Very-Low-Birthweight Infants at Seven Years: An Assessment of the Health and Neurodevelopmental Risk Conveyed by Chronic Lung Disease

Anita M. Farel, Stephen R. Hooper, Stuart W. Teplin, Marianna M. Henry, and Ernest N. Kraybill

ABSTRACT

To determine whether history of chronic lung disease (CLD) in children born at very low birthweight (VLBW) confers additional risk for impaired health, growth, and neurodevelopment, 17 VLBW children born in 1984 who had CLD (requiring supplemental oxygen more than 30 days after birth) in infancy and 28 VLBW children who did not have CLD were assessed at age 7 years. Assessments included a medical history, standard physical and neurological examinations, pulmonary-function tests, and tests of neuropsychological and psychoeducational functioning. Health status did not differ between the groups. In contrast, children with CLD did not perform as well in neuropsychological and psychoeducational assessments. Although CLD confers little added risk to health, it seems to add significantly to risks for poor school performance that are known to be associated with very low birthweight.

Premature birth and low birthweight are the major determinants of infant mortality and contribute disproportionately to disabilities in childhood. Prolonged respiratory insufficiency, usually due to severe respiratory distress syndrome (RDS) complicated by bronchopulmonary dysplasia (BPD), is a frequent concomitant of extreme prematurity and very-low birthweight. Although the developmental and health outcomes for very-low birthweight (VLBW) infants (less than 1500 grams) have been the subject of many investigations, there have been few attempts to examine the risk specifically conveyed by CLD, particularly at school age. Reports of outcome during early childhood have suggested that young children who had prolonged respiratory insufficiency associated with VLBW have impaired growth, delayed mental and motor development, increased morbidity due to respiratory infections, higher rehospitalization and post-neonatal mortality rates compared to VLBW infants without such respiratory problems (Bozynski et al., 1987; Markestad and Fitzhardinge, 1981; Landry et al., 1984; Berman et al., 1986; Sauve and Singhal, 1985; Meisels et al., 1986; Schreiner et al., 1987; Mayes et al., 1983; Yu et al., 1983; Shankaran et al., 1984; Stahlman et al., 1982; Vohr et al., 1982; Goldson, 1984; Rothberg et al., 1983; Ruiz et al., 1981). Little information is available about the effect of CLD on families, but there is some evidence that smaller and sicker premature infants, which would include those infants with CLD, may be at higher risk for subsequent abuse and neglect (Hunter et al., 1978, Leonard et al., 1990).

This report describes the health and developmental status of a cohort of 17 VLBW children with CLD and 28 VLBW children without CLD who were cared for in our institution in 1984. Children were evaluated at 7 years of age along the domains of health status, neuropsychological functioning, lung function, and growth. This study provides information on the specific risk conveyed by CLD on a background of VLBW at school age, as well as the long term sequelae of VLBW.

Risk Conveyed By Very-Low Birthweight at School Age

Although some studies of children born at VLBW report a low prevalence of serious handicapping or disabling sequelae at school age (Veen et al., 1991; Kitchen et al., 1992), questions remain about
possible risks for long-term difficulties associated with VLBW (Saigal et al., 1991; Klein et al., 1989; Lloyd et al., 1988). Abel Smith and Knight-Jones (1990) and Msall et al. (1991) have raised concerns about the persisting minor handicaps of VLBW school-age children compared to classmates who had normal birthweights. Several meta-analyses of VLBW outcome studies also reached pessimistic conclusions about outcome (Escobar et al., 1991; Ornstein et al., 1991; Aylward and Pfeiffer, 1989). Reports of outcomes at school age suggest that VLBW children are at risk for learning difficulties (Rickards et al., 1989). Aylward and Pfeiffer (1989).

Risk Conveyed by Very Low Birthweight and Chronic Lung Disease at School Age

Less is known about the risk specifically conveyed by chronic lung disease to the outcomes of VLBW infants at school age. In a study of severe chronic lung disease, intracranial hemorrhage, and parenting risk factors, Leonard et al. (1990) concluded that severe CLD was not related to negative neurologic or cognitive outcomes in children at four and a half years of age. Similar findings for a 10-year-old cohort were reported by Sauve and Singhal (1985) and for 8-year-old children who had been born prematurely by Robertson et al., 1992). However, other studies of school-age children who experienced pulmonary insufficiency as VLBW infants report gross and fine-motor coordination problems; difericulty with activities requiring visual motor integration; greater need for academic support services, particularly in arithmetic (Vohr et al., 1991); and minor neurological abnormalities and behavior disturbance (Noble-Jamieson et al., 1982). These inconsistent results reinforce the urgency of examining this issue in school-age children. Appropriate interventions can be designed and evaluated only by accurate identification of children at risk for ongoing health problems and developmental delay.

METHODS

Subjects

All subjects were surviving children whose birthweights were 1500 g or less, born in 1984, and treated in the Neonatal Intensive Care Unit of the University of North Carolina Hospitals. The UNC Hospitals comprise a 665 bed, state-supported university facility that is part of a statewide referral center network of the state's regional perinatal program. High-risk mothers and sick newborn infants are referred from central and eastern North Carolina. Of 132 very-low birthweight infants in the original cohort (birthweight 501-1500 g), there were 108 neonatal survivors. Twenty-three infants received supplemental oxygen 30 days or longer, and were considered to have CLD (Figure 1).

At initial discharge, 13 of the 23 CLD children were dependent on cardiorespiratory monitors and/or supplemental oxygen; 4 had tracheostomies. Two infants died within 1 year after discharge; one the result of abuse, the other due, at least in part, to inability to obtain appropriate emergency medical services.

At age 3, home visits by a trained nurse revealed that 13 of 21 surviving CLD children had both chronic health problems and developmental delays, 3 had chronic health problems without significant developmental delays, and 1 had developmental delay without significant health problems. Thirteen children had chronic and/or handicapping conditions including 7 with pulmonary symptoms attributed to underlying CLD, 2 had cerebral palsy, 3 had hydrocephalus, and 6 had vision or hearing deficits. Two children continued to receive supplemental oxygen. Seven children received medication (e.g. bronchodilators, anticonvulsants) on a regular basis.

When studied at age 5, only 1 child required bronchodilator therapy on a regular basis and 4 occasionally. Four children had a history of intermittent seizures, although none had active seizure disorders at the time of testing. In response to an open-ended interview, 7 families indicated that they believed that their child had 1 or more disabling conditions. These included cerebral palsy (4), sensory impairments (3), learning problems (3), and hyperactivity (Hooper et al., 1994).

We sent families of the 21 surviving CLD children a letter describing the study and inquiring about their interest in participating. We sent similar correspondence to the 81 families for whom we had recent addresses of VLBW children born in 1984 and treated in UNC Hospitals but who did not have CLD. We did
not pursue children whose parents indicated that they were not interested or families who could not be reached at the most recent address in the hospital record. Seventeen families of VLBW children discharged with CLD and 28 families of VLBW children who did not have CLD (non-CLD) participated in the study. Demographic characteristics of the two groups are shown in Table 1.

Mean birthweight was 874±208.8 g for the CLD group and 1152±195.6 g for the non-CLD group. The mean gestational age was 27.8±2.6 weeks for CLD children and 30±2.3 weeks for non-CLD children (Table 1).

Similar proportions of children were born below the 10th percentile on the according to standardized birthweight-for-gestational age norms, 35% vs 32% for the CLD and non-CLD groups, respectively.

The research plan was reviewed and approved by the Institutional Review Board of the School of Medicine, University of North Carolina at Chapel Hill. Informed consent of the parents was obtained for each child.

**Health and Developmental Assessment**

A medical history concerning current respiratory symptoms, use of medications, and neurologic functioning was obtained for all children by physician interview. Standard physical and neurological examinations that included measurements of weight, height, and head circumference, and screening for visual and hearing function were also conducted. Spirometry was performed in the standing position with noseclips using an 8-liter water-filled spirometer (Survey III, Warren E. Collins, Braintree, MA). Children were instructed in the performance of forced expiratory maneuvers, and data were collected when maximal, reproducible maneuvers could be performed. Best spirometric values for all parameters except peak expiratory flow (PEF) were chosen from the maneuver with the highest sum of forced vital capacity (FVC) and forced expiratory volume after 1 second (FEV₁). Values for PEF were chosen as the highest value from any technically acceptable maneuver. Spirometric measurements were expressed as percent predicted using the reference equations of Hsu et al. (1979).

**Neuropsychological Measures**

A battery of tests was used to assess global psychoeducational as well as the more specific neuropsychological domains of attention, motor, language, visual processing, memory, and social-behavioral function. Criteria for test selection included (1) relevance to documented neurodevelopmental outcomes for VLBW infants; (2) adequate psychometric properties and availability of age-specific normative data on which to base conversions of raw data into standard scores; (3) sufficient brevity for a child’s participation without undue fatigue; and (4) utility of the testing information for any clinical purposes which may arise for any subject in the sample (e.g., special education placement). All the measures represented in this battery are commonly employed in child neuropsychology investigations.

The Wechsler Intelligence Scale for Children-Revised (WISC-R) was used to gain estimates of overall cognitive functioning. The Verbal, Performance, and Full Scale IQ scores were employed (Wechsler, 1974). The Woodcock-Johnson Tests of Academic Achievement (Woodcock and Johnson, 1989) were used to estimate the subjects’ basic academic levels. Specifically, the Reading Cluster, composed of the Letter Word Identification and Passage Comprehension subtests, and the Mathematics Cluster, composed of the Applied Problems and Calculation subtests, were used. All achievement scores were transformed into age-based standard scores.

In addition, parents were asked whether their child was receiving special education services and whether they had had an Individualized Education Plan (IEP). Parents were also asked whether their child was limited in school work or in sports and games compared to other children.

**Attention**

The attention domain was tested by the Number Correct, Number of Commissions, and Correct Variability scores from the Gordon Diagnostic System, a computerized continuous performance test (Gordon, 1983). The Freedom from Distractibility Factor from the Wechsler Intelligence Scale for Children-Revised (WISC-R) also was included. This factor includes the subtests of Arithmetic, Digit Span, and Coding.

**Fine-Motor**

The fine-motor domain was tested by the Developmental Test of Visual-Motor Integration (VMI) and the Coding Subtest from the WISC-R. The VMI requires a child to copy increasingly complex designs, while the Coding Subtest is a graphomotor speed task.
Language

The language domain was tested by several tests designed to assess expressive and receptive language abilities. These tests included the Token Test for Children—a receptive language task, and the F-A-S Verbal Fluency Test—a verbal retrieval task. In addition, this domain included the Verbal Comprehension Factor from the WISC-R. This factor is composed of the Information, Similarities, Vocabulary, and Comprehension subtests.

Visual Processing

The visual processing domain was tested by the VMI and the Perceptual Organization Factor from the WISC-R. This latter factor is composed of the Picture Completion, Picture Arrangement, Block Design, and Object Assembly subtests.

Memory

The memory domain was assessed by tests purportedly measuring short-term auditory and visual memory, verbal retrieval, and active working memory. Measures within this domain were the Visual Memory Subtest from the Test of Visual-Perceptual Skills, the F-A-S Verbal Fluency Test, and the Digit Span subtest from the WISC-R. Although the Digit Span Subtest was used in constructing the overall memory domain score, the digits backward component of this subtest also was used because of its sensitivity to active working memory.

Social-Behavioral Measures:

The Parenting Stress Index (Abidin), and the Conners Hyperactivity Rating Scale (Conners, 1985), were used to appraise the child's social-behavioral functioning. The scores for each of the measures were converted into age-based standard scores with a mean of 100 and a standard deviation of 15.

The Parenting Stress Index is composed of 6 child scales (Adaptability, Acceptability, Demandingness, Mood, Distractibility/Hyperactivity, Reinforceability) and 6 parent scales (Depression, Attachment, Restricted Role, Sense of Competence, Social Isolation, and Relationship with Spouse). These scales yield an overall Child Scale, an overall Parent Scale, and a Total Stress Score. The Conners Hyperactivity Rating Scale is a parent-rating device composed of 10 items devoted to behaviors related to inattention and hyperactivity and provides a single overall score.

Functional Ability

Each child was assigned a functional ability classification of either normal, mild disability, or moderate-to-severe disability in each of 4 domains (IQ, gross motor, visual acuity, and hearing acuity). The criteria for each category appear in Table 2. The presence or absence of hyperactivity/attention dysfunction, as determined by a parent Conners score of 65 or greater, was also considered a mild disability. This method is similar to that used by Teplin et al. (1991), but whereas Teplin et al. classified all cerebral palsy (CP) as a moderate-to-severe disability, our classification considered CP to be mild if the child was ambulatory, and moderate to severe if not ambulatory. For each child, the lowest or most severe functional disability rating among the 5 categories was then assigned as the summary classification of functional ability.

Data Analyses

The groups (CLD and non-CLD) were evaluated with respect to the influence of 6 independent variables: birthweight, gestational age, mother's education, gender, race, and Grade III or IV intraventricular hemorrhage (IVH) diagnosed in the neonatal period. Using the Spearman Correlation Coefficient, the variables birthweight \(r = -.60, p < 0.0001\), gestational age \(r = -.49, p < 0.0006\), and intraventricular hemorrhage \(r = .31, p < 0.04\) were significantly correlated with the group variable (CLD vs. non-CLD). Consequently, these variables were taken into account as covariates in subsequent analyses of the medical and neuropsychological assessments. Differences between the non-CLD, VLBW children and normal children were assessed on the basis of normalized scores.

Medical and Pulmonary Exam

Data from the parent interview, general physical and neurologic exams, and lung function tests were analyzed. Chi-square tests (or Fisher's test when frequencies were small) and Spearman's rank correlations were used to evaluate associations between the CLD and non-CLD groups and selected variables.

Neuropsychological Exam

Although the sample was too small to conduct a factor analysis of the conceptually derived domains, a correlational analysis for the entire sample \(n = 45\) was conducted in order to determine the relative
RESULTS

Medical

Medical History:

Children in the CLD group required more hospitalizations than those in the non-CLD group. Fifteen of the 17 CLD children had been hospitalized since birth for a total of 51 hospitalizations. Twelve of the 28 non-CLD children were hospitalized 16 times since birth (p <01).

Respiratory Symptoms:

A substantial proportion of both groups were reported to have experienced ongoing respiratory symptoms. Wheezing with respiratory infections was reported for a large proportion of children with CLD; however, there were no significant differences in reported respiratory symptoms between those with and without a history of CLD. Fifty-one percent of all the VLBW children were reported to have had wheezing with upper respiratory infections in the previous 2 years and 16% were reported to have had a physician's diagnosis of asthma.

Growth:

The mean growth measures and percentages of children with abnormal growth for each group, by gender, are summarized in Tables 4 and 5. There were no significant group differences except in head circumference for females. The mean head circumference for girls with CLD was significantly smaller than that of girls without CLD; the former group also had a significantly higher incidence of microcephaly. Values for both groups were substantially different from those expected for the normal population.

Physical Examination:

There were no significant differences between the CLD and non-CLD groups with respect to physical findings. Three children in the CLD group and 1 child in the non-CLD group had abnormal lung findings. When both groups were combined (n=45), the following findings were noted: 10 children (6 in the CLD group; 4 in the non-CLD group) had scars from either burns or surgical procedures on their trunks, faces, or extremities, 3 (2 in the CLD group; 1 in the non-CLD group) had wheezing, and 3 children with mild cerebral palsy (2 in the CLD group, 1 in the non-CLD group) had limb asymmetries. One child in the CLD group had a tracheostomy. None of the children had clubbing or cyanosis, and none required supplemental oxygen. Although the differences between groups are small for any one variable, there is a consistent trend for the CLD group to be more severely affected and for both groups to have a higher incidence of problems that would be expected in the normal population.

Neurologic Examination:

The only statistically significant difference between the CLD (6 children) and non-CLD (1 child) groups was in the prevalence of strabismus (p<.01), which was significantly correlated with cerebral palsy (p<.01). There was a significant difference in the presence of strabismus at age 7 years and two neonatal factors: birthweight (p<.01) and gestational age (p<.02).

Two children in the CLD group had mild cerebral palsy associated with grade IV intraventricular hemorrhages (IVH) as newborns. The 1 non-CLD child with mild cerebral palsy did not have a history of IVH. All 3 children were ambulatory, either independently, or with the help of a walker. There was no correlation between the presence of cerebral palsy and either birthweight, gestational age, or current head circumference.

One child in the CLD group had significant sensory-neural hearing impairment (profound), and 4 (10%)
had corrected visual acuity worse than 20/40. One child in the CLD group had the most severe corrected visual acuity (20/200). Nearly half of the children (10 in the CLD group; 12 in the non-CLD group) had immature one-foot balance skills (i.e., could not balance on one foot for at least 10 seconds). Four children in each group had hyperreflexia.

**Functional Ability:**
While the percentage of children with normal overall function was similar between the two groups (Figure 2), the CLD group showed a higher percentage (35%) of children in the moderate-to-severe range as compared to the non-CLD group (11%), although this difference was not statistically significant (p > .1). Analysis of the total cohort (n = 45) of VLBW children by overall functional status at 7 years showed that 19 (42.2%) were normal, 17 (37.8%) were mildly disabled, and 9 (20%) were moderately to severely disabled.

**Pulmonary Function**
Spirometric data from 5 children with a history of CLD (29%) with a history of CLD and from 2 children (7%) with no history of early lung disease were excluded from analyses because of an inability to perform reproducible expiratory maneuvers (5 children), a history of lobectomy during infancy (1 child) and a current tracheostomy (1 child). Twenty-seven of the children (96%) without a history of CLD had measurements of FVC and FEV1 that were 80% of predicted values (Table 7). One child in this group had values for FVC < 80% predicted for normal children. Three children (25%) had values for FEF25-75 < 60% predicted for normal children. No differences were found between the mean level of any spirometric measure of lung function in children with CLD versus those without a history of CLD when measurements were expressed in terms of percent predicted values.

**Neuropsychological, psychoeducational, and social-emotional assessments**
In contrast to the findings based on physical measures, substantial differences between CLD and non-CLD children were found along several neuropsychological and psychoeducational dimensions.

**Neuropsychological Findings**
Means and standard deviations for all the neuropsychological variables are shown in Figure 3. All the mean scores differed between groups in the expected directions with the CLD group being lower than the non-CLD group. Analyses of covariance (ANCOVA) procedures revealed that children in the CLD group had lower average scores for tests of Language F(1,44) = 4.05 (p < .05), and Memory F(1,44) = 4.73 (p < .05) skills than children in the non-CLD group.

**School-Related Measures**
Significantly (p < .01) more youngsters in the CLD group had an IEP (35% versus 7%) and were in special education all day (24% versus 7%). Although more parents of youngsters in the CLD group felt that their child was limited in school work (35% versus 21%) or sports and games (29% versus 19%) compared to normal youngsters, these differences were not statistically significant.

**Social-Behavioral Findings**
None of the social-behavioral variables was significantly different between the groups (Figure 5). However, both groups were lower than 1 standard deviation below the mean on the Conners Hyperactivity Rating Scale, suggesting that hyperactivity may be one of the outcomes generally associated with VLBW as opposed to CLD in particular.

Each group was evaluated with respect to the percentage of subjects falling lower than 1 standard deviation below the mean for each of the neuropsychological domain scores, psychoeducational variables, and the Conners Hyperactivity Index. One-fourth or more non-CLD children were lower than 1 standard deviation below the mean on all variables except the motor domain, visual-perceptual domain, and math achievement. However, a significantly greater number of CLD children were at least 1 standard deviation below the mean, with rates over twice those exhibited in the non-CLD group. Only reading was not significantly different between groups, although both groups were significantly different from normal curve expectations.

When the groups were compared on the percentage of subjects falling at least 2 standard deviations below the mean on the neuropsychological, psychoeducational, and hyperactivity variables, differences between the CLD and non-CLD groups were apparent on Attention, Motor, Language, Verbal IQ, Reading, and Math. A complete set of references and results that were obtained for this battery of tests is available on request from the authors.

**DISCUSSION**

In addition to providing information on the specific risk conferred by CLD to children born at VLBW, these data also provide further evidence on the long-term sequelae of VLBW. While few differences between groups were noted for medical or physical findings, substantial and consistent differences were found among the neuropsychological and psychoeducational domains.

*Medical history, physical and neurological findings.*

The most striking medical difference between the 2 groups was the higher rate of re-hospitalization for the VLBW children who had CLD. Roussounis et al. (1993) noted that 5-year-old children in their CLD follow-up group had a significantly higher risk of being admitted to a hospital than the non-CLD cohort. However, Robertson et al. (1990) found no difference in the number of hospitalizations between cohorts of 8-year-old VLBW children with and without CLD. Prematurity and/or low birthweight have been associated with higher rates of rehospitalization in early life, primarily for respiratory illnesses (Kitchen 19..., Chan,......). Evidence of ongoing symptomatic episodes of airways obstruction was reported for a substantial proportion of the VLBW children at 7 years of age, both with and without a history of CLD. Prematurity and/or low birthweight have been associated with higher rates of recurrent wheezing and/or asthma (von Mutius 19., Schwartz 19......, Frischer 19......), and daytime cough (Cham) in school children. The occurrence of ongoing respiratory symptoms, particularly wheezing during the school years may be relevant to school performance, potentially contributing to school absenteeism and learning disabilities (Fowler, Taylor), although there were no objective differences in pulmonary function when these children were examined at 7 years of age. The finding of smaller head circumference among the girls with a history of CLD but not among the boys is unexplained, but may simply be a function of the small sample size. The association of relatively smaller head circumference among VLBW children with CLD was also found by Vohr et al. (1991).

*Functional Status:* 

When classifying these children by functional ability, the CLD group showed three times as large a proportion of moderate-to-severe disability, with a concomitantly smaller proportion of children in the mild disability range. The proportion of children with no functional disabilities was similar for both CLD and non-CLD groups. These data suggest, at least within the range of neonatal morbidity represented by this small group of children, that greater neonatal risk is reflected by higher proportions of more severely impaired children at school age. The functional ability profile of the entire VLBW cohort is almost identical to the distribution found by Teplin et al (1991) in their study of 6-year old extremely-low birthweight children.

*Pulmonary function*

The spirometric lung function of children with a history of CLD who could provide usable data was, on average, within the normal range expected for healthy children without a history of CLD. Differences in lung function between the 2 groups of children may have been underestimated, however, because of the substantial non-participation rate of those with a history of CLD (29% for children with a history of CLD as compared to 7% without CLD). We
did not, therefore, have the opportunity to include spirometric data from children who may have had more severe lung disease. While these results suggest that the functional lung development of this cohort of very low-birthweight children was reasonably good for both children with and without a history of CLD, individual children had a normal measurements. For example, 1 child with a history of CLD had values for FVC, FEV$_1$, FEF 25-75, and PEF of 58, 43, 20, and 44% predicted, respectively, consistent with substantial residual dysfunction. Other investigators have described persistent abnormalities in lung function consistent with varying degrees of obstructive airways disease in a substantial proportion of children with CLD in infancy (Smyth et al., 1979; Berman, et al., 1986; Hakulinen et al., 1990; Bader et al., 1987; Blayney et al., 1991). Blayney and colleagues (1991) have recently documented continued improvement in lung function of children with BPD between 7 and 10 years of age.

**Neuropsychological findings**

Despite the relatively limited findings of neuropsychological and social-behavioral differences between the non-CLD and CLD groups, the high incidence of children falling 2 or more standard deviations below the mean for normal children in the CLD group does suggest that many of these children are experiencing significant difficulties in nearly every domain, even when compared to the non-CLD group. The percentage of CLD subjects falling at least 2 standard deviations below the mean is 9 to 24 times higher than what might be expected from normal curve expectations (i.e., 2 %)

Chronic lung disease, in this paper, is defined as > 30 days of supplemental oxygen.

In further studies of this population, it may be more useful to correlate days on supplemental oxygen (a continuous variable) with each of the outcome measures. Because of the small sample size, only those variables very strongly associated with the presence of CLD will appear as statistically significant. A larger sample would undoubtedly have provided more statistically significant areas of difference between the 2 groups. Nonetheless, these data do show that CLD, in addition to VLBW, conveys significantly more risk for impaired neuropsychological and psychoeducational performance than does VLBW alone. These data confirm previous reports that the sequelae of VLBW alone extend into the school years.

**AUTHOR'S NOTES**

We are grateful to Tim Brown, Center for Development and Learning, for data management, Mary Ann Kimball, MSW, Center for Development and Learning for assistance with parent interviews, and to Tara Smith and Gary Koch, PhD Biostatistics Consulting Lab, for data analysis.

This research was supported through a grant from the North Carolina Council on Developmental Disabilities.

**REFERENCES**


psychopathology. Unpublished manuscripts. Children's Hospital National Medical Center, Washington, D.C.


Parker, P. A., Lindstrom, D. P., and Cotton, R. B. "Improved survival accounts for most, but not all, of the increase in bronchopulmonary dysplasia." Pediatrics 90: 5 (1992) 663 - 668.


Table 1
Demographic Characteristics (Mean ± S.D.)

<table>
<thead>
<tr>
<th></th>
<th>CLD (n =17)</th>
<th>Non-CLD (n = 28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal Education (years)</td>
<td>13.0 ± 1.5</td>
<td>13.5 ± 2.2 years</td>
</tr>
<tr>
<td>Age (years)</td>
<td>7.1 ± .18</td>
<td>7.0 ± .11</td>
</tr>
<tr>
<td>Black (%)</td>
<td>13 (76%)</td>
<td>14 (50%)</td>
</tr>
<tr>
<td>White (%)</td>
<td>4 (24%)</td>
<td>13 (46%)</td>
</tr>
<tr>
<td>Native American (%)</td>
<td>0</td>
<td>1 (  4%)</td>
</tr>
<tr>
<td>Male (%)</td>
<td>8 (47%)</td>
<td>12 (43%)</td>
</tr>
<tr>
<td>Female (%)</td>
<td>9 (53%)</td>
<td>16 (57%)</td>
</tr>
</tbody>
</table>


### Table 2
**Characteristics as Neonates (Mean ± S.D.)**

<table>
<thead>
<tr>
<th></th>
<th>CLD (n = 17)</th>
<th>Non CLD (n = 28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen Therapy (days)</td>
<td>129.3 ± 138.4**</td>
<td>6.4 ± 6.9</td>
</tr>
<tr>
<td>Birthweight (g)</td>
<td>874 ± 208.8**</td>
<td>1152 ± 195.6</td>
</tr>
<tr>
<td>Gestational Age (weeks)</td>
<td>27.8 ± 2.6**</td>
<td>30 ± 2.3</td>
</tr>
<tr>
<td>IVH, Grade III or IV</td>
<td>24%*</td>
<td>4%</td>
</tr>
<tr>
<td>Birth Head Circumference (cm)</td>
<td>49.8* ± 2.1</td>
<td>51.5 ± 1.6</td>
</tr>
</tbody>
</table>

*p < .05

**p < .01

### Table 3
**Functional Ability Criteria**

<table>
<thead>
<tr>
<th></th>
<th>IQ (WISC-R, Full Scale)</th>
<th>Gross Motor</th>
<th>Visual Acuity (Best Corrected)</th>
<th>Hearing Acuity (dB Loss)</th>
<th>Attention/ Activity (Conners [Mother])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&gt; 85</td>
<td>No cerebral palsy</td>
<td>&gt; 20/40</td>
<td>≤ 25</td>
<td>&lt; 65</td>
</tr>
<tr>
<td>Mild Disability (any one category)</td>
<td>71-85</td>
<td>cerebral palsy with independent ambulation</td>
<td>20/50 to 20/100</td>
<td>30-40</td>
<td>≥ 65 - 69</td>
</tr>
<tr>
<td>Moderate-Severe Disability (any one category)</td>
<td>≤ 70</td>
<td>Cerebral palsy without ambulation</td>
<td>≤ 20/200</td>
<td>&gt; 40</td>
<td>-------------------------------</td>
</tr>
</tbody>
</table>

### Table 4
**Parent's Reports of Medical History**

<table>
<thead>
<tr>
<th>Issue</th>
<th>% Entire Sample (n=45)</th>
<th>% CLD Group (n=17)</th>
<th>% Non-CLD Group (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worries about child's health</td>
<td>56</td>
<td>71</td>
<td>46</td>
</tr>
<tr>
<td>Currently on oxygen</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Coughing at night</td>
<td>20</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Coughing with exercise</td>
<td>20</td>
<td>29</td>
<td>14</td>
</tr>
<tr>
<td>Coughing with colds</td>
<td>82</td>
<td>88</td>
<td>79</td>
</tr>
<tr>
<td>Wheezing with colds</td>
<td>51</td>
<td>71</td>
<td>39</td>
</tr>
<tr>
<td>Wheezing with exercise</td>
<td>16</td>
<td>29</td>
<td>7</td>
</tr>
<tr>
<td>Wheezing apart from colds</td>
<td>9</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Wheezing at night</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>
Currently taking medications for wheezing & 20 & 24 & 18 \\
Currently have asthma & 16 & 24 & 11 \\
History of bronchitis & 31 & 41 & 25 \\
At least one postneonatal seizure & 11 & 18 & 7 \\
Hydrocephalus & 4 & ? & 0 \\
Cerebral palsy & 7 & 12 & 4 \\
Mental retardation & 13 & 29 & 4 \\
Learning disorders & 29 & 41 & 21 \\
Hyperactivity or attentional problems & 22 & 35 & 14 \\
Emotional problems & 9 & 18 & 4 \\
Visual problems & 22 & 47 & 7 \\
Hearing problems & 16 & 18 & 14 \\

Table 5  
Mean Growth Parameters (± S.D.)

<table>
<thead>
<tr>
<th>Males</th>
<th>CLD</th>
<th>Non CLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Circumference (cm)</td>
<td>50.4 ± 1.5</td>
<td>51.7 ± 1.7</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>20 ± 2.7</td>
<td>22.4 ± 2.9</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>115.3 ± 9.0</td>
<td>122.2 ± 6.6</td>
</tr>
</tbody>
</table>

Females

| Head Circumference (cm) | 49.4 ± 2.4* | 51.5 ± 1.6 |
| Weight (kg)             | 20.4 ± 4.7 | 23.9 ± 5.1 |
| Height (cm)             | 116.2 ± 7.8 | 119.4 ± 4.2 |

* p < .05

Table 6  
Percentage of Children with Abnormal Growth

<table>
<thead>
<tr>
<th>Males</th>
<th>CLD</th>
<th>Non CLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Circum &lt; 2nd percentile</td>
<td>14%</td>
<td>8%</td>
</tr>
<tr>
<td>Weight &lt; 10th percentile</td>
<td>29%</td>
<td>15%</td>
</tr>
<tr>
<td>Height &lt; 10th percentile</td>
<td>43%</td>
<td>15%</td>
</tr>
</tbody>
</table>

Females

| Head Circum < 2nd percentile | 50% | 0%* |
| Weight < 10th percentile | 20% | 13% |
| Height < 10th percentile | 40% | 13% |

*p < .01
Table 7
Spirometric Data (Mean ± S.D.)*

<table>
<thead>
<tr>
<th></th>
<th>CLD (n = 17)</th>
<th>Non CLD (n = 28)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Range</td>
</tr>
<tr>
<td>FVC</td>
<td>102 ± 23</td>
<td>58-148</td>
</tr>
<tr>
<td>FEV₁</td>
<td>102 ± 24</td>
<td>43-130</td>
</tr>
<tr>
<td>FEF₂₅-₇₅</td>
<td>86 ± 38</td>
<td>20-154</td>
</tr>
<tr>
<td>PEF</td>
<td>85 ± 21</td>
<td>44-126</td>
</tr>
<tr>
<td>FEV₁/FVC</td>
<td>0.90 ± 0.11</td>
<td>0.70-1.00</td>
</tr>
</tbody>
</table>

* p > 0.10 for all CLD vs. non-CLD group comparisons