Intensive Care Med (2008) 34:1076–1082
DOI 10.1007/s00134-008-1061-4

PEDIATRIC ORIGINAL

Hendrika Knoester
Madelon B. Bronner
Albert P. Bos

Surviving pediatric intensive care: physical outcome after 3 months

Received: 14 September 2007
Accepted: 13 February 2008
Published online: 21 March 2008

H. Knoester (✉) · A. P. Bos
Academic Medical Center, Pediatric Intensive Care Unit, Emma Children's Hospital,
Meibergdreef 9, 1105 AZ Amsterdam, The Netherlands
e-mail: h.knoester@amc.uva.nl
Tel.: +31-20-5665769
Fax: +31-20-6919338

M. B. Bronner
Academic Medical Center, Psychosocial Department, Emma Children's Hospital,
Meibergdreef 9, 1105 AZ Amsterdam, The Netherlands

Abstract *Objective:* This study investigated the prevalence and nature of physical and neurocognitive sequelae in pediatric intensive care unit (PICU) survivors. *Design and setting:* Prospective follow-up study 3 months after discharge from a 14-bed tertiary PICU in The Netherlands. *Patients and participants:* The families of 250 previously healthy children unexpectedly admitted to the PICU were invited to visit the outpatient follow-up clinic for structured medical examination of the child 3 months after discharge; 186 patients were evaluated. *Measurements and results:* Pediatric Cerebral Performance Category (PCPC) and Pediatric Overall Performance Category (POPC) values were determined at PICU discharge, at the outpatient follow-up clinic, and retrospectively before admission to the PICU. We found that 69% of children had physical sequelae. In 30% of cases these were caused by a previously unknown illness and in 39% by acquired morbidity. In 8% of the children the acquired morbidity was related to complications from PICU procedures. Three months after discharge 77% of the children had normal PCPC scores and 31% had normal POPC scores. *Conclusions:* Our results indicate that PICU survival may be associated with substantial physical sequelae. Structured follow-up research, preferably by multicenter studies, is warranted in PICU survivors.

Keywords Pediatric intensive care unit · Health status · Follow-up studies · Outcomes research

Introduction

The development of pediatric intensive care has contributed to improved survival in children with critical illness [1, 2]. Traditional outcome measures such as length of stay, number of ventilation days, and mortality are not the only relevant issues. New disease patterns have emerged due to long-term complications and effects of the original illness and its treatment. Physical sequelae, disability, and functional health have become equally important outcome measures in pediatric intensive care unit (PICU) survivors. Awareness of physical sequelae of underlying diseases and intensive care treatment and subsequently their impact on growth and development could lead to improvement in treatment and support after discharge.

Studies on physical sequelae in PICU survivors are scarce. In studies evaluating functional health and quality of life aspects, one third of the evaluated children are in full health 1 year after discharge and 60–80% of the children have good quality of life [3–9]. In 1992 the Pediatric Cerebral Performance Category (PCPC) and the Pediatric Overall Performance Category (POPC) were developed and validated to evaluate outcome in a general PICU population [10, 11]. In 58% and 27% of the studied children, respectively, PCPC and POPC scores at PICU discharge were normal. These scores correlated well with the results of extensive psychometric tests (such as Bayley Scales of Infant Development) performed at one and 6 months after discharge [11, 12].

In multidisciplinary PICU populations reports on outcome are scarce. Historically, outcome research in pediatrics has been based either on an age-specific approach such as follow-up studies of premature infants or on a more disease-oriented approach such as follow-up studies in survivors of cardiothoracic surgery or trauma [13–15]. Evaluative research of adult intensive care survivors has shown the effect of intensive care treatment per se [16–18]. The aim of this study was to evaluate physical and neurocognitive sequelae 3 months after discharge in children who were previously healthy and unexpectedly admitted to the PICU.

Materials and methods

This study was carried out between December 2002 and October 2005 as part of an on-going explorative research program on physical and psychological sequelae in children and their parents after an acute and unexpected PICU admission. The PICU of the Emma Children's Hospital, Academic Medical Center of Amsterdam is a tertiary PICU with 14 beds, admitting medical, surgical, and trauma patients from the greater Amsterdam area. The local ethics review board approved the study protocol.

Participants

This study included only previously healthy children who were unexpectedly referred to the PICU with an acute life-threatening illness; we excluded children with known underlying illnesses or scheduled elective surgery. We included all previously healthy patients with respiratory or circulatory insufficiency, all trauma patients irrespective of length of PICU stay, and patients admitted to the PICU for other reasons for 7 days or more. Exclusion criteria were admission due to abuse or self-intoxication and the inability to complete Dutch-language questionnaires. Patient characteristics were obtained from medical records and from the patient data management system.

Of the 250 children eligible for inclusion 186 participated. The parents of 64 did not participate: in 13 cases they refused to participate, in 33 they accepted participation but did not present at the outpatient clinic, and in 18 they did not respond at all. Reasons for refusal included: "everything is going well," "we have seen too many hospitals," "we need some rest," and "we don't want to remember that time". Participants and nonparticipants differed only in (a) length of stay, (b) length of ventilation, (c) reasons for admission, and (d) diagnosis at discharge. For example, participants had a longer length of stay and had more ventilation days than nonparticipants; 14 participants stayed in the PICU longer than 21 days and had more than 14 ventilation days (Tables 1, 2).

Definitions

The term previously healthy was defined as having no need for medical supervision at anytime before PICU admission. Included were children presenting at the emergency room and directly admitted to the PICU as well as children first admitted to the general ward who deteriorated and

Table 1 Patient characteristics of PICU admission in participants and nonparticipants

	Participants ($n = 186$)	Nonparticipants ($n = 64$)	p-value
Age of child, median (years; range)	1.4 (0.1–17.3)	1.5 (0.2–15.9)	0.423
Length of stay in PICU, median (days; range)	6.0 (1.0–336.0) *	4.0 (1.0–20.0)	0.006
Length of artificial ventilation, median (days; range)	5.0 (0.0–119.0) *	3.0 (0.0–19.0)	0.004
Risk of mortality[a], median (%; range)	4.2 (0.2–80.7)	3.8 (0.2–26.6)	0.293
Female	68 (37%)	23 (36%)	0.929
Reason for PICU admission *			0.001
Respiratory insufficiency	77 (41%)	33 (52%)	
Circulatory insufficiency	31 (17%)	13 (21%)	
Trauma	44 (24%)	9 (13%)	
Neurological disorder	22 (12%)	8 (12%)	
Metabolic disorder	6 (3%)	2 (3%)	
Gastrointestinal disorder	6 (3%)	0 (0%)	
Treatment characteristics (yes)			
Artificial ventilation	151 (81%)	55 (86%)	0.389
Circulatory support	46 (25%)	16 (25%)	0.966
Neuromuscular blocking agents	37 (20%)	18 (28%)	0.170
Corticosteroids	69 (37%)	21 (33%)	0.757
Central venous catheter	67 (36%)	18 (28%)	0.250

* $p < 0.05$ participants vs. nonparticipants; [a] Paediatric Index of Mortality II

Table 2 Diagnosis at PICU discharge in participants and nonparticipants

	Participants ($n = 186$)		Nonparticipants ($n = 64$)		p-value
	n	%	n	%	
Respiratory insufficiency					0.001
Pneumonia	41	22	19	30	
Upper airway obstruction	19	10	13	20	
Asthma	13	7	0	–	
Other	4	2	1	2	
Circulatory insufficiency					0.001
Congenital heart disease	14	8	0	–	
Other cardiac disease	4	2	1	2	
Meningococcal disease	11	6	8	12	
Toxic shock syndrome	0	–	4	6	
Other septic shock	2	1	0	–	
Trauma					0.001
Head trauma	35	19	7	11	
Other trauma	9	5	1	2	
Neurological disorder					0.001
Status epilepticus	15	8	5	8	
Meningitis	3	2	3	5	
Other	4	2	0	–	
Metabolic disorder	6	3	2	3	–
Gastrointestinal disorder	6	3	0	–	–

* $p < 0.05$ participants vs. nonparticipants

were subsequently admitted to the PICU. Physical sequelae are defined as any physical complaints or abnormalities found at the outpatient follow-up clinic by physical examination. Since all children were previously healthy, they had no physical complaints or abnormalities until shortly before PICU admission. Thus all residual physical complaints or abnormalities had to be related to either the underlying illness or to complications of PICU procedures.

Study protocol

After discharge from the PICU each family received a letter at home explaining the aim and content of the research program. Families were contacted by telephone to invite participation. In cases of failure follow-up letters with tear-off reply slip inviting participation were sent. Written informed consent was obtained from all participating families.

Three months after discharge, all families were invited to visit the outpatient follow-up clinic for structured medical examination of the child. Follow-up at 3 months after discharge was chosen because of psychological follow-up on posttraumatic stress disorder; the results of this assessment will be reported elsewhere. Structured medical examination was performed by semistructured history taking (current health status, well being, social, cognitive and physical functioning and development) and physical examination by one author (H.K.). Complications from PICU procedures such as scars, upper airway obstruction, postthrombotic syndrome and hypoxic-ischemic injury were structurally evaluated [19, 20]. Since many parents mentioned cognitive and behavioral problems spontaneously, these questions were added to the standard interview. Physical and neurocognitive sequelae found at the outpatient follow-up clinic were categorized into two groups: (a) previously unknown pre-PICU morbidity (e. g., a patient admitted to the PICU because of cyanosis caused by an until then not recognized congenital heart defect), (b) acquired morbidity (e. g., a patient with meningococcal infection, suffering from scars and postthrombotic syndrome following central venous catheterization). Acquired morbidity can be related either to the underlying illness for which PICU admission was necessary (scars due to meningococcal infection), to complications of PICU procedures (postthrombotic syndrome), or to a combination of the two. As no validated questionnaires exist to evaluate physical sequelae, we used PCPC and POPC scores to determine the extent of physical and neurocognitive sequelae. PCPC and POPC were determined at PICU discharge, 3 months after discharge, and retrospectively 24 h before admission to the PICU (baseline values) by one of the authors (H.K.).

Data were analyzed using the Statistical Package for Social Sciences, Windows version 11.5. Mann–Whitney and χ^2 tests were performed to compare participants and nonparticipants with regard to patient characteristics, reason for PICU admission, and diagnosis at discharge.

Results

Structured history taking at the outpatient follow-up clinic revealed concentration problems (9%), behavioral problems (15%), delayed psychomotor development (13%), temporary voice changes (7%), eating problems (9%),

Table 3 Physical sequelae 3 months after discharge in 186 participants (more than one problem per child possible): pre-PICU morbidity is a previously unknown underlying illness that was diagnosed during PICU admission; acquired morbidity is morbidity in a child that was healthy before PICU admission

	Pre-PICU morbidity ($n = 55$)		Acquired morbidity ($n = 73$)	
	n	%	*n*	%
Respiratory problems	21	11	23	12
Circulatory problems	14	8	0	–
Neurological problems	6	3	48	26
Metabolic disorder	6	3		
Miscellaneous problems	8	4	14	8
Tracheotomy	–	–	3	2
Scars	–	–	17	9
Hoarseness	–	–	5	3
Postthrombotic syndrome	–	–	7	4

sleeping problems (9%), and withdrawal symptoms (9%). In 9 of 40 school-age children problems at school were reported. Structured physical examination revealed abnormalities in weight gain (9%), pulmonary auscultation (9%) and neurological (23%) examination, hoarseness after endotracheal intubation (4%), and postthrombotic syndrome after central venous catheterization (4%) and scars (14%).

Of the 186 patients 128 (69%) had persisting complaints 3 months after discharge and 58 (31%) were healthy. Of the 128 children 55 (43%) had a previously unknown underlying illness (pre-PICU morbidity) that was diagnosed during PICU admission. This included patients with congenital anomalies (congenital heart defect, $n = 14$; metabolic disorder, $n = 4$), epilepsy ($n = 6$), and first-attack asthma patients ($n = 13$; Table 3).

Seventy-three (57%) children were healthy before PICU admission and had acquired morbidity (Table 3). The complaints in these children were diverse, and some children had a combination of problems. Complaints consisted of (a) pulmonary complaints (after admission due to RSV infection) or upper airway problems (tracheotomy) after endotracheal intubation; (b) neurological or neurocognitive problems caused by among other factors, hypoxic-ischemic brain injury, traumatic brain injury, meningitis, or intracerebral bleeding; (c) scars after meningococcal disease, trauma, operations, pleural drains, and (central) venous lines; (d) hoarseness 3 months after extubation (e) postthrombotic syndrome after central venous catheterization; (f) miscellaneous illnesses such as renal insufficiency, adrenal insufficiency, and gastroenterological problems (Table 3). In at least 15 (8%) children morbidity was related to complications from PICU procedures. In the other 61 children with acquired morbidity it was not possible to differentiate between morbidity related to underlying illness, to complications from PICU procedures, or both (Table 3).

Twenty-four hours before PICU admission 177 of the 186 evaluated children (95%) had in retrospect normal PCPC scores and 135 (73%) normal POPC scores (baseline values). The 9 children (5%) with abnormal PCPC scores and 51 (27%) with abnormal POPC scores had presenting symptoms which were not recognized more than 24 h before PICU admission. Figures 1 and 2 show

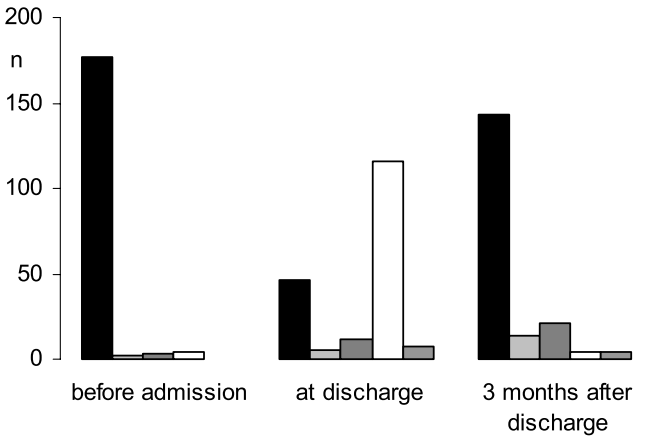

Fig. 1 Pediatric Cerebral Performance Category in 186 evaluated children 24 h before PICU admission, at PICU discharge, and 3 months after PICI discharge. *Columns from left to right: black*, normal; *light gray*, mild disability; *dark gray*, moderate disability; *white*, severe disabililty; *medium gray* coma/vegatative state

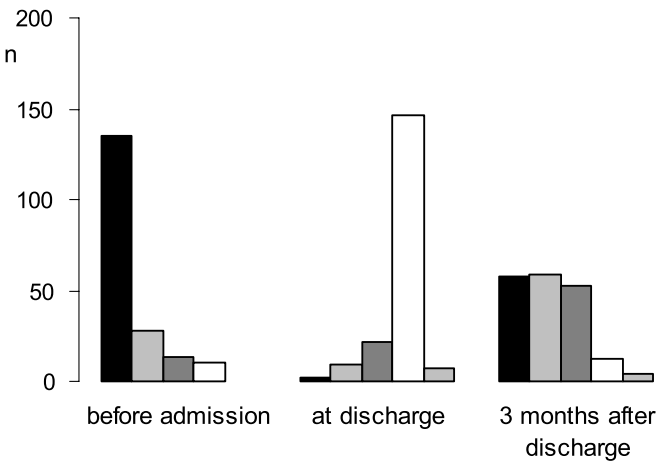

Fig. 2 Pediatric Overall Performance Category in 186 evaluated children. POPC scores 24 h before PICU admission, at PICU discharge and 3 months after PICI discharge. *Columns from left to right: black*, normal; *light gray*, mild disability; *dark gray*, moderate disability; *white*, severe disabililty; *medium gray*, coma/vegatative state

that at discharge 46 children (25%) had normal PCPC scores and 2 (1%) normal POPC scores. Three months after discharge 143 children (77%) had normal PCPC scores and 58 (31%) normal POPC scores. Three months after discharge, respectively, 147 (79%) and 93 children (50%) showed PCPC and POPC scores that were the same or improved compared to scores before admission. In respect 39 (21%) and 93 (50%) children's scores deteriorated (Figs. 1, 2).

Discussion

This is one of the first studies to report the nature and extent of physical sequelae in PICU survivors. Three months after discharge the evaluation of physical and neurocognitive sequelae in PICU survivors showed that only 31% of the evaluated children were healthy while 30% had a previously unknown underlying illness (pre-PICU morbidity), and 39% an acquired morbidity. In at least 8% of these children morbidity was related to complications from PICU procedures. Upper airway disease and pulmonary and neurological problems accounted for some 50% of persisting complaints. Upper airway disease, consisting of upper airway obstruction after endotracheal intubation, or lower airway disease after RSV infection and asthma was found in 47 of 186 evaluated children.

Neurological and neurocognitive sequelae, consisting of delayed psychomotor development, epilepsy, pareses, and concentration and behavioral disturbances, were found in 54 of 186 evaluated children. Studies evaluating neurocognitive outcome after PICU survival in a structured way are limited [11, 21–23]. To evaluate the extent of neurocognitive sequelae we used PCPC and POPC scores at discharge and at 3 months' follow-up. At discharge PCPC and POPC scores in our patients were reduced in, respectively, 73% and 91%. Three months later scores had substantially improved. This leads us to believe that long-term follow-up is necessary to evaluate neurocognitive development by structured psychometric testing. In at least 8% of patients morbidity was associated with complications of PICU procedures. Examples include hoarseness due to mucosal damage after endotracheal intubation and impaired growth of extremities due to vascular damage after central venous catheterization. Neither hoarseness nor impaired growth of extremities was ever mentioned spontaneously. In addition, use of medications (corticosteroids, ototoxic drugs, sedatives, and neuromuscular blocking agents) also may lead to long-term sequelae and were not evaluated [24–27].

A number of limitations may have biased the results of this study. First, a considerable number of children were lost due to nonresponse and refusal. Although other follow-up studies in PICU patients had similar response rates, this may have biased our results [4, 7]. We probably missed a number of patients of whom parents were experiencing psychological problems, such as posttraumatic stress disorder [28–30]. Furthermore, the distinct subgroups of participants were not equally distributed; relatively more trauma patients and children with cardiac disorders are evaluated and fewer children with septic shock. Second, structured history taking by one observer involved in PICU care may have biased our results. Third, participants had significantly longer length of stay and more ventilation days than nonparticipants. This might be associated with an increased number of complications and severity of sequelae. Fourth, follow-up time was only 3 months; therefore conclusions on sequelae over an extended period cannot be drawn. Finally, PCPC and POPC scores have been validated for PICU populations; it remains questionable whether these scores can be used to predict problems in the individual patient.

Despite these limitations we believe that these outcome data of a mixed pediatric and surgical PICU population are important. Our findings are comparable to the few existing studies on physical sequelae in PICU survivors. In an Australian study of 974 children 42% of survivors were normal and 17% functionally normal but required medical supervision. Of the remaining 41% functionally nonnormal survivors 32% will probably be able to lead an independent life [3]. The Health Utilities Index 2 used in four studies showed 27–37% of survivors in full health 1 year after discharge [5–7].

Suggestions for future research

Cohort studies of PICU survivors evaluating patient outcome (physical and neurocognitive sequelae, functional status, and quality of life) are essential. Awareness of long-term sequelae may result in changes in treatment during the acute phase and in supportive programs after discharge [17, 18, 31–33]. Long-term follow-up clinics of PICU survivors and rehabilitation programs in exactly the same manner as in neonatal and trauma patients should be developed to detect, support, and treat children with neurocognitive, developmental, and psychological problems. These programs are expected to improve daily life [34, 35]. Pediatric intensivists should be core-members of the multidisciplinary follow-up team as they are familiar with possible risks and complications of PICU treatment. In addition, notifying complications of PICU procedures may serve as a valuable tool of providing feedback on procedures in the acute phase. Proper cohort studies in a pediatric population should be multidisciplinary, multicenter long-term follow-up studies applying specific measurement tools to evaluate sequelae in different age groups.

Conclusion

PICU survival leads to substantial physical sequelae related to underlying illnesses, complications from PICU procedures, or both. We believe that preferably multicenter, long-term follow-up research in a structured and validated way is warranted in PICU survivors. This should include (a) multidisciplinary evaluation of physical and neurocognitive sequelae of the underlying illness and the intensive care treatment per se and subsequently their impact during growth and development, (b) evaluation of risk factors for sequelae, and (c) support after discharge if needed. To guarantee all this, follow-up is needed for a sufficient and extended period of time after discharge.

Acknowledgements. The authors thank J. H. van der Lee, MD, PhD, Department of Pediatric Clinical Epidemiology, Emma Children's Hospital, AMC Amsterdam, for advice and statistical expertise.

References

1. Maat M, Buysse CM, Emonts M, Spanjaard L, Joosten KF, Groot RD, Hazelzet JA (2007) Improved survival of children with sepsis and purpura: effects of age, gender, and era. Crit Care 11:R112
2. Tilford JM, Roberson PK, Lensing S, Fiser DH (1998) Differences in pediatric ICU mortality risk over time. Crit Care Med 26:1737–1743
3. Butt W, Shann F, Tibballs J, Williams J, Cuddihy L, Blewett L, Farley M (1990) Long-term outcome of children after intensive care. Crit Care Med 18:961–965
4. Buysse CM, Raat H, Hazelzet JA, Vermunt LC, Utens EM, Hop WC, Joosten KF (2007) Long-term health-related quality of life in survivors of meningococcal septic shock in childhood and their parents. Qual Life Res 16:1567–1576
5. Gemke RJ, Bonsel GJ, van Vught AJ (1995) Long-term survival and state of health after paediatric intensive care. Arch Dis Child 73:196–201
6. Jayshree M, Singhi SC, Malhi P (2003) Follow up of survival and quality of life in children after intensive care. Indian Pediatr 40:303–309
7. Jones S, Rantell K, Stevens K, Colwell B, Ratcliffe JR, Holland P, Rowan K, Parry GJ (2006) Outcome at 6 months after admission for pediatric intensive care: a report of a national study of pediatric intensive care units in the United kingdom. Pediatrics 118:2101–2108
8. Morrison AL, Gillis J, O'Connell AJ, Schell DN, Dossetor DR, Mellis C (2002) Quality of life of survivors of pediatric intensive care. Pediatr Crit Care Med 3:1–5
9. Taylor A, Butt W, Ciardulli M (2003) The functional outcome and quality of life of children after admission to an intensive care unit. Intensive Care Med 29:795–800
10. Fiser DH (1992) Assessing the outcome of pediatric intensive care. J Pediatr 121:68–74
11. Fiser DH, Long N, Roberson PK, Hefley G, Zolten K, Brodie-Fowler M (2000) Relationship of pediatric overall performance category and pediatric cerebral performance category scores at pediatric intensive care unit discharge with outcome measures collected at hospital discharge and 1- and 6-month follow-up assessments. Crit Care Med 28:2616–2620
12. Fiser DH, Tilford JM, Roberson PK (2000) Relationship of illness severity and length of stay to functional outcomes in the pediatric intensive care unit: a multi-institutional study. Crit Care Med 28:1173–1179
13. Davey TM, Aitken LM, Kassulke D, Bellamy N, Ambrose J, Gee T, Clark M (2005) Long-term outcomes of seriously injured children: a study using the Child Health Questionnaire. J Paediatr Child Health 41:278–283
14. Klassen AF, Lee SK, Raina P, Chan HW, Matthew D, Brabyn D (2004) Health status and health-related quality of life in a population-based sample of neonatal intensive care unit graduates. Pediatrics 113:594–600
15. Rijen EH van, Utens EM, Roos-Hesselink JW, Meijboom FJ, van Domburg RT, Roelandt JR, Bogers AJ, Verhulst FC (2005) Current subjective state of health, and longitudinal psychological well-being over a period of 10 years, in a cohort of adults with congenital cardiac disease. Cardiol Young 15:168–175
16. Angus DC, Carlet J (2003) Surviving intensive care: a report from the 2002 Brussels Roundtable. Intensive Care Med 29:368–377
17. Dowdy DW, Eid MP, Sedrakyan A, Mendez-Tellez PA, Pronovost PJ, Herridge MS, Needham DM (2005) Quality of life in adult survivors of critical illness: a systematic review of the literature. Intensive Care Med 31:611–620
18. Williams TA, Dobb GJ, Finn JC, Webb SA (2005) Long-term survival from intensive care: a review. Intensive Care Med 31:1306–1315
19. Kuhle S, Koloshuk B, Marzinotto V, Bauman M, Massicotte P, Andrew M, Chan A, Abdolell M, Mitchell L (2003) A cross-sectional study evaluating post-thrombotic syndrome in children. Thromb Res 111:227–233
20. Wain JC (2003) Postintubation tracheal stenosis. Chest Surg Clin N Am 13:231–246
21. Fellick JM, Sills JA, Marzouk O, Hart CA, Cooke RW, Thomson AP (2001) Neurodevelopmental outcome in meningococcal disease: a case-control study. Arch Dis Child 85:6–11
22. Lopez-Herce J, Garcia C, Rodriguez-Nunez A, Dominguez P, Carrillo A, Calvo C, Delgado MA (2005) Long-term outcome of paediatric cardiorespiratory arrest in Spain. Resuscitation 64:79–85
23. Horisberger T, Fischer E, Fanconi S (2002) One-year survival and neurological outcome after pediatric cardiopulmonary resuscitation. Intensive Care Med 28:365–368
24. Dominguez KD, Crowley MR, Coleman DM, Katz RW, Wilkins DG, Kelly HW (2006) Withdrawal from lorazepam in critically ill children. Ann Pharmacother 40:1035–1039

25. Halpern NA, Pastores SM, Price JB, Alicea M (1999) Hearing loss in critical care: an unappreciated phenomenon. Crit Care Med 27:211–219
26. Sorce LR (2005) Adverse responses: sedation, analgesia and neuromuscular blocking agents in critically ill children. Crit Care Nurs Clin North Am 17:441–xii
27. Samuelson K, Lundberg D, Fridlund B (2006) Memory in relation to depth of sedation in adult mechanically ventilated intensive care patients. Intensive Care Med 32:660–667
28. Balluffi A, Kassam-Adams N, Kazak A, Tucker M, Dominguez T, Helfaer M (2004) Traumatic stress in parents of children admitted to the pediatric intensive care unit. Pediatr Crit Care Med 5:547–553
29. Diaz-Caneja A, Gledhill J, Weaver T, Nadel S, Garralda E (2005) A child's admission to hospital: a qualitative study examining the experiences of parents. Intensive Care Med 31:1248–1254
30. Ehrlich TR, Von R, I, Grootenhuis MA, Gerrits AI, Bos AP (2005) Long-term psychological distress in parents of child survivors of severe meningococcal disease. Pediatr Rehabil 8:220–224
31. Dowdy DW, Needham DM, Mendez-Tellez PA, Herridge MS, Pronovost PJ (2005) Studying outcomes of intensive care unit survivors: the role of the cohort study. Intensive Care Med 31:914–921
32. Knoester H, Grootenhuis MA, Bos AP (2007) Outcome of paediatric intensive care survivors. Eur J Pediatr 166:1119–1128
33. Needham DM, Dowdy DW, Mendez-Tellez PA, Herridge MS, Pronovost PJ (2005) Studying outcomes of intensive care unit survivors: measuring exposures and outcomes. Intensive Care Med 31:1153–1160
34. McCormick MC, Brooks-Gunn J, Buka SL, Goldman J, Yu J, Salganik M, Scott DT, Bennett FC, Kay LL, Bernbaum JC, Bauer CR, Martin C, Woods ER, Martin A, Casey PH (2006) Early Intervention in Low Birth Weight Premature Infants: results at 18 Years of Age for the Infant Health and Development Program. Pediatrics 117:771–780
35. Savage RC, Pearson S, McDonald H, Potoczny-Gray A, Marchese N (2001) After hospital: working with schools and families to support the long term needs of children with brain injuries. Neurorehabilitation 16:49–58