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Predicting the outcome of specific language impairment at five years of age through early developmental assessment in preterm infants

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ABSTRACT

Background: Very preterm infants (<30 weeks of gestation) are at increased risk of specific language impairment and systematic developmental follow-up is essential for the provision of targeted early intervention.
Aims: To define the predictive value of early language testing and stability of language development, and perinatal and demographic risk factors for the diagnosis of SLI at 5 years, in a cohort of preterm infants.
Study design: We used a retrospective hospital based cohort study.
Subjects: Preterm infants <30 weeks of gestation, were cared for in NICU at RPAH, between 2004 and 2007, and prospectively enrolled in developmental follow-up. Standardised developmental assessment was done at 3 years utilising the Bayley Scales of Infant and Toddler Development-III and the Wechsler Preschool and Primary Scale of Intelligence-III was done at 5 years.
Outcome measures: Predictive value and stability of early language testing were assessed with respect to SLI at 5 years, using measures of diagnostic accuracy and kappa values. Multivariate logistic regression was performed during the distribution of perinatal and demographic risk factors for SLI.
Results: One-in-five met diagnostic criteria for SLI (19%, n = 24). Limited diagnostic accuracy was found with early expressive language and the stability of language scores demonstrated only fair agreement (Cohen's κ .383). Multilingual status and extreme gestational age at 24–25 weeks were associated with a six-fold increased risk of SLI (OR 6.09, 95% CI 1.89–19.56; OR 6.09, 95% CI 1.28–29.0).
Conclusion: We defined a high incidence of SLI among our cohort, but only a limited diagnostic accuracy of early language testing. Multilingual status and extreme prematurity were independent risk factors for SLI. It remains imperative to perform continued developmental assessments beyond pre-school age to identify language impairment with greater accuracy.

1. Introduction

Language and cognitive outcomes following very immature preterm birth are a significant concern [1–5]. Recent meta-analyses indicate that very preterm infants (<30 weeks of gestation) are at increased risk of early and pervasive language delays in the preschool years, with one-in-three meeting clinical criteria for delay in language comprehension and expression, in the absence of major disability and independent of socio-economic status [1,4,6]. Furthermore, infants born extremely preterm (<25 weeks of gestation) exhibit a ten-fold increase in risk of language problems and four-fold risk of speech pathology at school age [5]. Some studies suggest that language function in preterm infants is more related to a general cognitive deficit, than evidence for specific language impairment [5,7], but this has not replicated in others when controlling for cognitive function and articulation problems [8,9]. Other authors have focused on poor phonological working and long-term memory in preterm infants to account for language impairment [10–12]. Precise mechanisms are yet to be determined on how prematurity may specifically impact language development. Research demonstrates altered discrimination of simple speech sounds and deficits in auditory recognition memory early in life in preterm infants compared to those born at term [13].

Early prediction of language impairment is a major focus of developmental follow-up. Early language assessment examines basic receptive (comprehension) and expressive language (production). Later language function is divided into several components related to the rules governing its use – semantics (meaning of words and sentences), phonological awareness (understanding of speech sounds signalling meaning), morphology (change in word meaning with change in word form), syntax (word combinations), and pragmatics (rules in a social context) – each with a long-standing effect on an individual's capability for literacy, communication and academic achievement [14–16].

Preterm children have been shown to exhibit delays in phonological abilities, receptive and expressive language, utterance length and complexity, grammatical development and semantics and phonological

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working memory, detectable by 3 years of age [8,10,17–19]. Poor pre-reading skills and later school aged literacy, are three-to-five times more prevalent in the preterm population [10,20] and the risk of simultaneous information processing deficit, for example visual spatial recognition, pattern building and memory, and logical reasoning is reportedly up to thirty times greater in preterm children compared with matched term controls [5].

Methodological inconsistencies and heterogeneity across studies, including sample size and selection criteria including preterm gestation (ranging from 24 to 36 weeks) and birth weight (500 g–2500 g), languages spoken and social economic status, timing and method of clinical evaluation and relatively high attrition rates deem interpretation of the literature problematic. The methodological controversy regarding the appropriate criteria for evaluating preterm children's abilities using chronological versus corrected gestational ages remains unresolved [21–23] with variation in the application of age correction in clinical practise and research indicating limited relevance in developmental assessments undertaken beyond 2 years of age [23].

Perinatal and demographic risk factors identified as significant predictors of speech and language development in pre-school aged children born at term [24], have not been fully replicated in the preterm population. The true effect of gestation, birth weight, and environmental factors, including maternal age and level of education, marital status and family congruence, ethnicity and socioeconomic status has been extensively scrutinised, with little accord [1,2,8,25,26].

Systematic developmental follow-up is important to reliably identify the needs of preterm children and allow for the provision of targeted early intervention. However, given the complexity of language development, controversy exists regarding the prognostic value of early testing in children later identified with language impairment, as deficits and certain subdomains of complex language function may not be evident when tested at an early stage [27–29].

Stability of cognitive and language development in preterm and low birth weight infants also remains controversial, with some authors supporting the reliability and clinical value of well conducted standardised assessment in infancy [27,30], and demonstrating strong correlations of receptive and expressive language testing at 2 years with those at 4 years [8]. Conversely, van Noort-van der Spek et al.'s recent meta-analysis suggests stability of only simple language function (receptive vocabulary) compared to complex language function (including receptive and expressive) to school age [1].

Whilst there has been considerable emphasis on language development in the context of generalised cognitive delay in the preterm or low birth weight population, there are little data defining the perinatal or demographic risk for specific language impairment (SLI), despite a prevalence of approximately 7% in children commencing school [31,32]. SLI is diagnosed when a clear negative discrepancy exists between language skills and general intellectual development, in the absence of associated deficits in hearing, articulation, behavioural and communicative disorders (e.g. autistic spectrum disorder) [33]. Children with SLI exhibit difficulty in the initial phase of word learning, syntax and vocabulary including shorter length of word utterance [34] and may process phonological information differently compared to their peers [11]. Specific problems with initial perception and encoding into a phonological loop that inputs a new word into a short-term memory before it can be learned and committed to long-term memory have been identified, together with problems in word recognition and expression, forming the focus of current research and intervention [10–12,35].

Children with SLI often experience behavioural, emotional and social difficulties and exhibit a higher prevalence of hyperactivity/attention deficit or co-morbidity with dyslexia or developmental coordination disorder (DCD) [11,36,37]. Reading skills and expressive language are particularly related to behavioural problems, and in a major proportion, both emotional and social difficulties accompany persistent language problems extending into adulthood [38]. Particular childhood and adolescence concerns are of social withdrawal and isolation (identified as fewer preferred playmates) and more often the subject of peer rejection, and with social pragmatics, forming peer relations and poorer quality friendships [34]. Early identification and focused interventional procedures targeting linguistic weakness and facilitating the use of language in social situations may prevent emotional, social and learning deficits in childhood, and improve long-term adverse psychosocial, cognitive and communicative outcomes [34,39].

2. Aims and objectives

- To define the predictive value of early language testing at 3 years for the diagnosis of specific language impairment at 5 years of age.
- To explore the stability of language development using standardised assessment at 3 years and 5 years, “Do children with low scores on early language assessment remain low when reassessed at 5 years?”
- To explore the distribution of perinatal and demographic risk factors for children with a diagnosis of SLI compared to those without.

Information regarding identified thresholds of receptive or expressive language scores at 3 years, or perinatal risk factors for SLI may provide opportunity for targeted early intervention.

3. Methods

3.1. Study population

We used a retrospective hospital based cohort at the Royal Prince Alfred Hospital, in the years 2004–2007 of all infants born below 30 weeks of gestation and prospectively enrolled in long-term developmental follow-up. The Royal Prince Alfred Hospital is the largest tertiary maternity service in New South Wales with approximately 5600 births per year. The developmental follow-up service was established in 1984 specifically to assess long-term outcomes for infants born extremely preterm. The developmental team is multidisciplinary and includes a developmental paediatrician, clinical psychologist and physiotherapist. Infants born below 30 weeks of gestation have validated standardised neurodevelopmental assessments performed at 12 months, 3, 5 and 8 years of age. Data were extracted from a clinical database employed by the RPAH developmental follow-up programme, detailing all the patient's clinical and demographic details together with developmental assessments undertaken and outcomes. In our clinical setting, age corrected for prematurity is not applied beyond 12 months of age, therefore all ages at assessment represent chronological ages.

Inclusion criteria specified children born less than 30 weeks of gestational age and having valid standardised developmental assessments at 3 years and 5 years of age, conducted by the same team. The Bayley Scales of Infant and Toddler Development — Third Edition was utilised at 3 years and the Wechsler Preschool and Primary Scale of Intelligence — Third Edition (WPPSI-III) at 5 years, respectively. Exclusion criteria specified children with a diagnosis of autism or autistic spectrum disorder, or major neurosensory disability (defined as cerebral palsy, blindness, or hearing impairment requiring aids) and those with a genetic syndrome or chromosomal abnormality. Children whose families spoke no English or were lost to follow-up were also excluded.

In order to determine the diagnostic accuracy of receptive and expressive language scores at 3 years and the distribution of perinatal risk factors for SLI, children with a diagnosis of SLI were compared to children with normal language at 5 years. Children with a diagnosis of cognitive impairment or non-verbal learning disability at 5 years were excluded from this subgroup analysis.

3.2. Data collected

Early language measures using the Bayley-III at 3 years reported scaled scores of receptive and expressive language and derived composite language scores with percentile rank compared with normative