The Quality of the Early Motor Repertoire in Preterm Infants Predicts Minor Neurologic Dysfunction at School Age

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Objective The quality of a child's motor repertoire at age 3 to 4 months postterm is predictive of later cerebral palsy (CP). Its predictive power for minor neurologic dysfunction (MND) is unclear. This study aimed to investigate the predictive value of the quality of the early motor repertoire for the development of MND at school age.

Study design We assessed the motor repertoire from video recordings made at 6 to 24 weeks postterm in 82 preterm infants (mean gestational age, 29.7 ± 1.9 weeks; mean birth weight, 1183 ± 302 g). At age 7 to 11 years, Touwen's neurologic examination was performed, and the children were classified as normal (n = 49; 60%), MND (n = 18; 22%), or CP (n = 15; 18%).

Results Multiple logistic regression analysis showed that the quality of fidgety movements (FMs) and the quality of the concurrent motor repertoire had independent prognostic value for MND at school age. Abnormal FMs evolved into MND in 64% of the children. Nine of the 28 children with normal FMs and an abnormal concurrent motor repertoire developed abnormally (32%). Only 1 child of the 21 children with normal FMs and a normal concurrent motor repertoire developed MND (5%).

Conclusions Assessment of the quality of the early motor repertoire can accurately identify individual infants at high and low risk for MND at school age. *(J Pediatr 2008;153:32-9)*

Neurologic and developmental complications are common in infants born preterm. Well-documented sequelae of preterm birth that persist into childhood and adolescence include motor, cognitive, and behavioral impairments ranging in severity from cerebral palsy (CP) and sensory loss to minor neurologic dysfunction (MND), learning disabilities, and attention and behavior problems.[1,2] The early identification of infants at highest risk remains difficult. In the last 15 years, the quality of spontaneous general movements (GMs), assessed following Prechtl's method, has emerged as a reliable and valid predictor of severe neurologic deficits (eg, CP) for the individual infant.[3] This method is based on a visual Gestalt perception of the quality of GMs in the preterm, term, and postterm periods, up to 5 months postterm. The quality of so-called "fidgety movements" (FMs), which emerge at 6 to 9 weeks postterm and can be observed up to 20 weeks postterm, is a particularly accurate marker for neurologic outcome. Most infants (96%) with normal FMs have normal neurologic outcomes, whereas most infants (95%) in whom FMs are absent during this particular age period develop CP.[4,5] An early indicator with comparable prognostic value for the milder deficits (eg, MND), which are far more prevalent than CP in this population, has not yet been identified.

Previously, associations have been found between the development of MND in childhood and the quality of GMs at 2 to 4 months postterm.[6,7] Groen et al[8] showed that abnormal GMs at 8 to 17 weeks postterm were associated with coordination problems and fine manipulative disability at school age; however, the predictive value of GMs for the individual infant was low. The abnormality of the GMs was based on the extent to which the complexity and variation of spontaneous movements were reduced. Abnormal FMs (particularly their absence), despite their high predictive value for CP,[4] were not taken into account. In an earlier study, we used a different approach, carrying out separate global assessments of different qualitative aspects of the motor repertoire.[9] We found that both an abnormal quality of FMs and a monotonous character of concurrent movements increased the probability of

CI	Confidence interval	LR	Likelihood ratio
CP	Cerebral palsy	MND	Minor neurologic dysfunction
FM	Fidgety movement	NICU	Neonatal intensive care unit
GM	General movement	PVL	Periventricular leukomalacia

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Table I. Clinical characteristics and risk factors, according to neurologic findings at school age

	Children who developed normal or simple MND	Children who developed complex MND	Children who developed CP
Number	49	18	15
Gestational age, weeks	30.1 (28.6 to 31.7)	28.9 (27.8 to 31.0)	28.7 (27.7 to 30.0)*
Birth weight, g	1160 (950 to 1343)	1165 (898 to 1333)	1220 (870 to 1460)
Male infants	23 (47)	12 (67)	12 (80)
IUGR (birth weight <5th percentile)†	12 (24)	4 (22)	1 (7)
Prenatal corticosteroid use	34 (71)	11 (61)	9 (60)
Apgar score at 5 minutes	8 (8 to 9)	8 (5 to 8.3)‡	6 (5 to 7)‡
Umbilical pH	7.28 (7.25 to 7.31)	7.26 (7.21 to 7.33)	7.26 (7.21 to 7.33)
Ventilator support (IPPV of HFOV)	23 (47)	11 (61)	15 (100)‡,§
Septicemia	17 (35)	7 (39)	5 (33)
ICH grade 1 to 2¶	11 (22)	6 (33)	2 (13)
ICH grade 3 to 4	None	None	5 (33)‡,**
PVL grade 1††	19 (39)	14 (78)‡	8 (53)
PVL grade 2 to 3	None	None	4 (27)‡,**
BPD‡‡	11 (22)	5 (28)	9 (60)‡
Postnatal corticosteroid use	3 (6)	4 (22)	9 (60)‡,**

BPD, bronchopulmonary dysplasia; *HFOV,* high-frequency oscillatory ventilation; *ICH,* intracranial hemorrhage; *IPPV,* intermittent positive-pressure ventilation; *IUGR,* intrauterine growth restriction.
Data are expressed as median (25th to 75th percentile) or as n (%).
*$P < .05$ compared with infants who developed normally or simple MND.
†Birth weight according to the Dutch weight centiles of Kloosterman.[22]
‡$P < .01$ compared with infants who developed normally or simple MND.
§$P < .01$ compared with infants who developed complex MND.
¶Graded according to Papile et al.[23]
**$P < .05$ compared with infants who developed complex MND.
††Graded according to de Vries et al.[24] PVL grade 1 is also called prolonged flaring.
‡‡Defined as oxygen dependency at 36 weeks postmenstrual age.

developing MND at age 2 years.[3,9] The question then arises as to whether the assessment of the quality of FMs, in conjunction with the assessment of the quality of the concurrent motor repertoire, also has predictive value for MND at school age. Because FMs emerge at 6 weeks and disappear at around 20 weeks postterm, we investigated whether the quality of the motor repertoire at 6 to 24 weeks postterm has prognostic value for MND at age 7 to 11 years in preterm infants.

METHODS

Subjects

The study group comprised 82 infants (50 boys and 32 girls) born preterm between September 1992 and October 1997 and admitted to the neonatal intensive care unit (NICU) of the Beatrix Children's Hospital of the University Medical Center of Groningen. The infants were members of a larger group of 99 infants who were included in prospective studies of the prognostic value of the quality of GMs for neurologic and developmental findings. The results of these studies have been reported previously.[5,10-15] The study group can be considered a representative sample of the preterm infant population in our NICU (tertiary referral center) during the mid-1990s.

Seven infants died during the first few months of life, most due to severe respiratory problems. Conditions that could interfere with normal neurologic development became apparent in 3 infants (2 with blindness due to retinopathy of prematurity and 1 with morbus Duchenne). Five of the remaining 89 infants could not be traced. Two families refused to participate. Obstetrical and neonatal data are listed in Table I, grouped according to the child's neurologic status at school age. All parents gave written, informed consent. The University Medical Center of Groningen's Ethical Review Board approved the study design.

Recording and Evaluation of the Motor Repertoire between 6 and 24 Weeks Postterm

Video recordings, approximately 10 minutes long, were made of the infants at approximately 6 to 8, 12 to 14, and 18 to 21 weeks postterm. The timing and frequency of the video recordings differed for a few infants for logistical or family reasons. The recordings were made at either the outpatient clinic or home during periods of active wakefulness between feeds, with the partly dressed infant lying in the supine position.

A total of 214 recordings (median, 3 per infant; mean duration, 9:01 minutes) were available for analysis. The recordings of all infants were ordered according to increasing postterm age and evaluated offline by 3 of the authors (J.B., A.B., and C.E.) according to the criteria of Einspieler et al.[3] Two of the evaluators were unaware of the infant's clinical history and neurologic status; 1 evaluator knew the infant's clinical history. When the evaluators disagreed on the characterization of an infant, all 3 reevaluated that infant's record-