Neuroprotective Strategies Beyond Hypothermia and the Effect of Early Rehabilitation After Cardiac Arrest

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Background

In the last decade there has been a growing body of literature for the use of early rehabilitation and medical therapies beyond therapeutic hypothermia (TH) to improve neurodevelopmental outcomes. Evidence has shown that infants with congenital heart disease are at significant risk of neurodevelopmental delays. Post-cardiac arrest brain injury is a leading cause in morbidity and mortality in children. We report a case after cardiac arrest and describe our institutional post-cardiac arrest care (PCAC) protocol.

Case Description

This was a seven-week-old, full-term female with ventricular septal defect (VSD) associated congenital heart failure (CHF) and atrial flutter (AF). Patient was taken to the cardiac catheterization lab for a VSD device closure; however, the procedure was aborted after two episodes of cardiac arrest due to associated ventricular tachycardia which were followed by two additional episodes in the Cardiothoracic Intensive Care Unit (CTICU). An initial electroencephalogram (EEG) showed a moderate degree of encephalopathy and a PCAC neuroprotective protocol was started including hypothermia 32-33 C° for 48-72 hours with slow rewarming 0.2-0.4 C°/hr, dexmedetomidine 0.5-1 mcg/kg/hr, erythropoietin 2000 u/kg/day x five days, continuous EEG, and early rehabilitation interventions (physical, occupational and dysphagia therapy). Use of amantadine after one to two weeks was considered, but was not indicated.

Outcomes

Figure 1 shows the Glasgow Coma Scale (GCS) trajectory. At the time of PCAC initiation, GCS was four. On day three of PCAC, she developed deconjugated gaze and a head ultrasound revealed possible thalamic bleed with worsening encephalopathy on EEG. By day five, GCS was 11 and by day seven was 15.

Figure 2 shows in detail the early and gradual escalation of rehabilitation services. Patient was extubated on day 13, and on day 26 had VSD surgical repair.

Outcomes (Continued)

At four months old, she discharged home without supplemental nutrition or oxygen. She was assessed using the Developmental Assessment of Young Children (DAYC-2). Her General Development Index (GDI) was found to be below average (***Figure 3***), and she was referred for weekly outpatient rehabilitation. At 12 months of age, she demonstrated age-appropriate neurodevelopmental skills, GDI was found to be average (***Figure 4***). At 18 months of age, she was found to have regression in her language skills however overall, her GDI was average (***Figure 5***). She was referred for speech therapy.

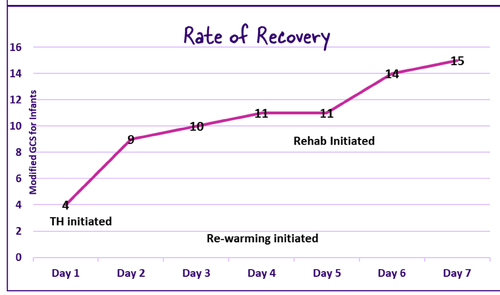

Figure 1

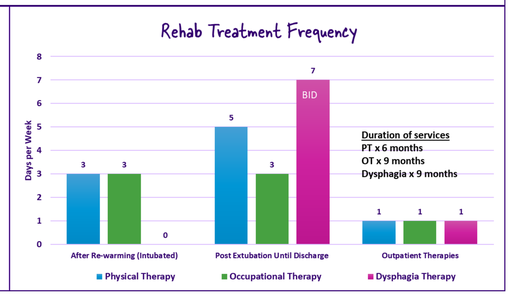

Figure 2

Developmental Assessment of Young Children – 2nd Edition			
Domain		**Percentile Rank**	**Description**
Cognitive		7th	Poor
Communication		30th	Average
Subdomain	Receptive language	37th	Average
	Expressive Language	25th	Average
Social-Emotional		45th	Average
Physical Development		25th	Average
Subdomain	Gross Motor	30th	Average
	Fine Motor	23rd	Below Average
Adaptive Behavior		23rd	Below Average
GENERAL DEVELOPMENT INDEX		**16th**	**Below Average**

Figure 3. Discharge at four-months-old.

Developmental Assessment of Young Children – 2nd Edition			
Domain		**Percentile Rank**	**Description**
Cognitive		66th	Average
Communication		39th	Average
Subdomain	Receptive language	34th	Average
	Expressive Language	50th	Average
Social-Emotional		58th	Average
Physical Development		63rd	Average
Subdomain	Gross Motor	70th	Average
	Fine Motor	47th	Average
Adaptive Behavior		27th	Average
GENERAL DEVELOPMENT INDEX		**50th**	**Average**

Figure 4. Outpatient Re-assessment at 12 months.

Developmental Assessment of Young Children – 2nd Edition			
Domain		**Percentile Rank**	**Description**
Cognitive		37th	Average
Communication		13th	Below Average
Subdomain	Receptive language	9th	Below Average
	Expressive Language	18th	Below Average
Social-Emotional		50th	Average
Physical Development		53rd	Average
Subdomain	Gross Motor	66th	Average
	Fine Motor	37th	Average
Adaptive Behavior		47th	Average
GENERAL DEVELOPMENT INDEX		**30th**	**Average**

Figure 5. Outpatient Re-assessment at 18 months.

Discussion/Conclusion

Due to her prolonged hospitalization, she was able to benefit from daily rehab intervention for two months prior to discharge, which may have contributed to her long-term neurodevelopmental outcomes. Other standardized assessments could be used such as the HINE to specifically address neuromuscular recovery.
The patient had also undergone developmental assessment in a high-risk infant program using the BAYLEY III. Her outcomes track along with her DAYC-2 results. These outcomes support the need for ongoing outpatient neurodevelopmental monitoring as the patient was exhibiting good progress however required speech therapy evaluation at 18 months.

Clinical Implications

This case supports the need for early aggressive intervention including hypothermia with rehabilitation therapies. Pediatric patients with congenital heart defects have been shown to have a pattern of neurodevelopmental and behavioral impairment characterized by mild cognitive impairment, impaired social interaction, and impairments in core communication skills, and impaired executive function. Evidence indicates collaborative multi-disciplinary programs capable of providing consistency of care is imperative for this complex and medically fragile patient population, yet implementation across practice settings remain challenging.

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