The Predictive Value of the Difference Between Pre- and Post-natal Arterial Blood Gas pH for Brain Injury on MRI

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Background

- Early biomarkers of neonatal encephalopathy (NE) due to hypoxic-ischemic encephalopathy (HIE) are critical for timely assessment and determining the need for neuroprotective therapies such as therapeutic hypothermia (TH).
- Previous studies, including those from our group, have shown that measures of metabolic acidemia (pH, base deficit (BD), and lactate) in postnatal blood gases (BGs) correlated with the severity of precooling neurological examination scores[1].
- The Weeke scoring system is an MRI scoring system that uses diffusion-weighted images to get an in-depth look at all areas of the brain, scored using 19 items. This system is used for analyzing MRIs of infants with HIE and has even been found to have predictive value up to school age[2].
- Many clinicians interpret improvement in BG values from cord to postnatal samples as clinically meaningful, **little is known about whether such differences relate to the extent of brain injury.**

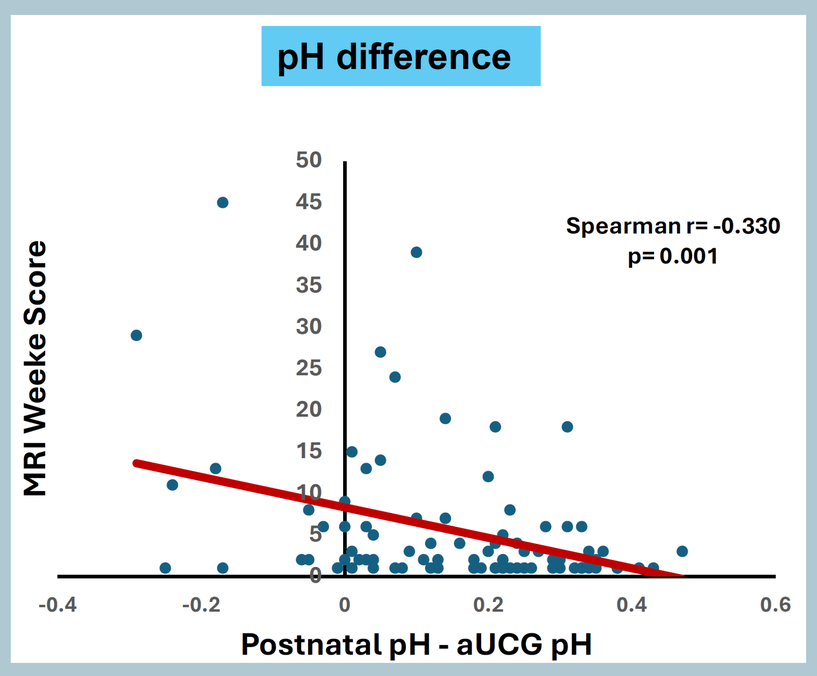
Methods

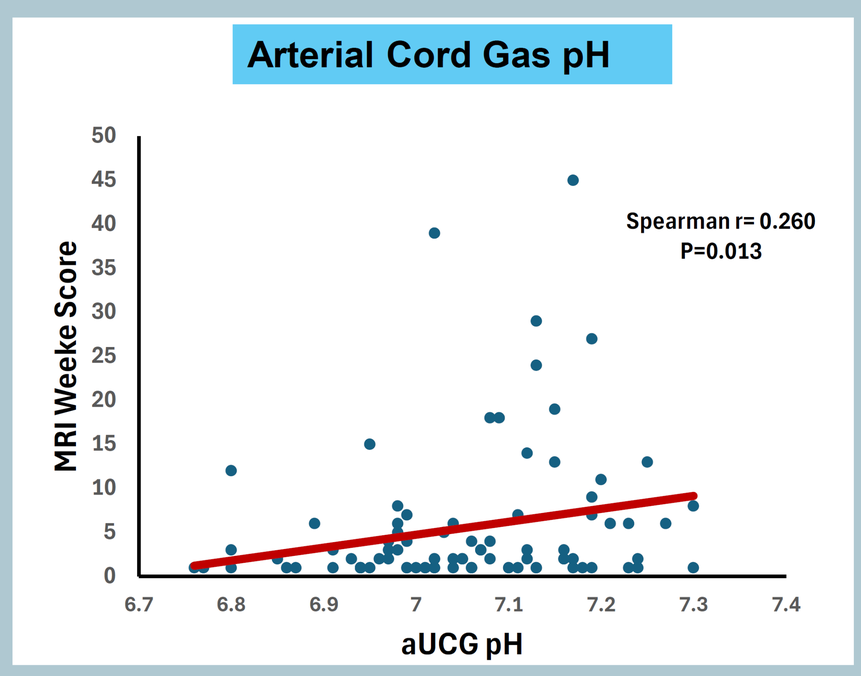
- **A retrospective single-center study of ninety infants treated with TH** in the neonatal intensive care unit at Brigham and Women's Hospital between 2017 and 2021.
- Differences between arterial umbilical cord blood gas (aUCG) and postnatal BG pH and BD were calculated and correlated with the degree of brain injury on MRI.
- MRIs were independently scored by two blinded neonatologists using the Weeke system, with discrepancies resolved by consensus. Injury was assessed across grey matter, white matter/cortex, cerebellum, and additional hemorrhagic/vascular findings (total score 0–55).

Results

- The difference between aUCG and postnatal pH showed a significant negative correlation with MRI Weeke scores (Spearman r = –0.33, p = 0.001), indicating that an increase in pH from cord to postnatal blood was associated with less severe brain injury.
- There were less significant correlations observed for individual pH values (cord or postnatal) **(Figure 1)**, differences in BD or individual BD values **(Figure 2)**, or the NE score **(Figure 3)** with MRI injury scores.

Figure 1. Scatter plots showing the relation between pH difference (postnatal-aUCG) , aUCG pH, and post-natal pH and Weeke Scores





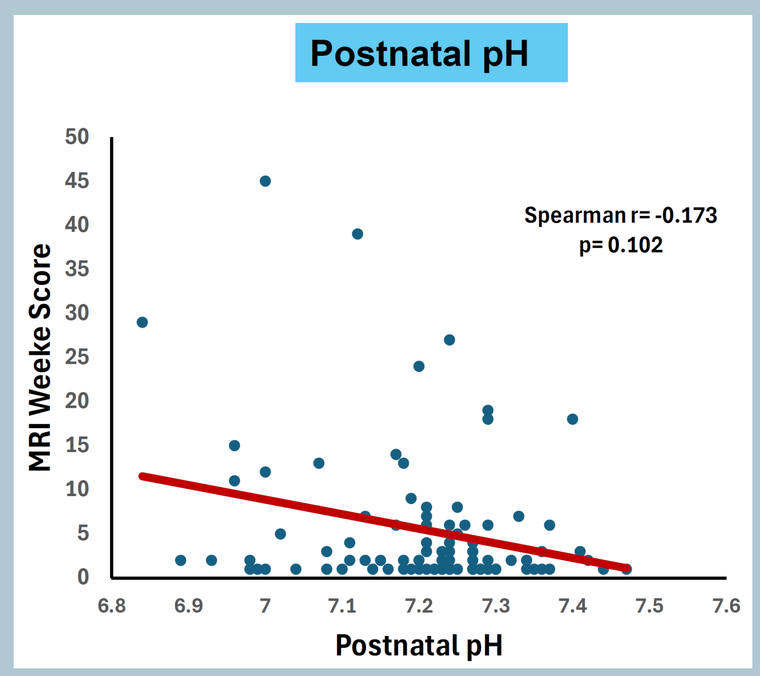
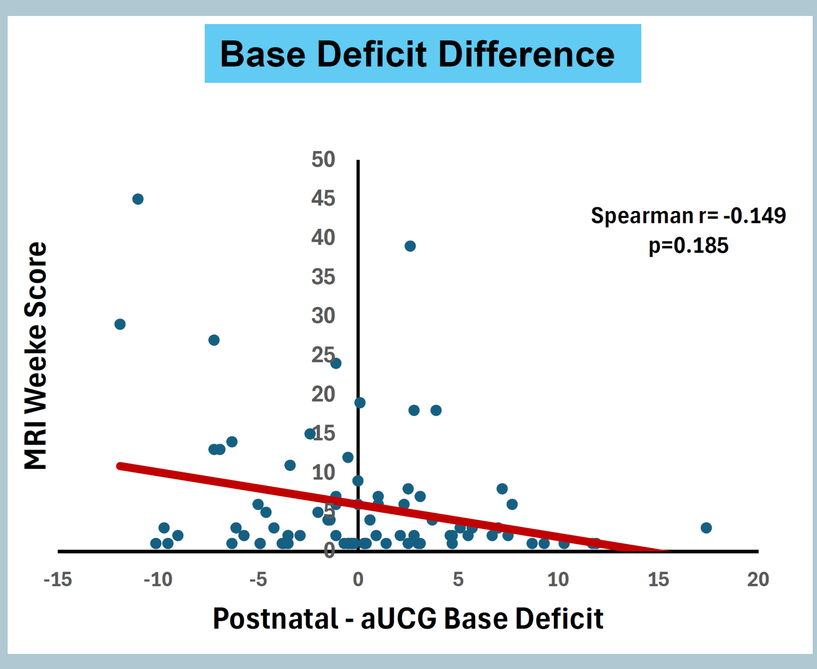
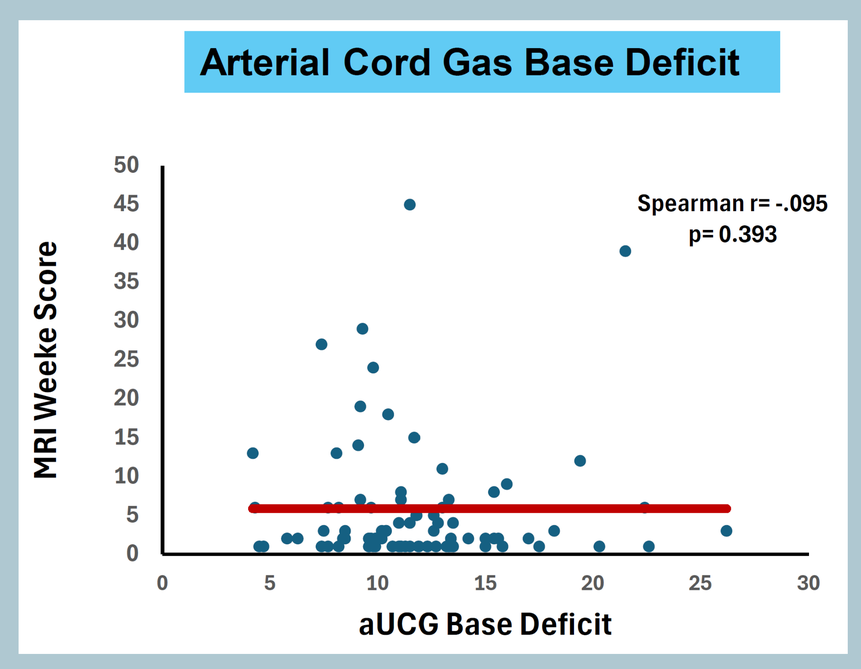


Figure 2. Scatter plots showing the relation between BD difference (postnatal-aUCG), aUCG BD, and post-natal BD and Weeke Scores





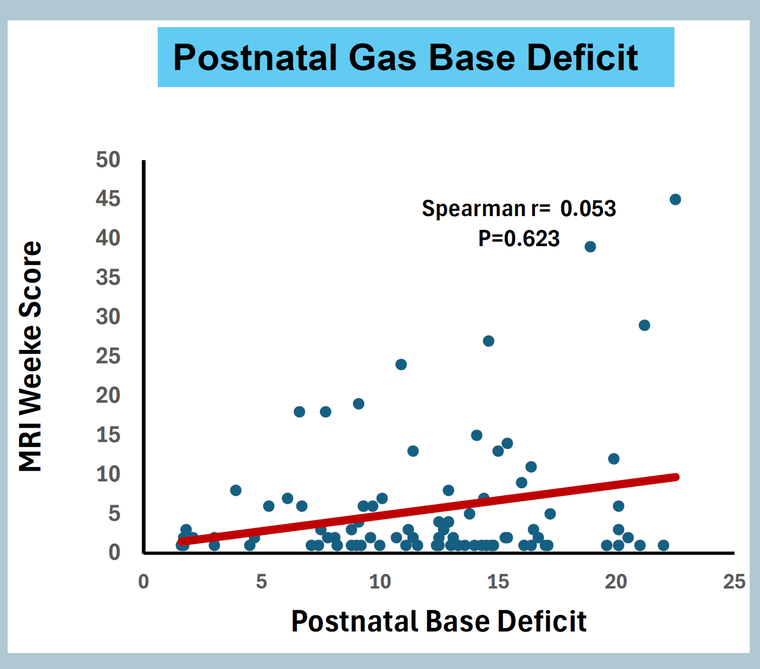
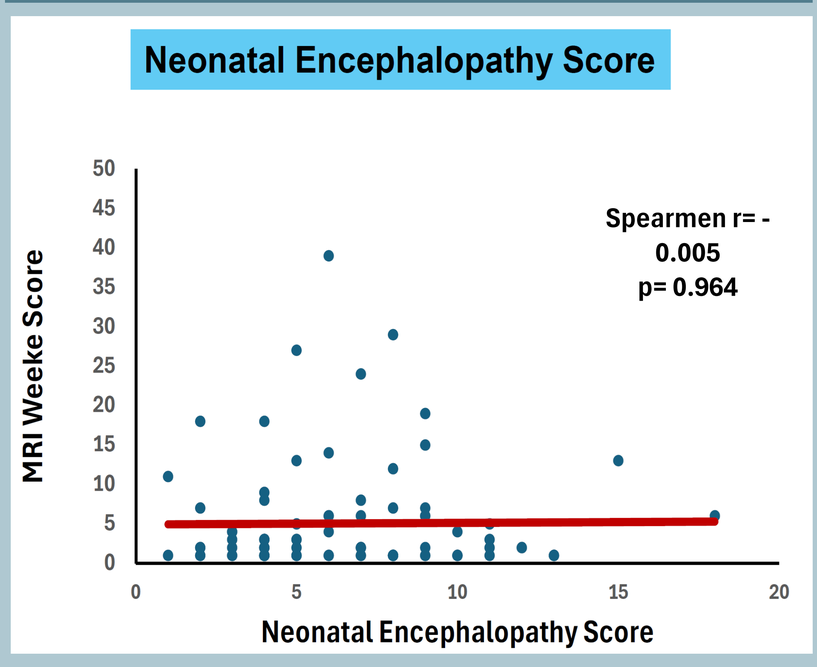


Figure 3. Scatter plot showing the relation between the pre-cooling neonatal encephalopathy score and the MRI Weeke score.



Discussion and Conclusions

- We report that the difference between pre-natal (cord) and post-natal pH values provides additional insight into the risk of brain injury on MRI beyond the use of either measure alone or the clinical examination.
- An improvement in pH after birth was associated with less severe MRI-detected brain injury, suggesting that changes in acid-base status during the early postnatal period may reflect evolving cerebral recovery or ongoing injury.
- Future studies should evaluate the clinical utility of incorporating pre- to post-natal differences in blood gas values into decision-making algorithms for initiating or refining neuroprotective interventions, including TH and emerging adjunctive therapies.

References

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2. Weeke, L. C. et al. A Novel Magnetic Resonance Imaging Score Predicts Neurodevelopmental Outcome After Perinatal Asphyxia and Therapeutic Hypothermia. J. Pediatrics 192, 33–40.e32 (2018).