Official Journal of the European Paediatric Neurology Society

Original article

Neurological examination of late-preterm infants at term age

Domenico M. Romeo [a,b], *Daniela Ricci* [a], *Claudia Brogna* [a], *Salvatore Cilauro* [c], *Maria Elena Lombardo* [d], *Mario G. Romeo* [c], *Eugenio Mercuri* [a,*]

[a] *Department of Pediatrics, Child Neurology and Psychiatry, Catholic University, Rome, Italy*
[b] *Division of Child Neurology and Psychiatry, Department of Pediatrics, University of Catania, Italy*
[c] *Neonatal Intensive Care Unit, Department of Paediatrics, University of Catania, Italy*
[d] *Department of Physiological Sciences, University of Catania, Catania, Italy*

ARTICLE INFO

Article history:
Received 11 January 2011
Received in revised form
17 March 2011
Accepted 21 March 2011

Keywords:
Late-preterm
Neurological assessment
Newborn

ABSTRACT

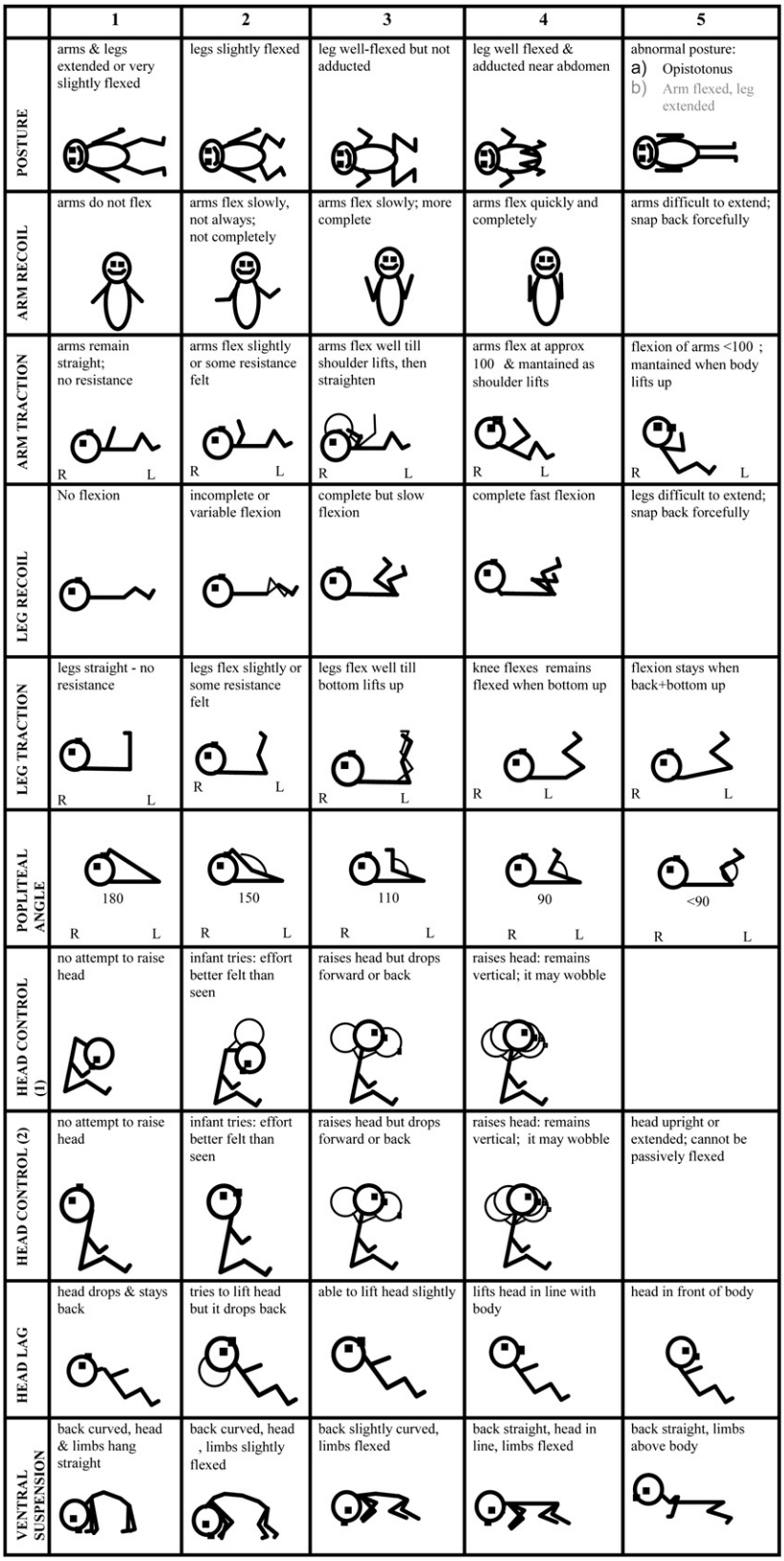
Background: Late-preterm infants represent 70% of the whole preterm population.
Aims: To establish the range and frequency distribution of neonatal neurological scores in a large cohort of low risk late-preterm infants and the possible differences with full-term infants.
Methods: Three hundred-seventy-five healthy infants born between 34 and 36 weeks gestational age (GA) without major brain lesions were assessed between 39 and 41 weeks post-menstrual age using the Hammersmith Neonatal Neurologic Assessment and compared to the scores obtained using the same examination in full-term infants.
Results: Infants born at 35 and 36 weeks GA had similar median scores in 32 of the 34 items. Infants born at 34 weeks GA had a different profile of scores compared to those born at 35 and 36 weeks, mainly in the tone items. While in infants born at 34 weeks the assessment at term age showed similar median scores to those obtained in full-term infants in 25/34 items, in those born at 35 and 36 GA the number of scores similar to full-term infants increased to 29/34. The main differences involved the tone items, with more marked flexor tone in the limbs and better head control for those born at 35 and 36 weeks.
Conclusions: This data can help as reference data when examining late-preterm infants at term age to see where the individual child stands compared to age matched low risk infants and to identify signs that are outside the reported range in infants with lesions or other risk factors.

1. Introduction

The neurological assessment of the newborn has been widely studied in both preterm and full-term infant using the examination developed by Dubowitz and Dubowitz in 1981[1] and updated in 1998.[2,3] The examination has been applied to large cohorts of healthy full-term newborns and low risk preterm infants in order to establish the frequency distribution of the scores for each item in both groups.[2–5] Data on preterm infants show that those born between 25 and 34 weeks have less flexor limb tone, poorer head control but better visual following than term-born infants.[4,5]

No data is available for late-preterm infants, i.e. infants born at 34–36 weeks gestational age (GA), who represent the

* *Corresponding author*. Pediatric Neurology, Catholic University, Largo Gemelli 8, 00168 Rome, Italy. Tel.: +39 (0) 630155340; fax: +39 (0) 630154363.
E-mail address: mercuri@rm.unicatt.it (E. Mercuri).
1090-3798/$ – see front matter © 2011 European Paediatric Neurology Society. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.ejpn.2011.03.009



1	.5	2	.5	3	.5	4	.5	5	
0	0	1	1	54	5	36	0	3	34w
0	0	1	2	16	5	76	<1	0	35w
0	0	0	1	24	5	69	0	1	36w
0	0	0	0	6	3	90	1	0	Full term

1	.5	2	.5	3	.5	4	.5	5	
1	0	0	1	49	13	34	1	0	34w
0	1	0	3	17	9	70	<1	0	35w
0	0	0	1	19	8	71	0	1	36w
0	0	5	2	22	3	67	1	0	Full term

1	.5	2	.5	3	.5	4	.5	5	
3	3	24	5	54	6	5	0	0	34w
0	0	2	1	28	8	61	0	0	35w
0	0	1	1	41	5	52	0	0	36w
0	0	1	0	22	8	69	0	0	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	4	1	34	3	57	0	1	34w
0	0	<1	<1	30	7	62	0	0	35w
0	0	10	<1	39	0	50	1	0	36w
0	0	3	1	4	1	91	0	0	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	13	10	35	5	37	0	0	34w
0	0	1	1	24	1	73	0	0	35w
0	0	0	1	31	0	68	0	0	36w
0	0	0	1	12	12	72	0	3	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	28	2	38	5	27	0	0	34w
0	0	4	1	54	4	37	0	0	35w
0	0	12	2	44	1	41	0	0	36w
0	0	5	5	19	20	51	0	0	Full term

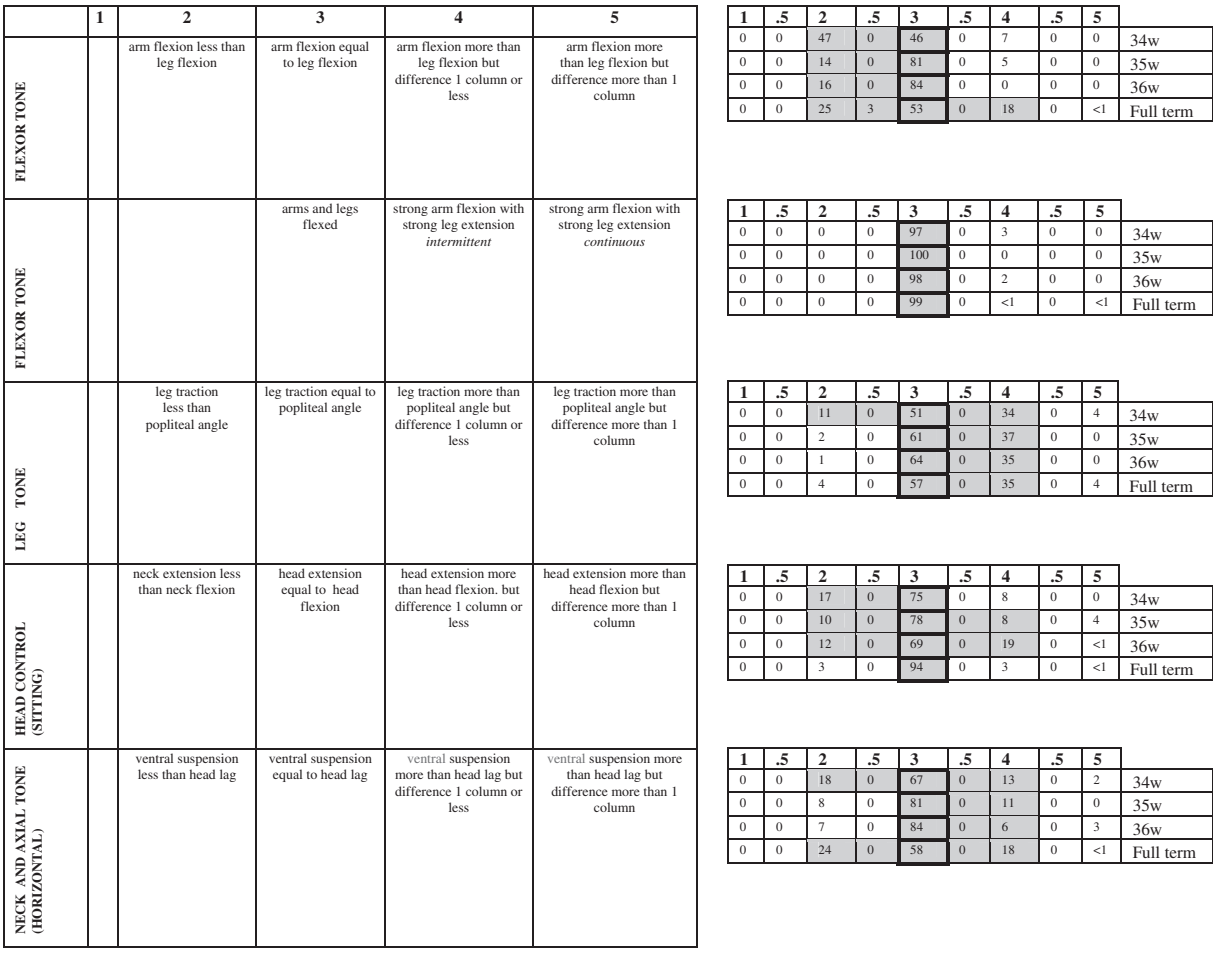
1	.5	2	.5	3	.5	4	.5	5	
0	0	15	2	51	9	23	0	0	34w
0	0	1	1	43	10	45	0	0	35w
0	0	5	1	42	11	41	0	0	36w
0	0	0	6	26	12	56	0	0	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	3	5	54	9	29	0	0	34w
0	0	4	3	44	5	44	0	0	35w
0	0	2	2	44	8	44	0	0	36w
0	0	0	4	29	15	52	0	0	Full term

1	.5	2	.5	3	.5	4	.5	5	
4	0	17	1	49	9	19	0	1	34w
0	0	4	4	56	15	21	0	0	35w
0	0	13	3	52	5	27	0	0	36w
0	0	9	4	44	12	31	0	0	Full term

1	.5	2	.5	3	.5	4	.5	5	
3	0	19	4	47	10	16	0	1	34w
0	0	4	6	47	24	19	0	0	35w
0	0	5	3	63	7	22	0	0	36w
0	0	4	5	47	16	28	0	0	Full term

Fig. 1 – Tone and posture items. The diagram of each item shows the range of scores in the 3 subgroups of late-preterm infants examined at term subdivided according to their gestational age and those of full-term infants examined in the first 48 h after birth, previously published.[3] The shading highlights the raw scores that were found in 90% of each group of preterm and term infants. The cell with highlighted border indicates the median scores.



	1	2	3	4	5
FLEXOR TONE		arm flexion less than leg flexion	arm flexion equal to leg flexion	arm flexion more than leg flexion but difference 1 column or less	arm flexion more than leg flexion but difference more than 1 column
FLEXOR TONE			arms and legs flexed	strong arm flexion with strong leg extension *intermittent*	strong arm flexion with strong leg extension *continuous*
LEG TONE		leg traction less than popliteal angle	leg traction equal to popliteal angle	leg traction more than popliteal angle but difference 1 column or less	leg traction more than popliteal angle but difference more than 1 column
HEAD CONTROL (SITTING)		neck extension less than neck flexion	head extension equal to head flexion	head extension more than head flexion. but difference 1 column or less	head extension more than head flexion but difference more than 1 column
NECK AND AXIAL TONE (HORIZONTAL)		ventral suspension less than head lag	ventral suspension equal to head lag	ventral suspension more than head lag but difference 1 column or less	ventral suspension more than head lag but difference more than 1 column

1	.5	2	.5	3	.5	4	.5	5	
0	0	47	0	46	0	7	0	0	34w
0	0	14	0	81	0	5	0	0	35w
0	0	16	0	84	0	0	0	0	36w
0	0	25	3	53	0	18	0	<1	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	0	0	97	0	3	0	0	34w
0	0	0	0	100	0	0	0	0	35w
0	0	0	0	98	0	2	0	0	36w
0	0	0	0	99	0	<1	0	<1	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	11	0	51	0	34	0	4	34w
0	0	2	0	61	0	37	0	0	35w
0	0	1	0	64	0	35	0	0	36w
0	0	4	0	57	0	35	0	4	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	17	0	75	0	8	0	0	34w
0	0	10	0	78	0	8	0	4	35w
0	0	12	0	69	0	19	0	<1	36w
0	0	3	0	94	0	3	0	<1	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	18	0	67	0	13	0	2	34w
0	0	8	0	81	0	11	0	0	35w
0	0	7	0	84	0	6	0	3	36w
0	0	24	0	58	0	18	0	<1	Full term

Fig. 2 – Tone pattern items-derived from responses documented in Fig. 1. Refer to Fig. 1 for diagram interpretation.

great majority of infants born prematurely (~70%).[6–11] Although it has been previously reported[8] that at 6, 9 and 12 months corrected age (CA) preterm infants born at 35 and 36 weeks have lower tone and reflexes when compared to term infants assessed at the same ages, nothing has been systematically reported for the term age.

The aim of this study was to establish the range and frequency distribution of neonatal neurological scores in a large cohort of low risk late-preterm infants and the possible differences with full-term infants.

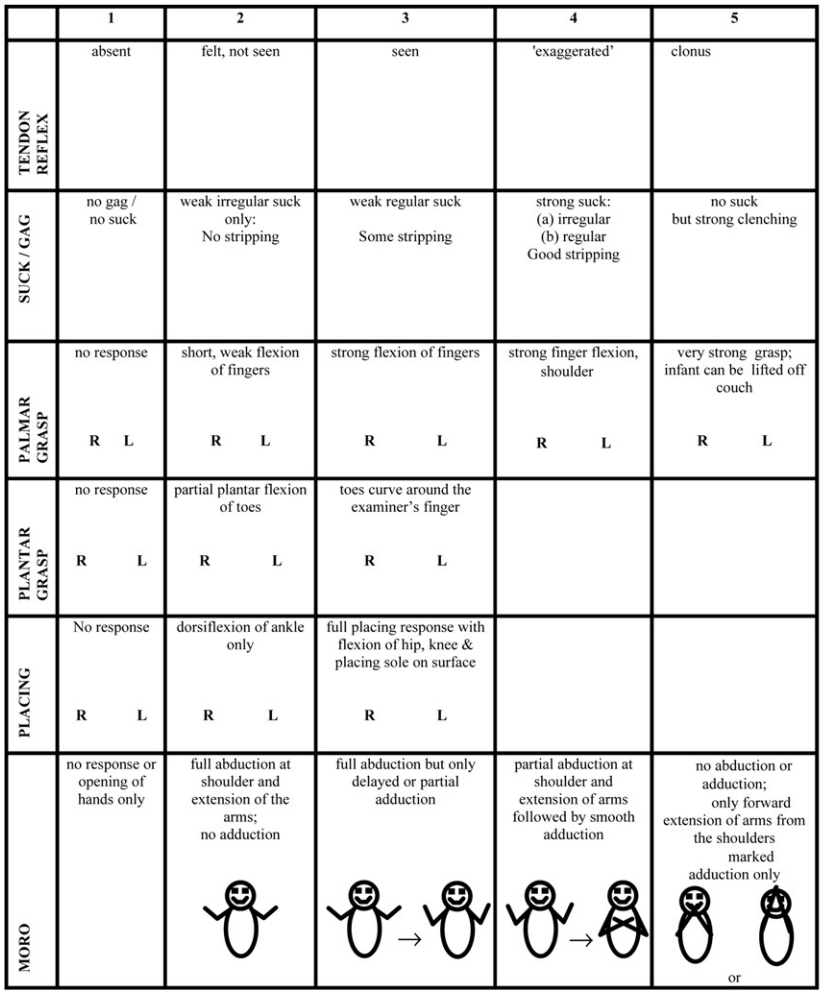
2. Patients and methods

The infants described in this study are part of a large cohort admitted to the Neonatal Unit of the University of Catania between January 2005 and December 2006. They were consecutively enrolled as part of a follow-up research program, including all infants born at a gestational age (GA) < 37 weeks.

In order to establish the distribution of frequency of neurological findings in a low risk population, infants were included if

a) they were born between 34 and 36 weeks GA; GA was calculated from antenatal ultrasound scan performed at 14–16 weeks of gestation.
b) their cranial ultrasound scans (cUS) were normal or only showed transient flares or germinal layer haemorrhages (GLH) in the first 2 weeks after birth and had no parenchymal abnormality at term age and no evidence of atrophy i.e. dilated ventricles (>14 mm VI), irregular ventricular margins, widened interhemispheric fissures or an enlarged extracerebral space.[12] Cranial ultrasound (US) was generally obtained within the 6th day and then at least weekly up to infant discharge, and always around term age.
c) they had, on the neurodevelopmental assessment, performed at 24 months corrected age using the Mental Developmental Index of Bayley Scales of Infant Development second edition,[13] results within the normal range for age.

Infants were not included if they were not clinically stable at term age showed a morbid condition, as hospital stay >5 nights, respiratory distress, APGAR < 6 at 5 min, pH < 7.20, transfer to the NICU (regardless length of stay or reported diagnosis).



1	.5	2	.5	3	.5	4	.5	5	
0	0	10	0	54	0	32	0	4	34w
0	0	19	<1	64	2	15	0	0	35w
0	0	15	1	68	4	12	0	0	36w
<1	0	21	0	78	0	<1	0	<1	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	1	0	17	0	82	0	0	34w
0	0	<1	0	8	<1	90	0	<1	35w
0	0	2	0	11	0	87	0	0	36w
0	0	1	0	5	0	92	0	2	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	9	0	63	2	22	0	4	34w
1	0	5	0	75	0	18	0	1	35w
0	0	7	0	72	<1	19	0	2	36w
<1	0	6	0	84	0	9	0	<1	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	4	0	96	0	0	0	0	34w
0	0	3	0	97	0	0	0	0	35w
0	0	2	0	98	0	0	0	0	36w
<1	0	2	0	98	0	0	0	0	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	14	0	86	0	0	0	0	34w
0	0	9	0	91	0	0	0	0	35w
0	0	5	0	95	0	0	0	0	36w
1	0	18	0	81	0	0	0	0	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	10	0	57	1	30	0	1	34w
0	0	11	0	49	0	40	0	0	35w
0	0	10	0	35	0	55	0	0	36w
0	0	1	0	20	0	79	0	0	Full term

Fig. 3 – Reflexes. Refer to Fig. 1 for diagram interpretation.

We also excluded infants with major congenital malformations, chromosomal abnormality, congenital infection or any other sign of encephalopathy.

2.1. *Clinical examination*

Neurological examination was performed and recorded using the Hammersmith Neonatal Neurologic Assessment,[2] consisting of 34 items. Items were grouped in six categories (tone, tone patterns, reflexes, movements, abnormal signs and behaviour). Infants were examined between 39 and 41 weeks post-menstrual age (PMA).

Infants were examined undressed on an open bed or in their cot in a warm quiet room. Behavioural state, graded according to Brazelton criteria[14] at the time of examination was recorded. In order to achieve comparable results, whenever possible, all the infants were tested in the same state, midway between feeds, predominantly in state 4 or 5.

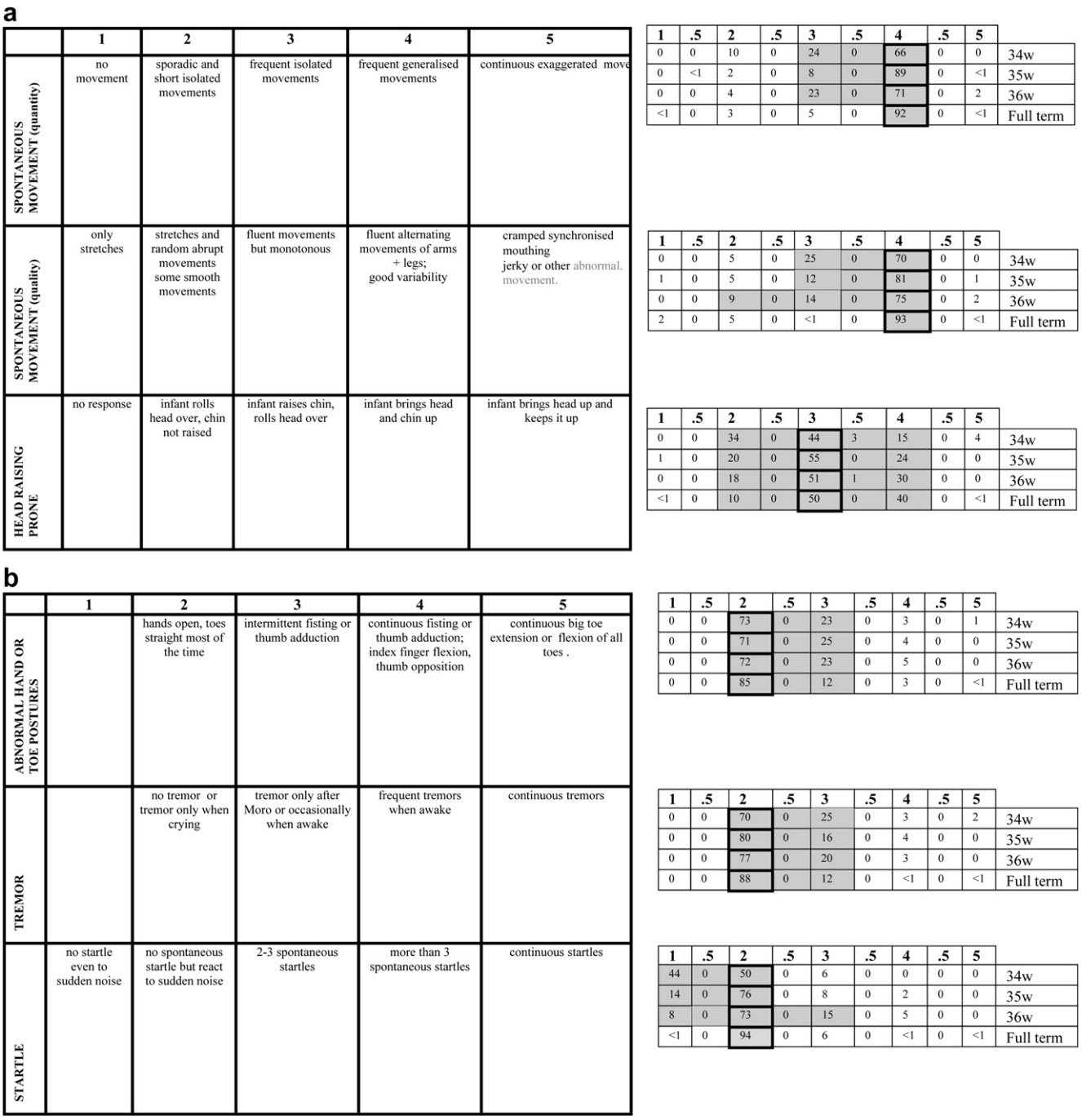
The proforma consists of numbered columns, between 3 and 5 for each item. If an item fell between 2 columns, it was given the appropriate half score between the columns (e.g. items scoring between 2 and 3 scored 2.5; between 2 and 1 scored 1.5). These scores are defined as raw scores.

In order to be able to evaluate the range and the distribution of the scores at different gestational ages and to compare these findings to our normative full-term,[2,3] the distribution of the raw scores (cells with highlighted border) for the cohort of late-preterm was plotted for each item and the median and 10th centile score noted as reported in previous studies.[3,5] The results of the cohort were analysed according to their gestational age at birth into: 34 weeks, 35 weeks, and 36 weeks.

Comparison between the distribution of infants born at the 3 different GA in the three groups subdivided according to the term equivalent age (TEA) assessment (39, 40, 41 weeks) was done by a non-parametric test (Kruskall–Wallis test followed by Dunn's post test). Comparison between cUS scans findings (normal Vs minor abnormalities) and genders for scores of each item were done by using the non-parametric test of Mann-Witney U. The level of significance was set at $p < 0.05$.

3. Results

Three hundred-seventy-five late-preterm infants fulfilled the inclusion criteria. The preterm delivery was related to placenta abruption, placenta previa, infection (unspecified



a

	1	2	3	4	5
SPONTANEOUS MOVEMENT (quantity)	no movement	sporadic and short isolated movements	frequent isolated movements	frequent generalised movements	continuous exaggerated move
SPONTANEOUS MOVEMENT (quality)	only stretches	stretches and random abrupt movements some smooth movements	fluent movements but monotonous	fluent alternating movements of arms + legs; good variability	cramped synchronised mouthing jerky or other abnormal movement.
HEAD RAISING PRONE	no response	infant rolls head over, chin not raised	infant raises chin, rolls head over	infant brings head and chin up	infant brings head up and keeps it up

1	.5	2	.5	3	.5	4	.5	5	
0	0	10	0	24	0	66	0	0	34w
0	<1	2	0	8	0	89	0	<1	35w
0	0	4	0	23	0	71	0	2	36w
<1	0	3	0	5	0	92	0	<1	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	5	0	25	0	70	0	0	34w
1	0	5	0	12	0	81	0	1	35w
0	0	9	0	14	0	75	0	2	36w
2	0	5	0	<1	0	93	0	<1	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	34	0	44	3	15	0	4	34w
1	0	20	0	55	0	24	0	0	35w
0	0	18	0	51	1	30	0	0	36w
<1	0	10	0	50	0	40	0	<1	Full term

b

	1	2	3	4	5
ABNORMAL HAND OR TOE POSTURES		hands open, toes straight most of the time	intermittent fisting or thumb adduction	continuous fisting or thumb adduction; index finger flexion, thumb opposition	continuous big toe extension or flexion of all toes .
TREMOR		no tremor or tremor only when crying	tremor only after Moro or occasionally when awake	frequent tremors when awake	continuous tremors
STARTLE	no startle even to sudden noise	no spontaneous startle but react to sudden noise	2-3 spontaneous startles	more than 3 spontaneous startles	continuous startles

1	.5	2	.5	3	.5	4	.5	5	
0	0	73	0	23	0	3	0	1	34w
0	0	71	0	25	0	4	0	0	35w
0	0	72	0	23	0	5	0	0	36w
0	0	85	0	12	0	3	0	<1	Full term

1	.5	2	.5	3	.5	4	.5	5	
0	0	70	0	25	0	3	0	2	34w
0	0	80	0	16	0	4	0	0	35w
0	0	77	0	20	0	3	0	0	36w
0	0	88	0	12	0	<1	0	<1	Full term

1	.5	2	.5	3	.5	4	.5	5	
44	0	50	0	6	0	0	0	0	34w
14	0	76	0	8	0	2	0	0	35w
8	0	73	0	15	0	5	0	0	36w
<1	0	94	0	6	0	<1	0	<1	Full term

Fig. 4 – a) Spontaneous movements. (b) Abnormal signs. Refer to Fig. 1 for diagram interpretation.

maternal pyrexia, generalized infection or chorioamnionitis), elective cesarean delivery, preterm labor. Thirty infants (8%) were small for gestational age.

Infants were subdivided into 3 subgroups according to their gestational age: 79 (34 female, 45 male) were born at 34, 168 (77 female, 91 male) at 35 and 128 (68 female, 60 male) at 36 weeks gestation.

Of the 375 infants studied, 144 children were tested at 39, 159 at 40 and 72 at 41 weeks PMA, with no statistical difference ($p > 0.05$) in the distribution of infants born at different gestational ages (34, 35, 36 weeks) in the three groups subdivided according to TEA assessment. Three hundred-thirty-eight infants showed normal cUS, 30 transient flares and 7 IVH I. No statistical differences ($p > 0.05$) were reported for scores of each item between infants with normal and minimal abnormalities on cUS or for genders.

3.1. *Tone items*

3.1.1. *Range of scores and median score in the late-preterm infants reaching term age – comparison of different gestational ages at birth*

The range of scores falling within the 90th centile in infants born at 34, 35 and 36 weeks was similar in 3 of the 10 items

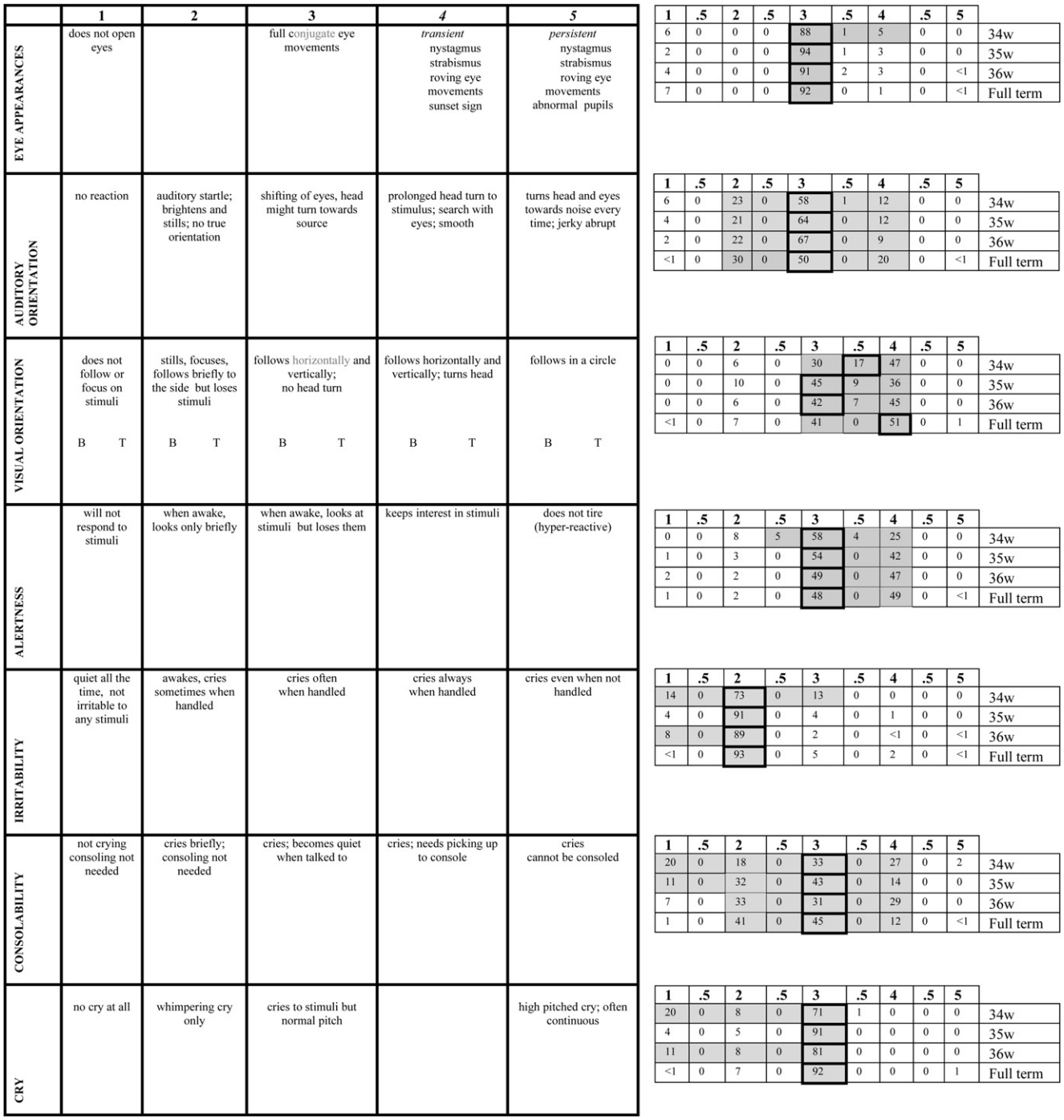


Fig. 5 – Behaviour. Refer to Fig. 1 for diagram interpretation.

assessing tone and different in the other 7. The median scores in the 3 subgroups were similar in 4 items and differed in the other 6 (Fig. 1). Infants born at 35 and 36 weeks differed only for 3 items for the range of the scores and 1 for median scores.

3.1.2. *Late-preterm compared to full-term infants*

The range of scores in infants born at 34 weeks was similar to that found in full-term infants in 2 items and different in the other 8. The median scores were similar in 3 items and different in the other 7 (Fig. 1). Infants born at 35 and 36 weeks had similar scores to those found in full-term infants in 6/10 items for the range of scores and 7/10 for median scores.

3.2. *Tone patterns*

3.2.1. *Range of scores and median score in the late-preterm infants reaching term age*

The range of the scores falling within the 90th centile was similar in the 3 gestational age subgroups in 2 of the 5 items

assessing tone patterns and differed in the other 3. The median scores were similar in all subgroups for all the items (Fig. 2). Infants born at 35 and 36 weeks had similar range and median scores in all the items.

3.2.2. *Late-preterm compared to full-term infants*

The range of the scores in infants born at 34 weeks was similar to that found in full-term infants in 1 item and different in the other 4. The median scores were similar in all the items. Infants born at 35 and 36 weeks had similar scores to those found in full-term infants in 2/4 for the range of scores and 4/4 for median scores (Fig. 2).

3.3. *Reflexes*

3.3.1. *Range of scores and median score in the late-preterm infants reaching term age*

The range of scores falling within the 90th centile was similar in the 3 gestational age subgroups in 2 of the 6 items assessing reflexes. The median score was similar in all 3 subgroups in all the items but 1 (Fig. 3). Infants born at 35 and 36 weeks differed only for 2 items for the range of the scores and 1 for median scores.

3.3.2. *Late-preterm compared to full-term infants*

The range of the scores in infants born at 34 weeks was similar to that found in full-term infants in only one item and different in the other 5. The median scores were similar in 5 of 6 items but different for the assessment of the Moro reflex (Fig. 3). Infants born at 35 and 36 weeks had similar scores to those found in full-term infants in 2/6 items for the range of scores and 5/6 for median scores.

3.4. *Movements*

3.4.1. *Range of scores and median score in the late-preterm infants reaching term age*

The range of the scores falling within the 90th centile was similar in the 3 gestational age subgroups in 2 of the 3 items assessing movements. The median score in the 3 subgroups was similar in all the 3 items (Fig. 4a).

3.4.2. *Late-preterm compared to full-term infants*

The range of the scores in infants born at 34 weeks was similar to that found in full-term infants in 1 item and different in the other 2. The median scores were similar in all the items. Infants born at 35 and 36 weeks had similar scores to those found in full-term infants in 1/3 for the range of scores and 3/3 for median scores (Fig. 4a).

3.5. *Abnormal signs*

3.5.1. *Range of scores and median score in the late-preterm infants reaching term age*

The range of the scores falling within the 90th centile was similar in the 3 gestational age subgroups in 2 of the 3 items assessing abnormal signs. The median scores in the 3 subgroups were similar for all the items (Fig. 4b).

3.5.2. *Late-preterm compared to full-term infants*

The range of the scores in infants born at 34 weeks was similar to that found in full-term infants in 2 items and different in the other 1. The median scores were similar in all the items. Infants born at 35 and 36 weeks had similar scores to those found in full-term infants in 2/3 for the range of scores and 3/3 for median scores (Fig. 4b).

3.6. *Behavioural items*

3.6.1. *Range of scores and median score in the late-preterm infants reaching term age*

The range of the scores falling within the 90th centile was similar in the three gestational age subgroups in 2 of the 7 items assessing behaviour and differed in the remaining 5. The median scores were similar in all 3 subgroups for 6 of the 7 items (Fig. 5).

3.6.2. *Late-preterm compared to full-term infants*

The range of the scores in infants born at 34 weeks was similar to that found in full-term infants in 2 items and different in the other 5. The median scores were similar for 6 of the 7 items and different for visual orientation. Infants born at 35 and 36 weeks had similar scores to that found in full-term infants in 4/7 items for the range of scores and 6/7 for median scores (Fig. 5).

The 30 infants small for gestational age showed a distribution of results similar to those appropriate for gestational age.

4. Discussion

This is the first study reporting the frequency distribution of neonatal neurological findings in a low risk late-preterm population assessed at term age.

When we analyzed the scores according to GA at birth, we found a narrow variability of neurological findings especially in infants born at 35 and 36 weeks GA. Their median scores were similar in 32 of the 34 items. In contrast, infants born at 34 weeks GA showed some differences compared to those born at 35 and 36 weeks, mainly in the tone items, in Moro reflex and visual orientation. This finding is consistent with our previous observation in very preterm infants suggesting that a longer extrauterine exposure to light and different stimuli can facilitate the ability to track a visual target.[5,15]

We were also interested to establish possible differences with full-term infants, by comparing our findings to reported normative data collected by our groups using the same assessment.[2,3] Full-term infants had a narrower range of scores as late-preterm but showed similar median scores in 25/34 item. Not surprisingly the main differences were in the tone items, with marked flexor tone in the limbs and better head control for full-term babies. The number of median scores similar to full-term infants increased to 29/34 if we only considered the infants born at 35 and 36 GA as those born at 34 weeks had a more immature tone than both 35 and 36 and full-term infants.

The pattern of neurological findings observed in infants born at 34 weeks examined at term age was in contrast, more similar to the neurological findings previously reported, using the same assessment, in very preterm infants.[4,5] When examined at term age, very preterm infants also had less flexor tone in the limbs, both on traction and recoil, a lower head control and a higher similar rate of brisk reflexes, stronger palmar grasps, startles and tremors.

Analysing the results subdivided according to GA at birth we were able to observe that not all the late-preterm infants have a similar neurological profile. While infants born at 34 weeks have at term age, a more immature profile, those born at the age of 35 weeks or after have a neurological profile that is more similar to that found in term-born infants. As in our cohort there was an equal distribution of minor US changes and of time at assessment at term age among the 3 subgroups subdivided according to gestational age at birth, we were able to exclude that our findings may be influenced by these variables, In contrast, the changes observed between infants born before and after 35 weeks GA are probably due to the critical period of brain growth and development occurring at this GA, related to the increasing of the volume of both gray and myelinated white matter.[9,10]

This data can help as reference data when examining late-preterm infants at term age to see where the individual child stands compared to age matched low risk infants and to identify signs that are outside the reported range in infants with lesions or other risk factors.

In a recent study[8] we have previously reported that late-preterm infants, when assessed at 6–12 months corrected age have a lower tone, compared to full-term infants assessed at the same age. Although this cohort is not the same than that assessed at 6–12 months, these results suggest that late-preterm infants may have a persistence of this tone pattern throughout the first year. Further prospective studies are needed to establish the correlation between neonatal and 12 months findings and to establish whether these infants may have minor neurological findings or motor coordination problems at school age.

Conflict of interest

None of the authors have any conflicts of interest to declare.

REFERENCES

1. Dubowitz LMS, Dubowitz V. *The neurological assessment of the preterm and full-term newborn infant. Clinics in developmental medicine No.79*. London: Spastics International Medical Publications/William Heinemann Medical Books; 1981.
2. Dubowitz LMS, Dubowitz V, Mercuri E. *The neurological assessment of the preterm and full-term newborn infant*. 2nd ed. Mc Keith Press; 1999.
3. Dubowitz L, Mercuri E, Dubowitz V. An optimality score for the neurologic examination of the term newborn. *J Pediatr* 1998;**133**:406–16.
4. Mercuri E, Guzzetta A, Laroche S, Ricci D, vanHaastert I, Simpson A, et al. Neurologic examination of preterm infants at term age: comparison with term infants. *J Pediatr* 2003;**142**: 647–55.
5. Ricci D, Romeo DM, Haataja L, vanHaastert I, Cesarini L, Maunu J, et al. Neurological examination of preterm infants at term equivalent age. *Early Hum Dev* 2008;**84**:751–61.
6. Escobar GJ, Clark RH, Greene JD. Short-term outcomes of infants born at 35 and 36 weeks gestation: we need to ask more questions. *Semin Perinatol* 2006;**30**:28–33.
7. Petrini JR, Dias T, McCormick MC, Massolo ML, Green NS, Escobar GJ. Increased risk of adverse neurological development for late preterm infants. *J Pediatr* 2009;**154**:169–76.
8. Romeo DM, Cioni M, Guzzetta A, Scoto M, Conversano M, Palermo F, et al. Application of a scorable neurologic examination to near-term infants: longitudinal data. *Neuropediatrics* 2007;**38**:233–8.
9. Adams-Chapman I. Neurodevelopmental outcome of the late preterm infant. *Clin Perinatol* 2006;**33**:947–64.
10. Kinney HC. The near-term (late preterm) human brain and risk for periventricular leukomalacia: a review. *Semin Perinatol* 2006;**30**:81–8 [Review].
11. Romeo DM, Di Stefano A, Conversano M, Ricci D, Mazzone D, Romeo MG, et al. Neurodevelopmental outcome at 12 and 18 months in late preterm infants. *Europ J Paediatr Neurol* 2010;**14**: 503–7.
12. Levene MI. Measurement of the growth of the lateral ventricles in preterm infants with real-time ultrasound. *Arch Dis Child* 1981;**56**:900–4.
13. Bayley N. *Bayley scales of infant development*. 2nd ed. San Antonio, TX: Psychological Corp; 1993.
14. Brazelton TB. *Neonatal behavioural assessment scale. Clinics in developmental medicin No.50*. London: Spastics International Medical Publications/William Heinemann Medical Books. Philadelphia: JB Lippincott Co; 1973.
15. Ricci D, Cesarini L, Romeo DM, Gallini F, Serrao F, Groppo M, et al. Visual function at 35 and 40 weeks' postmenstrual age in low-risk preterm infants. *Pediatrics* 2008;**122**:e1193–8.