In memoriam: Randall B. Griepp (1940-2022)

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The worldwide community of cardiovascular surgeons lost a pioneer with the passing of Randall (Randy) B. Griepp on September 8, 2022, at age 82 years. Perhaps best known for his contributions to the field of aortic surgery, including pioneering the use of deep hypothermic circulatory arrest (DHCA) in aortic arch surgery, Dr Griepp’s academic contributions and surgical firsts spanned the fields of transplantation, congenital heart disease, and left ventricular assist device development, as well as advancements in spinal cord protection during thoracoabdominal surgery.

EARLY LIFE AND EDUCATION

Randy was born at home in Marshall, Minn, to Colonel Frank R. Griepp, Jr, and Muriel Camilla Hawes on March 11, 1940. His father Frank, an ordained minister, joined the US Army Chaplain Corps in July 1946. Mostly on his own with his mother for the first 5 years of his life (Figure 1), the family was joined by brother Galen in 1946 and sister Marvel in 1952. In line with the life of an Army family, Randy’s upbringing was characterized by modest resources, average vocational schools, and constant dislocation, including postings in Honolulu, Hawaii, Augsburg, Del, and Monterey, Calif, with interim stops in Virginia, Maryland, and Washington, DC, before his father’s assignment in the Korean War (Figure 2). In this context, Randy developed an independence of spirit, and an adventurous and curious mind. Randy’s uncommon and creative intelligence was apparent in his first prize entry in the San Francisco Science Fair for an elegantly simple demonstration of what turned out to be an exponential relationship between oxygen consumption and temperature in goldfish. The experiment involved a fish tank with an expandable chamber, a bubble of pure oxygen, and the thermostat in his parents’ house. The experiment was thoughtful, creative, comprehensible, and repeatable, presaging not only an area of interest but also a research approach from which many would later benefit. Randy was presented the award by a hero of his, Physics Nobel Laureate William B. Shockley, Jr (Figure 3). In 1961, he entered the freshmen class at the California Institute of Technology (Caltech), planning to follow in the footsteps of his mentor: “I thought I could sort out a few things in nuclear physics” he recounted later with a smile. Exposure to classmates like Kip Thorne, a future Nobel laureate in physics and member of his freshmen section, convinced him that perhaps there were others who were better suited to pushing forward the field of theoretical physics. The combination of his ongoing interest in biology, and perhaps the experience of working as an overnight orderly in a hospital, led to a sudden realization that he would train as a physician: “I remember right where I was standing...”. After that moment, a new path had been set, and Randy became the only Caltech graduate from his year to proceed directly to medical school.

MEDICAL SCHOOL

Armed with a Bachelor of Science in Biology from Caltech (Figure 4), Randy matriculated at Stanford University School of Medicine with the intention to train as an internist, thinking it was “the most intellectual branch of clinical medicine.” Surgery was not on his radar, so much so that he showed up on the first day of his surgical rotation with the legendary Roy Cohn both late and finishing a Snickers bar—an error he was sure not to make in the future. Although general surgery did not interest him particularly, as a junior medical student he rotated to Norman E.
Shumway’s service and “was dazzled by the charismatic cardiac surgeon and consummate teacher.” Randy later recalled “when I saw the chief resident doing cases and Shumway first-assisting … well that was unheard-of; it was unlike any other surgical service I had seen … the field [of cardiac surgery] was a burgeoning one and he [Dr Shumway] was willing to let you in and actually teach you how to become a cardiac surgeon.”

Randy continued to spend time on Dr Shumway’s service and, due in part to the loss of an intern, functioned largely as a resident by the end of medical school. Still eager to experience the world of internal medicine and expand his own education, Randy approached Dr Shumway at the end of medical school with a proposition: Would he be willing to train him after an interim medical internship “in a city hospital”? Much to his relief, Dr Shumway responded laconically—“that sounds like a great idea … just give me a call about 6 months before you’ll be back.” Randy chose to do his medical internship across the country at Bellevue Hospital in New York. On a hectic service where two interns essentially took care of 50 patients, he met a medical student who was to become his wife, best friend, and lifetime collaborator. Eva Botstein (Figure 5) was born in Zurich on December 3, 1944, the daughter of 2 Polish-Jewish physicians. The family immigrated to New York when Eva was age 4 years. She graduated from the Bronx High School of Science and then Harvard/Radcliffe College in Cambridge, Mass, magna cum laude in History and Literature, before starting medical training at New York University. During her third year, and before they had even gone on a date, Eva had been struck by the taciturn and quietly confident intern on her service when, on one of the first weeks of her rotation a patient coded in the stairwell and Randy quietly took control and ran the code, despite the presence
of multiple obviously rattled senior residents and attending physicians. After only having known each other for 5 months, Eva agreed to return with Randy to Stanford to begin his residency; they were married 2 months later.

CARDIAC SURGERY TRAINING

Norman Shumway had successfully performed the first 2 orthotopic heart transplants at Stanford during his year in New York. After joining Shumway’s service as a trainee in 1968, Randy’s surgical acumen and expansive grasp of cellular physiology were soon recognized and he was invited to join the transplant service, which mostly involved experimental research work in the canine laboratory, where operative techniques involving atrial and venous anastomoses and topical myocardial cooling for orthotopic heart transplantation had been developed by Shumway and colleagues. This culminated in Randy performing his first heart transplant as a second-year resident, with Ed Stinson first assisting. This patient was for many years the longest surviving transplant recipient in the world, ultimately surviving 26 years, which Randy always described as “a lucky break” given what was known at the time about managing graft rejection. His prolific research during residency

FIGURE 3. First award in 1957 San Francisco Science Fair. Provided by and used with permission from the personal archive of Randall B. Griepp.

FIGURE 4. Randall B. Griepp at his graduation from Caltech in 1962. Provided by and used with permission from the personal archive of Randall B. Griepp.
included 15 first authored and 30 coauthored peer-reviewed publications on transplant operative techniques and outcomes, atrial function, coronary flow hemodynamics, topical hypothermia and myocardial preservation, and humoral and tissue immunity in orthotopic heart transplantation.

**EARLY CAREER**

After completing cardiac surgery residency, Dr Griepp joined Shumway’s service as a junior faculty member in 1973. Soon after, some of Dr Griepp’s attention began to shift away from transplantation, which led to new and inspiring questions to explore in the field at large. Following the model of working problems through in the laboratory and having observed the time-consuming re-warming process following total body hypothermia, Dr Griepp demonstrated a technique for DHCA in a series of canine autotransplants with extended periods of cardiac arrest at brain temperatures of 10 to 15 °C. “The next day I had a normal dog.” The seminal 1973 publication that demonstrated superior outcomes with this new technique in surgery of the aortic arch is still often cited. Additional innovations in cannulation and graft perfusion opened the door to the possibilities of aortic arch surgery, in which he continued to innovate and establish, meticulously through laboratory research and clinical follow-up data, providing a timeless benchmark in the operative approach and clinical outcomes in patients with aortic disease throughout his career (Figures 6 and 7). The early years on the faculty saw many other exciting collaborations and innovations in transplant immunology and immunosuppression (eg, lymphocyte reactivity, antithymocyte globulin, and use of cyclosporine A), and graft rejection monitoring (eg, electrocardiograph, fluoroscopy, coronary flow.
Prosthetic replacement of the aortic arch

Four patients are reported in whom the aortic arch and variable portions of the ascending and descending aorta were replaced with a prosthesis. In three patients the preoperative diagnosis was dissecting aneurysm of the aortic arch and in one an arteriosclerotic aneurysm of the aortic arch was present. A combination of surface cooling and cardiopulmonary bypass was utilized to produce total body hypothermia. Arch replacement was carried out during a period of total circulatory arrest. Cardiopulmonary bypass was then utilized to warm the patient and resuscitate the heart. The average duration of cerebral ischemia was 43 minutes and the average duration of myocardial ischemia was 74 minutes. The average lowest esophageal temperature was 14°C, and the average lowest rectal temperature was 18°C. Three patients are alive and well 4 to 13 months following surgery. One patient died 4 days postoperatively of pulmonary insufficiency. This experience indicates that by utilizing total body hypothermia and circulatory arrest aortic arch replacement can be carried out with an acceptable mortality rate. Corrective surgery should be offered to patients with life-threatening enlarging aneurysms of the aortic arch.

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THE CHAIRMAN YEARS

After 3 years on the Stanford faculty, Griepp saw an opportunity to pursue his clinical and research interests in the company of a similarly innovative and bold young renal transplant surgeon, Samuel L. Kountz, Jr. They had met as residents while harvesting organs for their respective transplant teams. Dr Kountz had performed the first successful nontwin donor renal transplant while a resident at San Francisco General Hospital and had gone on to develop the largest renal transplant program in the United States at an unlikely center in Brooklyn, known as Downstate Medical Center, where he was chair of surgery. In 1978, he recruited Dr Griepp to be the chief of cardiac surgery at Downstate. Sadly, Dr Kountz died unexpectedly 6 months after Dr Griepp took the position, and Dr Griepp served...
as the interim chair of surgery for the next 2 years, despite minimal interest and training in general surgery. Presaging the widely accepted method of training today, Dr Griepp completed 6 months as the chief resident in general surgery during cardiovascular residency. He remarked that it was “a little awkward” running into the chief resident in general surgery at Downstate while taking the general surgery boards shortly after having been introduced as the new acting chief of surgery “... fortunately I passed, so it worked out all right ....”

In the years that followed, Dr Griepp developed the neonatal congenital program, establishing a competitive reference center for transposition repairs. Under his leadership, Downstate became a center of hitherto unseen excellent outcomes in adult and particularly neonatal cardiac surgery, which caught the eye of Robert Litwak, then chief of the Division of Cardiac Surgery at Mount Sinai Hospital in New York. In 1985, Dr Litwak met with Dr Griepp to see if he would be willing to help them revitalize the pediatric and congenital program. At the end of the dinner, Dr Griepp explained that the only way he would consider coming to Mount Sinai were if he were offered Dr Litwak’s job. It was a proposition, whether unexpected or not, that Dr Litwak agreed to on the spot, considering it a propitious time for a change in leadership, provided that Dr Griepp saw a role for him in the department going forward, overseeing undergraduate and resident teaching. It proved to be the beginning of a warm and collaborative working relationship for years to come.

In August 1985, Dr Griepp was first appointed chief of the division and later chair of an independent Department of Cardiothoracic Surgery. Under his leadership, the department at Mount Sinai became a robust center of clinical and academic excellence, beginning with the establishment of a
neonatal and aortic surgery program with the aid of charismatic surgeons M. Arisan Ergin, Steven S. Lansman, and visionary pediatric cardiologist Richard (Dick) Golinko, whom Dr Griepp brought with him from Downstate. They all remained lifelong clinical and research collaborators and friends. The first hypoplastic left heart syndrome and arterial switch cases in New York were performed at Mount Sinai within less than a year of his appointment. Dr Griepp’s technical mastery and leadership played a critical role in gaining the respect and, more importantly, the support from colleagues who within a year saw the neonatal and pediatric cases were going well and changed their practice, not only keeping all their patients at Mount Sinai as opposed to out of state referral but also patients began to be referred from new sources across the tristate area for pediatric and aortic surgery.

Dr Griepp actually performed the first orthotopic heart transplant at Mount Sinai before regulatory approval to do so, which resulted in a fine to the hospital, an embarrassing New York Times article, and the submission of Dr Griepp’s letter of resignation, which was not accepted. Of this scandal, Dr Griepp would later remark: “I was frankly a bit naïve to the politics of it all. I wasn’t sure exactly why we hadn’t been approved yet, but the guy needed the operation.” It was an attitude reflecting his insistence that patient care and innovation when necessary to that end came first, and politics a distant second. For the duration of his time at Mount Sinai, Dr Griepp continued to be known in the tristate area and beyond for his balanced judgment, particularly when it came to deciding whether or not to intervene surgically in cases of aortic disease. Nonetheless, he was peerless in his ability to take on ostensibly inoperable cases (often after previous cardiac surgery) and achieve favorable outcomes using unorthodox strategies.

The establishment of the animal laboratory on arrival at Mount Sinai led to a continuation of his commitment to an evidence-based approach to pushing the envelope of what is possible, and establishing which current practices truly benefit patients. Over his tenure, the Mount Sinai animal laboratory received several million dollars in continuous grant support from the National Institutes of Health, for a period of 20 years. With the aid of fellow surgeons

FIGURE 9. The Academic Program of the Inaugural Aortic Symposium held in New York, NY, in May 1988, signed by the meeting faculty members. Provided by and used with permission from the personal archive of Randall B. Griepp.
Drs Ergin, Lansman, and Spielvogel, among many others (Figure 8), Dr Griepp’s group generated translational research in cerebral and spinal circulation, physiology, and pathoanatomy that led to landmark discoveries in establishing the limits of hypothermia and the influence of perfusion flow variations in the functional physiology and metabolic integrity of the cerebrospinal parenchyma. His career’s work produced more than 400 publications that served to innovate, as well as to document, audit, improve, and disseminate new information to peers. For more than 40 years, Dr Griepp gave us answers to problems from simplifying cannulation strategy and optimizing tissue perfusion at low temperatures, to maintaining hypothermic metabolism at low-flow states and avoiding indolent changes in perfusion pressure and distribution both in proximal cerebral and distal spinal cord circulations during aortic arch and thoracoabdominal surgery. His body of work generated many of the most significant landmarks in aortic surgery: use of profound HCA, including redefining the time limit to 30 minutes (from 1 hour) at 15°C, the futility of retrograde cerebral perfusion in maintaining parenchymal metabolic substrate, and reasserting the role of antegrade cerebral perfusion. He explained the physiology of cerebrospinal cord injury in less-than-profound HCA during aortic surgery and introduced the innovative trifurcated graft technique for arch replacement. Among all the valuable collaborators on this body of work, perhaps none has been more important than his wife, Eva, a pediatric cardiologist, who set aside her own career in the early years at Mount Sinai to contribute to the editing of manuscripts and the writing of grants.

Dr Griepp was also a consummate surgeon educator. He trained 32 residents and 16 research fellows, many now leaders in their own right, to whom he transmitted his approach to training, clinical care, and research. Known to lead by example, Dr Griepp was often the busiest surgeon on the service but arrived at rounds in a 3-piece suit prepared to engage with his patients in the dignifying way he believed they deserved. He was on time, having already consumed a coffee and a Snickers bar, and expected others to be equally organized. In the tradition of his mentor Norm Shumway, he maintained a work–life balance predicated on faith in the people he had chosen to train. Dr Shumway occasionally had to be chased down on the golf course, and Dr Griepp arguably took it to a new level by spending a portion of each weekend and the whole month of August on a series of multihull sailboats. Nevertheless, he could be counted on
to take time out to discuss personal/professional difficulties as well as surgical problems, seeming always to effectively help while often saying very little.

In the tradition of Dr Litwak many years before, in 2001 Dr Griepp was instrumental in recruiting his replacement as department chair, David H. Adams, and then remained on the faculty as a trusted mentor, senior surgeon, and investigator for another decade. Primarily aiming to develop perfusion protocols to minimize spinal injury during thoracoabdominal operations, \(^{13,21}\) Dr Griepp’s research was now fueled by his contention that there cannot be a single dominant artery responsible for segmental spinal perfusion. The results of his research work led to the collateral network theory, arguably among the most predominant concepts today, that blood supply to the anterior spinal cord is not provided exclusively by a single artery but a plethoric collateral network. \(^{17,22}\)

Among his most enduring contributions to teaching was the establishment, along with Steve Lansman, of the American Association for Thoracic Surgery (AATS) Aortic Symposium (Figure 9) providing a biennial international stage to connect with peers, exchange and disseminate knowledge, and advance the field of aortic surgery. The AATS Aortic Symposium remains the largest and most important aortic meeting in the world. For his monumental contributions and unwavering commitment to advancing the field of cardiac surgery, Dr Griepp received the 2019 AATS Lifetime Achievement Award, the Association’s most prestigious honor (Figure 10). In recognition for his pioneering work during his tenure at Mount Sinai Hospital, the Icahn School of Medicine at Mount Sinai endowed the Randall B. Griepp Professorship in 2020 and awarded it to Ismail El-Hamamsy, chief of aortic surgery. Dr Griepp remained actively involved in basic science and clinical research and continued to educate and inspire until his death on September 8, 2022, at the age of 82.

In addition to his work, Dr Griepp will be remembered for his quiet confidence and ability to remain above the...

FIGURE 11. Randall B. Griepp on his beloved sailing boat Traveling Light using a marine navigational sextant to take a sun sight (measurement) at noon. Provided by and used with permission from the personal archive of Randall B. Griepp.
fray, both in the operating room and around the conference table; his commitment to bringing his skills to bear for the good of others; and his humble, elegant, and consummately skilled approach to problem solving in everything he pursued. He was deeply devoted to his extended family, and particularly his wife and life-long collaborator, Eva, and his son, Matthew, now a psychiatrist in private practice. He devoted much of his later years to family, sailing, and boat and furniture building. When he stepped down as department chair in 2002, he sailed a new 42-foot boat from South Africa back to the United States via the Caribbean (Figure 11). He cruised on his beloved boat until just weeks before his death, continuing to channel his quiet, focused, and creative enthusiasm toward the next adventure.

Quotations are from personal communications with Dr Griepp collated in preparation for his Legends Series Lectureship for the Department of Cardiovascular Surgery at the Icahn School of Medicine at Mount Sinai, presented on November 18, 2020. https://www.mitravalverepair.org/video/2020-11-18-griepplegend-series.

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