

The developmental motor outcomes of infants with Hypoxic Ischaemic Encephalopathy II and III between the ages of 12-14 months at Chris Hani Baragwanath Academic Hospital

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Declaration

I, Neelam Sukha, declare that this research report is my own work. It is being submitted for the degree of Master of Science in Occupational Therapy in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

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Abstract

This study determined outcomes for motor developmental delay in infants, 12-14 months, diagnosed with HIE II and III, at Chris Hani Baragwanath Academic Hospital. Twenty nine infants diagnosed with HIE II and nine infants diagnosed with HIE III were assessed using the Peabody Development Motor Scale- 2, at their corrected age.

Demographic, antenatal and perinatal factors similar to those in other studies were found for this sample. Infants with HIE III had significantly more developmental delay ($p=0.01$) than infants with HIE II. Fifty two percent of infants with HIE II had no delay while a 100% of infants with HIE III presented with disability. A greater percentage of infants had delay in fine motor skills.

Infants with severe and moderate disabilities were receiving intervention whereas those mild disabilities were often missed in screening clinics. It is vital to ensure these infants are assessed and followed up to remediate difficulties as soon as they arise.

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Table of Contents

Declaration	ii
Abstract	iii
Acknowledgements.....	iv
Table of Contents	v
List of Tables	ix
List of Figures	x
Operational Definitions	xi
Abbreviations	xii
CHAPTER 1:	1
INTRODUCTION.....	1
1.1 INTRODUCTION	1
1.2 STATEMENT OF THE PROBLEM	2
1.3 THE PURPOSE OF THE STUDY	3
1.4 AIM OF THE STUDY	3
1.4.1 Objectives of the study	3
1.5 JUSTIFICATION FOR THE STUDY:	4
CHAPTER 2	5
REVIEW OF THE LITERATURE	5
2.1 HYPOXIC-ISCHAEMIC ENCEPHALOPATHY.....	5
2.1.1 Signs and symptoms of Hypoxic-ischaemic encephalopathy	6
2.1.2 Initial medical treatment for Hypoxic-ischaemic encephalopathy	8
2.1.3 Outcomes in Hypoxic-ischaemic encephalopathy	9
2.2 MOTOR DEVELOPMENT AND ITS IMPORTANCE IN INFANTS WITH HYPOXIC-ISCHAEMIC ENCEPHALOPATHY	10
2.2.1 The importance of motor development.....	11
2.2.2 Gross motor development	12
2.2.3 Fine Motor Development	12
2.2.4 Visual perception.....	13
2.3 EARLY INTERVENTION FOR INFANTS WITH HYPOXIC-ISCHAEMIC ENCEPHALOPATHY.....	14
2.4 ASSESSMENT OF INFANTS WITH HYPOXIC-ISCHAEMIC ENCEPHALOPATHY.....	15
2.4.1 Peabody Development Motor Scale 2 nd edition (PDMS 2)	15
2.5 FACTORS TO BE CONSIDERED IN THE EFFECTIVENESS OF OCCUPATIONAL THERAPY INTERVENTION OF CHILDREN WITH HYPOXIC- ISCHAEMIC ENCEPHALOPATHY	17
2.5.1 Treatment of motor deficits in Intervention of Children with Hypoxic- Ischaemic Encephalopathy	18

2.6 SUMMARY	19
CHAPTER 3	21
RESEARCH METHODOLOGY	21
3.1 RESEARCH DESIGN	21
3.2 STUDY SAMPLE	21
3.2.1 Study population	21
3.2.2 Selection of Participants	22
3.2.3 Sample Size	23
3.3. MEASUREMENT TECHNIQUES	23
3.3.1 Background Information Questionnaire	23
3.3.2 Peabody Development Motor Scale (PDMS)	24
3.3.2.1 Scoring of the PDMS-2	25
3.4 RESEARCH PROCEDURE	26
3.4.1 Data Collection	26
3.4.2 Ethical Considerations	27
3.5 DATA ANALYSIS	28
CHAPTER 4	30
RESULTS	30
4.1 DEMOGRAPHICS	30
4.1.1 Demographics-infant participants	30
4.1.1.1 Age and Gender	30
4.1.1.2 Birth weight	31
4.1.2 Demographics - mother	32
4.1.2.1 Age	32
4.2 BIRTH HISTORY	32
4.2.1 Gestation and type of delivery	32
4.2.2 Hospitalization after birth	33
4.3 INFANTS MEDICAL HISTORY	34
4.3.1 Diagnosis at birth	34
4.3.2 Intervention at and after birth	35
4.4 MOTOR FUNCTION MEASURED ON THE PEABODY DEVELOPMENT MOTOR SCALE 2(PDMS-2)	36
4.4.1 Subtests of the Peabody Development Motor Scale -2	36
4.4.1.1 Total Sample	36
4.4.2.2 Levels of disability for the total group on the subtests of the Peabody Development Motor Scale-2	37

4.4.2 Infants with HIE II and HIE III	39
4.4.2.1 Subtests of the Peabody Development Motor Scale-2	39
4.4.2.2 Levels of disability for the total group and infants with HIE II and HIE III on the Subtests of the Peabody Development Motor Scale-2	41
4.4.2 Motor Quotients of the Peabody Development Motor Scale -2	43
4.4.2.1 Total Sample	43
4.4.2.2 HIE II and HIE III Groups	45
4.5 RELIABILITY OF THE PEABODY DEVELOPMENT MOTOR SCALE-2	49
4.6 SUMMARY	49
CHAPTER 5	51
DISCUSSION	51
5.1 INTRODUCTION	51
5.2 FACTORS ASSOCIATED WITH HYPOXIC ISCHAEMIC ENCEPHALOPATHY IN THIS STUDY	51
5.2.1 Infants Demographics	51
5.2.2. Antenatal and perinatal factors	53
5.2.3 Medical History	54
5.3 MOTOR DEVELOPMENT	56
5.3.1 Overall total motor outcomes	56
5.3.2 Gross Motor Outcomes	58
5.3.3 Fine Motor Outcomes	61
5.4 RECOMMENDATIONS FOR AN INTERVENTION PROGRAMME	63
5.5 LIMITATIONS OF THE STUDY	66
5.6 SUMMARY	67
CHAPTER 6	69
CONCLUSION	69
6.1 RECOMMENDATIONS	70
REFERENCES	71
APPENDIX A	77
Background Information Sheet	77
APPENDIX B	79
Personal contact Details	79
APPENDIX C	80
Peabody Developmental Scales Assessment Form	80
APPENDIX D	86
APPENDIX E	88
Ethical Clearance Certificate	88
APPENDIX F	89

Information sheet	89
Informed Consent form:	90

List of Tables

Table 4.1. Age and Gender of the infant participants (n=38)	30
Table 4.2. Age of mothers (n=38).....	32
Table 4.3: Gestation and type of delivery	33
Table 4.4: Diagnosis at birth.....	35
Table 4.5: Rehabilitation Intervention received	36
Table 4.6: Summary of standard scores for the Peabody Development Motor Scale - 2 for total sample (n =38).....	37
Table 4.7 Level of disability on the Peabody Development Motor Scale -2 for total sample (n =38)	38
Table 4.8: Summary of standard scores and z scores for the subtests of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups	40
Table 4.9: Levels of disability based on the z scores for the subtests of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups	41
Table 4.10: Summary of standard scores for the quotients of the Peabody Development Motor Scale 2 for total sample (n=38)	43
Table 4.11 Level of disability on the Peabody Development Motor Scale -2 for total sample (n =38)	43
Table 4.12 Summary of standard scores and z scores for the quotients of the Peabody Development Motor Scale 2 for the HIE II and HIE III groups	45
Table 4.13 Levels of disability based on the z scores for the quotients of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups	46
Table 4.14 Cronbach alpha scores for the Peabody Development Motor Scale-2 for the total sample (n=38).....	49

List of Figures

Figure 4.1 Birth weight of the total sample (n= 38)	31
Figure 4.2 Comparison of the weeks of hospitalisation for the infants with HEI II (n=29) and HEI III (n=9).....	33
Figure 4.3: Distribution of HIEII and HIE III diagnosis (n=38)	34
Figure 4.4: Level of disability on the Peabody Development Motor Scale -2 for total sample (n =38)	39
Figure 4.5: Comparison of mean scores on the Peabody Development Motor Scale - 2 Subtests for the HEI II (n=29) and HEI III (n=9) groups.....	40
Figure 4.6: Level of disability on the Peabody Development Motor Scale -2 for the subtests of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups	42
Figure 4.7 Level of disability on the Peabody Development Motor Scale -2 for total sample (n =38)	45
Figure 4.8: Comparison of quotients on the Peabody Development Motor Scale -2 in infants with HEI II (n=29) and HEI III (n=9).....	46
Figure 4.9: Levels of disability based on the z scores for the quotients of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups	48

Operational Definitions

- **Hypoxic Ischaemic Encephalopathy (HIE)** : Clinical syndrome that causes disturbances in neurological function and is manifested by poor respiratory patterns, decreased tone and poor reflexes ,poor feeding patterns, changes in level of consciousness and seizures(1,2).
- **Occupational therapy** uses meaningful activities to assist patients with a range of problems to maximize their functioning. This empowers patients to be as independent as possible and to experience dignity and a good quality of life at work at home and at play (3)
- **Cerebral Palsy (CP)** “a group of disorders of movement and posture, causing activity limitations that are attributed to non-progressive disturbances that occurred in the developing foetal or infant brain” (4).
- **Neonatal follow up clinic (NNFUC):** Is a multi-disciplinary clinic run by occupational therapists, physiotherapists and speech therapists in order to screen development of high risk infants.
- **Peabody Developmental Motor Scales (PDMS-2):** Is a standardized motor assessment that is used to assess motor abilities in early childhood (5).

Abbreviations

AIMS - Alberta Infant Motor Scale

BA - Birth Asphyxia

BSID-II - Bayley Scales of Infant Development II

CP - Cerebral Palsy

CT - Computed Tomography

FCP – Family centred Practice

HIE – Hypoxic Ischaemic Encephalopathy

M-ABC - Movement Assessment Battery for Children

MRI - magnetic resonance imaging

NDT – Neurodevelopmental Therapy

PDMS–2 – Peabody Developmental Motor Scales – Second edition

TMQ – Total motor quotient

GMQ- Gross motor quotient

FMQ- Fine motor quotient

VMI - Visual motor integration

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Hypoxic-ischaemic encephalopathy (HIE) is caused by severe or persistent birth asphyxia in infants. Birth asphyxia (BA) occurs when there is poor gaseous exchange during the perinatal period. It is defined as foetal or neonatal hypoxia. If asphyxia is severe or persistent it can result in death or hypoxic-ischaemic brain injury presenting as encephalopathy in the early neonatal period (6).

Hypoxic-ischaemic encephalopathy is the abnormal behavioural state that can be seen in an infant in the early neonatal period. During a perinatal hospitalisation a study in Nepal found that 94% of infants diagnosed with HIE presented with tone abnormalities, sucking ability was poor in 32% and 19% presented with problems with consciousness (1).

The condition is associated with long term delayed developmental outcomes and is more prevalent in developing countries (1). Infants that survive present with different severities and the condition often leads to severe neurological impairment resulting in cerebral palsy (6). Previous follow up studies have shown the children with mild encephalopathy or HIE I are likely to be free of disability but those with moderate encephalopathy HIE II have a disability rate up to 25% with both neurological and developmental dysfunction. The majority of infants presenting with severe encephalopathy or HIE III usually have multiple disabilities (1).

Developmental delay in language as well as the motor and cognitive areas has been related to the severity of the HIE as well as other perinatal and social factors. The infants that present with cerebral palsy will require social support and health care which as well as special schooling in order to reach the potential they have for participation in their occupational performance areas (7). Infants with HIE II and III are

therefore referred for rehabilitation and occupational therapy which provide intervention for these children (8).

1.2 STATEMENT OF THE PROBLEM

Studies in developing countries on the follow up of infants with HIE indicate that the majority of those diagnosed with HIE II and HIE III present with major or minor motor disabilities at the age of one year(1)(2). The treatment of choice for these infants is early intervention for developmental delay with the United Nations Children's Fund (UNICEF) indicating that the most favourable time for intervention is from birth to three years (9). However, the type and implementation of the intervention provided is crucial (10).

As with other developing countries (11) infants at Chris Hani Baragwanath Academic Hospital (CHBAH) are enrolled in an early an intervention programme where families bring them at regular intervals for medical care and nutrition assessment. The assessment of developmental delay and parental education with regard to stimulation is provided by the allied medical services which include occupational therapy, but these programs are not structured and are subjective to each individual therapist.

Because of the socioeconomic circumstances of most of the parents of infants with HIE attending the early intervention programme and limited services available at the hospital, the infants are usually seen at monthly appointments and are provided with a verbal home programme in occupational therapy. Therefore therapy services for infants with HIE II and III, referred from the neonatal clinic to occupational therapy at CHBAH, need to be as effective as possible.

Before these services can be evaluated however it is important to understand how severely the infants are affected and what the deficits they present with in the South African population, so that best practice therapy services can be planned and implemented.

1.3 THE PURPOSE OF THE STUDY

Approximately 70 infants presenting with HIE II and III are referred for occupational therapy at CHBAH during a one-year period. While data regarding motor outcomes of infants with HIE II and III has been documented in other developing countries this has not been done in South Africa (1,2,11). The purpose of the study is therefore to determine the developmental motor outcomes of infants with HIE II and III at CHBAH.

Once the results are obtained it will be important for the paediatric occupational therapy department to use the information gathered to ensure the most effective programs are implemented to maximise these infant's early development.

1.4 AIM OF THE STUDY

To determine the extent of gross and fine motor developmental delay in infants diagnosed with HIE II and III between 12-14 months, seen at Neonate Clinic and referred to occupational therapy at CHBAH in Soweto.

1.4.1 Objectives of the study

- To describe the sample of infants with HIE II and III seen at CHBAH.
- To establish the gross and fine motor developmental level or outcomes of infants who have been diagnosed with HIE II and III using the Peabody Development Motor Scale 2nd edition (PDMS-2).
- To identify the factors such as maternal age, type of delivery, gestation period, gender and period of hospitalization that are related to motor outcomes that need to be considered in the formulation of appropriate occupational therapy home programmes for infants with HIE II and III.

1.5 JUSTIFICATION FOR THE STUDY:

The first 12-14 months is an important period for the development of motor performance skills. Occupational therapists are aware that the development of these motor skills is essential for the child to develop sensori-perceptual and cognitive performance skills and to allow them to become proficient in the occupational performance areas (7).

At CHBAH inpatient treatment sessions or frequent outpatient sessions for infants with HIE II and III in occupational therapy, are unrealistic due to increased workloads and financial constraints. The infants referred are seen as outpatients on a monthly basis and provided with verbal home programmes given by their individual therapists. This research will provide information on the development of these infants and further it may assist in developing and providing appropriate formal occupational therapy home programmes for these infants. Knowing the expected motor outcomes of infants diagnosed with HIE II and III between 12-14 months should provide the therapists with information which can optimize communication between the occupational therapists and the infants' families as well as allow for the most efficient use of therapeutic resources available.

CHAPTER 2

REVIEW OF THE LITERATURE

This literature review will include a description of HIE, the signs and symptoms as well as the severity and effects of this condition. The need for and factors relate to early intervention for HIE in occupational therapy are also reviewed. The motor developments that can be expected at 12-14 months of age and the assessment of this development are reviewed as well as occupational therapy programmes for motor delay in young children.

2.1 HYPOXIC-ISCHAEMIC ENCEPHALOPATHY

Perinatal asphyxia occurs when there is poor gaseous exchange during the perinatal period and is accompanied by the infant presenting with a metabolic acidosis (12). If asphyxia is severe or persistent it can result in hypoxic ischaemic brain injury presenting as encephalopathy in the early neonatal period, and result in a clinical syndrome called hypoxic- ischaemic encephalopathy or HIE (6).

Hypoxic-ischaemic encephalopathy causes disturbances in neurological function and is manifested by poor respiratory patterns, decreased tone and poor reflexes, poor feeding patterns, changes in level of consciousness and seizures (12,13).

Significant antenatal risk factors associated with HIE according to Ellis, Shresthra, Shresthra, Manandhar, Bolam and de L Costello, are high maternal age of more than 35 years and prim parity. They found no association between birth weight and encephalopathy but males were more at risk and although this factor was not independently significant in their Nepal study but it was in an Australian study by Badawi, Kurinczuk, Keogh, Alessandri, O'Sullivan, Burton et al. Twins or plural births presented significant risk in both studies (1)(14). The association between type of delivery and HIE is not clear. Badawi et al also found that instrumental vaginal delivery and emergency caesarean section had twice the increased risk of

encephalopathy relative to spontaneous vaginal delivery.(15) In the perinatal period HIE is associated with multi-organ injury, pulmonary, cardiac, renal and gastrointestinal dysfunction, and infectious diseases (15).

Hypoxic-ischaemic encephalopathy is of great clinical concern as it can lead to death and neurological damage which can result in cerebral palsy (6). This condition is diagnosed by reviewing the Apgar scores, the presence of seizures, cord blood acidosis and clinical signs associated with the central nervous system (2). An infant can be diagnosed as having grade HIE I, II or III according to their neurobehavioral state in the first few days of life (1).

2.1.1 Signs and symptoms of Hypoxic-ischaemic encephalopathy

Infants who present with HIE I are often irritable or hyper alert, they have mild tone changes, exaggerated primitive reflexes, normal brainstem reflexes but do not present with seizures and tachypnoea. Infants diagnosed with HIE II or moderate encephalopathy are lethargic, have moderate abnormal tone, have poor sucking ability, depressed primitive reflexes and normal brainstem reflexes. They may have seizures and the occasional apnoeas. In a study of infants with HIE II, it was found that half the infants developed normally while the other half, were diagnosed with Cerebral Palsy (CP) (1).

Thus according to Lindstrom, Hallberg, Blennow, Wolff, Fernell and Westgren there is continuum with respect to neurodevelopmental outcomes depending on the severity of infants with HIE II (16). Severe encephalopathy or HIE III manifests as a comatose infant, with severely abnormal tone, absent sucking ability and primitive reflexes, impaired brainstem reflexes and the presence of seizures and severe apnoea(1). Hypoxic ischaemic encephalopathy is often used to predict neurodevelopmental outcomes but this differs according to the individual grades (12). Infants diagnosed with HIE III may present with severe or dyskinetic cerebral palsy as they have had an “acute near total type of asphyxia” and present with MRI abnormalities in the cerebral cortex, basal ganglia, brainstem and thalamic areas (17). It has also been shown that

these infants may present with seizures have poorer fine motor skills and a lower IQ. (8)

There is strong correlation between the HIE score and neonatal seizures. It has also been noted that neonatal seizures are associated with worse neurodevelopmental outcomes in children with hypoxic ischaemic encephalopathy (17). A report in a Cochrane Review advised anticonvulsant therapy should be used for the treatment of prolonged or frequent clinical seizures, as if they are not controlled the seizures contribute to poor neurodevelopmental outcome. (22)

It has been noted however that the medical management of the control of seizures in HIE infants is difficult and thus these infants are at further risk, as Faye and Silverstein showed that after a four year follow up assessment, children who experienced neonatal seizures had a lower intelligence scale and higher rate of abnormal neurological findings. (18). In a study in Tanzania it was found that that the risk of having convulsions was three times higher among infants with severe HIE although the risk was only double in moderate HIE compared to infants with mild HIE scores. This study also noted that neurodevelopmental abnormalities were detected in infants at the age of six months (2).

Many studies on neurodevelopment outcomes of HIE at an early age have reflected on measures like seizures, abnormal muscle tone, delayed developmental milestones and cerebral palsy indicating the strong link between HIE and cerebral lesions. It is vital to stage the degree of encephalopathy as this is important for management of the infant and for prediction of long term outcomes for the neonate (18). Cerebral damage can be monitored in infants by the use of Computed Tomography (CT), scans, magnetic resonance imaging (MRI), cerebral function monitoring, cranial ultrasonography and Doppler ultrasonography (2). Because the technologies used to determine cerebral damage during perinatal period and predict the neurological outcome of HIE are not readily available in developing countries an HIE scoring system is used to identify and classify HIE at birth. The HIE score is used as a clinical tool and assesses the status of a child following birth asphyxia. The score consists of

a set of clinical signs which are assessed in relation to central nervous system (CNS) dysfunction. There are various HIE scoring systems which have been researched and they have been noted to be highly specific in detecting the degree of disability in infants (2). The most commonly used is the Sarnat score although there is a score that was developed in South Africa based on the Sarnat score and that is used as well (19,20). The Sarnat score allows clinicians to classify the grade of HIE that an infant is diagnosed with. The Sarnat scoring system looks at the infants' level of consciousness, muscle tone, complex reflexes and seizures within the first 12-36 hours of life (16) (13).

In five studies it was found that the incidence of severe neurological impairment and death was 50-100% in HIE III, 15-25% in HIE II and no deaths or severe disabilities was reported in HIE I (8). According to Velaphi and Patterson (2007) HIE accounts for nearly 60% of neonatal deaths in South Africa (6).

2.1.2 Initial medical treatment for Hypoxic-ischaemic encephalopathy

Hypothermia within the first day of life is the only therapeutic intervention that shows decrease in mortality and disability among neonates with moderate and severe Hypoxic ischaemic encephalopathy and is sited as best practice for this condition (13). Hypothermia slows down the cerebral metabolism thereby providing a neuroprotective intervention and decreasing the risk of neurodevelopmental sequelae (13)(18). Research shows increasing evidence that hypothermia reduces brain injury caused during the early neonatal period (21). A study by Shankaran, Pappas, Laptook, McDonald, Ehrenkranz, Tyson, et al, compared two groups of infants; one group underwent therapeutic hypothermia and the other was a control group showed a consistent decrease in severe disability in the group that underwent therapeutic hypothermia. The study showed a 68% reduction in death and disability in infants with HIE II and 28% reduction in infants with HIE III. However this article noted that cooling should be carried out in the first 72 hours of life (21).

Total body cooling takes place in the first 72 hours of life at a temperature of 33.5⁰ C and infants' are then rewarmed at 0.5 degrees every hour for 6 hours (21). This

procedure is thus time consuming and requires increased resources. As Velaphi and Pattinson reported administrative procedures in metropolitan hospitals are related to death and birth asphyxia in the neonate and not all infants diagnosed with HIE II AND III are cooled in the South African setting (6)

2.1.3 Outcomes in Hypoxic-ischaemic encephalopathy

A study carried out in by Garbutt and Trotman in the West Indies in neonatal units showed that infants diagnosed with HIE III had increased neurological deficits compared to those diagnosed with HIE I or II (18). In Nepal Ellis et al found that of the 131 infants with HIE, of the 57 infants that survived to one year, 20% had neurological impairments; of this 20%,18 infants were reported to have major impairment, 14 (78%) had spastic quadriplegic cerebral palsy and 8 (44%) had multiple impairments (1). These findings confirmed those of Thornberg, Thiringer, Odeback and Mislom in Sweden who also reported that infants with HIE III either died or had severe neurological deficits (22). Infants with HIE II have been found to have milder forms of cerebral palsy present with distinct or fewer areas of damage in the brain (12).

Two studies performed in low income countries that noted between 23% and 82% of children with moderate neonatal encephalopathy were diagnosed with cerebral palsy and were severely delayed in all areas (12). Since HIE in the perinatal period is a primary cause of cerebral palsy (13) this results in higher numbers of disabled children in these low income countries (12,18).

A study by Mwakyusa, Manji and Massaw in Zambia in 2009, found that 31% of the surviving infants with birth asphyxia had abnormal neurological findings at a four week follow up period (2). This is congruent with a reported incidence of HIE in developed countries at 1.5 per 1,000 live births in comparison to developing countries where it ranges from 2.3 to 26.5 per 1,000 live births (23). As for these developing countries the incidence of HIE has been found to be higher in South Africa, with contributing factors being both inadequate health services and so a smaller extent factors related to the mother not seeking care in time (6). It has been documented

that the incidence of HIE in South Africa is 4.6 per thousand live births (18) with many children surviving with moderate-to severe encephalopathy which is graded at birth.

Birth asphyxia resulting in HIE II or III places infants at risk for developmental delay and this can manifest as motor and cognitive deficits. Other studies have also found deficits in the visual and auditory systems, sensory motor difficulties and language processing delays (8,12,24). Children with HIE II particularly demonstrated deficits in the areas of visual motor integration, language and vocabulary (12).

Behavioural difficulties are also associated with infants with HIE (12). It has been noted that children with moderate encephalopathy often present with hyperactivity and thus experience learning difficulties at a preschool age (12). A study in Sweden noted that children with physical neurological impairments are easily detected, but children with subtle or cognitive impairments which develop later are often missed (16).

Initially in the first year the motor dysfunction has the greatest effect on development and therefore an understanding of this development is important for occupational therapist as they allow for evaluation and treatment of skills at different age bands.

2.2 MOTOR DEVELOPMENT AND ITS IMPORTANCE IN INFANTS WITH HYPOXIC-ISCHAEMIC ENCEPHALOPATHY

Early research by Gesell showed that normal development was sequential and took place as the central nervous system matured. Other theorists such as Piaget and Vygotsky emphasized the importance of the child's environment and social interactions as vital factors to consider during childhood development (7). It is thus noted that motor development is a complex process and can be influenced by many factors (25).

A study carried out by van Schie, Becher, Dallmeijer, Barkhof, van Weissenbruch and Vermeulen in Amsterdam however showed that the probability of poor motor outcomes increased in infants diagnosed with HIE II at the age of one year. Their research also indicated motor testing at the age of one can be prediction of outcomes

later in life (26). This was supported by Garbutt and Trotman who showed that a significantly higher number of infants at the age one diagnosed with HIE II and III had delayed motor milestones (18). In her assessment of the motor outcomes of 32 infants, at one year of age, with HIE II van Schie et al found 14 infants showed significant motor delays when assessed with the Alberta Infant Motor Scales (AIMS). When the same infants were assessed the Bayley Scales of Infant Development II (BSID-II) only nine presenting with severe delay (26). Since the AIMS only measures gross motor outcomes and the BSID-II measures both fine and gross motor as well as behavioural and mental outcomes these results may indicate that the gross motor capacity is more affected than the other aspects measured by the BSID-II. Allemand, Reale, and Sposato in an Italian study on the motor outcomes of infants with HIE found that 38% of their participants presented with CP at one year of age with the 25% having moderate disability being able to walk at the age two years. (27)

Even when children with HIE without a major disability were examined at eight and 15 years by Perez, Ritter, Brotschi, Werner, Caflisch, Martin et al in Switzerland they were found to have significant associated movement, gross motor and fine motor deficits. Only scores for static balance were within normal limits and their fine motor scores were lower than those for gross motor skills (28).

2.2.1 The importance of motor development

In the first six months of life infants engage in exploratory and social play (7). Their motor behaviours are characterized by variation and exploration (25). They enjoy playing with their hands at midline and transfer objects from one hand to the next. Their visual system plays a big role during this time as they focus and track objects in their environment as they are still learning to reach and grasp toys (7).

Research shows that from the age of six months adaptive motor development occurs (25). Between six to 12 months the infant develops the ability to move around in their environment and they start to use their hands to control and manipulate objects in their environment (7).

2.2.2 Gross motor development

As development occurs in sequential pattern it is known that gross motor activity begins prenatally (7). The new-borns first movements are reflexive and these actions contribute to processing and integrating information from the environment. In the prone the position the infant initially moves his head from side to side, by four months he is able to lift his head and visualize objects in the environment. At six months the infant is able weight bear through his upper limbs and can free one hand to grasp an object. This is the first step towards becoming mobile. At four months they have good head control and move their heads from side to side. Infants enjoy sitting at a young age and by the age of six months they begin to sit using their upper limbs for support and have a wide base of support. They begin to sit independently at the age of seven months and use their hands to play with toys within their base of support. Infants enjoy standing and bouncing with their parents support from the age of five months. This prepares the child upright independent standing posture at the age of one year (7).

The first method of exploring the environment physically is rolling. The infant is able to roll sequentially with dissociation by the age of six months. At the age of eight to nine months a child is able to transition from lying to sitting using his upper limbs to aid him. Thus at seven months a child begin to creep using his whole body together. Infants are able to crawl rapidly with skill by the age of ten months and thus explore a variety of environments with this movement. A ten-month-old child enjoys pulling to stand using various surfaces such as furniture and their parents' laps. The child then learns to shift his body weight to cruise along furniture which eventually independent walking at the age 12 to 14 months (7).

2.2.3 Fine Motor Development

Infants begin exploring their hands at an early age and the grasp reflex is present at birth in which the automatically close their fingers around an object placed in their palm. The first methods of voluntary grasp occur at the age of three months where the infant swipes at objects in his immediate environment, with a grasp that is mostly

inaccurate. (7) Accuracy of the grasp improves by five months but the child is unable to coordinate reach and grasp together. During this period they use a palmar pinch to hold objects in place with their fingers and thumb. By the age of six months a child has a more coordinated grasp and the infant is able to reach for an object that he or she wants using a radial palmar grasp which involves the first two fingers and the thumb to hold an object. The child will also use a raking motion of the fingers to acquire smaller objects.

A child develops voluntary release at eight months but his movement is uncoordinated and the child extends all his fingers to release an object. As the child becomes more stable the fine motor pinches become refined and by seven months the child uses his thumb, middle and index fingers to grasp object, this is known as a radial digital grasp. The nine-month-old infant will use his fingertips more often to grasp objects within his reach. A pincer grasp develops at around 10 to 11 months during which the child holds smaller objects between his thumb and finger pads. At this age the child is also able to release objects into container and this more controlled and coordinated (7).

By the age of one-year infants use a variety of grasps to interact with objects in their surroundings. They often use a pincer grip to grasp very small objects and this involves opposing the thumb to the index finger. They also use both hands to perform a variety of activities. The young child uses one hand in stabilizing position and the other to manipulate objects. Infants develop control over the intrinsic muscles in the hand between 12- 15 months and hold a variety of different objects including those that are flat (7).

2.2.4 Visual perception

Visual perception is important when assessing an infant as it impacts on all areas of development. The visual system plays an important role in the development of these skills. From the age of two months infants are able to accommodate, converge and follow objects. Their oculomotor control continues to develop until they are 5 years old. Infants develop visual perceptual abilities early on as they produce responses to

patterns and human faces , these include skills of pattern recognition, form constancy and depth perception (7).

It has been noted that these infants with motor delays have difficulty processing sensory information, thus they have difficulty adapting motor behaviour (25). Delayed motor development affects a child's ability to explore the environment and resulting in poor social skills and decreased independence in activities of daily living (29).

Since Cerebral palsy (CP) is one of the most common difficulties found in infants with HIE the assessment and treatment of motor dysfunction is one of the priorities (29). The diagnosis of Cerebral palsy is usually made the first 12 to 18 months of an infant's life as the infants with HIE fail to reach their motor milestones and present with poor gross motor function and signs of abnormal muscle tone (29).

2.3 EARLY INTERVENTION FOR INFANTS WITH HYPOXIC-ISCHAEMIC ENCEPHALOPATHY

Literature indicates that neurological deficits should be identified early in infants with in with HIE II and III for long-term therapy implementation (8) with early evaluations providing an indication of the problems for appropriate intervention and rehabilitation planning. Research shows evaluation of long-term sequelae should be done at 18 months, but there is evidence of disabilities in early infancy, so it has been suggested that neurodevelopmental screenings at an even earlier stage can provide an indication of later outcomes and result in the implementation of appropriate interventions sooner. It is noted that early intervention is important for improvement in both cognitive and motor functioning (24).

It was been shown that these infants benefit from rehabilitation therapy at hospitals, community clinics and eventually at schools. The therapy needs to be extended into the home to be carried out with the child's family in order maximise the child's development (7). Early prediction of outcomes allows for rehabilitative measures to be instituted and to facilitate parental counselling (2,26).

van Schie et al in their study on infants diagnosed with HIE indicated that assessment of motor development is useful predictor outcomes in terms of movement outcomes and emphasised it should be done at an early age. Lekskulchai and Cole reported that early intervention plays an important role in promoting further development (30).

Occupational therapy is one of the services from which these children with HIE benefit from and intervention focuses on improving a child's motor ability to interact with his environment and carry out activities of daily living (7). Occupational therapy provides early intervention as the most critical period of a child's development is between birth and three years. (7).

2.4 ASSESSMENT OF INFANTS WITH HYPOXIC-ISCHAEMIC ENCEPHALOPATHY

Infants diagnosed with HIE referred to occupational therapists are evaluated using a variety of assessments. Published research indicates that the standardised assessments most commonly used are the AIMS, the BSID-II (26) and Peabody Development Motor Scales (PDMS) (31). It is important that an appropriate measure be used for the assessment of motor outcomes to evaluate the change over time and for the setting of realistic goals in therapy. The use of assessments with established norms is important although none of these assessments have been standardised on a South African population. Assessments that assess both fine and gross motor capacity from birth in younger infants are the BSID-II and the PDMS 2 (5). Case – Smith reported that due to features of HIE such as irritability, abnormal tendon reflexes, seizures and tone deficits, these infants will need to be monitored by occupational therapists regarding their development.

2.4.1 Peabody Development Motor Scale 2nd edition (PDMS 2)

The Peabody Development Motor Scale 2nd edition is a norm referenced standardised assessment which is used to assess children from birth to seven years. The test has good content and criterion validity which is supported by correlations

with the balance scores ($r=0.64$), with the locomotor scores ($r=0.52$) and with the non locomotor scores ($r=0.43$) on the BSID II. It has an inter-rater reliability of >0.9 and a test retest reliability of 0.73- 0.96. It is easy to administer and can be completed in a relatively short time (5).

The concurrent validity of the PDMS 2 to an earlier version the PDMS was high with Pearson product-moment correlation coefficients of 0.84 for fine motor and 0.91 for gross motor scales (32). The PDMS has previously been shown to have high concurrent validity with the BSID II for age-equivalent scores, but not for standard scores (33). PDMS- 2 results for the fine motor quotient were compared with the fine motor section Movement Assessment Battery for Children (M-ABC) and convergent validity was confirmed (34). The cut off level used in America making a child eligible for early intervention on this test is a z score of 1.5 SD and there is some indication that the sensitivity of the PDMS 2 may be less than that of the PDMS for young children so they score slightly better on the PDMS 2 (32). Van Hartingsveldt, Cup and Oostendorp in a study on the reliability and validity of the fine motor aspect of the PDMS-2 felt that the test was not sensitive to all fine motor problems (34).

The PDMS 2 was developed to estimate the child's motor abilities, compare gross and fine motor skills, provide qualitative and quantitative data on individual skills, evaluate a child's progress and to be used as a research tool (35).

The subtests of the PDMS 2 include:

- Reflexes: an 8-item subtest measures a child's ability to automatically react to environmental events.
- Stationary: This 30-item subtest measures a child's ability to sustain control of his or her body within its centre of gravity and retain equilibrium.
- Locomotion: This 89-item subtest measures a child's ability to move from one place to another.
- Object Manipulation: This 24-item subtest measures a child's ability to manipulate balls.

- Grasping: This 26-item subtest measures a child's ability to use his or her hands.
- Visual-Motor Integration: This 72-item subtest measures a child's ability to use his or her visual perceptual skills to perform complex eye-hand coordination tasks (5).

Rodger, Brown, and Brown in their Australian study found the PDMS was frequently used to assess children with developmental delays, neurological impairments, learning disabilities and infants and toddlers (36). The PDMS-2 was used by Wang, Liao and Hsieh in Taiwan to assess the reliability, sensitivity to change and responsiveness of the test with children with cerebral palsy from 24 -65 months. The results showed good test-retest reliability of various scales of the PDMS 2 for children with CP over the age of 24 months (31) . Thus the PDMS 2 can be used reliability for the assessment of motor deficits in development for children with CP and for general motor skill acquisition in infants with global developmental delay. The test has been shown to be responsive to change and is therefore useful for monitoring progress intervention for motor delay as well (31)

2.5 FACTORS TO BE CONSIDERED IN THE EFFECTIVENESS OF OCCUPATIONAL THERAPY INTERVENTION OF CHILDREN WITH HYPOXIC-ISCHAEMIC ENCEPHALOPATHY

Occupational therapy for infants with HIE consists of the implementation of specifically designed programmes that enhance an infant's development in their daily environments (7). The most effective approaches used in paediatric occupational therapy settings are holistic and client and family centred (36). Family centred practice (FCP) is widely used as it recognises family expertise and focuses therapy on enhancing the caregivers' skills so that development of the child is managed adequately within their home environments.

The most common occupational therapy intervention strategies described by Rogers et al for infants with developmental delays, neurological impairments, learning

disabilities were self-care training skills, caregiver education, positioning, splinting techniques, general handling principles and neuro-developmental techniques. It was noted that improvement was seen when caregivers were compliant with therapy and home programmes provided to them (36). These home programmes should be specifically designed for the context of the family and their daily routines. Structure and clear instructions are important components of the home programmes as it has also been established that children with disabilities require opportunities for repeated practice (31).

2.5.1 Treatment of motor deficits in Intervention of Children with Hypoxic-Ischaemic Encephalopathy

Many different approaches are used to treat children with neurological motor deficits. The developmental skills and neurodevelopmental therapy (NDT) approaches are widely used (37). The NDT approach is used with children who have been diagnosed with CP and is based on handling children with abnormal tone to facilitate automatic reactions to promote normal movement patterns (37).

The developmental skills approach is used with children with global developmental delay and its primary focus is on learning and mastery of normal milestones by targeting specific skills. In this approach children engage in structured play activities to target specific skills (37).

The best practice approach in paediatric rehabilitation is a FCP and takes into account the child's environment, how they learn and how they play (38). This approach allows for communication and coordination and sharing of information between the families and the therapists to decrease stress within the family as well optimize outcomes for the child. This approach allows for practice in a variety of settings throughout in the child's natural environment (38). Research shows that the developmental and NDT approaches yield the same results in children with motor deficits and family centred intervention to ensuring progress of a child (37). It was also evident in research that programmes are more beneficial when therapist works with the caregivers rather than with the child alone. Thus structured home

programmes and parent education should be integrated into developmental follow up programmes (26).

When treating a child five different perspectives that should be considered are prevention, habitation, remediation, compensation and maturation. Case Smith identified these general goals of treatment for occupational therapy with children which include

- Facilitating change in the child's development and function.
- Ensuring improved behavioural responses to stimuli
- Encourage adaption and compensatory mechanisms due to the effects of disability
- Providing family support (7).

It is still noted however that therapist should try to individualize needs as much as possible (7) and that a multidisciplinary team is useful in implementing developmental programmes (26). A study carried out in Thailand by Lekskulchai and Cole showed that greater improvements are noted in children who receive a structured intervention programmes that are carried out at by their caregivers (30). It is also noted that one method of treating motor developmental cannot be exclusively used and that treatment will require modification with regards to different settings (26).

2.6 SUMMARY

As noted above Hypoxic Ischaemic encephalopathy is a complex condition that requires correct diagnosis at an early age to allow for prediction of prognosis and access to the appropriate rehabilitation in order to maximise a child's potential.

Children that have been diagnosed with HIE have a variety of difficulties. These difficulties range from having mild developmental delays to infant that diagnosed with CP which will affect them over their lifespan. Some infants display delays and poor motor control from birth whereas those with mild delays may only be identified later in

their development. It is therefore important that an in depth assessment be carried out when children are followed up so difficulties can be identified as early as possible.

Occupational therapists are one of the professionals in the multidisciplinary team that address the deficits found in children with HIE. They use standardised assessments to determine the dysfunction, including motor dysfunction early in the child's life. Once dysfunction has been established therapists can work together with families remediate these via structured home programmes or specialized intervention using the NDT developmental and family centred approaches.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN

A descriptive quantitative pre-experimental research design was used in the study. Survey and structured observation methods were used to gather information on the dependent variables, the demographics and motor function of infants with HIE. A static group comparison design was used to compare the data for the infants with HIE II and HIE III. The measurement of the performance problems in the motor function of infants with HIE was done using a standardised test, the PDMS-2, so that results could be compared to norms for typical infants, in order to allow for future treatment planning (39).

A cross-sectional design was used by assessing the infants at one time only as this reduced the chance of drop out from the study. Since a non - experimental design was utilized, there no randomisation and no consideration of cause and effect. There was no manipulation of variables and no control group was used as all infants were assessed once at their 12- 14 month follow up appointment at Neonate Follow up Clinic (NNFUC) or neuro - rehabilitation clinic. (39)

3.2 STUDY SAMPLE

3.2.1 Study population

All infants between the ages of 12-14 months whose discharge report from Neonatal Ward at CHBAH, which indicated that they were diagnosed with HIE II or III within their first few days of life were eligible for the study.

The research was conducted at the CHBAH in Johannesburg, South Africa. It was conducted at the neonatal follow up clinic (NNFUC), neuro rehabilitation clinic and in

the occupational therapy department at CHBAH where one could observe an infants' participation in test activities.

3.2.2 Selection of Participants

The entire population of infants was identified from their neonatology discharge summaries and were traced when they returned to CHBAH for follow up visits at Neonatal Follow up Clinic, Occupational Therapy and Neuro Rehabilitation Clinic. All infants that were assessed were currently being managed at NNFUC and referred for assessment to the allied health professions team which made up of an occupational therapist, physiotherapist and speech therapist who work in a trans disciplinary team. Those who were receiving treatment were mostly seen at Neuro Rehabilitation Clinic. These clinics provide services of an occupational therapist, a speech therapist, and a physiotherapist who work in a multi-disciplinary manner. The infants were identified through the researcher confirming their diagnosis on their discharge summaries and thereby assessed by the researcher.

Inclusion criteria

- All infants diagnosed with HIE II and III were included.
- Infants were assessed between the age ranges of 12-14 months.
- Infants born prematurely were considered and were assessed according to their adjusted chronological age. Research suggests that correction of chronological age for the degree of prematurity is the best way to effectively evaluate the gross motor development of preterm infants.(40)

Exclusion criteria

- Infants with other co-morbid conditions (e.g. hydrocephalus, chromosomal abnormalities) were not included in the study. This was established by reviewing the infants' neonatal discharge summaries which indicated their diagnosis at birth.

3.2.3 Sample Size

To survey a population of approximately 70 infants, a sample of 59 participants is required to be representative of the population with the level of acceptable error set at 5% according to the Cochran's sample size formula for categorical data (42). Because the infants with HIE III were to be compared to the infants with HIE II, a difference of a z score of 1SD between the groups on the PDMS 2 was accepted as being significant. Significance was set at $p \leq 0.05$ and thus the sample size was set at 22 participants per group of infants diagnosed with HIE II and HIE III

The study was conducted for just over a year in an attempt to achieve the sample required for the study from March 2011 until July 2012.

3.3. MEASUREMENT TECHNIQUES

3.3.1 Background Information Questionnaire

- Birth history and admission details were obtained from the discharge summary, a structured data collection sheet that is completed routinely for each infant and the infants' Road to Health Chart. The discharge summary included name of the infant, date of birth, their hospital number, address and telephone number of caregiver. This information was recorded on a separate sheet and kept secure by the researcher. (Appendix B) These sheets were matched by code to data collection sheets.
- The data collection sheet (Appendix A) was drawn up by the researcher based on information available in their discharge summaries. It included the infant's gestational age in weeks, whether the infant was full term or premature, birth weight, type of delivery, Apgar scores, medical conditions, the length of the infant's admission and type of ventilation received was recorded onto the background information questionnaire. Although it had been planned to record maternal details such as the size of the of the family in terms of siblings and the socioeconomic status of the family, only the mothers' age was routinely

recorded in the records assessed. The caregivers were able to provide verbal history about their health during the pregnancy and this was subjective.

3.3.2 Peabody Development Motor Scale (PDMS) (Appendix C)

This is a norm referenced standardised assessment which assesses the gross and fine motor skills of infants from birth to seven years. It is easy to administer and can be completed in a relatively 20 to 30 minute period short time. The subtests include:

- Reflexes: an 8-item subtest measures a child's ability to automatically react to environmental events. Only tested in infants less than 12 months of age.
- Stationary: This 30-item subtest measures a child's ability to sustain control of his or her body within its centre of gravity and retain equilibrium. The entry item for children at 12-14 months is kneeling in an upright position for 5 seconds.
- Locomotion: This 89-item subtest measures a child's ability to move from one place to another. The activities analysed are crawling, walking, running, hopping, and jumping. Entry level for a child of 12 months is moving to standing from sitting on the floor.
- Object Manipulation: This 24-item subtest measures a child's ability to manipulate balls. The activities analysed are throwing kicking and catching a ball. This subtest is given only to children ages 12 months and older. The item for 12 -13 months include catching a ball rolled along the floor, rolling a ball on the floor and throwing (flinging) a ball.
- Grasping: This 26-item subtest measures a child's ability to use his or her hands. It begins with ability to hold an object with one hand and progress to actions involving both hands. The entry level item for this subtest is picking up two cubes simultaneously.
- Visual-Motor Integration: This 72-item subtest measures a child's ability to use his or her visual perceptual skills to perform complex eye-hand coordination tasks such as reaching, grasping for objects, and building with blocks and copying design. The entry level items on the VMI subtest for 12 – 14 months includes turning pages in a book, stirring with a spoon, removing pellets from a

bottle, placing cubes in a cup, placing pegs in a pegboard and tapping a spoon on the table.

These items assess infants' according to their chronological age or adjusted age if they were premature. For easy administration of PDMS-2 test, entry/start point, basal level and ceiling level are used for all the subtests. The therapist assesses the child according to the entry level item for their age which 75% of the children in the normative sample at that age passed marked on each subtest in Examiner Record Booklet.(5).

If child does not score 2 on each of the first three items administered from the entry point then the therapist should test backward until child scores 2 on three items in a row. This will be the basal level. A basal level is established when child receives a score of 2 on three successive items in a row.

Once the basal level has been determined, the therapist administers progressively more difficult items until a ceiling is achieved by the child scoring 0 on each of the three items in a row.

As all the children in the study were over the age of 12 months the subtest of reflexes was not assessed. All subtests start at zero or one month and proceed up to 72 months.

3.3.2.1 Scoring of the PDMS-2

The items in PDMS-2 are scored by allocating a 2, 1 or 0. This is done by the examiner who uses the description given at each item and their judgement to allocate the score. The scoring system works as follows

- 2: "child performs the item according to the criteria specified for mastery."
- 1: "The child's performance shows clear resemblance to the item mastery criteria but does not fully meet the criteria"
- 0: "The child cannot or will not attempt the item, or the attempt does not show that the skill is emerging."(5)

All scores obtained on all items below the basal level are assumed to be 2 and any scores of 1 on items before the ceiling level was reached are added to give a raw score.

The test gives 5 different types of scores namely; raw scores, age equivalents, percentiles, standard scores and quotients. According to the authors of the test the standard scores provide the clearest indication of the child's performance in a subtest, thus these scores were used when analysing the data. The quotient scores are the most reliable scores in PDMS 2, as they are the sum of few subtests. Thus the gross motor quotient (GMQ) is made up of the following subtest; stationary, locomotion and object manipulation. The subtests of grasping and visual motor integration form the fine motor quotient (FMQ). All the subtests are then added to create a total motor quotient (TMQ) and this measures overall motor abilities.

3.4 RESEARCH PROCEDURE

The research was carried out at CHBAH at the various clinics in which these infants are followed up. Once ethical clearance had been obtained from the Human Research Ethics Committee at the University of the Witwatersrand, permission was obtained from the Hospital research committee as well as the superintendent of the allied medical disciplines to carry out the study. (Appendix D)

3.4.1 Data Collection

The infants were identified from appointments in the diaries of the various clinics. Infants with high risk are followed up at a neonatal follow up clinic and reviewed monthly by the allied disciplines to establish their strengths and weaknesses. These infants are also followed up by the neonatologists to address all medical concerns.

All 12-14 month old infants identified from the records by the researcher, as having been diagnosed with HIE II and III were assessed at their regular follow up appointments. They were identified at the neonatal follow up clinic or neuro rehabilitation clinic by reviewing their diagnosis in their neonatal discharge

summaries. The caregivers were then approached by the researcher and the study was explained to the caregiver's and they were asked whether they would like to participate or not. Once the caregiver agreed to partake the information consent sheet was provided to the caregiver. As this took place at the time of their regular appointments and it was once off assessment they did not need to return for a follow up assessment. Infants who do not return for follow up appointments were to be contacted telephonically to find out reason for not attending but many the telephone numbers did not exist or were incorrect thus this method was abandoned and only infants that were coming for appointments were used for the study .

The Peabody Developmental Motor Scale was administered to each infant whose caregiver gives informed consent. The background information sheet was completed from their file by the researcher. The assessments were all carried out by the researcher, as the test does require judgement from the therapist. Thus researcher had experience it paediatric occupational therapy and carried out all assessments independently thus also ensuring no examiner biases. Before carrying out the assessment the researcher filled out the background information history sheet.

Each assessment took approximately half an hour and the caregiver was seated with the researcher in the room. When a caregiver did not understand the information sheet or informed consent a translator (which was nurse or ot assistant), was used to aid them and to ask about their health during their pregnancy. The caregivers also prompted the infants during the testing thus using their home language to ensure the correct movement or instruction was carried out. Caregivers were informed to only repeat the researcher when communicating with the child to avoid any bias.

The item score was allocated with in the session, but the scores were added up and interpreted at a later stage and placed onto the database.

3.4.2 Ethical Considerations

Ethical clearance was obtained by the Human Research Ethics Committee at the University of the Witwatersrand (Appendix E). Parents, or primary caregivers' that

accompanied the child gave permission for their infant to participate for the research study. They received an information sheet (Appendix F) explaining the study and were asked to sign informed consent (Appendix F) for their infant's participation and for the infants medical records to be reviewed.

Confidentiality was ensured by the use of a cover sheet (Appendix B) on which personal identifying details were recorded. The front face sheet was numbered and immediately placed in a separate file by the researcher. The PDMS-2 record sheets and background information questionnaire were then marked with the subject code only so that there was no identifying information on these sheets.

Parents/mothers had the right to withdraw their infant from the research at any time and were allowed to request feedback at any stage during the research.

The parents/mothers of the infants that were identified with motor delay that were not receiving therapy were contacted telephonically and provided with names and numbers of service providers where their child could go for therapy. Alternatively they were given an appointment for an assessment with a relevant therapist in the Paediatric Department at CHBAH.

3.5 DATA ANALYSIS

Information from the data sheet was recorded on an excel spread sheet and was analysed accordingly. Descriptive statistics including the mean and standard deviation were used to analyse the demographic, antenatal and perinatal factors as well as the scores on the PDMS -2. This was done for the entire sample as well as the HIE III and HIE II group. The PDMS -2 assessment findings were recorded on the summary sheet and raw scores were converted to age- equivalents, percentiles, quotients and z – scores. Analysis of z scores was completed to identify the infants with mild, moderate and severe disability in this sample (7) (5).

A nonparametric statistic source was used as the groups were not equally distributed with greater number of infants diagnosed with HIE II and there was a small group of

infants with HIE III. The Mann Whitney U test was used to determine the difference between the groups with significance set at $p < 0.05$. Data was analysed using the STATISTICA programme version 10. Analysis of the factors associated with the motor outcomes of infants with HIE II and III was done using Spearman's correlation coefficient.

Frequency distributions for infant participants according to the z scores were used to represent the level of disability with z scores divided into levels of > -1 , -1 to -2 , -2 to -3 and < -3 to determine the percentage of the sample that presented with no disability to severe disability.

The reliability of the PDMS -2 in terms of item consistency for this sample was analysed using Cronbach's alpha.

CHAPTER 4

RESULTS

This chapter presents the results of the demographics, birth and medical history and motor outcomes scored on the Peabody Development Motor Scale (PDMS) for 38 infants presenting with HIE II and III between the ages of 12 to 14 months. The HIE II sample consisted of 29 (76.3%) infants with 9 (23.7%) of infants presenting with HIE III. The participants were recruited from the Neonatal Follow up Clinic (NNFUC), neuro- rehabilitation clinic and occupational therapy departments at CHBAH.

4.1 DEMOGRAPHICS

4.1.1 Demographics-infant participants

4.1.1.1 Age and Gender

The majority of the infant participants were 12 months old and they had a mean age of 12.55 months (Table 4.1).

Table 4.1. Age and Gender of the infant participants (n=38)

		Total Sample	HIE II Group (n=29)	HIE III Group (n=9)	P
		Percentage (n)			
Age	12 months	63.15% (24)	65.51% (19)	55.56%(5)	0.33
	12.5 and 13 months	18.43% (7)	20.69% (6)	11.12% (1)	
	13.5 and 14 months	18.43% (7)	13.80% (4)	33.34%(3)	
Gender	Male	60.52 % (23)	62.07% (18)	55.56%(5)	0.73
	Female	39.47% (15)	37.94%(11)	44.45%(4)	

None of the infants were between the ages of 12 and 12.5 months and 13 and 13.5 months. The groups were comparable for age and gender as there was no significant difference between the HIE II and HIE III groups in terms of the infant participant age or gender as the majority of the subjects in both groups were male

4.1.1.2 Birth weight

The mean birth weight of the infant participants was 3.09 kg. The birth weight's fell into a normal distribution and only six infants were below 2, 5 kg which is considered a low birth weight. (Figure 4.1)

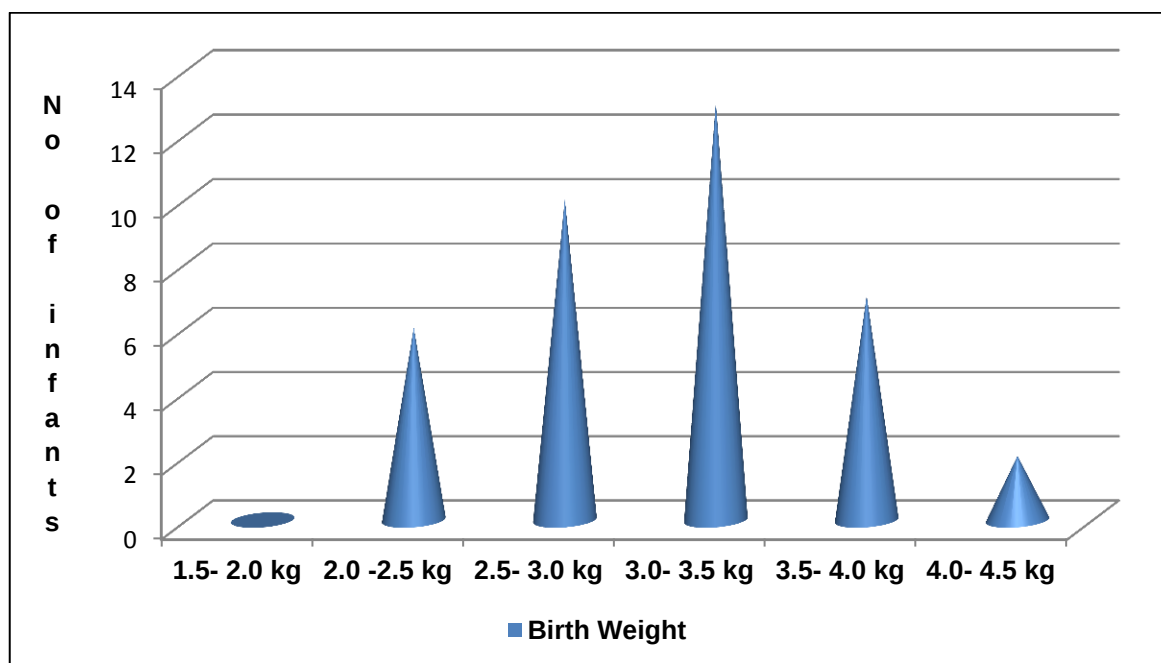


Figure 4.1 Birth weight of the total sample (n= 38)

The majority of the infants were 3 kg or heavier at birth with the mean birth weight for the HIE II group being 3.06 kg and for the HIE III group 3.17 kg. There was no significant difference between the groups for birth weight ($p \leq 0.56$).

4.1.2 Demographics - mother

4.1.2.1 Age

The mean age of the mothers at time of delivery was 26.81 years (Table 4.2). The youngest mother was 16 years old and the oldest mother was 40 years old.

Table 4.2. Age of mothers (n=38)

			HIE II Group (n=29)	HIE III Group (n=9)	p
		Percentage (n)			
Age	15-19 yrs	10.53% (4)	6.90% (2)	22.23%(2)	0.36
	20-24 yrs	23.69% (9)	31.04%(9)	0%	
	25-29 yrs	50.00% (19)	45.00%(13)	66.67% (6)	
	30- 34 yrs	10.53%(4)	10.35%(3)	11.12%(1)	
	35-40 yrs	5.27%(2)	6.90% (2)	0%	

Significance set at 0.05*

Majority of the mothers fell into the age range of 25 and 30 years old and there was no significant difference in the age of the mothers in the HIE II and HIE III groups.

4.2 BIRTH HISTORY

4.2.1 Gestation and type of delivery

The mean period of gestation was full term but of the 38 infants, 33 were born full term and five were born prematurely. Older mothers were significantly more likely to have had a caesarean delivery ($p \leq 0.014$). Slightly more infants were born via normal vaginal delivery than caesarean section (Table 4.3) but there was a high percentage of caesarean sections.

Table 4.3: Gestation and type of delivery

			HIE II Group	HIE III Group	p
		Percentage (n)			
Gestation	Full term	86.85%(33)	86.21%(25)	88.89%(8)	0.84
	Premature	13.16%(5)	13.80%(4)	11.12%(1)	
Type of delivery	Normal vaginal delivery	52.64%(20)	58.62%(17)	33.34%(3)	0.19
	Caesarean section	47.37%(18)	41.38%(12)	66.67%(6)	

Significance set at 0.05*

There were no statistically significant differences between the groups for gestation and type of delivery thus the groups were comparable for these aspects. The table depicts that more 66.67% of mothers who have infants diagnosed with HIE III has caesarean sections.

4.2.2 Hospitalization after birth

The mean hospital stay for the infants was 2.1 weeks.

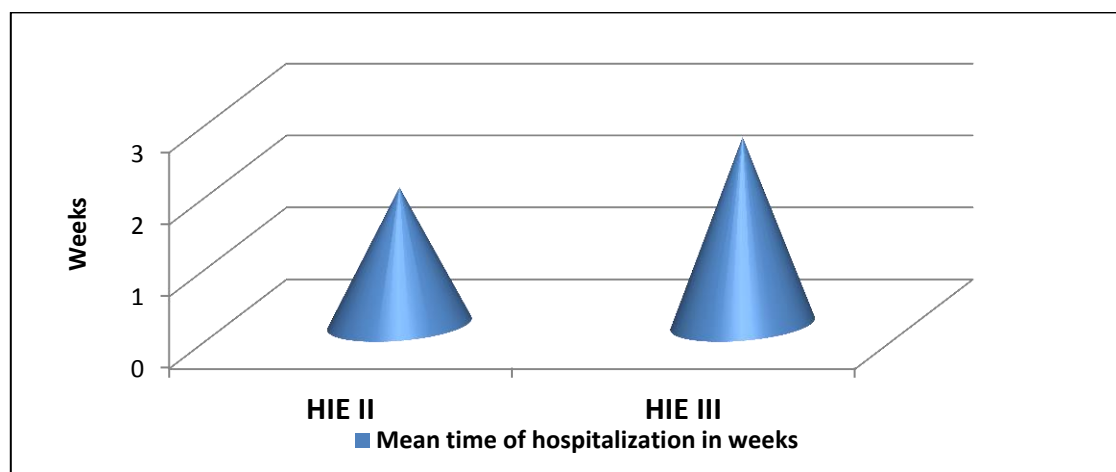


Figure 4.2 Comparison of the weeks of hospitalisation for the infants with HIE II (n=29) and HIE III (n=9)

When the length of hospitalisation for the infant participants with HIE II was compared to those with HIE III it showed infants with HIE III were hospitalized longer than infants with HIE II but this difference was not statistically significant ($p \leq 0.14$).

4.2.3 Details of mothers pregnancy

All the mothers reported a healthy pregnancy and no history of substance abuse was reported during the gestation period. This however was a subjective opinion by the caregiver and could not be confirmed from the records.

4.3 INFANTS MEDICAL HISTORY

4.3.1 Diagnosis at birth

A comparison of the diagnosis of the infants in the sample for HIE II and HIE III indicate that significantly more of the sample was diagnosed with HIE II. ($p \leq 0.01$) (Figure 3)

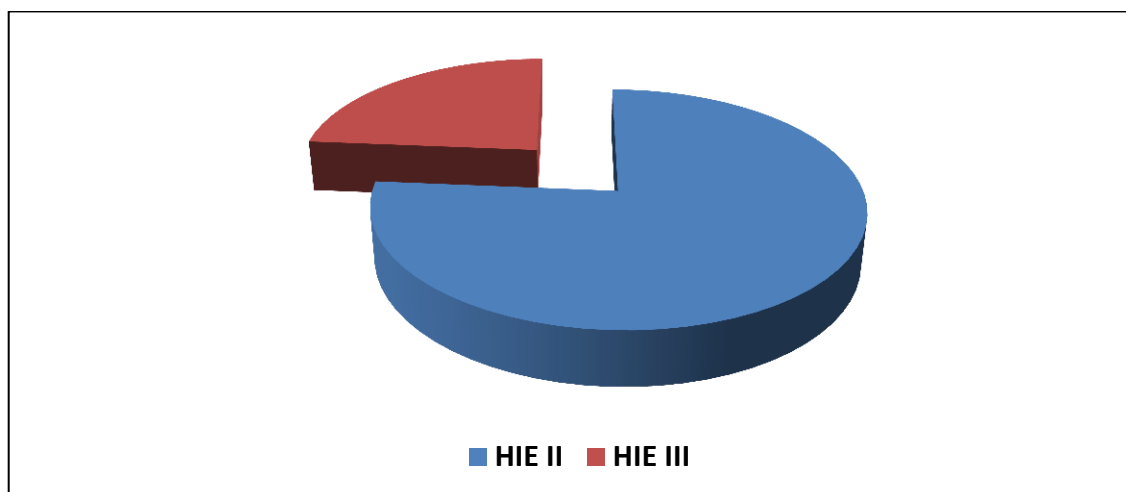


Figure 4.3: Distribution of HIEII and HIE III diagnosis (n=38)

In the sample significantly more infants attending NNFUC and therapy at the hospital had HIE II. While all of the infant participants were diagnosed with HIE II and HIE III at birth a small percentage had other diagnoses with significantly more infants in the HIE

III having seizures (Table 4.4). Of the infant participants diagnosed with CP 75% had had neonatal seizures, one had necrotising enterocolitis and one had respiratory distress syndrome.

Table 4.4: Diagnosis at birth

DIAGNOSIS	HIE II (n=29)	HIE III (n=9)	p
HIE	76.31% (29)	23.68% (9)	0.00*
Birth Asphyxia and respiratory distress syndrome	17.24%(5)	11.12%(1)	0.07
Seizures	41.38%(12)	66.67%(6)	0.00*
Neonatal Jaundice	10.35% (3)	0%	‘
Sepsis	6.90%(2)	11.12% (1)	‘
Necrotising enterocolitis	6.90%(2)	0%	‘

Significance set at 0.05*

“ too few participants for analysis

4.3.2 Intervention at and after birth

Of the 38 subjects only two required ventilation at birth. While all 38 subjects attended the NNFUC only 12 (31.5%) of the infant participants have been diagnosed with cerebral palsy and have been referred to the rehabilitation team of occupational therapy, physiotherapy, speech therapy and a dietician at the Neuro rehabilitation Clinic. (Table 4.5)

Table 4.5: Rehabilitation Intervention received

Type of therapy	Total Sample (n=38)	HIE II (n=29)	HIE III (n=9)	<u>P</u>
	Percentage (n)	Percentage (n)	Percentage (n)	
Cerebral palsy clinic	31.15%(12)	20.68% (6)	66.66% (6)	0.001*
Dietician	13.15%(5)	13.79%(4)	11.11%(1)	“ -
Occupational therapy	2.63%(1)	0	11.11%(1)	“ -
Speech therapy	5.26%(2)	3.44%(1)	11.11%(1)	“ -

Significance set at 0.05*

“too few participants for analysis

Of the remaining infant participants only five were being treated by a dietician, two attended speech therapy and one attended occupational therapy on a regular basis. This demonstrates that very few of the infants that are diagnosed with HIE II and III unless, diagnosed with cerebral palsy are not receiving intensive rehabilitation from an early age. Table 4.5 shows that significantly more infants diagnosed with HIE III attend cerebral palsy clinic thus indicating more motor and functional deficits in this group.

4.4 MOTOR FUNCTION MEASURED ON THE PEABODY DEVELOPMENT MOTOR SCALE 2(PDMS-2)

4.4.1 Subtests of the Peabody Development Motor Scale -2

4.4.1.1 Total Sample

The scores for the total sample and the HIE II and HIE III groups on the PDMS-2 were compared for the infant participants with HIE II and HIE III.

Table 4.6: Summary of standard scores for the Peabody Development Motor Scale -2 for total sample (n =38)

	Standard Scores		z score
Subtest	Mean (SD)	Range	Mean
Stationary	6.36 (3.98)	1 – 14	-1.21
Locomotion	5.73 (3.93)	1 – 12	-1.42
Object Manipulation	7.34 (1.32)	5 – 10	-0.88
Grasping	5.28 (3.70)	1 – 12	-1.57
Visual Motor Integration	5.34(2.98)	1 – 9	-1.55

Table 4.6 is a summary of the standard scores (mean- standard deviation and range) and the mean of the z scores obtained for the total group of infants. All the z scores except for object manipulation fell into the – 1 SD range indicating that as a group the infant participants were at risk of poor developmental delay in all other categories. The mean Z score for grasping and visual motor integration were lower than -1.5 indicating increased fine motor difficulties.

4.4.2.2 Levels of disability for the total group on the subtests of the Peabody Development Motor Scale-2

The data for each subtest was analysed according to the z scores to identify the infants with mild, moderate and severe disability in this sample. Those with z scores that fell above -1 were considered to have no disability, those whose scores fell between -1 and -2 were considered to have mild disability. z Scores of between -2 to – 3 indicated a moderate disability, while those who scored below -3 were considered to have a severe disability.(Table 4.7)

Table 4.7 Level of disability on the Peabody Development Motor Scale -2 for total sample (n =38)

	No disability z score <-1	Mild Disability z score -1 to - 2	Moderate disability z score -2 to - 3	Severe disability z score >-3
	Percentage (n)	Percentage (n)	Percentage (n)	Percentage (n)
Stationary	52.60% (20)	10.52%(4)	5.26%(2)	28.94%(11)
Locomotion	47.36%(18)	10.52%(4)	13.15%(5)	28.94%(11)
Object Manipulation	47.36%(18)	52.60% (20)	0	0
Grasping	31.57%(12)	23.68%(9)	13.15%(5)	31.57%(12)
Visual Motor Integration	42.10%(16)	21.05%(8)	21.05%(8)	21.05%(8)
Mean	44.21%(16.8)	23.68%(9)	10.52%(4)	22.10%(8.4)

The greatest number of infant participants fell into the group which had no disability but scored slightly below the norm of 0. There were a similar number of infant participants who fell into the mild and severe disability groups but this varied within the sub tests. (Figure 4.4) Only 10% of the sample fell into the moderate disability group.

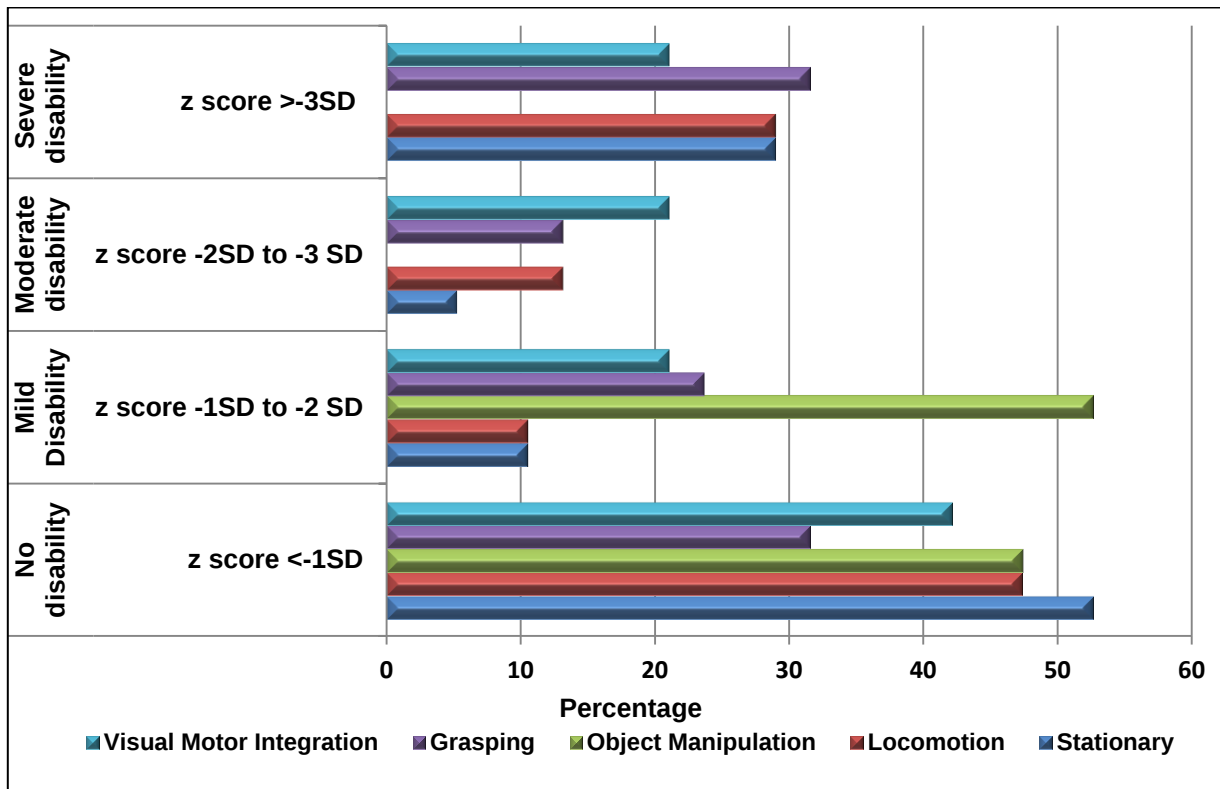


Figure 4.4: Level of disability on the Peabody Development Motor Scale -2 for total sample (n =38)

No infant participants had moderate or severe disability in terms of the object manipulation in the moderate and severe disability group but the results for object manipulation showed a higher disability than the other subtests with the greatest number of infant participants falling into the mild disability group.

4.4.2 Infants with HIE II and HIE III

4.4.2.1 Subtests of the Peabody Development Motor Scale-2

It is important to compare the scores of infants that are diagnosed with HIE II and HIE III as this shows how these infants differ during their development. The specific subtests also show where the greatest deficits are noted. There was a significant difference for all subtests between infant participants' scores in the HIE II and the HIE

III groups as can be seen in Table 4.8. Infant participants with HIE III had lower scores on all subtests in the PDMS -2.

Table 4.8: Summary of standard scores and z scores for the subtests of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups

Subtest	HIE II (n=29)			HIE III (n=9)			
	Standard Scores		z score	Standard Scores		z score	p
	Mean (SD)	Range	Mean	Mean (SD)	Range	Mean	
Stationary	7.31(3.74)	1-14	-0.89	3.33(3.31)	1-9	-2.22	0.007*
Locomotion	6.79(3.70)	1-12	-1.08	2.44(2.78)	1-9	-2.51	0.002*
Object Manipulation	7.65(1.23)	5-10	-0.78	6.33(1.11)	5-8	-1.22	0.006*
Grasping	6.34(3.52))	12	-1.21	1.88(1.69)	1-6	-2.70	0.0008*
Visual Motor Integration	6.10(2.71)	1-9	-1.29	2.88(2.57)	1-7	-2.37	0.003*

Significance set at 0.05*

While all the scores for the infant participants with HIE II are below -1 z scores placing them at risk fort motor delay.

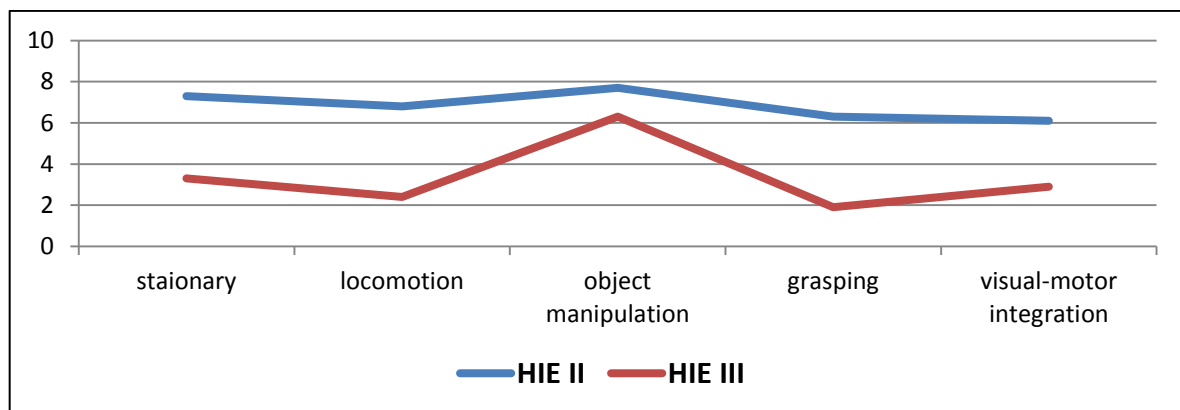


Figure 4.5: Comparison of mean scores on the Peabody Development Motor Scale -2 Subtests for the HIE II (n=29) and HIE III (n=9) groups

The scores for the infant participant with HIE III are below -2 on the z scores meaning that their motor delay for all subtests is severe enough to require therapy.

4.4.2.2 Levels of disability for the total group and infants with HIE II and HIE III on the Subtests of the Peabody Development Motor Scale-2

The data for each subtest was analysed according to the z scores to identify the infants with mild, moderate and severe disability in this sample (Table 4.9)

Table 4.9: Levels of disability based on the z scores for the subtests of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups

		Stationary	Locomotion	Object Manipulation	Grasping	Visual Motor Integration
HIE II (n=29)		Percentage (n)	Percentage (n)	Percentage (n)	Percentage (n)	Percentage (n)
No disability	z score <-1	68.65%(20)	62.06%(18)	58.62%(17)	41.37%(12)	48.27%(14)
Mild Disability	z score - to -2	6.89%(2)	10.34%(3)	41.37%(12)	27.58%(8)	20.68%(6)
Moderate disability	z score -2 to -3	3.44%(1)	13.79%(4)	0%(0)	10.34%(3)	20.68%(6)
Severe disability	z score >-3	20.68%(6)	17.24%(5)	0%(0)	20.68% (6)	10.34%(3)
HIE III (n=9)		Percentage (n)	Percentage (n)	Percentage (n)	Percentage (n)	Percentage (n)
No disability	z score <-1	11.11%(1)	11.11%(1)	11.11%(1)	0	0
Mild Disability	z score -1 to -2	22.22%(2)	11.11%(1)	88.89%(8)	11.11%(1)	22.22%(2)
Moderate disability	z score -2 to -3	11.11%(1)	11.11%(1)	0%(0)	22.22%(2)	22.22%(2)
Severe disability	z score >-3	55.55%(5)	66.66%(6)	0%(0)	66.66%(6)	55.55%(5)

A higher percentage of infant participants in the HIE II group had no disability and mild disability for the three subtests, stationary, locomotion and object manipulation. A higher percentage of these infant participants present with Visual-Motor Integration

scores in the moderate disability level and grasping scores on the severe level when compared to the scores on the other subtests.

Except for object manipulation the majority of the infant participants in the HIE III group fall into the severe level of disability. (Figure 4.6)

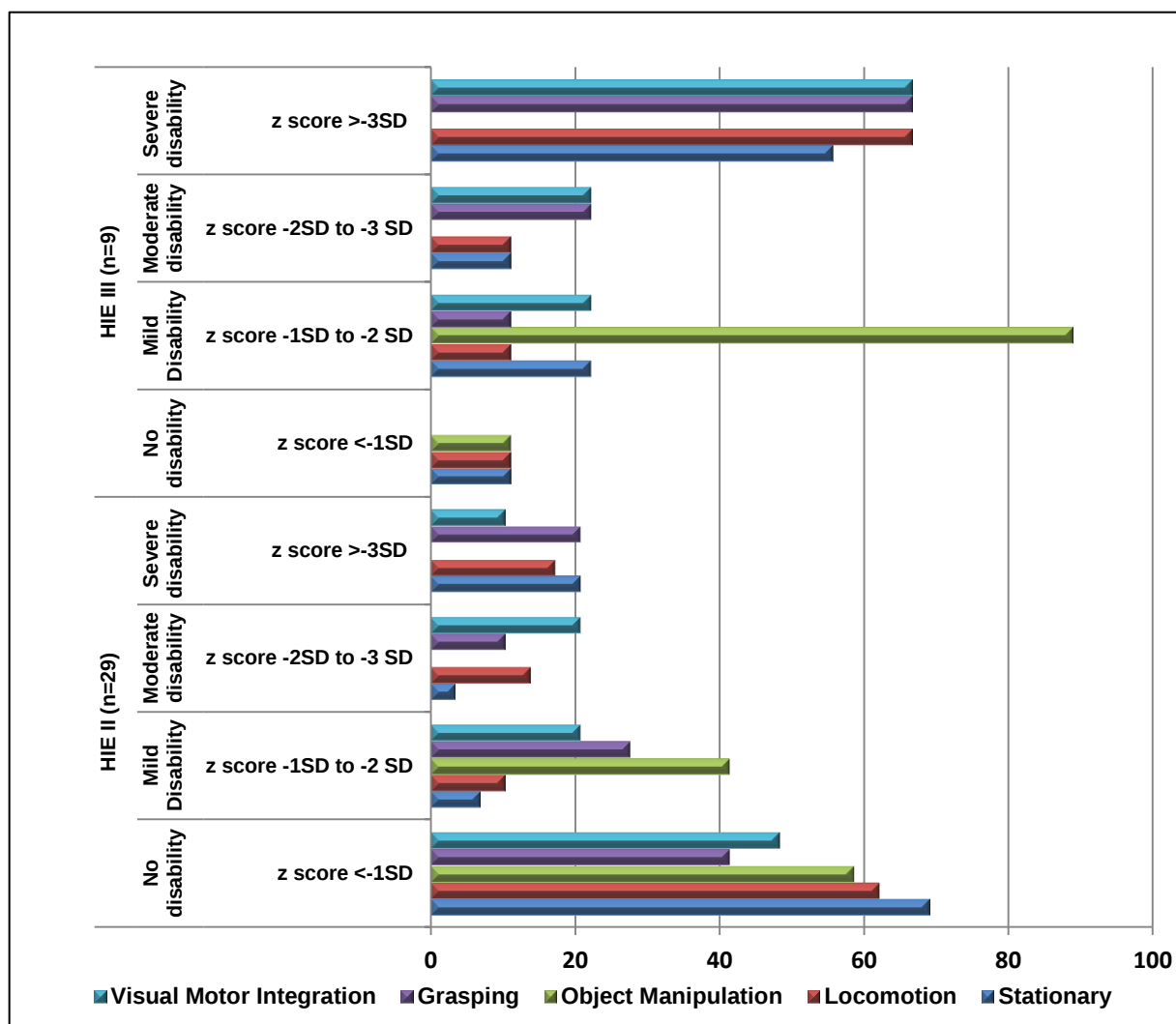


Figure 4.6: Level of disability on the Peabody Development Motor Scale -2 for the subtests of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups

Thus a higher percentage of infant participants diagnosed with HIE III, have more severe disabilities than those diagnosed with HIE II.

4.4.2 Motor Quotients of the Peabody Development Motor Scale -2

There are three motor quotients namely, gross motor, fine motor and total motor quotient. The quotients are derived by adding the subtest standard scores and converting the sum to a quotient.

4.4.2.1 Total Sample

Table 4.10 indicates that infant participants diagnosed with HIE had a variety in the range quotients that children had due the different grades assessed.

Table 4.10: Summary of standard scores for the quotients of the Peabody Development Motor Scale 2 for total sample (n=38)

	Standard Scores		z Scores
Quotient	Mean (SD)	Range	Mean
Gross Motor Quotient	75.52(17.93)	51 -102	-1.61
Fine Motor Quotient	71.44(18.45)	46 - 101	-1.71
Total Motor Quotient	72.91 (19.80)	44 - 98	-1.64

The great variation in the scores across the total sample placed the infant participants z scores between -1 and -2, thus showing the need for therapeutic intervention. The quotient standard scores all fell below the 79, the cut off point for no disability.

The data for each quotient was analysed according to the z scores to identify the infant participants with no (z score less than -1), mild (z score -1 to -2), moderate (z score -2 to -3) and severe (z score below -3) disability in this sample.

z Scores for the total sample indicated that 35.96% had no disability and that 32.45% had severe disability (Table 4.11).

The FMQ indicated that there was more delay in this quotient with only just over 25% of the sample having no disability for fine motor function compared to over 40% for gross motor function.

Table 4.11 Level of disability on the Peabody Development Motor Scale -2 for total sample (n =38)

	No disability z score <-1	Mild Disability z score -1 to - 2	Moderate disability z score -2 to - 3	Severe disability z score >-3
	Percentage (n)	Percentage (n)	Percentage (n)	Percentage (n)
Gross Motor Quotient	39.47%(15)	13.15%(5)	15.78%(6)	31.5%(12)
Fine Motor Quotient	26.31%(10)	26.31%(10)	15.78%(6)	31.5%(12)
Total Motor Quotient	42.10%(16)	15.78%(6)	7.89%(3)	34.21%(13)
Mean	35.96%(13.6)	18.42%(7)	13.15%(5)	32.45%(12.33)

Over 25% had a mild problem for the FMQ compared to the 13-15% who had a mild problem for the GMQ and the TMQ (Figure 4.7). The higher percentage of disability for the FMQ is congruent with the higher percentage of infant participants who had grasping and VMI disabilities as these subtests make up the FMQ score.

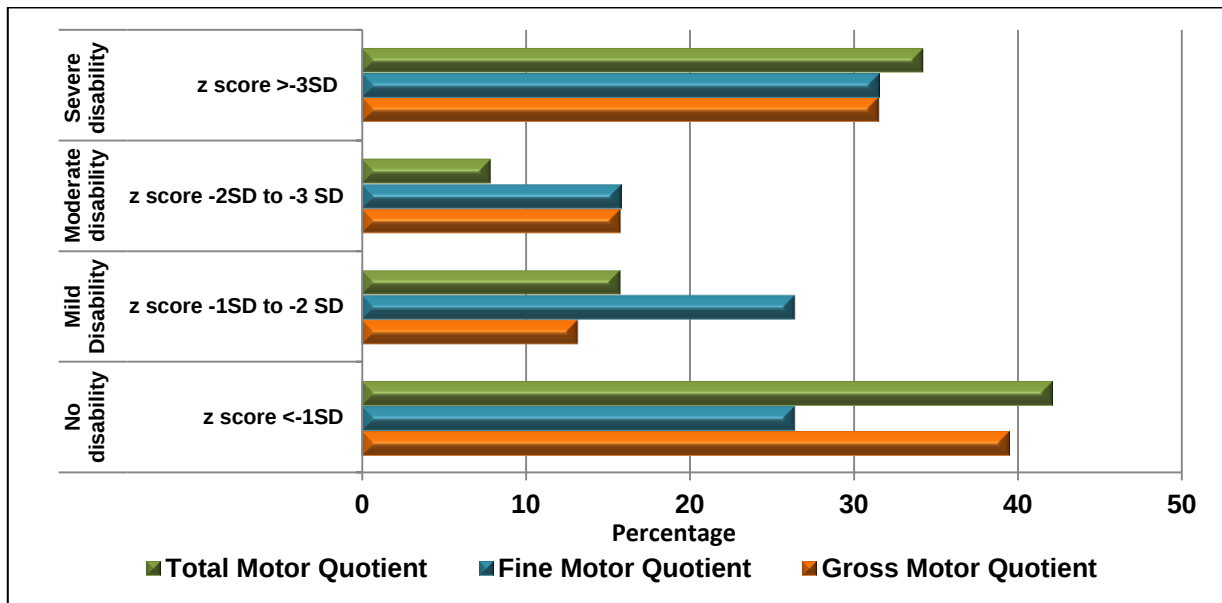


Figure 4.7 Level of disability on the Peabody Development Motor Scale -2 for total sample (n =38)

4.4.2.2 HIE II and HIE III Groups

The comparison of the quotients for the two groups confirms the significant difference between the groups for these scores.

Table 4.12 Summary of standard scores and z scores for the quotients of the Peabody Development Motor Scale 2 for the HIE II and HIE III groups

Quotient	HIE II (n=29)			HIE III (n=9)			
	Standard Scores		z score	Standard Scores		z score	P
	Mean (SD)	Range	Mean	Mean (SD)	Range	Mean	
Gross Motor Quotient	79.65(17.35)	51-102	-1.33	61.66(12.55)	51-85	-2.51	0.006*
Fine Motor Quotient	76.65(17.41)	46-100	-1.44	55.44(19.16)	46-101	-2.66	0.022*
Total Motor Quotient	78.3(18.44)	44-98	-1.33	54.6(13.38)	44-81	-2.66	0.001*

Significance set at 0.05*

The infant participants in the HIE II group have a score above the 79 cut off point for disability for GMQ but the low FMQ score which affects their total score indicating that fine motor ability is more dysfunctional in this group (Table 4.12).

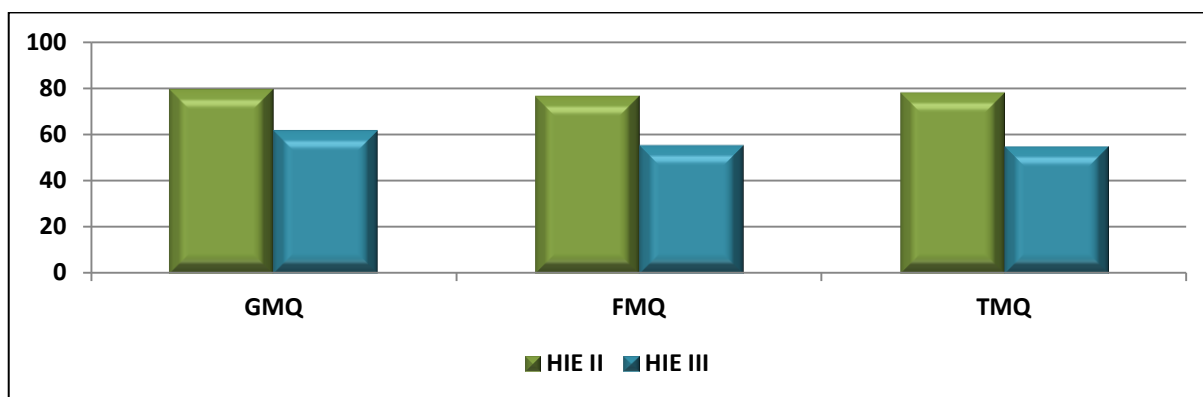


Figure 4.8: Comparison of quotients on the Peabody Development Motor Scale -2 in infants with HIE II (n=29) and HIE III (n=9)

The majority of the infant participants with HIE III had severe disability below a z score of -3 for all the quotients (Table 4.13) whereas the majority of the infant participants with HIEII had no disability for GMQ and TMQ and just over a third of them had no disability for fine motor function.

Table 4.13 Levels of disability based on the z scores for the quotients of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups

		Gross Motor Quotient	Fine Motor Quotient	Total Motor Quotient
HIE II (n=29)		Percentage (n)	Percentage (n)	Percentage (n)
No disability	z score <-1SD	51.72%(15)	34.48%(10)	55.17%(16)
Mild Disability	z score -1SD to -2 SD	10.34%(3)	31.03%(9)	17.24%(5)
Moderate disability	z score -2SD to -3 SD	17.24%(5)	13.79%(4)	3.44%(1)
Severe disability	z score >-3SD	20.68%(6)	20.68%(6)	24.13%(7)
HIE III (n=9)		Percentage (n)	Percentage (n)	Percentage (n)
No disability	z score <-1SD	0	0	0
Mild Disability	z score -1SD to -2 SD	22.22%(2)	11.11%(1)	11.11%(1)
Moderate disability	z score -2SD to -3 SD	11.11%(1)	22.22%(2)	22.22%(2)
Severe disability	z score >-3SD	66.66%(6)	66.66%(6)	66.66%(6)

In comparison to their GMQ and TMQ scores a greater number of infant participants with HIE II had a mild problem with fine motor function compared to infants with HIE III. (Table 4.13 and Figure 4.9) The percentages for the infant participants with HIE III had similar scores for gross and fine motor function for mild and moderate disability.

Differences in the percentage of infant participants with HIE II who scored at a level mild, moderate or severe disability was seen when the GMQ and FMQ were compared to the TMQ (Figure 4.9). Fewer infant participants scored at the moderate level on the TMQ than for the GMQ and FMQ.

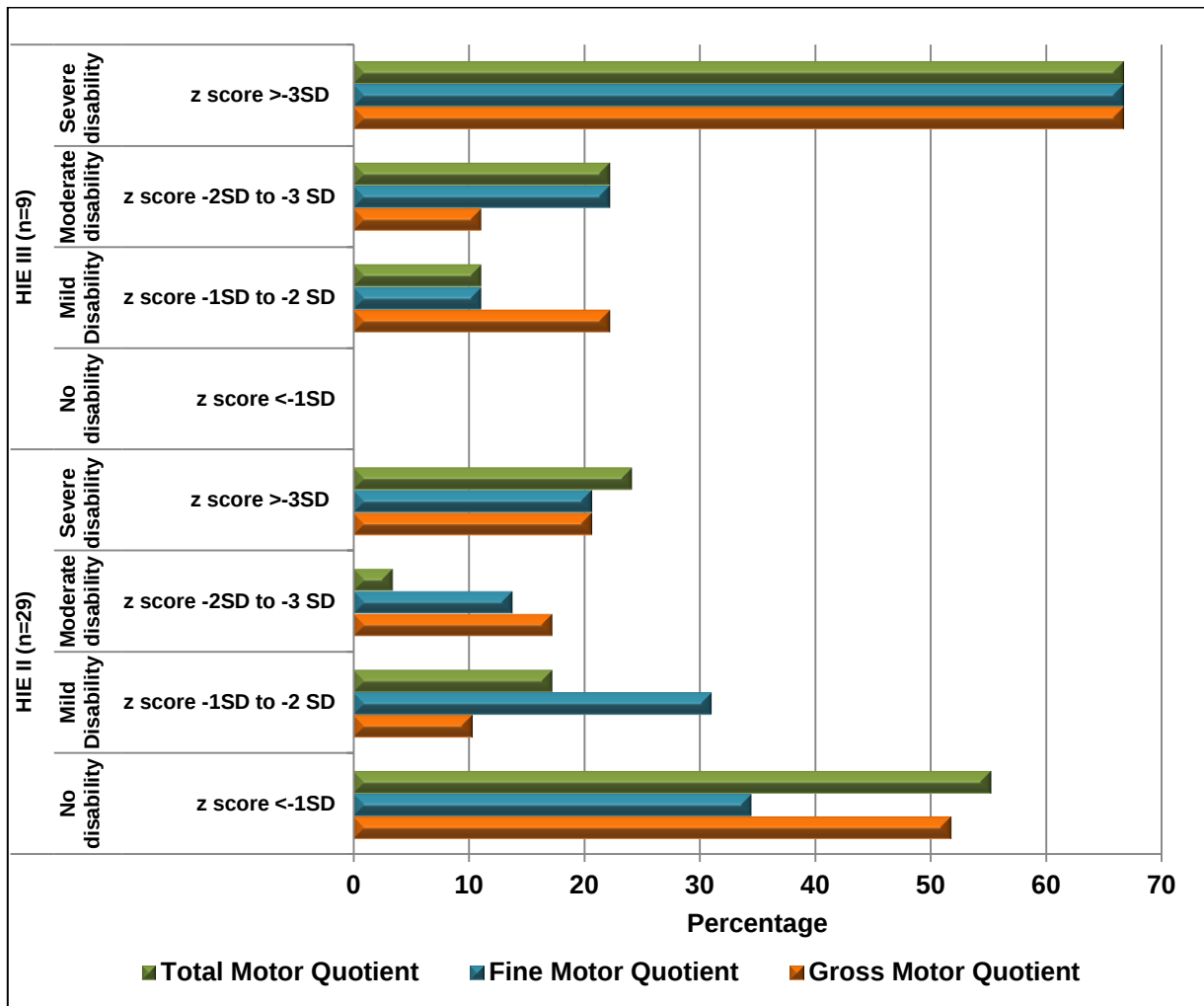


Figure 4.9: Levels of disability based on the z scores for the quotients of the Peabody Development Motor Scale-2 for the HIE II and HIE III groups

4.5 RELIABILITY OF THE PEABODY DEVELOPMENT MOTOR SCALE-2

The reliability of the Peabody Development Motor Scale-2 on the sample of infants in this study was shown to be high with a Cronbach's alpha: of 0.86 for the test on the total sample. The high total item correlation scores of between 0.97 and 0.72 indicate the test is reliable for this sample. The item with the lowest correlation was object manipulation.

Table 4.14 Cronbach alpha scores for the Peabody Development Motor Scale-2 for the total sample (n=38)

Subtest and Quotients	Item total Correlation
Stationary	0.92
Locomotion	0.90
object manipulation	0.72
Grasping	0.93
VMI	0.87
GMQ	0.90
FMQ	0.84
TMQ	0.97

4.6 SUMMARY

The results were analysed with 38 infant participants between the ages of 12 - 14 months. There were more males than females in the sample and birth weight of the two groups showed no significant difference with only 15.78% having a low birth weight. Of the total population of 47% who were born via emergency caesarean section, 67% of which were diagnosed with HIE III. It was also noted that all infants were hospitalized after birth but infants with HIE III had an extended stay in the hospital.

Of the 38 infant participants 29 were diagnosed with HIE II and 9 were diagnosed with HIE III. When reviewing their discharge summaries it was noted that significantly more

infant participants with HIE III had experienced seizures during their period of hospitalization. All infants attended a screening by allied medical professionals, but 67% of the infants diagnosed with HIE III and 21% diagnosed with HIE II attend the neuro rehabilitation clinic.

From the test scores generated from PDMS 2 it is noted that the mean z scores show a significant difference between the two groups of infant participants. Infant participants diagnosed with HIE III obtained lower scores for the all the subtests and quotients than those diagnosed with HIE II. The results indicate that greater percentage of infant participants diagnosed with HIE III have severe disabilities when compared to those with HIE II. It also shows that the majority of infant participants diagnosed with HIE II have no disability but comparatively speaking there is a higher percentage of them that have a mild disability for fine motor function measured by the subtests of grasping and visual motor integration that will require continuous screening to detect if further difficulties and delay develop.

The Cronbach alpha also shows the PDMS-2 can be reliably used with this sample of infant participants.

The finding of this research indicate that more than 50% of the infants diagnosed HIE have developmental delay in their gross and fine motor functioning when compared to norms for normal developing infants at the age of approximately one year. Infants diagnosed with HIE III were significantly more delayed in all aspects of motor development and a greater percentage of infant participants with HIE II showed more delay in fine motor functioning than gross motor functioning.

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

The discussion will consider the demographic factors of the infants in this study, the antenatal and perinatal factors related to their birth as well as their medical history in relation to other studies. A comparison of the type of motor delay for both gross and fine motor skills will be discussed for infants with HIE II and HIE III. Recommendations for occupational therapy intervention at CHBAH will be made based on these findings.

5.2 FACTORS ASSOCIATED WITH HYPOXIC ISCHAEMIC ENCEPHALOPATHY IN THIS STUDY

The first objective of this study was to describe the sample of infants with HIE II and III seen at CHBAH and the demographic, antenatal and perinatal factors associated with HIE.

5.2.1 Infants Demographics

The prevalence of HIE in this study was similar to that reported for South Africa as on average out of the 27 000 deliveries per year at CHBAH and associated clinics (41) approximately 70 infants with HIE II AND III are referred to rehabilitation screening services. It can be assumed from other studies in developing countries that this sample of infants makes up approximately 63% of the infants with HIE (1,14) if a percentage of 37% for infants with HIE I, not included in the study, is used. This results in a rate of 4.1 per 1000 live births for HIE in this sample which is congruent with the reported rate of 4.6 infants per 1000 live births expected in South Africa (18). This rate falls between that reported in developed countries like The United States of America and Australia (1.1 to 3.8 per 1000 live births) (15,28) and for developing countries like Nepal (6.1 per 1000 live births) (1).

After the initial screening at birth this study showed that only 54% of the infants with HIE II and HIE III returned for follow up services within a 14 month period. This is in keeping with other studies that showed a 79% follow up rate at six months and a 40% follow up rate at the age one of year (6,14).

At the time the assessment was carried out for purposes of this study 64% of the infants were 12 months, 18% were between 12 and a half and 13 months old and 18% were between 13 and a half and 14 months old. This indicates that more infants are followed up during their first year of life and that follow up visits are not commonly scheduled after the age of one year (Table 4.1), unless a disability or delay is detected. Hospital follow ups in infants over the age of one year decreases and therefore those with developmental problems may not be identified and referred for early intervention if evaluation is only scheduled for infants over 18 months old.

Literature indicates that the evaluation of long-term sequelae of HIE should be done at 18 months (8). However the reason this age group was chosen for this study was because infants between the ages of 12 and 14 months are developing the motor skills required to explore their environment independently and the hand function required for fine motor skills. It was felt that evidence of motor disabilities at the age of one year also means that follow up of mild disability or therapy for those not yet identified with moderate to severe disability can be commenced at an earlier age (24). Often these infants present at a much later stage when they have learning difficulties thus the critical early intervention period has been missed out (8).

Studies from other countries indicated that more males have been diagnosed with HIE in comparison to females (1,13). In this study 60% of the sample was male (Table 4.1). Literature reports these gender differences are directly related to responses of infants to brain injury. This is related to both hormonal modulation and genetically determined mechanisms which provide perinatal females with a level of protection against HIE (1,13,15).

5.2.2. Antenatal and perinatal factors

There was no significant difference between gestation period and outcome of infants with HIE and most mothers' reported an uneventful pregnancy. No records of the mothers' health during their pregnancy were available at the time the infants were assessed in this study. This was a limitation of the study as literature indicates that antenatal factors may be as important if not more important as casual effects of HIE (14).

Another antenatal factor associated with HIE assessed in this study was the age of the mothers' at the time of delivery, this was 26.8 years (Table 4.2). All but two mothers fell outside of the age group over 35 years, where the risk of neonatal encephalopathy is increased by high maternal age. The infants of both these mothers were diagnosed with HIE II (1).

Research in Australia by Badawi et al showed that the type of delivery was highly correlated to HIE. They reported that emergency caesarean sections in particular were associated with neonatal encephalopathy (14). The results of this type of delivery in this research were highly indicative of associated risks as 47.37 % of maternal total population underwent caesarean sections (Table 4.3). This is higher than the reported percentage of caesarean sections 32.6% at CHBAH (42) and may indicate that there were extenuating circumstances requiring this type of intervention. Although not statistically significant, it was noted that up to 25% more of the infants diagnosed with HIE III were born via caesarean sections (6).

When considering perinatal factors, birth weight as in others studies had no implications on infants diagnosed with HIE. In this study 84.2 % of the infants were born with normal birth weights' (>2500g) (Figure 4.1). These results are similar to a study in West Indies where 80% of their HIE sample had normal birth weights (18) and a study in Nepal where the figure was 78%. The studies in Nepal, Australia and the West Indies found no association between birth weights and HIE (1,15,18). Other factors related to their postpartum treatment and follow up are however related to the severity of their HIE.

5.2.3 Medical History

Only 23.7 % of the follow up sample was diagnosed with HIE III. The smaller number of infants diagnosed with HIE III in the NNFUC records is in keeping with the poorer prognosis and higher mortality rate between infants diagnosed with HIE III in comparison to HIE II.

A study at a university in the West Indies reported only a 27% return of infants diagnosed with HIE III at one year (18). This shows that the rate of return of patients with HIE at CHBAH is in keeping with trends in the West Indies (18).

While the mean hospital stay for infant participants was 15 days, infants diagnosed with HIE III were hospitalized longer than infants diagnosed with HIE II (Figure 4.2). This is on average longer than the seven days reported in a Nepal study, (1) but is in keeping with clinical signs identified on the Sarnat classification. The Sarnat classification indicated that infants with HIE III present with more severe neurological signs at birth (18). The severity of HIE in the infant participants was diagnosed within the first few hours after birth according to the Sarnat classification. Since it is vital to ensure infants are diagnosed accurately in the first few days of life, the Sarnat classification is used in the context of this study, as it has been shown to be a useful tool in both diagnosis and the prediction of outcomes in infants with the different severities of HIE. The classification is used in developing countries where sophisticated tests like MRI scans are not easily available (12). Mwakyusa et al reported a high correlation between HIE scores and neurodevelopmental difficulties (2). Health professionals in the multi-disciplinary team are reliant on the Sarnat classification to determine the prognosis of infants with HIE. It is important for allied medical professionals to note the infant's HIE score to ensure appropriate implementation of follow up and rehabilitation measures.

Other aspects of the medical history that should be noted include the presence of seizures. Seizures have been shown to be related to the level of HIE as well as having a significant impact on neurodevelopmental outcomes (17). Few of the infant participants in this study had complications like respiratory distress syndrome for any

conclusions to be drawn about the effect of this on the severity of their HIE. It was found that 47% of the sample experienced seizures during the neonatal period (Table 4.4). This is comparable to the 57% of the sample in a study by Garbutt and Trotman in the West Indies and 41.7% in a Tanzanian study of seizures experienced by HIE neonates (2,18). Although Mwakyusa, Manji and Massawe did not find a difference in the risk of seizures between infants with HIE II and HIE III in Tanzania, significantly more infant participants with HIE III had seizures in this study. This is supported by the findings of Jobe who found a strong correlation between the HIE score and neonatal seizures (17).

A higher percentage (75%) of infant participants who presented with neonatal seizures, were diagnosed with CP, seizures are an important predictor of future neurological complications. Seizures have been associated with increased risk of developing permanent neurological disorders such as intellectual disability and CP (43). Research also shows that the presence of neonatal seizures resulted in lower visual motor integration scores, fine motor skills and lower IQ scores (8).

Of the 12 infants that were diagnosed with CP six were initially diagnosed with HIE II and six with HIE III. This is in keeping with research by Lindstrom et al who found that 30 % of children diagnosed with HIE II have been diagnosed with CP later in life and Allemand et al found 13% of infants with HIE II and HIE III develop severe CP (16,27). Ellis et al found that 55% of children in Nepal who were diagnosed with HIE II and III developed severe impairments. This research shows that 34.21% of the infant participants presented with severe disability and 31.5% presented with CP on the TMQ score (1).

Infant participants in this study with severe neurological deficits and developmental delay were receiving intensive therapy. All 12 infants that were diagnosed with CP were attending neuro rehabilitation clinic where they were receiving a specialized intervention program from the multi- disciplinary team. One of the other infants' with a severe deficit was receiving individual occupational therapy, speech therapy and nutritional advice. No other infant participants with HIE II had been referred to the speech therapist and dietician for specific deficits (Table 4.5). It is clear that infants

presenting with CP and severe deficits are receiving intervention but those with moderate and mild disability may not have been identified as needing more than a review at NNFUC. Therefore a more formal screening for motor function at 12 months may be advisable in view of the findings of this study.

5.3 MOTOR DEVELOPMENT

The second objective of this study was to establish the gross and fine motor developmental level or outcomes of infants who have been diagnosed with HIE II and III. The PDMS-2 was used to evaluate infants gross and fine motor skills, the scores of which are combined to present a total quotient score for their overall motor skills or motor outcomes.

5.3.1 Overall total motor outcomes

In this study 23.65% of the participants were diagnosed with HIE III while 76.31% were diagnosed with HIE II. The results of the PDMS-2 indicate that the actual distribution mild, moderate and severe disability does not conform to these percentages even though the infants with HIE II had less disability overall.

Although the results showed the total sample of infant participants had z scores of the PDMS that fell between -1 and -2 (Table 4.6). This does not represent the actual level of disability when the findings are analysed further. Infant participants with HIE II had mean PDMS-2 z scores between -1 to -1.5 thus placing them all at risk for developmental delay. The mean PDMS-2 z scores of the infant participants with HIE III all were below -2. The results for the participants with HIE III was significantly lower with the scores all falling below -2 SD. This was true even for the three of the nine participants not diagnosed with CP. Research in the West Indies showed similar findings as larger proportions of infants with HIE III were developmentally delayed in comparison to infants with HIE II (18).

There is evidence to suggest that infants with HIE II and HIE III could possibly be on a continuum with regards to their developmental outcome depending on the severity of

their diagnosis.(16) It was therefore important to look at the frequency of the z scores to determine the percentage of infants presenting with no, mild, moderate and severe motor disability.

The PDMS-2 z scores in this study were analysed according to four levels. Z scores falling above -1 were considered as no disability, z scores between -1 and -2 were considered as mild disability, z scores of -2 to -3 indicating moderate disability and z scores below -3 considered as a severe disability(26).(Table 4.7). This categorisation was used so that the results of this study could be compared to the literature where four levels of severity of HIE are reported.

In total 45.60% of the total sample in this study presented with moderate to severe disability on the mean TMQ of the PDMS-2 (table 4.11). Twelve of the 13 infant participants identified with severe disability on the TMQ had been diagnosed with CP and developmental delay (12). Ellis et al in a study completed in Nepal found 28.07% of infants with HIE II and III had severe disability (1), while a study in Tanzania reported 41% of infants had severe disabilities (2), compared to the 32.45% found in this study. These findings were congruent with an Australian study that showed 42% of participants with HIE had severe developmental delay and 16% had mild developmental delay (44). The mean TMQ in this study showed 18.42 % of infant participants had mild disability and 35.98% had no disability (Table 4.11).

van Schie et al found that only 28% of their sample of infants with HIE II had moderate to severe disability however they had no surviving infants with HIE III in their study(26). Since survival rates particularly in infants with HIE III, affect the percentage of disability reported it is preferable to consider infants with HIE II and HIE III separately.

More than 50% of infant participants in this study with HIE II presented with no motor disability on the TMQ (Table 4.13) compared to the 36% found without disability by Van Schie et al (26). They however had 28% of their sample falling into a group with mild disability compared to the 17.24% in this study. This study's scores were based on the AIMS and BSID II which measure different and additional components of

development. Interestingly van Schie et al as with this study only had one participant that was found to have moderate disability but the 32% of their sample presenting with severe disability was higher than the 24.13% found in this study (26). Overall it appears that the use of the PDMS-2 identifies less disability as only the motor skills of the infants are being considered even though there is a good concurrent validity for the PMDS-2 and BIDS II (33). These results may also reflect the fact that the PMDS-2 is not sensitive to tone abnormalities, these were not noted but should be recorded in future research (8).

Mwakyusa et al. showed that the one infant diagnosed with HIE III in his study had major neurological impairments (2), in keeping with this research where all nine infants with HIE III had some degree of disability on the TMQ. In this study it was noted that 66.66% of the infants with HIE III were diagnosed with severe disability and developmental delay.

This study confirms that infants with HIE II have significantly better outcomes (Table 4.10) in terms of motor development (16) and that the majority will not need follow up in terms of developmental delay when the TMQ is considered. In contrast all the infants diagnosed with HIE III need to be followed up. The majority of them should be receiving therapeutic intervention for developmental delay and severe neurological impairments.

The PDMS-2 TMQ only presents an overall score, it is important to consider the sub tests and the GMQ and FMQ to obtain a picture of the variance in motor development in infants with HIE II and HIE III. Since no published studies were found outlining specific gross and fine motor skill deficits it is difficult to compare more than the overall quotient scores to the literature.

5.3.2 Gross Motor Outcomes

The gross motor outcomes on the PDMS-2 are a total quotient of the combined on the stationary locomotion and object manipulation subtest.

The results in this study for the GMQ were similar to those for the TMQ with nearly 40% of participants having no disability for gross motor function and just over 31.5 % having severe disability. Robertson et al reported that 26.2% of infants with HIE II had delayed gross motor skills whereas all children with HIE III had gross motor delays (8). In this research it was found that 20.68% of infants with HIE II and 66.66% of infants with HIE III had severe disability with regards to their gross motor functions. Tanzanian research showed that in the area of locomotion; 36% of HIE II infants were found to have delay and severe delays were found in HIE III infants (2). This is in keeping with other research conducted in developing countries. The children with gross motor difficulties are equivalent to the children diagnosed with CP (table 4.5) and this is expected as literature shows that CP can be seen in the first 12 to 18 months and is often noticed when children fail to reach their motor milestones e.g. sitting and walking (29).

The first subtest contributing to the gross motor outcome is stationary; it is the ability to sustain control of the body within its centre of gravity and retain equilibrium. This research showed that 28.94% of the total sample had severe disability in this subtest (Table 4.7). This consisted of the infants diagnosed with CP. Only one infant diagnosed with CP did not have a severe problem in the subtest of stationary and these results are in keeping with children with severe neurological impairments (7).

Over 50% of the total sample had no disability for the stationary subtest but results show that nearly 70% of these participants were diagnosed with HIE II and only one with HIE III. One infant participant that presented with moderate disability in terms of the stationary subtest had not been diagnosed with developmental delay and was not receiving intervention.

In the subtest of locomotion 13.15% of the total population presented with moderate disability and 28.94% with severe disability. This indicates that those with a severe disability the stationary subtest also had a severe disability in locomotion.

Of the infants diagnosed with HIE II 17.24% and 66.66% of those diagnosed with HIE III were severely disabled due to their locomotion skills. These represent the infant

participants diagnosed with CP and as locomotion is defined as a child's ability to move from one position to the next, this is in keeping with their diagnosis. Rosenbaum reports that children with CP have overall difficulties but their mobility is the most affected.(29). In comparison to a study by Allemand et al who found that only 13%of infants diagnosed with CP could not walk at two years old, Rosenbaum's reported a significantly higher percentage of infants with severe locomotion disabilities (28,30).

The small percentage of infant participants with HIE II with locomotion deficits that do not present with stationary deficits will need to be followed up every six months to monitor their locomotion skills.

The last subtest in the gross motor score is object manipulation and the z scores for this subtest showed no severe disabilities. The percentage of 41.37% of infants with HIE II and 88.89% of infants with HIE III showed mild disability in this area and are likely to have more difficulties in the future as children are only assessed in this test from the age of 12 months. This subtest is mostly based on an infant's ball skills, it begins with the infant being able to roll the ball at 12 and 13 months and catching and throwing a ball when they are older. The first item at 12 months allows the child to lose balance when sitting and the child still receives a score of one. Thus this test does not provide an adequate reflection of the infant's object manipulation at a young age. It is noted that infants with difficulties in the areas of locomotion and stationary subtests will experience difficulties in this subtest on the PDMS -2 when they are older and expected to stand and carry out ball skills required.

Infant participants who score 0 can still obtain standard score between 5 and 7 depending on their age in months. Thus some infants were able to achieve higher scores in this subtest which increased the mean score. It is noted that the coefficient alphas in the PDMS -2 manual for the subtest of object manipulation starts at 0.85 and gradually increases by 72 months as the Cronbach's coefficient alpha increases with the child's age (5). The Cronbach alpha for this item was the lowest obtained in this study at 0.72 confirming the lower reliability of the item for infants at the age range used for this study.

Since these scores affect both the GMQ and the TMQ it must be kept in mind that the overall results for these quotients may slightly under represent the severity of the infant participants with motor disabilities.

5.3.3 Fine Motor Outcomes

The subtests of grasping and visual motor integration form the fine motor quotient. A much lower percentage of infant participants (26.31%) presented with no disability for the FMQ. While the percentage of infant participants with severe and moderate difficulties was similar to the results for the gross motor skills, nearly double the percentage of infants had a mild difficulty with fine motor skills.

Most of the difference in the level of difficulty with fine motor skills occurred in the infant participants with HIE II with 31.03% of them presenting with mild disability in their fine motor skills (Table 4.13). This supports the findings of Perez, et al who found that fine motor skills were more affected in children with HIE without severe disability over the age of eight years.

A lower mean score for the fine motor quotient (71.44%) compared to the score for the gross motor quotient (75.52%) is recorded in the study. This must be considered in light of the scores obtained for the object manipulation subtest in the GMQ. This may have meant that the gross motor score on the PDMS-2 is a slight misrepresentation of the severity of the gross skills of infants in this age group. It must also be remembered that van Hartingsveldt et al questioned reliability and validity of the fine motor aspect of the PDMS-2 (34).

In the infant participants with HIE III the same significant trend was seen for gross motor skills as was seen for more severe disabilities in fine motor skills in the infant participants with HIE III. All but one participant presented with moderate to severe disability whereas approximately only 35% of infants participants with HIE II fell into these categories.

When considering severe disability in this sample it is not unexpected that a similar number of infant participants that presented with severe disability in gross motor skills

and stationary subtest (20.68%) also have severe disability in their fine motor skills. As Case Smith reports development occurs proximally and gradually progresses to distal parts such as the hands and feet therefore infants require proximal stability to encourage distal mobility and grasping (7). Thus when the subtests in the FMQ were considered a similar trend was seen for grasping, which is defined as a child's ability to use his or her hands during activity. It is thus also expected that infants diagnosed with CP would present with significantly lower scores in this area. All 12 infant participants with CP scored at a severe disability level (5). Again a higher percentage of infant participants with HIE III (66.66 %) had severe disability in grasping.

Interestingly fewer infants had severe disability in the VMI subtest; this measures a child's ability to use his or her visual perceptual skills to perform complex eye-hand coordination tasks (5). The lowest percentage for any subtest except object manipulation which was previously discussed fell into the severely disabled category for VMI. Only eight of the infant participants diagnosed with CP have a severe disability in this subtest, indicating that the skills measured were not reliant on motor function alone. This is contrary to the findings of Robertson and Finer who reported that the visual motor integration skills of infants with moderate and severe HIE were more affected compared to other developmental areas (8). Although literature has noted that children with moderate HIE often have a poorer performance in their scholastic abilities which is directly related to fine motor quotient (12). Barnett, Mercuri, Rutherford, Haataja, Frisone, Henderson et al. reported that only 15% of non-disabled children with HIE showed minor neurological perceptual-motor difficulties at the age of 5-6 years (45).

These infants will require further follow- up to establish whether or not the mild disability found resolves or if these infants require therapeutic intervention. This confirms the need to intensively follow up all infants with HIE II and HIE III at multidisciplinary developmental clinics from the early neonatal period (44).

5.4 RECOMMENDATIONS FOR AN INTERVENTION PROGRAMME

The third objective of the study was to identify the factors related to motor outcomes that need to be considered in the formulation of appropriate occupational therapy home programmes for infants with HIE II and III. Since the PDMS-2 identifies the need for intervention at a z score of -1.5 it is essential that all infants with a z score of -1 or less are monitored and that those with a score of -1.5 are referred for therapy and receive a home programme.

Literature shows that occupational therapists need to accurately assess an infant's development in order to provide accurate intervention programs (46). Norm referenced assessments such as the BSID II, PDMS-2 and the AIMS should be used as serial assessments to monitor development and the effectiveness of therapy (46), as these tools provide valuable information on an infants' development. Research in both Amsterdam and Switzerland used standardized assessments such as the BSID II and AIMS to evaluate infant's neurodevelopmental outcomes (26,28). It is recommended that standardized assessments be used during routine occupational therapy screening of infants diagnosed with HIE from the first year of life, since a high percentage of infants diagnosed with HIE require early intervention. Early intervention is described as the window in which intervention should be provided, this is to infants between the ages of naught to three years. This has been recognized as a key period in a child's development. It is also a term that is used to describe intervention to the young child who has a confirmed risk of delay or an existing developmental delay (7). In a context like CHBAH it is advisable that this intervention be provided in the first year of life when infants are still brought to NNFUC. Lekskulchai and Cole reported in a study in Thailand that children who underwent structured early developmental programs had improved motor performance (26).

A corner stone of early intervention is family centred therapy; all caregivers should be educated on the infant's diagnosis and prognosis at an early stage. In the current setting education should ideally be carried out in the caregiver's first language. A pamphlet should be made and distributed with all warning signs and possible delays

that can manifest so that caregiver's have a point of reference when not interacting with medical professionals.

On follow up after discharge infants diagnosed with HIE III should continue to be screened monthly as they are at higher risk for severe developmental delay. Infants diagnosed with HIE II should be screened every two to three months and their development monitored carefully. If moderate to severe difficulties are picked up in these infants, they should be referred to the correct professional for more intensive intervention.

Infants who have z scores between -1 and -1.5 on the PDMS -2 are considered to have a mild disability and should be monitored over six monthly periods with some guidance given to the caregiver about stimulation of development at home. Presently at CHBAH these infants are followed up at a clinic run by occupational therapists, speech therapists and physiotherapists. Each time the infant is seen, it is by a different therapist, this therapist screens for basic milestones and no standardised testing is completed. Verbal advice is provided to the caregivers regarding the stimulation of development. This is effective for the large number of children who are being monitored however all reports are subjective and there are periods where the professionals are not trained in specific developmental areas. This may result in inadequate provision of feedback to the caregiver. Thus a standardised norm referenced test should be used to improve assessment findings. The length of the test and its availability will determine which test can be used.

It is recommended that a trans disciplinary approach be implemented where by therapists from the three allied professions interact as a team to develop standard intervention strategies for the types of developmental delay seen in children with HIE. One of the therapists then provides the caregiver with the intervention home programme for the child (7). Thus all professionals contribute to the assessment of the child and planning of intervention, but one therapist executes the process. It is vital for therapists to be trained by their colleagues on implementation of the programs available, to ensure that all infants diagnosed with HIE are being monitored by the

allied health professionals. This approach is widely used in early intervention settings (7).

Since early intervention is not based on the child alone but on their ability to interact with their family and environment, family-centred practice (FCP) should form the basis of any intervention programme offered to these infants (47). Hanna and Rodger reported that FCP is an emerging and desirable approach used in paediatric settings and it is considered to be the “gold standard” in the rehabilitation intervention for children with disabilities (48). It should thus be utilized with infants diagnosed with HIE to achieve optimal outcomes.

An integral part of achieving FCP is developing home programmes. Home programmes are specifically created for use in the context of daily routines in the home environment (48). The results of this study show delay in all areas thus home programmes need to be developed in gross and fine motor skills as well visual motor integration for infants with HIE who present with mild to severe disabilities. This allows the therapists to support the caregivers during the early intervention process (47). The infants with moderate and severe delay should also attend bi weekly or monthly sessions of individual therapy.

The home programmes created would need to be generalised with empty spaces to add information, this will ensure that the programmes can be made specific to each infant's and family's needs as to enhance caregiver participation (48). All the home programmes designed for infants between 12 to 14 months with HIE will include activity focused motor intervention. This type of intervention allows for improved interaction with the family and environment through the development of functional developmental motor skills (47).

The gross motor and fine motor home programmes will be based on two treatment models. The NDT approach will be used as it involves handling children to promote normal movement patterns; this is relevant as this study reported a high percentage of infants with CP. A greater percentage exhibited mild to moderate disability thus a developmental approach will also be used as this looks at learning and mastering

normally sequenced motor milestones in a hierarchical manner (7). The program will include aspects of arousal and attention, postural control, hand function and vision. Vision will be addressed as this contributes to visual perceptual skills and fine motor skills (7). There will be slightly more emphasis on fine motor skills for infants with mild disability as this has been shown to be their greatest deficit.

These structured home programmes will be introduced at an early age and the infant will be evaluated at each appointment to evaluate the effectiveness of the programme. The importance of caregiver buy in and motivation, as well as their understanding of the importance of the home programme must not be underestimated as Novak and Cusick report that home programmes are only effective if well designed, appropriately implemented and effectively evaluated(48).

In view of long term outcomes it has been reported that infants who have motor and learning difficulties will have difficulties with their scholastic abilities. A Review by van Handel and Swaab et al reported that children with HIE III had low school readiness at the age of five and a half years and children with HIE II achieved lower scores in all domains. Infants with HIE II were also assessed as being at least one grade level behind in the areas of reading, spelling and mathematics (12).

Therefore children diagnosed with HIE with no severe disability will require follow up assessments to detect difficulties that can impact their school functioning.

5.5 LIMITATIONS OF THE STUDY

The greatest limitation of this study was the limited detail on discharge summaries from the neonatal wards. Initially the plan was to follow up potential participants from the discharge reports in the neonatal wards but as telephone numbers were incorrect or not recorded of the caregivers of infants diagnosed with HIE from the neonatal ward could not be contacted. Instead patients that returned for follow up to the NNFUC were assessed. Because the records at the NNFUC did not contain information about the pregnancy and little information on the socioeconomic status of the mother was recorded this information could not be retrieved so these variables were not

considered in this study. Antenatal information regarding the pregnancy was obtained from the mothers of the infant participants and this was a subjective opinion.

The PDMS-2 presented some limitations as the subtests presented with various levels of validity and reliability for infants in this age group as discussed above. Another limitation was that the PDMS 2 evaluated only motor skills and no objective measure of tone was recorded in the assessment. When carrying out these assessments the degree of tone abnormalities should also be recorded using a valid assessment tool.(e,g GMFCS- Gross motor functional classification scale.)

The small sample size in this study especially for the number of infant participants diagnosed with HIE III may have may have influenced both the external validity of the study and its generality, as well as the internal validity resulting in a Type II error in relation to the lower percentage of disability for motor outcomes found in this sample than that reported by van Schie et al for infants with HIE II (26).

5.6 SUMMARY

The demographic factors in terms of gender and perinatal factors found in this study related to HIE II and HIE III are similar to those reported in the literature for both developing and developed countries. Only the rate per 100 births differed slightly and was higher than for the rate in developed countries but lower than the rate reported for a country like Nepal. Due to the lack of adequate records the mortality rate for the infants diagnosed with HIE in the neonatal wards could not be established but significantly more infants diagnosed with HIE II returned for follow up at NNFUC and therefore it was assumed that more infants diagnosed with HIE II had survived.

The severity of the disabilities seen in the infant participants with HIE III was significantly greater than for those diagnosed with HIE II. This is in keeping with the literature internationally although the motor outcomes for this sample were better than those reported in the only other published study on young infants at one year with HIE complete in the Netherlands (26). All the Infants diagnosed with HIE III had disability with only one of them having mild disability and the majority having severe disability.

Over 50% of the Infants diagnosed with HIE II had no disability and only 20.6% had severe disability congruent with the 15%-25% reported by Robertson and Finer (8). This variance of disability in infants with a diagnosis of HIE II is similar to that reported in the literature (22) and this indicates they all need to be followed up so that mild disability is not missed as in this sample only those with severe and moderate disability were referred for therapy.

The results indicated that the infant participants scored better for their gross motor skills than their fine motor skills. This may have been due in part to the PDMS-2 object manipulation subtest scores which showed little disability for this sample. Therapists need to keep these findings in mind however, so when assessing at follow up clinics fine motor skills are monitored after the age of one year in infants with HIE who appear to have no disability.

The research has shown the need for the use of standardised testing at follow up clinics and recommendations for follow up and intervention have been made based on early childhood intervention principles which involves the caregivers carrying out stimulation programmes at home for children who are at risk but not in need of intensive therapy.

CHAPTER 6

CONCLUSION

The study was a quantitative study to determine the motor outcomes of infants between the ages of 12-14 months diagnosed with HIE II and HIE III. Thirty eight infant participants were identified at NNFUC and assessed using the PDMS-2. It was found that there were more infants diagnosed with HIE II attending follow up resulting in a sample of 29 infants with HIE II and nine infants with HIE III. The two groups of infants were comparable in terms of their demographics.

Demographic and ante and perinatal factors were assessed in this sample and analysed in relation to the severity of the infants HIE. It was found that while the rate per 1000 live births was slightly different to those reported for developed and developing countries, the factors like mode of birth, medical history and gender showed similar results to those in the literature. Significantly more Infants with HIE III did present seizures and required longer hospitalisation after birth.

Literature reports a variation in the amount of disability infants diagnosed with HIE II and III present with (22) and this was noted in this study. As reported in the literature all the infants diagnosed with HIE III presented with severe disability (13) although one of them had mild disability. As for other studies 48% of infants with HIE II presented with disabilities and less than half of these had severe disabilities. The severity of the developmental delay for this sample was slightly less than that found in the Netherlands by van Schie et al overall (26). The gross motor outcomes were slightly better than the outcomes for fine motor skills especially for infants with HIE II.

This study shows that infants with severe disability are receiving appropriate intervention before the age of 12 months but infants that are mildly delayed often only attending screening clinics like NNFUC.

As literature states early intervention is key in improving motor and cognitive functioning in infants thus more structured programmes should be put in place to

improve outcomes of infants with HIE. This study reinforces the importance of early intervention and the key role rehabilitation professionals play in the management of infants with HIE.

6.1 RECOMMENDATIONS

Mild difficulties are sensitive to standardised assessment tools which are commonly used in paediatric practice and thus mild difficulties are often overlooked during non-standardized assessments. It is thus advisable for clinicians to use more standardised assessments to detect degrees of developmental delay in infants with HIE. These infants would benefit from more structured and standardised early developmental assessments so appropriate home programmes and intervention can be prescribed.

Although all the infant participants with moderate and severe disabilities were receiving intervention it is important that these programmes are more carefully structured and based on evidence based practice that can assist in prompting optimal developmental outcomes.

As more infants with HIE II presented with difficulties in their fine motor skills, it is important that these children be followed up by occupational therapists for a longer period of time to ensure this does not impact on their scholastic skills.

Recent literature shows that therapeutic hypothermia carried out in the first few hours of life can reduce neurological damage in infants diagnosed with HIE and improved neurodevelopmental outcomes are noted. None of these infants underwent whole body cooling but since this method of treatment has now been introduced at CHBAH and further studies should be done to determine what effect this has on the motor outcomes of infants with HIE and HIE III as there is a consistent trend in the decrease in frequency of disability in these infants.(21) A larger population of infants should also be used to eliminate the possibility of a Type II error.

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APPENDIX A

Background Information Sheet

Subject Number: _____

Adjusted Age; _____ months

Birth History:

Gestation	Delivery	RVD Exposed	NVP given	BW
☐ FT	☐ NVD	☐ Yes	☐ Yes	_____grams
☐ Premature ($<36/40$) _____weeks	☐ Ceasar	☐ No	☐ No	☐ LBW
	☐ Breech	☐	☐ Unknown	☐ VLBW
	☐ Vacuum	Unknown		☐ ELBW
	☐ Forceps			

Medical History:

Length of hospital stay: _____			Type of ventilation: _____		
☐ BA	☐ HIE 1	☐ HIE II	☐ HIE III	☐ NEC	☐ Meningitis
☐ Hydrocephalus	☐ VP Shunt	☐ NNJ	☐ RDS	☐ Seizures	
☐ IVH Grade:	☐ Syndrome	☐ Dysmorphic features	☐ Cleft lip/palate	Other _____ _____	
☐ Clubfeet	☐ Splints	☐ Medication _____			

Details OF Pregnancy:

☐ Healthy	☐ Alcohol consumed _____	Other:
☐ Smoked _____ cigarettes/ day	☐ Other substances _____	

Family structure and support

Age of mother	
Family support	
Financial support	

Type of intervention received:

☐ Occupational therapy	☐ Physiotherapy	☐ Speech therapy
☐ C. p clinic	☐ Dietician	☐ Neonatal follow up clinic

APPENDIX B

Personal contact Details

Infants Name _____

Mothers Name _____

Date of Birth _____

Date of Discharge _____

Contact Number _____

Hospital Number _____

APPENDIX C

Peabody Developmental Scales Assessment Form

PDMS-2	Examiner Record Booklet
Peabody Developmental Motor Scales	Second Edition
Section I. Identifying Information	
Code _____	Female ☐ Male ☐

Item #	Age in Months	Item NAME, Position, and Description	Score Criteria	Administration			
				1	2	3	4
10 Start: 6 months	4	ALIGNING HEAD (<i>Sitting, supported with pillows around hips</i>) Dangle toy on a string 12 in. in front of child. Slowly move toy in 180-degree arc, from in front of child to his or her left side, back to front, and then to right side. (Count 4 seconds per segment of movement cycle: left, front, right, front.)	2 Holds head aligned for 8 seconds while rotating head to follow toy 1 Holds head aligned for 4-7 seconds while rotating head to follow toy 0 Holds head aligned for less than 4 seconds				
11	5	SITTING Place child in sitting position, hands on surface beside knees. When balance is secure, release child.	2 Maintains balance for 8 seconds 1 Maintains balance for 3-7 seconds 0 Maintains balance for less than 3 seconds				
12 Start: 7-9 months	6	SITTING/REACHING (<i>Sitting, pillows supporting hips</i>) Attract child's attention to toy on a string suspended at midline 12 in. in front of child's chest.	2 Maintains balance for 8 seconds while extending arms and hands to grasp toy 1 Maintains balance for 5-7 seconds while extending arms and hands to grasp toy 0 Maintains balance for less than 5 seconds				
13	6	PULLING TO SIT (<i>Lying on back, feet toward you</i>) Hold index fingers out, touching child's hands, if necessary, to get child to grasp them. Once fingers are grasped, say, "Get up." Pull your hands back so child's arms become straight.	2 Pulls up to sitting position 1 Pulls up 45-90 degrees from the surface 0 Pulls up less than 45 degrees or remains lying on surface				
14 Start: 10-11 months	6	SITTING Place child in sitting position and release your support.	2 Sits unsupported for 60 seconds 1 Sits unsupported for 30-59 seconds 0 Sits for less than 30 seconds				
15	7	SITTING WITH TOY Place child in sitting position and release your support. Place toy 12 in. in front of child. Say, "Get the toy."	2 Retrieves toy, returns to upright sitting, and maintains balance for 30 seconds 1 Retrieves toy, returns to upright sitting, and maintains balance for 15-29 seconds 0 Fails to retrieve toy, return to upright sitting, or maintain balance for 15 seconds				
16 Start: 12-15 months	9	SITTING Place child in sitting position and release your support. Give toy to child and say, "Play with the toy."	2 Maintains balance for 60 seconds while manipulating toy 1 Maintains balance for 30-59 seconds while manipulating toy 0 Maintains balance for less than 30 seconds				
17	10	RAISING TO SIT (<i>Lying on back</i>) Place child on back on floor. Attract child's attention to toy and then place it on chair where child can see it. Say, "Get the toy."	2 Pulls up to sitting position, using chair for support 1 Grasps chair and rotates body in effort to raise up 0 Remains lying on floor				
18	10	SITTING UP (<i>Lying on stomach</i>) Place child on stomach on floor. Attract child's attention to toy ; then hold toy out of child's reach, about 2 ft. above floor. Say, "Get the toy."	2 Raises to sitting position 1 Attempts to maneuver into sitting position 0 Remains lying on floor				
19 Start: 16-26 months	13	KNEELING Place child in a kneeling position, buttocks not resting on heels. Keeping toy at child's eye level and about 2 ft. away, move it in arc to one side of child. Say, "Watch the toy." Return toy to starting position and then move it in arc to other side. (Take about 4 seconds for each segment of movement cycle: front to left, left to front, front to right, right to front.)	2 Maintains balance for 5 seconds while rotating head 1 Maintains balance for 2-4 seconds 0 Maintains balance for less than 2 seconds				

Item #	Age in Months	Item NAME, Position, and Description	Score Criteria	Administration			
				1	2	3	4
7 Start: 5 months	4	PROPPING ON FOREARMS <i>(Lying on stomach, chin and forearms resting on surface)</i> Attract child's attention to toy on a string and then suspend it 12 in. above child's face.	2 Elevates head and upper trunk 45 degrees and bears weight on forearms for 5 seconds 1 Elevates head and upper trunk 45 degrees and bears weight on forearms for 3-4 seconds 0 Elevates head and upper trunk, bearing weight for less than 3 seconds, or fails to elevate trunk				
8	4	ROLLING <i>(Lying on back, feet toward you)</i> Shake rattle at midline 12 in. above child's face. Slowly move rattle in arc toward surface. Repeat procedure to other side.	2 Rolls to side with opposite arm crossing midline (both sides) 1 Rolls to side with opposite arm crossing midline (one side only) 0 Remains on back				
9 Start: 6 months	4	EXTENDING ARMS AND LEGS <i>(Lying on stomach, head toward you)</i> Attract child's attention to toy on a string that you dangle at midline 12 in. from child's head. Observe child's arms and legs for 5 seconds.	2 Extends arms and legs (alternately or together) off surface for 3 seconds 1 Extends arms and legs (alternately or together) off surface for 1-2 seconds, or moves only arms or legs for 3 seconds 0 Arms and legs remain inactive				
10	5	FLEXING LEGS <i>(Lying on back, bare feet)</i> If child has socks on, remove them and then gently bend both legs toward child's face, wiggle and then release them.	2 Brings feet to mouth for play or grabs feet with hands (both feet must come up, alternately or together) 1 Raises feet 90 degrees or less or brings 1 foot to mouth 0 Legs remain on surface				
11	5	EXTENDING ARMS AND LEGS <i>(Lying on back, head in midline)</i> Attract child's attention to toy on a string that you dangle at midline 12 in. from child's head. Observe child's arms and legs for 5 seconds.	2 Raises arms and legs (alternately or together) in smooth, fluid movements within 5 seconds after toy is presented 1 Raises arms and legs (alternately or together) within 6-7 seconds after toy is presented 0 Arms and legs remain inactive				
12	6	EXTENDING ARM <i>(Lying on stomach, chin and forearms resting on surface)</i> Attract child's attention to toy on a string just out of reach. Say, "Get the toy."	2 Raises upper trunk, shifts weight to side, lifts free arm, and reaches toward toy 1 Raises upper trunk, shifts weight to side, and lifts free arm without reaching toward toy 0 Both arms remain in contact with surface				
13 Start: 7 months	6	FLEXING BODY <i>(Lying on back, bare feet)</i> Gently bend both legs toward head 3 times. Do not place feet in child's hands, but encourage child to grasp them by saying, "Get your feet."	2 Grasps both feet and holds them for 3 seconds 1 Grasps both feet and holds them for 1-2 seconds or grasps 1 foot and holds it for 3 seconds 0 Legs remain on surface				
14	6	PUSHING UP <i>(Lying on stomach, head turned to side, forearms resting on surface)</i> Attract child's attention to rattle . Shake rattle 12 in. in front of child's forehead and 6 in. above child's head.	2 Elevates head and stomach by pushing up with arms, bearing weight on palms for 5 seconds 1 Elevates head and stomach by pushing up with arms, bearing weight on palms for 3-4 seconds 0 Bears weight for less than 3 seconds				
15	6	EXTENDING ARM <i>(Lying on back)</i> Shake toy on a string and then hold it 12 in. to right of child's head and 12 in. above surface. Repeat procedure to opposite side.	2 Shifts weight to side and supports self with arm for 3 seconds while extending opposite arm to reach for toy (both sides) 1 Shifts weight to side and supports self with arm for 1-2 seconds while extending opposite arm to reach for toy (1 or both sides) 0 Remains on back				

Locomotion—7

Item #	Age in Months	Item NAME, Position, and Description	Score Criteria	Administration			
				1	2	3	4
11	27-28	THROWING BALL—Overhand (Standing in an open area) Demonstrate throwing tennis ball overhand at least 7 ft. Give ball to child. Stand 8 ft. away and say, "Throw me the ball."	2 Initiates throw by moving arm upward and back; ball travels 7 ft. in the air 1 Initiates throw by moving arm down and back, sideways and back, upward, or downward; ball travels 6 ft. or less in the air 0 Drops ball or throws in any direction other than forward				
12	29-30 Start: 39-46 months	THROWING BALL—Underhand (Standing in an open area) Demonstrate throwing the tennis ball underhand at least 7 ft. forward. Give ball to child. Stand 8 ft. away and say, "Throw me the ball."	2 Initiates throw by moving arm down and back; ball travels forward 7 ft. in the air 1 Initiates throw by moving arm sideways, upward, or forward; ball travels less than 7 ft. in the air 0 Drops ball or throws in any direction other than forward				
13	29-30	KICKING BALL (Standing in an open area) Kick stationary ball so that it travels at least 6 ft. forward. Place ball 6 in. in front of child and say, "Kick the ball hard like I did."	2 Kicks ball forward 6 ft. using opposing arm and leg movements and initiating kick by extending leg back with bent knee 1 Kicks ball forward 2-6 ft. using opposing arm and leg movements and initiating kick by extending leg back with bent knee 0 Fails to use opposing arm and leg movements or ball travels less than 2 ft.				
14	33-34	CATCHING BALL (Standing in an open area) Stand 5 ft. in front of child. Say, "Catch the ball." Toss ball so that it arrives at chest height, contacting child's outstretched arms.	2 Catches ball with hands and arms extended 1 Brings arms toward chest in effort to catch after ball contacts hands and arms 0 Turns away from ball or arms remain stationary				
15	39-40 Start: 47-52 months	THROWING BALL—Overhand (Standing in an open area) Demonstrate throwing tennis ball overhand at least 10 ft. Give ball to child. Stand 11 ft. away and say, "Throw the ball as far as you can."	2 Throws ball forward 10 ft. by moving arm up and back using upper trunk rotation, arms and legs moving in opposition 1 Throws ball forward 3-9 ft. by moving arm up and back or sideways and back using upper trunk rotation, arms and legs moving in opposition 0 Throws ball forward less than 3 ft. or throws ball by moving arm down and back with trunk remaining stationary				
16	39-40	HITTING TARGET—Underhand (Standing 5 ft. from wall) From 5 ft. away, toss tennis ball underhand to 2-ft. target taped on wall (2 ft. above floor). Say, "Throw the ball and hit the target like I did."	2 Hits target 2 of 3 trials using an underhand toss 1 Hits target 1 of 3 trials using an underhand toss 0 Fails to hit target using underhand toss				
17	41-42	CATCHING BALL (Standing in an open area) Stand 5 ft. in front of child. Say, "Catch the ball." Toss ball so that it arrives at chest height.	2 Catches ball with hands (securing it to chest if necessary) with arms bent 45-90 degrees at the elbows and palms up or facing each other 1 Catches ball by encircling it with arms and hands, then pulling ball to chest (arms may be held out straight in preparation to catch) 0 Fails to catch ball				
18	43-44	HITTING TARGET—Overhand (Standing 5 ft. from wall) From 5 ft. away, toss tennis ball twice overhand to 2-ft. target taped on wall (2 ft. above floor). Say, "Throw the ball and hit the target like I did."	2 Hits target 2 of 3 trials using an overhand toss 1 Hits target 1 of 3 trials using an overhand toss 0 Fails to hit target using overhand toss				

Object Manipulation—17

Item #	Age in Months	Item NAME, Position, and Description	Score Criteria	Administration			
				1	2	3	4
3	0	RELEASING RATTLE—Disappearing Reflex (Lying on back) Place rattle in child's hand. After child holds rattle for 5 seconds, observe amount of time before release.	2 Drops rattle within 3 additional seconds 1 Drops rattle within 4-5 additional seconds 0 Drops rattle after 5 additional seconds				
4	2	GRASPING RATTLE (Lying on back) Lightly touch child's palm with rattle . Say, "Get your rattle."	2 Grasps rattle 1 Touches rattle with fingers but fails to grasp it 0 Fails to extend fingers				
5 Start: 3-5 months	2	HOLDING RATTLE (Lying on back) Place rattle in child's hand.	2 Holds rattle for 30 seconds 1 Holds rattle for 15-29 seconds 0 Holds rattle for less than 15 seconds				
6	3	MANIPULATING RATTLE (Lying on back) Shake rattle and place it in child's hand. Say, "Shake your rattle."	2 Moves rattle 15 degrees 1 Moves rattle 5-14 degrees 0 Moves rattle 4 degrees or less				
7	4	GRASPING RATTLE (Sitting on lap, facing table) Place rattle on table within 3 in. of child's hand. Say, "Get your rattle."	2 Grasps rattle 1 Touches rattle 0 Extends arm toward rattle				
8 Start: 6 months	5	PULLING STRING (Lying on stomach) Place toy on a string so string is at midline between child's hands. Say, "Get the toy."	2 Grasps string, pulls it, and obtains toy 1 Grasps, touches, or pulls string 0 Looks at toy				
9	5	SECURING PAPER (Sitting on lap, facing table) Place 8.5 × 11 in. paper within 3 in. of child's hand. Say, "Get the paper."	2 Secures paper by pulling with open hand or by wrinkling it 1 Touches paper 0 Extends hand toward paper				
10	5	GRASPING CUBE (Sitting on lap, facing table) Place cube on table within 3 in. of child's hand. Say, "Get the block."	2 Grasps cube for 15 seconds 1 Touches cube for 15 seconds 0 Extends hand to cube but fails to touch				
11 Start: 7-9 months	6	GRASPING CUBE (Sitting on lap, facing table) Place cube on table within 3 in. of child's hand. Say, "Get the block." Observe how child picks up cube.	2 Grasps cube with 4th and 5th fingers and palm, or grasps cube with thumb and 1st and 2nd fingers 1 Grasps cube with little finger and palm 0 Grasps cube with whole fist				
12	6	SHAKING RATTLE (Sitting on lap, facing table) Place rattle in child's hand. Say, "Shake your rattle."	2 Holds and moves rattle for 60 seconds 1 Holds and moves rattle for 11-59 seconds 0 Moves rattle for 10 seconds or less				
13	7	SHAKING RATTLE (Sitting on lap, facing table) Shake rattle back and forth through a 90-degree arc 3 times. Place it on table in front of child. Say, "Shake the rattle."	2 Moves rattle 3 times through 90-degree arcs 1 Moves rattle 3 times through 45- to 89-degree arcs 0 Moves rattle less than 45 degrees or arcs less than 3 times				
14	7	GRASPING CUBE (Sitting on lap, facing table) Place cube on table within 3 in. of child's hand. Say, "Get the block." Observe how child picks up cube.	2 Grasps cube with thumb and 1st and 2nd fingers with space visible between cube and palm 1 Grasps cube with 1st and 2nd fingers and heel of palm (no space between cube and palm) 0 Grasps cube with whole fist				
15 Start: 10-12 months	8	GRASPING PELLETS (Sitting on lap, facing table) Place 2 food pellets on table within child's reach. Say, "Get all the food."	2 Grasps both pellets at once using a raking motion with fingers 1 Grasps 1 pellet using a raking motion with fingers 0 Touches pellet(s)				

Item #	Age in Months	Item NAME, Position, and Description	Score Criteria	Administration			
				1	2	3	4
10	4	APPROACHING MIDLINE <i>(Lying on back)</i> Dangle toy on a string 12 in. above child's chest. Say, "Get the toy."	2 Moves hand within 4 in. of midline while reaching for toy 1 Moves hand in any direction except toward midline 0 Fails to move hand				
11	4 Start: 7 months	FINGERING HANDS <i>(Lying on back)</i> Hold child's arms between wrist and elbow and bring child's fingers together at midline; then release your hands.	2 Engages fingers in mutual touching for 5 seconds 1 Engages fingers in mutual touching for 3-4 seconds 0 Engages fingers in mutual touching for 0-2 seconds				
12	6	BRINGING HANDS TOGETHER <i>(Sitting on lap, facing table)</i> Place cube in child's hand. Say, "Play with your block."	2 Brings hands together and secures cube for 15 seconds 1 Brings hands together and secures cube for 1-14 seconds 0 Fails to bring hands together				
13	6 Start: 8 months	EXTENDING ARM <i>(Lying on back)</i> Shake and hold rattle 12 in. from child's nose. Say, "Get your rattle."	2 Extends arm toward rattle with elbow angle greater than 90 degrees while other arm remains stationary 1 Extends arm toward rattle with elbow angle less than 90 degrees while other arm remains stationary 0 Extends both arms toward rattle				
14	6	RETAINING CUBES <i>(Sitting on lap, facing table)</i> 2 cubes Place cube on table and say, "Get the block." After child picks up cube, place 2nd cube on table. Say, "Get this one, too."	2 Picks up 2nd cube and retains both for 5 seconds 1 Picks up 2nd cube and retains both for less than 5 seconds 0 Picks up only 1 cube				
15	7	TRANSFERRING CUBE <i>(Sitting on lap, facing table)</i> 2 cubes Place cube in child's hand. Place 2nd cube on table within reach of hand already holding cube and as far away as possible from empty hand. Say, "Get this one, too."	2 Transfers cube to other hand and picks up 2nd cube with original hand 1 Transfers cube to other hand and extends either hand to 2nd cube 0 Reaches for 2nd cube without transferring 1st cube				
16	7 Start: 9 months	TOUCHING PELLET <i>(Sitting on lap, facing table)</i> Place food pellet on table within child's reach. Say, "Get the food."	2 Touches pellet with finger(s) 1 Touches pellet with palm or touches table near pellet 0 Extends hand toward pellet				
17	7	BANGING CUP <i>(Sitting on lap, facing table)</i> Bang cup 3 times on table; then set it down. Say, "Bang the cup."	2 Bangs cup 3 times 1 Bangs cup 1-2 times 0 Picks up cup but fails to bang				
18	8 Start: 10 months	POKING FINGER <i>(Sitting on lap, facing table)</i> Put pegboard on table in front of child. Demonstrate poking index finger into hole. Say, "You do it."	2 Pokes finger in hole 1 Places finger within 1/4 in. of hole 0 Touches table or pegboard				
19	8	REMOVING PEGS <i>(Sitting on lap, facing table)</i> Place pegboard with 3 pegs loosely inserted in front of child. Say, "Get the pegs."	2 Removes 1 or more pegs 1 Attempts to remove peg 0 Touches pegs				

APPENDIX D

MEDICAL ADVISORY COMMITTEE
CHRIS HANI BARAGWANATH HOSPITAL
PERMISSION TO CONDUCT RESEARCH

Date: 01 March 2011

TITLE OF PROJECT:

The developmental motor outcomes of children with hypoxic ischaemic encephalopathy 2 and 3 between the ages of 12-14 months at CH Baragwanath Hospital

UNIVERSITY: Witwatersrand

Principal Investigator Ms N Sukia

Department: Occupational Therapy

Supervisor (If relevant): Mrs D Franszen

Permission Head Department (where research conducted) yes

Date of start of proposed study: 1 March 2011

Date of completion of data collection 31 December 2011

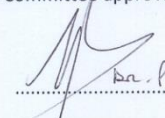
The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Hospital. The CEO /management of Chris Hani Baragwanath Hospital is accordingly informed and the study is subject to:-

- Permission having been granted by the Committee for Research on Human Subjects of the University of the Witwatersrand.
- the Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- the MAC will be informed of any serious adverse events as soon as they occur
- permission is granted for the duration of the Ethics Committee approval.


PROF. JOHN BETTIFOR
MBChB, FCF (S.A.)
CHIEF PAEDIATRICIAN
Recommended

(On behalf of the MAC)

Date: 01 March 2011


Dr. P. Lingham
Approved/Not-Approved

Dr. P. Lingham
MB B Ch (Rand) DCH(SA) DOH(Rand)
Deputy CEO
Chris Hani Baragwanath
Hospital
Mobile 082 419 1048
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Hospital Management

Date: 04 MAR 2011



Department of Health and Social Development

Occupational Therapy Department
Chris Hani Baragwanath Hospital
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2010.08.06

The Chief Executive Officer
Attention: Senior clinical executive
Chris Hani Baragwanath Hospital
P.O. Bertsham 2013

Dear Mrs Naik

N. SUKHA – Persal number 2264 5802

This is a request by Ms Sukha to do research with infants born at this hospital. It forms part of her MSc degree.

She is currently working in the neonatal unit and handles these babies daily. I support her request, as the research findings will guide therapists who are involved in early intervention.

I attach:

1. Letter of request
2. Ethical clearance by Wits University
3. Summary of the research protocol.

Yours sincerely

Tharina Coetzee
Asst Director

Supported Naik

APPENDIX E

Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Miss Neelam Sukha

CLEARANCE CERTIFICATE

M10532

PROJECT

The Developmental Motor Outcomes of
Children with Hypoxic Ischaemic
Encephalopathy 2 and 3 between the Ages of
12-14 Months at CH Baragwanath Hospital

INVESTIGATORS

Miss Neelam Sukha.

DEPARTMENT

Department of Occupational Therapy

DATE CONSIDERED

28/05/2010

DECISION OF THE COMMITTEE*

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE

CHAIRPERSON.....


(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Mrs D Franszen

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. I agree to a completion of a yearly progress report.
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

APPENDIX F

Information sheet

My name is Neelam Sukha and I am currently doing a masters degree in occupational therapy. I also work as an occupational therapist at Chris Hani Baragwanath hospital. I have worked with many children with Hypoxic Ischaemic Encephalopathy therefore I am currently carrying out a study to look at development of babies born with this condition. Since your child has this condition I would like you to partake in this study.

During this study I will assess your child's development using a standardized assessment tool. I will look at how your child moves and used their hands to hold things. I will also see how they play with a few toys. This will take approximately 30 minutes. The assessment is done to look at your child's motor development in terms how they react to their surroundings, how they control their own bodies, the way they move from one place to another, how they hold objects and play with toys and their ability to copy tasks. This study will aid therapists in providing early therapy guidelines for infants with this condition and will provide details of motor development in infants with this condition.

The information will be handled in a professional and confidential way and records will not have your child's name on them. Your participation in this study is voluntary and refusal to partake will in no way influence the treatment of your child.

If I find that your child has a problem and they are not attending therapy I will inform you about appropriate rehabilitation services .f you are willing to allow your child to take part in the study please read and sign the consent form.

Please feel free to contact me at any time for further information regarding this study.

Neelam Sukha

Occupational therapy Department

Chris Hani Baragwanath Hospital

(011) 933 – 9014

Informed Consent form:

I, _____ (name of parent / guardian) consent to
_____ (name of child) my child being part of this of
this study.

The study has been explained to me and I understand that the hospital medical records of my child will be used for the study.

I further understand that the study is voluntary and I can withdraw at any time and this will not impact on the treatment I receive at the hospital.

I have been given a copy of the Information Sheet with this consent form.

Please sign this letter to indicate your consent for partaking in this study.

Name: _____ (parent / guardian)

Date: _____

Signature: _____