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Specifics of inter-hospital transport of pediatric patients.

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ABSTRACT

INTRODUCTION: A newborn staying in a hospital department constitutes a patient requiring complex care, which sometimes involves the need for transport to another medical facility. The "N" (neonatal) ambulance is a common option for transporting newborns in Poland. The crew members and equipment of the ambulance are strictly defined by legal regulations. The equipment present in the "N" ambulance is tailored to the needs of neonatal patients, with the incubator being its most important component. A list of indications for transporting a pediatric patient to a higher referral hospital has been created. The purpose of this study is to create a pediatric patient profile based on the perspective of the transport team, as well as the characteristics of the medical interventions undertaken.

MATERIAL AND METHODS: The retrospective study was conducted based on the data provided by a hospital in central Poland. Medical records in the form of work sheets of the "N" type of emergency medical service team from the period 2018-2022 were analyzed. A total of 1,026 trip sheets were analyzed, wherein 1,025 cases were included in the study. The analysis included data on sex, birth age, body mass, the patient's condition in the department and during transport, the medical activities performed during transport, and the diagnosed condition. The rho-Spearman test was used to calculate the significance of the variables' correlation, at a significance level of $p<0.05$.

RESULTS: During the study period, the "N" ambulance transported patients with 60.8% being boys (n=623) and 39.1% being girls (n=401). Transport most commonly included full-term patients (57.8%; n=592), with normal body mass at birth (64.4%; n=660). There was a statistically significant correlation between the patient's condition in the department and the birth age (Spearman test=-0.286; p<0.000). The most common diagnoses concerned conditions beginning in the perinatal period (67.6%; n=1048). According to ICD-10, the most common diagnoses given to patients were: P07 (22.8%; n=239), P22 (21.8%; n=229), P23 (9.9%; n=104). The neonatal pathology department (63.3%; n=648) appeared to be the dominant department of destination transport. During transport, the condition of 95.8% of the subjects remained stable (n=982). Patients' condition during transport significantly correlated with department status (Spearman test=0.263; p<0.000). Respiratory support was required in case of 38.1% (n=391) patients in the department and for 37.4% (n=383) subjects during transport.

CONCLUSIONS Most of the inter-hospital transports involved boys. More than half of the subjects were born at term between 37 and 42 weeks of gestation, in good overall condition, but required transport to higher referral hospitals due to their condition. The condition of the patients during transport was mostly described as stable, and less than half of the subjects needed respiratory support.

KEY WORDS: Inter-hospital transport, ambulance, newborn, patient, pediatrics, neonatology.

INTRODUCTION

The newborn is a patient who usually requires comprehensive care. While still in the mother's body, they should be in constant follow-up of a team of doctors, nurses and midwives. Continuous follow-up of the pregnant patient allows early detection of defects and abnormalities in the pregnant woman and the fetus. The neonatology provides cares for the newborn in their first month of life. The principles of this care are defined by the standards of care in Poland [1,2]. An important part of medical care is proper communication between medical personnel and parents-to-be during pregnancy, labor and postpartum period. Care of the pregnant woman should be provided respectfully, the mode of communication should be continuous and open, allowing questions to be asked and answered. It is also important to remember about individualizing the needs, preferences and values of individual patients [3].

The standard of medical care in Poland lists three options for transporting newborns. According to the literature, the safest option is intrauterine *(in utero*) transport. It allows labor to begin in a hospital with the appropriate level of reference, where the newborn will receive immediate aid from highly specialized medical staff if necessary [4]. Another common option for transporting a newborn is by "N" (neonatal) ambulance. The members of the crew and equipment of the ambulance are strictly defined in legal regulations [5]. Transport can also be by air, assisted by the Polish Medical Air Rescue (LPR) team [6].

The equipment of a neonatal ambulance in Poland definitely differs from the equipment of a classic emergency medical team. The equipment present in the "N" ambulance is tailored to the needs of neonatal patients, with the incubator being its most important component. It is the task of the personnel in charge of transport to constantly monitor the patient's condition and vital signs during transport, and to record the collected data in a sheet prepared for this purpose, entitled: "The work sheet of the N-type emergency medical service team" [2].

It is worth noting that there are physiological differences in pediatric patients, depending on their age. This ranges from the respiratory rate, blood pressure, to body composition. Changes in medical management depend on the patient's age, body mass and anatomical structure. The following developmental stages of a pediatric patient can be distinguished: fresh newborn, newborn, infant and child [7].

A list of disorders that are an indication for transporting a pediatric patient to a higher referral hospital has been created. These disorders include prematurity of less than 35 weeks of gestation, body mass at birth of less than 2,000g, suspected congenital heart defects, metabolic defects, neurological or respiratory disorders, conditions requiring surgical protection, birth-related complications (e.g., trauma, hypoxia), hypoglycemia and hyperbilirubinemia, and suspected sepsis. The decision to transport a pediatric patient to another medical facility is made by the attending doctor [8]. The purpose of this study is to create a pediatric patient profile based on the perspective of the transport team, as well as the characteristics of the medical interventions undertaken.

MATERIALS AND METHODS

The retrospective study was conducted based on the data provided by a hospital in central Poland. The study received a positive opinion from the Research Ethics Committee of the University of Siedlce (7/2023) on December 7, 2023. The study consisted of the collection and thorough analysis of medical records in the form of work sheets of the "N" type of emergency medical service team, from the period of 2018-2022. A total of 1,026 trip sheets were analyzed, wherein 1,025 cases were included in the study. One trip sheet was not included in the study due to the team's decision not to transport a patient in moribund state. Data on sex, birth age, body mass, patient's condition in the department and during transport, medical activities performed during transport, diagnosed disease entity were analyzed. The rho-Spearman test was used to calculate the significance of the variables' correlation, at a significance level of $p<0.05$.

RESULTS

Pediatric patient profile

During the study period, the "N" transport ambulance transported patients, wherein 60.8% were male (n=623) and 39.1% were female (n=401). One patient's sex was marked "unspecified" (0.1%). The ages of pediatric patients were cataloged according to WHO recommendations for classifying newborns based on fetal age. Newborns born at term (37+0 to 42 Hbd) constituted 57.8% (n=592), while overdue newborns (born after 42 weeks of gestation) constituted 0.1% (n=1). Transport of extreme preterm infants (27+6/7 Hbd) constituted 2.6% of cases (n=26), while extreme preterm infants (28+0/7 to 31+6/7 Hbd) accounted for 6.3% (n=65). Moderate or late prematurity (32+0/7 to 36+6/7 Hbd) was documented in 19% of patients (n=195). In the remaining 14.2% of cases (n=146), information regarding birth age was not completed. The mean birth age of the patients was 36.97 (SD±2.86) weeks. A detailed summary of fetal age is presented in Figure 1.

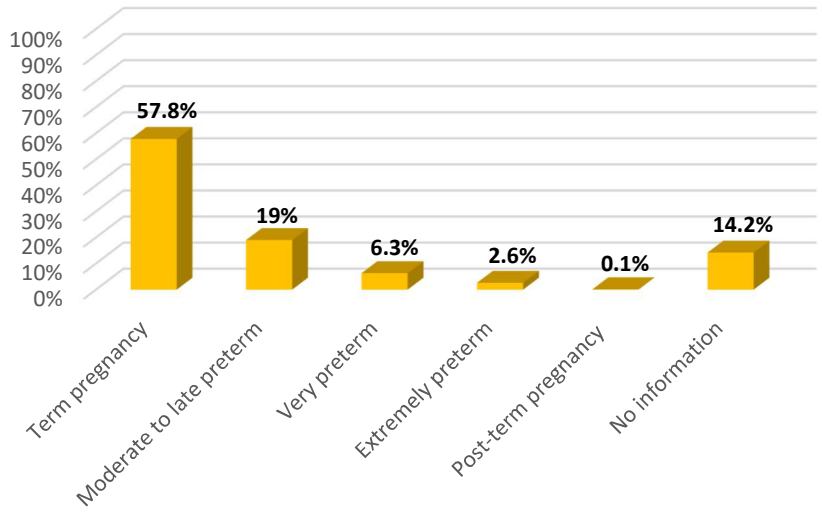

Figure 1. Classification of patients by fetal age.

Normal body mass at birth (2500-3999 grams) was recorded in 64.4% of the subjects (n=660). Macrosomia (body mass at birth ≥4,000 grams) affected 10.3% of patients (n=105). Extreme low body mass at birth (500-999 grams) concerned 1.9% of those studied (n=20), and very low body mass at birth (1000-1499 grams) concerned 5% (n=51). In contrast, moderately low body mass at birth (1500-2499 grams) was observed in 16.6% of patients (n=170). No information on body mass at birth was provided for 19 patients (1.8%). There was a significant correlation of sex with body mass at birth (Spearman test=0.124; p<0.000). The mean body mass of female patients was 2894.2 g (SD ± 866.22), while that of male patients was 3099.9 g (SD ± 855.98). The exact data is presented in Figure 2.

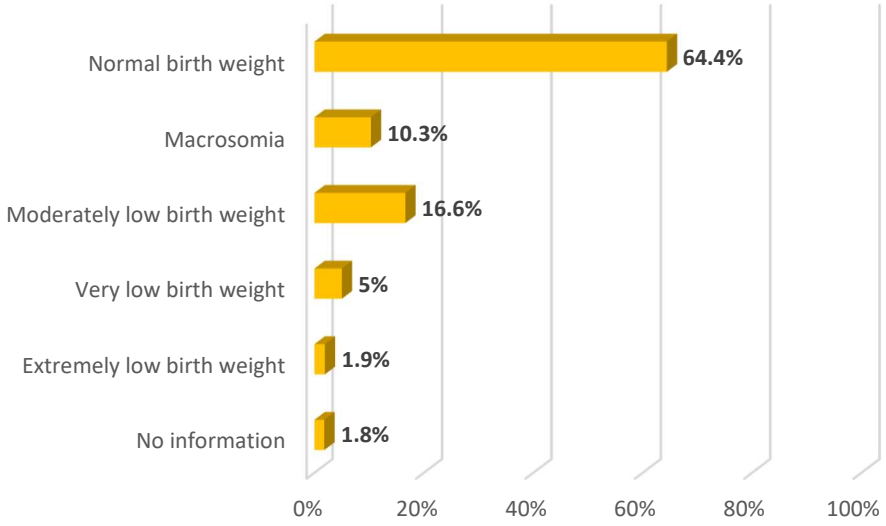

Figure 2. Patients' body mass at birth.

Good condition based on APGAR scales was recorded in 85.4% of the subjects (n=875), medium condition in 11% (n=113), while severe condition was found in 1.8% of the newborns (n=18). In case of 1.8% (n=19), no information was provided regarding the APGAR scale. There was no statistically significant correlation between sex and APGAR score (Spearman test=-0.015; p=0.636).

It was shown that the most common diagnoses in the studied patients concerned conditions beginning in the perinatal period (67.6%; n=1048). Congenital malformations, deformities and chromosomal aberrations ranked second (20%; n=311), while respiratory diseases ranked third (6.4%; n=100). Pediatric patients were least likely to have diagnoses such as cardiovascular diseases, skin and subcutaneous tissue diseases, musculoskeletal and connective tissue diseases, trauma, poisoning and other specified effects of external agents, and factors affecting health and contact with health services (0.1%; n=2).

It should be noted that at least two disorders have been assigned to most patients. Table 1 summarizes selected conditions beginning in the perinatal period according to the ICD-10 classification.

Table 1. Certain conditions originating in the perinatal period.

ICD-10	Certain conditions originating in the perinatal period	Number of diagnoses	
		[n]	[%]
P07	Disorders related to short gestation and low birth weight, not elsewhere classified	239	22.8
P22	Respiratory distress of newborn	229	21.8
P23	Congenital pneumonia	104	9.9
P39	Other infections specific to the perinatal period	92	8.8
P21	Birth asphyxia	69	6.6
P28	Other respiratory conditions originating in the perinatal period	67	6.4
P29	Cardiovascular disorders originating in the perinatal period	40	3.8
P90	Convulsions of newborn	32	3
P24	Neonatal aspiration syndromes	25	2.4
P05	Slow fetal growth and fetal malnutrition	19	1.8
P96	Other conditions originating in the perinatal period	15	1.4
P59	Neonatal jaundice from other and unspecified causes	14	1.3
P52	Intracranial nontraumatic haemorrhage of fetus and newborn	13	1.2
P61	Other perinatal haematological disorders	13	1.2
P76	Other intestinal obstruction of newborn	11	1
P36	Bacterial sepsis of newborn	10	0.9
P78	Other perinatal digestive system disorders	9	0.8
P92	Feeding problems of newborn	6	0.6
P94	Disorders of muscle tone of newborn	6	0.6
P37	Other congenital infectious and parasitic diseases	5	0.5
P35	Other congenital infectious and parasitic diseases	4	0.4
P70	Transitory disorders of carbohydrate metabolism specific to fetus and newborn	4	0.4
P55	Haemolytic disease of fetus and newborn	4	0.4
P25	Interstitial emphysema and related conditions originating in the perinatal period	3	0.3
P83	Other conditions of integument specific to fetus and newborn	3	0.3
P03	Fetus and newborn affected by other complications of labour and delivery	2	0.2
P50	Fetal blood loss	2	0.2
P08	Disorders related to long gestation and high birth weight	2	0.2
P77	Necrotizing enterocolitis of fetus and newborn	2	0.2
P04	Fetus and newborn affected by noxious influences transmitted via placenta or breast milk	2	0.2
P00	Fetus and newborn affected by maternal conditions that may be unrelated to present pregnancy	1	0.1
P54	Other neonatal haemorrhages	1	0.1

The neonatal pathology department was the dominant department to which pediatric patients were transported (63.3%; n=648), followed by the intensive care unit (10.6%; n=108), and the cardiology department (6.9%; n=71) in third place. The fewest subjects were transported to the pediatric department (0.6%; n=6). The detailed data is illustrated in Figure 3.

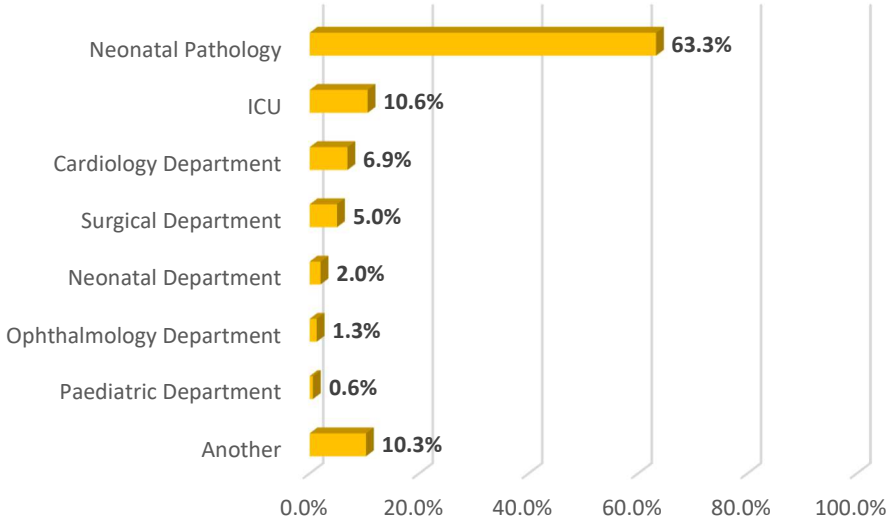

Figure 3. Target patient transport departments.

Comparative analysis of subjects in the department and during transport

There was no relationship between sex and the patient's condition in the department (Spearman's test=0.015; p=0.635) or during transport (Spearman's test=0.029; p=0.362). Patients in good condition constituted 53% (n=543), in medium condition - 30.4% (n=312), in severe condition - 16.1% (n=166), while agony condition affected 0.4% of the total (n=4). There was a statistically significant correlation between the patient's condition in the department and the birth age (Spearman test=-0.286; p<0.000). Good condition was reported in patients with a mean birth age of 37.85 weeks (SD ± 3.57), medium condition: 36.76 weeks (SD ± 3.04), severe: 34.66 weeks SD ± 4.85), while agony: 30.5 weeks (SD ± 7.23).

In contrast, the condition of 95.8% of the subjects remained stable during transport (n=982). The condition deteriorated in 2.4% of the subjects (n=25), and improved in 1.7% of the subjects (n=17). Death occurred in 1 patient (0.1%). It was shown that the patients' condition during transport significantly correlated with the condition in the department (Spearman test=0.263; p p<0,000). In contrast, there was no statistically significant difference between the subjects' condition during transport and birth age (Spearman test=-0.052; p=0.120). The detailed data is illustrated in Table 2.

Table 2. Comparative analysis of the patient's condition in the department and during transport.

Patient's condition in the department	*[n]*	*[%]*
Good state	543	53
Moderate state	312	30.4
Severe state	166	16.1
Agony state	4	0.4
Patient's condition during transport	**[n]**	**[%]**
Stable	982	95.8
Deterioration of the patient's condition	25	2.4
Improvement of the patient's condition	17	1.7
Death	1	0.1

Patients on breathing independently in the department were recorded at 61.8% (n=634), while 62.6% (n=642) were on transport. Respiratory support was required in case of 38.1% (n=391) patients in the department and for 37.4% (n=383) subjects during transport. A detailed comparative analysis is shown in Figure 4.

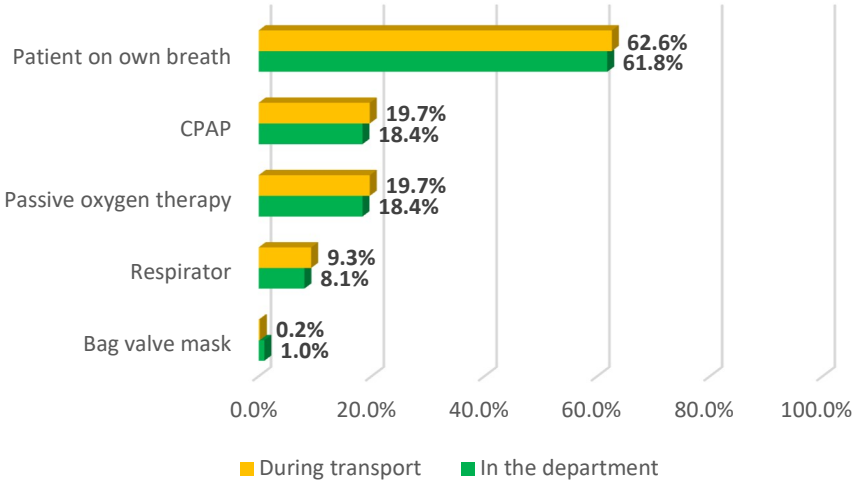

Figure 4. Comparative analysis of the respiratory capacity of subjects in the department and during transport.

70% of patients (n=717) had peripheral puncture in the department had. A total of 182 venous lines (17.8%) were placed by the "N" team, mostly in patients whose condition in the department was described as moderate (n=90; 49.45%) and severe (n=47; 25.82%). Peripheral insertion performed for transport did not depend on birth age (Spearman's test=0.023; p=0.497), body mass at birth (Spearman's test=-0.001; p=0.954), hospital ordering transport (Spearman's test=-0.019; p=0.551), destination (Spearman's test=-0.020; p=0.518), but was significantly dependent on the patient's condition in the department (Spearman's test=0.255; p<0.000).

DISCUSSION

The vast majority of newborns in modern times are born in good condition and do not require specialized medical care. This may be due to the public's developing awareness of pregnancy, prenatal care and childbirth. In most European countries these days, access to medical care, prenatal checkups or birthing schools is widespread. This allows early detection of abnormalities in the course of pregnancy and implementation of appropriate measures aimed at improving the well-being and health of the pregnant woman and fetus [9].

Pathological events during pregnancy or childbirth can be caused by conditions specific to pregnancy, conditions exacerbated by pregnancy, or random disorders [10]. Neonatal diseases are characterized by significant unpredictability, sudden and tragic course (e.g., placental abruption, preterm labor, hypoxia of the newborn before or during delivery, respiratory distress syndrome, meconium aspiration) [11]. Risk factors for the development of pre-, peri- or postnatal complications may include older age of patients, predisposing them to the development of chronic diseases such as hypertension, diabetes or even coronary artery disease [12]. Other risk factors include low level of education and awareness of the importance of health care in pregnant women, as well as the long distance between home and hospital [11].

Hospitals are tasked with providing around-the-clock specialized medical care. To meet these requirements aimed at the youngest patients, the hospital should have qualified, experienced medical staff, departments equipped with appropriate medical equipment and a well-organized work structure [13]. The diagnosis most often given to the studied pediatric patients referred to conditions beginning in the perinatal period. It seems fair to conclude that at the time of early detection of fetal pathology or abnormalities in the course of pregnancy, the patient should be taken care of in a specialized hospital with the appropriate reference level, with adequate facilities for pregnancy and childbirth. This will reduce perinatal complications and increase the safety of the pregnant woman and fetus, as well as reduce the number of inter-hospital transports of newborns [14,15].

Pregnancy screening allows early detection of abnormalities and pathologies in the pregnant woman and fetus. European guidelines recommend implementing education for parents-to-be about screening before birth and at any time during the prenatal period [16]. The number of diseases covered by screening in Poland from 1985 is 30. In most cases, screening involves inborn metabolic defects (including adrenal hyperplasia, thyroid disease), as well as cystic fibrosis and spinal muscular atrophy [17].

After completing the study, it was noted that the majority of pediatric patients qualified for transports were full-term and had normal body mass at births, while the transport of extreme preterm infants and preterm infants with extremely low body mass at birth involved fewer cases. Newborns born prematurely are particularly susceptible to systemic infections resulting from immaturity of defense mechanisms, prolonged hospitalizations, the need to support vital signs and invasive interventions [18].

The study found that the condition of the predominant number of pediatric patients did not change and remained stable during transport. This may suggest that effective neonatal transport protocols are in place at the studied healthcare facility to ensure patient safety during transport.

The study by Demeta D Soysala et al. demonstrated the problems arising during inter-hospital transport of pediatric patients. The study found that in 79.3% of cases, the destination hospitals were not informed about the patient's transportation, while information on the transported patient's health condition was adequate in only 26.1% of cases. The study found that 64.4% of patients were transported using ambulances, out of which only 16.2% of ambulances were adequately equipped. 26.3% of patients reached the destination hospital in agony. This may have been the result of pediatric patients being transported by inexperienced or unqualified personnel (42.8%) [19].

In contrast, a study by S. K. Dey et al. showed the problems that can arise during the transport of pediatric patients. The study found that the majority of inter-hospital transports (77%) involved preterm infants with low body mass at birth (75%). 87% of the subjects were transported to the destination hospital by ground ambulance, while medical personnel was involved in the transport only in 4% of cases. On admission to the hospital, hypothermia was reported in 7.6% of subjects, hypoglycemia in 11%, poor perfusion in 19%, and low saturation in 18%. In contrast, hyperthermia and hyperglycemia affected 5% of newborns. The authors concluded that the newborns included in the study who were reported dead in the hospital were more likely to suffer from hypothermia (p=0.007) and hypoxia (p=0.049). After reviewing the study, it can be concluded that the newborns involved in the study were transported despite the lack of safe transport and qualified medical personnel [20].

Independently breathing patients in the department constituted 61.8%, while constituting 62.6% during transport. Respiratory support was required by 38.1% of subjects in the department and 37.4% during transport. Respiratory distress syndrome (RDS) is the predominant cause of respiratory failure in premature infants. This may be due to insufficient lung development and surfactant deficiency. In study by Wheeler CR and Smallwood CD, a comparative analysis of approaches to treating respiratory failure in premature infants was performed, focusing on identifying the indications for intubation and its timing. The failure rate during CPAP use was recorded at 50% for subjects born at 26-28 weeks of gestation, 26% for subjects born at 29-31 weeks of gestation, and 20% for patients born at 33-34 weeks of gestation. The authors also noted that the indications for intubation increase in patients with lower gestational age: 76% at 26-28 weeks of gestation, 33% at 29-32 weeks, and 16% at 33-34 weeks. Intubation within 3 hours of birth has been reported in almost 75% of premature infants born in less than 28th week of gestation [21].

The vast majority of the newborns studied were transported to the neonatal pathology department (63.4%). The neonatal pathology department is a dedicated unit for the treatment of newborns with various perinatal and postnatal complications, such as prematurity, birth defects, low body mass at birth, metabolic diseases or respiratory problems. The prevalence of pediatric patient transports to this department

suggests that it plays a key role in providing care newborns who require specialized medical care. The results of our own research confirm that newborns requiring transport often need a higher level of medical care than that available in neonatology and pediatric departments [22].

Limitations of the study

For the purposes of the study, the trips of an "N" transport team reporting to a single medical entity in central Poland were analyzed, making comparative analysis between other "N" transport teams in the study impossible. The predominant limitation of the study appeared to be absence of due diligence during the medical record completion by members of the transport team, which resulted in ambiguities during data collection and analysis. The study is innovative, and not enough literature has been found on inter-hospital transport of pediatric patients.

CONCLUSIONS

During the period studied, most of the transports involved boys. More than half of the subjects were born at term between 37 and 42 week of gestation, in good general condition, but required transport to higher referral hospitals or hospitalization in specialized units due to their condition. Most often, patients were transported to the Neonatal Pathology Department. The predominant diagnosis given to pediatric patients was for conditions beginning in the perinatal period (in particular, disorders associated with short gestation period and low body mass at birth, as well as respiratory distress syndrome). The condition of the patients during transport was mostly described as stable, and less than half of the subjects needed respiratory support. It should be recognized that properly planned and managed transport is safe and contributes to favorable outcomes of neonatal care in the destination department.

SUPPLEMENTARY INFORMATION

Funding: *No fund was received related to this study.*
Institutional Review Statement: *The study was conducted according to the guidelines of the Declaration of Helsinki.*
Informed Consent Statement: *Informed consent was obtained from all subjects involved in the study.*
Data Availability Statement: *The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.*
Conflicts of Interest: *The authors declare no conflicts of interest.*
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