# Part I

# General issues

1a

# Introduction and historical overview: North American perspective

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William E. Ladd (1880–1967) is considered to be the father of pediatric surgery in North America. However, delving into records from the Massachusetts General Hospital (MGH), founded in 1821, discloses pediatric surgical cases cared for by surgeons 60 years before Ladd's time. A book published in 1839 by John C. Warren,[1] who performed the first publicly demonstrated operation under general anesthesia at the MGH in 1846, included pediatric cases. A generation later, his son, J. Mason Warren, wrote a book after anesthesia was well established in which many more pediatric cases were described.[2] When the Children's Hospital in Boston was founded in 1869 (Philadelphia Children's Hospital predated it in 1855), Benjamin Shaw, resident physician at the MGH wrote to the press, "Our existing institutions public and private provide adequately for hospital treatment of children." He stated that 190 of 1264 (14%) admissions to the MGH in 1868 were children.

A recent book, *The Children's Hospital of Boston, Built Better Than They Knew*, by Clement A. Smith,[3] describes a century of history at Children's. From 1882 to 1914 the most frequent surgical admission was for bone and joint tuberculosis. Early on there were no recognized cases of appendicitis, because Reginald Fitz at the MGH had not yet described that entity. In contrast there were 113 admissions for appendicitis from 1911 to 1913. When the present Children's Hospital was built in 1914, next to Harvard Medical School, a herd of cows was maintained across the street to provide tuberculosis-free milk for the patients. Ladd graduated from the Harvard Medical School in 1906. He trained as a general surgeon at the Boston City Hospital. He held an appointment as a Volunteer Assistant Surgeon at Children's in 1910, but maintained a private practice of general surgery and gynecology. On December 6, 1917, during World War I, a munitions ship exploded in the harbor at Halifax, Nova Scotia. There were hundreds of deaths and injuries. A plea for help was made to physicians from Boston. Ladd was among those who responded. Many of the patients were children. His career path changed soon thereafter to concentrate on pediatric surgery, succeeding James Stone as Chief of Surgery in 1927. He became the first geographic full-time surgeon for children and soon established a link with the Peter Bent Brigham Hospital, recognizing that pediatric surgeons should have strong ties with general surgery.

Another surgeon who responded to the call from Nova Scotia was Ernest Armory Codman (1869–1940). This textbook, which stresses long-term outcomes of pediatric surgery, would be incomplete without mention of Codman. He was a classmate of Harvey Cushing. Codman developed the anesthesia chart, with name, diagnosis, operation, vital signs, and remarks. When he wrote a paper on ether anesthesia and presented it for review, a senior surgeon at MGH described it as "too frank for the good of the hospital, for it described in detail the cases which I lost." When X-ray diagnosis was introduced in 1896, Codman became interested in that new tool. Although he was a surgeon, he became the first radiologist at the Children's Hospital in 1899. It was established as the first Pediatric Radiology Department in America. Although contemporary literature for the past decade has emphasized the importance of long-term follow-up and quality improvement, *Codman preached that philosophy almost a century ago*. He introduced the "end result idea." His approach was methodical, complete, and precise. When the Clinical Congress of Surgeons of North America met in 1912, Codman was made chairman of a committee on hospital standardization to

*Pediatric Surgery and Urology: Long-term Outcomes*, Mark Stringer, Keith Oldham, Pierre Mouriquand.
Published by Cambridge University Press. 


**Fig. 1a.1.** Cartoon shown by Ernest A. Codman on January 8, 1915, to a meeting of surgeons at the Boston Medical Library. It created a storm of resentment. The ostrich is kicking golden eggs into the outstretched hands of MGH staff who are labeled: Surgical, Gynecologic, Obstetric, and Pediatric (and humbug) Teams, and a Death Bed Team. President Lowell of Harvard stands above, straddling a bridge across the Charles River and saying, "I wonder if clinical truth is incompatible with medical science? Could my clinical professors make a living without humbug?" The ostrich is eating humbugs, and muses "If I only dared look and see, I might find a doctor who could cure my own ills." At the Clinical Truth Table are the Board of Trustees of the MGH. They are commenting, "If we let her know the truth about our patients do you suppose she would still be willing to lay?" At the top right is a Bill Head crediting the Massachusetts General Hospital with the first demonstration of Anesthesia, Practical Social Service, and Emancipation from Humbug by the End Result System. On the left, above the clinical teams, stands Harvard Medical School. Harvard College, Massachusetts Institute of Technology and Bunker Hill Monument are seen in the background across the river.

improve the quality of patient care. His zeal, together with his overt criticism of surgical practices of that time, created great animosity from other surgeons. In 1914, at a meeting in Philadelphia, he said, "Hospitals are responsible for the care given by their staff and should carefully note the results of each surgeon, and all of that should be made public." His most famous attack on the establishment occurred on January 8, 1915, at a meeting of surgeons in the Boston Medical Library. He unveiled a large cartoon, shown in Fig. 1a.1. He was virtually ostracized by colleagues in Boston Surgery. Indeed, Codman emphasized the need for long-term outcome research almost a century ago. It is a fascinating chapter in surgery. A recent biography of Codman, by William J. Mallon[4] described that saga. Codman's contributions were enormous. His book on the shoulder is a classic. He started the bone sarcoma registry, which still exists. He wrote many scholarly papers on a wide range of general surgical and orthopedic subjects. The cartoon resides today in the Boston Medical Library, Achieve Room, in the Countway Library of Medicine at Harvard Medical School.

Returning to Ladd, he was a founding member of the Board of Surgery and the American Association for

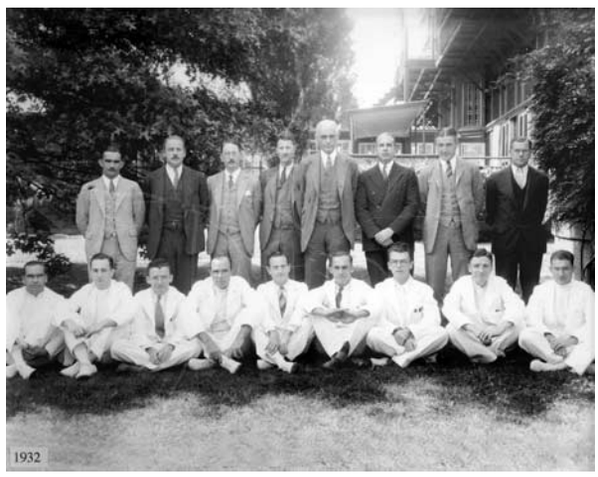


**Fig. 1a.2.** Department of Surgery under William E. Ladd, 1932. In back row, Ladd is the tallest figure fifth from the left; Thomas Lanman is the seventh. In the front row, Robert Gross, an intern, is seated second from the left. Note cottage-type buildings for patients.

Plastic Surgery (Fig. 1a.2). He wrote about many subjects, including pyloric stenosis, intussusception, biliary atresia, cleft lip, exstrophy of the bladder, Wilms' tumor, and malrotation of the intestine. He devised the treatment for malrotation of the intestine with midgut volvulus. The operation today is still termed "The Ladd's Procedure." In 1939 he saved a newborn with esophageal atresia,[5] a day after the same event occurred in Minneapolis by Dr. Logan Leven.[6] The early cases had division of the tracheoesophageal fistula, marsupialization of the upper pouch in the neck, and insertion of a gastrostomy. Later an antethoracic esophagus was constructed; the lower two-thirds was a Roux-en-Y loop of jejunum placed beneath the skin anterior to the sternum; the gap between the cervical esophagus and the jejunal loop was constructed from a skin tube, performed in stages. His associate Dr. Thomas Lanman, published in 1940 a series of 32 esophageal atresia failures,[7] predicting that, "Given a suitable case in which the patient is seen early I feel that with greater experience, improved technique, and good luck, the successful outcome of a direct anastomosis can and will be reported in the near future".[7] That came true in 1941, when Cameron Haight of Ann Arbor, Michigan reported such a case.[8]

A published genealogy of North American Pediatric Surgery[9] documents a direct line of descent from Ladd to 66% of all pediatric surgeons and 73% of training directors in North America. Reminiscences about Ladd by Orvar Swenson,[9] William Clatworthy,[9] and Alexander Bill,[10] describe Ladd's eminent position in surgery and the great respect that he enjoyed from those associated with him. The William E. Ladd Chair in Surgery was established at Harvard Medical School in 1941. Ladd was the first incumbent, foIlowed by Robert Gross, Aldo Castaneda, and Richard Jonas. It was my privilege as a medical student in 1951 to meet Dr. Ladd. He gave us an informal talk about scrofula. Ten years later, Dr. Edward D. Churchill, Chief of Surgery at the MGH, appointed me to the staff of the MGH, with the charge to develop a Pediatric Surgical Division. An early successful case was a 3 lb infant with esophageal atresia. Dr. Ladd, accompanied by Dr. Lanman, although both long retired, came to the MGH to discuss the case at Surgical Grand Rounds. Imagine what that meant to a young surgeon just getting started! Churchill gave me a cartoon showing a family of birds on a tree limb, in descending order of size, the big birds next to the trunk. At the end of the branch was a tiny bird with one foot on the limb flapping furiously to stay there! That cartoon might well have applied also to other of my surgical colleagues who were introducing pediatric surgery as a specialty in various places. Uniformly there was apprehension and a cool reception by established surgeons. In 1967, while walking down the operating room corridor one evening I chanced to look into an induction room. There was Dr. Ladd about to be anesthetized for surgery on a hip. It was a privilege to hold his hand as he went to sleep. He died that year, at age 87, ending a distinguished career in surgery.

Edward D. Churchill (1894–1972), Chief of Surgery at MGH, also contributed importantly to North American Pediatric Surgery. He developed the "rectangular" Surgical Residency,[11] in which smaller numbers of residents start but most finish a full 5-year program. This contrasted with the steep pyramid system extant at Johns Hopkins, Yale, Peter Bent Brigham Hospital, and Duke. The pyramid system was similar to surgical training in Germany. It graduated a superb and experienced surgeon, but many fell at the wayside who did not reach the top of the pyramid. A rectangular system is most common today. It assures full training for most who start such a program, although there may be an additional year or more for those destined for an academic career or a specialty like pediatric surgery. Churchill developed segmental resection of the lung;[12] some of his patients were children with bronchiectasis. Churchill's establishing a division of pediatric surgery at MGH resulted eventually in entry to pediatric surgery by 41 members of the MGH surgical residency staff. Some became program heads in North America: Scott Adzick, Philadelphia; Jay Vacanti, Boston, MGH; Robert Shamberger, Boston, Children's; Michael Harrison, San Francisco; Michael LaQuaglia, Sloan-Kettering Hospital, New York; Dennis Lund, Madison, Wisconsin; Lucien Leape, Boston, Floating Hospital; Dale Johnson, Salt Lake City; Judson Randolph, Washington D.C.; Willis Williams, Atlanta; Timothy Canty, Louisville; Michael Mitchell, Seattle; Terry Hensle, New York; Kenneth Crooks, Columbus; Jens Rosenkrantz, Los Angeles; and Judah Folkman and Hardy Hendren, each now Emeritus Chiefs in Boston.

Robert E. Gross (1905–1988) (Fig. 1a.3) was the most outstanding of those who trained under Ladd. He graduated from Harvard Medical School in 1931. Charles F. McKhann, Professor of Pediatrics, wrote a letter of recommendation about Gross to Ladd. Quoting from this letter given to me by his son, Charles McKhann Jr.: "Mr. R. E. Gross, a member of the fourth year class of Harvard Medical School, has asked me to write you concerning his qualifications for the position of House Officer in the Children's Hospital. Mr. Gross is an interested, eager and accurate student, somewhat above average, has a pleasant personality, and a good appearance. He should make a satisfactory House Officer." This understated letter did not portend what Gross would accomplish. His training included first a residency in Pathology under S. Burt Wolbach. He trained in general surgery under Elliot Cutler at the Peter Bent Brigham, and in Pediatric Surgery


**Fig. 1a.3.** Department of Surgery in 1959 under Robert E. Gross. Front row, left to right: Ernest Barsamian, Samuel Schuster, Thomas Holder, Robert Gross, Luther Longino, Donald MacCollum, Robert Smith, and Hardy Hendren. Second row, left to right: Lawrence Hill, Arnold Colodny, Donald Brief, John Crowe, Judson Randolph, David Collins, Morton Wooley, Lon Curtis, and Mayo Johnson.

under Ladd. Seven years after McKhann's letter, while he was Chief Surgical Resident, Gross successfully divided a patent ductus arteriosus.[13] The operation was performed when Ladd was out of town. Ladd never forgave Gross for that professional sleight. Gross later confided that he did not think Ladd would have allowed the operation if he had been present. The patient, Lorraine Sweeny, then 8 years old, is alive and well today, 66 years later. This underscores how pediatric surgeons strive to attain a long and productive life for their patients, often not possible in adults. Ladd retired in 1945. Franc Ingraham, Chief of Neurosurgery, was appointed as interim Chief while an *ad hoc* committee deliberated for 2 years (not uncommon at Harvard). Gross was appointed Chief in 1947. Churchill was chairman of the *ad hoc* committee!

Visitors who came to Boston to observe or work with Ladd and Gross included several who became very distinguished pediatric surgeons and mentors. C. Everett Koop, sent by his Chief, Isadore Ravdin, returned to Philadelphia to be the first Surgeon in Chief at that Children's Hospital.[14] Willis J. Potts returned to the Children's Memorial Hospital in Chicago. Robert Zachary returned to Sheffield, England and trained many registrars in pediatric surgery. Jesus Lozoya-Solis returned to Mexico City to become the dominant figure in pediatric surgery there. Alberto Peña was one of his many pupils. Lozoya believed pediatric surgeons should be first a pediatrician and secondarily a surgeon, differing from the opinion of Ladd and Gross. That pattern became prevalent in many Spanish-speaking countries of Central and South America.

Clarence Crafoord of Stockholm, Sweden reported successful resection of coarctation of the aorta in 1944.[15] Gross soon followed with his own important contributions to coarctation.[16] From his laboratory came also the use of human cadaver aortic grafts to replace the narrow aortic segment in coarctation cases which are too long for excision and primary anastomosis.[17] The grafts were freeze-dried and radiated for sterilization. This was a landmark contribution to the field of vascular surgery. Perchance I was recently contacted by an 88-year-old man who is Dr. Gross's first homograft coarctation repair. He is in good health, and had just returned from competitive bowling!

Ladd and Gross published a book in 1941 on *Abdominal Surgery of Childhood*.[18] It presented experience and statistics of follow-up in pediatric surgery at Children's, from 1915 to 1941. The book is a classic. Recently a copy was given to me which was given to Wolbach in 1941 by Gross. An inscription acknowledges Gross' gratitude for Wolbach's mentoring and guidance, expressing his high regard for Wolbach as his primary teacher and advocate.

In 1953 Gross published his own single author book, *The Surgery of Infancy and Childhood*.[19] It was dedicated to Wolbach. The copy given to Wolbach by Gross, which was recently given to me, bears the inscription: "Dear Uncle Burt, With this book come my deepest thanks for all you've done in so many ways. Devotedly, Bob." The book remains a classic today. It should be read by all pediatric surgeons. Many thousands of copies were published in multiple printings, in several different languages. Therefore, it can usually be found and purchased (for 15–20 times its original cost!).

Gross described repair of anomalies of the great vessels, which constrict the trachea, esophagus or both.[20] Little has been added concerning vascular rings in the past 50 years. He described treating omphalocele by wide undermining of the skin, and temporary closure over the viscera, leaving a huge abdominal wall hernia to repair later.[21] An interim technique used by some for several years was painting the sac with mercurochrome, awaiting its gradual epithelialization and contracture. His pupil, Samuel R. Schuster, later introduced temporary silastic covering of the protruding viscera, with staged closure soon thereafter.[22] This has endured.

Willis Potts authored a unique book in 1959[23] describing some of the more common entities in pediatric surgery. He wrote, "I want to dedicate this book to the infant who has the great misfortune of being born with a serious deformity. All life is before him and what is done during the first

few days may decide whether life will be a joy or a burden. If this infant could speak it would beg imploringly of the surgeon, 'Please exercise the greatest gentleness with my miniature tissues and try to correct the deformity in the first operation. Give me blood and the proper amount of fluids and electrolytes; add plenty of oxygen to the anesthesia and I will show you that I can tolerate a terrific amount of surgery. You will be surprised at the speed of my recovery and I shall always be grateful to you'." Regarding imperforate anus, Potts wrote, "In general, atresia of the rectum is more poorly handled than any other congenital anomaly of the newborn. A properly functioning rectum is an unappreciated gift of greatest price. The child who is so unfortunate as to be born with an imperforate anus may be saved a lifetime of misery and social seclusion by the surgeon who with skill, diligence and judgment performs the first operation on the malformed rectum". Pediatric surgeons continue to strive to correct the difficult entity of imperforate anus, most espousing the posterior sagittal approach introduced by DeVries and Peña.[24]

Although Gross opened the field of congenital heart surgery, others soon followed him. Alfred Blalock at Johns Hopkins advanced treatment of blue babies by introducing the Blalock–Taussig subclavian–pulmonary artery shunt.[25] Gross regretted that he had not paid heed to Helen Taussig who had visited him earlier from Hopkins and suggested "making a ductus" as treatment for blue babies. Willis Potts devised a direct aorta to pulmonary artery shunt.[26] Other surgeons worked to perfect a heart–lung machine. First was John Gibbon, of Jefferson Medical College in Philadelphia. He successfully closed an atrial septal defect for a child using a cardiopulmonary bypass but did not venture further into more complex defects. His research had started in the laboratory of Edward Churchill in Boston, who did not think there was much merit in that idea! In 1952 John Lewis showed that simple atrial defects could be closed with brief inflow occlusion and hypothermia, but this did not give enough time to repair complex malformations. Gross employed a rubber well sewn to the right atrium to access and close atrial septal defects.[27] Results of that were imperfect. It was C. Walton Lillehei in Minneapolis who focused the spotlight on congenital heart surgery. On April 25, 1954, he closed a large interventricular septal defect in a 4-year-old girl, with the father providing cardiopulmonary support by cross-circulation between parent and child, despite vigorous outcry by members of the medical department. His surgical chief, Owen Wangansteen, stood by him. He then demonstrated repair of complex anomalies, such as Tetralogy of Fallot.[28] This interesting surgical history was recently reported in riveting detail in a book entitled, *King of Hearts* by G. Wayne Miller, in 2000.[29] Thereafter a practical cardiopulmonary bypass machine was introduced by Lillehei and soon adopted by many surgeons, a key development in bringing congenital heart surgery to its current advanced state.

Gross stepped down as Surgeon in Chief in 1967, to concentrate on cardiac surgery. He retired in 1972. Gross revealed later that, during his entire career, he had operated with good vision in only one eye. This was told to one of his former residents who was facing loss of vision in one eye from a melanoma. Gross in retirement underwent surgery for his congenital cataract. That gave him binocular vision he had lacked during his brilliant surgical career. A Harvard Chair was named in his honor in 1985, on the occasion of his 80th birthday. The author was its first incumbent. Gross died with Alzheimer's disease on October 11, 1988, closing the career of a giant in American Surgery.

Ladd and Gross were both accomplished and imaginative surgeons. Their department of surgery trained a multitude of pediatric surgeons in North America. This heritage has been self-perpetuating. Recognition of pediatric surgery as a specialty did not come easily. Randolph outlined the genesis of other early programs in the United States:[30] Willis Potts in Chicago, 1947; Everett Koop in Philadelphia, 1950; Ovar Swenson at Boston Floating Hospital, 1952; William Clatworthy in Columbus, 1955; William Kiesewetter in Pittsburgh, 1958; Thomas Santulli, in New York. There were also Canadian programs in Montreal, Toronto, Winnipeg, Ottawa, and Vancouver.

The first full-time pediatric surgeon in North America was Herbert Coe in Seattle; he had visited Children's Hospital in Boston when Ladd had not yet limited his work to children. Coe was the driving force in establishing in 1948 the Surgical Section of the American Academy of Pediatrics. *The Journal of Pediatric Surgery* began in 1965 through the efforts of Everett Koop and Stephen Gans. The American Pediatric Surgical Association was founded in 1970. Recognition of special competence in pediatric surgery by the American Board of Surgery was finally accomplished in 1975 through the efforts of Harvey Beardmore and others. The British Association of Pediatric Surgeons which formed in 1953, has promoted interchange of knowledge among surgeons the world over. It has been fascinating to be privy to all of these developments spanning more than half a century.

The field of pediatric surgery has been virtually transformed in the past 50 years. Space does not permit mentioning all of the contributions and all of the contributors, but some deserve to be highlighted. Douglas Stephens of Melbourne, Australia, and later Chicago, taught us much about the embryology and classification of anorectal and genitourinary malformation.[31] Jonathan Rhodes of

Philadelphia reported the first primary pullthrough in the neonate with imperforate anus.[32] Cloacal malformations, once a no-man's land of pediatric surgery, have become reparable.[33,34] Infants with cloacal exstrophy always died, until a survivor was reported in 1960 by Peter Rickham, then in Liverpool.[35] Today, most of these infants can be repaired in a satisfactory fashion to lead useful lives. Key to development of much major pediatric surgery was the emergence of pediatric anesthesiology, which can support even small babies through a prolonged surgery as well as help surgeons care for them postoperatively. It is now appreciated that fluid loss and necessary replacement are much greater than we practiced 50 years ago to maintain metabolic hemostasis in the pediatric surgical patient.

Orvar Swenson, another protégé of Ladd, pioneered the enormous contribution of unlocking the mystery of Hirschsprung's disease. With Alexander Bill, he proved the pathology to be the aganglionic distal segment and described an effective operation for it.[36] Originally, the clinical picture of Hirschsprung's disease was an older child with lifelong constipation. Soon it was recognized that the most common presentation is a newborn with intestinal obstruction. It accounts for one-third of neonatal cases of bowel obstruction. To be sure, Duhamel, Soave, Rehbein, and others made modifications, but Swenson's carefully documented clinical research remains the basis for treatment of this problem half a century later. Swenson recently described the long-term result of his experience with Hirschsprung's.[37] Martin described a practical surgical solution for the infant with total colonic aganglionosis.[38]

Judah Folkman succeeded Gross as Surgeon in Chief at Children's Hospital in 1968. Twenty-three years earlier Koop had learned pediatric surgery from Ladd and Gross. In 1968 Folkman went to Philadelphia for a "cram course" in pediatric surgery by Koop, a successful *quid pro quo* for both institutions! For 14 years Folkman carried the Herculean load of that office plus overseeing a large surgical research laboratory, mentoring many postdoctoral research fellows. He chose in 1982 to concentrate his enormous productivity on the ever-expanding research laboratory program, devoted in large part to the field of angiogenesis research. This had begun with Folkman's astute observation that tumors grow by attracting new blood vessels. He reasoned that control of angiogenesis might control growth of tumors, as well as other non-malignant conditions characterized by vascular ingrowth, such as diabetic retinopathy. Alpha interferon, an angiogenic inhibitor, was shown to reduce dramatically the mortality of life-threatening giant hemangiomas in infants.[39] Like many spectacular advances, Folkman's work provoked derisive commentary and skepticism initially. However, his vision was amply vindicated by many other scientists who joined in this investigative effort around the world. Many clinical trials are in progress today at many major hospitals. The author succeeded Folkman as Chief of the Department of Surgery in 1982.

Joseph Murray opened the field of organ transplantation in Dec. 1954 when he transplanted a kidney from one identical twin to his brother in end-stage renal failure.[40] Later in 1962, he demonstrated successful cadaver renal transplantation using immunosuppression. For the seminal advance of transplantation, Murray was awarded The Nobel Prize in 1990.[41] Soon Starzl opened the field of liver transplantation.[42] Now half a century later heart, lung, pancreas, intestine, and even multivisceral organ transplantation have been added to the surgeons' repertoire. Organ availability has been a problem since transplantation began. Joseph Vacanti started the field of tissue engineering to solve this dilemma.[43]

Dudrick's introduction of total parenteral nutrition[44] has saved countless lives of children, and adults, where nutritional needs cannot be met otherwise. This began with a long struggle to save a baby with gangrenous bowel from malrotation and midgut volvulus at Philadelphia Children's Hospital. Another boon to mankind!

Neonatal physiology and nutrition[45] advanced greatly as pediatric surgery grew in scope and stature.[45]

Patricia Donahoe made great strides in developmental biology, starting with investigation of the Mullerian Inhibiting Substance.[46] Her investigations broadened to study mechanisms of fetal growth and differentiation.[47]

Robert Bartlett conceived the idea of extracorporeal membrane oxygenation while working as a resident under Robert Gross.[48] This saved countless lives in children and adults with cardiopulmonary failure. Ancillary to that was vast improvement in treatment of neonates with severe diaphragmatic hernia.

Michael Harrison and Alfred deLormier imaginatively introduced the field of fetal surgery.[49] Harrison's pupils, Adzick, Jennings, Flake, and Longaker and others carried this new field further forward, making it possible to salvage infants with once fatal problems.

Burn treatment was pushed to the forefront by the Coconut Grove Nightclub fire on Nov. 28, 1942 in Boston.[50] Much was learned about burns in caring for victims of that well known tragedy. Ultimately, expeditious excision and grafting of extensive deep burns was developed,[51,52] and the use of artificial skin to close large burn wounds after excision.[53,54] Burn mortality dropped remarkably through early excision and grafting.[55]

Limb replantation began in 1963 when Ronald Malt at Massachusetts General Hospital reunited the severed arm of a young boy after traumatic amputation,[56] sparking worldwide salvage of many digits and limbs.

Tracheal resection in children was made possible by the pioneering work of Hermes Grillo at MGH, who developed segmental tracheal and bronchial resection for benign and malignant conditions in adults. This soon became equally useful in children.[57,58]

Cancer chemotherapy was another seminal advance for pediatric surgery, greatly improving the cure rate of many malignancies. It was my privilege as a surgical resident to witness introduction of this in 1955 in Wilms' tumor cases by Sidney Farber, Chief of Pathology at Children's. Like Gross, Farber was a pupil of S. Burt Wolbach. Farber began with the premise that some types of cancer might be controlled by chemical agents. At the Fourth Annual Internal Cancer Research Conference in St. Louis, MO, in September, 1947, a case was presented of a patient who had a remarkable clinical response to a new experimental chemotherapeutic agent, Teropterin (teryl-triglutamic acid). This was the result of the keen observation by Brian L. Hutchings of the Lederle Laboratories. In 1942 Hutchings was trying to produce folic acid in large quantities and noted that one of the vats contained a filtrate that stimulated growth of a certain microorganism, whereas other vats produced no such growth. This filtrate, initially thought to be folic acid turned out to be a folic acid analog, Teropterin. It was shown subsequently that sarcomatous tumors transplanted into mice disappeared with the addition of this drug.

The anonymous patient presented at the conference was "Babe" Ruth, the celebrated slugger of the New York Yankees. In 1946 he presented with hoarseness, left retroorbital pain, and a neck mass. The neck mass was partially excised. The primary tumor was not laryngeal in origin as generally believed but a primary nasopharyngeal cancer at the base of the skull. He had a remarkable temporary relief from pain and regression of the tumor on treatment with teropterin.[59] Sidney Farber investigated the role of this agent and other folic acid agonists and antagonists. Farber's early work led to saving the lives of many children with leukemia,[60] which was once uniformly fatal. He organized the laboratory and clinical facility for chemotherapy, named the Jimmy Fund, in honor of one of the early tumor successes, a patient with an intestinal lymphoma. That patient is alive today. It was the beginning of a new era. The impact of chemotherapy for pediatric malignancies is now well established after nearly half a century of close collaboration between medical oncologists, radiotherapists, and surgeons. The Jimmy Fund Building was joined to the Charles A. Dana Cancer Center for adults, and was designated a comprehensive cancer center in 1973. Today, it is called the Dana-Farber Cancer Center.

Pediatric urology as a recognized field was virtually nonexistent 50 years ago. On my arrival at Children's Hospital, the resident just finishing gave the news that one duty would be to conduct the Urology Clinic every Monday afternoon. When professing to have no knowledge about pediatric urology, he was reassuring by saying "Don't worry, nobody else does either!" The clinic had many children with various tubes to be changed: nephrostomy, cystostomy, or urethral. There was no senior supervision of the clinic. That sparked an interest to learn something about urologic problems. Looking back through half a century, pediatric urology became a robust and recognized surgical specialty.[61] It began with a few general urologists who founded the Society for Pediatric Urology in 1951. On the 50th Anniversary, there were 437 members and 9 honorary members. Dr. Meredith Campbell of New York was the standard bearer. He was President for 5 years. His two volume *Pediatric Urology*[62] described the anomalies and diseases of the child's urinary tract. It was a scholarly work and illustrated routine operations of that era. All present pediatric urologists should read the book to appreciate the great advances in the past 50 years. Pediatric urology has paralleled the development of pediatric general surgery, although one generation later. As a specialty it was accepted slowly, just as occurred in pediatric surgery in 1975. The American Board of Urology recently approved certification of special competence, 30 years after that was achieved for pediatric general surgery. The Urology Section of the American Academy of Pediatrics, founded in 1971 currently has 462 members. Its annual meeting became the premier forum for those interested in this field. To illustrate progress in the specialty, several areas deserve mention.

Exstrophy of the bladder was managed mainly by ureterosigmoidostomy diversion and cystectomy until Jeffs,[63] and Chisholm[64] and others showed that primary repair is feasible although not always successful. This concept was advanced further with bladder augmentation, continent diversion, and even total repair in the newborn (bladder closure, ureteral reimplantation, and epispadias repair simultaneously).

Cloacal exstrophy was deemed insoluble until Rickham reported a survivor in 1960.[35] From this beginning extensive repair became feasible, with urinary continence in most and pull through of the colon in some of those with contractile muscle of the pelvis and perineum.[65]

Ureterocele was treated largely by wide unroofing; this relieved obstruction but produced massive reflux which furthered renal damage and often produced incontinence in those with ectopic ureteroceles which require repair of the cleft bladder neck and urethra. Superior results were achieved by total repair of the sometimes complex anatomy in one stage.[66]

Urinary tract imaging was formerly limited to intravenous pyelogram, retrograde pyelogram and static cystogram (often under anesthesia). Cine radiography taught much about both function and anatomy, but at the price of excessive radiation exposure. Development of more advanced techniques, such as "spot films," ultrasound study, nuclear contrast, magnetic resonance technique, and computerized tomography improved enormously the accuracy of urodiagnosis.

Endoscopic visualization of the urinary tract 50 years ago using battery powered incandescent light bulbs for illumination was crude to say the least, especially in infants for whom small caliber endoscopes were not available. Fiberoptic endoscopy revolutionized that modality, especially when flexible technique developed. Each training department should retain an old incandescent cystoscope to give trainees an appreciation for the blessings of new technology!

Urethral valves were described accurately in 1919 by Hugh Hampton Young, the father of North American Urology, at Johns Hopkins Hospital.[67] They were destroyed by blindly inserting a cold punch, which did not allow much accuracy. Open cystotomy carried down into the prostate urethra afforded better valve excision but sometimes produced incontinence.[19] Accurate valve surgery resulted from voiding cystourethrography and the improved vision with fiberoptic scopes. The result was recognition that urethral valves, like most pathology, occur in a spectrum of severity[68] from grade 4 with severe obstruction and hydroureteronephrosis, to grade 1 "mini valves," which show only subtle radiographic findings and have no upper tract dilatation.

Vesicoureteral reflux came to the forefront in the late 1950s and early 1960s, as dynamic urography developed. Wyland Leadbetter and his associate Victor Politano described the most often used technique of abolishing reflux by tunneling reimplantation of the ureter:[69] many variations followed. This work not only focused clinical awareness on the importance of reflux, but also served as a starting wedge for much of reconstructive urology.

Ileal loop introduced by Bricker in 1950[70] for drainage after anterior pelvic exenteration became an important method of drainage for both adults and children. It lessened greatly use of ostomy tubes of various sorts, often reducing incidence of urinary infection which always accompanies long standing tube drainage. However, after a decade of ileal loops, it became apparent that upper tracts often deteriorated, secondary to non- sterile reflux.[71] This was prevented by use of the colon conduit in which non-refluxing tunnels can be made.[72]

Megaureter was largely ignored in the literature, but its repair was a logical next step after ureteral reimplantation became well established. A book devoted exclusively to the ureter published in 1967 largely omitted this condition, with conclusion that it lacked importance and was not repairable.[73] However, after Bischoff in Germany described shortening and tapering the ureter,[74] operation was introduced in North America to shorten, taper, and tunnel reimplant the ureter with a high success rate.[75] Clinical experience and urodynamic study proved that a dilated ureter does not propel urine effectively because the walls cannot coapt.

Tubeless ureterostomy became popular, using end, loop, Roux-en-Y and even circle technique, as well as pyelostomy. That phase was short lived after the high complication rate of those diversions was reported,[76] and it was shown that the infant urinary tract can be primarily reconstructed without prior drainage.[77] Evaluation of the changes in urologic surgery described above evolved to reconstruction of previously diverted urinary tracts.[78,79] This led to the conclusions that (i) most diversions can be undiverted and (ii) most diversions are not necessary in the first place!

Hypospadias repair was vastly different at Boston Children's Hospital in 1953[19] from what surgeons practice today. Mild cases were not repaired. Severe cases were done in three stages, and were delayed until pubertal years. At that time MacCollum described 40 patients who had undergone satisfactory chordee release, but only 18 had completed stage 3. He stated, "The results have been exceedingly satisfactory and we see little need for improvement or change in operative technique, with the possible exception that earlier repair might have been desirable in some of the boys, a consideration which we did not find to be of great importance in many cases." From that viewpoint much changed, most recognizing that early repair is both feasible and desirable, and that there are many ways this can be accomplished, giving a penis which looks normal and has satisfactory function for both micturition and procreation!

## Conclusions

A retrospective view of both pediatric surgery and pediatric urology in the 20th century shows monumental changes and enormous benefits for pediatric patients. This evokes

speculation about what lies ahead as the efforts of many surgeons introduce solutions to many of the problems which still exist. A symposium on Pediatric Surgery was published in 1938.[80] The editor was William E. Ladd. His introduction stated, "Undoubtedly great strides have been made in this field of surgery in the last few years and I have confidence that greater advances are soon to follow." That prophesy was correct. It will surely prove true again when we look back in the distant future to our care of children at the beginning of this century.

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