Value of serial brain MRI in very preterm infants to assess brain growth and injury and tailor neuropromotive intervention in the NICU

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Background and Aim

- Very preterm born infants experience high rates of neurodevelopmental delays. Abnormal MRI imaging at term-equivalent strongly predicts neurodevelopmental impairment at 2 years.(1)
- Cranial ultrasound (CUS) is the most common modality used to diagnose and classify degree of neurological injury of very preterm infants in the neonatal intensive care unit (NICU).
- Early intensive neuropromotive intervention for very preterm (VP) infants before term age is associated with improved infant neurological outcomes and greater parental satisfaction. (2)(3)
- The aim of this study is to use early, serial brain magnetic resonance imaging (MRI) to better understand longitudinal brain growth, delineate neurological injury, and tailor neuropromotive intervention for VP infants prior to term age.

Methodology

- All infants born less than 33 weeks gestational age (GA) in a level-III NICU at an academic institution were approached for consent excluding those with congenital infections or significant anomalies or genetic syndromes.

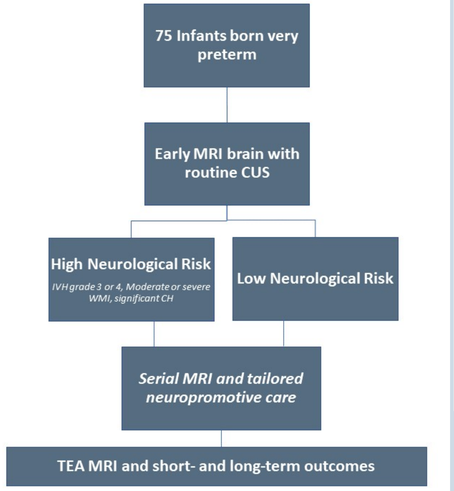


Fig1: Anticipated recruitment and research plan

- Along with routine HUS, early MRI scans were performed, and the group was categorized into high risk and low-risk groups based on the level of neurological injury present on early imaging.
- Any degree of intraventricular hemorrhage (IVH) with ventricular dilatation, moderate to severe white matter injury (WMI) and significant cerebellar hemorrhage were classified as high-risk.
- Serial MRI scans were obtained with each baby having at least 2 and a maximum of 6 scans.
- They were also compared to separate controls who underwent a single term equivalent (TE) MRI.



Image 1: Normal appearing head ultrasound of a 30-week GA newborn at 7 days of life

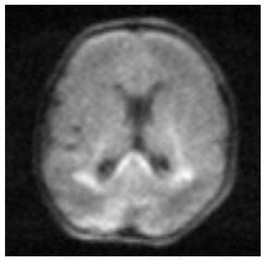


Image 2: Diffusion weighted image of same newborn at day 3 of life showing areas of acute WMI with restricted diffusion



Image 3: Normal appearing head ultrasound of a 31-week GA newborn at 4 days of life

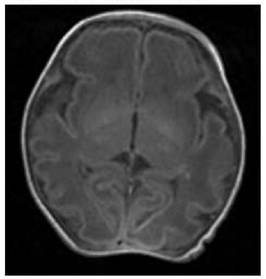


Image 4: Axial T1 image of same newborn at day 15 showing area of gliosis in left parietal lobe

Fig2: Comparison of cranial ultrasound and early MRI brain findings

Table1: Demographic and MRI data

	Low risk (n=23)	High risk (n=12)
Infant characteristics		
Gestational age in weeks+days (range,mean)	27+0 to 31+1 (28+4)	25+5 to 32+4 (28+6)
Birth weight in grams (range, mean)	620-1700 (1157.90)	550-1930 (1208.74)
Outcomes		
Number of MRI brain scans obtained (average)	59 (2.6/infant)	42 (3.5/infant)
Kidokoro score (range, mean)	0-8 (3.5)	8-22 (11.25)

Results

- Currently, 35 babies (of 75 projected) have been enrolled in this study.
- A total of 101 MRI scans have been performed of which 39 were early scans at 30-34 weeks GA. Interval scans were during the NICU stay with at least one TE scan at 38-42 weeks GA.
- Eleven babies met criteria for high-risk injury as per early MRI findings as opposed to 7 based on CUS.
- Early MRI scans (at 30-34 weeks GA) were more sensitive in detecting WMI, as opposed to CUS (moderate-severe WMI 6 vs 3 cases; any WMI 12 vs 4 cases). Three significant cerebellar hemorrhages were detected on MRI as opposed to 2 on CUS.
- The severity of WMI became less conspicuous by TE MRI as compared to early images.
- TE MRI was particularly helpful in assessment of cortical maturation and quantitative volumetric assessment especially when comparing with the earlier MRI images obtained.
- Data collection is ongoing and will be critical to inform more definitive results.

Conclusions

Our preliminary results show that early and serial brain MRI could offer valuable information for detecting and classifying brain injury in the preterm population. This can be implemented to tailor neuropromotive care in the NICU, during a critical period of brain development prior to term age.

Reference

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2. Pineda, R, Wallendorf, M, & Smith, J. 2020. A pilot study demonstrating the impact of the supporting and enhancing NICU sensory experiences (SENSE) program on the mother and infant. Early Human Development. 144: 1-8.

3. Pineda, Smith, J., Roussin, J., Wallendorf, M., Kellner, P., & Colditz, G. (2021) Randomized clinical trial investigating the effect of consistent, developmentally-appropriate, and evidence-based multisensory exposures in the NICU. Journal of Perinatology, 41(10), 2449–2462. https://doi.org/10.1038/s41372-021-01078-7)