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The long-term predictive validity of early motor development in "apparently normal" ELBW survivors

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ABSTRACT

Background: Within the able majority of ELBW survivors, there is a lack of identified predictors of which children will require extra support despite having escaped significant disability.
Aims: Investigate the predictive validity of early motor scores, compared to that of perinatal descriptors or early growth, on long-term motor impairment in non-disabled ELBW (<1000 g) children.
Study design: Prospective longitudinal study.
Outcome measures: 48 non-disabled ELBW children (27 male) completed the Neurosensory Motor Developmental Assessment (NSMDA) at 8 months, 2 years and 4 years post term and The Motor Assessment Battery for Children (MABC) at 11–13 years of age. Other possible predictors of long-term outcomes (gestational age, birthweight, multiple birth, head circumference measures and gender) were retrieved from the records.
Results: Early motor assessment (NSMDA score) independently predicted the MABC total score at 11–13 years of age with a positive predictive value of 87% by 4 years post term. There was increased risk of long-term motor impairment associated with male gender but the degree of prematurity, multiple birth status or early growth measures did not predict motor outcome. Postural control and sensory motor scores at 4 years post term, rather than neurological score, were associated with long-term motor outcomes for the ELBW children at 11–13 years of age.
Conclusions: Early motor scores are valid markers of long-term motor outcomes for "apparently normal" ELBW children. Early postural competence and sensory motor function are discriminating in regards to long-term motor function in neurologically normal ELBW children.

1. Introduction

The majority of extremely low birthweight (ELBW, <1000 g) children are able [1,2] but there is a high prevalence of developmental difficulties among these children [3–5]. These difficulties are associated with an increased use of support and educational services [6–8]. Perinatal variables, neuroimaging and early follow up assessment give predictive data to indicate which ELBW survivors are at risk of major disability including cerebral palsy (CP), cognitive impairment (more than 2 standard deviations below the mean on general developmental index) or uncorrectable visual or auditory impairment [1,2,9–11]. However, within the able majority of ELBW survivors, there is a lack of identified predictors of which children will require extra support despite having escaped major disability [12,13].

Neither the degree of prematurity nor early cognitive testing predicts which children within non-disabled preterm groups will have poorer functional outcomes and require extra services [8,14]. Neonatal ultrasound and magnetic resonance imaging provide evidence of white matter injuries that are associated with poorer outcomes for low birthweight children and adolescents [13,15,16]. However, there is still significantly increased prevalence of motor, learning and behaviour problems for preterm children compared to term born populations even in the presence of normal neonatal brain ultrasound scans [17], or if measures of central neural integrity like cognition are controlled [18,19]. For the able majority of ELBW survivors who have escaped moderate and severe disability, early prediction of mild impairment is unclear.

A recent geographic cohort study of very preterm survivors [11] that assessed visual impairment, deafness, cerebral palsy and cognitive impairment at 2 and 8 years of age found reasonable agreement between 2 and 8 year old classifications of disability for moderate and severe disability (moderate disability: 13.4% at 2 years old, 10.7% at 8 years old; severe disability 13.9% at 2 years old, 8.6% at 8 years old) with an

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encouraging trend of lessening rates of moderate to severe disability over time. However early diagnosis of mild impairment had poor long-term predictive validity. Many of those children presenting with mild disability at 8 years old had not been identified at the 2 year old assessment: 38 of the 97 children considered to have nil disability at 2 years old were considered disabled at the 8 year old review [11]. As this study did not include measures of motor competence beyond the assessment of cerebral palsy, the validity of early motor assessment for timely identification of mild impairment in ELBW survivors who do not have CP still requires investigation.

The prevalence of mild motor impairment in preschool assessments of ELBW children who do not have CP [20,21] suggest mild motor dysfunction may be a marker of those ELBW children who are likely to have ongoing developmental difficulties despite having escaped major disability. Although it is only a mild impairment, poorer motor ability in able ELBW children is associated with [3–5] and even predictive of [14,20,22,23] poorer outcomes generally. This association may represent an opportunity for early identification of those "apparently normal" ELBW children who are likely to have long-term developmental difficulties. With increasing prevalence of extremely preterm birth and improved survival rates [24], the ability to predict long-term outcomes for this growing population is becoming increasingly important.

In an effort to inform improved prediction of long-term outcomes for the able majority of ELBW survivors, this study examined the predictive validity of motor assessment at 8 months, 2 years and 4 years post term as predictors of ongoing motor impairment within a non-disabled ELBW cohort. The predictive validity of early motor assessment was compared with other data normally used to predict outcomes for ELBW children including degree of prematurity, multiple birth status, head circumference and gender. As normal motor function is dependent on competence in perception, postural responses and neuromotor control, this study also investigated what specific aspects of motor development were associated with long-term motor outcomes in these children who did not have neurological disability.

2. Methods

The ELBW participants in the study group were enrolled from the total cohort born less than 1000 g between January 1992 and December 1994 at the Mater Mothers' Hospital Brisbane, Australia. Only non-disabled survivors were included in the study (disability defined as diagnosis of neurological disability at 2 years of age, more than 2 standard deviations below the mean on a General Cognitive Index at 4 years of age or uncorrectable visual or auditory impairment). One child with an amputated digit was also excluded as this injury had the potential to affect motor assessment. As testing at 11–13 years of age required a central testing venue, only children living within 250 km of the testing centre were included. Ethics approval for the study was given by The Mater Health Services Human Research Ethics Committee and The Medical Research Ethics Committee of the University of Queensland. Written informed consent was obtained from all families and from the participating children themselves in the case of the long-term follow-up assessment at 11–13 years of age.

Participants completed standardised motor testing at 8 months, 2 years and 4 years post term as a component of a prospective longitudinal follow-up of growth and development. Further motor assessment was completed as these children reached 11–13 years of age. All assessments were completed to a set protocol by a trained team of assessors who were given no information regarding the birth status, medical history or previous assessment results of the participants.

Preschool motor assessments at 8 months, 2 years and 4 years post term were measured by The NeuroSensory Motor Developmental Assessment (NSMDA) [25]. The NSMDA provided scores for gross and fine motor performance and also scores for neurological function, postural reactions and sensory motor function: motor responses to sensory input (tactile, proprioceptive, ocular and vestibular systems). The sum of the scores in each of these areas produces the total NSMDA score which classifies motor performance as normal or abnormal development with minimal, mild, moderate, severe or profound dysfunction. The validity and reliability of this test has been established for use with preterm populations [25,26]. Other possible predictors of long-term motor outcome which have established association with long-term outcomes for able low birthweight populations were retrieved from hospital records. These included the perinatal variables of gestational age, birth weight, multiple birth status, the child growth standard of head circumference and gender [1,2,27,28].

Long-term motor outcome at 11–13 years of age was measured using The Movement Assessment Battery for Children (MABC) [29]. MABC Total score is a composite of scores for manual dexterity, ball skills and static and dynamic balance components of the test. Raw scores are converted with normative tables to categorise the motor performance as typical, suspect or definitely abnormal. Performance that rates the child's motor competence at less than the 5th percentile is classified as a definite motor problem. All children, including those who were 13 years old, completed the tests for the 11–12 year old age bracket which is the ceiling range of the test. The validity and reliability of the MABC, which is high [29,30], has been demonstrated for older children in studies which have shown the 11–12 year old band to be differentiating of motor performance in children up to 17 years old [31,32].

3. Statistical analysis

Statistical analysis was carried out using SPSS version 14 (SPSS Inc., Chicago, USA), 5% statistical significance was assumed (two-tailed), and the distribution of variables was examined. Differences between the ELBW children who participated in the study and those of the defined cohort who did not were examined. Means and standard deviations (SD) are presented for parametric data, medians and interquartile ranges (IQR) for non-parametric data and percentages for categorical data. The independent *t*-test, Mann–Whitney *U* test, Pearson's chi-squared or Fisher's exact test were used to examine differences between participants and non-participants for parametric, non-parametric and categorical data respectively.

Regression analysis was performed to examine which of the variables were independent predictors of long-term motor score. Gestational age, birthweight squared (transformed due to non-normality), multiple birth status, head circumference (at 8 months, 2 years and 4 years post term respectively) and gender were included along with motor score as these measures have established predictive validity for the outcome of interest across preterm birth populations. Three separate regression analyses were performed with data collected at three different ages to examine at what age predictive validity for long-term motor outcome within an able ELBW group might emerge. The standardised coefficients were examined to demonstrate the relative power of the predictors with an indication of how much of a change in the outcome measure in standard deviation units is uniquely associated with 1 standard deviation of change in the risk factor [13].

The sensitivity, specificity and positive predictive values of an abnormal NSMDA score on the long-term motor outcome using the MABC were calculated with 95% confidence intervals (CI). Finally, the relationships between the various early motor subscales of the NSMDA (gross motor and fine motor performance, neurological function, postural reactions and sensory motor function) with the long-term motor outcome measure of MABC total score were examined using Spearman's correlation coefficient.

4. Results

Of the 105 children who met inclusion criteria, 45 children were lost to follow-up or had moved out of the study area by the 11–13 year old review while 12 children who were contacted either refused or were not available to participate within the designated