Early Human Development 86 (2010) 225–229

Contents lists available at ScienceDirect

Early Human Development

journal homepage: www.elsevier.com/locate/earlhumdev

The quality of general movements in the first ten days of life in preterm infants

N.K.S. de Vries [a,*], A.F. Bos [b]

[a] Department of Pediatrics, Leeuwarden Medical Center, The Netherlands
[b] Department of Pediatrics, Division of Neonatology, Beatrix Children's Hospital, University Medical Center Groningen, The Netherlands

ARTICLE INFO

Article history:
Received 1 December 2009
Received in revised form 11 March 2010
Accepted 16 March 2010

Keywords:
General movements
Preterm
Chaotic movements
Outcome
Infants

ABSTRACT

Background: The assessment of the quality of general movements (GMs) in preterm infants early in life has been used mainly to determine temporary or permanent neurological dysfunction and not to predict outcome.
Aim: Assessing the quality and evolution of GMs during the first ten days of life in preterm infants, and relating them to clinical factors and neurological outcome at 24 months' post-term.
Methods: Using Prechtl's method, the GM quality was assessed in 45 preterm infants on days 2, 4, 6 and 10. They were related to clinical factors and outcome. After GM assessment, an extra item was scored: chaotic features (ChF). ChF was defined as chaotic GMs or poor repertoire GMs+chaotic movements.
Results: Abnormal GMs were seen mostly in early recordings. A better GM trajectory correlated with a higher birth weight, a higher gestational age and a lower Nursery Neurobiologic Risk Score (NBRS). Predictive value for normal outcome of at least one normal GM was 94%. Predictive value for abnormal outcome of only abnormal GMs was 21%. ChF were seen mostly in early recordings. Occurrence of ChF on day 2 correlated with lower serum calcium.
Conclusions: Preterm infants often showed abnormal GMs during the first few days. This was related mostly to a higher NBRS. Normalization of GMs during the first ten days was associated with a lower NBRS and was a reliable predictor for neurological outcome. ChFs could be a GM quality that is associated to lower calcium, indicating hyperexcitability of the nervous system.

1. Introduction

General movements (GMs) are endogenously generated movement patterns in fetuses and infants [1]. Normal GMs at preterm and term age are characterized by a large variability in speed, amplitude, force, and intensity. The sequence of arm, leg, head, and trunk movements is complex with rotations superimposed on flexion and extension. This makes normal GMs look fluent and elegant. Abnormal GMs appear monotonous and their complexity, variability, and fluency are reduced.

Many preterm infants display qualitatively abnormal GMs during their preterm period. Nevertheless, longitudinal research revealed that the quality of GMs can normalize before, at, or after term [2–4]. Some infants show abnormal GMs consistently after term age — a predictor of an abnormal neurodevelopmental outcome. In general, the best period of assessing the quality of GMs to predict outcome is around three to four months post-term [1,2,5–7].

The predictive value of the quality of GMs soon after birth is largely unknown. To date, the method was used during the first days of life solely to determine acute neurological dysfunction caused by the many physiological changes (e.g. septicaemia) and changes related to medication (dexamethasone and indomethacin) that might have a temporary influence on brain function [8–10]. It is important, however, to determine which clinical factors influence the quality of GMs, albeit temporarily, and whether or not the quality of GMs this early in life has predictive value at all.

In our earlier study on GMs in extremely low birth weight infants (ELBW) during the first fourteen days of life, we found that all infants had abnormal GMs during the first four days (neither fluent or elegant, nor complex). In addition, we quite frequently observed so-called chaotic movements (Ch), a rather rare type of GM [8].

The aim of the present study was to assess the quality of GMs in the first ten days of life in a large group of preterm infants and to examine the relationship of the quality of GMs to clinical factors and neurological outcome at the age of 24 months post-term.

2. Patients and methods

2.1. Patients

Forty-five preterm infants with a gestational age (GA) of 32 weeks or less, born between November 2003 and April 2004 and admitted to

Abbreviations: A, abnormal; BW, birth weight; Ch, chaotic; ChF(s), chaotic feature(s); CS, cramped-synchronized; ELBW, extremely low birth weight infants; GA, gestational age; GM(s), general movement(s); H, hypokinetic; IVH, intraventricular hemorrhage; LR, likelihood ratio; N, normal; NBRS, Nursery Neurobiologic Risk Score; NICU, Neonatal Intensive Care Unit; PVL, periventricular leucomalacia; PR, poor repertoire; SD, standard deviation; SGA, small for gestational age.

* Corresponding author. Department of Pediatrics, P.O. Box 888, 8901 BR Leeuwarden, The Netherlands. Tel.: +31 058 2863381; fax: +31 058 2863390.
E-mail address: nathalie.de.vries@znb.nl (N.K.S. de Vries).

0378-3782/$ – see front matter © 2010 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.earlhumdev.2010.03.004

the Neonatal Intensive Care Unit of the Beatrix Children's Hospital in Groningen, the Netherlands, were enrolled in the study. A part of our study group ($n=19$) consisted of the ELBW infants we had reported on in an earlier study [8]. Infants with major congenital anomalies were excluded. All parents gave their informed consent to the video recordings. The university hospital's review board approved the study. The postnatal data of the infants were recorded for further analysis.

2.2. Clinical characteristics

The clinical characteristics (see Table 1), were divided into three categories:

1) Independent factors. These factors were independent of the recording day and related to the infant: birthweight (BW), GA, small for gestational age (SGA) (SGA = <−1.3 SD), Nursery Neurobiologic Risk Score (NBRS), intraventricular hemorrhage (IVH), periventricular leukomalacia (PVL). The NBRS involved seven items that affect cell injury in the neonatal brain [11]. It was determined at discharge. Brain ultrasound scans were performed at weekly intervals until normalization, stabilization of degree of abnormality, or at discharge from the NICU. The worst ultrasound was taken for statistical analysis. An IVH was considered significant when it was Grade 2 or higher (unilateral or bilateral), according to Papile et al. [12]. PVL was graded according to De Vries et al. [13].
2) Dependent factors. These factors might be different on different recording days. We measured serum calcium and bilirubin in all infants within 24 hours of the video recording. At the time of video recording we also noted whether or not the infants were on the ventilator or were receiving conventional phototherapy. None of the infants received sedatives, analgesics or steroids in the first 10 days, which could have influenced the quality of GM.
3) Mortality and outcome. Two out of the 45 infants were lost to follow-up and eight infants died. GA or BW did not differ in the infants who died or were lost to follow-up, compared to the other infants. Of the eight infants that died, four died during the first ten days after birth. One infant died on day 4 due to septicemia with multi-organ failure, the second infant died on day 6 due to neurological complications related to preterm birth (Grade 4 IVH), the third infant died on day 3 due to respiratory insufficiency as a result of immaturity, and the fourth infant died on day 4 because of circulatory insufficiency due to a septicemia. The remaining 35 infants were followed up until a median age of 24 months post-term. The follow-up consisted of a pediatric examination supplemented with Touwen's neurological examination, performed by a single pediatrician. None of the infants had cerebral palsy at the age of 24 months post-term. Five infants showed either motor delay or cognitive delay, or both.

Table 1
The clinical characteristics.

Clinical characteristic	$N=45$ infants
BW, median (min–max)	865 (520–2035)
GA, median (min–max)	28.6 (25.0 –32.0)
SGA	11/45
NBRS, median (min–max)	3 (0–9)
Mortality	8/45 (4<10 days)
IVH grade ≥ 2	2/45
PVL grade 1	7/41
PVL grade ≥ 2	0
Calcium (mmol/l) median (min–max)	2.2 (1.01–2.98)
Bilirubin (μmol/l), median (min–max)	142 (15–307)
Outcome of surviving infants	30 normal; 5 abnormal; 2 unknown

3. Methods

3.1. Video recording of spontaneous movements

One-hour digital video recordings were made of all infants on days 2, 4, 6, and 10. Compared to our earlier study on ELBW infants [8] we chose for recordings until day 10 instead of day 14, since this study comprises also preterm infants with a higher gestational age, who were discharged to another hospital earlier. Of the intended 180 recordings (45×4), 24 recordings are lacking due to problems of logistic or patient-related problems such as death or discharge. The recordings were made with the infants lying in the incubator in supine position or on their sides, naked, or wearing only a diaper. Care was taken that the infants could move their limbs and trunks freely. Infants were fed every two hours, which could not affect GM quality differences. The video-camera was mounted high-up, at the foot of the incubator. We chose to record the infants for one hour to collect three GMs. The GMs were stored on a digital video-disc for subsequent analysis.

3.2. Analysis of GMs

The GMs were analyzed by the authors NV and AB according to Prechtl's method, which has a high interobserver agreement (89–93%). [1] Both authors were blind to the medical status of the infants. Prechtl's method is designed to assess normal and abnormal qualities of GMs on the basis of visual Gestalt-perception. Normal GMs are characterized by complexity, variability, and fluency. Four main types of abnormal GMs are distinguished in the preterm period [1,14]. These are:

1) Poor repertoire (PR) GMs. The sequence of successive movement components is monotonous and arm, leg, trunk, and head movements do not occur in the normal rich and complex sequence.
2) Cramped-synchronized (CS) GMs. The GMs appear rigid and stiff, they lack the normal smooth and fluent character and all the limb and trunk muscles contract and relax almost simultaneously.
3) Chaotic (Ch) GMs. All limb movements are of large amplitude; they occur chaotically and lack all fluency or smoothness, or both.
4) In case GMs were absent or very short (<3 s) during the one hour of recording, we scored the quality of the GM as “hypokinetic” (H).

We defined and allotted scores to GM trajectories (graded 1 to 6) that reflected the sequence of abnormal (A) or normal (N) GMs on the four recording days: 1 = AAAA; 2 = AAAN; 3 = AANA or ANAA; 4 ANNA; 5 = AANN or ANNN; 6 = NNNN. This means the higher the GM trajectory score the better the trajectory. In case of just one video recording, we scored 1 in case of an abnormal GM or 6 in case of a normal GM.

In our previous study we found Ch rather often. Besides that, it appeared to us that quite a number of infants showed periods of Ch GMs but that these were not seen the entire time the GMs lasted, so they could not be scored as Ch. Therefore, we added an extra item which we termed chaotic features (ChFs), which we assessed after having assessed the quality of the GMs. In case chaotic features were present an infant displayed Ch GMs or PR GMs with some chaotic features (PR + ChF).

3.3. Statistical analysis

The statistical analysis comprised univariate analyses. In case of categorical variables we used Fisher's Exact test; for non-parametric continuous variables the Mann–Whitney U test, and for continuous variables Spearman's Rho Correlation Coefficient. To assess the independent influence of several factors on the quality of GM, backward multiple logistic regression analysis was performed. For calculating