teacher during our medical school careers, or our internships, or early residency years. This particular teacher obviously had been stimulated by his forebears and in turn carried the torch of inquiry to yet another individual. This has been the basic groundwork, if you will, of the continuing development of the speciality.

Returning to the question "What kind of a person is a neurosurgeon?". I have attempted, in the preceding comments, to identify the groundwork for his basic native inquisitiveness. The second point I would like to enlarge is that of the peculiar trait of every neurosurgeon to develop a compelling

self-discipline and a continuing desire to self-evaluate his level of competence and performance. Cushing, in the previously quoted comments, alluded to this when he contended that the surgeon is traditionally cut from a different piece of cloth. My personal opinion is that the weave of the cloth making the body of the neurosurgical cloak is ever so tightly interwoven with strong internal desire on the part of the neurosurgeon to excel. How then does this internal discipline come about during the formative training years?

Obviously the training of the modern day neurosurgical resident must result in an extremely thorough understanding of the form and function of the nervous system as well as its pathological states. This dictates then that he must have formal training in fundamental surgical principles, neuroanatomy, neurology, neurophysiology, neuropathology, neuroradiology, and an exhaustive experience in surgical judgment and operative techniques. Much of this early foundation is in the form of didactic and formal exposures to these basic sciences. This knowledge may be gleaned in conferences with his chief of service, the faculty of the neurosurgical department, and also in a continuing program of self-education, directed by the faculty of the neurosurgical department in which he is training, but executed through the individual's own personal discipline which requires him to always seek out the basic answers to questions that arise. During these formative months and years, he should then develop, at times by example and on other occasions through internal discipline, a sense of direction and a scale of value judgments which, when crystallized, allow the development of what we commonly refer to as judgment and surgical maturity. His chief of service and peers, both at resident and faculty levels, must exemplify this same internal discipline and drive for new information and continued excellence, lest by their laziness or indifference they set a poor example for the budding neurological surgeon.

During these formative years of training, the resident at all levels of training is under close scrutiny by his chief of service, his senior residents, and the faculty of the department. The scrutiny of his teachers and fellow residents in his first exposure to "peer review" for the career which he has chosen. Like it or not, he learns to accept constructively the criticism of his chief. His chief, by example, teaches him judgment and compassion during the many months and years of exposure to the various disease entities and pathological conditions encountered. I believe that the faculty of such a training program must instill in the individual trainee the following basic traits: (1) compassion for his fellow man; (2) a burning drive to gain new knowledge; (3) the faculty for maintaining a level and cool head during times of momentous decision; (4) the desire to self-evaluate one's knowledge and skills.

Assuming that we all as teachers have fulfilled the above criteria in the training of a neurological surgeon, where then do the practicing neurosurgeon's responsibilities lie as he enters the threshold of practice, be it in an academic or nonacademic environment? His medical responsibilities are to his patient primarily. I will not at this point enlarge further upon the Hippocratic Oath or the ethical and moral responsibilities of the physician to his patient, other than to say that without a moral and ethical approach to every individual patient there is no honest compassionate practice of medicine. The era of needless surgical procedures has all but passed. Yet, unfortunately, there are still those surgeons who would shade the picture just a wee bit if things were going a bit slow. Fortunately, these men are in the minority and are fast found out by their colleagues—a form of peer review.

The neurosurgeon above all must be honest unto himself. He must ask himself the questions: Is my judgment in the best interest of the patient? Is this procedure, be it diagnostic or surgical, indicated? Am I operating too many discs or discs that otherwise might get well with a few more days of conservative therapy? Is my surgery and my knowledge abreast of current information and current procedures? This is, in its purest form, self-discipline, an internal review of one's worth.

What should the neurosurgeon's responsibilities be to his hospital? Should he practice in an array of hospitals within the community or should he attempt to establish a primary or base unit? To the new neurosurgeon, practice will begin slowly and he is sorely tempted to affiliate himself with the staffs of several or many hospitals in order to make a living. But he will soon find himself bogged down in the performance of his daily activities in two to four hospitals, sometimes at a great distance from each other, and will find that he spends most of his time in transportation between hospitals, giving relatively little of his time to the care of his patients. What of the neurosurgical emergency that arises in a postoperative patient in the middle of the night in a small community hospital with no house staff and an inadequately trained general nursing staff? What then of his moral, ethical, and legal responsibilities? Would it not have been better for him to have established a base hospital initially, holding to the basic tenets that a base hospital and a slowly developing practice, which is respected by his colleagues, is better than an itinerant milk route with which he gives service to many but good care to only a few? Pressures will be brought to bear against the emerging neurosurgeon to affiliate himself with this or that hospital under the guise of statements such as, "We want a complete hospital and your services are sorely needed," or "We feel we are best equipped to handle your specific problem." At this point he should seriously look at each of these hospitals and say to himself "Why hasn't this particular hospital