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## VIEWPOINT

# Neonatal Neurocritical Care Training—The Time Has Come

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**Neonatal neurocritical care** is a rapidly evolving interdisciplinary subspecialty that provides complex diagnostic testing, gestational age-directed neuromonitoring, and prognostication required to care for neurologically compromised maternal/fetal dyads, preterm or term neonates, and developing children after discharge from the neonatal intensive care unit (NICU). As evidenced by the significant increase in critically ill neonates admitted to NICUs across the United States and the persistent population of infants with neurologic sequelae of in utero and perinatal disorders, there is growing urgency to improve and standardize strategies for monitoring, detecting, and preventing brain injury in newborns of all birth weights and gestational ages. There is, in addition, a pressing need to address previously unrecognized populations requiring neonatal neurocritical care: fetuses with genetic, metabolic, and infectious diseases leading to secondary structural disorders, neonates with congenital heart disease, and those with epileptic encephalopathies, neuromuscular, and other neurogenetic disorders. Despite growing recognition of these demands, there has been no formalized identification of core competencies in this rapidly growing subspecialty nor standardization of training for those who provide this highly specialized care. Subsequently, the call for formal specialty training in neonatal neurocritical care is now loud and clear.

## Clinical Data and Literature Suggesting an Urgent Need for Neonatal Neurocritical Care

There were 3 591 328 live births in the United States in 2023.<sup>1</sup> Among these deliveries, approximately 10.5% were born preterm, 11 000 experienced hypoxic ischemic encephalopathy, and increasing numbers of infants were diagnosed with genetic disorders requiring precision treatments. An estimated 13% to 15% of children were admitted to NICUs across the United States, as many as 25% of those required neurologic consultations, and almost all were deemed at risk for neurodevelopmental disability.<sup>2</sup> However, despite significant advances in perinatal and neonatal medicine, rates of adverse outcomes for these infants remain unacceptably high. More specifically, the incidence of high-grade intraventricular hemorrhage in preterm infants has not changed across the past 10 years, 30% to 50% of all infants with hypoxic ischemic encephalopathy either die or manifest neurodevelopment disorders by age 2 years despite being treated with therapeutic hypothermia, and the availability of transformative genetic sequencing and precision medicine approaches has yet to reach all NICUs providing neurocritical care for the most vulnerable neonatal patients (E. Edwards, [MD?], Vermont Oxford Network Database of Very Low Birth Weight Infants, written communication, [month year]).<sup>3,4</sup>

In contrast, review of the published literature and NIH REPORTER demonstrate that there have been more than 25 000 peer-reviewed research articles related to the newborn brain, more than

5000 National Institutes of Health (NIH)-funded grants dedicated to this topic, a growing number of brain-focused care protocols, new consensus statements, and multiple clinical practice guidelines across the past decade. More than 20 publications have called for formal training in neonatal neurocritical care, and a recent survey of members of the Newborn Brain Society and the Neonatal Neurocritical Care Special Interest Group demonstrated overwhelming support for translating published training competencies, existing expertise, and infrastructure across centers into a standardized curriculum for neonatal neurocritical care.<sup>5</sup> Among 82 institutional responders from 30 countries, 42% reported having a neonatal neurocritical care service. However, only one-third reported formal training in neonatal neurocritical care, 81% affirmed significant variability among training pathways, and 88% were in favor of both standardized training programs and accreditation for neonatal neurocritical care. Critically, the increasing trend toward family-centered care in NICUs across the United States has also prompted parents to request the highest levels of care for their critically ill preterm and term-born infants.

## Evidence Demonstrating the Efficacy of Specialized Neurocritical Care

Both intraventricular hemorrhage and white matter injury are common in prematurely born infants. Preventive neonatal neurocritical care-driven approaches, including timing of cord clamping, monitoring of blood gases, conservative resuscitation strategies, and continuous assessment of cerebral oxygenation, all improve outcomes in this vulnerable population.<sup>3</sup>

Neonates with hypoxic ischemic encephalopathy have also benefitted from neonatal neurocritical care. For infants with moderate to severe hypoxic ischemic encephalopathy born at an outside hospital, pediatric specialized transport teams result in improved outcomes, as does institution of therapeutic hypothermia before transport.<sup>3</sup> Furthermore, implementation of a comprehensive neonatal neurocritical care service has been associated with decreased brain injury and shortened hospital stays for all neonates with moderate to severe hypoxic ischemic encephalopathy.<sup>3</sup> Similarly, neonatal neurocritical care has been associated with both improved seizure detection and decreased administration of antiseizure medication at discharge in patients of all gestational ages.<sup>6</sup> Finally, the addition of sophisticated genetic testing to the neonatal neurocritical care armamentarium offers the promise of earlier diagnosis, targeted prenatal and perinatal care, and postnatal treatment strategies for neurologically compromised fetuses, as evidenced by those neonates with spinal muscular atrophy and mitochondrial disease.<sup>4</sup>

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## Multidisciplinary Collaboration a Critical Part of Neonatal Neurocritical Care

Unique among pediatric fellowships, neonatal neurocritical care trainees include neonatologists, pediatric neurologists, and developmental pediatricians, groups with diverse educational backgrounds. All require dedicated training in the same core curriculum of neonatal critical care, fetal neurology, and neurodevelopment. All must also acquire comprehensive knowledge in the diagnosis and management of neurological conditions affecting neonates, including (1) genetic, metabolic, infectious, and environmental disorders of fetal development; (2) those resulting from preterm birth; (3) perinatal brain injury; (4) genetic, metabolic, and neuromuscular disorders; (5) those attributable to systemic disorders ranging from congenital heart disease to necrotizing enterocolitis; and (6) neurodevelopmental sequelae that manifest in children in NICU follow-up clinics. To accomplish these goals, trainees will necessarily work with multidisciplinary experts across specialties that include genetics, neurophysiology, neuroradiology, neurosurgery, neuropathology, psychiatry, palliative care, and maternal-fetal medicine. With this in mind, a Task Force of Newborn Brain Society members was convened in September 2021, they applied to the United Council for Neurologic Subspecialties for formal accreditation of neonatal neurocritical care fellowship training, and their was application approved in 2022, with fellows having begun training in July 2024 to usher in a new era of neonatal neurocritical care training.

## Optimizing Care for the Most Vulnerable Patients and Their Families Through Neonatal Neurocritical Care Training

Sixty years after the first NICU opened in the United States and almost 4 decades after Joseph Volpe's proclamation that neonatal neurology demands the attention of practitioners, neuroscientists, and parents alike, formalized training that will produce standards of professional excellence in neonatal neurocritical care has arrived. Building on this foundational work, future plans include a network of accredited sites to facilitate rigorous review and implementation of quality improvement-driven clinical protocols and standardized collection of data to enable disease discovery, identify emerging trends in fetal and neonatal disorders, and promote earlier targeted intervention for neurogenetic and neuromuscular disorders. Relatedly, this combination of common data elements, care protocols, and network infrastructure will support facile generation and implementation of data-driven hypotheses and multicenter randomized clinical trials that leverage new therapeutics and neuromonitoring, neuroimaging, and genetic technologies to advance neonatal neurocritical care. Finally, regular program director meetings will facilitate consistent collaboration and learning across accredited programs, leading to growth and innovation in neonatal neurocritical care-related educational activities across clinicians and disciplines, all in the service of advancing brain-focused care and improving outcomes for patients and their families.

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