



## SCIENTIFIC LETTER

## Pediatric and neonatal transport from a secondary hospital: Vulnerabilities, inequities and areas of improvement<sup>☆</sup>

### Transporte pediátrico y neonatal desde un hospital secundario: vulnerabilidades, desigualdades y áreas de mejora

Dear Editor:

Specialized pediatric and neonatal interhospital transport (PNIHT) is crucial for ensuring the safety of critically ill patients, especially for hospitals without pediatric or neonatal intensive care units or pediatric surgery departments.<sup>1</sup>

Specialized teams significantly reduce mortality and complications during interhospital transport.<sup>2</sup> However, Spain lacks universal coverage, with significant regional differences.<sup>1</sup> In this context, several Spanish medical societies (SECIP, SENEo, SEUP, and SEMES) have issued recommendations for its development.

We conducted a retrospective observational and analytical study (2018–2023) with consecutive sampling to analyze the characteristics, interventions, and complications of all patients transported from a secondary hospital without a PNIHT.

The sample included all patients aged less than 15 years, without exclusion criteria, and the objective was to identify vulnerability profiles and areas of improvement. We reviewed health care records and transport reports and analyzed the data with R Studio 4.2.0 (significance:  $P < .05$ ). The study was approved by the Ethics Committee (No. 24317).

There were a total of 363 transports: 60.3% involved male patients, and the median patient age was 4.8 years. Of all transports, 93.1% ( $n = 338$ ) were urgent, one-third (33.8%)

required a mobile ICU, and 84.6% ( $n = 307$ ) were performed within 24 h of admission.

The distribution by diagnosis showed a predominance of surgical cases (54.3%), primarily on account of appendicitis, which partly explains the low overall complexity of the cohort. Neonatal (10.2%) and respiratory (8.8%) conditions were associated with the highest clinical vulnerability, with a higher proportion of these patients requiring respiratory support (59.5% and 78.1%, respectively, compared to 0% for surgical patients;  $P < .001$ ), neurologic support (43.2% and 9.4% compared to 0%;  $P < 0.001$ ), and admission to intensive care (78.4% and 87.5% compared to 4.6%;  $P < .001$ ) (Table 1). We found no significant seasonal differences ( $P = .186$ ) (Tables 1 and 2).

The incidence of complications was 5.7%, higher compared to specialized transport systems (1.6%–2.1%).<sup>2–5</sup> However, direct comparison is limited by methodological and population differences. Newborns (13.5%) and respiratory patients (21.9%) were the groups at highest risk ( $P < .05$ ), consistent with other studies.<sup>3</sup> The observational design and the lack of risk-adjusted analyses precluded inferences of causality. However, the consistent clustering of complications in newborns and respiratory patients supports the biological plausibility of these findings. There were no deaths during transport or in the 24 h after.

Stabilization at the sending hospital is key to ensuring safe transport. In our hospital, initial stabilization and escalation of respiratory support were performed either before the arrival of the medical emergency team or upon arrival at the receiving hospital, which could contribute to higher rates of complications in neonatal and respiratory patients, although studies with control groups would be required to make a direct comparison. These findings are consistent with other studies, which identify them as the most vulnerable<sup>3</sup> and likely to benefit from specialized transport.

Established systems such as CATS (United Kingdom) and NETS (Australia) have been found to improve safety and standardization of NPIHT following their implementation.<sup>2,4,5</sup> In Spain, the Catalan model, among others, has made progress in this area, and positive clinical results have been reported.<sup>1,3</sup>

Based on this evidence, we propose three potential priorities for local improvement:

DOI of original article:

<https://doi.org/10.1016/j.anpedi.2026.504195>

<sup>☆</sup> Previous presentation: This study was presented as an oral communication at the XXXV Guillermo Arce and Ernesto Sánchez Villares Memorial Conference of the SCCALP, November, 2024; Salamanca, Spain; and as a poster at the XXX Congress of Neonatology and Perinatal Medicine; October 2025; Las Palmas de Gran Canaria, Spain.

**Table 1** Epidemiological and clinical characteristics by diagnostic group.

<b>Clinical characteristics</b>							
<i>Reason for transport, n (%)</i>	Total	Surgical	Neonatal	Respiratory	Neurologic	Other	
	363 (100)	197 (54.3)	37 (10.2)	32 (8.8)	30 (8.3)	67 (18.5)	
<i>Predominant disease (%)</i>		Acute appendicitis (62.8)	Perinatal asphyxia (28.9)	Severe bronchiolitis (46.9)	Status epilepticus (40)	Other <sup>a</sup>	
<b>Demographic characteristics</b>							
<i>Male sex, n (%)</i>	219 (60.3)	128 (65)	26 (70.3)	20 (62.5)	15 (50)	30 (44.8)	<i>P</i> = .032
<i>Age in years, median (IQR)<sup>b</sup></i>	4.8 (1.8–9.2)	9.2 (7.1–11.8)	0.0 (0–0.1)	1.9 (0.8–7.5)	2.1 (0.8–5.4)	6.5 (3.2–10.1)	<i>P</i> < .001
<b>Transport characteristics</b>							
<i>From emergency department, n (%)</i>	166 (45.7)	139 (70.6)	0 (0.0)	5 (15.6)	8 (26.7)	14 (20.9)	<i>P</i> < .001
<i>Urgent transport, n (%)</i>	338 (93.1)	197 (100)	30 (81.1)	32 (100)	30 (100)	49 (73.1)	<i>P</i> < .001
<i>Mobile ICU, n (%)</i>	123 (33.9)	0 (0.0)	37 (100)	32 (100)	30 (100)	49 (73.1)	<i>P</i> < .001
<i>Transport &lt; 24 h of admission, n (%)</i>	307 (84.6)	197 (100)	23 (62.2)	27 (84.4)	22 (73.3)	38 (56.7)	<i>P</i> < .001
<b>Temporal distribution</b>							
<i>By year, n (%)</i>							<i>p</i> = .245
2018	53 (14.6)	31 (15.7)	4 (10.8)	4 (12.5)	3 (10)	11 (16.4)	–
2019	55 (15.2)	18 (9.1)	7 (18.9)	8 (25)	6 (20)	16 (23.9)	–
2020	64 (17.6)	38 (19.3)	8 (21.6)	3 (9.4)	5 (16.7)	10 (14.9)	–
2021	61 (16.8)	34 (17.3)	4 (10.8)	8 (25)	5 (16.7)	10 (14.9)	–
2022	61 (16.8)	31 (15.7)	7 (18.9)	3 (9.4)	4 (13.3)	16 (23.9)	–
2023	69 (19.0)	45 (22.6)	7 (18.9)	6 (18.8)	7 (23.3)	4 (6.0)	–
<i>By season, n (%)<sup>c</sup></i>							<i>P</i> = .186
Spring	93 (25.6)	52 (26.4)	11 (29.7)	5 (15.6)	7 (23.3)	18 (26.9)	–
Summer	106 (29.2)	49 (24.9)	13 (35.1)	9 (28.1)	13 (43.3)	22 (32.8)	–
Fall	78 (21.5)	47 (23.9)	8 (21.6)	7 (21.9)	4 (13.3)	12 (17.9)	–
Winter	86 (23.7)	49 (24.8)	5 (13.5)	11 (34.4)	6 (20.0)	15 (22.4)	–
<i>By day of week, n (%)</i>							<i>P</i> = .682
Holidays/weekends	155 (42.7)	83 (42.1)	16 (43.2)	13 (40.6)	16 (53.3)	27 (40.3)	
<b>Pretransport support</b>							
<i>Respiratory support, n (%)</i>	58 (16.0)	0 (0.0)	22 (59.5)	25 (78.1)	7 (23.3)	4 (6.0)	<i>P</i> < .001
Conventional oxygen therapy	21 (5.8)	0 (0.0)	2 (5.4)	14 (43.8)	2 (6.7)	3 (4.5)	–
High-flow oxygen therapy	6 (1.7)	0 (0.0)	3 (8.1)	3 (9.4)	0 (0.0)	0 (0.0)	–
NIV	15 (6.9)	0 (0.0)	8 (21.6)	7 (21.9)	0 (0.0)	0 (0.0)	–
IMV	16 (4.4)	0 (0.0)	9 (24.3)	1 (3.1)	5 (16.7)	1 (1.5)	–
<i>Neurologic support, n (%)</i>	31 (8.5)	0 (0.0)	16 (43.2)	3 (9.4)	11 (36.7)	1 (1.5)	<i>P</i> < .001
Passive cooling	10 (2.8)	0 (0.0)	10 (27.0)	0 (0.0)	0 (0.0)	0 (0.0)	–
Anticonvulsants	13 (3.6)	0 (0.0)	3 (8.1)	0 (0.0)	10 (33.3)	0 (0.0)	–
	6 (1.7)	0 (0.0)	3 (8.1)	2 (6.3)	1 (3.3)	0 (0.0)	–
<i>Sedation/analgesia</i>							
PCAC	2 (0.6)	0 (0.0)	0 (0.0)	1 (3.1)	0 (0.0)	0 (0.0)	–
<i>Hemodynamic support, n (%)</i>	7 (1.9)	0 (0.0)	3 (8.1)	0 (0.0)	4 (13.3)	0 (0.0)	<i>P</i> < .001
Prostaglandins	1 (0.3)	0 (0.0)	1 (2.7)	0 (0.0)	0 (0.0)	0 (0.0)	–
Dopamine	2 (0.6)	0 (0.0)	2 (5.4)	0 (0.0)	0 (0.0)	0 (0.0)	–

**Table 1** (Continued)

	4 (57.2)	0 (0.0)	0 (0.0)	0 (0.0)	4 (13.3)	0 (0.0)	–
Dopamine + dobutamine							
Venous access, <i>n</i>	324 (89.3)	180 (91.4)	32 (86.5)	30 (93.8)	23 (76.7)	17 (25.4)	<i>P</i> < .001
(%)							
Peripheral	306 (84.3)	180 (91.4)	25 (68.6)	30 (93.4)	22 (73.3)	15 (22.4)	–
Central/PICC <sup>d</sup>	18 (5.0)	0 (0.0)	7 (18.9)	0 (0.0)	1 (3.3)	10 (14.9)	–
<b>Final destination</b>							
PICU/NICU, <i>n</i> (%)	104 (28.7)	9 (4.6)	29 (78.4)	28 (87.5)	18 (60)	20 (29.9)	<i>P</i> < .001

Methodological note: The statistical comparisons are exploratory and aim to identify patterns of vulnerability rather than causal associations. No exclusion criteria were applied to reflect real-world clinical practice in patient transport.

Abbreviations: ICU, intensive care unit; IMV, invasive mechanical ventilation; NICU, neonatal intensive care unit; NIV, noninvasive ventilation; PCAC, post-cardiac arrest care; PICC, peripherally inserted central catheter; PICU, pediatric intensive care unit.

<sup>a</sup> Others include: infectious (*n* = 17), hematological and oncological (*n* = 17), endocrine and metabolic (*n* = 8), psychiatric (*n* = 6), cardiovascular (*n* = 5), gastrointestinal (*n* = 4), renal and urinary (*n* = 1), miscellaneous (*n* = 9).

<sup>b</sup> The distribution of patients by age group showed that 10.2% (*n* = 37) were neonates, 23.7% (*n* = 86) infants (1–24 months), 31.4% (*n* = 114) preschool-aged children (2–5 years), 24.5% (*n* = 89) school-aged children (6–11 years), and 10.2% (*n* = 37) adolescents (12–14 years).

<sup>c</sup> Cold vs warm seasons: 56.3% vs 43.7% (*P* = .077).

<sup>d</sup> Includes PICC, umbilical central line, and intraosseous line.

**Table 2** Complications during transport and upon arrival at the receiving hospital, by diagnostic group.

Type of complication, <i>n</i> (%)	Neonatal ( <i>n</i> = 37)	Respiratory ( <i>n</i> = 32)	Neurologic ( <i>n</i> = 30)	Other <sup>a</sup> ( <i>n</i> = 200)	Total ( <i>n</i> = 299 <sup>b</sup> )	<i>P</i>
<i>Respiratory</i>	3 (8.1)	7 (21.9)	1 (3.3)	1 (0.5)	12 (60)	<.001
Respiratory acidosis <sup>c</sup>	2 (5.4)	7 (21.9)	0 (0.0)	1 (0.5)	10 (83.3)	–
Accidental extubation	1 (2.7)	0 (0.0)	1 (3.3)	0 (0.0)	2 (16.7)	–
<i>Altered level of consciousness</i>	1 (2.7)	0 (0.0)	1 (3.3)	0 (0.0)	2 (0.7)	.083
<i>Hemodynamic</i>	1 (2.7)	0 (0.0)	0 (0.0)	1 (0.5)	2 (0.7)	.344
<i>Changes in temperature<sup>d</sup></i>	3 (8.1)	0 (0.0)	0 (0.0)	0 (0.0)	3 (1)	<.001
<i>Loss of venous access</i>	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	1 (0.3)	.740
<i>Total patients with complications</i>	5 (13.5)	7 (21.8)	2 (6.7)	3 (1.5)	17 (5.7)	<.001
<i>Total complications</i>	8	7	2	3	20 (6.7%)	–

Methodological note:

a) Given the low incidence of individual events, statistical comparisons were limited to overall complication rates.

b) Definition of complication: adverse event occurring during transport or objectively measurable clinical deterioration within 24 h of arrival to the receiving hospital compared to pretransport status, including respiratory, cardiovascular, neurological, body temperature, and technical complications, using a methodology adapted from previous studies on pediatric transport.<sup>2,3</sup>

c) The rates were calculated based on the 299 patients with arrival data. Since some patients experienced more than one event, the number of complications (20) exceeds the number of affected patients (17).

d) Biochemical complications (respiratory acidosis) were confirmed by comparing blood gas analysis results obtained before transport and upon arrival at the receiving facility. No cardiopulmonary resuscitation maneuvers, intubations, ventilatory adjustments, venous catheterizations, or administration of critical medications were recorded during transport; documented therapeutic escalations (adjustment of respiratory support, vasoactive drugs, temperature correction) were performed after arrival at the receiving facility.

e) The high proportion of transports for appendicitis (≈124/363) reduced the average complexity of the sample, which may indicate appropriate pretransport management. However, it is important to note that more than half of the urgent transports were for acute appendicitis, a condition that generally does not require specialized care during transport, which artificially lowers the overall complication rate and concentrates morbidity in a small but clinically fragile subgroup of patients.

<sup>a</sup> Others include: surgical (*n* = 136), infectious (*n* = 17), hematological and oncological (*n* = 17), endocrine and metabolic (*n* = 8), psychiatric (*n* = 6), cardiovascular (*n* = 5), gastrointestinal (*n* = 4), renal and urological (*n* = 1), miscellaneous (*n* = 6).

<sup>b</sup> Analysis of 299 out of 363 transports with complete transport data after arrival at the receiving facility. A total of 20 complications were recorded in 17 patients (17 out of 299 = 5.7% of patients; 20 out of 299 = 6.7% of complications).

<sup>c</sup> pH < 7.35 or pCO<sub>2</sub> > 45 mmHg on arrival compared to pretransport levels, and/or defined as a decrease in pH of >0.1 units or an increase in pCO<sub>2</sub> of >10 mmHg when comparing pretransport blood gas values to those on arrival.

<sup>d</sup> Includes unintentional rewarming (*n* = 2) in patients with prior passive hypothermia, and unplanned cooling (*n* = 1).

- 1 Strengthen protocolization and team training at sending hospitals in patient stabilization and communication with receiving hospitals.
- 2 Improve regional coordination through health care networks that optimize time and resources.
- 3 Establish registers and shared indicators to enable ongoing evaluation and interregional comparisons.

Although our study was conducted in a single center, it provides recent data that is representative of the situation in many secondary hospitals in Spain.

Three decades after Rubio Quiñones et al. described these structural deficiencies in transport,<sup>6</sup> the inequalities persist and the standardization of PNIHT is still pending. Our findings indicate the need to improve early identification and initial stabilization of high-risk patients, as well as to establish standardized registries that would allow for the evaluation of the safety of PNIHT in different clinical scenarios.

In Spain, the differences between autonomous communities call for organizational models tailored to each region, achieved through coordination among emergency services, tertiary hospitals, and health authorities. Ensuring safe and equitable critical care transport should be a priority for the National Health System. These findings underscore the need to reduce regional variability in pediatric transport. This is supported by the scientific evidence<sup>1-5</sup>: The outstanding debt owed to critically ill pediatric patients in Spain should be settled without further delay; today may be the time to move from diagnosis to action.

In conclusion, this study highlights the vulnerability of certain patients and supports the need to improve initial stabilization and coordination of sending teams. The creation of PNIHT networks would provide an opportunity to improve critical pediatric care in Spain.

## Funding

This research did not receive any external funding.

## References

1. Millán García Del Real N, Sánchez García L, Ballesteros Díez Y, Rodríguez Merlo R, Salas Ballestín A, Jordán Lucas R, et al. Importance of specialized paediatric and neonatal transport. Current situation in Spain: towards a more equitable and universal future. *An Pediatr (Engl Ed)*. 2021;95:485.e1–10.
2. Ramnarayan P, Thiru K, Parslow RC, Harrison DA, Draper ES, Rowan KM. Effect of specialist retrieval teams on outcomes in children admitted to paediatric intensive care units in England and Wales: a retrospective cohort study. *Lancet*. 2010;376:698–704.
3. Corniero P, Girona-Alarcón M, Alejandro C, Campos R, Millán García Del Real N, Esteban E. Assessment of patient safety during interfacility transport. *An Pediatr (Engl Ed)*. 2025;102:503884.
4. Ramnarayan P, Dimitriadis K, Freeburn L, Kashyap A, Dixon M, Barry PW, et al. Interhospital transport of critically ill children to PICUs in the United Kingdom and Republic of Ireland: analysis of an international dataset. *Pediatr Crit Care Med*. 2018;19:e300–11.
5. Browning Carmo KA, Williams K, West M, Berry A. A quality audit of the service delivered by the NSW Neonatal and Paediatric Transport Service. *J Paediatr Child Health*. 2008;44:253–72.
6. Rubio Quiñones F, Hernández González A, Quintero Otero S, Pérez Ruiz J, Ruiz Ruiz C, Seidel A, et al. Valoración de 200 traslados de niños críticos en una Unidad de Cuidados Intensivos Pediátricos. *An Esp Pediatr*. 1996;45:249–52.

Patricia Musgo Balana<sup>a</sup>, Claudia Rondón Martínez<sup>a</sup>, Belén Valles Fernández<sup>b</sup>, Pablo del Villar Guerra<sup>a,\*</sup>

<sup>a</sup> *Servicio de Pediatría, Hospital El Bierzo, Ponferrada, León, Spain*

<sup>b</sup> *Unidad de Cuidados Avanzados, Hospital Covián, Arriondas, Spain*

\* Corresponding author.

E-mail address: [pdelvillarguerra@gmail.com](mailto:pdelvillarguerra@gmail.com) (P.d.V. Guerra).

15 December 2025 28 February 2026