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## Effect of place of birth and transport on morbidity and mortality of preterm newborns

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### Abstract

**Objective:** To evaluate the effect of place of birth and transport on morbidity and mortality of preterm newborns in the southern region of Brazil.

**Methods:** This cohort study included preterm newborns transported to a reference intensive care unit (transport group = 61) and followed up until discharge. Data about care in hospital of origin and transport were obtained at admission. This group was compared with infants born in the maternity ward of the reference hospital paired according to gestational age (control group = 123). Primary outcome was death, and secondary outcomes were changes in blood glucose, temperature and oxygen saturation at admission and the incidence of necrotizing enterocolitis, bronchopulmonary dysplasia and sepsis. Relative risk (RR) was used to evaluate the association between variables and outcome. The level of significance was set at  $\alpha = 5\%$  and  $\beta = 90\%$ .

**Results:** Mean travel distance was 91 km. Mean gestational age was 34 weeks. Of the neonates in the transport group, 23% ( $n = 14$ ) did not receive pediatric care in the delivery room. During transportation, 33% of newborns were accompanied by a pediatrician, and the equipment available was: incubator (57%), infusion pump (13%), oximeter (49%) and device for blood glucose test (21%). The transport group had a greater incidence of hyperglycemia (RR = 3.2; 2.3-4.4), hypoglycemia (RR = 2.4; 1.4-4.0), hyperthermia (RR = 2.5; 1.6-3.9), and hypoxemia (RR = 2.2; 1.6-3.0). The percentage of deaths was 18% in the transport group and 8.9% in the control group (RR = 2.0; 1.0-2.6).

**Conclusions:** This study revealed deficiencies in neonatal care and transport. Perinatal care and transport should be better organized in the northeastern region of Rio Grande do Sul, Brazil.

*J Pediatr (Rio J).* 2011;87(3):257-262: Neonates, patient transport, intensive care unit.

### Introduction

In developed countries, 15 to 20% of the newborns (NB) are delivered in places without the adequate infrastructure and have to be taken to more developed centers.<sup>1</sup> In Brazil, these data are not available, but the number is estimated to be higher. Most studies that analyzed results of the level of perinatal care found that morbidity and mortality among

very low birth weight or very ill NB increase when they are born in centers without the adequate specialization for that type of care.<sup>2-3</sup>

A study conducted in Canada<sup>2</sup> analyzed the records of 3,769 infants born before 32 weeks' gestation and admitted to 17 neonatal intensive care units (NICU) from 1996 to

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1997. Infants born out of a tertiary center and transferred had a significantly greater risk of death due to severe intraventricular hemorrhage, respiratory distress syndrome, patent ductus arteriosus, and nosocomial infection than infants born in tertiary care centers. Some of the factors that contributed to this mortality increase were the inadequate structure of the hospital of origin and the negative effect of transport.

Another study conducted between 1993 and 1995 analyzed mortality rates in a group of 2,375 very low birth NB according to level of perinatal care of the hospital where they were born. Mortality rates adjusted to birth weight (BW) and race were significantly greater in level I and II hospitals than in level III hospitals. Even transferences between two tertiary care centers may increase mortality, which confirms the risk of transport for neonatal morbidity and mortality.<sup>4</sup>

Based on that knowledge, the concept of regionalized perinatal care has been developed. The first study about regionalization was published in 1975.<sup>1</sup> That study included criteria that classified maternal and neonatal care into three complexity levels and recommended the transference of at risk patients to centers with the necessary specialists and resources and compatible with the level of risk and the severity of the disease.

The success of transport depends on the quality of care in the delivery room, the continuous and adequate attention to the NB in the neonatal unit before transfer, the choice of type of transport, the team that will be in charge of transport, and the quality of transport to the reference unit. Inadequate care in any phase may produce irreparable harm to the neonate.

This study evaluated the care provided to NB that required special attention in the towns in the northeastern region of the state of Rio Grande do Sul, in southern Brazil, and the quality of NB transport to a reference unit.

## Methods

This cohort study was conducted from August 2008 to July 2010 and included preterm NB transferred to the NICU of the General Hospital (GH) of Caxias do Sul, Brazil, in the first 3 days of life; the patients were followed up until hospital discharge or death. The GH is a reference hospital in the northeastern region of the state of Rio Grande do Sul, in southern Brazil, and admits only patients of the Brazilian Unified Health System. It has a tertiary level neonatal unit. All the premature infants born in one of the 52 counties in the region and transferred to the GH up to 72 hours of life were included in the study. Exclusion criteria were NB transferred after 72 hours of life and those born in counties that are not located in the northeastern region of the state of Rio Grande do Sul.

At NB admission to the NICU, a form was filled out by one of the authors or the neonatal intensivist with the necessary information about the care provided in the place of origin and about NB transport. These data were obtained from the physician or nurse that accompanied the patient. In specific cases, when data were missing, the authors obtained information via phone call to the physician that treated the NB in the hospital of origin. To check the effect of place of birth and transference on morbidity and mortality of transferred NB, two groups were organized: group 1 (transport group) included the 61 premature NB transferred to the GH; and group 2 (control group) comprised 123 NB delivered in the GH maternity ward and recruited immediately after the inclusion of a case, paired for gestational age (GA) with an acceptable variation of more or less one week.

Maternal variables were age, number of prenatal visits, gestational age, use of antenatal corticosteroids and mode of delivery. The NB variables were sex, BW, Apgar score at 1 and 5 minutes, and length of NICU stay. To evaluate the conditions of care in the maternity ward of origin and during transport, the equipment and medications used for NB care and during transport, the distance traveled and travel time, and the type of healthcare workers that participated in the care and transport were analyzed.

For comparisons between the two groups during hospitalization, the primary outcome was death, and the secondary outcomes were hyperglycemia (blood glucose > 160), hypoglycemia (blood glucose test < 40), hypothermia (temperature < 36 °C), hyperthermia (temperature > 37.5 °C) and oxygen saturation < 90%, variables that were collected in the first 30 minutes after admission. Other secondary outcomes were necrotizing enterocolitis (Bell classification),<sup>5</sup> bronchopulmonary dysplasia (oxygen dependent at 28 days of life), early (up to 3 days of life) and late (after 3 days of life) sepsis defined by positive blood culture. Data were entered in a database of the Epi-Info 6.04 software, and analyses were conducted using the Statistical Package for the Social Sciences (SPSS) 18.0. Relative risk was used to evaluate the association between independent variables and the outcome under study. In univariate analysis, the Student *t* test and the Mann-Whitney test were used for continuous variables, and a chi-square test or the Fisher exact test, for dichotomous qualitative variables. The level of significance was set at  $\alpha = 5\%$  and  $\beta = 90\%$ . The study was approved by the Research Ethics Committee of Universidade de Caxias do Sul.

## Results

During the study, 61 premature NB were transferred to the NICU of the GH; 54% ( $n = 33$ ) were male infants. Mean distance travelled by the NB was 91 km; the shortest

distance was 12 km, and the longest, 240 km. Mean travel time was 79 minutes.

Mean NB birth weight was 1,045 g and mean gestational age, 34 weeks. They stayed a mean 9 hours in the maternity ward of origin before transference.

Table 1 shows the comparison of maternal and NB variables between the two groups. The NB transport group had a lower number of prenatal visits, lower use of antenatal corticosteroids by the mother before 34 weeks of gestation, and a lower rate of cesarean sections.

The analysis of care given to pregnant women during delivery in the place of origin revealed that 95% were assisted by obstetricians. In the NB transport group, neonates were seen in the delivery room by a pediatrician in 77% of the cases (n = 47); 73% (n = 44) required some type of reanimation in the delivery room. The medication used in the neonatal unit to treat NB was: oxygen (93.4%; n = 57), intravenous fluids (62.3%; n = 38), antibiotics (21.3%; n = 13) and vasoactive drugs (1.6%; n = 1).

Table 2 lists the equipment used in the neonatal unit to treat the NB before transference and during transport. During treatment in the neonatal unit, infusion pumps were used for 16.4% (n = 10) of the NB. Glucose levels were controlled in 41% (n = 25) of the cases. A hood was used for half of the NB that received oxygen. An oximeter to control oxygen administration was used for 49% of the NB (n = 30). During transportation, there were low percentages of use of transport incubator, infusion pump, device for blood glucose test and oximeter.

During transport, NB infants were accompanied by a pediatrician in 33% of the cases (n = 20), a physician other than a pediatrician in 43% (n = 26), a nurse in 20% (n = 12), and only by a family member in 2% (n = 1). During transport, NB received intravenous fluids (59%; n = 36) and oxygen (88.5%; n = 54).

**Table 2 -** Health care equipment used in the neonatal unit and during transport of newborns, Caxias do Sul, 2008-2010

Equipment	Neonatal unit n (%)	Transport n (%)
Incubator/crib with temperature control	43 (70.5)	35 (57.4)
Infusion pump	10 (16.4)	8 (13.1)
Hood	30 (49.2)	-
Device for BGT	25 (41)	13 (21.3)
Oximeter	30 (49.2)	30 (49.2)
Bag and mask	14 (23)	21 (34.4)
Intubation material	14 (23)	0

BGT = blood glucose test.

\* Differences are due to missing data.

Table 3 shows the distribution of live births according to outcome variables. In the group of transferred neonates, there were more cases of hyperglycemia or hypoglycemia, hyperthermia and oxygen saturation below 90% (Table 3). There were no differences between the two groups in cases of bronchopulmonary dysplasia, necrotizing enterocolitis, early or late sepsis.

There were no statistically significant differences in mean number of days in NICU between the NB group (16 days) and the infants born in the GH (20 days) (p = 0.13).

The number of deaths represented 18% (n = 11) of the NB transport group and 8.9% (n = 11) of the control group, and this result reached borderline significance (p = 0.07).

**Table 1 -** Comparison of maternal and newborns' variables between the two groups, Caxias do Sul, 2008-2010

Variables	Transport n = 61	Controls n = 123	p
Maternal age*, mean (SD)	25.3 (7.7)	27.0 (7.2)	0.162
Adolescent mothers (95%CI)	28.8% (17.8-42.1)	18.0% (11.7-26.0)	0.1
Antenatal visits during gestation, median (IQR)	5 (2-7)	7 (5-7)	< 0.001
GA (weeks), median (IQR)	34.0 (31.0-36.0)	34 (31.8-35.0)	0.939
Use of corticosteroids < 34 weeks	24.0% (9.4-45.1)	72.7% (59.0-83.9)	< 0.001
Male infants (95%CI)	54.1% (40.9-66.9)	54.5% (45.2-63.5)	0.999
Cesarean section (95%CI)	42.6% (30.0-56.0)	67.2% (58.1-75.4)	0.002
1-min Apgar score, median (IQR)	7 (4-8)	7 (4-8)	0.726
Birth weight†, mean (SD)	2.045 (640)	1.920 (576)	0.177

GA = gestational age; IQR = interquartile range; SD = standard deviation; 95%CI = 95% confidence interval.

\* In years.

† In grams.

**Table 3** - Distribution of live newborns according to outcome variables during stay in neonatal intensive care unit in the General Hospital, Caxias de Sul, 2008-2010

Variables	Transport* (n = 61) n (%)	Controls* (n = 123) n (%)	RR (95%CI)	p
BGT > 160	17 (31.5)	3 (2.9)	3.2 (2.3-4.4)	< 0.001
BGT < 40	7 (15.9)	4 (3.8)	2.4 (1.4-4.0)	0.017
Temperature > 37.5 °C	10 (27.0)	3 (4.7)	2.5 (1.6-3.9)	0.002
Temperature < 36 °C	24 (47.1)	50 (45.0)	1.1 (0.7-1.7)	0.472
SaO <sub>2</sub> < 90	19 (31.7)	5 (6.6)	2.2 (1.6-3.0)	< 0.001
BPD	2 (3.3)	9 (7.4)	0.5 (0.2-1.9)	0.341
NEC	1 (1.6)	4 (5.2)	0.4 (0.1-2.6)	0.383
Early sepsis	2 (3.3)	9 (7.3)	0.5 (0.2-1.9)	0.230
Late sepsis	4 (6.6)	8 (10.4)	0.7 (0.3-1.7)	0.428
Death	11 (18.0)	11 (8.9)	2.0 (1.0-2.6)	0.074

BGT = blood glucose test; BPD = Bronchopulmonary dysplasia; NEC = Necrotizing enterocolitis; TRR = relative risk.

\* Differences are due to missing data.

## Discussion

This study revealed several deficiencies in the care and transport of NB and a trend towards an increase in the number of deaths of transferred NB (18%) when compared to infants born in the reference hospital (8.9%).

One of the limitations of this study was the small sample size, which decreased the power of analysis for the outcome death. A larger number of selected cases might have resulted in a statistically significant difference in the number of deaths between the two groups.

The sample size was also not large enough to detect the effect of transport over the incidence of bronchopulmonary dysplasia, necrotizing enterocolitis and sepsis, which had similar rates in the two groups.

Several data for this study were collected by interviewing the physician or nurse that participated in neonatal transport, which may have led to an information bias. In many cases, data collection had to be completed by means of a phone contact with the physician that treated the NB in the place of origin. At that moment, all data were collected again to check the reliability of the data previously collected, and no discrepancies were found.

The analysis of the prenatal care received during gestation revealed that the number of prenatal visits was smaller for the mothers of transferred NB, as well as the number of women in premature labor that received antenatal corticosteroids. Several studies<sup>6-8</sup> showed that a higher number of prenatal visits is associated with a decrease in neonatal mortality. In a similar way, the use of corticosteroids by pregnant women in premature labor is a strategy that has a great impact on neonatal mortality,

and is, together with the use of surfactants, one of the reasons for the extraordinary advances in neonatology in the last decades.<sup>9,10</sup> These factors, therefore, might have affected negatively the worse mortality rate in the NB transport group.

The analysis of mode of delivery revealed that there were 50% more cesarean sections in the group of GH neonates. Some studies have described that birth by cesarean section of extremely low birth weight NB is a protective factor against NB death.<sup>11-13</sup> However, there is no consensus in the literature about the best mode of delivery for extremely premature NB.<sup>11</sup>

Although this study was conducted only with premature NB, 23% of the transferred NB did not have any pediatric care in the delivery room. The reanimation of a NB in the delivery room is vital for the good prognosis of a neonate and should be performed by a pediatrician trained for this type of procedure. The absence of a trained pediatrician to treat the NB in the delivery room has a direct impact on the chances of survival and the future good quality of life of this NB.

The infants included in the study remained a mean 9 hours in the maternity ward of origin while they waited for transference. During this time, most received oxygen and intravenous fluids. Oxygen was administered to 93.4% of the NB, and an oximeter was used to control oxygen administration in only half of the cases. An infusion pump, an essential device in the adequate control of intravenous administration of fluids, particularly in premature NB, was used in a small number of cases. In this study, the infusion pump was used in only 16% of the cases, although intravenous fluids were administered to 62% of the NB.

Glucose control, recommended for all premature NB to detect blood glucose variations, was used in only 41% of the cases. The essential equipment to treat NB at risk in the maternity wards of origin was, therefore, underused.

Another study about equipment available in the maternity wards of the same region revealed severe deficiencies in basic resources to treat NB in most of the counties in the northeastern region of the state of Rio Grande do Sul.<sup>14</sup> Nine hospitals (40.9%) have no infusion pump for the neonatal unit, five (22.7%) do not have a hood or oximeter, and one (4.5%) has no bag and mask or any device for glucose blood tests.<sup>14</sup>

The evaluation of neonatal transport also revealed serious deficiencies. All the NB infants were transferred in an ambulance and accompanied by healthcare workers from the county of origin. However, only 33% of these NB were accompanied by a pediatrician during transport, and 22% were transferred without the presence of any physician despite the ethical and legal involvement of the worker that assisted the patient. In addition, about half of all premature neonates were transferred without a transport incubator despite the fact that they were born in one of the coldest regions of the country, where temperatures are often below zero Celsius in the winter. This fact had effects on the body temperature of the transferred NB, and 50% of them had hypothermia when admitted to the reference hospital. There is an association between hypothermia and increased mortality, and maintaining the temperature of the NB is a very effective measure to decrease neonatal morbidity and mortality.<sup>15</sup>

In contrast, a large number of NB with hypothermia were born in the GH maternity ward, where there are adequate resources to control the temperature in the delivery room, such as environmental heating, warmed cribs, use of caps and plastic bags for premature births. The cause of hypothermia might be associated with not using the transport incubator to transfer the NB to the NICU, which confirms the importance of adequate temperature control even during transport between hospitals.

During transport, the rates of use of the infusion pump, the oximeter and the device to control blood glucose were very low, although these devices are indispensable for the adequate clinical control of the patient. Because of that, 47% of the NB infants had abnormal glucose levels, and 32% had hypoxemia at admission.

Primary level maternity wards need a minimal level of material and human resources to be able to provide care for pregnant women and their NB. High risk births reach 15% of all births and, therefore, all maternity wards should have human resources and equipment to treat these NB adequately at birth, during their stay in the neonatal unit, and during transport to a reference unit. Inadequate care during any of these stages may bring negative repercussion for neonatal morbidity and mortality.<sup>6</sup>

In the organization of perinatal care in a hierarchical system of neonatal care, transport has a fundamental role as pregnant women and their NB are transferred from a primary level maternity ward to reference services.<sup>16</sup> This service should be regional and located in towns that are centers of reference operating 24 hours a day with adequate vehicles and equipment for neonatal transport and a specialized team for NB transport.<sup>17,18</sup>

In a significant number of counties in the region, our study found deficiencies in pediatric care and the lack of basic equipment for the care of NB and their transport when necessary. Therefore, norms for the operation of maternity wards should be established and enforced, and the quality of the care provided should be controlled.<sup>16</sup>

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