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Potential Risk Modifiers for Severe Intraventricular Hemorrhage in Very Low Birthweight Infants Requiring Transport

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Abstract

Background: Very low birthweight (VLBW) infants must undergo transport when born at a facility unequipped for their care. Previous research suggests increased risk for intraventricular hemorrhage (IVH) associated with transport. It is unknown whether logistical aspects of transport, particularly mode and distance, or skill level of the resuscitation team are drivers of risk.

Objective: To determine if transport vehicle, distance traveled, or absence of advanced resuscitation team increased risk for severe IVH in outborn VLBW infants.

Design/Methods: Outborn VLBW infants, transported by specialized team via helicopter or ambulance to a Level IV NICU, were included; inborn VLBW infants served as controls. Infants transported >24h after birth, by referring center's team, or without head ultrasound were excluded. Baseline clinical data were collected along with IVH grade, transport vehicle, distance traveled, and skill of resuscitation team.

Results: 293 outborn were matched to 293 inborn infants. Outborn infants had increased incidence of severe IVH even when controlling for antenatal steroids, race, delivery method, and surfactant use (17% vs. 11%, OR=1.6, 95% CI 1.1–2.7). Despite this increased incidence, severe IVH was not associated with transport vehicle (p=0.90; OR=0.76, 95% CI 0.34–1.7), distance traveled (p=0.13; OR 0.84, 95% CI 0.60–1.2), or skill of resuscitation team (p=0.18; OR=0.49, 95% CI 0.21–1.1).

Conclusion(s): Compared to inborn, outborn infants had increased risk of severe IVH. Transport vehicle, distance traveled, and skill of resuscitation team did not significantly impact risk.

Keywords

VLBW; transport; IVH; neonate; neurology

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Declaration of Interest

The authors report no conflicts of interest.

Introduction

Very low birthweight (VLBW) infants must undergo transport when born at a facility unequipped for their care. Previous research suggests that transported VLBW infants are at increased risk for intraventricular hemorrhage (IVH) compared to those born at tertiary care facilities [1–3]. Transport is an inherently stressful process and provides many candidate risk factors for IVH; defining which factors confer risk is essential in developing targeted neuroprotective strategies. For referring providers to make informed transport decisions, detailed study of these factors in a large cohort of infants is needed. In this project we examined transport vehicle, distance traveled, and presence of a specialized neonatal resuscitation team as potential risk modifiers for severe IVH in outborn VLBW infants, while controlling for important clinical risk factors.

Methods

In this retrospective cohort study, we collected data for all outborn admissions to a single level IV referral NICU (St. Louis Children's Hospital) between 2009–2015. Infants were included if they were VLBW (gestational age [GA] <32 weeks and/or birthweight [BW] <1500g) and transported by our transport team within 24 hours of birth. Infants without head ultrasounds were excluded. Inborn VLBW infants admitted to the same NICU from 2009–2012 served as a larger pool of infants for comparison.

Transports included a neonatal fellow, pediatric nurse(s), and paramedic(s) with specialized training in the resuscitation and post-birth management of VLBW infants. Three modes of transport cover a multi-state catchment area (Eastern/Central Missouri and Southwestern Illinois); most infants were transported by ambulance or helicopter. Infants transported by fixed-wing were excluded, as they must ride to/from the airfield via ambulance, confounding analysis.

Clinical information including BW, GA, sex, antenatal steroids, delivery method, and highest grade of IVH by 28 days of life were collected. We documented histologic chorioamnionitis, BW <10th percentile for GA, adequate prenatal care (>4 visits), 1 and 5 minute Apgar scores, surfactant use in the delivery room, duration of invasive ventilator use, and inotrope requirement with the intent to outline differences in clinical condition between cohorts at birth. For outborn infants, transport vehicle and distance traveled were abstracted. Impact of provider skill level was coded as the presence of the transport team or delivery at a facility with a minimum of Level II nursery care. Severe IVH was defined as grade III or IV [4]. Using propensity score matching on GA and BW, a comparable group of inborn infants was matched to those outborn. These data were analyzed using Fisher's Exact test, Kruskal-Wallis test, and multivariate binary logistic regression using R version 4.0.2 (Vienna, Austria).

Results

293 outborn and 600 inborn infants met inclusion criteria; after propensity score matching, each group contained 293 infants. There was no difference in sex, GA, BW, histologic

chorioamnionitis, Apgar scores, and inotrope use between groups. Outborn infants were born less often by Cesarean section, were more often Caucasian, received less surfactant and antenatal steroids, and had a greater incidence of severe IVH (Table 1). Even when controlling for factors known to modify risk of IVH (antenatal steroids, delivery method, race, and surfactant administration), outborn infants had a greater incidence of severe IVH (17% vs. 11%, $p < 0.01$; OR=1.6, 95% CI 1.1–2.7).

23% of infants transported by ambulance and 22% transported by helicopter had severe IVH; risk did not differ by transport vehicle in univariate analysis or when correcting for key clinical factors ($p = 0.901$; OR=0.76, 95% CI 0.34–1.7). Risk similarly did not increase with distance traveled ($p = 0.133$; OR=0.84, 95% CI 0.60–1.2). Crude rates of severe IVH were slightly higher in infants without an advanced resuscitation team (22% vs. 15%), but this difference was not statistically significant ($p = 0.18$; OR=0.49, 95% CI 0.21–1.1). Decompensation during transport was rare (5% of trips) and associated with greater incidence of severe IVH (38%). However, this group was too small to make meaningful statistical comparisons.

Discussion

VLBW infants who must be transported after birth face a significant risk of severe IVH. Previous studies have reported conflicting results on whether the transport process is an independent risk factor [2–3, 6]. Complicating analysis, medical transport is not one homogenous, controlled event [7]. Here, we address the impact of three transport-related factors in a large cohort of newborns at a single children's hospital covering a multi-state referral area. Although we confirm the increased incidence of severe IVH in an outborn cohort, this increased risk is not associated with transport vehicle, distance traveled, or expertise of the resuscitation team.

The correlation between extensive resuscitation at birth and IVH has been well documented [8–11]. Although difficult to quantify, it is reasonable to speculate that infants who must be born in outlying hospitals are born in less controlled situations. However, even after matching by GA and birthweight, and adjusting for skill of resuscitation provider and key IVH risk factors, outborn infants still faced increased risk of severe IVH. These results are consistent with other studies examining transport risks for VLBW infants [5,8,12–14]. One emerging area of investigation aims to assess sound and vibration levels infants experience during transport, with the hypothesis that tempering this stress with specialized isolettes or mattresses may decrease risk of IVH [15,16]. Helicopters expose infants to greater lateral and vertical but smaller head-to-toe and more predictable forces than ambulances, where forces are more impulsive and dynamic [17,18]. However, given that our data suggest equivalent IVH risk regardless of transport vehicle, the mitigation of vibration alone may be insufficient intervention to decrease risk of IVH in transport.

Although birth at an outlying facility remains a consistent risk factor for IVH, our data do not suggest a neuroprotective advantage to method or distance of transportation, suggesting that infants should be transferred by whatever means is the safest and most efficient. Further

research is needed to identify other transport or resuscitation-related factors that increase risk of IVH in outborn VLBW infants.

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Table 1.

Clinical and demographic factors

	Inborn (n=293)	Outborn (n=293)	P value
EGA, mean (SD), weeks	28.6 (2.9)	28.5 (2.9)	0.82
Birth weight, mean (SD), grams	1280 (451)	1286 (463)	0.89
Male sex, n (%)	154 (53)	163 (56)	0.51
SGA ^a , n (%)	26 (9)	27 (9)	1.00
Race, n (%)			<0.01*
Asian	11 (4)	1 (1)	
Black	153 (52)	58 (19)	
Hispanic	8 (3)	5 (2)	
White	121 (41)	229 (78)	
Antenatal steroids, n (%)	245 (84)	182 (62)	<0.01*
Adequate prenatal care ^b , n (%)	274 (94)	279 (95)	0.48
Caesarian section, n (%)	224 (76)	191 (65)	<0.01*
Chorioamnionitis, n (%)	74 (25)	62 (21)	0.28
Advanced resuscitation, n (%)	293 (100)	177 (60)	<0.01*
Apgar score, median (range)			
1 minute	5 (0–9)	5 (0–10)	0.73
5 minutes	7 (0–9)	7 (0–10)	0.23
Surfactant in delivery room, n (%)	246 (84)	127 (43)	<0.01*
Inotrope use, n (%)	78 (27)	96 (33)	0.12
Cumulative length of invasive ventilatory support, n (%)			0.04*
None	32 (11)	31 (11)	
< 4 hours	45 (15)	28 (9)	
4–24 hours	90 (31)	78 (27)	
>24 hours	126 (43)	156 (53)	
Grade III or IV IVH, n (%)	34 (11)	52 (17)	0.04*

^aSGA defined at BW < 10th centile for GA;

^b defined as >4 visits

* Denotes significance at p< 0.05.