# Evaluating the effect of mean airway pressure on kidney oxygenation in preterm neonates receiving positive pressure ventilation

School of Medicine and Public Health
UNIVERSITY OF WISCONSIN-MADISON

Matthew W. Harer, MD; Derek Gross; Michael Lasarev, MS
Department of Pediatrics, University of Wisconsin
School of Medicine and Public Health, Madison, WI

UnityPoint Health Meriter
PARTNER OF UWHealth

## Abstract


- Preterm neonates frequently require positive pressure ventilation (PPV) to support respiratory function during their NICU admission.[1]
- Careful titration of mean airway pressure (MAP) is essential for these patients to avoid barotrauma and hemodynamic compromise that may lead to acute kidney injury (AKI). [2]
- Near infrared spectroscopy (NIRS) monitoring has the potential to evaluate the effect of different MAPs by measuring renal regional tissue oxygenation ($RrSO_2$). [3]


## Objective

1) To determine if increases in MAP result in decreases in kidney oxygenation.
2) To identify a MAP range that yields "optimal" $RrSO_2$ (defined as ≥ 50%).

## Methods and Materials

- A retrospective analysis of MAP and $RrSO_2$ was performed on preterm neonates <32 weeks' gestation who were enrolled in a prospective NIRS monitoring study.
- INVOS NIRS sensors were placed on neonates within 48 hours of age and monitored $RrSO_2$ every 5 seconds until 7 days of age.
- Time-synced hourly MAP and $SpO_2$ averages were obtained via chart review.
- Statistical analysis included linear and binomial mixed-effect models, Mann-Whitney U tests, and Fisher's exact test.

| | IMV (n=18) | NIV (n=20) | P-value |
|---|---|---|---|
| **Gestational age (wks)** | 26.4 (25.1-28.5) | 29.6 (28.5-31.1) | <0.01 |
| **Birth weight (g)** | 800 (640-1163) | 1175 (1013-1525) | <0.01 |
| **Small for gestational age (n)** | 3 (17%) | 2 (10%) | 0.65 |
| **Male (n)** | 10 (55%) | 13 (65%) | 0.74 |

**Table 1**. Demographic profile of the 35-neonate cohort, 18 received IMV and 20 received NIV between 2-7 days of age. The average gestational age and birth weight was lower for the IMV group compared to the NIV group.

**Figure 1: An infant receiving respiratory support via cPAP.** About 2.4 million babies are born very and extremely preterm globally each year. It is estimated that ~60–95% of these infants will require respiratory support during their neonatal period.[1]

**Figure 2: Example of renal NIRS sensor placement.** Sensors were placed transversely on the left or right flank of neonates. Mepitel is a protective, gel-impregnated, and adhesive gauze that was used as a barrier between the NIRS sensors and the skin.

**Contact Information:** mwharer@wisc.edu, @triplebadger10

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## Results

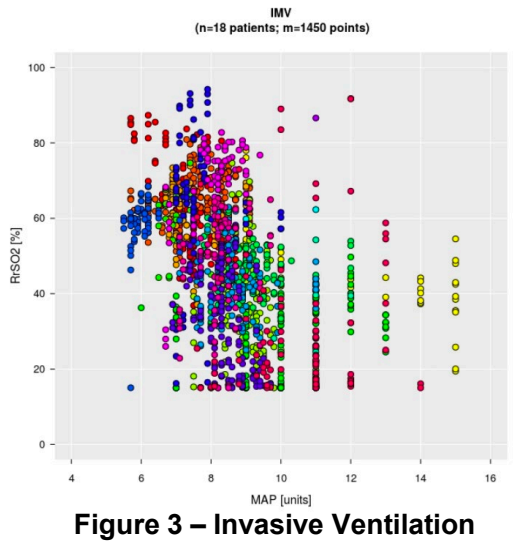


**Figure 3 – Invasive Ventilation**
Linear mixed-effect models indicate association between MAP and RrSO2. A 1 cmH2O increase in MAP is associated with a 0.59% reduction in mean $RrSO_2$ (95% CI: -2.63–1.50; p = 0.58).

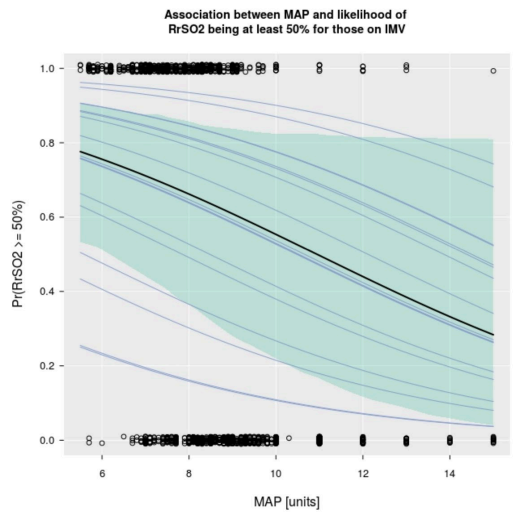


**Figure 4 – Invasive Ventilation**
Data gave limited evidence to support an association between MAP and the odds of having $RrSO_2$ ≥ 50% (OR = 0.80; 95% CI: 0.63–1.04, p = 0.09).

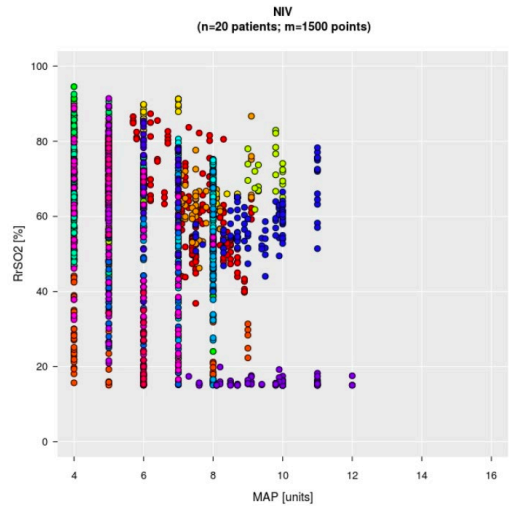


**Figure 5 – Non-Invasive Ventilation**
Linear mixed-effect models indicate no consistent association between MAP and $RrSO_2$. A 1 cmH2O increase in MAP is associated with only a 0.94% in mean $RrSO_2$ (95% CI: -2.89– 1.12; p = 0.14).

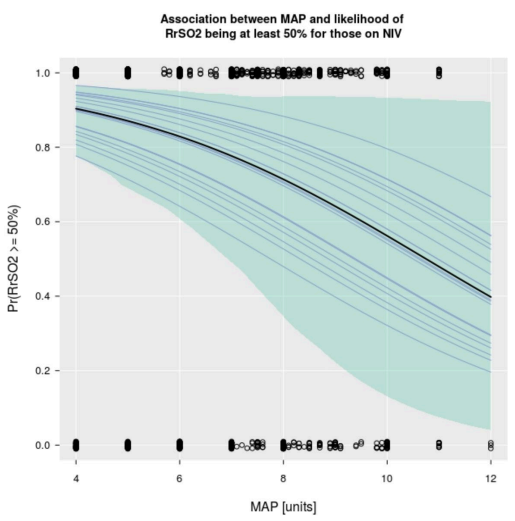


**Figure 6 – Non-Invasive Ventilation**
Evidence for an association between MAP and the odds of having $RrSO_2$ be at least 50% is, at best, suggestive and inconclusive (OR = 0.72; 95% CI: 0.53–0.99, p = 0.05).

## Conclusions

- There are no consistent associations between MAP and $RrSO_2$ in preterm neonates receiving either IMV or NIV.
- There is limited evidence suggesting an association between MAP and the odds of having $RrSO_2$ be within an "optimal" range (≥ 50%).
- Further evaluation of this data should include controlling for confounding variables like blood pressure and hemoglobin.
- Additional studies are needed to evaluate which respiratory interventions can improve kidney oxygenation.

**Citations**

[1] Chan KYY, Miller SL, Schmölzer GM, Stojanovska V, Polglase GR. Respiratory Support of the Preterm Neonate: Lessons About Ventilation-Induced Brain Injury From Large Animal Models. Front Neurol. 2020 Aug 14;11:862.
[2] Bhombal S, Noori S. Hemodynamic management in chronically ventilated infants. Semin Fetal Neonatal Med. 2019 Oct;24(5):101038.
[3] Harer MW, Chock VY. Renal Tissue Oxygenation Monitoring-An Opportunity to Improve Kidney Outcomes in the Vulnerable Neonatal Population. Front Pediatr. 2020 May 14;8:241.