

Children with stroke need the ICU too

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Despite the often-heard phrase, “children do better than adults” with stroke, increasing amounts of data suggest that children may be quite ill after an acute stroke and may be left with lifetime disabilities.^{1,2} Multiple outcome studies have demonstrated that between 40% and 60% of child survivors of ischemic stroke have significant residual neurologic impairments including epilepsy,^{3,4} hemiparesis,³ cognitive deficits,^{5,6} and reduced quality of life.⁵ When stroke affects the developing brain, some impairments may only become evident with maturation, as the child progresses in school and faces greater cognitive and behavioral demands.⁶ While outcome after childhood stroke has been increasingly studied, there have been fewer studies on the relationship between acute medical requirements and short-term outcome after stroke.

In this issue of *Neurology*®, Fox et al.⁷ present a retrospective cohort study of critical care usage in non-neonatal pediatric stroke with data from Kaiser Permanente of Northern California from 1993 to 2003. Their objective was to determine rates and predictors of critical care utilization in children; specific outcomes were admission to the intensive care unit (ICU), intubation, and surgical decompression. Within a population of 2.3 million children, 256 childhood stroke cases (132 hemorrhagic and 124 ischemic) were identified. The range of stroke severity in children is striking. While 62% were admitted to the ICU, 22 children (9%) were not admitted at all, primarily those with delayed presentation with stroke. Of the 62% of the children admitted to the ICU, 32% were intubated and 11% were treated with decompressive neurosurgery, with the highest rates among children with hemorrhagic stroke. Younger age and altered mental status at presentation were independently associated with ICU admission. When children already in the ICU at the time of stroke were excluded, lack of a premorbid diagnosis (such as cancer or complex congenital heart disease) was associated with higher rates of ICU admission.

Neurologic deficits at discharge were documented in 57% and were less common after hemorrhagic than ischemic stroke: 48% vs 66% (odds ratio 0.5, 95% confidence interval 0.3–0.8). Case fatality was 4% overall—7% among children admitted to the ICU—and was similar between ischemic and hemorrhagic stroke.

The acute phase after stroke is particularly important in children because they appear to be at higher risk for developing increased intracranial pressure. As Fox et al.⁷ point out, most pediatric strokes are large vessel, not lacunar; children rarely have cerebral atrophy, so there is usually no “extra room” to accommodate swelling after a stroke; and children have a higher proportion of hemorrhagic strokes than do adults.

The rate of ICU admission reported in children with stroke is remarkably similar to the 63% of adults with stroke who are admitted to the ICU.⁸ Different factors seem to lead to ICU admissions in children and adults, however, in part because children and adults have different types of strokes and stroke risk factors. While both children and adults with stroke who are admitted to the ICU tend to be younger, ICU-admitted children are more likely to have hemorrhagic stroke and have no premorbid conditions, while ICU-admitted adults with stroke tend to have ischemic stroke and have premorbid conditions such as hypertension.⁸

Limitations of this work include the unavailability of detailed neurologic outcome data. The time period of this study, 1993–2003, may reflect older care practices compared to what is done in 2012. The authors appropriately point out that while few children with ischemic stroke had hemicraniectomy in this study, the frequency of hemicraniectomy might be different today, now that we have data from adult stroke literature suggesting benefit from the procedure. Finally, the authors provide data on the frequency of hemicraniectomy, but there are no data on the frequency of elevated intracranial pres-

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sure (ICP) or need for ICP monitoring in children with stroke.

These days, debate over health care financing is common, with cost becoming an increasingly important outcome. ICU admission is expensive and presumably drives up the price of a stroke admission. Based on the KIDS Inpatient Database in 2003, the cost of acute inpatient pediatric stroke care in the United States was estimated at \$42 million for 2,224 children with stroke.⁹ In a study of medical costs in neonatal and pediatric stroke in a managed care organization (also Kaiser Permanente of Northern California from 1996 to 2003), the average cost of a childhood stroke admission in 2003 dollars was \$81,869.¹⁰ The average adjusted 5-year acute and chronic health care costs for pediatric stroke in the this study were substantial: \$135,161 per child; stroke accounted for 93.5% of the total health care costs in these children, and increased the total health care costs 15-fold compared to stroke-free controls.¹⁰ Perhaps more important, there are substantial unmeasured long-term costs associated with stroke in children, who have more years of potential post-stroke survival than adults. With a high rate of persistent neurologic deficit and disability after stroke, it is difficult to estimate the potential lifetime cost of disability in a child.

Adult studies suggest that in some cases ICU care improves long-term outcome after stroke.^{11,12} The next steps in pediatric stroke research will be studies that examine both short- and long-term outcomes, and determine which critical care interventions have lasting benefit, and for which patients.

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