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ROBERT EDWARD GROSS

1905—1988

A Biographical Memoir by

FRANCIS D. MOORE AND JUDAH FOLKMAN

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Biographical Memoir

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ROBERT EDWARD GROSS

July 2, 1905–October 11, 1988

BY FRANCIS D. MOORE AND JUDAH FOLKMAN

DURING A REMARKABLE CAREER as one of America's great pioneers of surgery Robert E. Gross made many contributions that have altered the practice and understanding of surgery, pediatrics, and cardiology throughout the world. These include the performance for the first time of successful major surgery on the great vessels near the heart, with the ligation of a patent ductus arteriosus on August 26, 1938; the first successful corrective surgery of coarctation of the aorta in 1945; the performance of several other important, innovative surgical procedures; and one of the largest series in the world of successful open heart repairs of congenital anomalies of the heart in infants and children. In 1941 Dr. Gross joined his professor, Dr. William E. Ladd, in publishing the first textbook on surgery in children, defining for the first time this new field of learning and practice.

For more than forty years Robert Edward Gross was engaged in pediatric surgery at Harvard Medical School and Children's Hospital in Boston, Massachusetts. From 1947 to 1966 he was the William E. Ladd Professor of Child Surgery at Harvard Medical School and the surgeon-in-chief at that hospital.

Gross was born in Baltimore, Maryland, on July 2, 1905, the son of Charles Jacob and Emma Houch Gross. His fa-

ther was manager of the Stieff Piano Company, a firm that had been owned by his grandmother's family. Robert had five sisters and two brothers with whom he grew up in Baltimore. As a boy, Robert was described as a sensitive, somewhat shy tinkerer, an avid reader, a keen observer, and an enjoyer of the outdoors. During his summer holidays in high school he journeyed first by train and boat and later by jalopy to a central Minnesota farm to work. There he strengthened his instinctive concern for living things and nature's ways. These rewarding summertime experiences led to his choice of Carleton College in Northfield, Minnesota, for his next step in education. He had yet to form any firm career plans, but enjoyed chemistry and was considering a career in chemistry. As a Christmas gift from a friend he received Harvey Cushing's biography of Sir William Osler. According to Gross he nearly dropped out of college to find the time to read this book. By the spring of this first year he had decided to enter medicine and to attend Harvard Medical School, because his newly found author-idol, Dr. Harvey Cushing, was teaching there. He graduated in 1927 with honors from Carleton, Phi Beta Kappa, and entered Harvard Medical School.

At the medical school Gross was one of the top students of his class, much stimulated by a fourth year elective surgical service with William E. Ladd at Children's Hospital, as well as the teachings of Cushing, who was in the last five years of his tenure at Harvard. After receiving his M.D. degree in 1931, with honors, and becoming a member of Alpha Omega Alpha, Gross took a postgraduate training period of two years with Dr. Simeon Burt Wolbach. Wolbach was the George Cheever Shattuck Professor of Pathology and chairman of the Department of Pathology at Harvard Medical School, and chief of the departments of pathology at the Peter Bent Brigham, Boston Children's, and Lying-In

hospitals. Wolbach was to become a great friend and confidant of Gross, with whom he enjoyed important professional relationships, particularly the opportunity to study fresh human material at autopsy, including many congenital anomalies, but most especially those of the heart and great vessels. In addition, Wolbach provided Gross with his only regular relaxation—early morning horseback rides on weekends near his home in Framingham, Massachusetts. Wolbach kept a stable of riding horses in Framingham, the town where Gross later was to establish his home.

In 1933 Gross entered a surgical training program under Dr. Elliott Cutler at Peter Bent Brigham Hospital. Cutler was the successor to Harvey Cushing as Moseley Professor. The influence of Cutler naturally included special attention to surgery of the heart and great vessels, because in 1924 he had performed operations on a few patients suffering from mitral stenosis. Several years later he published a review of cardiac surgery, including a prediction that one of the first successful procedures around the heart would be the ligation of the patent ductus arteriosus. This rather common anomaly (failure of closure of an artery essential in fetal life) condemned children to heart failure, infections, and an early death.

In 1937, as a resident at Peter Bent Brigham Hospital, Gross was appointed by Cutler to the position of George Gorham Peters Traveling Fellow. For nine months this enabled him to visit the most active surgical centers of Britain and the continent. In Edinburgh he worked at the Royal Hospital for Sick Children and in the laboratories of Sir David Wilkie.

After returning to the Harvard medical community in 1938, he was appointed chief resident in surgery under Ladd at the Boston Children's Hospital. There he was stimulated by a pediatric colleague, Dr. John Hubbard. Working

in the laboratory and autopsy room the two young men, one a pediatrician and the other a surgeon, worked out a surgical approach for the ligation of the patent ductus arteriosus. During August of 1938, while Ladd was on holiday, but with the approval of the acting chief, Dr. Thomas Lanman, Gross performed the first successful ligation of the patent ductus arteriosus. In an unpublished autobiographical document written in 1987 (now in Judah Folkman's library) Gross described several remarkable events in his career, including the following:

As time went on there was an urge to attack several blood vessel anomalies which had been seen previously at autopsies during my training two years before. The first consideration had to do with possibly attacking a ductus arteriosus that had remained patent. How could one be closed off surgically? It had never been accomplished anywhere before. Possible surgical approaches to a ductus were practiced on humans in the autopsy room and on animals. After deciding clearly on the best approach, there seemingly would be no difficulty or risk in ligating a patent ductus. Our first operation for such a procedure was performed on a seven-year-old girl on August 26, 1938. The postoperative course was uneventful and without worry. The next morning she was up and out of bed and around the ward. She was discharged in ten days. Our patent ductus operations were always done through a left antero-lateral approach through the third intercostal space.

Eleven children were operated upon satisfactorily for ductus closure by ligation. The twelfth was a fourteen-year-old girl also treated by ligation. She was well at the time of hospital discharge. Two weeks after that, there was a party for her at her home. While dancing with friends, she suddenly collapsed on the floor and was instantly dead! The family permitted an autopsy examination, which showed that the ductus ligature had cut through, permitting massive hemorrhage. I never again ligated a ductus. All subsequent patients were handled by careful local dissection placing double clamps on the ductus, then cutting the ductus in half and meticulously closing each end by suturing. This became the standard technique, giving completely satisfactory results. It was used with total satisfaction up through the last ductus operation I performed, which was number 1,610, in March 1972.

The patient who had the operation recalled at the age of fifty-eight that in the early 1980s she visited Dr. Gross in his retirement home in Vermont. She stated, "We reminisced about our surgery and he laughed and said, 'You know, Lorraine, if you hadn't made it, I might have ended up here in Vermont as a farmer.'"

Almost immediately Gross began his studies on surgical correction of congenital narrowing or coarctation of the aorta. Gross described this in the same autobiographical note:

As a next endeavor, attention became concentrated in 1938 on the possibility of surgical treatment for coarctation of the aorta. I was joined in this endeavor by an outstanding assistant resident, Dr. Charles Hufnagel. In the laboratory, we practiced on dogs to find the best way to remove a short segment of abdominal aorta, bringing the remaining ends together for a satisfactory anastomosis. It was not at all difficult to establish a good arterial channel. But, alas, some of the animals had extensive hind-leg paralysis postoperatively. I was so discouraged that orders were given to abandon the whole project.

In mid-April 1939, Dr. Clarence Crafoord, from Sweden, visited Harvard, and Dr. Elliott Cutler asked me to show him around the Brigham and the Children's hospitals and also our experimental laboratory across the street. This I had the pleasure of doing. We ended up in the surgical research area. Dr. Hufnagel, extremely competent in research activities, summarized for Dr. Crafoord various projects that were in progress. Finally, he brought four dogs out of their cages and let them run freely. He said to me, "Dr. Gross, each of these dogs has had resection of an abdominal segment of aorta, and anastomosis of the remaining ends." I asked him how was it that these dogs could run? He answered, "They were done under general anesthesia and then laid down on a bed of ice. Through an anterior abdominal incision we did the usual aortic resection and reanastomosis." It was wonderful to have someone in the laboratory who could think properly! Besides my learning how to attack resections in humans accompanied by hypothermia, I certainly got into the habit of listening to young men!

The European war was still on, and all thoughts of attacking coarctations in humans had to be put off. Immediately after the global conflict, within a

few days of each other, we in Boston and Crafoord in Sweden did a successful repair of a coarctation in humans. Since then, over a span of 26 years, 825 patients with coarctations were operated upon by us. In 104 of these, it was necessary to insert a graft to fill in a rather long gap.

Although coarctation of the aorta is a relatively rare congenital anomaly, this resection of the aorta with anastomosis, and in some cases with the interposition of a preserved human aorta homograft, became the model on which surgery for aortic aneurysm (pathologic enlargement) in the adult was based. Within a few years these procedures were carried out in large numbers all over the world for thousands of older patients, some of them in the elderly age groups suffering from aneurysm of the aorta.

In his approaches both to patent ductus arteriosus and to coarctation of the aorta Robert Gross demonstrated to the world that anatomical study and a carefully planned surgical approach (with extensive rehearsals both in the autopsy room and in the experimental animal) could result in successful treatment of very ominous and previously forbidding diseases of the heart and of the great vessels. In operations on these large vessels, which contain blood under tremendous pressure, even a momentary lapse of technique could lead to an instantly fatal outcome. These events were widely heralded and immediately recognized throughout the world as amongst the first successful operations on what we now call cardiac surgery even though they were procedures carried out on the great vessels within an inch or two of the heart, rather than on the heart itself.

Other innovative procedures carried out by Gross included the correction of an anomalous arterial ring around the esophagus. Again, his own words tell the story of these developments:

In June 1945 our attention was drawn to a teenage boy who had difficulty in swallowing and also had rather noisy respiratory sounds in the chest.

Roentgenographic studies quickly and clearly showed a pulsating vessel behind the esophagus, pressing upon it. Also, there was a pulsation on the anterior surface of the trachea. These facts could very clearly be substantiated by roentgen studies with a swallow of barium, and also by injecting a little radiopaque material down the trachea.

At surgical exploration, there was an amazing finding of a "double aortic arch," the first part of the ascending aorta splitting, with half going up and across behind the esophagus and the other limb going up in front of the trachea, both branches meeting on the left side to form the descending aorta. The anterior arch was of much larger size than the rear one. It was not at all difficult to divide the posterior arch and suture closed each end thereof. This completely freed the esophagus from its compression. The anterior arch, being the larger of the two, was intentionally saved. Severance of the posterior arch had relieved tension on the anterior limb and allowed it to swing free from the trachea. It was all a surprise, and a very happy outcome. This case opened the way for studying and identifying other patients with anomalous and troublesome pressure on the esophagus or the trachea, or both simultaneously. The list of patients coming to operation included those with double aortic arch, anomalous position of the left subclavian artery, anomalous left carotid artery, aberrant right subclavian artery, and others. All of these could be satisfactorily operated upon with excellent results. Between June 1945 and September 1971, we operated upon 165 of these patients with arterial anomalies without fatality and with very satisfactory results.

Gross was also one of the first to operate successfully on tiny newborn babies for life-endangering anomalies of the circulatory system. He writes of some of these experiences:

Some cardiac anomalies are so serious that they must be repaired within two or three days after birth. An example of this is the so-called "total anomalous pulmonary vein drainage." Essentially, the critical condition is that the lungs become greatly congested because pulmonary veins do not take away the oxygenated blood and deliver it to the left side of the heart. A perfect example of what could be accomplished was shown on March 2, 1967, when a 36-hour-old baby in great respiratory distress was brought into the hospital. The cardiologists were immediately "on the ball." Appropriate studies showed tremendously congested lungs, almost certainly indicating very poor drainage of blood through the pulmonary veins. Opera-

tion was undertaken within a few hours after admission. Our small pump-oxygenator was employed very satisfactorily. There was no difficulty in raising the heart forward and upward, getting an excellent view of what was behind it. There was no vein drainage into the left side of the heart. All the pulmonary veins gathered into a single large trunk, running downward through the diaphragm. It was not at all difficult to ligate the lowest part of this trunk just at the diaphragm, and then open the trunk above this, so it could be widely anastomosed into the back of the left auricle. There was a fast and very satisfactory recovery.

The child grew in a rapid and completely satisfactory way. She was active and a very good student at school. To have this wonderful youngster, at the age of 17 years, voluntarily come in to see me, say "hello," and give thanks was gratifying beyond description. She was bright, active, rather athletic, a superb student in her fourth year of high school and headed for college. This all made me thank the Lord for what could be accomplished by surgery.

In preparing his team for operations on the heart itself Gross was influenced by the previous work of Dr. John Gibbon, Dr. Kirklin, Dr. Lillehei, and Dr. Blalock in developing pump-oxygenator equipment for the adult. Gross himself was gifted in the use of tools; he kept in his operating room a special tool kit, which the nurses had painted gold and indicated that it was for his use only. In developing a pump-oxygenator adapted to use in tiny babies, these mechanical skills of Gross became especially important. He tells the story:

One of the most successful projects in the laboratory was to devise and build a small pump-oxygenator so that surgical repair of some of the serious cardiac anomalies in babies could be successfully accomplished. In the basement of the laboratory there was a very good machine shop. And we fortunately obtained a top-flight machinist who was very productive and who stayed with us until he was 80 years old (Mr. Fred Savage). We drew up sketches and specifications of what we wanted, and he had great skill in building what we needed. The pump-oxygenator was only 18 inches long, 10 inches wide, and 10 inches high. It had a horizontal glass enclosure and carried a horizontal rotating shaft driven at variable speeds. This rotating

shaft carried rotating metal discs driven by a variable-speed motor. Blood could be pumped through the machine, picking up oxygen, and then returned to the patient.

It was with this device that Gross carried out his extensive open cardiac repairs on newborn babies or very young infants with congenital heart disease.

Despite this abiding interest in cardiovascular disease Gross did not lose his longstanding focus on the broad issues of surgical care of the infant. In 1941 he coauthored with William E. Ladd a book titled *Abdominal Surgery of Infancy and Childhood*. This defined the field of pediatric surgery for the first time and was the standard textbook in the field for many years. It was not merely a scholarly clinical report and academic statement; it was also a casebook based on detailed study of a large number of patients cared for by Ladd and Gross and their colleagues and analyzed from the point of view of embryology, pathology, and pediatrics. Many of these disorders were for the first time grouped into recognizable categories or syndromes that now could be recognized and analyzed throughout the world. Gross expanded this book considerably and published it in 1953 as *Surgery of Infancy and Childhood*. It became a classic and was published in more languages than any other medical text at the time.

There were many difficulties in early attempts to open the heart for repair. Prior to the development of the extracorporeal pump-oxygenator Gross moved towards a solution for some cases by designing in 1952 an ingenious rubber well, which could be temporarily sutured to the atrium so that blood could well up in it. At the low pressures of blood in the atrium, blood could accumulate in the well without overflowing. He then could operate on atrial septal defects in a “deliberate and unhurried manner, albeit under a pool of blood and without direct vision.”

Despite an intense research orientation, Gross, in per-

forming new operations in life-endangering conditions and in expanding and defining the field of children's surgery, was a humane physician, insisting that each surgeon look after every aspect of his own patients' welfare, never entrusting such to others. He was personally acquainted with all of his patients and their families and set a high standard for the ethical and humane practice of pediatric surgery.

In 1966 Gross resigned his position as surgeon-in-chief at Children's Hospital to take on a position heading up cardiac research as director of the cardiac program at Boston Children's Hospital. At that time Dr. Robert H. Ebert, dean of the faculty of medicine at Harvard Medical School, said:

It is fitting that this program, which has such great potential in helping young heart patients, should be headed by Dr. Gross who already has contributed so much in this field. His new hospital appointment is in recognition of the many advances in pediatric cardiac surgery, which have come about because of his work, and as a logical progression in his splendid career.

Honors awarded to Dr. Gross were numerous. He is the only physician to receive the Albert Lasker Award twice. In 1954 he was given this honor with the citation: "Whereby surgery upon the heart and great vessels was at last removed from the realm of the experimental trial and placed upon a firm clinical basis." He shared the award with Dr. Alfred Blalock and Dr. Helen Taussig, also pioneers in the surgical correction of children's cardiac disorders and anomalies. In 1959 he was given the Lasker award again, this time for his "foremost role in the extension of surgery to the relief or cure of other cardiovascular defects."

His honors included the Gold Medal of the American Surgical Association and honorary degrees from Carleton College (Minnesota), Suffolk University (Boston), and the universities of Louvain (Belgium), Turin (Italy), and Sheffield (England). He was elected to the American Pediatric Hall

of Fame and was awarded the Sheen Award of the American Medical Association, the Rudolf Matas Vascular Surgery Medal, and the Roswell Park Memorial Medal. In 1957 he was made a Grand Officer of the Order of Leopold by the Belgian government, in part because of his successful operation on fifteen-year-old Prince Alexander. Greece bestowed on him the Gold Cross of the Royal Order of the Phoenix. In 1970 he was awarded the Henry Jacob Bigelow Award of the Boston Surgical Society, its highest honor.

Gross was a founder, member, and president of many surgical and pediatric societies. He was a founder and the first president of the Society for Pediatric Surgery and a founder of the Board of Thoracic Surgery and the American Board of Surgery. He was made a member of the Academy of Surgeons of France and the British Association of Pediatric Surgeons. He was president of the Massachusetts Heart Association.

The Robert E. Gross professorship of pediatric surgery was established in 1985 at the Harvard Medical School and Dr. William Hardy Hendren was appointed the first incumbent.

In 1984 Gross received an honorary degree from Harvard University. His citation read: "With keen mind and compassionate hands, this brilliant surgeon has brought health to the youth of the world."

A shy man, Gross eschewed ostentation of any kind. He refused to meet with newspaper reporters, even at the time of such remarkable events as his treatment of President Kennedy's baby in a hyperbaric oxygen chamber. This shyness was sometimes mistaken for aloofness. That such was not the case is demonstrated by the fact that he was referred to as "my doctor" by his patients throughout his life. When they grew up and had children of their own they consulted him first whenever anyone in their family was

sick. It was not unusual for him to make an evening house call on a postoperative child. Medical students, usually in awe of him, found a sympathetic teacher who called them "son." He also protected his residents from the distraction of financial worry. His personal check often appeared when a resident's baby was born or when a wife was ill, or an invitation was extended to stay at his home temporarily until the crisis was over. Gross' reserve, however, was not born of timidity. For thirty-five years of his life he was the epicenter of a surgical revolution and set in motion the development of cardiovascular surgery, establishing new principles used today throughout the world, both in the repair of congenital anomalies in children, in the surgery of infancy and childhood, and the application of many of these principles in the adult.

In the later years of his life Gross was severely incapacitated by a back ailment. Despite this, he continued to attend clinical meetings, celebrations, and teaching sessions of the Harvard Medical School and Children's Hospital. He died quietly at a nursing home in Plymouth, Massachusetts, on October 11, 1988.

Dr. Gross was elected to the National Academy of Sciences in 1975. His career epitomizes the remarkable combination of science, art, skill, and clinical achievement that characterizes leadership in surgery. His scientific research was not carried out at a laboratory bench, but in the clinics, operating rooms, autopsy rooms, and animal laboratories of Harvard Medical School and Children's Hospital. The opinions held of Dr. Gross by persons in medicine and pediatrics are exemplified by the comment of Alexander S. Nadas, long a colleague of Dr. Gross and cardiologist-in-chief, emeritus, at Boston Children's Hospital: "Dr. Gross was a remarkable, extremely innovative surgeon. His impact on the field of cardiovascular surgery is immeasurable.

He challenged the belief that the human heart was beyond repair, and brought heart surgery from the experimental laboratory to clinical reality.”

HONORS AND DISTINCTIONS

DEGREES

- 1927 B.A., Carleton College
 1931 M.D., Harvard University, Medical School

HONORARY DEGREES

- 1951 D.Sc., Carleton College
 1959 M.D., Honoris Causa, Louvain University
 1961 M.D., Honoris Causa, Turin University
 1962 D.Sc., Suffolk University
 1963 D.Sc., University of Sheffield
 1984 D.Sc., Harvard University

HOSPITAL AND UNIVERSITY APPOINTMENTS

- 1934-36 Instructor in pathology, Harvard Medical School
 1937-39 Instructor in surgery, Harvard Medical School
 1939-40 Junior associate in surgery, Peter Bent Brigham Hospital
 1939-42 Associate in surgery, Harvard Medical School
 1939-46 Associate visiting surgeon, Children's Hospital, Boston
 1940-46 Senior associate in surgery, Peter Bent Brigham
 Hospital
 1942-47 Assistant professor of surgery, Harvard Medical School
 1947-88 Ladd Professor of Children's Surgery, Harvard Medical
 School
 1947-67 Surgeon-in-chief, Children's Hospital, Boston
 1952 Surgeon-in-chief, pro-tempore, Ohio State University
 1967-72 Surgeon-in-chief, cardiovascular surgery, Children's
 Hospital, Boston

PROFESSIONAL AND HONORARY SOCIETIES

- 1953 Honorary member, Reno Surgical Society
 1955 Honorary member, Dallas Southern Clinical Society
 1956 Honorary member, Buffalo Surgical Society
 1958 Honorary appointment, American National Red Cross,
 North Shore chapter
 1961 Honorary fellow, Spokane Surgical Society
 1967 Honorary citation, Barnstable County chapter,
 Massachusetts Heart Association

FOREIGN SOCIETIES

- 1959 Officer of the Order of Leopold, Belgium
 1959 Honorary officer of the International Red Cross,
 Belgium
 1960 Honorary member, Pediatric Society of Guatemala
 1964 Honorary member, La Bocado de Cirurgia Pediatrica
 de Mexico
 1968 Honorary member, Surgical Infantil Argentina Society
 1973 Honorary fellow, Royal College of Surgeons of England

COMMITTEES

- 1954-55 Director, American Heart Association
 1958-60 Director, American Heart Association
 1960 President, Massachusetts Heart Association
 1963-64 President, American Association for Thoracic Surgery
 1969-70 Board of directors, Massachusetts Heart Association
 1970-71 First president, American Pediatric Surgical Association

EDITORSHIPS

- 1970 Editorial board, *Surgery*

AWARDS

- 1940 F Mead-Johnson Award, American Academy of Pediatrics
 1940 Rudolf Matas Vascular Surgery Award, Tulane University
 1954 Children's Service Award, Toy Manufacturers of
 America
 1954 Albert Lasker Award, American Public Health
 Association
 1956 Roswell Park Gold Medal, Buffalo Surgical Society
 1957 Gold Medal, Louisville Surgical Society
 1959 Laeken Award, Brussels, Belgium
 1959 Gold Medal, Detroit Surgical Association
 1959 Billroth Medal, New York Academy of Medicine
 1961 Gold Medal Award, Golden Slipper Square Club of
 Philadelphia
 1962 Award of the Brotherhood Temple Ohabei Shalom,
 Brookline
 1965 William E. Ladd Medal Award, Surgical Section,
 American Academy of Pediatrics

- 1965 Gold Cross, Royal Order of the Phoenix of the Greek Government
- 1968 Dennis Browne Gold Medal, British Association of Pediatric Surgeons
- 1969 Dr. Rodman E. Sheen and Thomas G. Sheen Award, American Medical Association
- 1970 Alfred Jurzykowski Medalist, New York Academy of Medicine citation with Dr. Farber and Dr. Neuhauser and the Children's Hospital Medical Center
- 1970 Henry Jacob Bigelow Memorial Medal
- 1971 Tina Award, Foundation for Children, Houston, Texas Certificate of Award, 26th annual Philadelphia book show, presented to W. B. Saunders Company for *An Atlas of Children's Surgery* by Dr. Robert E. Gross
- 1973 Distinguished Service Medal, American Surgical Association

SELECTED BIBLIOGRAPHY

1933

Idiopathic dilatation of common bile duct in children. Review of literature and report of two cases. *J. Pediat.* 3:730-55.

1939

With J. P. Hubbard. Surgical ligation of patent ductus arteriosus; report of first successful case. *JAMA* 112:729-31.

1940

With W. E. Ladd. Surgical treatment of duplications of alimentary tract; enterogenous cysts, enteric cysts, or ileum duplex. *Surg. Gynec. & Obst.* 70:295-307.

With W. E. Ladd. Surgical anastomoses between the bile and intestinal tracts of children; follow-up studies. *Ann. Surg.* 11:51-63.

With J. B. Blodgett. Omphalocele (umbilical eventura) in the newly born. *Surg. Gynec. & Obst.* 71:520-27.

1941

With W. E. Ladd. *Abdominal Surgery of Infancy and Childhood*. Philadelphia: W. B. Saunders Company.

1945

With C. A. Hufnagel. Coarctation of the aorta. Experimental studies regarding its surgical correction. *New Engl. J. Med.* 233:287-93.
Surgical correction for coarctation of the aorta. *Surgery* 18:673-78.

1946

With P. F. Ware. Surgical significance of aortic arch anomalies. *Surg. Gynec. & Obst.* 83:435-48.

1948

With E. B. D. Neuhauser. Compression of the trachea by anomalous innominate artery. Operation for its relief. *Am. J. Dis. Child.* 75:570-74.

Surgical treatment for coarctation of the aorta. *Surg. Gynec. & Obst.* 86:756-58.

With E. S. Hurwitt, A. J. Bill, Jr., and E. C. Peirce, II. Preliminary observations on the use of human arterial grafts in the treatment of certain cardiovascular defects. *New Engl. J. Med.* 239:576-79.

1950

Coarctation of the aorta. Surgical treatment of one hundred cases. *Circulation* 1:41-55.

With E. B. D. Neuhauser. Treatment of mixed tumors of the kidney in childhood. *Pediatrics* 6:843-52.

1952

Surgical closure of an aortic septal defect. *Circulation* 5:858-63.

1953

With E. Watkins, Jr., A. A. Pomeranz, and E. I. Goldsmith. A method for surgical closure of interauricular septal defects. *Surg. Gynec. & Obst.* 96:1-23.

The Surgery of Infancy and Childhood. Its Principles and Techniques. Philadelphia: W. B. Saunders Company.

1956

With T. C. Jewett, Jr. Surgical experiences from 1,222 operations for undescended testis. *JAMA* 160:634-41.

1959

With S. Farber and L. W. Martin. Neuroblastoma sympatheticum. A study and report of 217 cases. *Pediatrics* 23:1179-91.

1962-63

With W. F. Bernhard, E. S. Tank, and G. Frittelli. Experimental and clinical cardiovascular surgery under hyperbaric conditions. *New England Cardiovascular Society* XXI:31-33.

1968

With W. W. Miller, A. Nadas, and W. F. Bernhard. Congenital pulmonary atresia with ventricular septal defect. Review of the clinical course of fifty patients with assessment of the results of palliative surgery. *Am. J. Cardiology* 22:673-80.

1970

An Atlas of Children's Surgery. Philadelphia: W. B. Saunders Company.

