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Very low birth weight infants in China: the predictive value of the motor repertoire at 3 to 5 months for the motor performance at 12 months

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ABSTRACT

Background: Studies on motor performance and its early markers are rare in China, especially in very low birth weight (VLBW) infants.
Objective: Apart from the assessment of the inter-scorer agreement, we aimed to analyze to what extent the motor repertoire at 10 to 18 weeks postterm was related to neonatal complications, and gross and fine motor performance at 12 months after term.
Study design: Exploratory prospective study.
Subjects: Seventy-four VLBW infants (58 males; mean gestational age = 29 weeks; mean birth weight = 1252 g).
Method: Five-minute video recordings were performed at 10 to 18 weeks after term; fidgety movements and the concurrent motor patterns (resulting in a motor optimality score) were assessed according to the Prechtl general movements assessment (GMA). The gross and fine motor performance was assessed by means of the Peabody Developmental Motor Scales, second edition, at 12 months.
Results: Reliability was excellent. Pneumonia was associated with absent fidgety movements; the motor optimality score was lower in infants with pneumonia and/or bronchopulmonary dysplasia. Both absent fidgety movements and a lower motor optimality score were associated with a poor or very poor gross and fine motor performance at the 12-month-assessment.
Conclusion: Both the assessment of fidgety movements and the evaluation of the concurrent motor repertoire contribute significantly to an identification of VLBW children with a poor gross and fine motor outcome at 12 months. The results of this study document the need for an early identification of infants at high risk for a poor motor performance.

1. Introduction

Research on the development of very low birth weight (VLBW) infants has come to the fore in recent years, but there still appears to be little or no data available from China [1–3] albeit there are more than 100,000 infants born with VLBW annually [4]. Although the survival rate of VLBW infants has been greatly improved, they are still more likely to develop neurological deficits. Studies on large samples show that 25% to 50% of VLBW infants will develop cognitive and/or behavioral deficits, and 5% will develop cerebral palsy or other neuromotor impairments [3,5,6]. Hence, an early identification of infants at increased risk for neurological deficits is of utmost importance. The Prechtl general movements assessment (GMA) is a non-invasive, reliable and valid method for an effective assessment of the function of the young nervous system [7–10]. General movements (GMs) are spontaneous movements that emerge at 9 weeks postmenstrual age and last until 5 months after term. They vary in intensity and speed, and involve the entire body with variable sequences of neck, trunk, arm, and leg movements. Preterm GMs are followed by writhing GMs around term age. By the end of the second month after term, writhing movements gradually disappear and are then replaced by fidgety GMs, which are tiny movements of the neck, trunk, and limbs in all directions, with small amplitude, moderate speed, and variable acceleration [7,8,11].

Apart from classifying GMs as "normal" or "abnormal" (i.e. the global GMA), GMs and the concurrent motor repertoire can be assessed in more detail [7,12]. The detailed scoring of the motor repertoire at 3 to 5 months focuses on the quantity and quality of various movements including fidgety GMs, on postural patterns, and the overall movement character [7,13,14]. It has a high inter-rater reliability with intra-class

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correlation coefficients (ICC) ranging from 0.80 to 0.94 [15]. The scoring list has been successfully used to predict the severity of cerebral palsy [16,17], or to identify an increased risk for minor neurological dysfunction [13,18] and suboptimal cognitive development [19,20] in infants born preterm. It has also been used to demonstrate that, e.g., prenatal exposure to polychlorinated biphenyls [21] or selective serotonin reuptake inhibitors [22] have an impact on the developing nervous system.

The aim of our study was to assess Chinese infants with VLBW at 10 to 18 weeks after term by means of both global and detailed GMA and to associate these findings with their motor performance around 12 months (corrected for preterm birth). Apart from (a) the assessment of the inter-scorer agreement, we specifically aimed to (b) analyze to what extent the motor repertoire at 10 to 18 weeks was related to (i) neonatal complications, and (ii) the gross and fine motor performance at 12 months postterm age.

2. Methods

2.1. Participants

A successive sampling method was used to recruit preterm infants who met the following criteria: (i) birth weight under 1500 g; (ii) born between September 1, 2011 and August 31, 2013; (iii) seen for a visit at the Department of Rehabilitation of the Children's Hospital of Fudan University, Shanghai, PR China, at an age of 10 to 18 weeks after term. The following exclusion criteria applied: infants with brain malformations, a chromosomal defect, or known syndrome. A total of 77 infants were found to be eligible for the study. Three infants were excluded because their neonatal core data were incomplete. The final sample comprised 74 children (58 male, 16 female). The gestational age at birth ranged from 24 to 34 weeks (mean = 29 weeks, SD = 2 weeks); their mean birth weight was 1252 g (SD = 210 g; range: 700 to 1495 g). The neonatal complications included brain injury (44.6%; in 21 infants [28.4%] the clinical protocol only lists “abnormal brain image” without further specification; 12 infants [16.2%] had intraventricular haemorrhage grade III/IV or white matter abnormalities), respiratory distress syndrome (32.4%), septicaemia (14.9%), bronchopulmonary dysplasia (BPD, 10.8%), pneumonia (9.5%), and necrotizing enterocolitis (6.8%); most of the infants had multiple complications.

2.2. Assessment of the motor repertoire at 10 to 18 weeks postterm age

The infants were videoed at a median age of 13 weeks (range: 10 to 18 weeks) postterm. Recordings were made during active wakefulness according to the standards of the Prechtl GMA [7,23]. Periods of fussing, crying, hiccupping, and sucking on a dummy were excluded. The average duration of the video recordings available for analysis was 5 min (range: 2 to 10 min).

Fidgety movements were scored as (a) present and normal; (b) present and abnormal; or (c) absent [7,8,11]. Infants who showed “sporadic fidgety movements” (i.e. isolated bursts of fidgety activity lasting <3 s) were classified as “absent fidgety movements” [24]. The detailed scoring consists of the assessment of movement patterns (24 items), postural patterns (13 items), and the observation of the movement character (10 items). The score sheet comprises the following five subcategories: (i) fidgety movements, (ii) age-adequacy of motor repertoire, (iii) quality of movement patterns other than fidgety movements, (iv) posture, and (v) overall quality of the motor repertoire [7,13,14]. Added up, the subcategories yield a total score of 28 to 5 (the “motor optimality score”), the maximum score indicating the best performance [7,13,25].

This score sheet was translated from English into Mandarin by a rehabilitation doctor (M.Z.); it was proofread and modified, where necessary, by a senior paediatrician (H.Y.), who is a licensed tutor for GMA. Finally, the Mandarin version was re-translated into English and reviewed by another licensed tutor for GMA (C.E.), who also provided training for the detailed assessment.

To assess inter-scorer agreement, three scorers, all of whom were trained and certified in the Prechtl GMA (basic training level), performed the detailed GMA of 30 infants (40.5%). Scorer 1 (F.F.Z.) is a PhD student with her focus on GMA; prior to launching the study, she assessed GMs for more than a year with an average of 40 infants per week. Scorer 2 (Q.H.) is a paediatrician working in a community department and had used GMA for 2 years, assessing approximately 15 infants per week. Scorer 3 (J.Y.C.) is a physiotherapist at the Children's Hospital of Fudan University; she had applied the GMA for more than a year on an average of 40 infants per week. All three scorers had been trained in the detailed assessment by C.E. All scorers independently assessed the 30 videos without any knowledge of the medical history of the infants. During assessment, they were allowed to watch the videos as often as necessary.

After finishing the individual assessments, Scorers 1 to 3 discussed disagreements with a licensed tutor for GMs (H.Y., who was also unfamiliar with the infants' medical history) and agreed on a final motor optimality score for each infant. The remaining 44 infants were assessed by all scorers together.

2.3. The outcome assessment

At a median postterm age of 12 months (range: 12 to 18 months), we applied the Peabody Developmental Motor Scales, second edition (PDMS-2; [26]; translation into Mandarin [27]) in order to assess qualitative and quantitative aspects of gross and fine motor development. The scales contain sub-tests of the following six parameters: (a) reflexes, (b) stationary (body control and equilibrium), (c) locomotion, (d) object manipulation, (e) grasping, and (f) visual–motor integration. Raw scores are converted into age-equivalent scores for each sub-test, percentiles, sub-test standard scores, and composite standard scores called motor quotients. For children older than 1 year, the results from (b), (c) and (d) generate the Gross Motor Quotient (GMQ); the results of (e) and (f) yield the Fine Motor Quotient (FMQ); the sum of GMQ and FMQ reveals the Total Motor Quotient (TMQ). Although the PDMS-2 has a mean motor quotient standard score of 100 and a standard deviation (SD) of 15, it classifies performance primarily based on 10-point increments (rather than the 15-point SD increments) into the following categories: very superior (standard score: 131–165), superior (standard score: 121–130), above-average (standard score: 111–120), average (standard score: 90–110), below average (standard score: 80–89), poor (standard score: 70–79), and very poor (standard score: 35–69) [26].

The assessment was performed by two paediatricians (D.D.L. and W.S.)—without knowledge of the medical history and the results of the GMA—at the Department of Rehabilitation, Children's Hospital of Fudan University.

2.4. Statistics

Statistical analysis was performed using the SPSS package for Windows, version 22.0 (SPSS Inc, Chicago, IL). Intra-class correlation coefficient (ICC) statistics were applied to examine pairwise agreement of the motor optimality scores among the three scorers and an overall agreement among all scorers.

Fisher's exact test was applied to compare nominal data (e.g. neonatal complication × fidgety movements). The independent samples *T*-test was used to compare whether two groups (e.g. with absent or present fidgety movements) have different average values of birth weight and gestational age. The Mann–Whitney *U* test was applied to compare two groups with regard to neonatal complications on one dependent outcome variable (i.e. motor optimality score). Linear-by-linear association was applied to assess the relation between nominal variables (e.g. fidgety movements) and ordinal variables (i.e. categories