Int. J. Prenatal and Perinatal Psychology and Medicine Vol. 12 (2000) No. 1, 71–76

Reflections on Assessment of the Preterm Infant

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Keywords: Neurobehaviour, general movements, MRI, neonate

Abstract: Early detection of neurobehavioral abnormalities in the preterm infant provides a window of opportunity for therapeutic intervention at a time of great cortical plasticity. Three different types of assessment are evaluated: (1) The Neurobehavioral Assessment of the Preterm Infant (NAPI) which is a measure of relative maturity in response to an invariant sequence of maneuvers and item presentations, (2) The evaluation of spontaneous general movements (GMs) which may be predictive of cerebral palsy (CP), they are captured on videotape and entails no handling of the infant, and (3) Magnetic resonance imaging (MRI) which provides structural information about brain development and injury. All methods have limitations as to when they can be optimally performed. Infants must be medically stable to undergo the NAPI and MRI when it requires transportation out of the nursery. GMs can be videotaped at any time but assessments several months post-term are more reliably predictive of CP than early assessments. More work must be done to optimize the contemporary and predictive value of early infant assessments.

Resumo: *Reflexões sobre a avaliação do bebê pretermo.* A detecção antecipada de anormalidades neurocomportamentais no bebê pretermo proporciona oportunidade para intervenções terapeuticas num momento de plasticidade cortical grande. Três tipos diferentes de Teste são avaliados (1) A Avaliação neurocomportamental da criança pretermo (NAPI) que é uma medida de maturidade relativa em resposta a uma sequência invariante de manobras e items apresentados, (2) A avaliação de movimentos gerais espontâneos (GMs) que podem predizer o dano cerebral (CP), eles são captados em videotape e a criança não é manuseada, e (3) A Imagem de resonância magnética (MRI) que oferece informação da estrutura sobre o desenvolvimento e dano do cérebro. Todos os três métodos tem limitações no que se refere ao melhor momento para sua aplicação. Os bebês precisam de estar estáveis, do ponto de vista médico, para o NAPI ser aplicado, e, para o MRI já que para esta avaliação o bebê tem que ser transportado para outra enfermaria. GMs podem ser filmados em qualquer hora mas a avaliação feita alguns meses após termo parece predizer o dano cerebral (CP) com maior precisão do que a feita mais cedo. Entretanto, mais estudos precisam de ser desenhados e executados para investigarem o valor da avaliação do bebê pretermo, como diagnóstico e prognóstico.

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Introduction

The Need for Assessment

Of all newborns in the United States in 1998, 7.6% were low birthweight (LBW) preterm infants < 2500 g (Guyer 1999). Assessing the development of these infants is a tremendous responsibility. The results of assessments may change family's lives. There is, therefore, a moral obligation to provide as early as one can, the most reliable information with the least negative impact on the infant. Early neurological assessments that provide reliable contemporary and predictive information establish the foundation for therapeutic intervention, give insight to long term outcome and can indicate the need for vigilance in long-term monitoring.

Infant development is a non-linear process whereby a number of stable and dynamic states can exist simultaneously. Developmental changes can be viewed as a series of states of stability, instability and phase shifts driven by the ontogenic process and modulated by biological and environmental experiences. In other words, developmental milestones that are innately programmed to emerge can be advanced or delayed and these behavioral changes can be related to developmental conditions (Gottlieb 1992).

Developmental Changes

A great deal of rapid changes taking place in the third trimester. The obvious parameter is rapid growth that can be measured in head circumference, height and weight. Recent magnetic resonance imaging (MRI) studies of the preterm infant brain have documented week to week measurable changes in total brain volume, the volume of cerebral gray matter, unmyelinated white matter, myelinated white matter and intraventricular cerebrospinal fluid volume (Huppi 1998). The changes of brain structure are accompanied by changes in infant behavior. Resting positions of the preterm neonate at increasing stages of maturation have been documented as stick figures (Dubowitz 1981; Amiel-Tison 1968) and these positions can be closely linked to the myelination of the subcorticospinal and corticospinal systems (Amiel-Tison 1999).

Much work has been done to show that the trajectory of sleep patterns and changes from 27 to 41 weeks of sleep/wake behavior have been clearly documented (Curzi-Dascalova and Mirmiran 1996). As maturation of behavioral states emerges so the opportunity to assess neurobehavioral performance in the awake state becomes viable. In light of the rapid maturational changes of the normally developing brain in the preterm period the additional challenge of reliably detecting brain injury during this period is complex.

Biological Injury

Confounding the normal process of development is the biological injury that many LBW infants sustain. This injury is frequently multi factorial and may include damage to the brain as a result of hemorrhage, which may be transient or permanent, or hypoxic-ischemic encephalopathy that may emerge over time. The extent of vision and/or hearing impairment takes varying time periods to detect and evaluate. Compromised lung function can have long-term consequences for development in

both mental and motor domains. Feeding and gastrointestinal (GI) difficulties can be congenital, induced as a result of aversive early oral experience, developmental relating to brain injury, or simply difficulties related to immaturity where demands are placed upon a system that is still "catching up". Consequences of GI difficulties include delayed growth and development that can be reflected in poor muscle tone and control. Of greatest import is the injury that results in long term adverse consequences. The brain exhibits extraordinary cortical plasticity and many foci of brain abnormality are self-correcting or have no measurable long-term impact on function or behavior. Mild hemorrhage (grades I and II) without ventrical enlargement detectable in the first weeks of the life frequently resolve before term age and have no long-term consequences (Ford 1989). Patchy white matter abnormalities have been found in children who have normal neurological examinations at 2 years of age (Aida 1998; Rutherford 1996).

The methods of assessments evaluated in this paper can be viewed as measures of equilibrium and dysequilibrium. Positive coactions between genetic and environmental factors lead to a state of equilibrium and perturbations to the system in the form of biological injury bring about dysequilibrium (Adamson-Macedo 1997).

Selected Assessments: The advantages and disadvantages of three widely differing forms of neonatal assessment are presented below.

The Neurobehavioral Assessment of the Preterm Infant (NAPI)

The NAPI (Korner and Thom 1990) was specifically designed to assess the preterm infant. It is a measure of relative maturity that follows an invariant sequence of item presentation. During the development of this test (Korner et al. 1991) the extent, limitation, and reliability of the repertoire of behavior were measured, and the assessment was tailored to optimize the detection of the maturation of neurobehavioral functioning. Rigorous test development based on sound psychometric properties resulted in normative values for infants from 32 weeks postconceptional age. The NAPI assesses a number of different behavioral domains including motor development, alertness and orientation, temperament as assessed by irritability, and behavioral state control. As with any neonatal test a single exam has limited value, but longitudinal research using weekly NAPI assessments has established a pattern of individual stability within developmental change (Korner 1989). This means that fundamental strengths and weaknesses remain constant over a trajectory of development in the neonatal period. It is important that environmental, prandial and temporal conditions are optimized according to the guide lines recommended (Korner and Thom 1990), and medical conditions are taken into consideration, in order to feel confident that a single exam is representative of an infant's abilities.

Correlations between the NAPI and neurological exam at 4 months have been demonstrated (Dittrichova et al. 1996), and two NAPI clusters, the alertness and orientation, and motor development cluster correlates well with the Bayley Mental Development Index (MDI) and Psychomotor Development Index (PDI) respectively at 2 years in a small sample of LBW infants (Constantinou 1997).

Spontaneous General Movements (GMs)

Evaluation of the spontaneous general movements of preterm infants as a predictor of cerebral palsy (CP) is a more recent method of assessment (Prechtl 1993). Infants are video taped in a supine position wearing only a diaper. General movements are complex motor patterns involving all part of the body and observed when the infant is in an awake state. The GMs last from several seconds up to more than a minute. Between six and 20 weeks these movements develop a characteristic fidgety quality which has been described and shown to be predictive of CP (Prechtl 1993; Hadders-Algra 1996; Prechtl 1997).

Spontaneous general movements are evaluated as normal or abnormal using Gestalt-perception (Lorenz 1971) which is based on the knowledge that normal movements have a rich complexity and variability of form which is fluent and elegant. Movements that are repetitive, rigid and lack rotations and fluency are indicative of abnormality. At the end of two months post -term movements transform and a "fidgety" quality emerges. Fidgety movements are defined as small circular movements of the neck, trunk and limbs and may be concurrent with other movements. The absence of fidgety and/or presence of abnormal fidgety movements is predictive of cerebral palsy (CP) (Prechtl 1997).

The advantage to this method is that it is non-invasive and relatively inexpensive. However, several authors have shown that GMs are sensitive to both medical treatment (Bos 1998) and developmental change (Ferrari et al. 1990; Prechtl 1990). Infants may fluctuate between normal and abnormal movements over time making it imperative to assess infants repeatedly, or to assess several months post term when fidgety movements occur.

Magnetic Resonance Imaging (MRI)

In recent years the use of MRI in the neonatal period has proven to be a valuable tool in revealing the evolving structure of the brain. Increased ventricle size and ischemia to white matter have been shown to be somewhat predictive of poor long-term outcome but other abnormalities have not been consistently linked to later poor outcome. Studies of specific regions of the brain have shown that abnormalities of the posterior limb of the internal capsule and the basal ganglia are highly predictive of neurodevelopmental impairment (Rutherford 1998) as are extensive white matter abnormalities (Rutherford 1996). Future work with the use of diffusion weighted imaging which detects pre-mylinated pathways is a promising tool to enhance the detection of emerging abnormalities.

Discussion

It is an undeniable fact that repeated assessments over time give more reliable information in a dynamically changing system than a single observation. However, in the clinical setting repeated examinations in the neonatal period are generally too costly and impractical. For this reason much weight is frequently placed on a single exam, so the environmental conditions for assessment in all cases are critical to a dependable outcome.

Many forms of neonatal assessment are to some degree taxing and invasive to the fragile neonate. Physical examination can be depleting of limited energy reserves and MR imaging usually requires sedation to ensure that the infant remains still throughout the imaging phase. The success and reliability of assessments is state dependent. The NAPI is skillfully designed to facilitate the optimum state for the maneuvers to be performed. For measures of muscle tone, a quiet state is ideal; for assessment of visual tracking skills and active orientation an alert awake state is the optimum condition. Assessments of GMs require infants to be actively moving in an awake behavioral state. Successful MRI requires the infant to be motionless during the procedure.

Conclusion

A truly reliable contemporary and predictive method of early preterm assessment has still to be found. All assessments have limitations in terms of their accuracy of early prediction. The dynamic nature of infant development can be a partial explanation and the theory of discontinuity of development (Prechtl 1984) may give insight to the reasons behind the poor sensitivity and specificity of some methods of assessment. It is suggested that studies be made on the validity of combining information from more than one type of assessment in order to strengthen the reliability of prediction.

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