The past, present, and future of pediatric neurosurgery

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It is uncomfortable to be given an honor you feel is undeserved. It is embarrassing to accept an honor you feel is undeserved. I stand before you with both emotions, but also with gratitude for the honor, knowing I stand on the shoulders of so many others who have led our subspecialty in the past two generations of pediatric neurosurgeons, including Donald Darrow Matson.

Matson was born in 1913, the son of an army officer. He graduated from Cornell in 1935 and entered Harvard Medical School in 1939. While a medical student at Harvard, he published a paper on chronic pulmonary sepsis in the *New England Journal of Medicine*. After graduating from medical school, he undertook a 29-month surgical internship at the Brigham and Children’s Hospitals and then a fellowship in neurosurgery with Franc Ingraham until 1943. During that time, the pair wrote the classic paper, “Subdural Hematomas in Infancy,” which was published in the *Journal of Pediatrics*. Matson served in the army in Europe during World War II for 3 years, returned to Boston to join Dr. Ingraham, and worked with him as a research fellow in neurosurgery. He gained experience in hydrocephalus, craniosynostosis, and nerve regeneration as well as the use of polyurethane tubing, a precursor to shunts. He then served as a neurosurgery resident at Duke University Hospital, the Children’s Hospital in Boston, and Peter Bent Brigham hospital and was a fellow in neurosurgery at the Lahey Clinic. He rejoined Dr. Ingraham in 1948, and the two were partners for years. In 1954, they published the first pediatric neurosurgery textbook, *Neurosurgery of Infancy and Childhood*. When Ingraham retired in 1964, Matson succeeded him. He was a leader in several neurosurgical societies and president of the Harvey Cushing Society (1968–1969). He died in 1969 at the age of 55 during the height of his career, of an illness thought initially to be periarteritis nodosa but later determined to be Creutzfeldt–Jakob disease. In a memorial article published in the *Journal of Neurosurgery*, he was described as “a devoted husband and father, a warm and gratifying friend, a superb surgeon, a competent scientific investigator, a literary man in the field of medicine, an articulate spokesman for neurosurgery, and a teacher of men.” Thus, I do feel uncomfortable standing here.

I want to begin my lecture by giving thanks—thanks professionally to Don Reigel, who developed the pediatric neurosurgery department at the Children’s Hospital of Pittsburgh and introduced me in 1974 to the joy of caring for children with neurosurgical disorders; to Peter Jannetta, who offered me the position as chief of pediatric neurosurgery in 1991 and allowed me to develop it into the program I wanted it to be; and to my partners, Ian Pollack and David Adelson, who have been all I could have asked for in collegiality, collaboration, productivity, and the joy of working together. Personally, I thank my daughter Julie, my son Todd, and my wife Elizabeth for their love and support, for being willing to give up much of me so that I could do this work. Lastly, spiritually, I thank God for the privilege of being a pediatric neurosurgeon. In religious terms, it is a blessing—a gift from God—to be able to do this work.
This afternoon, I would like to ponder three questions: where we were, where we are, and where we should go? I want to consider where we were in 1978 when I finished my neurosurgery residency, where we are now, 25 years later, and where we should be 25 years from now. We will consider three generations of pediatric neurosurgery, defining a generation as 25 years: the generation before 1978, the generation between 1979 and 2004, and the succeeding generation between 2005 and 2029.

Where Were We?
Pediatric neurosurgery was in its infancy in the generation that ended in 1978. At the start of that generation in 1953, there may have been only two pediatric neurosurgeons, Frank Ingraham and Donald Matson. By the end of the generation there were approximately 28 full-time pediatric neurosurgeons, contributors to the edition of Pediatric Neurosurgery/Surgery of the Developing Nervous System. The Pediatric Section of the American Association of Neurological Surgeons had been founded and included 75 members.

Pediatric neurosurgery fellowships were developed during that generation. In 1953, there was a so-called fellowship at the Boston Children’s Hospital, in which fellows functioned “like supernumerary residents,” to use Robin Humphrey’s term. By 1978 there were about five sustained fellowships—in Boston, Toronto, Philadelphia, Chicago, and Los Angeles.

Technologically, diagnostic tests evolved during that period, from ventriculography to angiography to CT scanning, which was introduced in the mid-1970s. The first shunt had been invented by Nulsen and Spitz in 1951. By 1978, shunts had become state-of-the-art systems such as the Raimondi Uni-shunt, which was wire reinforced with a distal slit valve. Because it had no barium in it, it never became calcified or brittle, but because of the wire reinforcement, it perforated the abdominal wall and all of the hollow abdominal viscera at one time or another. The operating microscope was introduced in the mid-1960s and binocular microscopes were in use by 1978.

At pediatric neurosurgery meetings authors presented case reports, retrospective case series, and an occasional clinical or laboratory investigation. In 1978 members at the pediatric section meeting discussed topics such as CSF antibiotic levels in treating shunt-related infections, the value of CT scanning in diagnosing arachnoid cysts, and the quality of survival in patients with cerebellar astrocytomas. Virtually every paper presented was either a retrospective case series or a technical note. Parenthetically, only four of the 10 papers presented during that meeting were subsequently published—one of the few characteristics of pediatric neurosurgery in 1978 that is still true.

The vast majority of pediatric neurosurgery manuscripts published during that generation were similar to the presentations themselves: either single case reports or retrospective case series; however, this form of increasing medical knowledge was probably appropriate during that era.

I believe that one highlight of that generation occurred in its final year, with the founding of the ASPN. The organization was founded by 16 neurosurgeons who established standards for pediatric neurosurgeons. They were committed to “advancing the development of pediatric neurosurgery through laboratory and clinical research,” impressive foresight as to how we should advance our field. In 1985, I declined an invitation to join the ASPN. I thought it was too cliqueish, too expensive, and too weak academically; papers presented at the annual meetings and published subsequently in Concepts in Pediatric Neurosurgery were not peer reviewed. There was some truth to each of those criticisms, but they did not undermine the fundamental thrust of the organization: to define pediatric neurosurgeons and to contribute to the development of pediatric neurosurgery by clinical and laboratory research.

Such was the climate in 1978 when I began practice in pediatric neurosurgery; there were approximately 28 full-time pediatric neurosurgeons, five fellowships, clinical series involved retrospective data, first-generation CT scanners had been introduced, and the political organization was in its infancy.

Where Are We?
Between 1979 and 2004, the number of full-time pediatric neurosurgeons increased from 28 to approximately 135. The field grew from five unaccredited fellowships to 22 accredited fellowships in 2004 (more than the number of applicants for fellowships).

Politically, pediatric section membership increased from 75 to 316. This second generation has been characterized by the maturation and expansion of the ASPN to include most of the active pediatric neurosurgeons in the US and Canada. The American Board of Pediatric Neurosurgery was developed to provide formal credentials for pediatric neurosurgeons. Accredited pediatric neurosurgery fellowships were developed. By 2003 we witnessed the decision to require reaccreditation in pediatric neurosurgery as well as the development of the means by which to enforce this process; in so doing, we became the first neurosurgical subspecialty to require reaccreditation.

Technological changes have been vast, most being unimaginable at the start of the decade. We went from CT scanning to MR imaging to functional MR imaging to MR spectroscopy; from binocular microscopes to ceiling-mounted, stereotactically coordinated microscopes with binocular vision for two observers and the capacity to obtain digital photographs and videos. Shunt technology evolved from the Raimondi Uni-shunt to antibiotic-impregnated, programmable shunt systems with built-in anti-phon devices. Another development, the ultrasonic surgical aspirator, has allowed the removal of tumors in the basal ganglia and spinal cord. Endoscopes were developed, permitting the widespread treatment of hydrocephalus with endoscopic third ventriculostomy. Arteriovenous malformations are now often obliterated using stereotactic radiosurgery, avoiding craniotomies. Baclofen pumps, vagal nerve stimulators, and DBS were developed. We expanded our clinical practice to include disorders rarely treated in 1978—brachial plexus injuries, spasticity, dystonia, and intractable seizures.

The quality of presentations at national meetings improved. In 1982, I gave a lecture at the pediatric section meeting in Toronto entitled, “How to Prepare and Present a Medical Lecture.” I used approximately 300 slides that were shown from two racks of projectors, with three projectors in each rack and each rack focused on a separate