

Perioperative Sodium Levels in Congenital Heart Disease



Wilhelmina Children's Hospital

Authors: Mirthe van der Meijden & Maaïke Nijman (on behalf of Manon Benders, Hans Breur, Nathalie Claessens, Kim van Loon)

Background

- The compromised cerebral development of neonates with **congenital heart disease (CHD)** poses an increased risk for cerebral injury during cardiac surgery with cardiopulmonary bypass (CPB) [1,2,3].
- Osmotic demyelination syndrome** is a phenomenon in adult CHD, comprising the manifestation of myelinolysis due to rapid correction of hyponatremia [4], which is possibly underdiagnosed in pediatric CHD.
- Perioperative dysnatremia** occurs frequently in neonates with CHD, with predominant preoperative hyponatremia (<135 mmol/L) and postoperative hypernatremia (>145 mmol/L), indicative of a rapid sodium increase [5,6,7].
- Perioperative dysnatremia was associated with hospital length of stay, ventilation times, neurologic clinical events, and mortality [6,7,8].

Aims

Describe the perioperative sodium course in neonatal CHD

Explore whether perioperative sodium fluctuations are associated with white matter injury

Methods

- We included neonates with CHD born at ≥ 36 weeks gestation who underwent cardiac surgery with CPB and did not participate in a neuroprotective trial.
- Pre- and postoperative T1, T2, and DWI MRI-scans were assessed regarding white matter injury.

Expectations

Prevalent perioperative dysnatremia in neonatal CHD

Predominant hyponatremia in the preoperative period and predominant hypernatremia in the postoperative period

More new postoperative white matter injury in neonates with a rapid increase of perioperative sodium

Results

We included 47 neonates with CHD undergoing cardiac surgery with CPB, of which 28 were included in the analyses regarding white matter injury.

Perioperative sodium level course

- The perioperative sodium level course of neonates with CHD is summarized in **Table 1** and **Figure 1**.
- More than half of neonates showed preoperative hyponatremia (51.3%), while none showed preoperative hypernatremia.
- Postoperatively, the greater proportion of neonates showed hypernatremia (53.2%), yet almost a third of neonates showed hyponatremia (31.9%).
- Maximum sodium change during surgery (M = 5.5 hours) was explained by gender, birthweight, age, CPB time, selective cerebral perfusion time, deep hypothermic cardiac arrest, and temperature during surgery ($F(8,836) = 145.3, p < .001$, adjusted $R^2 = 0.58$).
- Preoperative sodium levels were negatively correlated with maximum sodium change during surgery, $r(252) = -.29, p < .001$.

White matter injury

- Maximum intraoperative sodium increase was not associated with new postoperative white matter injury ($r(762) = .04, p = .284$)

Conclusions

The sodium pattern of neonates with CHD reflects low preoperative and high postoperative levels, indicative of a rapid increase during surgery

Neonates with lower preoperative sodium levels are at risk for a greater, and thus faster, sodium increase during surgery

There is no increased incidence of white matter injury in neonates with a rapid sodium increase during surgery

Table 1. Perioperative sodium levels in neonatal CHD

	Median (IQR)	n
Preoperative (0h-72h before surgery)		
Sodium, mmol/L	136.0 (9.0)	39
Hyponatremia, n (%)	20 (51.3)	39
Hypernatremia, n (%)	0 (0)	39
Intraoperative		
Sodium on CPB prime, mmol/L	167.0 (4.3)	45
Sodium, mmol/L	138.0 (8.0)	47
Maximum sodium change, mmol/L	8.0 (5.0)	47
Postoperative (0h-72h after surgery)		
Sodium, mmol/L	142.0 (6.0)	47
Hyponatremia, n (%)	15 (31.9)	47
Hypernatremia, n (%)	25 (53.2)	47
Preoperative hyponatremia and postoperative hypernatremia, n (%)	7 (14.9)	47

Abbreviations. IQR = interquartile range

- Andropoulos et al. (2010)
- Claessens et al. (2017)
- Peyvandi et al. (2018)
- Andropoulos et al. (2019)
- King & Rosner (2010)
- Kaufman et al. (2017)
- Ontenada et al. (2018)
- Darmon et al. (2013)

Figure 1. Average perioperative sodium level course in neonatal CHD

