

J. López-Herce
L. Sancho
J. M. Martínón
the Spanish Society
of Paediatric Intensive Care

Study of paediatric intensive care units in Spain

Received: 8 March 1999
Final revision received: 27 September 1999
Accepted: 29 September 1999

J. López-Herce (✉) · L. Sancho
Paediatric Intensive Care Unit,
Gregorio Marañón University Hospital,
Dr Castelo 49, E-28009 Madrid, Spain
e-mail: pielvi@mx4.redestb.es
Tel.: + 34-1-5 86 67 08
Fax: + 34-1-5 86 80 18

J. M. Martínón
Paediatric Intensive Care Unit,
Galicia General Hospital, c/Galeras s/n,
E-15705 Santiago de Compostela, Spain

Abstract Objective: To describe the organisation of paediatric intensive care units in Spain and the medical assistance provided during 1996.

Methods: A written questionnaire was sent to all the paediatric ICUs linked to or within the Spanish public health system.

Results: Thirty-one of the 34 paediatric ICUs replied. All are medico-surgical units. Eighteen treat only paediatric patients, 12 paediatric and neonatal patients, and one paediatric and adult patients. Fifteen units have fewer than seven beds, eight have between 7 and 12 beds, and eight between 13 and 18 beds. Of the paediatric ICUs, 83.8% are staffed by paediatricians specialised in paediatric intensive care. The mean number of on-call on site periods of duty for each member of the medical staff was 5.1 ± 1.7 per month. Thirty of the 31 units undertake paediatric resident training, 13 train residents specialising in paediatric intensive care and 12

participate in medical student training.

In 1996 there were 9,585 admissions (309 ± 182 patients per ICU) signifying 35.3 ± 14 patients/bed. Of the patients, 65.9% were medical and 34.1% surgical. The mean duration of stay was 5.6 ± 2.1 days. The mortality rate was $5.4 \pm 3.2\%$. The main causes of death were multiple organ failure and brain death.

Conclusions: In Spain, paediatric intensive care is principally performed by specialised paediatricians. Although the general results for 1996 are similar to those of other European countries, efficiency studies are necessary to plan and re-organise the paediatric intensive care units in Spain.

Key words Intensive care · Paediatrics · Critical care · Paediatric intensive care unit · Intensivist · Organisation and administration · Mortality · Efficiency

Introduction

The availability of paediatric intensive care is a reflection of the quality of a country's paediatric medical care. Aspects of fundamental importance to this service include: that the paediatric intensive care be adapted to the geographical and demographic characteristics of the country; the type of assistance (public and/or private); co-ordination between the neonatal, paediatric and adult intensive care facilities and the

type of staff attending critically ill paediatric patients [1, 2].

In Spain, the Paediatric Intensive Care Society of the Spanish Association of Paediatrics carried out a study analysing the existing paediatric ICUs and drew up certain directives for the planning of their further development [3]. In this plan the distribution of different Paediatric Intensive Care Units (PICUs) was arranged according to political (in autonomic communities), geographical and population distribution. Three

different levels of assistance were proposed according to technical facilities, staff available and pathology that can be assumed for each PICU. First and second level PICUs would have a third level reference unit. Unfortunately, and despite the fact that the greater part of paediatric intensive care in Spain is in the public sector, these directives have not been followed up by the health authorities and the growth of PICUs has not been in line with health care needs, rather it has reflected the results of the individual efforts of each hospital.

Physicians and health authorities are ever more conscious of the fact that health resources are not unlimited. The provision of intensive care represents a large percentage of a hospital's budget and therefore this care should not be undertaken/expanded without an assessment of need and efficiency [4, 5, 6]. A knowledge and understanding of the current situation is an essential first step in planning the development or expansion of paediatric intensive care in any country. In recent years, several studies have analysed the characteristics of intensive medical care in countries such as the USA [7], Holland [8] England [9, 10] and Australia [10]. The present study has been carried out with the aim of detailing the characteristics of the PICUs in Spain and analysing the medical activity during 1996.

Material and methods

During the second half of 1997, the Spanish Society of Paediatric Intensive Care sent a written questionnaire to medical directors of the 34 Spanish PICUs within or linked to the Spanish public health system. Questionnaires were not sent to those units dedicated exclusively to neonatal intensive care. This questionnaire consisted of two parts. The first part looked at the characteristics of the unit: types of pathology admitted (medical and/or surgical), types of patients (paediatric and/or neonatal), age range admitted, number of beds, techniques used in the unit, the paediatric ICU personnel (medical staff, on-call on site duty medical staff, number of on-call on site periods of duty per month, nursing staff) and the teaching aspects (specialist and rotating medical residents and university teaching).

The second part of the questionnaire requested information about the medical activity during 1996: the total number of patients admitted, the number of surgical and medical patients, age, sex, diagnostic groups (surgical: cardiac, thoracic, abdominal, orthopaedic, urological, neurosurgical and others; transplants: kidney, liver, cardiac, bone marrow; medical: trauma, poisoning, respiratory, cardiac, neurological, sepsis, hemato-oncological, digestive, renal, endocrine and others), techniques used (mechanical ventilation, high frequency ventilation, central venous, arterial and Swan-Ganz catheterization, dialysis techniques, intracranial pressure monitoring, jugular venous bulb saturation monitoring, use of inhaled nitric oxide, extracorporeal membrane oxygenation, parenteral nutrition, transpyloric enteral nutrition), mean duration of admission, mortality, surgical and medical mortality, mortality by diagnostic groups and causes of death.

Those units not responding to the questionnaire were telephoned twice and a new questionnaire was sent by post.

Table 1 Percentage of Paediatric Intensive Care Units in which intensive care-specific techniques are available

Mechanical ventilation	100 %
Central venous catheterization	100 %
Parenteral nutrition	100 %
Arterial catheterization	96,7 %
Peritoneal dialysis	93,5 %
Intracranial pressure monitorization	87 %
Inhaled Nitric Oxide	64,5 %
Swan-Ganz catheterization	51,6 %
Arteriovenous or venovenous hemofiltration	48,3 %
High-frequency mechanical ventilation	38,7 %
Yugular venous bulb saturation	32,2 %
Gastric tonometry	16,1 %
ECMO	3,2 %

Results

Thirty-one of the 34 paediatric ICUs answered the questionnaire. The results are expressed as mean \pm SD. When data did not have normal distribution, we used the range and the median and its 95 % confidence intervals.

Unit characteristics

The 31 ICUs are medical and surgical, although in one the surgical patients are attended by a different medical team from the Anaesthetics Department. Eighteen ICUs (58 %) only admit paediatric patients, 12 admit paediatric and neonatal patients and 1 admits paediatric and adult patients. In 25 of the hospitals there are separate ICUs for neonatal patients. Seven out of 12 PICUs attending paediatric and neonatal patients have independent neonatal ICUs in the same hospital and patients less than 1 month of age are usually admitted into PICUs after cardiac or other major surgery. The minimum age admitted is between new-born and 2 months (median 0.5 month, C.I. 0–1) and the maximum age between 10 and 18 years (median 14, C.I. 14–15). The number of beds per ICU ranges from 3 to 18 (median 8, C.I. 6–12.5). Fifteen units (48.3 %) have six beds or fewer, 8 (25.8 %) between 7 and 12 beds, and 8 (25.8 %) between 13 and 18 beds. Table 1 shows the percentage of ICUs in which intensive care-specific techniques are available.

Twenty-six (83.8 %) of the 31 ICUs are staffed by full-time specialists in paediatric intensive care, four (12.9 %) by specialists in adult intensive care with full-time paediatric specific dedication and one by general paediatricians. The number of physician staff varies from 1 to 8 (mean 3.8 ± 1.8). The paediatric ICUs with 3–6 beds are staffed by a mean of 3.1 ± 1.5 physicians (range 1–6), those with 7–12 beds by 3.3 ± 1.6 physicians (range 2–6) and those with 13–18 beds by 5.7 ± 1.5 phy-

Table 2 Distribution of surgical and medical pathologies

Surgery	Percentage	Medical	Percentage
Abdominal	26,7 %	Respiratory	25,9%
Cardiac	26,7%	Trauma	14 %
Neurosurgery	18,6 %	Neurologic	13,7%
Orthopaedic	8,4 %	Sepsis	13,5 %
Urologic	5,8 %	Cardiac	10,7%
Respiratory	5,1 %	Digestive	3,8 %
Transplant	2,4 %	Endocrinologic	3,5 %
Others	6,1 %	Oncologic	3,1 %
		Renal	2,9 %
		Intoxication	2,8 %
		Others	5,9 %

sicians (range 3–8). The median age of the staff was 44 years, C.I. 42–45, (range 37–52); the minimum age was 30–50 years (median 38, CI 36–40) and the maximum age 36–69 years (median 50, C.I. 49–52.5). The number of physicians performing on-call on site duties in the units was 7.7 ± 1.9 . Every unit has a medical staff on-call on site in the unit 24 h a day. In 30 of the 31 ICUs, the intensivists perform the on-call on site duties. General paediatricians are the only physicians performing on-call on site duties in only one ICU. In 8 of the ICUs, all the on-call duties are covered by the permanent staff. On-call on site duty is also carried out by specialists in neonatology in 13 units, by general paediatricians in 21 units, by adult intensive care specialists in 4 units and by anaesthetists in 2 units. The mean number of on-call on site periods of duty for each member of the medical staff was 5.1 ± 1.7 per month. The number of days on-call on site performed by each member of staff in non-holiday periods is 4.3 ± 1.3 per month (range 2.5–10) and 6.8 ± 2.2 per month (range 3.5–15) in holiday periods.

Twenty-nine units have nursing staff specific to the paediatric ICU. Two ICUs are covered by nurses from the paediatric departments. The number of nurses per ICU is 18.6 ± 10.3 (range 3–46). The number of nurses per bed ranges from 0.8 to 3.4 (mean 2.0 ± 0.5). The number of staff nurses per bed is 2.2 ± 0.4 in the ICUs with 6 or fewer beds, 1.8 ± 0.7 in the ICUs with 7–12 beds, and 2.0 ± 0.6 in the ICUs with 13–18 beds. In 29 of the ICUs, the nurses work in three shifts (early, late, night) and in 2 units in two shifts. The mean number of nurses on the early shift is 4 ± 2 , on the late shift 3.4 ± 2.1 and on the night shift 3.3 ± 1.7 .

Thirty of the 31 ICUs have training for paediatric residents and 27 of these have a specific paediatric intensive care training scheme. The median number of residents who pass through each ICU annually is 36.5, C.I. 18–83 (range: 1–43 residents: 82 % paediatricians, 13.8 % adult intensivists, 2.3 % anaesthetists, 0.7 % emergency physicians and 1.1 % foreign physicians). The training of residents specialising in paediatric inten-

Table 3 Percentage of patients in whom each intensive care-specific technique was used

Technique	Percentage
Central venous catheterization	33 %
Mechanical ventilation	32,3 %
Arterial catheterization	18,3 %
Continuous enteral nutrition	17,8 %
Parenteral nutrition	15,2 %
Extrarenal depuration techniques	2 %
Intracranial pressure monitorization	1,8 %
Inhaled nitric oxide	1 %
Swan-Ganz catheterization	0,5 %
Transpyloric enteral nutrition	0,5 %
High frequency mechanical ventilation	0,2 %
Yugular venous bulb saturation	0,2 %
ECMO	1 patient

sive care is undertaken in 13 of the ICUs. Of the 18 paediatric intensive care specialists trained each year, 11 are in large, 4 in intermediate and 3 in small paediatric ICUs. The number of paediatric intensive care residents per year in each training ICU varies from 1 to 3 (mean 1.5 ± 0.8). The duration of the rotation for residents specialising in paediatric intensive care is 6–18 months. Twelve of the 31 ICUs are linked to universities for medical student training. The median number of students who rotate through each ICU annually is 6, C.I. 4–11, (range 10–126).

Medical activity during 1996

There were 9,585 paediatric ICU admissions during 1996 (mean 309 ± 182 patients/unit, range 51–746 patients/unit). The number of patients per bed for the year was 35.3 ± 14 (range 8.5–71.5). The number of admissions per bed was similar within each type of ICU, small (37.7 ± 18), medium (34.5 ± 9.4) or large (35.5 ± 11.6). The minimum ages of patients admitted were in the range of 0–9 months (median 1 month, C.I. 0–1) and the maximum ages were between 10 and 21 years (median 15 years, C.I. 14–16). The age distribution of the patients was: 0–28 days: 9.4 %; 1–12 months: 22.9 %; 1–5 years: 35.5 %; 6–10 years: 17 % and more than 10 years: 15.1 %. Of the admissions, 6,380 (66.5 %) were medical and 3,205 (33.5 %) were surgical. Table 2 shows the percentage of each medical and surgical pathology and Table 3 shows the percentages of patients in whom each intensive care-specific technique was used.

The mean duration of stay was 5.6 ± 2.1 days (range 2.3–10.5). The mean duration of stay for medical patients was 6.5 ± 3 days (range 3.0–12.4), and for surgical patients 4.4 ± 2.4 days (range 2.0–8.5).

The overall mortality rate was 5.4 ± 3.2 % (range 1.4–15.4). The mortality rate in the paediatric ICUs

Table 4 Mortality according to pathology

Surgical pathology	Mortality	Medical pathology	Mortality
Transplants	12,6%	Oncologic	12,8%
Cardiac	6,9%	Cardiac	7,6%
Neurosurgery	2,9%	Sepsis	7,4%
Respiratory	2%	Trauma	6,2%
Abdominal	1,1%	Renal	4,8%
Urologic	0,6%	Respiratory	3,9%
Orthopaedic	0%	Neurologic	3,6%
		Endocrinologic	2,4%
		Intoxications	1,8%
		Digestive	1,3%

with 6 or fewer beds was $4.8 \pm 4.0\%$, in those with 7–12 beds $5.9 \pm 2.8\%$ and in those with 13 or more beds $6.3 \pm 0.8\%$. Medical patient mortality ($6.5 \pm 3.7\%$) was higher than that of surgical patients ($2.6 \pm 3.2\%$). Table 4 shows the mortality according to pathology. The causes of death were: cerebral death 21.7%, multiorgan failure 20%, cardiac 16.2%, respiratory 15.2%, shock 11.4%, infection 7.4% and others 8.4%. Eight percent of all deaths, corresponding to 57.8% of the cases of brain death, were organ donors.

Discussion

In Spain the distribution of the PICUs is not uniform. There is a concentration of ICUs in the major cities whilst there are still large geographical areas without specific paediatric intensive care [11]. In these areas critically ill children are admitted to adult ICUs. The preparation of physicians in these ICUs and the materials available are generally insufficient to treat paediatric patients correctly. Some patients are transferred to distant paediatric ICUs, often in ill-equipped vehicles manned by personnel without adequate training to transport critically ill paediatric patients. A recent study has compared the results of the paediatric intensive care between two regions of Australia (a big centralised PICU with very efficient transport) and United Kingdom (paediatric intensive care provided in paediatric and adult units). The mortality and duration of ICU stay were less in the centralised PICU [10]. The benefits of centralisation can be attributable to larger paediatric ICUs and full-time specialist paediatric intensive care consultants [10].

All the PICUs in Spain are medico-surgical. Fifty-eight percent of the PICUs in Spain admit exclusively paediatric patients and 38% admit paediatric and neonatal patients. Unfortunately, despite the fact that a large number of hospitals in Spain have neonatal intensive care (neonatal ICUs), intensive care for paediatric patients is still insufficient. Probably the only way to achieve adequate intensive care for all paediatric pa-

tients, with an acceptable cost-benefit relationship, would be to centralise the paediatric intensive care in a few big paediatric ICUs [10] or to combine the paediatric and neonatal intensive care into one unit in those hospitals which, in terms of their size, personnel availability and catchment area population, cannot justify the existence of separate paediatric and neonatal ICUs. Nevertheless, the organisation of paediatric intensive assistance in each country must consider such factors as geographical and population distribution, political organisation and the availability of an efficient and quick medical transport system.

Though the number of beds in the ICUs is very variable, 48.3% of the units have 6 or fewer beds and 74% between 3 and 12 beds, very similar to the data presented in the American study [7]. The number of full-time physicians in the paediatric ICUs is equally variable, although it should be noted that there is no significant difference in the number of staff between the ICUs with 6 or fewer beds (3.1 doctors/unit) and those with 7–12 beds (3.3 doctors/unit). ICUs with fewer than six beds require a proportionally greater number of physicians and each hospital should assess the possibility for collaboration/combination with the neonatal ICU.

Most of the ICUs answering the questionnaire are able to carry out conventional intensive paediatric care, using mechanical ventilation, central venous and arterial catheterization, intracranial pressure monitoring, parenteral nutrition and peritoneal dialysis. In contrast, Swan-Ganz catheter monitoring, arterio-venous or veno-venous haemofiltration and the use of inhaled nitric oxide are only available in about half the units. Attention should be drawn to the fact that only one hospital in Spain has performed ECMO and on only one occasion; this technique should be established in other centres in this country.

In Spain, the paediatric intensive care units are staffed mainly by paediatricians specialised in paediatric intensive care. Only four of the ICUs answering the questionnaire are staffed by adult intensive care specialists with training in paediatric intensive care. A study in the USA has suggested that the mortality is lower in those units staffed by paediatric intensivists [12]. All the ICUs except one have a full-time consultant and medical staff. These findings are considerably higher than in the American study, in which only 79.6% of the ICUs have a full-time consultant, 48.5% have full-time medical staff, and only 55% of the ICUs with six or fewer beds have a paediatric intensivist on their staff [7]. The age of the physicians in the paediatric ICUs is relatively uniform between the different units, though the mean minimum age stands out for being relatively old (37.7 years), reflecting a slow staff turnover. Herein lies one of the fundamental problems of paediatric intensive care in Spain, with the on-call on site duties being performed by the staff physicians leading to a progressive

physical and emotional stress build-up with the risk of detriment to professional and personal conduct [13]. On-call on site duties in paediatric ICUs are mainly covered by the PICU staff, although in 74% of the units other physicians, mainly paediatricians not specialised in intensive care, also perform on-call on site duties. Although the number of on-call on site periods of duty in non-vacational periods is acceptable (4.3 per month), during the holiday periods there is a significant increase in this number, which rises to a mean of 6.8 per month, with the risk of deterioration in medical assistance and in the physical and psychological well-being of the physicians.

Most of the paediatric ICUs have a nursing staff specific to the unit and there are usually three shifts: early, late and night. It is noteworthy that medium-sized ICUs have fewer nurses than small or large units, though the difference is not statistically significant.

Most of the paediatric ICUs have training for paediatric residents and have a specific training plan for paediatric intensive care. Most of the rotating residents are paediatricians and the rotation is usually every 3–4 months. Only 42% of the ICUs participate in the training of specialists in paediatric intensive care, with the largest units being responsible for most of this training. Only 38.7% of the units participate in university training, compared with 76.6% in the American study [7]. We think that ICUs should become more involved in the training of medical students [14] and that a specific academic-practical training programme should be established within the paediatric rotation of medical student training in Spain.

Analysis of the patients admitted during 1996 shows that more than half the children requiring intensive care were males and that two-thirds of all admissions were children below 5 years of age. There were twice as many medical admissions as surgical, though this proportion varied considerably among the hospitals and types of ICU. Other studies have also found that surgical patients represent between 22 and 36% of all paediatric intensive care admissions [4, 15, 16]. Abdominal, cardiac and neurosurgical were the most frequent surgical pathologies whilst respiratory pathology was the most frequent medical cause of admission.

Regarding the techniques used, one-third of the patients were put on mechanical ventilation and had central venous catheterization. Swan-Ganz catheterization, however, was infrequent. In a French multicentric study, the percentage of children requiring mechanical ventilation was 64%, central venous catheterization 42% and arterial catheterization 23%. These findings were higher than those found in the present study, probably due to the inclusion of more severe pathology, as evidenced by a mortality of 13% – double that found in this study [16, 17].

The mortality in this study was similar to that found in other European countries and the USA [5, 7, 8, 10], although we have not performed an analysis of the mortality in relation to the severity of the pathology. In this study, as in that performed by Pollack in the USA [7], the mortality increased as the size of the ICU increased, perhaps due to the fact that the larger ICUs are situated in tertiary hospitals and thus admit more serious pathology. When the above author analysed the mortality according to the severity of pathology, he found a lower mortality in the tertiary ICUs than in the non-tertiary ones [18]. In the USA it has also been reported that the mortality is higher in the teaching centres, possibly due to the fact that critically ill patients are left under the care of residents [12]. In the USA, a PICU may be controlled by a 2nd- or 3rd-year resident during the on-call hours [19].

In this study, the medical patient mortality was higher than the surgical. The highest surgical mortality was in the transplant patients. This was due particularly to the high mortality (41.6%) in the bone marrow transplant patients requiring intensive care, a finding also reported by other authors [20], followed by cardiac surgery. The medical pathologies with the highest mortalities were oncological, cardiac and sepsis. These findings concur with other studies, which report the high mortality of oncology patients [21]. As has been reported in other studies, the main causes of death in critically ill paediatric patients were multiple organ failure [22] and brain death [23], followed by cardiac and respiratory failure. It is of note that 57.8% of the deaths due to brain death were organ donors, showing Spain to have one of the highest percentages of donors world-wide [24].

The mean duration of stay in the paediatric ICUs was 5.6 days, similar to that reported in other European and American studies [4, 5, 15, 16, 25], but higher than in the centralised Australian PICU [10]. As in other studies, the duration of stay for medical admissions was longer than for the surgical ones [26]. Although bed occupancy was similar between the large, medium and small units, a study of efficiency cannot be carried out as the admission and discharge criteria were not analysed [4].

Our study is only based on a questionnaire with the limitation that data recovery implies. Our data do not exactly reflect the total paediatric intensive assistance performed in our country, as we have not included children in adult ICUs and some PICUs admit children and neonates. Nevertheless, we consider that our results accurately reflect the organisation of PICUs in our country.

Acknowledgements We thank Dr Gregorio Garrido Investigation Section of the Preventive and Quality Control Service, Gregorio Marañón General University Hospital, Madrid, for the statistical analysis.

Appendix

The following Paediatric Intensive Care Units took part in the study: Complejo Hospitalario de Albacete (A. Martinez), Hospital General de Alicante (R. Reig), Hospital Torrecárdenas de Almería (J. García), Hospital Infanta Cristina de Badajoz (J. Espinosa), Hospital San Juan de Dios de Barcelona (A. Palomeque), Hospital Santa Cruz y San Pablo de Barcelona (J. Nadal), Hospital Valle de Hebrón de Barcelona (J. Iglesias), Hospital de Cruces de Bilbao (T. Hermana), Hospital Puerta del Mar de Cádiz (S. Pantoja), Hospital Reina Sofía de Córdoba (J. Pérez), Hospital Virgen de las Nieves de Granada (J. Gualda), Hospital Clínico San Cecilio de Granada (A. Ruiz), Hospital Juan Canalejo de La Coruña (E. Quiroga), Hospital Materno-Infantil de Las Palmas (R. González), Hospital Materno Infantil

Carlos Haya de Málaga (C. Calvo), Hospital Doce de Octubre de Madrid (F. Mar), Hospital Gregorio Marañón de Madrid (A. Carrillo), Hospital La Paz de Madrid (F. Ruza), Hospital Niño Jesús de Madrid (J. Casado), Hospital Central de Asturias de Oviedo (C. Rey), Hospital Son Dureta de Plama de Mallorca (J. Simonet), Hospital del Parc Taulí de Sabadell (J. Cristobal), Hospital N^a Sra de Aránzazu de San Sebastián (E. González), Hospital Marqués de Valdecilla de Santander (F. Ortiz), Hospital Central de Galicia de Santiago (J.M^a. Martínón), Hospital Virgen Macarena de Sevilla (A. Gómez), Hospital Virgen del Rocío de Sevilla (A. Tovaruela), Hospital Virgen de la Salud de Toledo (J.A. Alonso), Hospital Clínico de Valencia, Hospital Xerán-Cíes de Vigo (A. Réparaz), Hospital Miguel Servet de Zaragoza (J. Melendo).

References

1. Yeh TS (1992) Regionalization of paediatric critical care. *Crit Care Clin* 8: 23-35
2. Gemke RJ, Van der Voot E, Bos AP (1997) The necessity for centralization of paediatric intensive care. *Ned Tijdschr Geneesk* 141: 2325-2327
3. Sección de Cuidados Intensivos Pediátricos de la Asociación Española de Pediatría (1984) Plan de cuidados intensivos pediátricos en España en la década de los 80. *An Esp Pediatr* 20: 657-719
4. Ruttimann UE, Patel KM, Pollack MM (1998) Length of stay and efficiency in paediatric intensive care units. *J Pediatr* 133: 79-85
5. Gemke RJ, Bonsel GJ, Van Vught AJ (1994) Effectiveness and efficiency of a Dutch paediatric intensive care. *Crit Care Med* 22: 1477-1484
6. Klem SA, Pollack MM, Glass NL, Spohn WA, Kanter RK, Zucker AR, Ruttimann UE (1990) Resource use, efficiency and outcome prediction in paediatric intensive care of trauma patients. *J Trauma* 30: 32-36
7. Pollack MM, Cuerdon TC, Getson PR (1993) Paediatric intensive care units: results of a national survey. *Crit Care Med* 21: 607-612
8. Gemke R, Bonsel GJ (1995) Comparative assessment of paediatric intensive care: a national multicenter study. Paediatric Intensive Care Assessment of Outcome (PICASSO) Study Group. *Crit Care Med* 23: 238-245
9. Bennett NR (1997) Provision of paediatric intensive care services. *Br J Hosp Med* 58: 368-371
10. Pearson G, Shann F, Barry P, Vyas J, Thomas D, Powell C, Field D (1997) Should paediatric intensive care be centralised? Trent versus Victoria. *Lancet* 349: 1213-1217
11. López-Herce J, Sancho L, Martínón JM (1999) Distribución de los cuidados intensivos pediátricos en España. *An Esp Pediatr* 50: 14-16
12. Pollack MM, Cuerdon TT, Patel KM, Ruttimann UE, Getson PR, Levettown M (1994) Impact of quality-of-care factors on paediatric intensive care unit mortality. *JAMA* 272: 941-946
13. Bustinza A (1997) Estudio descriptivo de la situación de Burnout en los pediatras intensivistas de la Asociación Española de Pediatría. *An Esp Pediatr* 105 (suppl): 65-67
14. Rogers PL, Grenvik A, Willenkin RL (1995) Teaching medical students complex cognitive skills in the intensive care unit. *Crit Care Med* 23: 575-581
15. Gemke RJ, Bonsel GJ, McDonnell J, Van Vught AJ (1994) Patient characteristics and resource utilization in paediatric intensive care. *Arch Dis Child* 71: 291-296
16. Martinot A, Leteurtre S, Grand Bastien B, Duhamel A, Leclerc F (1997) Characteristics of patients and use of resources in French paediatric intensive care units. *Le groupe francophone de Réanimation et urgences pédiatriques. Arch Pediatr* 4: 730-736
17. Earle M Jr, Martinez Natera O, Zaslavsky A, Quinones E, Carrillo H, García Gonzalez E, Torres A, Márquez MP, García-Montes J, Zavala I, García-Davila R, Todres ID (1997) Outcome of paediatric intensive care at six centers in Mexico and Ecuador. *Crit Care Med* 25: 1462-1467
18. Pollack MM, Alexander SR, Clarke N, Ruttimann UE, Tesselaar HM, Bachlis AC (1991) Improved outcomes from tertiary center paediatric intensive care: a statewide comparison of tertiary and nontertiary care facilities. *Crit Care Med* 19: 150-159
19. Committee on Hospital Care and Paediatric Section of the Society of Critical Care Medicine (1993) Guidelines and levels of care for paediatric intensive care units. *Paediatrics* 92: 166-175
20. Tood K, Wiley F, Landaw E, Gajewski J, Bellamy PE, Harison RE, Brill JE, Feig SA (1994) Survival outcome among 54 intubated paediatric bone marrow transplant patients. *Crit Care Med* 22: 171-176
21. Van Veen A, Karstens A, Van der Hoek AC, Tibboel D, Hahlen K, Van der Voort E (1996) The prognosis of oncologic patients in the paediatric intensive care unit. *Intensive Care Med* 22: 237-241
22. Baeza J, Miranda P, Rui-Perez E, Cordero J (1989) Mortalidad en las unidades de cuidados intensivos pediátricos. El papel del fallo agudo de órganos y sistemas. *Rev Chil Pediatr* 60: 319-326

-
23. Martinot A, Lejeune C, Hue V, Fourier C, Beyaert C, Diependaele JF, Deschil-dre A, Leclerc F (1995) Modality and causes of 259 deaths in a paediatric intensive care unit. *Arch Pediatr* 2: 735–741
24. Bosch X (1998) Spain celebrates leading the world in organ donation. *Lancet* 351: 1868
25. Ruttimann UE, Pollack MM (1996) Variability in duration of stay in paediatric intensive care units: a multiinstitutional study. *J Pediatr* 128: 35–44
26. Mickell JJ, Furgiuele TL (1988) Acute mechanical ventilation: an index of the absolute need for paediatric intensive care unit beds. *Crit Care Med* 16: 504–509