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A Preschool-Age Neurodevelopmental Comparison Between Normal-Birthweight Infants and Low-BirthWeight Infants With and Without Intraventricular Hemorrhage

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A PRESCHOOL-AGE NEURODEVELOPMENTAL COMPARISON BETWEEN NORMAL-BIRTHWEIGHT INFANTS AND LOW-BIRTH-WEIGHT INFANTS WITH AND WITHOUT INTRAVENTRICULAR HEMORRHAGE

by

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William F. Corey

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ABSTRACT

A Preschool-Age Neurodevelopmental Comparison Between Normal-Birthweight Infants and Low-Birth-Weight Infants With and Without Intraventricular Hemorrhage

by

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Advances in medical technology have provided the mechanisms for sustaining life in premature and low-birthweight infants, resulting in the survival of more of these infants. Low-birthweight (LBW) and preterm infants are placed at risk by a number of medical complications, including intraventricular hemorrhage (IVH).

The outcome of low-birthweight infants with intraventricular hemorrhage has been the subject of a great deal of research and continues to be a much-discussed topic in the medical and psychological communities. As more data become available, it appears that more questions arise concerning the later neuodevelopmental and neuropsychological outcome of these infants.

For this reason, research concerning the later status of infants born with intraventricular hemorrhage is needed. The purpose of this study was to determine if there are differences in cognitive and motor functioning among infants with intraventricular hemorrhage (IVH), infants who were low birthweight (LBW), and normal-birthweight (NBW) infants.

Forty-four subjects (10 with mild IVH, 9 with severe IVH, 12 LBW, and 13 NBW), who were born between January 1, 1984, and June 1, 1985, and were either patients in the neonatal intensive care unit at University of Utah Medical Center (the IVH and LBW infants) or were residents of the well-baby nursery (the NBW infants) at University of Utah Medical Center, served as the sample population. The subjects were tested at 3 to 4.5 years of age using the Stanford-Binet Intelligence Scales (Fourth Edition) and the motor section of the McCarthy Scales of Children's Abilities. In addition, infant medical data were obtained from medical records, and demographic data were collected including mother's age at time of birth, family income, mother's and father's education level, and birth order of the infant.

The MIVH, SIVH, and LBW groups had significantly lower gestational ages and birthweights and significantly more medical complications than did the NBW group. The MIVH and SIVH groups also had significantly lower birthweight and gestational ages than did the LBW group, but approximately equivalent numbers of medical complications.

Significant group differences were found only between the MIVH and NBW groups on the McCarthy motor score, with the MIVH group appearing to outperform the NBW group following statistical manipulation with analysis of covariance. No other significant group differences were found. Further research with a larger sample is recommended in order to more fully understand the later outcome following LBW and IVH.

(103 pages)

CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

Advances in medical technology have provided the mechanisms for sustaining life in premature and low-birthweight infants, resulting in the survival of more of these infants. Low-birthweight (LBW) and preterm infants are placed at risk by a number of medical complications, such as respiratory disorders, hypertension, hypotension, and seizure disorders (Hawgood, Spong, & Yu, 1984). Of these medical complications, intraventricular hemorrhage is the most common and potentially serious medical condition (Volpe, 1987), reported to occur in approximately 45% of low-birthweight and preterm infants (Ahmann, Lazzara, Dykes, Brann, & Schwartz, 1980; Bejar et al., 1980; Dolfin et al., 1982; Lipscomb, Thorburn, & Reynolds, 1981; Papile, Burstein, Burstein, & Koffler, 1978; Papile, Munsick-Bruno, & Schaefer, 1983).

The outcome of low-birthweight infants with intraventricular hemorrhage has been the subject of a great deal of research recently and continues to be a much-discussed topic in the medical and psychological communities. As more data become available, questions continue to arise concerning the neurodevelopmental outcome of these infants.

Problem Statement

With a few exceptions, research on low-birthweight infants with intraventricular hemorrhage has focused on early developmental and neurological outcome. Follow-up studies of low-birthweight infants have been conducted through school age, but many such studies have neglected to report the cognitive and behavioral consequences of one of the major medical complications of low-birthweight, intraventricular hemorrhage (IVH).

Neurological and developmental delays have been directly correlated with severity of IVH and inversely correlated with the infant's gestational age (Catto-Smith, Yu, Bajuk, Orgill, & Astbury, 1985; Papile, Munsick, Weaver, & Pecha, 1979; Papile et al., 1983; Williamson, Desmond, Wilson, Andrew, & Garcia-Prats, 1982; Williamson et al., 1983). Papile and others found significant correlations between severity of IVH and incidence of handicaps in two studies of infants at one year post birth (Papile et al., 1979; 1983). Similar results were reported for infants assessed at 24 months (Catto-Smith et al., 1985) and 36 months (Williamson et al., 1982; 1983). In addition, researchers comparing LBW infants with and without IVH have concluded that the IVH population displays motor but not cognitive deficits at 12 and 24 months of age, respectively (Boyznski et al., 1984; Gaiter, 1982), while other studies of children tested at 12, 18, 24, and 36 months of age showed no significant differences between IVH and LBW groups on cognitive or motor measures (Goodwin, 1986; Greisen, Peterson, Pedersen, & Balkgaard, 1986; Leonard et al., 1980; Scott, Ment, Ehrenhranz, & Warshaw, 1984; Naulty et al., 1980).

Recently, Goodwin (1986) studied a population of 4- and 5-year-old children who were LBW infants suffering IVH at birth. The children were classified into mild and severe groups using the Papile criteria for severity of hemorrhage (i.e., Grades I & II were categorized as mild, with Grades III and IV categorized as severe). A test battery was used to assess cognitive, motor, language, abstract reasoning, and behavioral indices of neurodevelopmental outcome. Medical sequelae (apnea, birth asphyxia, hyaline membrane disease, hyperbilirubinemia, respiratory distress syndrome, seizure disorder, etc.) of IVH and test results were used as discriminant variables to predict group membership (mild or severe IVH) in a discriminant function analysis. Results suggest that medical sequelae accurately discriminate mild and severe IVH groups but that outcome measures do not. Both the mild and severe IVH groups appeared to be performing below norms for the assessment instruments used, although no significant differences between mild and severe groups on cognitive, motor, language, or behavioral functioning at preschool age were found. Seizure disorder and birth asphyxia appeared to be the best predictors of neurodevelomental outcome.

More recently, research by Wingate-Corey et al. (1988) has suggested that children who had IVH Grade III hemorrhages at birth did better on a number of cognitive and motor measures than did children who had Grade I or II hemorrhages. Children who had a Grade IV hemorrhage did the worst on these measures. Results of this study and of others indicate that the severity of IVH may predict immediate neurological damage, yet severity of IVH may not predict long-term neurodevelopmental outcome. In addition, since the variable of birthweight in the Goodwin study was not taken into consideration as a possible predictor of longer-term outcome, and since neither of the above studies used a normal-birthweight comparison group, the question of how birthweight and IVH differentially contribute to outcome is open. For these reasons another IVH study was indicated, taking into consideration the variable of birthweight with the inclusion of a full-term control group as comparison.

Purpose and Objectives

The purpose of this study was to determine how the variables of birthweight and IVH interact, taking into consideration the medical problems that often accompany LBW and IVH, the gestational ages of the infants, the family's income, and other variables that correlate with the outcome variables. By using a four-group study, which includes a full-term infant control group (normal birthweight) and three groups of LBW infants, two of which had IVH (one severe and one mild group) and one of which did not have IVH, some of the questions surrounding the subsequent outcome of LBW and IVH at preschool age were explored.

The inclusion of a full-term control group was indicated in order to try to control for the effects of LBW and IVH on outcome scores. The mild IVH (MIVH) group was composed of Grade I and II hemorrhages, the severe IVH (SIVH) group was composed Grade III and IV hemorrhages. Perhaps as important as grade of hemorrhage to the discussion of outcome of IVH are the accompanying medical problems associated with IVH, such as bronchopulmonary dysplasia, which may be a co-predictor of outcome (Landry, Fletcher, Zarling, Chapieski, & Francis, 1984).

Obviously, there are numerous complex issues associated with the study of outcome following IVH. The present study has addressed some of these issues and identified others. The use of a number of statistical analyses was indicated to control for the effects of LBW, IVH, gestational age, medical problems, family income, APGAR scores, mother's age at time of birth, parents' educational level, and birth order. The specific research hypotheses tested are discussed below.

Hypotheses

1. There is no difference on outcome measures between the SIVH group, the MIVH group, the LBW group, and the normal birthweight (NBW) group.
2. There is no difference on outcome measures between the SIVH group and the MIVH group.
3. There is no difference on outcome measures between the MIVH group and the LBW group.
4. There is no difference on outcome measures between the MIVH group and the NBW group.
5. There is no difference on outcome measures between the SIVH group and the LBW group.
6. There is no difference on outcome measures between the SIVH group and the NBW.
7. There is no difference on outcome measures between the LBW group and the NBW.

CHAPTER II

REVIEW OF THE LITERATURE

This section provides an overview of research concerning low-birthweight, preterm infants who suffer from intraventricular hemorrhage (IVH). Brief explanations of the medical concomitants of low-birthweight, low-birthweight outcome studies, IVH, IVH among low-birthweight infants, IVH outcome studies, and neurological testing of the age group included in the study are presented.

Medical Concomitants of Low Birthweight

Low-birthweight infants are considered to be those who are born weighing less than 2500 g. Very-low-birthweight (VLBW) infants are those infants who weigh less than 1500 g at birth (Morales & Koerten, 1986). In addition to issues of birthweight, infants are classified as to prematurity of birth, with a birth at 36 weeks gestational age or earlier being considered premature. Mortality rate for low-birthweight (LBW) and premature infants has decreased (from approximately 60% to approximately 35%) over the past 40 years, and many infants with extremely low birthweights (under 1000 g) are able to survive (Stewart, Reynolds, & Lipscomb, 1981).

Low-birthweight infants are naturally prone to medical problems that full-term infants are not, due most likely to the immaturity of the infant's organ systems at birth. Advances in neonatal intensive care unit (NICU) technology have provided the protection against death or severe morbidity that the LBW infant previously faced. The result, however, may be that the NICU, in saving lives, is creating a population of infants with a greater morbidity than has been seen previously.

Indeed, Stewart et al. (1981) concluded that the "same derangements that cause death in VLBW infants cause handicaps in survivors" (p. 1038).

Murphy, Nichter, and Liden (1982) outlined a number of the medical problems that LBW infants face, including asphyxia, apnea, respiratory illnesses, and patent ductus arteriosus. LBW infants are also susceptible to further illness after the infant has been released from the NICU, often prompting a return to the unit (Murphy et al., 1982). These types of difficulties may act to further complicate the LBW infant's medical status because the infant-parent bonding process is often interrupted. Given this kind of outlook, it is not difficult to see that the long-term medical outcome for LBW infants is sometimes poor.

Murphy et al. (1982) suggested that a number of factors have made prediction of development among LBW infants more difficult. The medical and epidemiological factors involved are lower mortality rates (allowing for smaller and smaller infants to survive), type of birth (primigravida births are associated with prematurity), and lack of prenatal care. Other factors suggested by the authors are education and income of parents, which have an inverse relationship with prematurity, perhaps due to better prenatal care among more affluent and highly educated parents. Finally, the authors stated that communication problems between parent and the staff of the NICU might contribute to long-term misconceptions and attitudes toward the infant that may possibly influence development.

Hack, Merkatz, McGrath, Jones, and Fanaroff (1984) stated that the sequelae of prematurity may be divided into three major categories: 1) long-term physical disease, 2) neurologic sequelae, and 3) developmental quotients. They found that LBW infants who remained small for gestational age had more chronic diseases than infants who "caught-up" in growth. In terms of neurologic sequelae, Hack et al. found that LBW infants who were appropriate for gestational age (AGA) had specific neurologic abnormalities such as spastic diplegia and quadriplegia, hydrocephalus, and blindness due to retrolental fibroplasia. It should be noted that more of the AGA LBW infants who remained underweight experienced neurologic difficulties than the small-for-gestational-age (SGA) infants who were "catching-up" in weight. As for developmental quotients, infants who remained small had significantly lower scores than those who grew to an appropriate size.

Therefore, it would appear that the early outlook for LBW infants seems to depend upon early growth and upon whether the infant is average or small for gestational age, and whether or not the infant begins to "catch-up" in weight (Hack et al., 1984). Allen (1984) held that the population of handicapped children, and especially those who suffer cerebral palsy, includes a disproportionate number of SGA, LBW infants. Silva, McGee, and Williams (1984) stated, "it is better to be born too early than born too small" (p. 5).

Outcome Studies of Low-birthweight Infants

Smith, Somner, and von Tetzshner (1982) suggested three reasons for studying LBW infants: 1) since LBW infants vary considerably more than a normal population of term infants, the principles and mechanisms of development may become known by studying these infants; 2) it is important to study LBW children in order to identify the early indications or signs in children who will later show developmental handicaps; and 3) it is important to identify the characteristics of the environment that distinguish later poor outcome from normal outcome.

Smith et al. collected a wide range of medical data having to do with the pregnancy, delivery, and perinatal period. The authors devised an "optimality index" based on pregnancy, delivery, and early postnatal status for each case. Results indicated that the optimality index may be a good predictor of intellectual functioning at 3, 6, 9, 12, 18, and 36 months, based on the Stanford-Binet and the Reynell receptive scale. In addition, infants who had a low optimality index but who performed well on the intellectual measures also had higher SES compared with infants who did poorly on the optimality index and the intellectual measures. These results suggest that an interaction exists between birth variables and environment that may moderate later intellectual outcome.

Kitchen et al. (1983) followed 252 VLBW children (between 500 and 1500 g) for two years in two different hospital settings. It was found that the occurrence of different outcomes for the two hospitals studied was significant. The authors stated, "Not a single association of poor outcome was common to the two populations" (p. 556) despite the fact that the two hospitals were only one kilometer apart. In addition, Kitchen et al. suggested that the prediction of handicaps based on IVH is tentative, possibly due to the difficulty in detecting ischemic cerebral insult. The authors concluded that monitoring of the quality of care in the NICU is an important step in developing more reliable techniques for predicting later outcome of LBW infants.

In a review of literature concerning VLBW infants, Stewart et al. (1981) asserted that care for the VLBW (and hence the LBW) infant has been steadily improving over the last 20 years. With better care, the incidence of iatrogenic disease has decreased, as has the incidence of later handicaps among this population. As of the date of this review, the authors suggested that the care of VLBW infants is entering a new phase in which the mortality rate will decrease even more for this population, but with a corresponding increase in handicapping conditions.

Stewart et al. (1983), in related work, examined 382 surviving infants who were LBW at birth. The mean birthweight was 1209 g with a range from 638 to 1500 g. At two years, 88% of the children were found to have no major handicapping conditions. Of the remaining subjects, 22 (55%) suffered cerebral palsy, 15 (38%) had mental retardation, 14 (35%) had sensorineural hearing loss, 4 (10%) had hydrocephalus, 3 (7%) had retrolental fibrosis, and 1 (3%) had congenital cataracts. (Total percentages equal more than 100% because some subjects had more than one handicapping condition.)

Hirata et al. (1983) examined VLBW infants (501 to 750 g) in a follow-up outcome study. Of the 28 (47% of the original population) who survived at least 28 days, 4 died with intracranial hemorrhage, their mothers having had an increased usage of tocolytic drugs and betamethasone. Of the other 24 survivors, two died following discharge, leaving 22 long-term survivors. Among the long-term survivors, 18 (82%) were observed until 7 years of age. The mean IQ for survivors born in the study hospital was 100, and the mean IQ was 87.2 for subjects not born in the hospital in which the study was performed. The authors found that two subjects (11%) had neurologic deficits, 12 (67%) of the subjects were "completely normal," and four (22%) were functioning with borderline or below-average intelligence.

Two authors (Davies, 1984; Escalona, 1984) stated that early studies have focused upon the incidence of major handicapping conditions of the LBW infant and have not attended to more subtle delays or disabilities that may not be apparent until later years. Davies (1984) further asserted that the incidence of cerebral palsy, mental retardation, and visual and hearing impairment has yet to be determined for the LBW population. She also stated that school learning difficulties occur proportionately more frequently among the LBW population, suggesting that more research has to be completed in order to tease out these issues.

Davies also pointed out that disabilities result if an impairment (a medical diagnostic term) causes restriction in some way which will limit the infant. Davies concluded that follow-up is as important an activity as the efforts used to keep this population alive immediately after birth, and that the presence of mild neurological dysfunction should not go untreated.

Escalona (1984) cited other studies and reviews suggesting that the study of LBW infants (or any high-risk group) should necessarily include a look at the SES of the family, the child's immediate environment while growing up, and development of the child's psychosocial domain when investigating the child's cognitive development. More recently, Bennett (1987) has concluded that reported positive effects in intervention outcome studies have usually been short-term in nature, and therefore suspect.

Perhaps given some of the above concerns, some authors have followed LBW infants to early school age (i.e., 6-7 years) in an attempt to tease out the more subtle differences in neurological and intellectual functioning which would become more apparent at these ages. Wallace, Escalona, McCarton-Daum, and Vaughan (1982) suggested that the later outcome in the form of cognitive dysfunction may be mediated by factors other than the original brain insult. Factors such as socio-environmental circumstances are said to play a role in later outcome.

Wallace et al. examined 33 LBW children using measures of intelligence, visual motor integration, neurobehavioral factors, and academic achievement. They found that differences in social class may effect a significant difference in performance. More interesting, however, was the finding that neonatal auditory performance was a good predictor of later (school-age) performance. This suggests that auditory processing, if affected by a structural insult, may lead to later rather subtle deficits.

Drillien, Thomson, and Burgoyne (1980) also studied a LBW population longitudinally from 1 to 3 years up to school age (6 to 7 years). The WISC, Bender-Gestalt, Bristol Social Adjustment Scale, and Draw-A-Person were used to assess subject's abilities. Results of a regression analysis suggested that the family SES, intrauterine insult, postnatal complications, and neurological status of the infant in the first year of life were good predictors of later behavioral, cognitive, and academic performance. The authors also found that the LBW subjects did significantly poorer than the normal birthweight controls in all areas. Drillien et al. concluded that the incidence of major handicapping conditions among LBW infants has, indeed, decreased, but that the incidence and prevalence of other more subtle deficits which are only seen later in life (i.e., at school age) has increased.

Kitchen et al. (1982) studied VLBW children who were born between 1966-1978, comparing children born in earlier years to children born in later years. The infant survival rate increased over the years, as did the incidence of cerebral palsy. The authors found that the differences which were significant at earlier ages (cognitive differences assessed by Wechsler Intelligence Scales) were insignificant at eight years of age. They concluded that although early perinatal factors may predict early cognitive functioning, such differences may decrease or diminish altogether by school age.

Noble-Jamieson, Lukeman, Silverman, and Davies (1982) studied 23 LBW infants at school age using a normal birthweight control group matched on the variables of age, sex, and SES. They found statistically significant differences on neurological exam scores and reading ability scores, but no significant differences in behavioral problems or cognitive functioning between the LBW children and normal birthweight controls.

These results contradict other studies in this section and suggest that the differences in later functioning between LBW and normal birthweight children are indeed somewhat subtle. A number of conclusions may be made concerning the study of LBW infants at later ages: 1) differences between LBW infants and normal birthweight controls may be rather subtle; therefore, a number of instruments which purport to measure different domains should be employed; 2) the later effects of auditory insult should be minimized by excluding subjects with such problems or analyzing the results obtained from such subjects separately, 3) it is important to include, or at least to hold constant, such variables as SES and socioenvironmental influences when studying this population; 4) data should be gathered at a single institution in order to control for the effects of differences in care between two institutions; and 5) one should control for appropriateness for gestational age, as this variable may itself be a predictor of later outcome.

Intraventricular Hemorrhage

Low-birthweight infants are more susceptible to medical problems because of the LBW infant's immature organ systems at birth. However, due to increasing medical technology and techniques, the mortality rate of LBW infants has decreased over the past 40 years to the extent that infants who would not have previously survived now may be expected to live (Lipscomb et al., 1981; Stewart et al., 1983). The result of this higher survival rate among preterm LBW infants is an increase in the survival of infants with intraventricular hemorrhage (IVH). As Volpe (1987) has stated, "Periventricular-intraventricular hemorrhage is the most important of the varieties of neonatal intracranial hemorrhage because this type is both common and serious" (p. 311).

Indeed, Volpe refers to the incidence of IVH as "epidemic" in neonatal intensive care units (1987, p. 311). Others generally concur, indicating that IVH is the most immediate medical threat to the LBW infant, greatly decreasing the infant's chances for survival (Ferrari, Grosoli, Fontana, & Cavazzuti, 1983; Morales & Koerten, 1986; Yu, Downe, Astbury, & Bajuk, 1986). For example, in a series using 488 LBW infants, the mortality rate was 21% for non-IVH infants versus 44% among infants with IVH (Morales & Koerten, 1986).

In the preterm infant, the blood supply to the subepydemal germinal matrix feeds an area which is characterized as a "rich capillary bed" (Volpe, 1987, p. 312). This area has not yet matured in the preterm infant (thus the term "capillary bed") and is highly cellular and gelatinous in texture. During the final 12 to 16 weeks of gestation, this immature area becomes less and less prominent until it disappears. It is during this period, prior to the disappearance of the subepydemal germinal matrix, that the life-saving measures necessitated during birth may disturb the cerebral blood flow, placing the LBW infant at-risk for IVH (Volpe, 1987).

The lesion in IVH usually involves bleeding into the subepydemal germinal matrix. In fact, 80% to 90% of the cases of IVH originate in the subepydemal germinal matrix at or slightly posterior to the head of the Caudate Nucleus and Foramen of Monroe. Therefore, as mentioned above, the site of the hemorrhage is directly related to the infant's gestational age because the germinal matrix is a structure which diminishes in size until it is non-existent in a normal full-term infant (Volpe, 1987, p. 313).

The severity of IVH has been classified into four grades, according to the location and involvement of bleeding. The four grades are: (1) germinal matrix hemorrhage, (2) intraventricular hemorrhage without ventricular dilation, (3) intraventricular hemorrhage with ventricular dilation, and (4) intraventricular hemorrhage with parenchymal hemorrhage (Papile et al., 1983). The first two grades of IVH are considered mild, whereas the last two grades are considered rather serious, due to the dilation of the ventricles and the presence of parenchymal hemorrhage.

Classification of IVH using ultrasound scans has been performed by Volpe (1987, p. 331), who proposes three grades of severity instead of four: (1) Germinal matrix hemorrhage with no or minimal (i.e., < 10% of ventricular area) intraventricular hemorrhage, (2) intraventricular hemorrhage consuming 10% to 50% of ventricular area, and (3) intraventricular hemorrhage involving > 50% of the ventricular area, which usually distends the lateral ventricle. It has also been suggested by Volpe (1987) that ultrasound classification of IVH is much more accurate than previous methods such as CT scans.

Volpe (1987) stated that there are three syndromes which typify the clinical features of IVH. The first is usually present within minutes or over a period of hours, and is most often first seen as respiratory distress. This syndrome presents with hypoventilation and apnea, cardiac arrhythmias, generalized tonic seizures, fixation of pupils, flaccid quadriparesis, decerebrate posturing, and deep stupor or coma. Other symptoms of the primary syndrome are falling hematocrit, hypotension, bradycardia, metabolic disturbances, and a bulging anterior fontanel. These symptoms are obvious and catastrophic, requiring immediate and aggressive care. Outcome is seen as poor, according to Volpe, but may be mediated by the extent of the hemorrhage and parenchymal insult.

A second syndrome involves more subtle symptoms such as alterations in the level of consciousness, decreases in spontaneous motoric behavior, decreases in elicited motoric behavior, hypotonia, and changes in eye movement and positioning. In contrast to the first syndrome, these symptoms develop over many hours. Finally, the clinically silent syndrome is so named because the signs may be easily overlooked during a clinical evaluation (Volpe, 1987, p. 326).

In terms of diagnosing IVH, Volpe (1987, p. 326-327) has insisted that the procedure of choice is portable cranial ultrasonography, also known as ultrasound. A number of reasons, including high resolution imaging, portable instrumentation, and the lack of ionizing radiation are given for the choice of ultrasound in diagnosing IVH.

Intraventricular Hemorrhage Outcome Studies

Schub, Ahmann, Dykes, Lazzara, and Blumenstein (1981) followed IVH infants at 34 months of age. Infants were divided into groups based on diagnoses using CT scans, graded as "normal," "subepedymal hemorrhage (SEH)," or "mild IVH," "moderate IVH," and "marked IVH." The authors used either the Bayley Scales of Infant Development or the Stanford-Binet, plus a neurological examination as measures. Comparisons were made between SEH/IVH infants with non-IVH controls, between SEH/IVH infants controls matched for APGAR score, gestational age and birth-weight, and intragroup according to degree of hemorrhage. Outcome was defined as : 1) Good--no neurologic deficits and a developmental index of > 90, 2) Intermediate--no or minor neurological deficit and a developmental index of 70-90, and 3) Poor--significant neurological deficit and a developmental index < 70.

The authors found that among the SEH/IVH infants, 64% had good outcomes, 24% had intermediate outcomes, and 12% had poor outcomes. Intragroup comparisons revealed that across degrees of severity of IVH, outcome was remarkably similar. They concluded that the IVH infants did not differ markedly from non-IVH controls, although there were some

Intra (IVH) group differences, with the mild IVH group doing better than the moderate and severe groups.

Gaiter (1982) studied 12 and 18 month-old performance on the Bayley Scales of Infant Development with infants who had experienced IVH at birth. Infants were selected for the study if they were appropriate for gestational age and their birthweight was below 1750 g. The study group consisted of 38 infants, 19 with IVH and 19 without IVH, IVH was diagnosed by CT scan and graded according to Papile et al.'s (1978) classification. In the IVH group, 9 had a Grade II hemorrhage and the remaining 10 had a Grade III hemorrhage.

Gaiter found that at 12 months the Bayley Mental and Motor scores were not significantly different for the comparison groups, although the controls were 1 to 1-1/2 months ahead of the IVH group on motor scores, with the Grade III infants showing the most delay. The authors stated that there is a trend toward significant difference between the groups on the motor measures. At 18 months, no significant differences were found between the controls and the IVH infants, although more of the IVH group would be classified as "high risk" for later developmental deficits than the control group because of the greater incidence of a variety of medical complications. Gaiter suggests that bronchopulmonary dysplasia (BPD) as a complication of IVH may moderate later outcome to the extent that BPD is a "second order" effect which may work to provide a negative impact on infant development.

In a study designed to assess whether or not IVH is associated with developmental and/or neurological handicaps at 12 months, Papile et al., (1979) studied 100 preterm LBW infants using the Bayley Scales of Infant Development and a neuromotor examination. The authors found a significant relationship between Grades III and IV IVH and poor Bayley and neuromotor outcome at 12 months. In a subsequent study, Papile et al., (1983) found that Grades I and II IVH subjects did not differ significantly from non-IVH controls; however, Grades III and IV IVH subjects did significantly worse on outcome measures.

In related research, Papile et al. (1983) compared the outcome of VLBW infants with and without IVH to determine if there were significant differences on neuromotor and developmental measures. Infants who were admitted to the newborn intensive care unit were selected for the study if they weighed less than 1501 g and survived the first 28 days of life. Diagnosis of IVH was made using CT scan.

A total of 198 subjects who survived at least one year were evaluated, 82 with IVH and 116 without IVH. Among the non-IVH subjects, developmental assessment showed that 53% were normal, 37% were suspect, and 10% were abnormal. Among the IVH Grade I infants, 52% were normal, 39% were suspect, and 9% were abnormal. Among the IVH Grade II infants, 61% were normal, 28% were suspect, and 11% were abnormal. Among the IVH Grade III infants, 14% were normal, 50% were suspect, and 36% were abnormal. Finally, among the IVH Grade IV infants, 12% were normal, 12% were suspect, and 76% were abnormal. These results suggest that more severe gradations of IVH are associated with more negative outcomes, at least at the age of 12 months.

Landry et al. (1984) evaluated the effects of medical complications normally associated with IVH using a population of VLBW premature infants. Five groups of subjects were formed based on the following medical complications: 1) IVH with respiratory distress syndrome (IVH-RDS), 2) RDS without IVH, 3) IVH with bronchopulmonary dysplasia

(IVH-BPD), 4) BPD without IVH, and 5) Hydrocephalus secondary to IVH (HYD). Subjects were administered the Bayley Infant Development Scales at 6, 12, and 24 months of age.

The results indicated that there were no significant differences between IVH with and without respiratory distress syndrome (RDS), or between differing grades of IVH. However, Landry et al. did find that infants with HYD and BPD scored significantly lower on the Bayley than other groups. This indicates that the other medical complications often associated with IVH may be a significant source of variation in terms of later developmental outcome.

Scott et al. (1984) evaluated 88 VLBW infants at 6, 12, and 18 months using the Bayley Mental Index. Infants were diagnosed as having varying grades of IVH or no IVH by CT scan. Upon comparison, the IVH group had significantly lower gestational ages and significantly more neonatal seizures than the non-IVH group. Although not significant, the differences on the Bayley Mental Index suggest a downward trend after 6 months, with the IVH infants doing more poorly on the Bayley at 12 and 18 months. The authors stated that a number of infants may be experiencing the presence of a "silent hemorrhage" which has been relatively difficult to diagnose until the advent of echoencephalography. They suggested that this silent hemorrhage may have been present in other series in which statistically significant differences were not found between IVH and non-IVH groups.

Tekolste, Bennett, and Mack (1985) found similar results, except that the cognitive scores were not significantly different, only the motor scores on the Bayley (nine subjects were evaluated with the Stanford-Binet). These results are also similar to those of Catto-Smith et al. (1985) who found that mild IVH subjects performed about as well as controls on the Bayley, while more severe IVH subjects did significantly worse than controls on neuromotor functioning, but approximately the same on cognitive functioning.

Williamson et al. (1983) followed a group of IVH infants to a mean age of 3.5 years. They found that IVH grade was not significantly related to neurological outcome, although LBW and severe IVH were related to the need for special education placement at 3.5 years. The authors also found that performance on the McCarthy Scales was significantly correlated with severity of IVH, birthweight, and SES.

Summary

Table 1 shows an overview of the studies included in the literature review, with brief explanations of the conclusions of the studies. In conclusion, LBW studies suggest that birthweight, gestational age, and medical concomitants such as respiratory distress syndrome are significant predictors of later outcome. The IVH studies seem to indicate that Grades I and II IVH are not significantly different than controls in terms of later outcome, but that Grades III and IV do differ significantly in terms of outcome. In addition, the literature suggests that motor scores, regardless of the instrument used, are more likely to be effected by IVH than are cognitive scores.

Also, there is evidence in the literature that the neurodevelopmental deficits of interest in this study would not become apparent until 2 or 3 years of age. Finally, the inclusion of some family, environmental, and medical variables would seem to be important as ancillary variables which may have an impact on later outcome. Papile

Table 1

Low Birthweight and Intraventricular Hemorrhage Research Literature

STUDY	SUBJECTS	MEASURES	CONCLUSION
Morales & Koerten, 1986	488 infants between 500 and 1500 g with and without IVH.	Mortality	21% of all infants died. 44% of infants $\leq$ 1000 g died compared to 8% of infants 1000-1500 g.
Stewart et al., 1981	22 reports of very low birthweight infants mortality rates	Mortality/Morbidity	Overall, mortality was 62% in 1946 with approximately 23% experiencing handicaps. In 1977, mortality was 35% with 10% morbidity.
Murphy et al., 1982	Review of methodological issues	Not Applicable	There are multiple contributing factors to developmental outcome.
Hack et al., 1984	182 infants < 1500 g who were either small or appropriate for gestational age	Weight, height, incidence of chronic disease	Infants born small for gestational age are more at risk for chronic disease than appropriate for gestational age infants.
Smith et al., 1982	62 neonates with birthweights below 2000 g	Stanford-Binet Reynell Receptive Scale	There is an interaction between birth variables and environment which may moderate later intellectual outcome.
Kitchen et al., 1983	252 VLBW infants (500-1500 g) followed for two years	Presence of major physical handicaps	Differences in hospital care contribute to differences in outcome in terms of handicaps.
Stewart et al., 1983	382 infants who were between 638 and 1500 g at birth	Handicapping conditions	88% had no handicaps at 2 years, remaining subjects suffered various handicapping conditions.
Hirata et al., 1983	60 infants with birthweights between 501 and 750 g	Mortality, handicapping conditions	28 survived 28 days or longer, 22 were long-term survivors; of these, 12 were "completely normal."
Davies, 1984	Studies of LBW infants	Mortality, handicapping conditions	More focus needs to be centered on subtle problems not found in this population until later.
Escalona, 1984	114 infants with birthweight < 2250 g	Bayley Scales of Infant Dev. & Stanford-Binet	25% experienced neurologic impairment, suggesting that biologically vulnerable infants are also more vulnerable to environmental influences.
Wallace et al., 1982	33 6-year-old LBW children	Wide Range Achievement Test, WISC-R, Dev. Test of Visual-Motor Integration, Sentence Repetition, SES, Einstein Neonatal Neurobehavioral Assessment Scale	Socioenvironmental circumstances (as measured by SES) play a role in later outcome.

(continued)

Table 1 (continued)

Low Birthweight and Intraventricular Hemorrhage Research Literature

STUDY	SUBJECTS	MEASURES	CONCLUSION
Drillien et al., 1980	261 children 6-1/2 to 7 years who were LBW as infants	WISC, Bender-Gestalt, Bristol Social/Adjustment ment Scale, Draw-A-Person	Significant differences at earlier ages (cognitive) functioning) were insignificant at 6-1/2 to 7 years.
Noble-Jamieson et al., 1982	23 LBW infants at school age who were LBW as infants	WISC-R and Neurological Assessment	Differences between LBW and NBW infants may be rather subtle at school age, requiring a number of different measures to detect.
Schub et al., 1981	42 IVH infants at 34 months of age	Bayley Scales of Infant Development or Stanford-Binet	IVH infants did not differ markedly from non-IVH infants, although the mild IVH group did better than the moderate and severe groups.
Gaiter, 1982	38 infants, 19 with IVH, 19 without. Of the IVH infants, 10 were Grade III and 9 were Grade I or II	Bayley Scales of Infant Development.	At 12 and 18 months, scores were not significantly different, although the Grade III IVH infants showed most delay.
Papile et al., 1979	100 preterm LBW infants	Bayley Scales of Infant Development and a neuromotor exam	Grades III and IV IVH infants did significantly worse on the Bayley and neuromotor exam at 12 months.
Papile et al., 1983	198 infants, 82 with IVH and 166 without IVH	Bayley Scales of Infant Development	Grades III and IV IVH infants fared far worse than the mild (Grades I and II) IVH infants at 12 & 24 months.
Landry et al., 1984	126 infants under 1501 g at 6, 12, and 24 months of age	Bayley Scales of Infant Development	No significant differences between differing grades of IVH or between infants with and without RDS. Infants with hydrocephalus and BPD scored significantly lower than other groups.
Scott et al., 1984	88 VLBW with and without IVH infants evaluated at 6, 12, and 18 months	Bayley Mental Index	Although not statistically significant, the IVH group showed a downward trend, doing more poorly on the BMI at 12 and 18 months.
Tekolste et al., 1985	81 children, 38 with IVH (20 Grade I, 7 Grade II, 9 Grade III, and 2 Grade IV) and 48 were LBW	Bayley Scales of Infant Development or Stanford-Binet	No significant differences were found on the cognitive measures, although the IVH infants did worse on motor measures than controls.
Catto-Smith et al., 1985	31 infants tested at 24 months	Bayley Scales of Infant Development	Mild IVH subjects performed as well as controls on the Bayley while severe IVH subjects did significantly worse on neuromotor functioning but about the same on cognitive functioning.
Williamson et al., 1983	29 LBW infants with IVH tested at 3-1/2 years	Neurologic exams	IVH grade is not significantly related to neurological outcome, although LBW and severe IVH were related to need for special education placement.

(personal communication, February 10, 1988) has suggested that the one important factor that needs more investigation in this area is the use of a full-term control group in comparison with an IVH group and a LBW group.

The investigation of IVH using a LBW and a term population without IVH is, therefore, indicated in order to determine which outcome effects, if any, can be attributed to IVH and which can be attributed to LBW, in addition to determining if the LBW and IVH populations differ significantly from the normal birthweight population. In addition, the effects of the numerous medical problems associated with LBW and IVH, and how such problems interact with IVH, may be best investigated using IVH and LBW populations in comparison with a normal birthweight population.

CHAPTER III

PROCEDURES FOR DATA COLLECTION

This study was completed as a cooperative venture between the investigator, the Early Intervention Research Institute (EIRI) at Utah State University, and the University of Utah Medical Center (UUMC). Children born between January 1, 1984, and June 1, 1985, were eligible for participation in the study. Medical records for each child were obtained from UUMC.

Sample

The sample for this study consisted of 44 children comprising four subsets: 1) low birthweight infants without IVH (LBW), 2) low birthweight infants with mild (Grades I and II) IVH (MIVH), 3) Low birthweight infants with severe (Grades III and IV) IVH (SIVH), and 4) normal birthweight infants (NBW). The LBW sample was collected initially from University of Utah Medical Center NICU discharge summaries and admission notes. A total of 97 discharge summaries were located representing infants who were born between January 1, 1984, and June 1, 1985 (a sample of 3 to 4-1/2 year olds). Of these 97, 23 were randomly selected by sorting the summaries alphabetically and choosing every 4th summary. The 23 names were then given to a social worker at the University of Utah who attempted to contact the infant's parent(s). Of the 23 selected, 12 agreed to participate.

The two IVH samples were also derived from the University of Utah NICU discharge summaries and admission notes. For the inclusive years (1-1-84 to 6-1-85), a total of 46 potential subjects were found. Of these, the social worker at the University of Utah was able to recruit

19 (10 MIVH, 9 SIVH). The subjects obtained had suffered either a Grade I, II, III, or IV hemorrhage at birth. Five subjects had a Grade I hemorrhage, five subjects had a Grade II hemorrhage, seven subjects had a Grade III hemorrhage, and two subjects had a Grade IV hemorrhage.

The NBW sample was derived from the University of Utah medical records department. A total of 1,437 names were provided as live births between the inclusive dates. Of these, 50 were randomly selected in two different sessions (25 each time). Of these 50, 26 were found to be acceptable for the study. The other 24 were unacceptable because they were low birthweight (15), had some type of major medical difficulty after birth (5), or died sometime after birth (4). The use of low birthweight as an exclusionary criteria for the NBW group was indicated in order to delete the effects that low birthweight might have on outcome measures (as suggested by the literature), thereby preserving a "pure" group of subjects who were all NBW at birth. Of the 26 acceptable candidates for the NBW group, 13 agreed to participate following contact by the social worker.

Due to the nature of selection (i.e., the inability to select all cases within the given parameters), it was necessary to determine if the cases which were not selected differed significantly from the subjects on medical variables among the LBW and IVH groups, and for all other demographic variables among all four groups. In order to determine this, chi-square statistics were computed for categorical variables, and t-tests were run on continuous variables.

The results of this initial analysis are presented in Appendix E Tables E-1 through E-3 for the medical variables present in the MIVH, SIVH, and LBW samples and Tables E-4 through E-7 for the continuous variables found among all samples. No significant differences were found for any variables between the subjects and non-subjects, suggesting that the samples used are representative of a randomly selected sample from the population.

Procedures

Following agreement to participate as elicited from the social worker, parents of subjects were contacted by the researcher to explain the study and answer any questions that parents may have had using an oral explanation of the study (see Appendix A). The parents were then told that a diagnostician would contact them to make an appointment for testing. After making an appointment by telephone, the diagnosticians tested the subjects at their home. Testing was done in the subject's home to maximize the convenience for the parent and, therefore, increase willingness to participate in the study.

In order to protect the subject's confidentiality, subjects were assigned code numbers. A master list matching the code numbers to subject data was maintained under lock and key by the researcher until the coding had been completed, after which the master list was destroyed. Subject names were not used on test protocols, or if they had been placed on such protocols, were erased by the researcher and replaced by code numbers.

The six diagnosticians were graduate students at Utah State University, except one who was a professional psychologist. The graduate students had completed courses in group testing and had given at least five of the test batteries used in the study. Subjects were randomly assigned to diagnosticians, making sure that they were "blind" to which group the subjects were in. All testing was completed within five weeks time, except for the SIVH group which was completed separately at a later date than the other groups. The diagnostician had the parent sign two identical release forms, one of which was left with the parent (see Appendix B). The assessment of the child was completed in one session of approximately 90 minutes.

Diagnosticians scored the test protocols and delivered them to the investigator who re-scored the protocols and checked for accuracy. Only minimal scoring errors were found among the 44 protocols. The parents were sent a summary of their child's test performance after the data had been entered on coding sheets (see Appendix C).

Data and Instrumentation

Demographic data for each subject were obtained by having an available parent complete a brief questionnaire (see Appendix D). The questionnaire asked for the age of mother at birth (of the subject), family annual income, birth order of the child, and a number of other demographic questions which were not used in the analyses. Maternal obstetric and infant medical data were obtained from medical records at the University of Utah Medical Center.

The neurodevelopmental battery used was comprised of eight scales from the fourth edition of the Stanford Binet (vocabulary, comprehension absurdities, quantitative reasoning, pattern analysis, copying, bead memory, and memory for sentences), and the gross and fine motor scales of the McCarthy Scales of Children's Abilities.

The McCarthy Scales of Children's Abilities (McCarthy, 1972) serve as a single instrument to assess a child's developmental level in the cognitive, motor, memory, and language areas. The test has been standardized for children from 2-1/2 years to 8-1/2 years of age. The standardization was completed on a sample of 1,032 children from 2-1/2 to 8-1/2 years of age. The sample, according to the manual, was stratified according to the 1970 census for rural, urban, and ethnic variables. Test-retest reliability is reportedly .89 to .91 for the General Cognitive Index and .69 to .78 for the Motor Scale (the lowest subscale reliability). Validity estimates are reported with the Stanford-Binet Intelligence Scale (.81) and the Wechsler Preschool and Primary Scales of Intelligence (.63 with WPPSI Verbal IQ, .62 with WPPSI Performance IQ, and .71 with the WPPSI Full Scale IQ).

The Stanford-Binet Intelligence Scale--Fourth Edition (Thorndike, Hagen, & Sattler, 1986) was standardized using a sample of 1,728 men, women, and children. The scales selected for use in the neurodevelopmental battery described above have been standardized for children from 24 months to 18+ years. The verbal, comprehension, and absurdities scales measure verbal reasoning; the quantitative scale measures quantitative reasoning; the pattern analysis and copying scales measure fluid analytic ability; and the bead memory and memory for sentences scales measure short-term memory functioning. Validity estimates for the new Stanford-Binet were obtained using confirmatory factor analysis and correlations between the Stanford-Binet and other intelligence scales. According to the test manual, the Stanford-Binet correlates with the WISC-R at .83, the WPPSI at .80, and the K-ABC at .89.

The justification for this choice of outcome measures is two-fold: 1) The Stanford-Binet fourth edition scales measure verbal and quantitative reasoning, fluid analytic ability, and short-term memory functioning, while the McCarthy measures fine and gross motor functioning; and 2) all measures have been standardized to be used with the subject age population. The use of the Stanford-Binet and the McCarthy is believed to be important because IVH outcome studies have previously suggested that cognitive functioning (i.e., verbal and quantitative reasoning, fluid analytic ability, and short-term memory) is not affected by the hemorrhage at later periods of life if the hemorrhage is mild (i.e. Grade I or II), whereas motor functioning (McCarthy motor scale) is affected even by a mild grade of hemorrhage (e.g., Gaiter, 1982; Scott et al., 1984; Tekolste et al., 1985). The use of a battery measuring both cognitive and motor functioning is, therefore, indicated in order to partial-out the effects of the mild grades of hemorrhage from the affects of being born too small (i.e., LBW).

CHAPTER IV

ANALYSIS OF DATA AND RESULTS

The purpose of this study was to determine if there were group differences between MIVH, SIVH, LBW, and NBW infants at preschool age on measures of motor coordination, verbal reasoning, abstract-visual reasoning, quantitative reasoning, short-term memory, and overall intelligence or IQ. In order to achieve this goal, a number of different analyses were performed.

Data Preparation

Data from the discharge summary, test protocols, and questionnaires were transcribed onto data coding sheets by the investigator. Data were then entered onto a computer account file and checked for accuracy against the coding sheets. Descriptive statistics were run to determine if there were any outliers, indicating a previously undetected error. Following these procedures, statistical comparisons were run in order to determine if the groups selected came from a representative sample of the available population.

Description of the Sample

Descriptive statistics are shown on Table 2 as an overview depicting the means and standard deviations of infant and parental demographic and perinatal variables by group, and for the entire sample. There were 43 Caucasians and 1 American Indian in the sample. Table E-8 (see Appendix E) shows the incidence of infant demographic variables and severity of intraventricular hemorrhage by group. All subjects were at least appropriate for gestational age at birth, with a number of the NBW

Table 2

Means and Standard Deviations of Infant, Perinatal, and Parent Demographic Variables by Group and for Entire Sample

	MIVH (N = 10)		SIVH (N = 9)		LBW (N = 12)		NBW (N = 13)		Entire Sample	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Mother's Age	27.50	7.73	26.33	5.98	23.17	5.09	29.08	6.14	24.94	6.04
1-Minute APGAR Score	4.60	1.96	4.33	2.39	4.58	2.19	7.46	0.96	5.49	2.32
5-Minute APGAR Score	7.10	0.74	5.78	1.39	6.92	1.88	8.85	0.38	7.34	1.59
Birthweight	1468.00	272.39	1432.22	521.46	2088.33	331.99	3567.69	425.18	2144.70	957.25
Gestational Age	31.20	2.44	30.33	2.24	34.42	2.19	39.46	1.66	33.73	4.50
Income (x 1000)	34.00	13.96	33.89	13.68	28.08	23.13	26.77	17.06	30.69	16.96
Education Level Father (years)	13.78	2.11	13.88	1.73	14.00	2.11	14.00	1.95	13.92	1.91
Education Level Mother (years)	13.20	1.62	12.89	1.69	12.50	2.61	13.38	1.61	13.00	1.92
Birth Order of Subject	2.20	1.87	3.89	2.71	1.50	1.00	3.38	2.14	2.71	2.13
Age at time of testing (months)	44.10	3.32	43.44	3.97	44.25	5.51	49.31	4.68	45.55	5.03

infants large for gestational age. The incidence of medical complications between the MIVH and SIVH groups is depicted on Table E-9 (see Appendix E). There were no significant differences between these groups for the incidence of medical problems. Table E-10 (see Appendix E) shows the MIVH and LBW group's medical complications. Note that the MIVH group had significantly more incidence of bronchopulmonary dysplasia and hypotension than does the LBW group. Table E-11 (see Appendix E) shows the SIVH and LBW medical complications. The SIVH group had significantly more cases of hypernatremia, bronchopulmonary dysplasia, pulmonary interstitial emphysema, pneumonia, apnea, and hypotension than did the LBW group.

Finally, Tables E-12 through E-17 (see Appendix E) show the infant, perinatal, and parent's demographic variables compared by group. Tables E-13 and E-15 depict that the LBW group had significantly greater birthweight and gestational age than did the MIVH and SIVH groups, although all other demographic variables were essentially equivalent. Table E-12 shows that the MIVH group had significantly higher 5-minute APGAR scores than did the SIVH group. Table E-14 depicts that the age at time of testing between the MIVH group and the NBW group was significantly different, with the NBW group as older. Table E-15 displays that the SIVH group were more likely to be born at a later order in their family than their LBW counterparts.

Tables E-14 and E-16 show that the NBW subjects had significantly higher 1- and 5-minute APGAR scores, birthweights, and gestational ages than the MIVH and SIVH subjects, as expected. The results shown on Table E-16 also indicate that NBW subjects had higher APGAR scores, birthweight and gestational ages than did the LBW subjects. Their mothers were also significantly older, on the average, than the mothers of the LBW subjects.

Description of the Test Results

The test results were compared across all four groups and between group dyads to determine if there were significant differences. The use of analysis of covariance was indicated in this situation due in part to the availability of a large array of possible covariates (the demographic and medical problem variables), and because the use of covariates which correlate at .60 or better have the same effect on statistical power as doubling the cell sizes (Hopkins, 1973). Given the low numbers of subjects per cell, this approach seemed the most appropriate.

The correlation matrix yielded a number of candidates for covariates per outcome measure variable, although none of the covariate candidates correlated at .60 or better, all were significantly correlated to their respective outcome measure using a .01 alpha level and a coefficient cut-off of 0.30. Stepwise regression analyses confirmed the relationships between outcome measure and the respective covariate(s). In addition, the stepwise regression results guided the deletion of covariates since a larger than optimal number of possible covariates were possible based on correlation coefficients of 0.30 or better. The outcome measures and associated covariate choices with multiple R values derived from the regression analyses are shown on Table E-18 (see Appendix E).

Observed and adjusted means tables and analysis of covariance (ANCOVA) results are shown on Table 3. Note that there were no significant differences found on the outcome measures between groups

Table 3

Observed and Adjusted Means for Outcome Measures (MIVH, SIVH, LBW, NBW)

	MIVH		SIVH		LBW		NBW			
Outcome Measure	Obs	Adj	Obs	Adj	Obs	Adj	Obs	Adj	F	Sig. of F
McMotor	43.00	46.30	34.56	41.27	43.92	42.29	46.31	37.92	1.76	.172
SBVR	98.70	98.71	82.22	93.39	92.00	89.37	102.92	94.38	.90	.453
SBAVR	86.50	88.51	83.56	94.39	95.42	89.66	94.08	86.99	.37	.777
SBQR	91.50	86.48	75.44	94.92	93.42	86.47	96.77	89.26	.54	.655
SBSTM	100.30	98.59	86.67	97.69	84.42	82.20	102.85	95.75	1.90	.147
SBTOT	93.20	90.66	80.67	95.16	88.75	84.69	99.00	91.10	1.33	.280

McMotor = McCarthy Scales of Children's Abilities--Motor Score

SBAVR = Stanford-Binet Abstract-Visual Reasoning

SBQR = Stanford-Binet Quantitative Reasoning

SBSTM = Stanford-Binet Short-Term Memory

SBTOT = Stanford-Binet Total Score (IQ)

using a multiple group design. Tables E-19 through E-24 (see Appendix E) show the ANCOVA results for group pairings. The only statistically significant results were found between the MIVH and NBW groups, in which the NBW group did significantly worse on the motor measure than did the MIVH group, taking into consideration the covariates of anemia and apnea.

CHAPTER V

DISCUSSION OF RESULTS

The purpose of this section is to summarize the results of the statistical analyses, and discuss the implications of these results in detail. Following this, a brief presentation of the strengths and weaknesses of the study is provided. Finally, suggestions for further research are presented.

Summary of the Results

This study used a four-group quasi-experimental design. The purpose of this study was to test seven hypotheses through use of a group comparison model: 1) there are no differences on outcome measures among the MIVH, SIVH, LBW, and NBW groups, 2) there is no difference on outcome measures between the MIVH and SIVH groups, 3) there is no difference on outcome measures between the MIVH and LBW groups, 4) there is no difference on outcome measures between the MIVH and NBW groups, 5) there is no difference on outcome measures between the SIVH and LBW groups, 6) there is no difference on outcome measures between the SIVH and NBW groups, and 7) there is no difference on outcome measures between the LBW and NBW groups.

Results concerning the first hypothesis (there is no difference on outcome measures among MIVH, SIVH, LBW, and NBW groups) indicate that MIVH, SIVH, LBW, and NBW groups were equivalent on all outcome measures.

On all other measures, there were no statistically significant differences between the MIVH, SIVH, LBW, and NBW groups. However, a survey of the observed and adjusted means for the various outcome measures suggest some interesting findings. As shown in Table 4, the order of mean performance on the McCarthy motor scale is NBW, LBW, MIVH, SIVH, an expected outcome as would be suggested by the conclusions of several authors (e.g., Catto-Smith et al., 1985; Papile et al., 1979; Tekolste et al., 1985). However, when the presence of anemia and apnea were controlled for as covariates, the order was manipulated to MIVH, LBW, SIVH, NBW, suggesting that these two medical problems at infancy may play a role in mediating motor outcome at preschool age.

Discussion

Analysis of covariance was used to statistically manipulate the order of performance among outcome measures. In essence, the adjusted means represent how the performance order would be changed if the presence of the various covariates were statistically taken into consideration.

Table 4

Order of Performance on Outcome Measures as Determined by ANCOVA for MIVH, SIVH, LBW, and NBW Groups

Outcome Measure	Observed	Adjusted	Covariate
McMotor	NBW, LBW, MIVH, SIVH	MIVH, LBW, SIVH, NBW	Anem, AP
SBVR	NBW, MIVH, LBW, SIVH	MIVH, NBW, SIVH, LBW	HYTEN, HONAT, AP1
SBAVR	LBW, NBW, MIVH, SIVH	SIVH, LBW, MIVH, NBW	HYTEN, ET
SBQR	NBW, LBW, MIVH, SIVH	SIVH, NBW, MIVH, LBW	HYTEN, Sex, AP
SBSTM	NBW, MIVH, SIVH, LBW	MIVH, SIVH, NBW, LBW	SP, HYNAT, Sex
SBTOT	NBW, MIVH, LBW, SIVH	SIVH, NBW, MIVH, LBW	HYKTEN, Sex, Thor

McMotor = McCarthy Scales of Children's Abilities--Motor Score
SBAVR = Stanford-Binet Abstract-Visual Reasoning
SBQR = Stanford-Binet Quantitative Reasoning
SBSTM = Stanford-Binet Short-Term Memory
SBTOT = Stanford-Binet Total Score (IQ)

Order of mean performance for cognitive measures presented an interesting picture. Observed means for Stanford-Binet verbal reasoning, quantitative reasoning, short-term memory, and total IQ reflected the expected first component, NBW. Following that, however, order of the other components was mixed. The LBW and MIVH group preformed similarly on the verbal reasoning, quantitative reasoning and total IQ. On short-term memory, the SIVH group did better than the LBW group on observed means but the SIVH group performed lower on all other measures.

When the medical problem of hypertension was added as a covariate (in addition to other covariates for a particular grouping), however, the SIVH group went from last to first place on Stanford-Binet abstract-visual reasoning, quantitative reasoning, and total IQ. On abstract-visual reasoning scale of the Stanford-Binet the order of performance, without covariance, was LBW, NBW, MIVH, SIVH. This was the only scale in which the NBW group did not outperform the other groups.

It should be noted that the order of performance of adjusted means in Table 4 for the cognitive measures represents results that were not statistically significant. Although discussion can be made concerning these orders of performance, their non-significance renders a tentative nature of such discussions. Only the motor score comparisons yielded significant results indicating the importance of the covariates' apnea and anemia as predictors of outcomes.

Based on the observed means, it becomes apparent that the only outcome measure in which an unexpected outcome occurs, in terms of the first component of an ordering, is abstract-visual reasoning, in which the LBW group did better than the other three groups. This order is statistically manipulated to SIVH, LBW, MIVH, NBW with the use of the covariates hypertension and number of exchange transfusions. All other observed orders involve the NBW group as the first member of the ordering, with either the MIVH or LBW groups in second place.

With the exception of abstract-visual reasoning, and when covariates were not used, the NBW subjects performed as well as expected when compared to the other three groups. When the variable of hypertension was used as the covariate, the total IQ, quantitative reasoning, and abstract-visual reasoning of the SIVH group was manipulated to appear higher in rank than the NBW, LBW, and MIVH groups. When anemia and apnea were used as covariates, the MIVH group appeared to perform better than the other groups on the motor scale. When hypertension, hyponatremia, and APGAR at one minute were used as covariates, the MIVH group appeared to do better on visual reasoning than the other groups. Finally, when seizure disorder, hypernatremia, and sex were controlled for, MIVH appeared to do better.than the other groups on short-term memory. Again, the appearance of higher ranks of order of performance are based on a statistical manipulation using analysis of covariance. Furthermore, only the motor score comparisons yielded statistically significant results. Although the other results are suggestive, they are not salient indicators as are the results involving apnea and anemia as predictors.

These results, although not based on statistically significant differences have practical significance in that they lead to three conclusions.

1. When hypertension was used as a covariate, SIVH subjects were numbered higher due to statistical manipulation than the other subjects on abstract-visual reasoning, quantitative reasoning, and total IQ. The use of hypertension as a covariate did not significantly change the order of performance on verbal reasoning for the SIVH group, indicating that the presence of hyper-

tension was correlated with SIVH subjects' abstract-visual reasoning, quantitative reasoning, and total IQ, but not verbal reasoning.

2. The presence of anemia and apnea in MIVH subjects was probably a good predictor of poor motor outcome due to the fact that this covariate allowed for the displacement of the NBW group from first to last place, and the MIVH group from third to first place.

3. Since the MIVH and SIVH groups had significantly lower birthweights and gestational ages than the NBW and LBW groups, and since they also dominated the first place on adjusted means, it appears that the inclusion of the given covariates are better predictors of outcome than are the variables of birthweight and gestational age.

Hypotheses #2 and #4-7 were all accepted, since all other inter-group comparisons yielded no significant results. This suggests that the MIVH and SIVH groups, as well as the LBW and NBW groups, perform at approximately the same level on motor and cognitive measures at preschool age. The third hypothesis, that there is no difference on outcome measures between the MIVH and LBW groups, was rejected. The MIVH group, using anemia and apnea as covariates, appears to outperform the NBW group on the motor measures. This indicates that the covariates (apnea and anemia) are the predictors of outcome rather than other variables such as birthweight on IVH, since the covariates statistically manipulate the order of performance through the use of analysis of covariance. Many authors have shown that children with severe IVH may eventually perform cognitively as well as similar LBW children (e.g., Drillien et al., 1980; Gaiter, 1982; Hirata et al., 1983; Papile et al., 1983; Schub et al., 1981). However, some researchers found a deficit in motor performance among even mild IVH subjects (Williamson et al., 1982). Other researchers (Catto-Smith et al., 1985) found that severe IVH subjects did worse on motor measures than did controls, but approximately the same on cognitive measures. In the present study, there was no motor deficit detected among children in the IVH groups, indeed, after controlling for the presence of apnea and anemia the MIVH group did better on motor scores than the NBW group. The other researchers did not statistically control for medical problem variables in this manner, which may explain the differential results.

The obtained results are especially interesting in that the differences between birthweight among the groups is highly significant. The LBW group has a significantly higher mean birthweight than the MIVH and SIVH groups, and a significantly lower mean birthweight than the NBW group. In addition, the mean gestational age for the MIVH, SIVH, and LBW groups are significantly different, with the LBW group having the higher mean gestational age than the MIVH and SIVH groups. It has been generally thought that both birthweight and gestational age play an important role in determining the status of outcome among infants with IVH and premature infants (e.g., see Allen, 1984). The present study indicates that it may be the medical problems associated with birthweight, rather than birthweight or gestational age, or a combination thereof, that predicts outcome.

The results presented here concerning the LBW and IVH groups are supported by another study in this series (Wingate-Corey et al., 1988) in which there were no significant differences found between IVH and LBW groups using a neurodevelopmental battery. The results of the present study, however, indicate that the medical complications which were present (and significantly different between groups) in the Wingate-Corey study were not present here in the same numbers. This is due to the fact that the present population were different subjects than the population used by Wingate-Corey, and, therefore, had different profiles of medical problems.

These findings are generally consistent with other findings in this area. Goodwin (1986), in a comparison of mild and severe IVH subjects (13 mild, 16 severe), found that both groups performed similarly on cognitive measures but performed at below the average norms for the measures administered. In the present study, SIVH subjects performed below the standard error of measurement on all measures except the short-term memory scale. In addition, the LBW group averaged below the standard error of measurement on the short-term memory scale of the Stanford-Binet. The MIVH group performed slightly above the standard error of measurement on the Stanford-Binet (t score of 84).

The outcome following IVH may be due to a variety of variables that produce handicaps regardless of the early neurological status of the child. Variables such as family socioeconomic status, the parent's skills as a natural "intervenor," and the parent's commitment to the child's well-being may also need to be investigated in order to more clearly delineate the factors effecting outcome of LBW and IVH infants. The present study indicates that the medical problems of apnea and anemia may have more predictive power in terms of neurodevelopmental outcome than the grade of IVH, and that the medical problems of hypertension and hyponatremia may have some predictive power.

Many authors have found that severe IVH infants fair poorly in terms of motor functioning (Gaiter, 1982; Papile et al., 1979; 1983). These results are usually found among children tested at 12 and 18 months. When tested at later ages (24 months and 3-1/2 years), the severe IVH children continued to perform lower on motor tasks than mild

IVH, but about the same on cognitive measures (Catto-Smith et al., 1985; Williamson et al., 1983). The order of results of the ANCOVA observed means for the motor scores (NBW, LBW, MIVH, SIVH) suggests that the present sample are performing at the same relative position to those in the above named studies.

Volpe (1987, p. 317) states that increased cerebral blood flow plays an important part in the pathogenesis of IVH. Since motor measures, more than cognitive measures, seem to be sensitive to the deficits encountered by children who had IVH, perhaps the neuropathology of IVH includes damage to the motor area secondary to increased blood pressure--damage which may decrease in influence with increasing age.

Among infants who survive the more severe hemorrhages, hypertension may be a good predictor of outcome. Experimental studies with beagle puppies suggests that hypertension is a contributing factor in the pathogenesis of IVH (Goddard-Finegold & Michael, 1984). The occurrence of hypertension in this population correlated negatively with Stanford-Binet verbal reasoning, abstract-visual reasoning, quantitative reasoning, and total IQ. The occurrence of hypercapnia, which is often related to respiratory problems in infants, may also play a role in the pathogenesis of IVH (Volpe, 1987, p. 321).

A number of respiratory medical problems, along with hypertension, may be more important predictors of outcome than the presence or grade of IVH. The fact that the most severe cases of IVH usually die of numerous complications, leaving the more viable infants, suggests that Grades III and IV IVH subjects comprise a truncated population which has already passed its most strenuous test of survival, during and immediately following, birth.

In conclusion, the present study supports a number of other studies which indicate that the grade of hemorrhage in IVH is not as good a predictor of outcome as hypotension and hyponatremia when considering cognitive measures. The present study's findings concerning motor measures more strongly indicate that the medical problems of apnea and anemia outweigh the predictive power of IVH and birthweight in terms of motor performance among children in the study ages.

Strengths and Weaknesses of the Study

This section provides an overview of the strengths and weaknesses of this study. Suggestions for future research follows.

Strengths

The major strength of this study was the use of a normal birthweight control group. Many studies have attempted to investigate the differences between IVH and LBW infants without taking into consideration the comparison of these groups with a full-term, normal birthweight group. Without the NBW control group, it remains unclear as to how the IVH and LBW groups compare to other infants of the same age who did not undergo the types of insults that the experimental groups encountered. Another strength of the study was in the use of the Stanford-Binet 4th edition and McCarthy Test of Children's Abilities motor section. The Stanford-Binet may be used at a wide range of ages and yields a great deal of information concerning developmental issues, whereas the McCarthy yields important information about gross motor functioning, which is an important variable to consider when dealing with the possibility of neurodevelopmental deficits. A number of studies in this area have been limited by their use of a neurological examination (e.g., Bierman-Van Eendenburg, Jugens-van der Zee, Olinga, Huisjes, & Touwen, 1981), or simply a cognitive measure (e.g., Drillien et al., 1980).

Another strength in this study was the inclusion of medical and infant and parent demographic variables in an attempt to discern a pattern of prediction. A number of studies have neglected such ancillary variables and their contribution to outcome.

This study also assessed children at 37 to 54 months of age. Many studies in the field assess neonates or 1 and 2 year olds; however, it is known that a disability may not be apparent until a certain age, or may decrease as the child grows and develops new behaviors (Rourke, Bakker, Fisk, & Strang, 1983). Assessments at later ages with the use of a NBW control group have not been forthcoming.

A final strength of the present study was the use of ANCOVA on continuous variables. A number of researchers have produced contingency tables based on categorical data, or upon percentages of infants who ended up in various categories of disability. The use of a robust statistical test, given the presence of highly correlated covariates, was much needed (Hopkins, 1973).

Weaknesses

The major weakness of this study was the small N in each of the groups. This problem becomes most apparent in the interpretation of ANCOVA results in which small cells comprise the comparisons. A larger sample (i.e., at least 30 subjects per cell) would have allowed for more detailed types of analyses. The small sample size also limits generalizability to a larger population of LBW infants with and without IVH.

A second weakness in this study was the lack of more Grade IV subjects in the IVH group. Although the sample did include two Grade

IV it is believed that the sample represents a more mild IVH population in that the Grade III children do not have as many deficits caused by severe insult as do the Grade IV children. Some previous research, however, has suggested that IVH grade is not the most important predictor of later outcome (e.g., Goodwin, 1986; Hawgood et al., 1984), so this issue remains unclear. It would have been optimal to have been able to include a larger Grade IV IVH group in the analysis in order to further investigate the effects of severe IVH in older children.

A third weakness was the inability to match subjects on birthweight between IVH and LBW groups. The LBW group's mean birthweight was significantly higher than the MIVH and SIVH group's mean birthweight, not allowing any discussion of the role birthweight plays in predicting outcome.

Finally, the generalizability of the present study was also limited because the sample was all caucasian with one American Indian, and all from one catchment area (University of Utah Medical Center). The mean income of the samples (49,000) suggests that the subject population had at least middle class SES (there was an outlier skewing the income upward). Parent income may be an important predictor of outcome, and, therefore, should be included in any further research.

Indications for Future Research

Research in this area is still needed, especially if something is to be learned about the later neurodevelopmental outcome following IVH and/or a LBW infancy. The present study raises some questions about the differences between LBW and IVH populations, and how variables such as hypertension, apnea, and anemia contribute to such differences.

In terms of future research, a design incorporating matched groups (matched on birthweight, gestational age, medical problems, and age at time of testing), with adequate sample sizes (i.e., N 30 per cell) from a number of different sites nationwide, is indicated. Also, the inclusion of IVH Grades III and IV is important in order to ascertain the differences in these groups on a number of different measures. The measures should include cognitive, neurodevelopmental, psychological, and behavioral indices in order to maximize construct validity. In addition, such a study would benefit from the use of a NBW comparison group. The undertaking of such a project would require a great deal of resource allocation and cooperation from a number of different medical centers and other health providers throughout the country.

Unfortunately, there is no clear picture of what variables will predict the cognitive, behavioral, and motor performance of LBW infants with and without IVH. Perhaps the best that can be concluded from research in this area is that birthweight, gestational age, medical problems, and family variables all interact to predict outcome for the infant. This is no different for the LBW infant than the NBW infant. Finally, and on an optimistic note, this study indicates that the long-term cognitive and motor performance may be within the average range, even for some children with severe IVH at birth.

REFERENCES

Ahmann, P. A., Lazzara, A., Dykes, F. D., Brann, A. W., & Schwartz, J. F. (1980). Intraventricular hemorrhage in the high-risk preterm infant: Incidence and outcome. Annals of Neurology, 7, 118-124.

Allen, M. C. (1984). Developmental outcome and followup of the small for gestational age infant. Seminars in Perinatology, 8, 123-156.

Bejar, R., Curbelo, V., Coen, R. W., Leopold, G., James, H., & Gluck, L. (1980). Diagnosis and follow-up of intraventricular and intracerebral hemorrhages by ultrasound studies of infant's brain through the fontanelles and sutures. Pediatrics, 66, 661-673.

Bennett, F. C. (1987). The effectiveness of early intervention for infants at increased biologic risk. In M. J. Guralnick, & F. C. Bennett (Eds.), The effectiveness of early intervention for at-risk and handicapped children (pp. 79-112). New York: Academic Press.

Bierman-Van Eendenburg, M. E. C., Jugens-van der Zee, A. D., Olinga, A. A., Huisjes, H. H., & Touwen, B. C. (1981). Predictive value of neonatal neurological examination: A follow-up study at 18 months. Developmental Child Neurology, 23, 296-305.

Bozynski, M. E. A., Nelson, M. N., Rosati-Skertich, C., Genaze, D., O'Donnell, K., & Naughton, P. (1984). Two year longitudinal followup of premature infants weighing 1200 grams at birth: Sequelae of intracranial hemorrhage. Developmental and Behavioral Pediatrics, 5, 346-352.

Catto-Smith, A. G., Yu, V. Y. H., Bajuk, B., Orgill, A. A., & Astbury, J. (1985). Effect of neonatal periventricular hemorrhage on neurodevelopmental outcome. Archives of Disease in Childhood, 60, 8-11.

Davies, P. A. (1984). Follow up of low birthweight children. Archives of Disease in Childhood, 59, 794-797.

Dolfin, T., Skidmore, M. B., Fong, K. W., Hoskins, E. M., Milligan, J. E., Moore, D. C., & Shennan, A. T. (1982). Perinatal factors that influence the incidence of subepedymal and intraventricular hemorrhage in low birth weight infants. Columbus, OH: Ross Laboratory Publications.

Drillien, C. M., Thomson, A. J. M., & Burgoyne, K. (1980). Low-birthweight children at early school age: A longitudinal study. Developmental Medicine and Child Neurology, 22, 26-47.

Escalona, S. K. (1984). Social and other environmental influences on the cognitive and personality development of low birth weight infants. American Journal of Mental Deficiency, 88, 508-512.

Ferrari, F., Grosoli, M. V., Fontana, G., & Cavazzuti, G. B. (1983). Neurobehavioral comparison of low risk preterm and fullterm infants at term conceptual age. Developmental Medicine and Child Neurology, 25, 450-458.

Gaiter, J. L. (1982). The effects of intraventricular hemorrhage on Bayley developmental performance in preterm infants. Seminars in Perinatology, 6, 305-316.

Goddard-Finegold, J., & Michael, L. H. (1984). Cerebral blood flow and experimental intraventricular hemorrhage. Pediatric Research, 18, 7.

Goodwin, G. T. (1986). A neuropsychological approach for differentiating the residual effects of neonatal intraventricular hemorrhage. Unpublished doctoral dissertation, Utah State University, Logan.

Greisen, G., Peterson, M. B., Pedersen, S. A., & Balkgaard, P. (1986). Status at two years in 121 very low birthweight survivors related to neonatal intraventricular hemorrhage and mode of delivery. Acta Paediatrica Scandinavia, 75, 24-30.

Hack, M., Merkatz, I. R., McGrath, S. K., Jones, P. K., & Fanaroff, A. A. (1984). Catch-up growth in very low birthweight infants. American Journal of Diseases in Childhood, 138, 370-375.

Hawgood, S., Spong, J., & Yu, V. Y. H. (1984). Intraventricular hemorrhage: Incidence and outcome in a population of very low birthweight infants. American Journal of Diseases in Childhood, 138, 136-139.

Hirata, T., Epcar, J. T., Walsh, A., Mednick, J., Harris, M., McGinnis, M. S., Sehring, S., & Papedo, G. (1983). Survival and outcome of infants 501 to 750 grams: A six year experience. The Journal of Pediatrics, 102, 741-748.

Hopkins, K. D. (1973). Research design and analysis clinic: Preventing the number-one misinterpretation of behavioral reserach or how to increase statistical power. The Journal of Special Education, 7, 103-107.

Kitchen, W. H., Ryan, M. M., Rickards, A., Astbury, J., Ford, G., Lissenden, J. V., Keith, C. G., & Keir, E. H. (1982). Changing outcome over 13 years of very low birthweight infants. Seminars in Perinatology, 6, 373-388.

Kitchen, W. H., Yu, V. Y. H., Orgill, A. A., Ford, G., Rickards, A., Astbury, J., Lissenden, J. V., & Bajuk, B. (1983). Collaborative study of very low birthweight infants: Correlation of handicap with risk factors. American Journal of Diseases in Childhood, 137, 555-559.

Landry, S. H., Fletcher, J. M., Zarling, C. I., Chapieski, L., & Francis, D. J. (1984). Differential outcomes associated with early medical complications in premature infants. Journal of Pediatric Psychology, 9, 385-401.

Leonard, C., Miller, C., Piecuch, R., Ballard, R., Clyman, R., Lane, B., & Sniderman, S. (1980). Developmental outcome of 93 infants weighing 1250 grams, with and without intraventricular hemorrhage: Two-year follow-up. Columbus, OH: Ross Laboratory Publications.

Lipscomb, A. Q., Thorburn, R. J., & Reynolds, E. O. R. (1981). Pneumothorax and cerebral haemorrhage in preterm infants. Lancet, 1, 414.

McCarthy, D. (1972). The McCarthy Scales of Children's Abilities. New York: The Psychological Corporation.

Morales, W. J. & Koerten, J. (1986). Obstetric management and intraventricular hemorrhage in very low birthweight infants. Obstetrics and Gynecology, 68, 35-39.

Murphy, T. F., Nichter, C. A., & Liden, C. B. (1982). Developmental outcome of the high-risk infant: A review of methodological issues. Seminars in Perinatology, 6, 353-364.

Naulty, C. M., Binder, H., Murray, S. L., Markle, B., Barnet, A., & Wagman, B. (1980). Neurodevelopmental outcome of low birthweight infants at 18-36 months with and without intraventricular hemorrhage. Columbus, OH: Ross Laboratory Publications.

Noble-Jamieson, C. M., Lukeman, D., Silverman, M., & Davies, P. A. (1982). Low birth weight children at school age: Neurological, psychological and pulmonary function. Seminars in Perinatology, 6, 266-273.

Papile, L. A., Burstein, J., Burstein, R., & Koffler, H. (1978). Incidence and evolution of subependymal and intraventricular hemorrhage: A study of infants less than 1500 grams. Journal of Pediatrics, 92, 529-534.

Papile, L. A., Munsick, G., Weaver, N., & Pecha, S. (1979). Cerebral intraventricular hemorrhage in infants < 1500 grams: Developmental follow-up at one year. Pediatric Research, 13, 528.

Papile, L. A., Munsick-Bruno, G., & Schaefer, A. (1983). Relationship of cerebral intraventricular hemorrhage and early childhood neurologic handicaps. Journal of Pediatrics, 103, 273-277.

Rourke, B. P., Bakker, D. J., Fisk, J. L., & Strang, J. D. (1983). Child neuropsychology: An introduction to theory, research and clinical practice. New York: The Guilford Press.

Scoub, H. S, Ahmann, P. A., Dykes, F. D., Lazzara, A., & Blumenstein, B. (1981). Prospective long-term follow-up of prematures with subependymal/intraventricular hemorrhage (SEH/IVH). Pediatric Research, 15, 711.

Scott, D. T., Ment, L. R., Ehrenhranz, R. A., & Warshaw, J. B. (1984). Evidence for late developmental deficits in very low birthweight infants with intraventricular hemorrhage. Child's Brain, 11, 261-269.

Silva, P. A., McGie, R., & Williams, S. (1984). A longitudinal study of the intelligence and behavior of preterm and small for gestational age children. Journal of Developmental and Behavioral Pediatrics, 5, 1-5.

Smith, L., Somner, F. F., & von Tetzshner, S. (1982). A longitudinal study of low birthweight children: Reproductive, perinatal and environmental precursors of developmental status at three years of age. Seminars in Perinatology, 6, 294-304.

Stewart, A. L., Reynolds, E. O. R., & Lipscomb, A. P. (1981). Outcome for infants of very low birthweight: Survey of world literature. Lancet, 1, 1038-1040.

Stewart, A. L., Thorburn, R. J., Hope, P. L., Goldsmith, M., Lipscomb, A. P., & Reynolds, E. O. (1983). Ultrasound appearance of the brain in very preterm infants and neurodevelopmental outcome at 18 months of age. Archives of Disease in Childhood, 58, 598-604.

Tekolste, K. A., Bennett, F. C., & Mack, L. A. (1985). Follow-up of infants receiving cranial ultrasound for intracranial hemorrhage. American Journal of Diseases in Childhood, 139, 299-303.

Thorndike, R. L. Hagen, E. P., & Sattler, J. M. (1986). Stanford-Binet Intelligence Scale (fourth edition). Chicago, IL: Riverside Publishing.

Volpe, J. (1987). Neurology of the newborn. Philadelphia: W. B. Saunders, Co.

Wallace, I. F., Escalona, S. K., McCarton-Daum, C., & Vaughn, H. G. (1982). Neonatal precursors of cognitive development in low birthweight children. Seminars in Perinatology, 6, 327-333.

Williamson, W. D., Desmond, M. M., Wilson, G. S., Andrew, L., & Garcia-Prats, J. A. (1982). Early neurodevelopmental outcome of low birth weight infants surviving neonatal intraventricular hemorrhage. Journal of Perinatal Medicine, 10, 34-41.

Williamson, W. D., Desmond, M. M., Wilson, G. S., Murphy, M. A., Rozelle, J., & Garcia-Prats, J. A. (1983). Survival of low-birth-weight infants with neonatal intraventricular hemorrhage: Outcome in the preschool years. American Journal of Diseases in Childhood, 137, 1181-1184.

Wingate-Corey, T., Casto, G., Immel, N., Clark, E., Chan, G., Dolcourt, J., Bodner, A., & Raltson, C. (1988). A preschool-age assessment of neuropsychological function of low birthweight infants with and without perinatal intraventricular hemorrhage. Unpublished Manuscript, Utah State University, Logan.

Yu, V. Y. H., Downe, L., Astbury, J., & Bajuk, B. (1986). Perinatal factors and adverse outcome in extremely low birthweight infants. Archives of Disease in Childhood, 61, 554-558.

APPENDICES

Appendix A

Oral Explanation of the Study

Purpose

1. The purpose of the study is to find out the developmental status of infants born between 1984 and 1985 who were low birthweight and either suffered intraventricular hemorrhage or did not. In addition, we're studying a control group of infants who were full term.

2. This study is testing areas of development such as language, motor, memory and thought processes in these infants that are now between 2-1/2 and 4 years of age.

The Assessment

1. The assessment will be done by a trained diagnostician, at no charge to the parent.

2. The assessment will determine performance on a variety of functions including memory, speech, motor, verbal reasoning, etc.

3. The testing will take 1-1 1/2 hours. The parent will be asked to complete some questionnaires about the child's health, behavior and information about the family.

4. The parent will receive a written report and oral explanation of the child's assessment results from the diagnostician.

5. The parent can receive a summary of the group results upon request.

Advantages of Participation

1. Free testing and assessment report which can be used for planning the child's education and other services.

2. Knowledge of the child's strengths and weaknesses and recommendations for future services which might be beneficial.

Risk of participation

1. None anticipated.

Consent/Confidentiality

1. The parents will be asked to sign a consent form and will receive a copy of that form.

2. No identifying information will be reported regarding the child or the family (i.e., the name, or individual scores).

3. The test data obtained from this study will be confidential. The child's test results can only be obtained by other agencies with written permission by the parent.

4. The child can withdraw from the study at any time without prejudice.

Appendix B

Informed Consent Form

Informed Consent Form

This certifies that I have been informed of the purpose of the proposed research project which involves the follow-up of my child in a retrospective study comparing children who were low birthweight and who suffered intraventricular hemorrhage with children who were full term at birth.

I understand that the risks to my child are minimal and that potential benefits include my acquiring a better understanding of my child's developmental status. I understand there will be a neuropsychological assessment of my child done by a trained diagnostician. The assessment will include a test of memory and verbal and quantitaive reasoning, and a test of motor skills. The total testing time will be approximately 1 to 1-1/2 hours and I will receive a written report and oral explanation of my child's test results. I also understand that any records kept on my child will remain confidential, that no identifying information (such as name) will be reported, and that I may request and receive the results of the study.

If I decide to withdraw from the study, I understand that I may do so at any time, without prejudice. If I have any questions, I may contact Bill Corey at (801) 750-3686 at any time. I also understand that I may contact Glendon Casto at (801) 750-2000 in those cases where a problem can not be discussed with Bill Corey.

Medical Treatment or Compensation for Physical Injury: In the event your infant sustains physical injury resulting from the research project in which your infant is participating, the University of Utah will provide your infant, without charge, emergency and temporary medical treatment not otherwise covered by insurance. Furthermore, if your baby's injuries are caused by negligent acts or omissions of University employees acting in the course and scope of their employment, the University may be liable, subject to limitations prescribed by law, for additional medical costs and other damages your infant sustains.

If you believe that your infant has suffered a physical injury as a result of participating in this research program, please contact the Office of the Vice President for Research, phone number 581-7236. If you feel your baby has been unfairly treated, or if you feel you have been inadequately informed about the risks and alternate procedures, or were under duress to continue the study, you can call the institutional Review Board (581-3655).

I certify that a copy of this consent form has been given to me

____ ______________

Parent signature Date

____

Witness of Parent Signature and Title of Signee

Appendix C

Assessment Results Summary Sheet

ASSESSMENT RESULTS

NAME: ________________________________ DATE of BIRTH __________

DATE of ASSESSMENT ___________ AGE ____ EXAMINER ______________

The following is a brief summary of the test results obtained during a recent assessment of your child. As you are aware, the assessment was a part of a research project conducted through Utah State University and the University of Utah Medical Center. Test scores should be interpreted as estimations of your child's current level of functioning, not as absolutes.

Stanford-Binet Intelligence Scale (4th edition) This is a standardized test of general cognitive ability comprised of four sub-sections which are labeled verbal reasoning, quantitative reasoning, abstract/visual reasoning, and short-term memory. These four areas each yield their own standard age score, and also combine to produce an overall standard age score (SAS). The average performance range is between 84 and 116 for the SAS's. Your child's scores were as follows:

Scale:

SAS Verbal Reasoning____ Quantitative Reasoning____
Abstract/Visual Reasoning____ Short-Term Memory____ Overall____
McCarthy Scales of Children's Abilities. This is also a standardized test, the motor sub-test of which was administered in order to determine your child's performance on a number of motor tasks. Performance within the average range is represented by a Scale Score between 40 and 60. Your child's motor scale score was measured at _____.

Thank you again for allowing us to test your child. If you have any further questions regarding this study, please feel free to contact me at 750-3686 or 752-3011.

Sincerly,

William F. Corey, M.S.
Project Coordinator
Early Intervention Research Institute
Utah State University
Logan, Utah 84322-6580

Appendix D

Demographic Questionnaire

FOR OFFICE USE ONLY

Informant: ____________________ Completed by: ____________________ Program: ____________
Data Completed: ________________ Child's ID #: ____________________

PARENT SURVEY

A. 1. Child's name: ____ SEX: M F
Last First Middle

2. Birthdate: ____________________ Age: ____________________

3. Birthplace: ____________ ______ ____________
City State County

B. 1. Address: ____
Street

____________ ______ ______ ____________
City State ZIP Code County

2. Home phone number: (____) ______-______

C. Mother (primary female caregiver)

1. Name: ____________________

2. Birthdate: ____________ Age: _____

3. Currently living w/child? Yes ___ No ___

4. Race/Ethnic Origin:

_____ White
_____ Black
_____ Hispanic
_____ Asian
_____ American Indian
_____ Other ____________________

5. Marital Status:

_____ Married/Living with Someone
_____ Separated
_____ Divorced
_____ Spouse Deceased
_____ Single

6. Relationship to Child:

_____ Natural
_____ Foster
_____ Adopted
_____ Step-parent
_____ Other ____________________

D. Father (primary male caregiver)

1. Name: ____________________

2. Birthdate: ____________ Age: _____

3. Currently living w/child? Yes ___ No ___

4. Race/Ethnic Origin:

_____ White
_____ Black
_____ Hispanic
_____ Asian
_____ American Indian
_____ Other ____________________

5. Marital Status:

_____ Married/Living with Someone
_____ Separated
_____ Divorced
_____ Spouse Deceased
_____ Single

6. Relationship to Child:

_____ Natural
_____ Foster
_____ Adopted
_____ Step-parent
_____ Other ____________________

C. Mother (primary female caregiver)

7. Circle highest level of education completed by mother:

1 2 3 4 5 6 7 8 Grade School
9 10 11 12 High School
13 14 15 16 College
17 and over Graduate School

8. Highest degree completed by mother

_____ None
_____ High School
_____ Bachelors
_____ Other ______________________
_____ Masters
_____ Doctorate

9. Current Occupation: ________________
____

_____ Hours employed per week
_____ Hourly wage/monthly salary

If unemployed, are you currently seeking employment?

_____ Yes _____ No

10. Work phone number (____) _____-_____

D. Father (primary male caregiver)

7. Circle highest level of education completed by father:

1 2 3 4 5 6 7 8 Grade School
9 10 11 12 High School
13 14 15 16 College
17 and over Graduate School

8. Highest degree completed by father

_____ None
_____ High School
_____ Bachelors
_____ Other ______________________
_____ Masters
_____ Doctorate

9. Current Occupation: ________________
____

_____ Hours employed per week
_____ Hourly wage/monthly salary

If unemployed, are you currently seeking employment?

_____ Yes _____ No

10. Work phone number (____) _____-_____

D. 1. Total yearly income for household (check one):

_____ below $ 5,000
_____ $ 5,000 to $ 7,999
_____ $ 8,000 to $10,999
_____ $11,000 to $14,999
_____ $15,000 to $19,999
_____ $20,000 to $24,999
_____ $25,000 to $29,999
_____ $30,000 to $34,999
_____ $35,000 to $39,999
_____ $40,000 to $49,999
_____ $50,000 and over

2. Are you currently receiving any public assistance (for example, welfare, SSI, food stamps, medicaid)?

_____ Yes _____ No

3. Approximately how much of the family income is spent each year on medical and educational care for your child that is not covered by other sources (i.e., insurance)?

$ ______________

4. Current type of dwelling place (check one).

_____ House
_____ Duplex (or double house)
_____ Apartment
_____ Other (specify) ________________________________

5. How is dwelling paid for?

_____ Own (includes loan payments); total mortgage payment (if any) per month:
$_______________
_____ Rent; total rent per month:
$ _______________
_____ Public houseing; amount paid per month:
$ _______________
_____ Staying with someone temporarily; monthly cost:
$ _______________
_____ Other (specify ______________________________; monthly cost:
$ _______________

E. 1. List all adults (over age 18) currently living in the home:

Name	Age	Relationship to child	How much time do they spend each day taking care of the child?
______________	___	______________	______________
______________	___	______________	______________
______________	___	______________	______________
______________	___	______________	______________

2. Are you or any of the adults living in the house currently attending school?

_____ Yes _____ No

Name	Degree Sought	Area of Study
______________	______________	______________
______________	______________	______________
______________	______________	______________

3. Hours per day child typically spends with babysitter or in other daycare?

_____ hours

4. List the names, addresses, and phone numbers of the closest relatives or friends not living with you.

Name	Address	Phone Number
______________	______________	______________
______________	______________	______________
______________	______________	______________

5. List other children living in the home:

Name	Age	Relationship	Grade in School	Does this child need or receive special education services?
______________	___	______________	______________	_____ Yes _____ No
______________	___	______________	______________	_____ Yes _____ No
______________	___	______________	______________	_____ Yes _____ No
______________	___	______________	______________	_____ Yes _____ No
______________	___	______________	______________	_____ Yes _____ No
______________	___	______________	______________	_____ Yes _____ No
______________	___	______________	______________	_____ Yes _____ No

6. Primary language spoken in the home ______________________________.
Other languages regularly spoken in home ______________________________.

Appendix E

Additional Data Tables

Table E-1

Incidence of Medical Complications Between Subjects and Non-Subjects by Group (MIVH)

Characteristics	Subjects (N = 10) N	%	Non-Subjects (N = 15) N	%
MEDICAL COMPLICATIONS				
Metabolic Acidosis	2	18	3	20
Hypercalcemia	0		0	
Hypocalcemia	7	64	13	87
Hypernatremia	2	18	4	27
Hyponatremia	1	09	2	13
Hyperglycemia	0		4	27
Hypoglycemia	1	09	1	07
Birth Asphyxia	3	30	8	53
Hyaline Membrane Disease	7	70	12	80
Tachypnea	1	10	2	13
Bronchopulmonary Dysplasia	4	36	8	53
Pulmonary Interstitial Emphysema	1	09	4	27
Pneumonia	3	27	6	40
Apnea	4	40	7	47
Hypertension	0		0	
Hypotension	6	60	9	60
Patent Ductus Arteriosus	3	30	6	40
Persistent Fetal Circulation	0		0	
Seizure Disorder	1	09	1	07
Post Hemorrhagic Hydrocephalus	2	20	3	20
Hydrocephalus	1	09	0	
Thrombocytosis	1	09	2	13
Porencephalic Cyst	0		0	
Hyperbilirubinemia	8	80	15	100
Anemia	6	60	7	47
Pneumothorax	1	10	2	13
Vision Problems	0		0	
Hearing Problems	0		1	07
MEDICAL PROCEDURES				
Umbilical Artery Catheterization	9	90	15	100
Lumbar Puncture	3	30	8	53
Ventricularperitoneal Shunt	0		0	

No significant differences found using Chi Square

Table E-2

Incidence of Medical Complications Between Subjects and Non-Subjects by Group (SIVH)

Characteristics	Subjects (N = 9) N	%	Non-Subjects (N = 14) N	%
MEDICAL COMPLICATIONS				
Metabolic Acidosis	0		3	
Hypercalcemia	0		0	
Hypocalcemia	7	64	8	57
Hypernatremia	4	44	5	36
Hyponatremia	1	09	4	29
Hyperglycemia	2	22	2	14
Hypoglycemia	0		0	
Birth Asphyxia	7	78	11	79
Hyaline Membrane Disease	7	70	14	100
Tachypnea	1	11	0	
Bronchopulmonary Dysplasia	4	36	7	50
Pulmonary Interstitial Emphysema	3	33	2	14
Pneumonia	4	44	3	21
Apnea	6	67	9	64
Hypertension	2	22	2	14
Hypotension	4	44	5	36
Patent Ductus Arteriosus	3	33	6	40
Persistent Fetal Circulation	0		0	
Seizure Disorder	2	22	2	14
Post Hemorrhagic Hydrocephalus	3	27	4	29
Hydrocephalus	0		0	
Thrombocytosis	0		0	
Porencephalic Cyst	0		0	
Hyperbilirubinemia	9	100	11	79
Anemia	6	67	7	47
Pneumothorax	2	18	3	21
Vision Problems	0		0	
Hearing Problems	0		0	
MEDICAL PROCEDURES				
Umbilical Artery Catheterization	7	78	13	93
Lumbar Puncture	6	67	6	43
Ventricularperitoneal Shunt	0		1	07

No significant differences found using Chi Square

Table E-3

Incidence of Medical Complications Between Subjects and Non-Subjects by Group (LBW)

Characteristics	Subjects (N = 12) N	%	Non-Subjects (N = 11) N	%
MEDICAL COMPLICATIONS				
Metabolic Acidosis	0		1	09
Hypercalcemia	0		0	
Hypocalcemia	7	58	7	64
Hypernatremia	1	08	0	0
Hyponatremia	0		0	
Hyperglycemia	0		0	
Hypoglycemia	0		0	
Birth Asphyxia	5	42	1	09
Hyaline Membrane Disease	7	58	6	55
Tachypnea	4	33	4	36
Bronchopulmonary Dysplasia	0		1	09
Pulmonary Interstitial Emphysema	0		0	
Pneumonia	0		0	
Apnea	3	25	4	36
Hypertension	0		0	
Hypotension	1	08	0	
Patent Ductus Arteriosus	2	17	1	09
Persistent Fetal Circulation	0		0	
Seizure Disorder	2	17	0	
Post Hemorrhagic Hydrocephalus	0		0	
Hydrocephalus	0		0	
Thrombocytosis	0		1	09
Porencephalic Cyst	0		0	
Hyperbilirubinemia	9	75	6	55
Anemia	5	42	2	18
Pneumothorax	1	08	0	
Vision Problems	0		0	
Hearing Problems	0		0	
MEDICAL PROCEDURES				
Umbilical Artery Catheterization	10	83	6	55
Lumbar Puncture	4	33	1	09
Ventricularperitoneal Shunt	0		0	

No Significant Differences Found using Chi Square

Table E-1

Differences Between Subjects and Non-Subjects for Continuous Data by Group (MIVH)

Variable	Subjects (N = 10)		Non-Subjects (N = 15)		T Value	2-Tail Prob.*
	Mean	SD	Mean	SD		
Mother's Age	27.50	7.74	23.53	6.38	1.40	0.196
1-Minute APGAR Score	4.60	1.96	4.80	2.27	-0.23	0.817
5-Minute APGAR Score	7.10	0.74	6.60	1.64	0.90	0.313
Birthweight	1468.00	272.39	1384.0	286.73	0.73	0.468
Gestational Age	31.20	2.44	30.13	2.62	1.03	0.310
Number of Exchange Transfusions	8.00	7.57	7.67	8.39	0.10	0.919

*Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-5

Differences Between Subjects and Non-Subjects for Continuous Data by Group (SIVH)

Variable	Subjects (N = 9)		Non-Subjects (N = 14)		T Value	2-Tail Prob.*
	Mean	SD	Mean	SD		
Mother's Age	26.33	5.98	23.64	3.67	1.34	0.249
1-Minute APGAR Score	4.33	2.40	4.00	2.22	0.34	0.742
5-Minute APGAR Score	5.78	1.39	6.79	1.67	-1.50	0.134
Birthweight	1432.22	521.46	1481.43	545.79	-0.21	0.831
Gestational Age	30.33	2.24	30.00	2.39	0.33	0.738
Number of Exchange Transfusions	8.33	8.41	8.64	9.37	-0.08	0.935

*Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-6

Differences Between Subjects and Non-Subjects for Continuous Data by Group (LBW)

Variable	Subjects (N = 12)		Non-Subjects (N = 11)		T Value	2-Tail Prob.*
	Mean	SD	Mean	SD		
Mother's Age	23.17	5.09	21.64	5.52	0.69	0.499
1-Minute APGAR Score	4.58	2.19	5.81	1.47	-1.57	0.126
5-Minute APGAR Score	6.92	1.88	7.27	0.65	-0.60	0.547
Birthweight	2088.33	331.99	2020.91	240.06	0.55	0.586
Gestational Age	34.42	2.19	33.18	1.68	1.66	0.111
Number of Exchange Transfusions	1.17	1.12	0.64	1.21	1.10	0.285

*Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-7

Differences Between Subjects and Non-Subjects for Continuous Data by Group (NBW)

Variable	Subjects (N = 13) Mean	SD	Non-Subjects (N = 13) Mean	SD	T Value	2-Tail Prob.*
Mother's Age	29.08	6.61	25.31	5.44	1.59	0.126
1-Minute APGAR Score	7.46	0.97	8.00	1.00	-1.40	0.176
5-Minute APGAR Score	8.85	0.38	9.00	1.00	-1.48	0.153
Birthweight	3539.69	425.18	3512.31	441.19	0.16	0.873
Gestational Age	39.46	1.66	40.31	1.49	-1.36	0.185

* Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-8

Incidence of Infant Demographic Variables and Severity of IVH by Group

		MIVH Group (N = 11)		SIVH Group (N = 9)		LBW Group (N = 12)		NBW Group (N = 13)	
Characteristics		N	%	N	%	N	%	N	%
Sex	- Male	4	40	5	56	5	48	8	62
	Female	6	60	4	44	7	52	5	38
Location	- Inborn	8	80	7	78	11	72	13	100
	Outborn	2	20	2	22	1	28	0	
Size	- SGA	0	--	0	--	0	--	0	--
	AGA	11	100	9	100	12	100	8	62
	LGA	0	--	0	--	0	--	5	38
Severity of IVH									
	Grade I	5	45	--	--	--	--	--	--
	Grade II	5	45	--	--	--	--	--	--
	Grade III	--	--	7	78	--	--	--	--
	Grade IV	--	--	2	22	--	--	--	--
	None	--	--	--	--	12	100	13	100

SGA = Small for Gestational Age

AGA = Approrpiate for Gestational Age

LGA = Large for Gestational Age

Table E-9

Incidence of Medical Complications Between Groups (MIVH vs. SIVH)

	MIVH Group (N = 10)		SIVH Group (N = 9)	
Characteristics	N	%	N	%
MEDICAL COMPLICATIONS				
Metabolic Acidosis	2	20	0	
Hypercalcemia	0		0	
Hypocalcemia	7	70	7	78
Hypernatremia	2	20	4	44
Hyponatremia	1	10	1	11
Hyperglycemia	0		2	22
Hypoglycemia	1	10	0	
Birth Asphyxia	3	30	7	78
Hyaline Membrane Disease	7	70	8	89
Tachypnea	1	10	1	11
Broncho Pulmonary Dysplasia*	4	40	4	44
Pulmonary Interstitial Emphysema	1	10	3	33
Pneumonia	3	30	4	44
Apnea	5	40	6	67
Hypertension	0		2	22
Hypotension**	6	60	4	44
Patent Ductus Arteriosus	3	30	3	33
Persistent Fetal Circulation	0		0	
Seizure Disorder	1	10	2	22
Post Hemorrhagic Hydrocephalus	2	20	3	33
Hydrocephalus	1	10	0	
Thrombocytosis	1	10	0	
Porencephalic Cyst	0		0	
Hyperbilirubinemia	8	80	9	100
Anemia	6	60	6	67
Pneumothorax	2	20	2	22
Vision Problems	0		0	
Hearing Problems	0		0	
MEDICAL PROCEDURES				
Umbilical Artery Catheterization	9	90	7	78
Lumbar Puncture	3	30	6	67
Ventricularperitoneal Shunt	0		0	

No significant differences using Chi Square

Table E-10

Incidence of Medical Complications Between Groups (MIVH vs. LBW)

Characteristics	MIVH Group (N = 10) N	MIVH Group (N = 10) %	LBW Group (N = 12) N	LBW Group (N = 12) %
MEDICAL COMPLICATIONS				
Metabolic Acidosis	2	20	0	
Hypercalcemia	0		0	
Hypocalcemia	7	70	7	58
Hypernatremia	2	20	1	08
Hyponatremia	1	10	0	
Hyperglycemia	0		0	
Hypoglycemia	1	10	0	
Birth Asphyxia	3	30	5	42
Hyaline Membrane Disease	7	70	7	58
Tachypnea	1	10	4	33
Broncho Pulmonary Dysplasia*	4	40	0	
Pulmonary Interstitial Emphysema	1	10	0	
Pneumonia	3	30	0	
Apnea	4	40	3	25
Hypertension	0		0	
Hypotension**	6	60	1	08
Patent Ductus Arteriosus	3	30	2	17
Persistent Fetal Circulation	0		0	
Seizure Disorder	1	10	2	17
Post Hemorrhagic Hydrocephalus	2	20	0	
Hydrocephalus	1	10	0	
Thrombocytosis	1	10	0	
Porencephalic Cyst	0		0	
Hyperbilirubinemia	8	80	9	75
Anemia	6	60	5	42
Pneumothorax	2	20	1	08
Vision Problems	0		0	
Hearing Problems	0		0	
MEDICAL PROCEDURES				
Umbilical Artery Catheterization	9	90	10	83
Lumbar Puncture	3	30	4	33
Ventricularperitoneal Shunt	0		0	

*Significantly Different ($p \leq .05$) using Chi Square
**Significantly Different ($p \leq .01$) using Chi Square

Table E-11

Incidence of Medical Complications Between Groups (SIVH vs. LBW)

Characteristics	SIVH Group (N = 10)		LBW Group (N = 12)	
	N	%	N	%
MEDICAL COMPLICATIONS				
Metabolic Acidosis	0		0	
Hypercalcemia	0		0	
Hypocalcemia	7	78	7	58
Hypernatremia*	4	44	1	08
Hyponatremia	1	11	0	
Hyperglycemia	2	22	0	
Hypoglycemia	0		0	
Birth Asphyxia	7	78	5	42
Hyaline Membrane Disease	8	89	7	58
Tachypnea	1	11	4	33
Broncho Pulmonary Dysplasia*	4	44	0	
Pulmonary Interstitial Emphysema*	3	33	0	
Pneumonia*	4	44	0	
Apnea*	6	67	3	25
Hypertension	2	22	0	
Hypotension*	4	44	1	08
Patent Ductus Arteriosus	3	33	2	17
Persistent Fetal Circulation	0		0	
Seizure Disorder	2	22	2	17
Post Hemorrhagic Hydrocephalus	3	33	0	
Hydrocephalus	0		0	
Thrombocytosis	0		0	
Porencephalic Cyst	0		0	
Hyperbilirubinemia	9	100	9	75
Anemia	6	67	5	42
Pneumothorax	2	22	1	08
Vision Problems	0		0	
Hearing Problems	0		0	
MEDICAL PROCEDURES				
Umbilical Artery Catheterization	7	78	10	83
Lumbar Puncture	6	67	4	33
Ventricularperitoneal Shunt	0		0	

*Significantly Different ($p \leq .05$) using Chi Square

Table E-12

Differences Between Groups on Infant, Perinatal, and Parent Demographic Variables (MIVH vs SIVH)

Variable	MIVH (N = 10)		SIVH (N = 9)			
	Mean	SD	Mean	SD	T Value	2-Tail Prob.*
Mother's Age	27.50	7.74	26.33	5.98	0.36	0.716
1-Minute APGAR Score	4.60	1.96	4.33	2.40	0.27	0.795
5-Minute APGAR Score	7.10	0.74	5.78	1.39	2.62	0.026
Birthweight	1468.00	272.39	1432.22	521.46	0.19	0.857
Gestational Age	31.20	2.44	30.33	2.24	0.80	0.430
Family Yearly Income (x 1000)	34.00	13.96	33.89	13.68	0.02	0.987
Education Level-Father (years)	13.78	2.11	13.88	1.73	-0.10	0.918
Education Level-Mother (years)	13.20	1.62	12.89	1.69	0.41	0.688
Birth Order of Subject	2.20	1.87	3.89	2.71	-1.59	0.141
Age at time of Testing (months)	44.10	3.32	43.44	3.97	0.39	0.703

*Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-13

Differences Between Groups on Infant, Perinatal, and Parent Demographic Variables (MIVH vs LBW)

Variable	MIVH (N = 10)		LBW (N = 9)		T Value	2-Tail Prob.*
	Mean	SD	Mean	SD		
Mother's Age	27.50	7.74	23.17	5.09	1.58	0.150
1-Minute APGAR Score	4.60	1.96	4.58	2.19	0.02	0.985
5-Minute APGAR Score	7.10	0.74	6.92	1.88	0.29	0.761
Birthweight	1468.00	272.39	2088.33	331.99	-4.73	0.000
Gestational Age	31.2	2.44	34.42	2.19	-3.26	0.005
Family Yearly Income (x 1000)	104.60	223.65	28.08	23.13	1.18	0.309
Education Level-Father (years)	13.78	2.11	14.00	2.11	-0.23	0.821
Education Level-Mother (years)	13.20	1.62	12.50	2.61	0.74	0.452
Birth Order of Subject	2.20	1.87	1.92	1.24	1.12	0.307
Age at time of Testing (months)	44.10	3.32	44.25	5.51	-0.08	0.938

*Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-14

Differences Between Groups on Infant, Perinatal, and Parent Demographic Variables (MIVH vs NBW)

Variable	MIVH (N = 10)		NBW (N = 13)		T Value	2-Tail Prob.*
	Mean	SD	Mean	SD		
Mother's Age	27.50	7.74	29.08	6.61	-0.53	0.612
1-Minute APGAR Score	4.60	1.96	7.46	0.97	-4.62	0.001
5-Minute APGAR Score	7.10	0.74	8.85	0.38	-7.41	0.000
Birthweight	1468.00	272.39	3539.69	425.18	-13.40	0.000
Gestational Age	31.20	2.44	39.46	1.66	-9.66	0.000
Family Yearly Income (x 1000)	34.00	13.96	26.77	17.06	0.59	0.560
Education Level-Father (years)	13.78	2.11	14.00	1.95	-0.25	0.808
Education Level-Mother (years)	13.20	1.62	13.38	1.61	-0.27	0.789
Birth Order of Subject	2.20	1.87	3.38	2.14	-1.39	0.173
Age at time of Testing (months)	44.10	3.32	49.31	4.68	-2.98	0.005

*Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-15

Differences Between Groups on Infant, Perinatal, and Parent Demographic Variables (SIVH vs LBW)

	SIVH (N = 10)		LBW (N = 9)			
Variable	Mean	SD	Mean	SD	T Value	2-Tail Prob.*
Mother's Age	26.33	5.98	23.17	5.09	1.31	0.220
1-Minute APGAR Score	4.33	2.40	4.58	2.19	-0.25	0.809
5-Minute APGAR Score	5.78	1.39	6.92	1.88	-1.53	0.128
Birthweight	1432.22	521.46	2088.33	331.99	-3.52	0.006
Gestational Age	30.33	2.24	34.42	2.19	-4.19	0.001
Family Yearly Income (x 1000)	33.89	13.68	28.08	23.13	0.67	0.482
Education Level-Father (years)	13.88	1.73	14.00	2.11	-0.14	0.892
Education Level-Mother (years)	12.89	1.69	12.50	2.61	0.39	0.684
Birth Order of Subject	3.89	2.71	1.50	1.00	2.82	0.031
Age at time of Testing (months)	43.44	3.97	44.25	5.51	-0.37	0.702

*Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-16

Differences Between Groups on Infant, Perinatal, and Parent Demographic Variables (SIVH vs NBW)

	SIVH (N = 11)		NBW (N = 13)			
Variable	Mean	SD	Mean	SD	T Value	2-Tail Prob.*
Mother's Age	26.33	5.98	29.08	6.61	-1.01	0.324
1-Minute APGAR Score	4.33	2.39	7.46	0.97	-3.71	0.004
5-Minute APGAR Score	5.78	1.39	8.85	0.38	-6.44	0.000
Birthweight	1432.22	521.46	3539.69	425.18	-10.03	0.000
Gestational Age	30.33	2.24	39.46	1.66	-10.41	0.000
Family Yearly Income (x 1000)	33.89	13.68	33.77	25.96	1.08	0.292
Education Level-Father (years)	13.88	1.73	14.75	2.70	-0.15	0.882
Education Level-Mother (years)	12.89	1.69	14.07	2.60	-0.69	0.500
Birth Order of Subject	3.89	2.71	3.69	2.06	0.47	0.648
Age at time of Testing (months)	43.44	3.97	45.46	14.15	-3.16	0.005

*Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-17

Differences Between Groups on Infant, Perinatal, and Parent Demographic Variables (NBW vs LBW)

Variable	NBW (N = 13)		LBW (N = 12)			
	Mean	SD	Mean	SD	T Value	2-Tail Prob.*
Mother's Age	29.08	6.61	23.17	5.09	-2.49	0.021
1-Minute APGAR Score	7.46	0.97	4.58	2.19	-4.19	0.001
5-Minute APGAR Score	8.85	0.38	6.92	1.88	-3.49	0.005
Birthweight	3539.69	425.18	2088.33	331.99	-9.46	0.000
Gestational Age	39.46	1.66	34.42	2.19	-6.51	0.000
Family Yearly Income (x 1000)	33.77	25.96	28.08	23.13	-0.58	0.570
Education Level-Father (years)	14.75	2.70	14.00	2.11	-0.71	0.483
Education Level-Mother (years)	14.08	2.59	12.50	2.61	-1.51	0.144
Birth Order of Subject	3.69	2.06	1.92	1.24	-2.59	0.017
Age at time of Testing (months)	45.46	14.15	38.42	15.14	-1.20	0.241

*Pooled variance estimates were used unless the F-value for homogeneity of variance indicated the use of separate variance estimates.

Table E-18

Outcome Measures and Associated Covariates

Outcome Measure	Covariate(s)	Multiple R
McCarthy Motor Score	ANEM, AP	.677
Stanford-Binet Verbal Reasoning	HYTEN, HONAT, AP1	.774
Stanford-Binet Abstract Visual Reasoning	HYTEN, ET	.643
Stanford-Binet Quantitative Reasoning	HYTEN, Sex, AP	.838
Stanford-Binet Short-Term Memory	SD, HYNAT, Sex	.698
Stanford-Binet Total Score	HYTEN, Sex, THOR	.850

ANEM = Anemia

AP = Apnea

AP1 = 1 Minute APGAR Score

ET = Number of Exchange Transfusions

HONAT = Hyponatremia

HYNAT = Hypernatremia

HYTEN = Hypertension

SD = Seizure Disorder

THOR = Pneumothorax

Table E-19

Observed and Adjusted Means for Outcome Measures by Group (MIVH vs. SIVH)

	MIVH		SIVH	
Outcome Measures	Obs.	Adj.	Obs.	Adj.
McMotor	43.00	40.76	34.56	36.79
SBVR	98.70	93.09	82.22	87.83
SBAVR	86.50	82.07	83.56	87.99
SBQR	91.50	79.68	75.44	87.26
SBSTM	100.30	94.39	86.67	92.58
SBTOT	93.20	84.56	80.67	89.30

Analysis of Covariance Results (MIVH vs. SIVH)

	MS	F	Sig. of F	Covariates
McMotor	68.37	1.42	.251	ANEM, AP
SBVR	110.68	.81	.382	HYTEN, AP1 HONAT
SBAVR	140.55	.32	.581	HYTEN, ET
SBQR	230.03	.80	.387	HYTEN, Sex AP
SBSTM	14.10	.04	.849	SD, HYNAT, Sex
SBTOT	91.83	.84	.377	THOR, Sex, HYTEN, AP1

McMotor = McCarthy Scales of Children's Abilities--Motor Score
SBAVR = Stanford-Binet Abstract-Visual Reasoning
SBQR = Stanford-Binet Quantitative Reasoning
SBSTM = Stanford-Binet Short-Term Memory
SBTOT = Stanford-Binet Total Score (IQ)
AP1 = 1 Minute APGAR Score
ANEM = Anemia
AP1 = 1 Minute APGAR Score
HONAT = Hyponatremia
HYTEN = Hypertension
THOR = Pneumothorax
GA = Gestational Age
AP = Apnea
ET = Number Exchange Transfusions
HYNAT = Hypernatremia
SD = Seizure Disorder

Table E-20

Observed and Adjusted Means for Outcome Measures by Group (MIVH vs. LBW)

	MIVH		LBW	
Outcome Measures	Obs.	Adj.	Obs.	Adj.
McMotor	43.00	45.25	43.92	41.67
SBVR	98.70	99.05	92.00	91.65
SBAVR	86.50	88.02	95.42	93.90
SBQR	91.50	92.49	93.42	92.43
SBSTM	100.30	100.68	84.42	84.04
SBTOT	93.20	93.99	88.75	87.96

Analysis of Covariance Results (MIVH vs. LBW)

	MS	F	Sig. of F	Covariates
McMotor	62.71	.84	.371	ANEM, AP
SBVR	281.42	1.54	.230	AP1
SBAVR	127.65	.66	.427	ET
SBQR	.02	.00	.992	Sex, AP
SBSTM	1455.01	3.50	.079	SD, HYNAT, Sex
SBTOT	191.58	1.05	.319	THOR, Sex, AP1

McMotor = McCarthy Scales of Children's Abilities--Motor Score
SBAVR = Stanford-Binet Abstract-Visual Reasoning
SBQR = Stanford-Binet Quantitative Reasoning
SBSTM = Stanford-Binet Short-Term Memory
SBTOT = Stanford-Binet Total Score (IQ)
AP1 = 1 Minute APGAR Score
ANEM = Anemia
AP1 = 1 Minute APGAR Score
HONAT = Hyponatremia
HYTEN = Hypertension
THOR = Pneumothorax
GA = Gestational Age
AP = Apnea
ET = Number Exchange Transfusions
HYNAT = Hypernatremia
SD = Seizure Disorder

Table E-21

Observed and Adjusted Means for Outcome Measures by Group (MIVH vs. NBW)

	MIVH		NBW	
Outcome Measures	Obs.	Adj.	Obs.	Adj.
McMotor	43.00	50.64	46.31	38.67
SBVR	98.70	104.04	102.92	97.59
SBAVR	86.50	88.07	94.07	92.50
SBQR	91.50	91.59	96.77	96.67
SBSTM	100.30	100.59	102.85	102.55
SBTOT	93.20	97.70	99.00	94.49

Analysis of Covariance Results (MIVH vs. NBW)

	MS	F	Sig. of F	Covariates
McMotor	330.53	6.64	**.019**	ANEM, AP
SBVR	116.84	.92	.350	AP1
SBAVR	65.20	.37	.552	ET
SBQR	99.65	.97	.337	Sex, AP
SBSTM	16.85	.12	.736	SD, HYNAT, Sex
SBTOT	21.16	.37	.551	Sex, Thor, AP1

McMotor = McCarthy Scales of Children's Abilities--Motor Score
SBAVR = Stanford-Binet Abstract-Visual Reasoning
SBQR = Stanford-Binet Quantitative Reasoning
SBSTM = Stanford-Binet Short-Term Memory
SBTOT = Stanford-Binet Total Score (IQ)
AP1 = 1 Minute APGAR Score GA = Gestational Age
ANEM = Anemia AP = Apnea
AP1 = 1 Minute APGAR Score ET = Number Exchange Transfusions
HONAT = Hyponatremia HYNAT = Hypernatremia
HYTEN = Hypertension SD = Seizure Disorder
THOR = Pneumothorax

Table E-22

Observed and Adjusted Means for Outcome Measures by Group (SIVH vs. LBW)

	SIVH		LBW	
Outcome Measures	Obs.	Adj.	Obs.	Adj.
McMotor	34.56	38.00	43.92	40.47
SBVR	82.22	89.17	92.00	85.05
SBAVR	83.56	94.35	95.42	84.62
SBQR	75.44	89.57	93.42	79.29
SBSTM	86.67	95.06	84.42	76.03
SBTOT	80.75	90.33	88.75	79.08

Analysis of Covariance Results (SIVH vs. LBW)

	MS	F	Sig. of F	Covariates
McMotor	23.45	.33	.573	ANEM, AP
SBVR	74.79	.43	.523	AP1, HYTEN HONAT
SBAVR	333.77	1.36	.259	ET, HYTEN
SBQR	419.50	1.15	.300	Sex, AP HTEN
SBSTM	1511.03	3.52	.079	SD, HYNAT, Sex
SBTOT	554.95	3.23	.092	THOR, Sex, AP1, HYTEN

McMotor = McCarthy Scales of Children's Abilities--Motor Score
SBAVR = Stanford-Binet Abstract-Visual Reasoning
SBQR = Stanford-Binet Quantitative Reasoning
SBSTM = Stanford-Binet Short-Term Memory
SBTOT = Stanford-Binet Total Score (IQ)
AP1 = 1 Minute APGAR Score
ANEM = Anemia
AP1 = 1 Minute APGAR Score
HONAT = Hyponatremia
HYTEN = Hypertension
THOR = Pneumothorax
GA = Gestational Age
AP = Apnea
ET = Number Exchange Transfusions
HYNAT = Hypernatremia
SD = Seizure Disorder

Table E-23

Observed and Adjusted Means for Outcome Measures by Group (SIVH vs. NBW)

	SIVH		NBW	
Outcome Measures	Obs.	Adj.	Obs.	Adj.
McMotor	34.56	43.50	46.31	37.36
SBVR	82.22	92.29	102.92	92.85
SBAVR	83.56	95.67	94.07	81.97
SBQR	75.44	88.39	96.77	83.83
SBSTM	86.67	96.81	102.85	92.70
SBTOT	80.67	93.00	99.00	86.67

Analysis of Covariance Results (SIVH vs. NBW)

	MS	F	Sig. of F	Covariates
McMotor	59.54	1.20	.287	ANEM, AP
SBVR	.86	.01	.934	AP1, HONAT HYTEN
SBAVR	595.64	2.61	.123	ET, HYTEN
SBQR	48.68	.21	.656	Sex, AP HTEN
SBSTM	61.03	.44	.518	SD, HYNAT, Sex
SBTOT	98.55	.97	.339	Sex, Thor, AP1, HYTEN

McMotor = McCarthy Scales of Children's Abilities--Motor Score
SBAVR = Stanford-Binet Abstract-Visual Reasoning
SBQR = Stanford-Binet Quantitative Reasoning
SBSTM = Stanford-Binet Short-Term Memory
SBTOT = Stanford-Binet Total Score (IQ)
AP1 = 1 Minute APGAR Score
ANEM = Anemia
AP1 = 1 Minute APGAR Score
HONAT = Hyponatremia
HYTEN = Hypertension
THOR = Pneumothorax
GA = Gestational Age
AP = Apnea
ET = Number Exchange Transfusions
HYNAT = Hypernatremia
SD = Seizure Disorder

Table E-24

Observed and Adjusted Means for Outcome Measures (LBW vs. NBW)

	LBW		NBW	
Outcome Measures	Obs.	Adj.	Obs.	Adj.
McMotor	43.92	45.89	46.31	44.34
SBVR	92.00	93.69	102.92	101.23
SBAVR	95.42	96.78	94.08	92.72
SBQR	93.42	94.81	96.77	95.38
SBSTM	84.42	86.49	102.85	100.77
SBTOT	88.75	92.15	99.00	95.60

Analysis of Covariance Results (LBW vs. NBW)

	MS	F	Sig. of F	Covariates
McMotor	10.51	.16	.690	ANEM, AP
SBVR	196.30	1.00	.329	AP1
SBAVR	63.35	.78	.388	ET
SBQR	1.66	.01	.928	Sex, AP
SBSTM	1061.26	3.08	.094	SD, HYNAT, Sex
SBTOT	37.80	.38	.544	Sex, Thor, AP1

McMotor = McCarthy Scales of Children's Abilities--Motor Score
SBAVR = Stanford-Binet Abstract-Visual Reasoning
SBQR = Stanford-Binet Quantitative Reasoning
SBSTM = Stanford-Binet Short-Term Memory
SBTOT = Stanford-Binet Total Score (IQ)
AP1 = 1 Minute APGAR Score
ANEM = Anemia
AP1 = 1 Minute APGAR Score
HONAT = Hyponatremia
HYTEN = Hypertension
THOR = Pneumothorax
GA = Gestational Age
AP = Apnea
ET = Number Exchange Transfusions
HYNAT = Hypernatremia
SD = Seizure Disorder

Appendix F

Definition of Medical Terms

APGAR:

A system of coding an infant's medical conditions. The coding is performed at one and five minutes post birth and includes the variables of heart rate, respiration, muscle tone, color and stimuli response.

Apnea:

Periods in which an infant stops breathing.

Anemia:

A condition in which the red blood cell count in the blood is less than normal.

Birth Asphyxia:

Impaired or absent supply of oxygen to an infant during birth.

Bronchopulmonary Dysplasia:

Abnormal tissue development in the bronchial tubes and lungs.

Hyaline Membrane Disease:

A disease in the lining of the lung, which is characterized by the translucent appearance of the membrane in the lungs.

Hydrocephalus:

A condition in which there is an excessive accumulation of fluid in the ventricles, resulting in dialation of the ventricles and subsequent thinning of the cortex and separation of the cranial bones.

Hyperbilirubinemia:

A high level of bilirubin (bile pigent) in the blood.

Hypercalcemia:

An abnormally high concentration of calcium in the blood.

Hyperglycemia:

An abnormally high level of sugar in the blood.

Hypernatremia:

An abnormally high level of sodium in the blood.

Hypertension:

High Blood Pressure.

Hypocalcemia:

An abnormally low concentration of calcium in the blood.

Hypoglycemia:

An abnormally low level of blood sugar.

Hyponatremia:

An abnomally low level of sodium in the blood.

Hypotension:

Low blood pressure.

Metabolic Acidosis:

A decreased Ph and bicarbonate concentration in the fluids of the body, possibly caused by the accumulation of excess acids, or losses of Ph from the body due to diarrhea or renal disease.

Lumbar Puncture:

A procedure in which the spinal cord is punctured in order to relieve pressure on the cortex.

Patent Ductus Arteriosus:

The failure of an opening in the infant's heart to close after birth.

Pneumothorax:

The presence of air or gas in the pleural cavity.

Porencephalic Cyst:

A cyst which develops on the cavity of the ventricles.

Pulmonary Interstitial Emphysema:

A rupturing of the air cells in the lungs, resulting in air in the pulmonary tissues and the connective tissues.

Respiratory Distess Syndrome:

Hyline membrane disease of the newborn.

Retrolental:

An abnormal increase in non-neoplastic fibrous tissue posterior to the lenses of the eye.

Thrombocytosis:

An increase in the number of platelets in the blood.

Ventriculoperitoneal Shunt:

A tube is placed in the ventricle, usually from the third ventricle to the subarachnoid space to relieve hydrocephalus.

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