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Building a Pediatric Neurocritical Care Program: A Multidisciplinary Approach to Clinical Practice and Education from the Intensive Care Unit to the Outpatient Clinic

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We describe our 10-year experience developing the Ruth D. & Ken M. Davee Pediatric Neurocritical Care Program at Northwestern University Feinberg School of Medicine. The neurocritical care team includes intensivists, neurologists, and an advanced practice nurse who have expertise in critical care neurology and who continue care in long-term follow-up of intensive care unit patients in a dedicated neurocritical care outpatient clinic. Brain-directed critical care requires collaboration between intensivists and neurologists with specific expertise in neurocritical care, using protocol-directed consistent care, and physiological measures to protect brain function. The heterogeneity of neurologic disorders in the pediatric intensive care unit requires a background in the relevant basic science and pathophysiology that is beyond the scope of standard neurology or critical care fellowships. To address this need, we also created a fellowship in neurocritical care for intensivists, neurologists, and advanced practice nurses. Last, we discuss the implications for pediatric neurocritical care from the experience of management of pediatric stroke and the development of stroke centers.

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Introduction

There have been a number of reports and position articles on the practice of pediatric neurocritical care or inpatient neurology at academic medical centers in the United States[1-6] and recent proposals on the training required for a pediatric neurointensivist.[3,7-9] Here we describe our specific 10-year experience developing the Ruth D. & Ken M. Davee pediatric neurocritical care program at Northwestern University Feinberg School of Medicine, including long-term follow-up of intensive care unit (ICU) patients in a dedicated neurocritical care follow-up clinic. We describe the design of our fellowship program in neurocritical care for intensivists and neurologists and the rationale for this approach. Last, we discuss the implications for neurocritical care from the experience of management of pediatric stroke and the development of stroke centers.[10-13]

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Published Experience of Pediatric Neurocritical Care in the United States

The models of pediatric neurocritical care reported to date are from Children's National Medical Center (CNMC)[1] and the Boston Children's Hospital Pediatric Critical Nervous System Program.[2,3] Both share common features, which are distinctly different from the practice of adult neurocritical care.

The CNMC group was multidisciplinary and comprised an intensivist, neurologist, and 3 pediatric neurosurgeons.[1] The decision to involve this team in particular cases was at the discretion of the critical care service. Importantly members of this service were relieved of other duties for part of the day to evaluate ICU consults. In addition to providing expert and consistent care, this team established guidelines for the management of common ICU neurologic diseases, ensured a consensus with other specialties for their use, and introduced multiple new brain monitoring techniques. They combined these clinical initiatives with a quarterly teaching conference.

The Boston Children's service uses a rotating group of pediatric neurology attending physicians, also exempted from other clinical duties during the 2-week block of service.[2] Again, the request for neurocritical care involvement is at the discretion of the attending intensivist. In contrast to the CNMC model, the Boston neurocritical care service comprises only neurologists, but each neurologist has a subspecialty expertise (epilepsy, neurovascular, neuromuscular, behavioral, or neonatal) relevant to neurocritical care.[3]

Between these published data and our own experience (Table 1), there are common themes. The successful clinical practice of pediatric neurocritical care requires a close collaboration between neurologists and intensivists. The neurologists must have a certain level of subspecialty training relevant to acute brain insults. The neurocritical care team requires protected time to allow rounds in the ICU, which may be lengthy, and to allow time to evaluate often highly complex patients. With a dedicated team, protected time, and collaboration with the intensivists, care can then be consistent and follow specific protocols.

Structure of the Lurie Children's Hospital Davee Neurocritical Care Program

Ann & Robert H. Lurie Children's Hospital of Chicago is a 288-bed institution located on the campus of the Northwestern University Feinberg School of Medicine. In 2013, the total number of admissions to the hospital was 11,500. The ICUs comprise a 40-bed pediatric ICU (PICU) and 36-bed cardiac intensive care unit (CICU), in addition to a 44-bed neonatal ICU. The average annual number of PICU

Table 1 Essential and Ideal Components of a Pediatric Neurocritical Care Program

Organization	ICU Care	Follow-up Care	Education	Administration and Support
Multidisciplinary team of neurologist (s) and intensivist(s)	Protocol-driven care	NCC team follows patients in hospital after leaving the ICU	Create a culture of brain-directed critical care	Department or hospital support or both, recognizing the need to protect team members time
Specialty-trained APN with expertise in NCC	Iterative modification of care practices based on outcome data		Training rotations in NCC for fellows in critical care, psychiatry, and anesthesia	
Protected time for the NCC service	Involvement of bedside nurses	Dedicated NCC follow-up clinic	Training rotation in NCC for APNs	Data collection for all patients used to link long-term outcome to ICU care and to modify practice
Joint rounds with critical care	Internal guidelines based on best available preclinical and clinical research		Weekly NCC teaching conference and joint conference with adult stroke and NCC teams	
Stable NCC team for consistency of care	Use of all available monitoring tools (e.g., NIRS, pupillometry, optic nerve ultrasound, and brain tissue oxygen monitoring)	Staffed with neurologist, intensivist, physiatrist, and APN	Monthly NCC teaching conference	Participation in multicenter studies
Responsible for Neonatal, Cardiac, and Pediatric ICUs	24/7 EEG monitoring with interpretation by the NCC service	Outcome measures collected for all patients	Emphasis on the integration of ICU neurologic examination with fundamental cellular mechanism of cerebral injury	Emphasis on publication and sharing of experience and protocols

NCC, neurocritical care; NIRS, near infrared spectroscopy; APN, advanced practice nurse.