

Cooling Efficiency and Transport Timing in Neonates with HIE Undergoing Therapeutic Hypothermia

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Introduction

Hypoxic-ischemic encephalopathy (HIE) is a leading cause of neonatal brain injury, associated with significant long-term neurodevelopmental risks¹. Therapeutic hypothermia (TH) is the standard of care and is most effective when initiated within 6 hours of birth². Infants born outside a tertiary care NICU (outborn) often experience delays due to transport retrieval and stabilization.

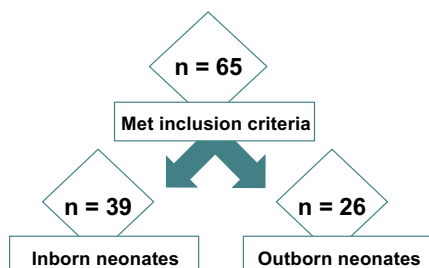
Variability in neonatal stabilization practices and temperature monitoring affects cooling efficiency. Passive cooling during transport may help initiate hypothermia, but maintaining the therapeutic range can be a challenge without servo-controlled active cooling devices.

Aim

To compare the time to reach and maintain therapeutic temperature range for outborn neonates compared to inborn with the purpose of identifying strategies that enhance stabilization and improve outcomes.

Methodology

Retrospective chart review of neonates with HIE treated with therapeutic hypothermia. Inclusion required confirmed HIE and complete clinical data. Variables included birth history, TH details, short-term outcomes, and transport metrics for outborns. Inborn vs. outborn comparisons assessed cooling efficiency and time to reach therapeutic range.



Results

Table 1: Demographics and Clinical Characteristics of Neonates

	Inborn (n=39)	Outborn (n=26)
Gestational Age, mean ± 2SD	38week ± 2w3d	40w1d ± 2w3d
Birth Weight (g), mean ± 2SD	3311.54 ± 1158.92	3238.54 ± 1636.62
Mode of Birth		
Vaginal	12	10
Gender		
Male	21	14
10-min APGAR <6	26	16
Cord Gas		
Severe Acidosis (pH ≤7.0 or base deficit ≥-16)	22	16
Chest Compressions	8	7
Sarnat Stage at Cooling		
Moderate	21	12
Severe	2	5
First pH		
Severe Acidosis (pH ≤7.0 or base deficit ≥-16)	3	1
Age at Decision to Start TH (hours), mean ± 2SD	1.20 ± 1.48	1.28 ± 1.46
Mode of Transport (Outborn only)		
Air	-	2
Ground	-	8
Temperature Monitoring (Outborn only)		
Axillary	-	22
Frequency of Temperature Recording (Outborn only)		
Every 20 min	-	15
Every 30 min	-	6
Inconsistent	-	4
Time to Achieve TH (out born)		
Started Within Range		11
Time Specified <2h		5
Not Met		3
% Time Outside TH Range, mean ± 2SD	-	27.2 ± 76.94%
Other Outcomes		
PPHN	1	2
Coagulopathy	3	5
Reverse TH Prior to 72h	1	2

Table 1: Overview and comparison of findings between inborn and outborn neonates

Parameter	Inborn (n=39)	Outborn (n=26)
Cooling Method	Active	Passive
Availability of Cooling Device	Yes; Criticool	---
Achieved Target Temperature <2h	39	2
Achieved Target Temperature 2-6h	---	2
Not Recorded / Not Met	---	7
Cool at Start	0	11
Temperature Monitoring	Continuous	Variable

Table 4: Cooling and temperature data for inborn and outborn neonates

Encephalopathy staging

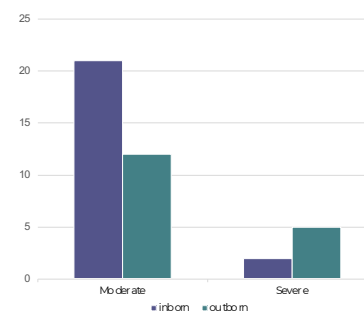


Table 2: Encephalopathy staging comparison for inborn and outborn neonates

Cerebral Function Monitoring Findings

	Inborn	Outborn
Seizures	6	4
Burst Suppression	2	3
Abnormal	4	4
No Documentation	26	15
Isoelectric	1	0

Table 3: CFM (EEG) findings for inborn and outborn neonates

Complications	Inborn	Outborn
PPHN	1	2
Coagulopathy	3	5
Reverse TH Prior to 72h	1	2

Table 5: Comparison of complications between inborn and outborn neonates

Conclusions

- Outborn neonates showed variability in achieving and maintaining therapeutic temperature during transport
- Standardized protocols and real-time temperature monitoring are essential to improve cooling efficiency
- Active temperature management after initiating servo-controlled cooling can enhance consistency and timeliness in reaching and maintaining target temperatures

QI Goals

- System-level changes are needed to optimize neonatal transport and improve neuroprotective care
- Outreach and knowledge translation help peripheral birthing centers adopt best practices with therapeutic hypothermia
- Servo-controlled cooling devices can improve consistency and timeliness

Limitations

- Retrospective design limited by incomplete or inconsistent documentation
- Dispatch delays due to transport availability could not be reliably captured or quantified
- Inconsistent temperature monitoring during transport may have affected cooling efficiency assessments.

References

1. Hagberg H, David Edwards A, Groenendaal F. Perinatal brain damage: The term infant. *Neurobiology of Disease*. 2016;92:102-112. doi:https://doi.org/10.1016/j.nbd.2015.09.011
2. Lemyre B, Chau V. Hypothermia for newborns with hypoxic-ischemic encephalopathy. *Paediatrics & Child Health*. 2018;23(4):285-291. doi:https://doi.org/10.1093/pch/pxy028