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].
- 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. Difference in pH was calculated by **subtracting the aUCG pH from the postnatal pH.** Difference in BD was calculated by **subtracting the postnatal BD from the aUCG BD.**
- The Weeke scoring system is a comprehensive MRI scoring method that evaluates the extent of brain injury across multiple regions using diffusion-weighted imaging alongside conventional sequences, incorporating 19 items scored based on the severity and distribution of injury. It is widely used in infants with NE and has demonstrated strong predictive value for neurodevelopmental outcomes extending into early childhood and school age.[2]
- The BWH NE score is a standardized clinical exam-based scoring system evaluating nine variables in six neurologic domains (score range 0–27), with a threshold ≥4 indicating eligibility for therapeutic hypothermia.
- 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

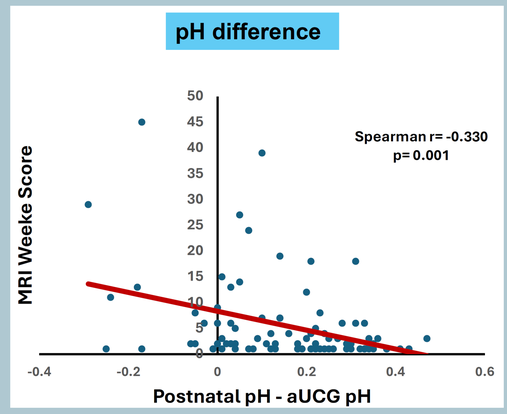
- The difference between aUCG and postnatal pH showed a significant negative correlation with MRI Weeke scores (Spearman r = –0.33, p = 0.001), indicating that an increase in pH from cord to postnatal blood was associated with less severe brain injury.
- There were less significant correlations observed 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.

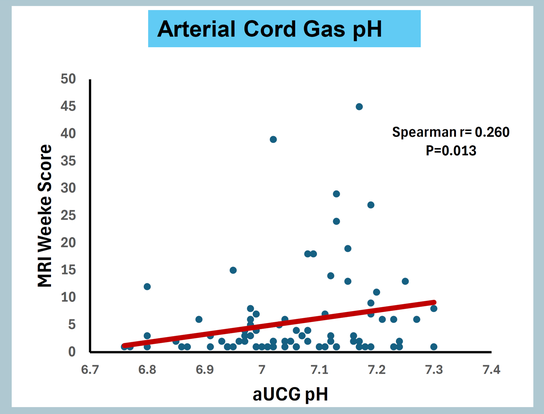
References

1. Sakpichaisakul K, Supapannachart KJ, El-Dib M, et al. Blood gas measures as predictors for neonatal encephalopathy severity. *J Perinatol.* 2021;41(9):2261-2269. doi:10.1038/s41372-021-01075-w.

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).

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





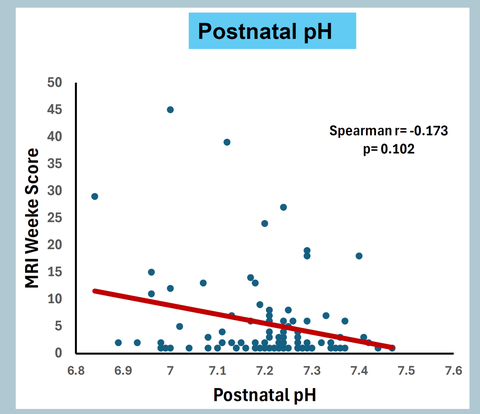
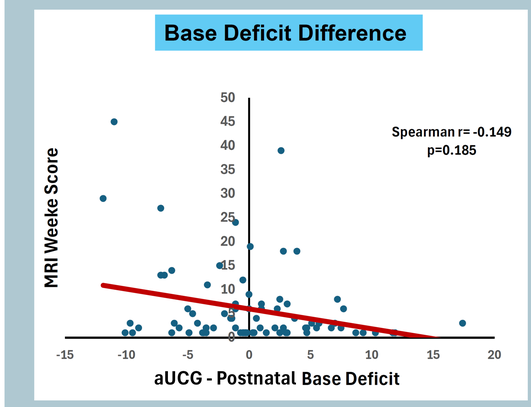
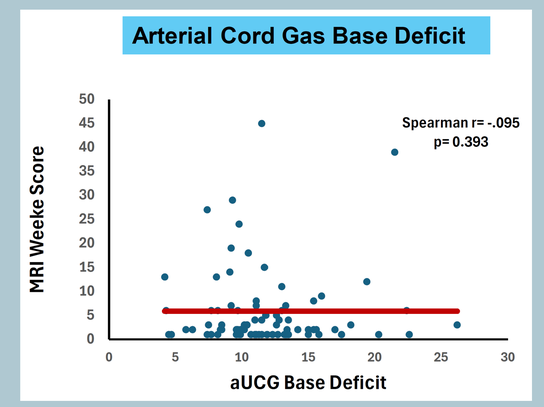
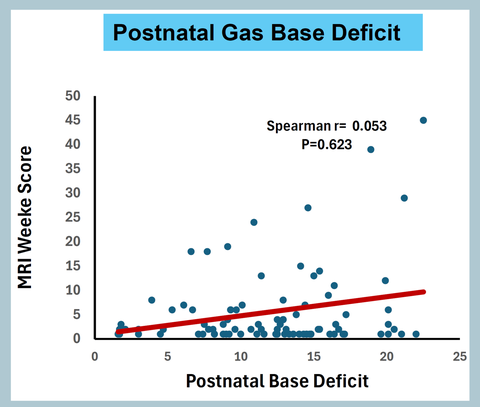


Figure 2. Scatter plots showing the relation between BD difference (aUCG - postnatal), aUCG BD, and post-natal BD and Weeke Scores







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.

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

