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## Building a Career as a Pediatric Stroke Neurologist

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**P**ediatric stroke neurology has emerged as a distinct field over the last 15 years. In 2003, Dr Gabrielle DeVeber and a small, international group of child neurologists started the International Pediatric Stroke Study, a prospective, multicenter registry for neonates and children with ischemic stroke.<sup>1</sup> At that time, the pediatric stroke literature consisted primarily of single-hospital series, case reports, and a handful of analyses using large administrative databases. Hematologists had a greater interest in pediatric stroke than neurologists, publishing numerous studies of genetic thrombophilias as potential stroke risk factors and sickle cell disease as an extraordinarily strong stroke risk factor.<sup>2,3</sup> To date, the only randomized clinical trials in the pediatric stroke field are sickle cell disease trials, demonstrating the efficacy of blood transfusion therapy in select patients for prevention of stroke and silent infarction.<sup>4-6</sup>

Since 2003, the International Pediatric Stroke Study has published dozens of original manuscripts, and investigators worldwide have made notable contributions to literature, organized to identify research priorities, and collaborated to publish national consensus-based clinical guidelines (in Australia, the United Kingdom, and the United States).<sup>7-9</sup> This body of work has established many unique facets of pediatric stroke: from distinct etiologies like focal cerebral arteriopathy, a presumed inflammatory disease rarely seen in adults; to stroke syndromes unique to infants, like presumed perinatal ischemic stroke which presents with pathological early handedness. However, this expansion in knowledge has created a greater need for subspecialization in pediatric vascular neurology. Published clinical guidelines have created new implementation challenges. Recent adult stroke thrombectomy trials have further increased the need for child neurologists with stroke expertise; every children's hospital is now scrambling to decide when to offer thrombectomy to children and create local hyperacute stroke protocols. Academic opportunities to address what are many pressing clinical questions are abundant with large grants being earned, diverse research programs and networks thriving across the globe, strong mentorship for junior investigators within these networks, and publications increasing exponentially. Now is a fantastic time to join the field of pediatric stroke.

### How Can a Child Neurologist Train in Pediatric Stroke?

A standard approach to pediatric stroke training does not exist. In the early 2000s, most pediatric stroke experts self-trained simply by starting pediatric stroke programs and studying and contributing to the literature. Today, a number of pediatric stroke fellowship opportunities are available. In the United States, the Accreditation Council for Graduate Medical Education (ACGME) is the physician-led organization that sets standards for medical training programs. Child neurologists interested in stroke have 2 following options: (1) completing a formal, ACGME-accredited Vascular Neurology fellowship, offered to adult and child neurologists; or (2) completing an informal pediatric stroke fellowship that is not ACGME-accredited. These options have distinct advantages and disadvantages. ACGME-accredited vascular neurology fellowships have an external body providing oversight, setting training requirements, and generally ensuring high-quality training. Trainees are eligible for board-certification in Vascular Neurology by the American Board of Psychiatry and Neurology. The training is heavily clinical and adult-focused: arguably appropriate given that much of pediatric stroke care extrapolates from adult stroke literature. However, trainees spend less time caring for pediatric patients and interacting with pediatric stroke experts and generally have less time for research. The informal fellowships tend to be focused entirely on pediatrics. Because of the inherently lower volume of pediatric versus adult stroke patients, they provide a less intense clinical experience, but allow more time for research. A typical American pediatric academic center sees 1 to 4 new acute ischemic stroke cases per month. Because half of childhood strokes are hemorrhagic, programs that engage pediatric stroke neurologists in the care of cases of intracerebral, intraventricular, or subarachnoid hemorrhage provide a stronger and more diverse clinical experience.

On a per capita basis, Canada has probably trained the largest number of pediatric stroke specialists, thanks primarily to the seminal fellowship program established at the Hospital for Sick Children in Toronto. However, while the Canadian system has rigorously regulated credentialing

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processes for child neurology and adult stroke, formal accreditation does not yet exist for pediatric stroke. For similar reasons to those noted above, current Canadian pediatric stroke fellowships remain academically oriented, usually combining clinical training with a large research component. On the clinical side, fellowships are structured according to established Residency Training Program Criteria (CanMEDS) while research training often includes completion of formal graduate degrees such as a Masters of Science in Clinical Epidemiology.

In Europe, even pediatric neurology training differs from country to country—in some countries via a basic training in pediatrics in others via neurology. In a few European countries, such as the United Kingdom, pediatric neurology is an independent subspecialty. Considering these different approaches for training in neuropediatrics, training in cerebrovascular disorders also differ. For some, basic training in cerebrovascular disorders is included in the general neuropediatric training, while others have training in this special field during their training of adult neurology. Many Europeans working in the field of pediatric cerebrovascular disorders did get their knowledge by clinical practice, research, and international meetings. In general, only large centers as Great Ormond Street in London or University Hospitals in Munich offer formal fellowships in pediatric cerebrovascular problems. Most Europeans heading for this subspecialty decide to take positions in large hospitals known for their experience in pediatric cerebrovascular disorders. The majority also decides to do part of their training outside their home country, in other European or North American centers offering formal training options in cerebrovascular disorders. The European mentality is that training abroad broadens your experience in a different way than home-based training and gives you the opportunity for international contacts and future collaborations.

In Australia or New Zealand, accredited pediatric stroke fellowships do not currently exist. Child neurologists interested in pursuing a career in pediatric stroke could seek informal training in an adult neurovascular program, but such opportunities are limited and are only available on an ad hoc basis. As a consequence, trainees are forced to seek fellowship opportunities in North American pediatric stroke programs. The personal and financial challenges associated with relocation to an overseas center are far outweighed by the benefits of training in structured pediatric neurovascular program and opportunities to establish long-lasting collaborations within multinational pediatric stroke research networks.

### Questions to Ask When Evaluating Pediatric Stroke Fellowship Options:

1. Is this an ACGME-accredited program that will make me eligible for the Vascular Neurology boards? (Relevant to United States programs only.)
2. Would I see just children, or also adults? How about neonates? (At some centers, neonates with stroke are primarily cared for by neonatal neurologists.)
3. Would I see just ischemic strokes, or also hemorrhagic strokes? (At some centers, hemorrhagic strokes are primarily managed by neurosurgeons.)

4. How much of my time would be dedicated to clinical work versus research?
5. How will this experience enable me to establish or grow a new pediatric stroke center in the subsequent stages of my career?
6. What is the quality of the mentorship I would receive in terms of clinical care and research?
7. What exposure would I have to multidisciplinary teams including diagnostic and interventional radiologists, neurosurgeons, intensivists, physiatrists, and hematologists?

### How Can a Child Neurologist Have a Career in Pediatric Stroke?

While adult vascular neurologists can easily have a full-time clinical practice focused entirely on neurovascular disease, pediatric vascular neurologists typically need to combine their stroke clinical practice with something else, whether other clinical work (including neuro-critical care) or research. Obtaining the funds to buy out clinical time can be challenging, but young child neurologists can benefit from early career awards, like Child Neurology Career Development Program (<http://www.cncdp-k12.org/>) funded by the National Institutes of Health in the United States. Pediatric stroke clinician scientist positions can now be found around the world though the models differ by country or even institution.

All child neurologists aiming to build careers in pediatric stroke should recognize the importance of multidisciplinary clinical programs. Children with cerebrovascular disease often need the expertise of neurosurgeons, neuro-interventional radiologists, hematologists, neuropsychologists, physiatrists, and physical, occupational, and speech therapists. Anxiety and depression are common in this population, creating additional needs for mental health providers. Patient-centered programs with direct collaboration among the necessary experts help ensure the needs of the individual child are appropriately met. Some countries with national health systems, like the United Kingdom, have formalized this approach.<sup>10</sup>

### What Are the Most Pressing Research Topics in Childhood Stroke?

With the success of adult stroke thrombectomy trials, the question of whether to offer thrombectomy to children with large artery occlusion has become a pressing issue subject to much heated debate. Another top priority, identified through a Delphi consensus process, is to determine whether high-dose corticosteroids improve the outcomes of children with focal cerebral arteriopathy.<sup>10</sup> Multicenter studies for both topics are under development. The recent American Heart Association Scientific Statement on pediatric stroke reviews the current state of the literature and identifies numerous knowledge gaps.<sup>7</sup> The field remains in need of new investigators willing to tackle the challenges of studying a rare disease. With very few prevention strategies and lifelong morbidity suffered in most survivors, the plastic brains of children with stroke bring exciting opportunities to advance novel neurorehabilitation research.

## How Can I Get Involved in the Pediatric Stroke Community?

Join the new International Pediatric Stroke Organization! Incorporated in 2019, this nonprofit organization (501c3) will serve as a global society for all health professionals and scientists interested in stroke and cerebrovascular disease in infants and children. Its mission is to improve the lives of children with stroke through research, education, and advocacy. Its website includes resources like training opportunities.<sup>11</sup>

### Disclosures

The authors are founding members of International Pediatric Stroke Organization. Dr Jordan received professional fee as a medical expert for a legal testimony.

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