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RECORD REVIEW OF PATIENTS WITH BRAIN ABSCESS AND EMPYEMA.

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the degree

of

Master of Occupational Therapy

Johannesburg, 2009.

Declaration

I, Katherine Linda Schwenke, 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.

……..(Signature of Candidate)

day of 2009.

Dedication

This work is dedicated to

FB, WM, C

Abstract

Studies of patients presenting with brain abscess (BA) and Empyema are not routinely focused on occupational therapy (OT). There is a paucity of literature on deficits other than hemiplegia. Aims of this study were to determine the relationship between BA, Empyema, motor and other deficits and whether an OT intervention protocol is needed. Record review was used to establish clinical presentation trends. Hemiplegia was the most common motor deficit and the majority scored below the norm on the Beery- Buktenika Developmental Test of Visual Motor Integration (VMI). Patients with Brain Abscess generally had more significant deficits than those with Empyema for both motor and process deficits. Part B followed up a small sample (n=8) which indicated clinical improvement on the VMI test with the score on the supplemental test of motor coordination remaining a concern. Occupational Therapy is recommended to address these issues based on the Occupational Therapy Practice Framework-II.

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Definition of Terms

Subdural Empyema- purulent infection of the subdural space of the brain[1,2]

Brain Abscess- purulent infection of the brain tissue itself[1,2]

Visual- Motor Integration- the ability to integrate visual images with the appropriate motor output[3]

Human Occupation- engagement in all areas of life- personal management, work, schooling[4]

Cognition- the mental process of knowing, thinking and learning[5]

Perception- a conscious registration of a sensory stimulus[6]

Prevalence- percentage of the population affected with a condition or disease at one point in time[5]

Hemiplegia- paralysis of one side of the body. Usually following an upper motor neuron lesion and often associated with changes in tone on that side of the body[2].

Abbreviations

BA- Brain Abscess

CP- Cerebral palsy

DTVP-II- Developmental Test of Visual Perception

EDE- Extradural Empyema

Framework-II - Occupational Therapy practice framework: Domain and process, second edition

MOHO-Model of Human Occupation

OT- Occupational Therapy

RVD- Retroviral Disease

SDE- Subdural Empyema

SES- socioeconomic status

TB- Tuberculosis

VMI- Visual Motor Integration

CHAPTER 1: INTRODUCTION

Both Brain Abscess (BA) and Empyema are rare but serious disorders [7-9] with an incidence of approximately 2- 3 patients per million per year[2]. Brain abscess (or cerebral abscess) and Empyema are considered suppurative infections in the central nervous system. Empyema commonly occur in the subdural space are known as Subdural Empyema, in the extradural space where they are known as Extradural Empyema or adjacent to the falx where they are known as Parafalx Empyema[1,2]. While cerebral abscesses occur in the brain parenchyma [1,2].. They both present more commonly in underdeveloped countries[10] and due to the rarity of BA and Empyema, especially in first world communities, very little research has been done on these conditions.

The clinical findings associated with BA and Empyema are related to the effect of a space occupying lesion. These symptoms include headache, fever, vomiting, seizures, mental changes and coma while the signs they present with are focal neurological deficits, papilloedema, hemiplegia, cranial nerve palsies and ataxia[1,7].

An occupational therapy (OT) evaluation of a patient including those with BA or Empyema considers the patient holistically. The occupational therapy practice framework: domain and practice, 2nd edition (Framework-II) was developed to express OT's holistic contribution to health promotion and participation[11]. This framework-II is divided into two sections-he domain which encompasses the professions body of knowledge and expertise and the process which is client- centred and focuses on delivery of OT services[11]. Together the domain and process of the Framework-II direct OT assessment and treatment to focus on the interaction of the client, context and his/ her occupations[11]. The domain area specifies amongst others, the performance skills and client factors to be assessed and treated in occupational therapy[11] Client factors are the abilities, characteristics or beliefs specific to that client that affect performance of occupations. These client factors include aspects such as body functions which are divided into mental functions, sensory functions and pain,

neuromuscular and movement related functions, cardiovascular and respiratory function, voice and speech functions and skin functions[11]. The client factors are ideal to be used of categorising the dysfunction seen in the patients with BA and Empyema.

Performance skills are concrete actions needed to engage in occupation. These skills are learned and develop over time[11]. It has been proposed that the body functions described above combine in distinctive combinations for engagement in occupation. Performance skills are divided into motor and praxis skills, sensory- perceptual skills, cognitive skills and communication and social skills. . This research focuses on the performance skills and client factors under the domain area and the evaluation component of the process area.

A model that is useful in occupational therapy in the planning, assessing, treating and final evaluation of a patient is Kielhofner's Model of Human Occupation (MOHO). The model also emphasises the importance of occupation and engagement but speaks of the interlinking spheres of volition, habituation and performance[4]. The mind- brain- body performance subsystem is similar to that described in the interlinking body functions and performance skills as described in the framework-II and as occupational therapists gives us a structure in which to view the patient's skills and abilities[4].

This model and framework provide an ideal structure for evaluating both the performance components and occupational performance areas of patients with BA and Empyema. This allows the occupational therapist to consider all deficits included within the patient's context which is necessary as although the physical (motor)components of BA and Empyema have been studied there is little research on the "mental" (cognitive and perceptual) implications of these conditions[8].

According to the International Classification of functioning, disability and health (ICF) cognition and perception are grouped together under the mental functions subsystem of the body functions section[12]. This correlates with the practice framework-II client factors, specifically mental functions

and performance skills specifically process skills[11]. Whereas cognition is the mental process of knowing and thinking, perception is the conscious registration of a sensory stimulus[5]. These concepts of perception and cognition are involved in an ongoing, mutually- influencing process[4]. Sensory integration studies found that problems with sensory perception were strongly related to learning problems[13]. Therefore cognition and perception, although different processes can be said to be related. There is sparse research into the mental (process) performance components secondary to BA and Empyema. Gormley et al. (1996) found in their research on cognitive problems that these are the most severe of the long term deficits seen following brain abscess. This was especially true in children with the long term implications being poor scholastic achievement up to six years post treatment[9]. Thus there is some evidence, although limited, that BA and Empyema cause cognitive problems with resultant poor functioning in at least one of the occupational performance areas- scholastic achievement.

No other more current research on the mental deficits found following BA and Empyema were found. The literature however does routinely list the physical (motor) performance component deficits e.g. hemiparesis and epilepsy[9,14] secondary to BA and Empyema. Since visual motor integration is the ability to synchronise visual perception and motor skills[15,16] this was the aspect reviewed in this study as this is also strongly related to learning and academic dysfunction. This ability is one of the foundational skills needed for school tasks such as handwriting [17-19].

According to Beery (1997) individuals with documented educational difficulties as well as children who are often sick or hospitalised have more difficulties with visual- motor integration. Beery hypothesises that the Beery- Buktenika Developmental Test of Visual Motor Integration (VMI) does therefore differentiate between subjects with problems and those that have no VMI difficulties[3]. This is consequently an appropriate assessment to use with patients at Chris Hani Baragwanath hospital as it is also easily administered and is low cost[3] and therefore suitable to use in a setting such as a tertiary hospital situated in Soweto. Soweto is the most densely populated urban

residential area[20] in South Africa with problems of poor housing, overcrowding, high unemployment and poor infrastructure. The Soweto population was found to have a low Socioeconomic Status on various SES scales and is considered a third world population[21] and therefore the population assessed at Chris Hani Baragwanath Hospital was considered to fall into the low SES bracket.

1.1 Problem statement

Due to the rarity of BA and Empyema [7,8], especially in first world communities where most medical research is conducted, this condition has received little attention. Although there is research on the motor and cognitive deficits with a diagnosis of BA or Empyema,

No research could be found on occupational therapy related to these patients. This research will therefore aim to lay groundwork for evaluating the occupational therapy specific needs of this group of patients.

This condition is more common in third world communities and although there are a number of patients with BA and Empyema seen at Chris Hani Baragwanath Hospital there is no rehabilitation-related research in this area. From personal clinical experience it was found there is no routine referral procedure of patients with BA and Empyema to occupational therapy if there are no obvious motor neurological sequelae e.g. hemiplegia/ hemiparesis. Based on the evidence above a protocol of using the VMI to assess all patients with BA and Empyema routinely on discharge was developed in the Occupational Therapy Department at Chris Hani Baragwanath Hospital in 2005. This was done to anticipate the effect of any motor related and visual perceptual problems these patients may have on their occupational performance academically. The need for this study was identified because of the lack of knowledge about what VMI deficits the patients present with and how this affects their return to school. Literature indicates that these types of problems may persist up to six years later[9] and therefore appeared appropriate to reassess the patients, with the VMI, at one year

post discharge. Therefore the population group to be studied are those patients who were attending school.

1.2 Purpose of the study

There are only two South African studies on the prevalence, treatment and clinical presentation available. These were both completed in Cape Town. There are no records about the BA and Empyema patients at the Neurosurgery unit at CH Baragwanath hospital. The purpose of this research is to collect data about patients at Chris Hani Baragwanath Hospital for two years in relation to deficits associated with BA and Empyema to:

- Describe demographic trends found in the Brain Abscess/ Empyema patient population.
- Establish the visual motor integration deficits associated with acute Brain abscess and Empyema and at one- year post infection.
- Ultimately suggest a framework that provides access to appropriate assessment and treatment by an occupational therapist as part of a multidisciplinary approach for every child with BA and E.

1.3. Aim of study

To review records of patients with BA and Empyema admitted to Chris Hani Baragwanath Hospital over a two year period to determine demographic trends, motor and process deficits commonly seen, as well as to compare their visual motor integration of these patients on discharge and one year post discharge

1.4. Objectives

1. To review occupational therapy records of all patients with BA and Empyema between 2005-2007 admitted to the Neurosurgery unit at Chris Hani Baragwanath hospital to establish the frequency of motor and process deficits noted by clinicians.

2. To establish a relationship between BA, Empyema and VMI problems in these patients.
3. To establish differences in discharge and one- year follow up VMI scores for patients with BA and Empyema.
4. To format an approach based on the Occupational Therapy Practice Framework- II to guide the treatment of these patients in occupational therapy.

CHAPTER 2: LITERATURE REVIEW

This review of the literature will consider brain abscess (BA) and Empyema and the neurological sequelae of these conditions. Human Occupation and its role in occupational therapy in patients with BA and Empyema in school going children will be considered. The relationship between Visual Motor Integration (VMI) and academic performance at school will also be discussed to determine the link between school performance, VMI and BA and Empyema. The use of record review as a research procedure will also be discussed.

2.1 Brain abscess and Empyema

Intracranial abscesses are serious, life threatening infections. They include brain abscess, Subdural Empyema and Extradural Empyema and Parafalx Empyema [22]. For the purposes of this literature review this topic will be discussed under the headings of brain abscess and Empyema. Few studies were found to classify and compare BA versus Empyema[23]. Brain abscess and Empyema are similar in many aspects but may differ in terms of predisposing factors, site and route of infection and neurological outcomes[23].

2.1.1. Brain abscess

In order to understand BA thoroughly it is important to look at current literature and issues that are being debated. Brain abscess is one of the most common focal suppurative processes of the Central Nervous System[9] although still considered a rare condition. A South African study conducted at the Red Cross Children's hospital in Cape Town found the incidence of Brain Abscess to be 98 in 25 years[24], while a study conducted at Groote Schuur hospital between 1993 and 2003 showed an incidence of 121 patients[25].

It is a purulent infection of the brain tissue[1] itself and is usually secondary to focal infections elsewhere, commonly in the sinuses[1]. Micro- organisms are introduced to the brain tissue due to trauma, infection within the cranium, meningitis or dissemination of a contagion through the blood stream[26]. Epidural abscess are most common following trauma and postoperative infections[27]. The temporal lobe and cerebellar hemisphere are common locations for BA[26].

There are commonly four stages of development of the abscess: Firstly, early cerebritis on days one to three, followed by late cerebritis on day four to nine. This is followed by early encapsulation on days 10 to 13. The late capsule stage is seen from day 14 onwards[26]. The literature suggests that the majority of organisms responsible for BA are anaerobic bacteria[26,28].

Brain abscess is usually diagnosed based on clinical signs and symptoms. These include behavioural changes, seizures and neurological deficits[28] and typically they present with evidence of an acute infection: nuchal rigidity, fever and malaise[28].

Brain abscess is considered an emergency, and despite aggressive therapy, mortality is still high[1]. According to McGillicuddy and Hoff mortality is between 22 and 33%[1], however in 1988 Johnson et al. found mortality rates to be as low as 5- 10%[28]. The differences in these statistics may be that the research carried out by Johnson et al. was done in the United States of America whereas McGillicuddy and Hoff were using international statistics.

2.1.2. Empyema

Empyema is defined as pus or infected fluid collecting in a body cavity. A purulent infection of the subdural space of the brain is known as a Subdural Empyema, whereas infection in the extradural space is an Extradural Empyema and that adjacent to the parafalx is a Parafalx Empyema [9]. The condition often results in an accumulation of pus with a resulting intracranial mass. This inflammatory response leads to brain oedema and as a result neurological deterioration[1].

Although Empyema is rare[27,29-31] it accounts for 22 to 25% of all intracranial infections and is usually secondary to other infections, most commonly sinusitis, meningitis or infection following trauma[1,29,32]. Empyema are always considered medical emergencies [10] and most patients present with a triad of symptoms- sinusitis, fever and a rapid, progressive neurological deterioration[29]. Signs of increased intracranial pressure such as headaches, nausea and vomiting are common [9]. Other neurological deficits routinely found following Empyema are hemiparesis, aphasia and focal seizures[9,29,32]. Hemiparesis of the contralateral side has been found in 85% of cases[29]. Patients deteriorate quickly if not treated and early diagnosis is made based on the clinical picture, supported by clinical tests such as computed axial tomography (CT) scans[9]. In patients where the primary source of infection is secondary to a surgical procedure or haematoma, there is a sluggish clinic course with no neurological deficit[9].

The type of microorganism responsible for the Empyema is related to the primary infection site. Most commonly, secondary to an infection of the sinuses, there is infection by anaerobic bacteria. This is significant as it influences which antibiotic treatment the patient will receive[9].

Before 1949 all cases of Subdural Empyema were considered fatal but advances in radiological diagnosis, surgery and antibiotic therapy have significantly changed the prognosis[9,31] . With the current improvements in treatment (neurosurgical as well as antibiotic) the mortality rate has decreased and now ranges between 14 % and 28%[29]. These statistics were from first world hospitals where patients were admitted to tertiary hospitals.

Only two research papers on South African trends was found[24,25] and the one research is over ten years old, while the other is not specific to patients of a school going age. Domingo et al. found mortality rates to be 16% between 1966 and 1991[24] while Sichizya et al. found mortality rates to be 13%[25]. Improved mortality rates have been shown since 1952, especially in cases where the duration of symptoms from onset is shorter[25].

Empyema as well as BA are more commonly seen in young males[28-30]. Tewari et al. reviewed 45 patient records of which 35 were male[29]. In a similar study where CT scans were evaluated Johnson et al. found a similar trend of the majority of the patients being male[28]. This is thought to be due to rapidly developing sinuses in young adolescent males and a tendency among boys to blow their noses vigorously[29]. BA and Empyema are also more common in developing countries[9,27]. The relative absence of medical care, accessibility of antibiotics in developing countries[27] or as a result of increased immunodeficiency in these countries[27]are thought to be contributing agents as well.

2.2 Sequelae of brain infection

Both BA and Empyema are commonly treated surgically where the entire infected area must be removed. Results were found to be more effective with prompt surgical treatment[9]. Prognosis is dependant on preoperative neurological condition of the patient. With improved management of BA and Empyema, neurological sequelae has dropped but still occurs in 4 % to 27 % of cases[9]. In South Africa in the 25 years up to 1991 Domingo and Peter also found a high incidence of morbidity (especially epilepsy) and behavioural and intellectual impairment. This study found only 25% of the population had a focal neurological deficit following brain abscess[24].In later years Sichizya et al. found only five percent of patients presented with a focal neurological deficit, specifically hemiplegia, while 11% of their sample developed epilepsy[25]. This more current study shows improvement in morbidity from the study conducted between 1966 and 1991.

Sequelae, commonly listed in conjunction with BA and Empyema are classified as focal neurological deficits, cognitive impairment and seizures. The focal neurological deficits most often seen are hemiplegia and aphasias[9]. Focal seizures are common, but more significant is a predisposition of these patients to status epiliepticus. Therefore routinely these patients are placed on anti-convulsant treatment[9,24]. This trend was also observed with the South African studies[24,25].

Cognitive disabilities are one of the most serious long-term problems. One study carried out by Carey and colleagues showed in 1972 that 70% of children tested six years post abscess were struggling at school[9]. Another follow up study by Nielsen et al [33] in 1983 found that at follow up (3-40 years following surgical drainage of the abscess) 43% of patients had neurological deficits and 15% had intellectual impairment. The neurological impairments included epilepsy, hemiparesis and aphasia[34]. Most of the patients with intellectual impairment had their abscess during childhood[34]. It also appears that the younger the child was when the initial abscess presented, the more affected the intellectual development of that child[9,34]. Both these studies are not recent and there have been advances in medical and surgical treatment of these cases[9] which will impact post- abscess and Empyema morbidity. The implication is that the prevalence of cognitive (process) deficits may not be as high.

Medical Problems themselves have also been found to impact on school performance[35]. Patients with BA and Empyema are routinely hospitalised for drainage and antibiotic therapy. Patients with BA and Empyema have also suffered a neurological insult that may further hamper return to school[9]. BA and Empyema are common in older children and adolescents[28] and as this is the age of school attendance there are implications for this occupational performance area. It is therefore imperative that all areas of human occupation are taken into account with patients with BA and Empyema.

2.3. Human Occupation, Brain abscess and Empyema

Human occupation is a uniquely human capacity to be involved in doing or to engage in action[4]. Human occupation is routinely divided into three broad areas of behaviour or occupational performance areas: play/ leisure, activities of daily living and work[4]. Work includes schooling and education[4,36] as it improves ability to engage in productive performance. In terms of this, the role of student is an important part of childhood (over the age of six years) and is also crucial in peer relations and preparation for adult life[4]. Education is also one of the most important tools for human

resource development and should therefore be available to all children[35]. School going children who are hospitalized are at risk for missing periods of school and therefore may struggle to return to school on discharge[35].

The Occupational Therapy practice framework: Domain and process, second edition (Framework- II) was developed specifically for occupational therapy to guide practice[11]. Inherent within this framework are the core beliefs of human occupation and independence. Human occupation will be discussed in more depth under G Kielhofner's model. The framework-II is divided into two sections- domain and process. Domain is the knowledge and expertise of the profession while process is the method in which occupational therapy service is delivered. These two aspects are intrinsically linked in deliverance of occupational therapy service, both assessment and treatment[11].

The Model of Human Occupation (MOHO) represents human occupation as three interlinking subsystems. These subsystems are volition, habituation and performance[4]. The volition subsystem is a collection of choices and knowledge of oneself that enables decision making within occupational behaviour[4]. It is essentially the person's motivation to engage in occupations. The impact of disease on this aspect of engagement can be debilitating. This may be due to a sense of loss, inability to make choices and frustration with current abilities compared to previous abilities. This aspect relates directly to client factors of Framework-II.

Habituation is the routine that governs our occupation. These routines are partly influenced by the social or cultural groups of which one is part and are uniquely individual[4]. The presence of either physical, cognitive or perceptual disturbances places restrictions on what may be accomplished by an individual[4]. Habits and roles fall under the habituation subsystem in MOHO and performance patterns in Framework-II and both indicate that the presence of dysfunction may restrict these[4]. Dysfunction may restrict these in terms of excluding an individual, causing them to fail or preventing opportunities for engagement[4].

The performance subsystem in MOHO is more correctly called the mind- brain- body performance subsystem. Underlying the subsystems mentioned above is the aptitude to perform[4]. Any disability typically involves disturbances of a combination of the neurological, musculoskeletal and cognitive systems[4]. In the case of BA and Empyema there is typically a disturbance of the neurological and cognitive systems[9]. The performance subsystem has implications on how occupational performance tasks are performed[4]. These implications are evident in the way in which tasks are performed and are referred to as skills[4]. These skills are divided into three types: motor skills, process skills and communication/ interaction skills. Motor skills include aspects like posture, mobility, coordination and are referred to in this research[4]. Process skills are used to coordinate all actions in an occupational task. These are classified under the broad headings of energy, knowledge, organisational and adaptive domains. These aspects are covered by client factors and performance skills in the Framework-II and include the visual perceptual and cognitive skills [4].Cognitive impairments related to BA and Empyema have been shown to impact on the patients competence to perform, but the effect of visual perceptual deficits has not been researched.

The communication/ interaction skills are divided into language, relations and information exchange[4]. These are some of the "process" deficits which may be related to neurological conditions such as BA and Empyema.

The last aspect of the MOHO and Framework-II that has implications on the patient with BA and Empyema is the physical and social environment[4]. This is particularly true of patients with long term complications of BA and Empyema. as the number of patients with cognitive impairments following BA or Empyema may be as high as 70%[9]. These individuals will therefore require environmental and/ or social adaptation to continue with appropriate occupational performance.

In studies where children with head injuries were investigated it was found that children with no previous school issues had multiple failures and many of the learners were put into remedial or slow learner classes[37].The research also found that the immediate effects of the head injury were the

most pronounced and that with time the majority of children appeared to recover. However when followed up after 5 years they found that a significant number (23.7%) had impaired performance on neuropsychological tests [37]. Klonoff et al also found that between 31% and 38% had residual neurological deficits [37]. These residual neurological deficits would negatively impact on any cognitive skills and therefore on the work area of occupational performance. Klonoff emphasises the importance of the environment although this research found large variance between prognosis and environmental resources[37].

Carey et al. conducted follow up research on 40 brain abscess survivors [38]. They found that although all patients returned to school, two thirds of the patients followed up had consequent school difficulties[38]. This indicates the impact of the BA and Empyema on the work occupational performance area. Research conducted by Seydoux and Francioli in Switzerland found that the sequelae following BA was serious enough to alter the occupational performance in half of the patients they reviewed[39]. Nielsen et al. on the other hand found that two thirds of the patients reviewed were able to return to work without restriction[33]. However half of these patients did have minor neurological deficits or epilepsy. This may be due to more accommodating work environments in Denmark where this study was conducted.

One of the skills needed for school performance and therefore the work occupational performance area is visual motor integration[17-19].

2.4. Visual Motor integration

Visual motor integration is the skill of synchronising visual perception and motor skills [16,40]. This is a complex process. To carry out intricate movements the central nervous system must firstly process sensory information efficiently. There is then perceptual interpretation of information into a stable spatial representation. This representation is formed from integration of information from proprioceptors and visual systems. Following this, precise movement is possible[41]. Visual motor

integration is dependant on other skills such as visual attention, visual memory and visual discrimination[16].

2.4.1 Localisation of Visual Motor Integration in the Brain

Despite the need for further research into localisation of brain functions, some research has been done to localise visual- motor integration. There is some agreement that the right hemisphere and the motor cortex contralateral to the dominant hand are responsible for this integrative function[3]. However researchers such as Grafton maintain that it is impossible to pinpoint the exact location where visual motor integration occurs[3]. These researchers propose that rather there is integration of information in various areas including the motor and sensory association areas, cerebellum and subcortical nuclei. This process is active[3].

Anderson has investigated the role of the posterior parietal cortex in visual- motor integration, spatial perception and visual- motion analysis. His findings indicate that the pathway in the dorsal areas of the extrastriate cortex is involved in spatial aspects of visual processing[42]. While other sources state that the skills necessary for visual perception are heavily reliant on vision with some references [19] arguing that vision is primary to the perceptual process [19], Anderson argues that vision is only one aspect of visual motor integration[42].

Almost 80% of all Empyema occur over convexities, below or surrounding the falx [32] and 12% occur in the interhemispheric fissure[32]. The patients found to have intellectual impairment in the Ali et al study usually had an abscess located in the frontal lobe[34]. Ali et al. investigated cognitive impairments, not necessarily perceptual impairments. Their findings are in keeping with the view that the frontal lobes are the higher control centres[12,34], while the parietal lobe is responsible for visual- spatial functions[12,42].

2.4.2 Development of Visual Motor Integration

The interplay between sensory processing, perception and motor output is a circular one and cannot be separated into different systems[41]. Rosenbaum et al. suggests that intellectual and perceptual-motor skills develop in similar ways and share neural areas of influence, especially in the cerebellum. In the cerebellum cognitive functions as well as perceptual abilities are linked and there is interplay between these apparently different systems[43].

Dunn et al. state that visual motor integration is an important aspect of a child's development in terms of both physical development and for formal learning activities [44], while Beery and Buktenika have emphasised the importance of the integration of the sensory and motor skills[3]for learning activities. A child may have age- appropriate motor and visual skills but be able to integrate the two. Beery emphasised the impact of this on higher levels of thinking and behaviour, which will in turn affect achievement in a scholastic environment[3]. Visual- motor is one of the first integrations of the brain to develop[3] and is necessary as a building block for other skills essential for a child to cope at school.

The effect of visual- motor integration problems may not be obvious until the patient is asked to perform a specific task. In these, the patient will be slow or unable to perform the task[16]. Deficits in visual perception have been found to affect a person's ability to use tools and materials, especially in relation to each other[16]. This in turn may affect composite skills like cutting, writing, construction toys, doing puzzles. These are all skills needed for school achievement[16].

2.4.3. School Achievement and Visual- Motor Integration

Goldstand et al. have found a significant relationship between sensory abilities (including vision), perceptual and perceptual- motor performance on school participation[19]. Specifically, VMI skills have been found to be very important in functional tasks such as handwriting, which are essential in

school performance[17,18]. This is particularly true because pencil and paper activities are one of the main mediums of instruction at schools.

Visual Motor integration is influenced by a number of motor skills such as pencil grip, fine- motor skills, eye- hand coordination and process skills like motor- planning and visual perceptual ability to name a few. Visual Motor Integration reflects the ability to combine all of these skills as each of these alone or in combination may influence academic performance [17,18]. Beery and Buktenika demonstrated the link between visual motor integration and performance at school when they found that a child's ability to copy geometric forms correlated significantly with their academic achievement[3]. Other research has previously linked performance on the VMI test to school performance: Duffrey et al found that VMI and Goodenough- Harris scores were linked to future academic achievement[18]; while Weil et al found that children with the ability to copy the first 9 forms on the VMI performed better at letter copying activities[18]; Klein also found the VMI to be an indicator of academic success in younger children[18]. All this research indicates that the VMI is an appropriate measure to determine school performance.

Research carried out on children in a mainstream school in Cleveland, Ohio, found a significant correlation between teachers subjective rating of academic performance and the VMI test scores [15]. This research used subjective teacher ratings as a measure because it is a common means of assessing school performance. This research could be applicable in SA where subjective teacher ratings are also used as a means of assessment in the younger grades. However it was conducted on upper- middle class, Caucasian children in the United States of America[15] which makes it less applicable to the South African context where the majority of the population are not upper middle class or Caucasian.

The VMI test was also found to be significantly correlated to the Stanford Diagnostic reading test, as well as mathematics achievement ratings[15]. A correlation was also found between the VMI and writing skills. Interestingly it was also found that there was a significant difference in VMI scores

between children performing better at maths and reading than those who performed inadequately[45]. Sortor et al indicated that these significant correlations between perceptual motor skills and learning skills may contribute to basic learning skills such as:

- Accurate visual perception of letters
- Form constancy (this is important to ensure that differences in handwriting and font can be accurately interpreted)
- Visual discrimination of similar letters
- Visual memory
- Visual spatial skill
- Visual fine motor skill [45]

These are motor and process skills used in schooling which indicates again the relevance of using the VMI as an assessment tool. Because of this large body of evidence to support the positive link between scores on the VMI test and achievement at school it was felt to be an appropriate test to draw conclusions about the BA and Empyema population. However most of the research mentioned was carried out in developed countries and was not related to individuals with neurological difficulties.

Visual motor integration problems that may arise following BA or Empyema have not widely been investigated. School achievement has also not been widely investigated following BA or Empyema. In other studies where children with head injuries were investigated it was found that children with no previous school issues had multiple failures and many of the learners were put into remedial or slow learner classes[37].This research also found that the immediate effects of the head injury were the most pronounced and that with time the majority of children recovered. However when they followed up these children at five years they found that a significant number (23.7%) had impaired performance on neuropsychological tests [37]. Klonoff et al also found that between 31% and 38% had residual neurological deficits [37].

2.4.4 Visual Motor Integration problems in brain injury

Unilateral brain injury in adults results in specific patterns of deficits. Studies on children have shown less specific patterns of dysfunction[46]. Visual perceptual deficits have commonly been studied in children with cerebral palsy. In these patients the prevalence of perceptual problems ranges from 39 to 100% [47]. Abercrombie et al. found the test scores of children with neurological deficits to be lower than non- neurologically impaired children with motor impairment[48]. Akshoomoff et al. found that at each age of development the subjects struggled with age appropriate skills. These resolve to near normal levels of performance, but then on presentation of more difficult tasks the deficits reappear[46].

Only one study relating specifically to Empyema and visual motor integration was found[8]. This case study of only one patient showed below age- appropriate standard scores for visual motor integration both on initial assessment and on reassessment at six months[8]. However the case study was of a 13 year old boy who had a history of learning and behavioural difficulties. Unfortunately no premorbid VMI test was completed so it is difficult to conclude whether these problems were premorbid[8]. Maertens et al. did conclude however that neuropsychological tests correlated well with CT scans and clinical findings and were sensitive to dysfunction that may go undetected on CT scans[8]. The VMI test could well be one of the tests to be used in these instances because of its high correlation with other standardised tests[3,15,45].

2.5 Tests of Visual Motor Integration

Standardised tests are used in occupational therapy practice to determine a patients need for therapy, to monitor their progress and to guide decision making about appropriate intervention[49].Tests that can be used to assess Visual Motor Integration are the Bender Visual Motor Gestalt, the Benton Visual Retention Test and the Developmental test of Visual Motor Integration[6]. These tests all require the copying of a geometric form. The Bender was published in 1963 and the

Benton in 1974. The Developmental Test of Visual Motor Integration although developed in 1967 has been revised and the 1997 version is currently being used at Chris Hani Baragwanath hospital[6]. Other tests such as the Developmental Test of Visual- Perception (revised) (DTVP-II) were not chosen as they assess a range of visual perceptual skills, not specifically visual motor integration.

2.5.1. Developmental Test of Visual Motor Integration

Vereeken found that the copying of geometric forms does measure visual- motor integration as the individual needs to be visually aware of location and direction of forms and then needs to construct the form using fine hand and arm movements that correspond to eye movements[3]. Beery and Buktenika used this concept when they published the first version of their test for visual motor integration in 1967 as the Beery- Buktenika Developmental Test of Visual Motor Integration. The test is designed to assess to what extent the individual can integrate their motor and visual abilities[3].

The 1997 revised version of the test is being used currently at CH Baragwanath Hospital[3]. This version of the test was the first to include the supplemental tests. The supplemental tests which are called visual perception and motor coordination are administered after the VMI and are timed by the tester. The supplemental tests are helpful in determining whether it is the individuals visual or motor abilities that are impaired and are affecting the individuals overall VMI[3] or whether integration of these skills itself are problematic.

Both the VMI test and its supplemental tests have a one- point- per- item scoring system. This one point raw score can then be converted to a standard score. Standard scores are similar to those used to represent IQ scores. They have a mean of 100 and standard deviation of 15[3]. The VMI test standard scores are presented in two month intervals while the supplemental tests standard scores are presented in four month intervals ranging from three years to adults[3].

The VMI test consists of 27 shapes that are graded in complexity. The first three shapes are imitated and the remaining 24 shapes are copied by the subject. The three imitated shapes are included in the total score and therefore in the standard score[3].

The test has been found to be both reliable and valid. It has also been used on individuals with educational, psychological and neurological problems[3]. One thousand and thirty children were originally used in 1964 to norm the VMI. This was followed up using 2060 children in 1981 and 2734 children in 1989. All these norms were established in the United States of America[3]. The visual perception and motor supplemental tests were normed using 2614 children in 1996[3]. These norms have been found to be consistent over time and place[3].

2.5.2. Developmental test of Visual Motor Integration in the South African context

The VMI test was deemed suitable for use with a population at Chris Hani Baragwanath Hospital as it has been used on individuals with educational, psychological and neurological problems[3]. The lack of cultural bias of the VMI test [3], has been supported by research conducted on a multi- ethnic South African sample. They found that the VMI is an appropriate tool to use on a South African population[44]It was found that in a sample of 238 preschoolers in South Africa that there was a strong correlation between scores on the VMI test and The Copying Test. However there were statistical differences between the different racial groups and socioeconomic classes. The research also found that The Copying Test correlated better with teachers subjective ratings of the children's abilities[44]. The study concluded that although there were significant differences on visual perceptual testing between racial groups and socioeconomic classes the scores were consistent between tests[44]. However the research was carried out on a small sample from one specific semi- rural area and this may affect its validity in generalising these trends to an urban population such as Soweto. This indicates that the VMI test is valid for use on the South African population as a visual motor integration diagnostic tool.

Performance on VMI test has been linked to socioeconomic status [3,44]. Research found that in young children issues such as poverty, attending overcrowded and poorly resourced schools negatively affects development. It was also found that VMI test results improved proportionally with socioeconomic status[44]. Thus socioeconomic status has been well documented as an indicator of performance on the VMI test. Within the South African context previously disadvantaged groups and those of lower SES were those of colour[20,21]. This may account for this link found in South African in unpublished research conducted on a representative South African sample in The Eastern Cape. This study analysed VMI test scores according to SES status and racial groups[50]. A statistical correlation between SES and scores on the VMI motor subtest, but not on the VMI test or visual perceptual subtest was reported. VMI scores were analysed according to population group (African, coloured, white) and found that there was no statistical correlation between the VMI and motor tests and population group. They did find that there was a correlation on the visual- perceptual subtest in the African group, with this group scoring significantly lower on this subtest[50]. As a result it was proposed that there should be South African specific norms for the VMI test[50]. The research was however only conducted on a narrow age range of seven years, nought months to seven years, three months[51], so the recommendation should be viewed in this light.

Dunn et al. also recommended that further research be done into the evident disparities between urban and rural communities and SES[44]. They suggested that assessment of visuomotor skills norms should be differentiated by race and SES[44]. Older research from 1976 also questioned whether the VMI test was culturally unbiased[52]. This research looked at the correlations between 58 black children and 33 white children on the Bender- Gestalt test and the VMI test. Their findings suggest that neither test is helpful in alleviating racial differences. This research admits that it was only a preliminary investigation and its results should only be cautiously used in extrapolating trends to broader populations[52]. Chris Hani Baragwanath Hospital serves a historically disadvantaged community that struggles with the issues of poverty, poor school services and poor accessibility to resources which may impact on VMI test scores. Visual Motor Integration test scores were taken

from existing occupational therapy records. It is therefore important to consider record review as a research tool.

2.6. Record review as a research tool

The HPCSA has published a document "guidelines with regard to the records of patients". These guidelines state that the following are to be compulsory in each patient's records:

- Personal particulars (this was unspecified)
- History of the patient
- Times/ dates and places of every consultation
- Assessment of the patient's condition
- Proposed management
- Referrals to other professions
- Patients reaction to treatment
- Test results
- Consent (if applicable)[53]

This document also states that records may not be altered and additional entries need to be dated and signed [53]. Unfortunately the guidelines are not specific as to the depth of information required in treatment and assessment notes.

Badcock et al. found that record review is an appropriate research tool when used as a pilot study in planning, as a quality assurance tool, in looking at patterns of disease over long periods and investigative questions where patients cannot be randomized [54]. A record review is used to obtain information from various documents that were not necessarily intended for the purpose of the research which may result in missing information[55].

It has been found that the quality of documentation in medical records is of variable quality [54]. Some of the limitations of using a record review are that the clinicians record the information they feel is relevant or important making the records subjective [54]. It has also been found that legibility and interpretation of information are problematic when using a record review [54]. It is also interesting to note that in record review studies the researcher extracts information from documents that weren't created for the purpose of that particular study [55] which accounts for missing information

Record reviews seldom provide information about the best treatment approach but they can raise and suggest ideas about treatment, prognosis and give suggestions for further studies [56]. Lowenstein suggests that the biggest advantage of record reviews is that they provide information during ordinary medical care. There are no expectations or skewed results as a result of a patients perceived involvement in research[56]. Record review is also an ideal method for small sample size studies. Petersen states that although studies on participants with a specific disease often result in small sample sizes, this type of research remains important because it often provides data that would otherwise not be available and lays the groundwork for future research[57].

However the major limitation is that there is no standard for patient care or the manner in which patient records are kept. This is usually seen in the vague descriptions recorded. for example "patient well, no complaints". Also most records are recorded in a casual haphazard way which is less conducive to studying. It has also been found that up to one third of background history is lost when emergency physicians record information on admission [56].

More relevant to this research was research done on record retrieval on physiotherapy records in Gauteng, South Africa [58,59]. With transformation of the government in 1997, came attempts at transforming Health care[58,60]. This was documented in the White paper: transformation of the health system in South Africa. Part of these attempts was the development of the national health information system (NHIS) to facilitate health management. Unfortunately there has been little

emphasis on the quality of records kept and therefore of data recorded. This seems to be especially concerning among rehabilitation records [58].

M'kumbuzi et al [58] found that most physiotherapists were more concerned with patients receiving physiotherapy than ensuring that records pertaining to these clients were well kept. No studies were found that investigated OT records and so these conclusions regarding physiotherapy records are being inferred for OT records.

2.7. Summary

There is a paucity of research on BA and Empyema and their impact on performance components and occupational performance. From the literature various inferences can be drawn about the impact of a space occupying lesion on the physical and mental performance components, particularly in the occupational performance area of scholastic achievement[9].

Visual motor integration has been shown to be a predictor of scholastic achievement and can be easily assessed using the Beery- Buktenika VMI test on individuals attending occupational therapy at Chris Hani Baragwanath Hospital. This test has been shown to be consistent in use with a South African population.

Due to the rarity of BA and Empyema a record review was considered the best method to determine the visual motor integration ability of patients with BA and Empyema at Chris Hani Baragwanath Hospital.

CHAPTER THREE: RESEARCH METHODOLOGY

This study made use of record review and a single group pre- test post- test design. The reasons for the choice of design are explained below.

The project was completed in two parts:

Part A- Record review of occupational therapy records of all patients admitted to Chris Hani Baragwanath Hospital with BA and Empyema between December 2005 and May 2007. These records included an initial VMI score

Part B- Pre- Post test design. A follow up VMI test was administered on patients' whose records were reviewed. This was carried out at least one year post discharge.

PART A- Record Review

3.1. Type of design

A descriptive study design using retrospective record review was used. All occupational therapy records of patients with BA and Empyema admitted to the Neurosurgery unit at Chris Hani Baragwanath Hospital who attended school thus of the age group six to 18 years, were retrospectively reviewed. Routinely on discharge all patients with BA and Empyema are screened for visual motor integration difficulties using the VMI test and the visual and motor sub-tests and these results were also recorded.

Although prospective study designs have been recommended for small and rare conditions like BA and Empyema, this design's draw back is that it could take up to five years to get a representative sample. Record review has therefore been selected for this study. Review of records for research is an important and frequently used way of assessing outcomes of a condition where patients are not easily accessible[61]. This type of design was considered suitable due to the rarity of BA and Emyema[7-9]. It was not possible to obtain a large enough sample for a prospective study. A review of the

occupational therapy records was used to determine the demographic data, the motor and process deficits and the visual motor integration scores of the BA and Empyema population.

3.2. Population and Sample selection

All records of patients with BA and Empyema that were admitted to the Neurosurgery unit at Chris Hani Baragwanath Hospital were reviewed. Records of patients admitted between December 2005 and May 2007 were used. Thirty three records were available for review. Since one of the objectives focused on visual motor integration and its affects on scholastic achievement, only the records of those patients that attended school were reviewed thus giving an age range of six to 18 years.

3.2.1 Sample size

It was determined that from a sample size of 31 subjects a 90% confidence interval for the prevalence of Visual motor integration problems and motor and process deficits can be determined to an accuracy of 15%. This sample size was determined following the conservative approach that the prevalence of visual motor integration problems and motor and process deficits is 50%. The confidence and accuracy was motivated by the fact that the research is addressing a rare condition[7-9]. Although at least 31 subjects were needed, 33 suitable records were sourced and reviewed.

3.3. Data capture instrument

A record review was undertaken using the existing occupational therapy records of each patient. Information found in these records was gathered from medical hospital files and a comprehensive occupational therapy assessment, in order to fulfil the objectives of the research the following detailed medical information:

- Location of BA or Empyema

- Cause of BA or Empyema
- Demographic data

and the following functional information:

- VMI scores of the Beery- Buktenika Developmental Test of Visual Motor Integration(
- Motor Coordination subtest scores of the Beery- Buktenika Developmental Test of Visual Motor Integration
- and Visual Perception subtest scores of the Beery- Buktenika Developmental Test of Visual Motor Integration(appendix 1),
- Motor and process deficits (appendix 7)

A protocol for the pre- discharge administration of the VMI test was developed prior to inception of this research. The VMI test was used as it was readily available at Chris Hani Baragwanath hospital and was easy to administer. Only information obtained from the VMI test was included in the data collected as it gave good insight into visual motor integration deficits experienced by subjects and other tests were excluded as they weren't routinely used to assess these patients.

The information available in the occupational therapy records was inconsistent. This presents a limitation of using record review as has been discussed in the literature review and discussion.

3.4. Research Procedure and data collection

Ethical clearance was obtained from the Ethics Committee for Research on Human Subjects at the University of the Witwatersrand (M070431) (Appendix 2). Permission was received from the Chief Executive Officer of Chris Hani Baragwanath Hospital and the Occupational Therapy Department to carry out research and that the records would be made available to the researcher. All occupational therapy records reviewed contained information about occupational therapy assessment and treatment. It was found that therapy only started once the patients were medically stable. All

medical information was recorded on the spreadsheet from the occupational therapy records. The information recorded was date of admission, location of lesion, cause of the BA or Empyema, demographic data and other medical problems. Occupational therapy was routinely carried out for these patients who were referred. Those that had no need for occupational therapy were only seen on discharge for the administration of the VMI test.

The VMI test was administered routinely on discharge for all patients with BA and Empyema and the scores and test forms were stored with the patient's occupational therapy record. If there were any problems noted on this test the patient was given an appointment to continue with occupational therapy for this problem on discharge. If the patient is transferred to another hospital referral letters were written to those hospitals to continue out- patient treatment for this problem.

Once records had been retrieved the spreadsheet (appendix 9) was filled in by the researcher. The spreadsheet was coded and a list of the patients' names with their code was kept separately by the researcher to maintain confidentiality.

Rigour was introduced into the study by the same person collecting all the data from the records so there was consistency about what was extracted from records. All suitable records were reviewed and all data was recorded in a standard format.

PART B- Post discharge follow up

3.5. Type of design

A longitudinal pre- post test design was used to follow up the subjects whose records had been reviewed. In this design subjects are tested one or more times after initial testing. The fundamental feature of this design makes it possible to evaluate individual change over time[62]. Patients that were available to return for a follow up VMI assessment one year post discharge were approached by the occupational therapy department at Chris Hani Baragwanath Hospital to return for reassessment.

In using a retrospective record review no matched control group was utilised for this study possibly affecting the internal validity of the study.

3.6. Population and Sample Selection

Of 33 subjects whose occupational therapy records were reviewed in Part A, two subjects were deceased and one subject had no contact details. Of the remaining 30 records 26 had correct details which were used by a research assistant employed at the department of occupational therapy at Chris Hani Baragwanath Hospital to contact the subjects with information about the research project. The subjects were invited to participate in the study and subjects requested to attend a follow up assessment if they were willing to take part in the research. Five of these subjects declined for unspecified reasons. Four other records had incorrect or expired contact details and the subjects could not be contacted. Patients for which there were no telephone contact details were contacted by telegram asking them to make contact with the research assistant.

Drop out mortality rate is problematic in a small sample study as there can be a threat to the overall research results[62]. The drop out mortality rate in this case was 0.6% (2 patients) and did not dramatically affect the results.

Of the 21 patients contacted only eight attended the follow up assessment session.

3.7. Measurement Instruments

3.7.1 The Beery- Buktenika Developmental Test of Visual- Motor Integration

Tests that can be used to assess Visual Motor Integration are the Bender Visual Motor Gestalt, the Benton Visual Retention Test and the Developmental test of Visual Motor Integration[6]. These tests all require the copying of a geometric form. The Bender was published in 1963 and the Benton in 1974. The Developmental Test of Visual Motor Integration although developed in 1967 has been revised and the 1997 version is currently being used at Chris Hani Baragwanath Hospital[6]. Other tests

such as the Developmental Test of Visual- Perception (revised) (DTVP-II) were not chosen as they assess a range of visual perceptual skills, not specifically visual motor integration.The VMI test was used for the one year follow- up testing to assess visual motor integration. This test was developed by Keith Beery who is a psychologist specializing in child development[3]. It consists of a test of visual motor integration and two supplemental tests of visual perception and motor coordination. In 1967 the test was first published as the Beery- Buktenica Developmental test of Visual Motor Integration. It was republished in 1989 with weighted scoring. This weighted scoring was revised when the supplemental tests for visual perception and motor coordination were introduced in 1997[3]. It was republished in 2006 but for the purposes of this research the 1997 version of the VMI test was used as this is what is available at Chris Hani Baragwanath Hospital and had been used to assess the patients whose records were reviewed. According to Beery the VMI is a developmental sequence of geometric forms that are copied to assess the ability of subjects to combine visual and motor abilities[3].The VMI test is administered to a subject with standardised instructions, instructing the subject to copy the shape into a block below the stimulus.

The supplemental tests can be administered to compare the subject's visual and motor abilities. These tests use the same geometric forms but are administered after the VMI. In the visual perceptual test one stimulus that is exactly the same is chosen from amongst others that are slightly different. The subject has three minutes to indicate the correct pattern. In the motor coordination test the subject traces between double sided lines without crossing the lines. In both supplemental test the other demand (i.e. visual perception in motor coordination test and motor coordination in visual perception test) has been reduced [3]. The supplemental tests are timed by the examiner.

The VMI can be administered both individually and in a group. Beery states that older children of a school going age can be tested in a group. It is important with all ages to monitor and ensure the correct posture and procedure of subjects[3].

The 27 forms are each allocated one point if they are correct and zero points if they are incorrect, thus giving a possible total score of 27. There is specific criteria for correct scoring of each form

which is available in the administration, scoring and teaching manual[3]. Please see test forms and scoring forms in Appendix 1.

On development of the test, 72 geometric forms were selected. These forms were analysed according to chronological age abilities. This was narrowed to 30 forms and finally to 27. The final forms were selected based on the chronological age abilities and that the earlier forms were appropriate for preschool ages in order for it to be more useful as an early screening tool[3]. The norming of the forms has been discussed earlier.

The VMI test was found to be both reliable and valid. Reliability scores were as follows[3] as represented in table 3.1.:

Table 3.1. Reliability and validity of VMI test

	VMI	Visual	Motor
Interscorer	94	98	95
Content sampling	96	N/A	N/A
Time sampling	87	84	83
Average	92	91	89

Beery, K. 1997. Pg 110.

A test must be reliable or consistent in its measure before it can be considered a valid measure[3]. Content validity is determined by the procedures used in choosing the items for the test [3]. As discussed previously the norming procedure for the test was very strong indicating strong content validity[3].

Concurrent validity (scores of VMI were compared to other tests designed to measure similar constructs) was good although correlations were only moderately high with newer less well developed tests[3].

Construct validity was also good. The constructs examined in the VMI test were all found to correlate indicating good construct validity. Much research has been done on the predictive validity

of the VMI and has found that, particularly in combination, it is an excellent predictor of future problems[3,17,19,44].

The VMI was also found to be gender and ethnically neutral[3] by some researchers, which was also found when research was conducted using the VMI on a South African population of pre- schoolers [44]. Unpublished research conducted on a South African population found there was no statistical difference between VMI test results, visual perceptual results and different SES levels, but that there were statistical differences between motor test scores and SES[51]. But other research, in contradiction has found that race as well as SES status impact scores on the VMI test[44,50].

No significant differences were found on the VMI test between rural versus urban populations[3]. However there was a statistical difference between scores of subjects of high versus low socioeconomic status[3,44]. All subjects in this research were from low SES and therefore the reliability of the findings cannot be generalised to the entire population.

Inter-rater reliability has ranged between .73 and .99[3] for pre- school and primary school children. However inter-rater reliability was poor when the VMI test was administered by inexperienced scorers[3]. In this research the VMI test was administered by qualified occupational therapists who had been trained as undergraduate students on the test and therefore inter-rater reliability should not be negatively influenced.

The use of the VMI test with BA and Empyema did have some limitations. Although there are many tests which may be more appropriate as measures of school performance, the Beery- Buktenika test of Visual Motor Integration was chosen as it had been routinely administered as part of the occupational therapy protocol, it is easy to administer, cost effective and relatively culturally unbiased[3]. This study was also limited to assessing visual motor integration and relating this to the school area of occupational performance. Rigour was added to the study by comparing scores on a normed standardised test which has been shown to be suitable for use in South Africa. There are limitations of using the VMI test with a South African population. Due to the small sample size which

was homogenous in terms of race and assumed SES (all patients followed up came from Soweto and surrounding townships) these factors were not considered in the analysis of the results of the study.

3.7.2 Interview

An informal interview was conducted with the patients who returned for a follow up assessment. The patient was interviewed briefly to determine descriptive, subjective, qualitative data about how they were managing at school. The following questions were asked:

- Are you coping at school?
- Have you failed at school since being hospitalised?
- Are you struggling with anything that you previously found you could cope with?

This information was collaborated with the caregiver who accompanied the patient to the follow up assessment. Please see the attached interview form (Appendix 6).

A research assistant contacted the subjects who had agreed to complete follow up assessments to make an appointment. This was done in the vernacular to ensure the patients understanding of the appointment time and date. These subjects were seen in the Occupational Therapy Department at Chris Hani Baragwanath Hospital. An information sheet (Appendix 3) was given to their parents and the research was explained to them and their parents if required by the research assistant. Informed consent forms (Appendix 4) were signed by their parents/ guardians and assent forms (Appendix 5) by subjects themselves. A follow up VMI test was administered on these subjects including the supplemental tests of visual perception and motor coordination were also administered. Additionally the motor and process deficits were assessed using the non- standardised checklist (Appendix 7).
A brief, informal interview was done with the subject and their parent/ guardian about the subject's current school performance.

3.9. Ethical Considerations

Permission from the hospital was obtained. Ethical clearance was passed by the Ethics Committee for Research on Human Subjects of the University of Witwatersrand (M070431). (Appendix 2)

Verbal permission has been given by the Head of Department of the Neurosurgery department, Professor Gopal and the head of the Occupational Therapy Department, Mrs JC Coetzee to carry out this research.

All subjects were given the choice to refuse assessment and treatment by Chris Hani Baragwanath hospital and this is taken into account when occupational therapy treatment is given to patients. The subjects were invited to participate in the follow up assessments in the Occupational Therapy Department. If they agreed and came for the follow up appointment their parent/ guardian signed informed consent and the subjects signed their assent to participate.

Subjects were assured that refusing to participate would not result in any consequence to them in relation to any occupational therapy treatment they were receiving or may need to receive in the future. Patients and parent/ guardians had the option to withdraw at any stage of the study.

It should be noted that the measurement technique and data analysis as described below was the same for part A and part B of the study:

3.10. Measurement technique

Records were reviewed in part A of the study as described previously. In part B of the study VMI tests were administered. These were recorded on the VMI test forms and the informal data on school performance was recorded in the occupational therapy records.

One- point scoring is used to mark the forms. There is specific scoring criteria set out for each form[3]. The subjects' results were recorded on the test booklet and scores were entered into a spreadsheet.

3.11. Data Analysis

3.11.1 Descriptive statistics

Descriptive statistics were used to analyse demographic results and establish trends. Mean ages were calculated and percentages were calculated for place of residence and gender. The frequency of diagnosis and causes were determined and plotted on graphs. Motor and process deficits were represented graphically and the prevalence of these deficits per diagnosis was also represented in bar graph format.

Visual Motor Integration scores were represented in tables indicating the range of standard scores and frequency of these scores.

Correlations were calculated between the deficits and VMI scores and these were also represented in table format.

Comparisons were made between pre and post test VMI scores and p- values were calculated to determine the statistical significance of the change in scores. T-test was used to analyse the differences in scores.

The VMI test is a standardised test with the distribution of test scores following a normal or bell-shaped curve. This curve is due to the fact that the majority of people fall within the middle part of the distribution, and increasingly smaller numbers receive scores at the high and low ends[49]. Standard deviation or z- scores of between one and minus one represent this middle portion of the population. A negative value on the standard deviation or z- score is indicative of a z- score that is below the mean[49]. Generally z- scores below minus one are considered to be indicative of a delay or deficit in this particular area[49] and an indication for treatment of VMI.

3.11.2 Inferential statistics

Comparisons were made between pre and post test VMI scores and p- values were calculated to determine the statistical significance of the change in scores. T-Test was used to analyse the differences in scores as well as confidence intervals.

The numbers on the supplemental tests are different as not all subjects completed these tests. The limitation of using a t-test was that this was a small sample that was not normally distributed and therefore non- parametric statistics would be a better option. In view of possible clinical significance, confidence intervals were used but also used. The Wilcoxon Sign test was used as a final method for looking at differences between means of paired samples as it was assumed with a small sample size that the data would not be normally distributed.

CHAPTER FOUR: RESULTS

In this chapter the data collected from the record review as well as from the post- discharge follow-ups is outlined and presented.

The results will be presented in two parts:

Part A- A record review of occupational therapy records of all patients admitted to Chris Hani Baragwanath Hospital with BA and Empyema between December 2005 and May 2007. These records included an initial VMI score for 33 patients whose records were reviewed.

Part B- A follow up VMI test was administered on patients' whose records were reviewed. This was carried out at least one year post discharge.

PART A- Record review

4.1. Demographics

Thirty three occupational therapy records of patients treated in the Chris Hani Baragwanath Hospital's neurosurgery unit, were reviewed (n= 33). All of the records reviewed were of patients who were attending school at the time of admission.

Table 4.1. illustrates the demographic profile of study population (n= 33).

Table 4.1: Demographics of record review sample (n= 33)

Characteristics		
Age range (on initial assessment)	8 years – 21 years	Mean age: 16.2 yrs
Place of residence	**Gauteng- 29 (88%)**	• Soweto- 17 (57%) • Sebokeng- 3 (9%) • Bekkersdal- 2 (8%) • Randfontein- 3 (8%) • Orange Farm- 1 (2%) • Katlehong- 1(2%) • Roodeport-1 (2%)
	North west Province-4 (12%)	• Makwassie-1 (3%) • Orkney- 1 (3%) • Mafikeng- 1 (3%) • Ottosdal- 1 (3%)
Gender	Males	27 (81, 8%)
	Females	6 (18,2%)
Deceased subsequent to initial assessment	2	

The age range included one patient of 21 years who was still attending school. The majority of patients were from Soweto, Gauteng (88%) as Chris Hani Baragwanath Hospital is in Soweto, Gauteng. Most of the patients were males (81, 8%).

4.1.1. Diagnosis

The specific diagnosis related to brain abscess or Empyema was obtained from the records. Figure 4.1 indicates the different diagnosis.

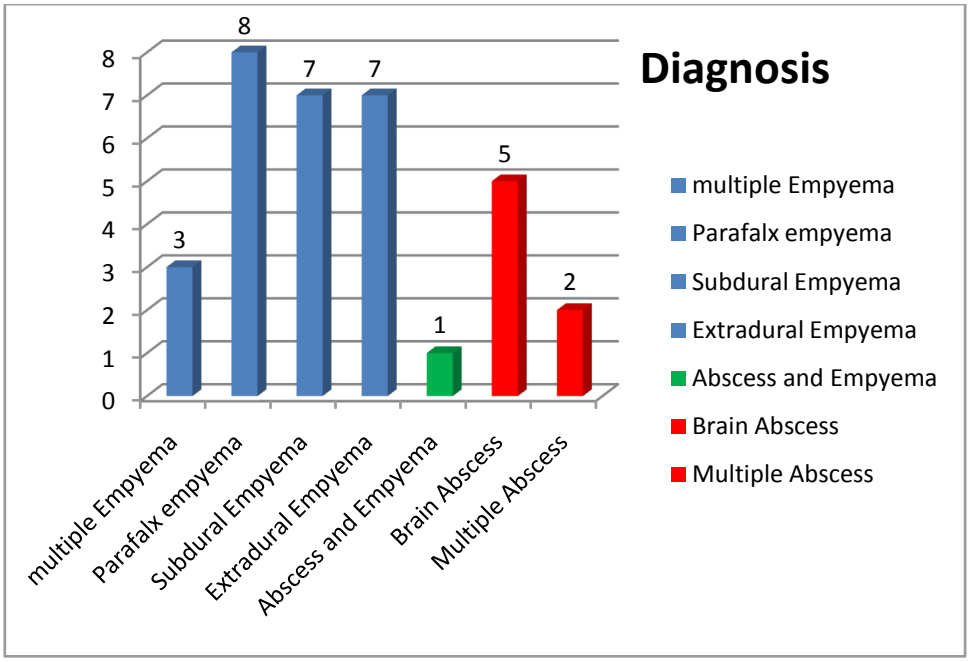

Figure 4.1. Frequency of Diagnosis (n=33)

The majority of patient records(75,8%) reviewed presented with Empyema (multiple Empyemas, Parafalx Empyema, Subdural Empyema and Extradural Empyema). Three percent presented with both abscess and Empyema and 21,2% presented with abscess (both single and multiple abscesses).

4.1.2 Causes

The causes of brain abscess and Empyema are illustrated below in table 4.2.

Table 4.2. Causes of brain abscess and Empyema

Causes of BA and E	
Sinusitis	23 (69,7 %)
Unknown cause	3 (9,09%)
Mixed causes	3 (9,09%)
Meningitis	2 (6,06%)
Mastoiditis	1 (3,03%)
Retroviral disease	1 (3,03%)

The most common cause of BA and Empyema was sinusitis, followed by unknown causes and mixed causes.

4.1.3 Co- morbid Medical conditions

Figure 4.2 indicates various co- morbid medical conditions found in the sample population (n=33).

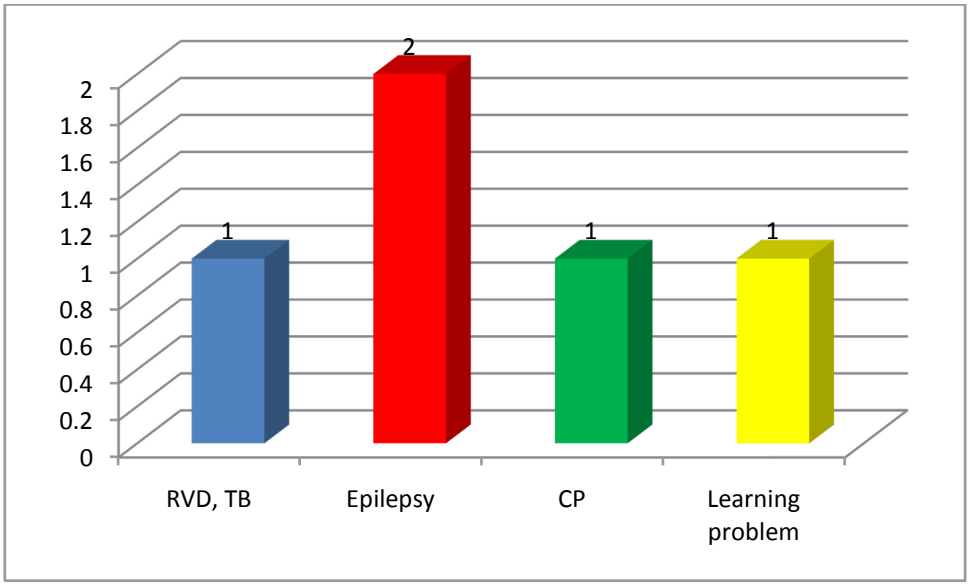

Figure 4.2. Co- morbid medical conditions

Four of the sample population had co- morbid medical conditions, with one of these subjects having both cerebral palsy and epilepsy. One patient presented with retroviral disease (AIDS) and

tuberculosis. One patient presented with epilepsy and the last patient presented with learning problems.

4.2. Deficits

4.2.1 Motor deficits

The effect of BA and Empyema on the patients whose records were reviewed was established by reviewing the data recorded in the occupational therapy recordsThe frequency of motor deficits is illustrated in figure 4.3.

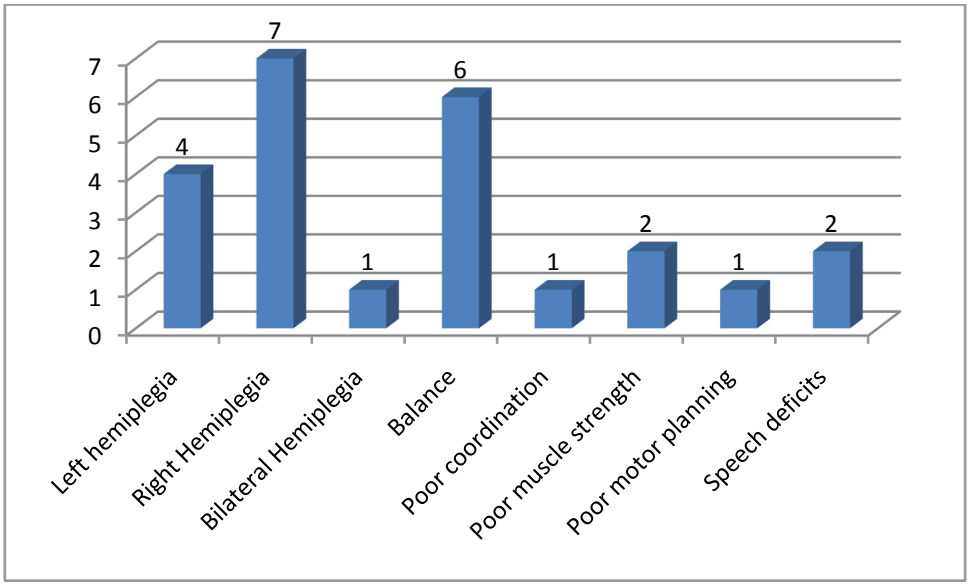

Figure 4.3: Frequency of motor deficits

Twenty four deficits are represented in this figure. These were present in 16 of the patients. Seventeen of the patients whose records were reviewed had no motor deficits and 16 patients had motor deficits. Some of the patients had multiple deficits. Most common were hemiplegia with right hemiplegia being more common. Balance was affected in just over a third of these patients.

Figure 4.4 indicates the frequency of motor deficits broken down into separate diagnoses.

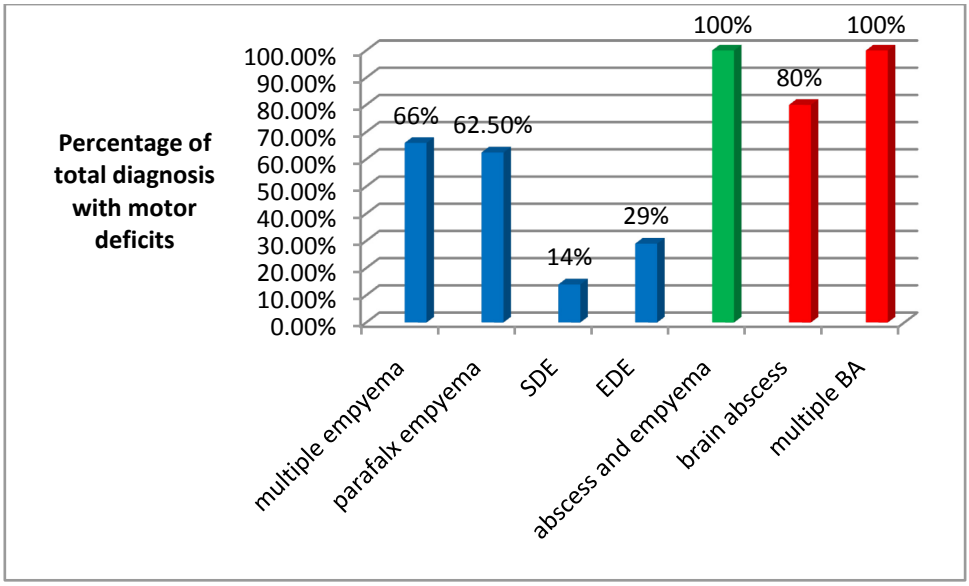

Figure 4.4. Frequency of motor deficits per diagnosis (n=15)

This figure shows that the patients who presented with multiple brain abscess and abscess and Empyema had motor deficits 100% of the time. 80% (four of the five) of all patients with brain abscess presented with motor deficits. In the Empyema population the prevalence of motor deficits was much lower. 66% of patients with multiple Empyema and 62,5% of patients with Parafalx Empyema had motor deficits. Patients with Subdural Empyema presented with motor deficits in only 14% of cases, and in Extradural Empyema in 29% of cases.

4.2.2. Process deficits

A number of other deficits including cognitive and perceptual deficits were identified from the occupational therapy assessment records. Figure 4.5 illustrates the deficits noted on assessment.

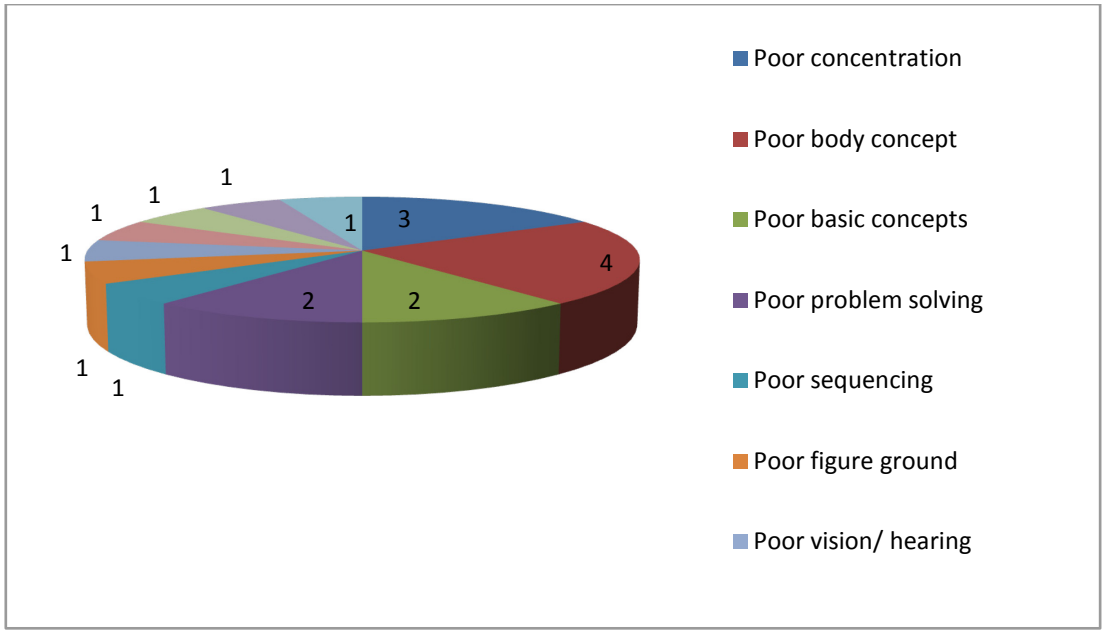

Figure 4.5: Frequency of process deficits (n= 10)

Of the 33 subjects only 10 had process problems (45, 5%). Again some patients presented with more than one of the deficits listed above. The most common deficit was poor body concept with a frequency of four, followed by poor concentration with a frequency of three.

Figure 4.6 indicates the frequency of these process deficits per diagnosis.

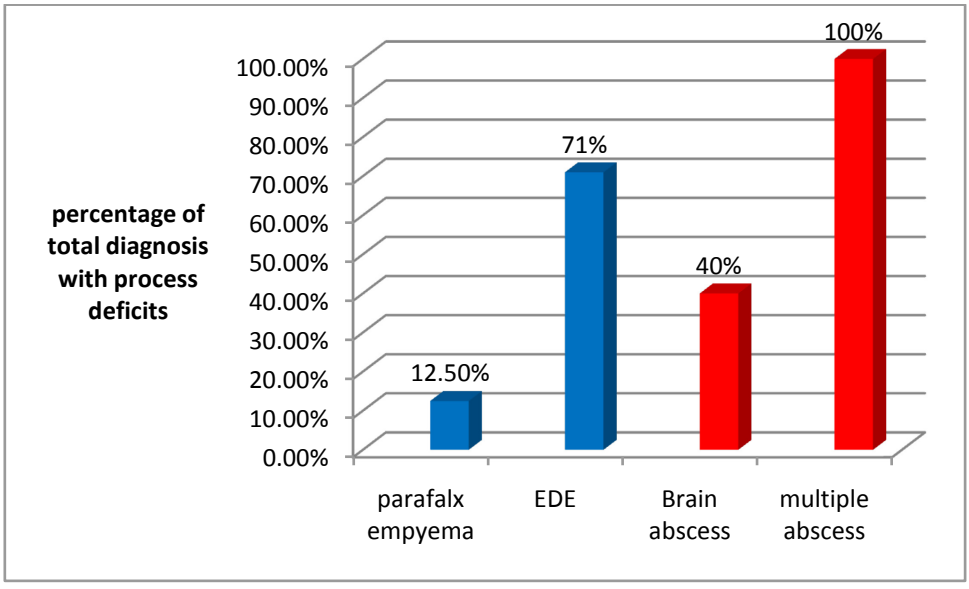

Figure 4.6 Frequency of process diagnosis per diagnosis (n=10).

When the data is analysed according to diagnosis it is found that in only four of the seven diagnoses were other problems noted. As was seen with motor deficits, the patients with multiple abscesses had deficits in 100% of the cases. Patients with Extradural Empyema had the next highest prevalence with process deficits occurring in 71% of cases. Those presenting with brain abscess had deficits in 40% of cases and patients presenting with Parafalx Empyema had deficits in only 12,5% of cases.

4.2.3 Correlation between motor deficits

Table 4.3 below illustrates the motor deficits with a significant correlation (>0.6) to each other. All the correlations were positive

Table 4.3. Correlation between motor deficits (n=16).

	Right hemiplegia	Poor sitting balance	Poor coordination
Poor standing balance	0.6934		
Left hemiplegia		1.000	1.000

The table shows a positive correlation between poor standing balance and right hemiplegia. There was a perfect correlation between poor sitting balance and left hemiplegia; and poor coordination and left hemiplegia. There was insignificant correlation between the other motor deficits and so they have not been represented in this table.

4.2.4 Correlation between process deficits

There was a positive correlation between poor hearing and poor body concept of 0.7025. There were no other statistically significant correlations between the process deficits. The subject presenting with hearing loss had no premorbid hearing loss.

4.2.5 Correlation between motor and process deficits

Table 4.4 illustrates the correlation between all the deficits, both motor and process. The table indicates that there was a perfect correlation between poor sitting balance and left hemiplegia; poor coordination and left hemiplegia; and poor standing balance and poor problem solving. There was

highly positive correlation between right hemiplegia and poor concentration and poor concentration and poor speech. There were also positive correlations between right hemiplegia and poor standing balance; any motor deficit and poor hearing; poor muscle strength and poor 3D perception; poor muscle strength and poor sequencing.

There were negative correlations between poor sitting balance and process deficits; poor coordination and process deficits; and left hemiplegia and process deficits.

Table 4.4. Correlation between all deficits

	ALL motor skills	Right hemiplegia	Poor sitting balance	Poor standing balance	Poor coordination	Poor muscle strength	Poor speech	Left hemiplegia	Poor motor planning	Poor body concept
Poor standing balance		0.6934								
Left hemiplegia			1.000		1.000					
ALL process deficits			-0.7510		-0.7510			-0.7510		
Poor concentration		0.9155					0.9155			
Poor basic concepts									1.000	
Poor body concept									0.7025	
Poor hearing	0.7025								1.000	0.7025
Poor 3D perception						0.6359				
Poor sequencing						0.7002				
Poor problem solving				1.000						

4.3. Visual Motor integration

Table 4.5 indicates the frequency of Visual Motor Integration, visual perceptual and motor standard scores. The VMI test was found to have only been completed with 20 of the patients whose records were reviewed.

Table 4.5. Frequency of VMI, visual perceptual and motor scores

VMI Standard score	Frequency	Cumulative percentage	Visual standard score	Frequency	Cumulative percentage	Motor Standard Score	Frequency	Cumulative percentage
45	2	10%	45	1	5%	45	5	25%
47	1	15%	46	1	10%	46	1	30%
49	1	20%	51	3	25%	49	1	35%
53	1	25%	55	1	30%	51	1	40%
60	1	30%	57	1	35%	55	1	45%
62	1	35%	58	1	40%	57	1	50%
63	1	40%	64	1	45%	63	1	55%
65	1	45%	65	1	50%	67	2	65%
66	1	50%	70	1	55%	69	1	70%
70	1	55%	80	1	60%	70	1	75%
75	1	60%	82	1	65%	73	1	80%
77	1	65%	84	1	70%	80	1	85%
80	1	70%	85	1	75%	85	1	90%
86	1	75%	86	1	80%	92	1	95%
87	2	85%	93	1	85%	97	1	100%
91	1	90%	96	1	90%			
109	1	95%	103	1	95%			
120	1	100%	107	1	100%			

As shown in the above table VMI scores ranged from 45 to 120. Two patients reviewed had scores of 45 and two scores of 87.

Visual perceptual scores ranged from 45 to 107, again with almost equal frequency except the score of 51 which had a frequency of three.

The motor scores ranged from 45 to 97. Five patients had scores of 45 and two had scores of 67.

The scores represented in red for each test are the scores below average. The scores in green are the scores which fall within the norm and the blue scores are those that are above average.

4.3.1. Correlation between VMI scores and deficits

There was a negative correlation between VMI scores and the presence of any motor deficit (r = -0.6101). This indicates that the presence of motor deficits correlates with poorer scores on the VMI test. It is interesting to note that there was a positive correlation of 0.7025 between hearing loss and VMI scores. However this should be interpreted with caution as only one subject presented with a hearing deficit.

PART B- Post discharge follow ups

At least one year post initial assessment the patients were contacted for a follow up assessment. Figure 4.6. indicates the follow up details of the patients contacted.

Follow up details of patients contacted	Number of patients
Deceased	2
No contact deta1ils	1
Incorrect/ expired contact details	4
Unable to attend	5
Contacted for follow up	21

Table 4.6: Patients followed up

Of 33 occupational therapy records reviewed, two patients were deceased and one patient had no contact details. Of the remaining 30 records 26 had correct contact details on which they were contacted. Five of these patients were unable to attend the follow- up session for unspecified reasons. Four records had incorrect or expired contact details. This left a total of 21 patients who could be contacted.

These 21 patients were contacted and invited to attend a follow up visit as part of the research. Information was given from the information sheet. Twenty one patients were given appointments to attend the follow up session but only eight came, giving a follow up sample size of eight (24,2% of original sample). However, only eight subjects came for follow up assessment.

4.4. Demographics of follow up sample

Table 4.7 indicates the demographic data of the follow up sample (n=8).

Table 4.7. Demographics of follow up sample (n= 8)

Characteristics		
Age range (on reassessment)	11yrs-20yrs	
Place of residence	**Gauteng 87.5%**	• Soweto 3 (37.5%) • Sebokeng 2 (25%) • Bekkersdal 1 (12.5%) • Roodepoort 1(12.5%)
	North West province 12.5%	• Orkney 1 (12.5%)
Gender	Males	6 (75%)
	Females	2 (25%)

The age range of the follow up sample ranged from 11 yrs to 20 yrs. Eighty seven point five percent (7 of the 8 patients) of the follow up sample were from Gauteng with the remaining one patient being from the North West province. Seventy five percent of the sample was male.

4.4.1. Diagnosis of follow up sample

Figure 4.7 illustrates the diagnoses of the follow up sample

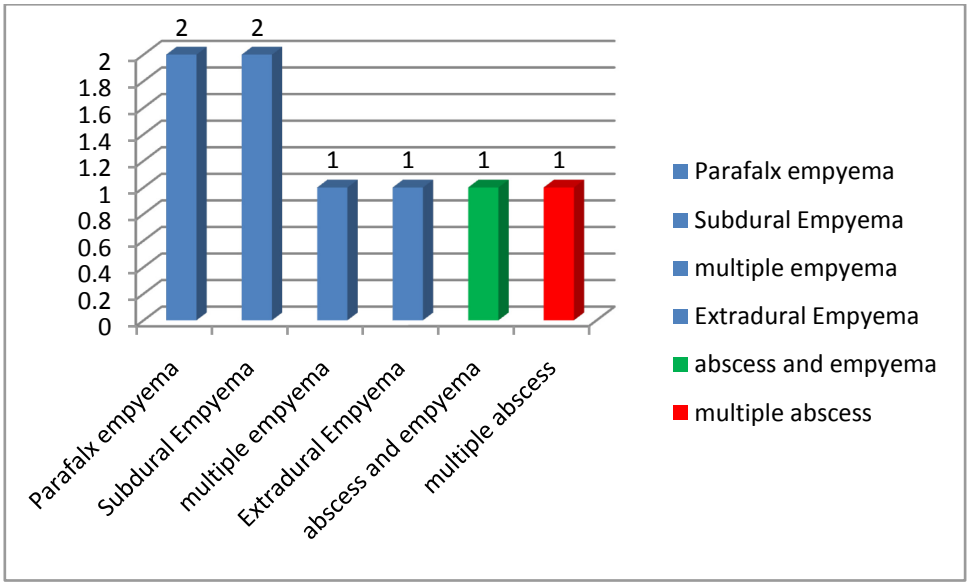

Figure 4.7. Frequency of diagnoses of follow up sample (n=8)

Empyema was more common with 75% of the follow up sample having a diagnosis of Empyema. Parafalx Empyema and Subdural Empyema were most common (25% of the total sample). Twelve point five percent of the sample suffered from abscess and Empyema and 12.5% suffered from multiple abscesses.

This was similar to the initial sample where the majority of patients presented with Empyema (75,8%) and only 21,2% presented with abscess.

4.4.2. Causes

Table 4.8. illustrates the causes of brain abscess and Empyema in the follow up sample.

Table 4.8. Causes of Brain Abscess and Empyema in follow up sample

Causes of brain abscess and Empyema	
Sinusitis	5 (62.5%)
Mixed causes (conjunctivitis and sinusitis)	1 (12.5%)
RVD	1 (12.5%)
Meningitis	1 (12.5%)

Again the leading cause of BA and Empyema was sinusitis with an equal distribution of the other causes (mixed causes, RVD, Meningitis). This was also the case with the initial sample.

4.5. Motor deficits

Table 4.9 indicates the motor deficits found in the follow up group on initial assessment.

Table 4.9. Initial motor deficits of follow up sample

Motor deficits	
12.5%	• Poor bilateral coordination • Poor speech (dysarthria)
25%	• Left hemiplegia • Poor balance
12.5%	• Poor muscle strength

On follow up assessment none of the sample had residual motor deficits. On initial assessment 50% of the sample had no motor deficits. The remaining 50% of the population had the motor deficits described above. Twelve comma five percent of the sample had poor bilateral coordination, poor speech and poor muscle strength. Twenty five percent had left hemiplegia and poor balance.

4.6. Process deficits

At the time of the follow up assessment no cognitive problems were reported by the majority of the sample. One subject was reported to have cognitive problems which were seen in his poor performance at school (to be discussed in section 4.2.4.).

On initial assessment the same subject presented with cognitive problems. This subject presented with poor body concept and poor 2D- 3D spatial perception. The remaining 87.5% of the sample had no deficits in this area.

4.7. School performance

A brief interview was conducted with both the subject and their caregiver to establish whether there were any school difficulties for the sample. 87.5% of the sample reported no problems at school and no school failures. Their comments during this interview ranged from: “no complaints” to “patient doing well at school”.

The remaining subject had multiple failures at school.

4.8 Comparison of pre and post test VMI scores

Table 4.9. illustrates the means of the pre and post test VMI standard scores, visual standard scores and motor standard scores.

Table 4.10. Comparison of pre and post test scores

Standard scores	Mean Pre- test	n	Mean Post- test	n	p- value	Significance of p-value
VMI standard	82.5	8	92.5	8	p= 0.19	p>0.05
Visual standard	88.25	4	94.25	4	p=0.44	p>0. 05
Motor Standard	60.3	3	75.7	3	p= 0.14	p>0. 05

On follow up not all of the subjects completed both the subtests. The follow up groups pre test (test completed on discharge) and post test (test completed on follow up) scores were compared. The visual motor integration test had an initial mean score of 82.5. This score improved to 92.5 at follow up. The motor standard subtest had an initial score of 60.3 which improved to 75.7 on follow up. The visual perceptual subtest had an initial mean of 88.25 which improved to 94.25 on follow up. All p-values for these comparisons were not statistically significant. Five of the eight subjects had improved VMI test scores on follow up. All five of these subjects had follow up scores that were greater than minus one. This has clinical significance as it is the z- score at which deficits are said to be treated (appendix 8). Since the sample was small and not normally distributed the non parametric Wilcoxon test was used to analyse the data. This, again shows there is no statistical change between the pre and post test VMI scores (Table 4.11).

Table 4.11. Wilcoxon two sample test

	P- value	Significance
VMI	P= 0.3658	Not significant
Visual supplementary	P= 0.197	Not significant
Motor coordination	P= 0.7013	Not significant

Therefore confidence intervals were used to assess the difference in the pre and post test z scores to see if there was a clinical difference as no statistical difference had been found.

Table 4.12 Confidence intervals for pre and post test scores

	Z score pre test	Z score post test	Confidence interval	P- value
VMI	-1.16	-0.78	-1,35 to 0,59	Not significant
Visual supplementary	-0.52	-0.95	-0,66 to 1, 52	Not significant
Motor coordination	-1.93	-1.58	-2,18 to 1,32	Not significant

Table 4.12 indicates that the differences were also non significant for the VMI test and supplementary tests. The 95% confidence interval crosses zero, indicating a p- value of greater than 0,05 and therefore non- significant difference between pre and post test scores.

Another way to view clinical significance of the z scores for the VMI test is to consider those that fall below -1. The scores for the VMI and motor components were below -1 on the initial test and the motor subtest scores remained below -1 on follow up. A score of less than -1 indicates a need for treatment[49].

4.9. Summary

In summary the most common diagnosis found in both the initial sample and follow- up sample was Empyema with three times as many patients with Empyema as compared to Brain Abscess. The most common motor deficit seen was hemiplegia and the most common process deficit was poor body concept. Motor deficits were present in 16 of the subjects and process deficits in only ten of the subjects.

The majority of patients scored below the norm on the VMI test and the supplemental tests. Due to inconsistency in the record keeping, only 20 of the patients had completed VMI tests on discharge but a significant number of these 20 subjects had VMI problems.

On follow up there was clinical improvement of these scores, but no statistical improvement of VMI scores. Scores on the follow- up VMI test were better and correlated with the subjects subjective reports of coping well at school. The follow up subject with poor VMI scores had multiple failures at school.

CHAPTER FIVE: DISCUSSION

The purpose of this research was firstly to review occupational therapy records to analyse demographic trends within this diagnosis group. These were analysed based on cause, diagnosis, age, gender and deficits as a result of BA and Empyema.

5.1. Demographics

The number of available records for review was 33. This is a higher prevalence over a two year period than that found by Domingo and Peters in Cape Town over 25 years[24]. This may be due to the higher population in Soweto or that Chris Hani Baragwanath Hospital serves a wider geographical area. Soweto has also been said to have a population that is a lower SES. Poorer conditions have been linked to BA and Empyema which may account for these higher numbers in Soweto. This study was also carried out in 1994. Since then there has been increased urbanisation and poorer health care delivery possibly accounting for larger numbers of BA and Empyema.

Eighty eight percent of patients lived in Gauteng, mostly in Soweto (57%). Soweto is a township in South Western Gauteng with an indigent population and BA and Empyema are more common in developing countries[9,27]. This is thought to be due to poor accessibility to medical care and increased immunodeficiency in these communities[27]. Although the socioeconomic status of these patients was not formally assessed it can be assumed that this population is traditionally within the lower socioeconomic class and there is decreased accessibility to health care. However only one of the sample was immuno- compromised indicating this may not be as relevant a reason in the school-going population.

Of the records reviewed two patients were deceased at the time of review. Both patients suffered from BA. This is six percent of the total population and 29% of the brain abscess (multiple and single abscess) population. This is in keeping with the statistics found in literature which found that mortality of BA ranged between 22 and 33% [1], however not in keeping with mortality rates found by

Johnson which were as low as five to ten percent[28]. The prevalence of mortality in brain abscess indicates the virility of an infection of the parenchyma itself, as compared to Empyema where the infection is not within the brain tissue [1,9]. The mortality rate is lower than literature has found it to be but in keeping with diagnosis, where BA was found to have a higher mortality rate than Empyema[24].

Of the total sample 81.8% were male and 18.2% were female. This is in keeping with the literature which states that BA and Empyema are most common in boys[28-30,63]. Tewari et al. suggest the reason it is more common in boys is there is rapid growth of the frontal sinuses in males and that boys tend to blow their noses more vigorously[29].

The mean age of the patients included in the study was 16.2 yrs with an age range of 8yrs to 21 yrs. This is similar to trends discussed in the literature[24] and those found in South Africa. Research found that in most cases the subjects were in their second decade of life[8,28-30,63]. Only records of patients attending school were reviewed. However one patient was 21 years old and still attending school. This may indicate premorbid learning difficulties.

The causes of BA and Empyema in this research were most commonly sinusitis, followed by unknown causes. The literature states sinusitis, otitis media and mastoiditis as the most common causes[29,63]. Other causes found in this research were meningitis and HIV related infections[35].

Record review used as the method of data collection in this research, was an appropriate tool to use as it has been found to be useful especially in investigative studies where patients cannot be randomised[54]. Because of the small sample size due to the rarity of the condition[27,29,30] there was no randomisation of the sample. All records of patients attending school at the time of the initial sample were included in the sample. This assists in addressing the rigour of the study where only small samples are available[57].

However a limitation experienced in this research was the poor completion of the records. Many of the records were incomplete and the contact details recorded was incorrect. There was also poor consistency between records about the way in which data was recorded. It has previously been noted that record reviews are compromised by the fact that clinicians only record information that they feel is relevant[54], the haphazard way records are kept[56], poor emphasis on the quality of records kept[58] and a perception among clinicians that record keeping is not as important as clinical work[58]. The above points all impacted on the quality of records used in this study and therefore compromised the quality of the data obtained.

5.2. Motor and Process deficits

Data on functional deficits was obtained from the occupational therapy records. Routinely the literature classifies deficits as focal neurological deficits, cognitive impairment and seizures[9]. Two of the patients were known epileptics prior to hospitilisation. There was no record of any of the other patients having post- Empyema or abscess seizures. However as discussed previously, a lack of protocol as to what should be included in occupational therapy records may mean this information was simply not recorded. On review of the records it was found that four of the patients had pre existing conditions that may have had an impact on the motor, process and VMI test scores found. One patient had both cerebral palsy and epilepsy, another patient had only epilepsy, the other patient had documented learning problems and the last patient had retroviral disease and tuberculosis. Most children with epilepsy have normal intelligence and lead normal lives when the disease is controlled with anti- epileptic medication [64]. But prognosis does depend on the type of seizure and whether there is underlying brain pathology[64]. In this study we unfortunately do not know the premordid functioning of the individual with epilepsy and therefore cannot predict whether it will have an impact on process, motor and VMI abilities.

The subject that had both premorbid cerebral palsy and epilepsy was also found to have the lowest scores on the VMI test. This subject also presented with numerous motor and process deficits. The

definition of cerebral palsy indicates that motor and process deficits are usually found and so this is not unusual in this case. Children with cerebral palsy are also commonly found to have visual perceptual problems[6] as was seen with this subject.

The patient who presented with retroviral disease and tuberculosis, also presented with severely impaired VMI scores. This subject also had motor and process deficits on initial assessment. Research has found that disability experienced by patients with retroviral disease is commonly due to the suppression of the immune system and subsequent infections experienced by the patient[64]. Children with retroviral disease are commonly found to have developmental delay as well as poor motor and independent living skills[64].

As will be discussed later, literature has established a link between VMI and school performance[17-19]. The subject who had premorbid learning difficulties therefore may have had premorbid VMI difficulties. There was no documentation of what difficulties these were and it is therefore impossible to determine whether the VMI, process and motor deficits seen in this subject are as a result of the Empyema or whether it is due to the premorbid problems.

The focal neurological deficits seen in this research were right and left hemiplegia's and bilateral hemiplegia. Hemiplegia has been described as paralysis on one side of the body associated with changes in tone and most commonly following an upper motor neuron lesion[2,5]. For the purposes of this research the term hemiplegia is used to describe one- sided paralysis. Hemiplegia is reported as the most commonly listed neurological deficit in BA and Empyema[34]. In this research hemiplegia was the most common neurological deficit seen with 36% of patients presenting with a hemiplegia (frequency= 12) as seen in figure 4.2. Right hemiplegia (frequency=7) was most common at 21%. Speech deficits were also listed as common deficits in the literature[33,34]. In this research only two patients presented with speech deficits (dysarthria and global aphasia).Other motor deficits seen were poor balance, poor coordination, poor muscle strength, poor motor planning. Nielsen et al. list visual disturbances and hearing loss as the other significant physical deficit[33]. In this study only one

patient was found to have hearing loss and whereas many of the patients had visual motor integration problems only two patients had recorded visual disturbances related to the infection itself. In both these cases these problems resolved before discharge from hospital.

There was a perfect correlation between poor sitting balance and left hemiplegia and poor coordination and left hemiplegia. Hemiplegia is mentioned as the most common deficit[34] but balance and coordination are not mentioned in the literature. This may be because all previous studies were published by doctors who routinely test and diagnose hemiplegia on admission of the patient, whereas client factors like balance and coordination are standard assessment for occupational therapists[11].

On review of the records it was found that ten patients of a possible 33 records had cognitive deficits (30%). These included poor concentration, poor body concept, poor basic concepts, poor problem solving, poor sequencing and poor figure ground perception. These were deficits found on initial assessment and may be due to the acute infective and surgical process. This may account for the high prevalence of 30% versus the prevalence found in the literature. The literature however does support the importance of these cognitive problems. Gormley et al. state that the most serious long term implications of BA and Empyema are cognitive impairments[9]. This is supported by research conducted by Carey et al.[38] This research found that six years post abscess 70% of children assessed were struggling at school[9]. Nielsen found on following up patients with BA and Empyema (three- 40 years post treatment) that 15% had an intellectual impairment[34].

There was no significant inter-correlation between these process deficits. The very high positive correlation between right hemiplegia and poor concentration and poor standing balance and problem solving seem coincidental and it must be accepted that these results could be due to the small sample size resulting in a type I error.

Poor body concept and its correlation to poor motor planning is expected as research has said that motor planning is dependant on intact body concept[6].

Unfortunately no clear data was obtainable from the records regarding the specific area of the brain the BA or Empyema was located. BA and Empyema can occur in any area of the brain, either infra or supratentorially and may extend to the other compartment[29]. The symptoms a patient presents with are usually related to the effects of increased intracranial pressure, irritation of the meninges and infection of the cerebral tissue itself[63]. Depending on the location of the BA or Empyema the patient may present with differing symptoms ranging from subtle changes in personality for frontal lobe infections to seizures, decreased level of consciousness and septic shock[63].

Unfortunately due to inconsistent record keeping localisation of the BA or Empyema was not recorded and so this cannot be linked to existing research. Extensive research has been done on localising the area of the brain responsible for visual motor integration. Initially it was thought to be solely in the right hemisphere and the motor cortex contralateral to the dominant hand[3]. However recent research into localisation of VMI has found that it is more specifically the pathway in the dorsal areas of the extrastriate cortex[42].

However differences in abscess and Empyema were evident. Seventy five comma eight percent of the records reviewed presented with Empyema (multiple Empyemas, Parafalx Empyema, Subdural Empyema and Extradural Empyema). One patient (three percent of the sample) presented with abscess and Empyema and the remaining 21, 2% were diagnosed with abscess (both single and multiple abscess). The patients presenting with abscess and the one patient who presented with both Empyema and abscess consistently had more deficits on initial assessment. One hundred percent of the patients with multiple BA and 80% of the patients with BA had motor deficits. The patient who had both BA and Empyema also presented with motor deficits. This is compared with only 66% of patients with multiple Empyema, 62, 5% of patients with Parafalx Empyema, 29% in Extradural Empyema and only 14% in patients with Subdural Empyema.

One hundred percent of the patients with multiple abscess were found to have process deficits and 40% of those with single abscess had process deficits. Only 12,5% of patients with Parafalx Empyema presented with these deficits. Interestingly seventy one percent of the patients with Extradural Empyema were found to have process deficits. This prevalence of process deficits in Extradural Empyema is not in keeping with literature findings. Literature describes Extradural Empyema as less virulent and having a less obvious clinical presentation[65]. This finding is therefore not in keeping with the anatomy of the Extradural Empyema which occurs in the extradural space and so should have less serious clinical implications[2]. Two of the seven (28,6%) patients presenting with Extradural Empyema were recorded as having premorbid problems. The one patient had epilepsy premorbidly and the other patient had learning problems according to his family.

This increased prevalence of deficits (both motor and process) is in keeping with the pathology of Brain Abscess versus Empyema. A Brain Abscess is an infection of the brain itself whereas an Empyema is outside the brain in the extradural or subdural space[1,9].

5.3. Visual Motor Integration

The Beery- Buktenika Developmental Test of Visual- Motor Integration was used as a routine assessment tool on discharge with all patients with BA and Empyema done by the staff of the occupational therapy department. The VMI was used as it is readily available at Chris Hani Baragwanath hospital, is easy to administer and is relatively low cost. The VMI was also chosen because of the extensive research that correlates its results with academic performance [3,15,17,18]. The VMI was used at Chris Hani Baragwanath Hospital's Occupational Therapy Department as a baseline measurement by staff to establish whether patients needed further occupational therapy on discharge.

The test was found to be reliable and valid for individuals with educational, psychological and neurological problems therefore it was relevant to use with patients with BA and Empyema [3]. It has

also been tested on a South Africa population. Test scores between the copying test and the VMI were found to have a strong correlation[44] within a South African context.

Of the total 33 records reviewed 20 had completed VMI and supplemental tests. Again the limitation of using a record review method of study meant that there was poor record of information[54,56,58], even data that was meant to be routinely recorded in a standard way. Another limiting factor of obtaining these VMI results was that the test was completed on discharge and it may have occurred that the patients were discharged without notification of the occupational therapy department.

The VMI had standard scores of between 45- 120 with the majority of subjects falling below the normal. This trend was also evident with the visual perceptual scores. There was a large range of scores (45- 107) but again the majority of scores fell below the normal. Motor standard scores were also similarly distributed, ranging from 45- 97 with all subjects falling below the norm. For the VMI test 75% scored below normal. Of the remaining 25%, 15% were within the normal range and ten percent were above average. A similar trend was true of the visual perceptual scores. Seventy five percent scored below normal, 15% were within the normal range and ten percent scored above average. For the motor substest 90% of all subjects scored below normal and the remaining ten percent fell within the normal range. This is different from the percentile ranks found by Beery et. al.[3]. Their distribution of scores had only 37% in the below average category compared to the 75 to 90% found in this research. It was found by Beery during standardisation of the VMI test that socioeconomic status impacted on performance scores[3] Subjects from low socioeconomic backgrounds had consistently lower scores on the VMI test[3,44] in the literature and as the patients were accessing government health care the assumption can be made that they were of a lower socioeconomic class. This was also found on a South African population in the Western Cape and Eastern Cape. It was found that patients from higher socioeconomic group scored better on the test[44,51].

Literature has supported the notion of brain injury impacting on visual perception[46,47]. The authors of these studies did not specifically discuss visual motor integration but concentrated on visual perception. They did find deficits in visual perception in their research[46,47]. The fact that both BA and Empyema are space occupying lesions within the brain may account for the consistently low scores. However these consistently lower than average scores may be partly attributed to SES group from which the sample was drawn. The impact of the brain lesion and therefore in order to give the best treatment to these patients the implementation of a standard referral to occupational therapy is needed.

There was a negative correlation between VMI scores and motor deficits, indicating that the subjects who performed worse on the VMI were more likely to have motor deficits. This is in keeping with the concept of visual motor integration where motor output plays a role in the overall skill. This is evident in the fact that the motor subtest scores are lower than the VMI scores or visual perceptual scores.

Visual motor integration as the synchronisation of visual skills and motor skills [16,40]will be affected by deficits in motor deficits. This was seen in the multiple brain abscess group where 100% of the patients presented with motor deficits and 100% of the patients had very poor VMI scores. Their z scores were at the lower end of the sequence for the VMI and supplemental tests.

The role of vision in visual motor integration is debated. Goldstand et al. emphatically states that visual perception is heavily reliant on vision and is primary to the process[19]. Anderson states that is only one aspect of visual motor integration[42]. Both references agree that it is a part of the process and visual problems will have implications on visual motor integration scores. Three of the patients seen had visual disturbances. They suffered from conjunctivitis, bilateral orbital cellulitis and poor vision due to unknown causes. The scores these three patients achieved were very different. The one patient had VMI, visual perception and motor coordination scores that were within the normal range. The other patient had scores that were very low. However this patient also presented with a

left hemiplegia and so it is not possible to infer whether the low scores were as a result of visual disturbances or the hemiplegia. The third patient had poor VMI scores but normal visual perceptual and motor scores indicating an integration issue. This patient had a right hemiplegia on initial assessment which may also impact on his visual motor integration.

The supplemental tests of visual perception and motor coordination are helpful in pinpointing whether deficits are visual perceptual, motor or the integration of these skills[3]. These are important baseline skills for the formal learning environment. Sortor et al. [45] found that there is a significant correlation between perceptual motor skills and learning skills, and that these contribute to skills like accurate perception of letters, visual discrimination, visual memory, visual spatial skill and fine motor skills[45]. These are skills used in schooling and therefore the VMI is a relevant test to use as an assessment tool. Again, this link between VMI skills and the occupational performance area of schooling emphasises the importance of a standard protocol for assessment of all patients presenting with BA and Empyema.

The VMI test should not be re- administered within one year of the initial assessment. This is to ensure that results are not affected by memory and learning[3]. Therefore follow up assessments were administered at least one year post discharge. Due to the fact that age related standard scores are available for this test it is possible to determine that improvement in function is independent of age related improvement[3]. Unfortunately the poor follow up attendance was not predicted which affected the sample size and therefore the relevance, ability to generalise findings to the greater population and the validity of these results were compromised.

On reassessment there was clinical, albeit no statistical improvement on these VMI test scores. Empyema The resolution of symptoms associated with BA or Empyema, such as oedema and the resolution of the actual infection, may account for the clinical improvement on the VMI test. All

patients on follow up were also found to have resolution of their motor deficits which also accounts for the improvement on the VMI test scores. There was no statistical improvement on VMI pre and post test scores. However non- significance does not mean there was no effect[66] and it is possible due to the very small sample size that a type II error occurred. Clinical significance was therefore based on the accepted practice that z scores greater than minus one are indicative of no need for treatment[49]. Since five of the eight subjects had VMI test scores of greater than minus one on follow up and the mean z score improved from minus one it was accepted that clinically these patients required no further therapy.

Of the patients followed up, the majority had supplemental test scores that fell within accepted norms. Only one patient had decreased scores but this patient was immuno- compromised and may have underlying medical conditions that affect his process skills. These scores are independent of age and this indicates that over time there was improvement of scores irrespective of the initial diagnosis. It also may indicate that on initial assessment there are still secondary effects of the BA or Empyema such as oedema that may affect performance on the VMI test[2].

Five of the eight subjects had scores of less than minus one on the motor coordination supplemental test, however at follow up none of the subjects were found to have motor deficits. The motor assessment used was a non- standardised assessment and focused more on gross movements. The motor coordination supplementary test focuses on fine motor abilities, specifically pencil grip, finger strength and fine coordination and these aspects clearly remained a problem in these subjects.

Results of other studies indicate that South African children normally have lower scores on the visual supplemental test confirming that in this group residual motor functioning is a concern that needs to be addressed[51].

5.4. School performance

It is also of concern that seven of the eight subjects reported to be coping at school despite below norm scores on the VMI test. As previously mentioned the VMI test has been found to be an

indicator of school performance[15,17,19,44] and the expectation was that these patients would therefore report difficulties at school. This lack of correlation may have been due to the subjective nature of the interview.

Of the patients followed up, the majority had improved VMI and supplemental standard test scores. Only one patient had decreased scores but this patient was immuno- compromised and may have other underlying medical conditions that affect his cognition and perception. These scores are independent of age and this indicates that over time there was improvement of scores irrespective of the initial diagnosis. It also may indicate that on initial assessment there are still secondary effects of the infection such as oedema that may affect performance on visual perceptual tests[2]. It was also found that the scores on the motor supplemental test were consistently poor on follow up as they remained below minus one. This decreased motor supplemental test score was also found with children of a low SES in the Eastern Cape[51]. This poor performance on this aspect of the test may then be attributable to the low SES of this patient group, and not only to the effect of the BA or Empyema.

No triangulation of school performance in terms of contacting the schools was possible due to ethical constraints and therefore the subjective interview alone was used.

When patients were followed up a brief informal interview was done to determine if there were any school difficulties. Due to the limited sample size it is difficult to draw conclusions about the accuracy of these results for all patients with this condition. On follow up, 87.5% (7 of the 8) of the sample were not experiencing any problems at school. The remaining subject had multiple failures at school. This subject had the lowest scores on the VMI and supplemental tests of visual perception and motor coordination. He also had a pre-morbid history of school failures. It is therefore difficult to identify if these issues are secondary to Brain Abscess or due to a premorbid learning problem. The majority of the other patients who commented that they were coping at school had VMI and supplemental test scores in the normal range. Only one patient who said they were coping at school

had poor VMI scores again showing the need for not only a standardised in- patient referral protocol for occupational therapy but also a follow up protocol. This will serve to address long- term perceptual issues that may affect the patients functioning in occupational performance areas.

As documented above there was clinical improvement in all subjects. Only one of the subjects received outpatient therapy and yet there was improvement in all subjects. This improvement may have been as a result of plasticity. Neuroplasticity, although previously discounted, has been found to have a large impact on recovery, particularly of motor control[67]. The recovery seen in these patients may be due to the effect of plasticity of motor control systems.

There is substantial research on surgical, radiological and neurological assessment and outcomes in the literature[1,7-9,27-31,63] but there is a paucity of research on visual motor integration in patients with BA and Empyema. Research conducted by Maertens et al.[8] identified neuropsychological evaluation as a means of evaluating continued morbidity in Subdural Empyema. Maertens et al. [8]also found following Subdural Empyema there was a general deterioration in intellectual functioning particularly in linguistic functioning, fine movement, sensation and auditory memory[8]. In this research visual motor integration standard scores were found to be decreased on both the initial assessment and follow up assessment. This research also found that at the six- month follow up their cognitive function had returned to pre-morbid functioning but there was continued motor impairment. This continued fine- motor function issue would affect VMI. This research also highlights that patients pronounced normal on follow up neurological examination may not have normal neuropsychological scores[8].

Subjects who were found to be struggling were referred for further therapy. However none of these subjects, except one attended therapy. This may be due to the subjective view that they were well and had no further problems, as found in the subjective interview.

This is similar to trends found in this research. Patients were followed up by the doctors and pronounced well but they reported school failures. The VMI test may therefore be a better indicator of the patients' cognitive status and ability to return to school. The occupational therapist therefore needs to be an integral part of the management of these patients to ensure that functioning in all occupational performance areas is optimal.

5.6. Importance of small sample studies

Despite the many limitations discussed in doing a small sample study there are important aspects that need to be considered. Small sample studies show trends, which we can then use to establish benchmarks. These benchmarks can be used to evaluate assessment and treatment service delivery against other available standards[57].

These trends, even if from a rare condition or a small sample study help clinicians to develop guidelines for clinical protocols. From developing clinical protocols best practices can emerge[57].

The trends in this study resulted in the guideline presented in the conclusion chapter.

5.7 Summary

Brain Abscess and Empyema have been shown in both the literature and this research to have numerous effects. These range from motor deficits (hemiplegia, speech deficits and epilepsy) to process deficits (body concept deficits, concentration). In order to improve service delivery in this specific diagnosis to the occupational therapy patients at Chris Hani Baragwanath hospital the VMI test was routinely administered on discharge. From this data it was found that patients presenting with Brain Abscess and Empyema have significantly lower scores on this VMI test than the norms of the VMI test. On follow up one year later these scores are improved but still below normed scores. On follow up it was also found in all patients that the motor deficits found initially had resolved. Because of the absence of obvious neurological signs at follow up these patients may be discharged as "clinically well". However the scope of the occupational therapy assessment lends itself to

comprehensive assessment of all occupational performance areas thus giving an accurate and holistic view of the functioning of the patient. It is therefore important to have a standard referral of all patients with Brain Abscess and Empyema to occupational therapy. The need for a guideline for occupational therapists treating these cases is also evident and an outline based on the practice framework is presented in the conclusion.

CHAPTER SIX: CONCLUSION

Brain abscess and Empyema are medical emergencies[9] that may present in a variety of ways. The literature commonly associates them with neurological sequelea. There is a paucity of literature regarding the process deficits and even specific motor deficits. As a result there was a need to investigate what deficits are found following BA and E. As this condition commonly affects children and adolescents[28-30] it was also important to determine whether there was a long term implication of the infection on their schooling.

Because of the rarity of the condition a very small sample was available. All records of all patients with BA and Empyema admitted to Chris Hani Baragwanath hospital Neurosurgery unit between 2005 and 2007 were reviewed. Despite using an all inclusive sample only 33 records were available for review. This may impact the accuracy and applicability of the results found. However the paucity of data on BA and Empyema and its assessment and treatment by occupational therapists necessitated this research. However the findings were similar to those found in the literature indicating that despite a flawed research technique there is generalisability of the findings.

However it was found that there was a difference in the severity of deficits found between patients presenting with brain abscess versus those presenting with Empyema. Eighty percent of all patients with BA and 100% of patients presenting with multiple abscess had motor deficits as compared to between 14 and 66% of patients with Empyema. This was also true when looking at the prevalence of process deficits with the majority of patients with Empyema not presenting with process deficits at all. This is most probably due to the location of the infection as an abscess is within the brain parenchyma and an Empyema is commonly outside the brain but within the meninges[2]. This was particularly true of the population that presented with multiple abscesses. These patients had motor and process deficits in 100% of the cases.

The use of record review has been noted as a valid tool when the purpose is to draw up clinical protocols[55]. However the success of using a record review lies in the accuracy and comprehensiveness of the records. Unfortunately in this case the records were found to be incomplete and differing data was recorded. This has severely limited the results of the study.

It is therefore imperative that all patients with brain abscess and Empyema, but particularly with abscess are referred to occupational therapy for a comprehensive assessment of their process and motor subsystems.

The Developmental Test of Visual Motor Integration is an easily administered and relatively low cost test. On initial assessment it was found that all the patients had low to average standard scores. It is difficult to conclude whether this is purely as a result of the brain abscess and Empyema or whether there were premorbid VMI difficulties. Although there was no statistically improvement seen on the follow up VMI scores there was a clinical improvement to a mean score of above minus one in VMI skills. The one patient who performed particularly poorly on the follow up VMI test was also struggling at school and had multiple school failures. Again it is difficult to conclude whether this is as a result of the BA or whether there were premorbid learning difficulties.

However as Maertens et al stated: "…raises the interesting question of exactly how many patients routinely judged normal on follow up neurological examination would still be reported normal if detailed neuropsychological evaluation were performed as well… in conclusion, serial neuropsychological assessment appears to be an extremely useful adjunct to traditional neurological examination, in exploring the morbidity of Subdural Empyema, and assisting in treatment making decisions[8]"

6.1. Limitations of study

This was a pilot study which presents several inherent problems. These problems highlight the importance of conducting pilot effectiveness studies prior to implementing randomized controlled trials. This allows for control of research methodological errors in future studies. The following limitations are noted:

The population in this sample was limited to one tertiary hospital within Gauteng. This limited the total sample size to 33 and the follow up sample size to eight. It was thus not a true reflection of the larger population of patients with BA and Empyema. This small sample size limited the socioeconomic and ethnic differences within the population and prevented generalization to a larger population.

As previously discussed a prospective study would have been appropriate in terms of the size of the study and to ease follow up of subjects. A retrospective record review was done because it was anticipated that too few subjects would be available for the research. However this has limited both the follow up sample and the consistency of some of the data collected. In using a retrospective record review no matched control group was utilised for this study possibly affecting the internal validity of the study. Attention therefore needed to be paid to the rigour of the study as a small sample size was used, by limiting the inclusion criteria to those patients attending school with the specific diagnosis of BA or Empyema.

As there was no control group, the influence of typical development cannot be excluded as a reason for the improvement of subjects on the VMI test. However the test scores for the VMI test are standardized which does exclude normal development to an extent[3].

Even though the standardized VMI test was used to assess visual- motor integration skills the assessment of the motor and process deficits that were analysed were not standardized. A standardized occupational therapy assessment was not used and thus these observations were subjective and sometimes not recorded at all in the assessment.

As mentioned previously the VMI test has been found to have less accurate results for the South African population with research actually suggesting the need for South African norms on this test. Use of this test may then have negatively impacted participants scoring and may indeed have resulted in a measuring error. All the participants on follow up had below average scores. This may be due to this measuring error.

Furthermore, the VMI has a high inter rater reliability in primary school children and when administered by experienced scorers[3]. In this research the VMI test was administered by qualified occupational therapists who had been trained as undergraduate students on the test and therefore inter- rater reliability should not be negatively influenced. However the inter-rater reliability for the identified motor and process deficits could not be determined as a non- standardised occupational therapy assessment was used to assess these factors. This was true of the initial and follow up assessments.

The use of a record review was found to be one of the limitations of this study as the data recorded was inconsistent and sparse at times. This meant that limited conclusions could be drawn regarding localising the lesion and even visual motor integration scores as this information was not consistently recorded. Inconsistent recording of data meant that it was problematic to draw conclusions about whether that deficit was absent or simply not assessed.

6.2. Recommendations for further study

The limitations experienced using a retrospective record review could be alleviated by doing a prospective study of this population. It would be beneficial to use standardised assessments and standard record sheet to ensure the same areas are assessed in all patients.

As recommended by other research, norms on the VMI test should be developed for the South African population[50].

Further research should also be conducted on a larger sample including subjects from all SES groups to establish if differences in findings on the VMI test were purely due to the effects of low SES or the condition itself.

Information regarding the patient's premorbid schooling and their later schooling should be collected in order to realistically compare the outcomes.

The sample size of the study, especially the follow up patients also limited the accuracy of the results. A larger study would therefore more accurately reflect this population.

A guideline for assessment and treatment of all patients with Brain Abscess and Empyema should be developed. This framework should include the comprehensive assessment protocol for this population group as well as minimum standards of treatment.

A referral protocol for all Brain Abscess and Empyema patients should be investigated and the viability of implementation of this at all neurosurgery units should be considered.

6.3 Occupational Therapy Guideline for Brain Abscess and Empyema

Using the Occupational Therapy Practice Framework: Domain and process 2nd edition, the following guideline has been drawn up for assessment and treatment of patients with BA and Empyema[11]. The following table has been drawn up to guide assessment and treatment of patients with BA and Empyema. The table has been divided into the different phases of assessment and treatment to highlight when different assessments should be carried out or for when the focus of treatment should be slightly different. In order to comprehensively assess these patients assessment has been divided into performance skills and client factors. Treatment has been divided into the type of intervention used and the occupational therapy approach.

Table 6.1. Occupational Therapy Guideline for Brain Abscess and Empyema

	Assessment		**Treatment**	
	Client Factors	**Performance Skills**	**Types of Occupational therapy intervention**	**Occupational therapy intervention approaches**
Acute	**Specific mental functions** • Attention • Memory • Thought **Global mental functions** • Consciousness • Orientation • Energy and drive	• Cognitive skills • Sensory- perceptual skills • Communication and social skills	• Occupation based intervention • Cognitive skills • Sensory- perceptual skills • Motor • Sensory • Purposeful activities • Motor • Preparatory methods ○Motor	**Remediation/ Restoration** • Performance skills ○ Cognitive skills ○ Sensory perceptual skills ○ Motor • Client factors ○ Specific mental functions ○ Global mental functions ○ Sensory functions ○ Neuromuscular and movement related functions **Prevention** • Performance skills ○ Motor and praxis skills • Client factors ○ Sensory functions **Promotion** Performance skills ○ Cognitive skills
	Sensory functions	• Sensory- perceptual skills		
	Neuromusculoskeletal and movement related functions • Muscle power • Muscle Tone • Muscle endurance • Control of voluntary movement	• Motor and praxis skills		

				○ Motor and praxis skills • Client factors ○ Neuromuscular and movement related function
Pre- discharge	**Specific mental functions** • Attention • Memory • Perception • Thought • Emotional • Experience of self and time **Global mental functions** • Temperament and personality • Energy and drive	• Sensory- perceptual skills • Communication and social skills • Cognitive skills	• Occupation based intervention ○ Sensory- perceptual skills ○ Cognitive skills ○ Motor ○ Sensory • Purposeful activity ○ Cognitive skills ○ Sensory- perceptual skills ○ Motor skills • Preparatory methods ○ Motor skills	**Remediation/ Restoration** • Performance skills ○ Sensory- perceptual ○ Cognitive skills ○ Motor skills • Client factors ○ Specific mental functions ○ Global mental functions **Modify** • Environments **Prevention** • Performance skills ○ Motor and praxis skills • Client factors ○ Sensory ○ Neuromuscular and movement related functions
	Sensory functions	• Sensory- perceptual skills		
	Neuromusculoskeletal and movement related functions • Muscle power • Muscle Tone • Muscle endurance • Control of voluntary movement • Gait patterns	• Motor and praxis skills		

Chronic	**Specific mental functions** • Higher level cognitive • Perception • Mental functions of sequencing complex movement • Emotional • Experience of self and time **Global mental functions** • Temperament and personality • Energy and drive	• Sensory- perceptual skills • Communication and social skills • Cognitive skills	• Occupation- based intervention ○ Cognitive skills (schooling) ○ Sensory- perceptual skills	**Remediation/ Restoration** • Performance skills ○ Sensory perceptual skills ○ Cognitive skills ○ Motor skills • Client factors **Modify** • Environments **Promotion** • Performance skills ○ Cognitive skills ○ Motor skills • Client factors ○ Specific mental functions
	Neuromusculoskeletal and movement related functions • Muscle power • Muscle Tone • Muscle endurance • Control of voluntary movement • Gait patterns	• Motor and praxis skills		

Appendix 1

THIS SIDE UP

Let's Draw!

Use a soft, black pencil or a black ball-point pen.
Remember, you get one try with no erasing.
Keep the booklet straight in front of you and don't tilt it.
Just do the best you can on both the easy ones and the hard ones.

Don't skip any!

Please turn the page from the top to begin.



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Imitation of vertical, horizontal, and circular lines

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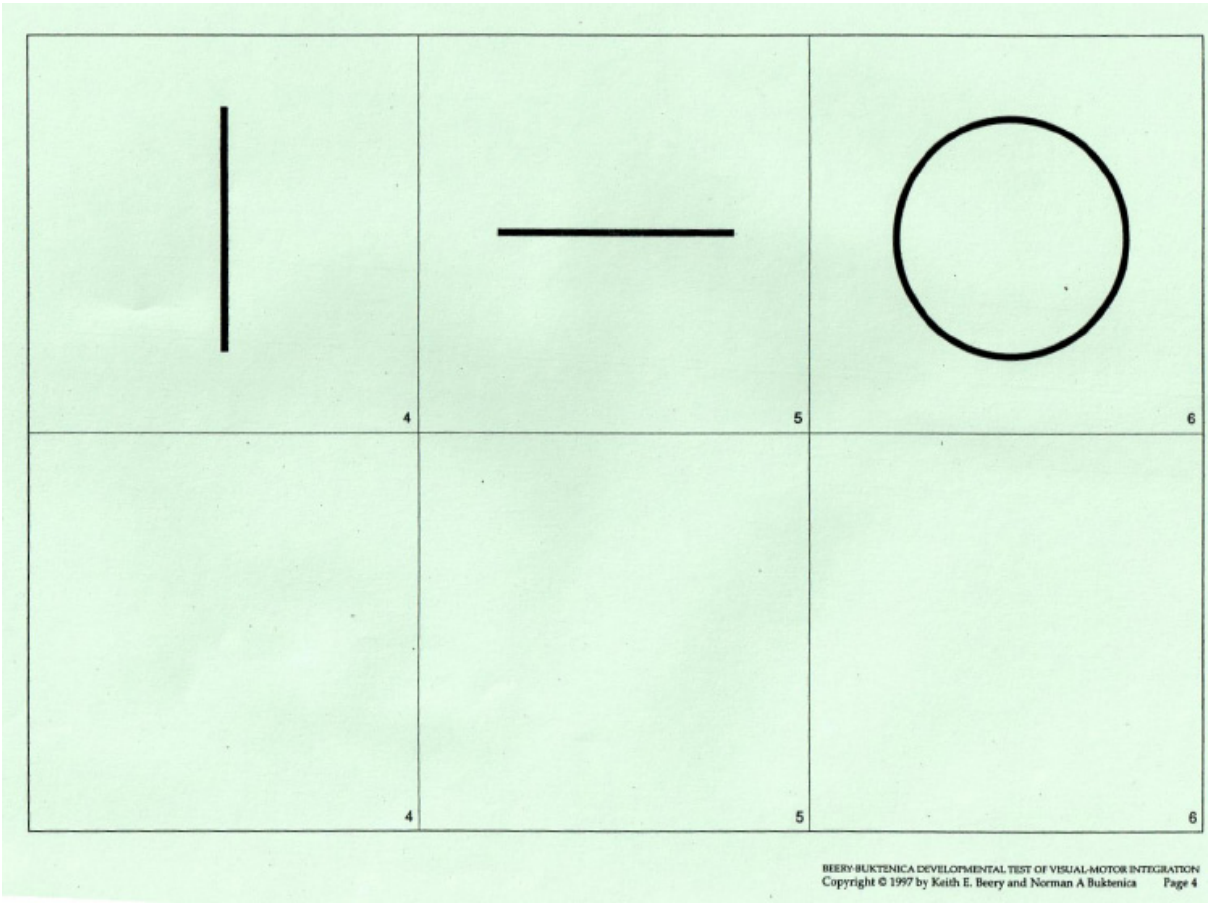

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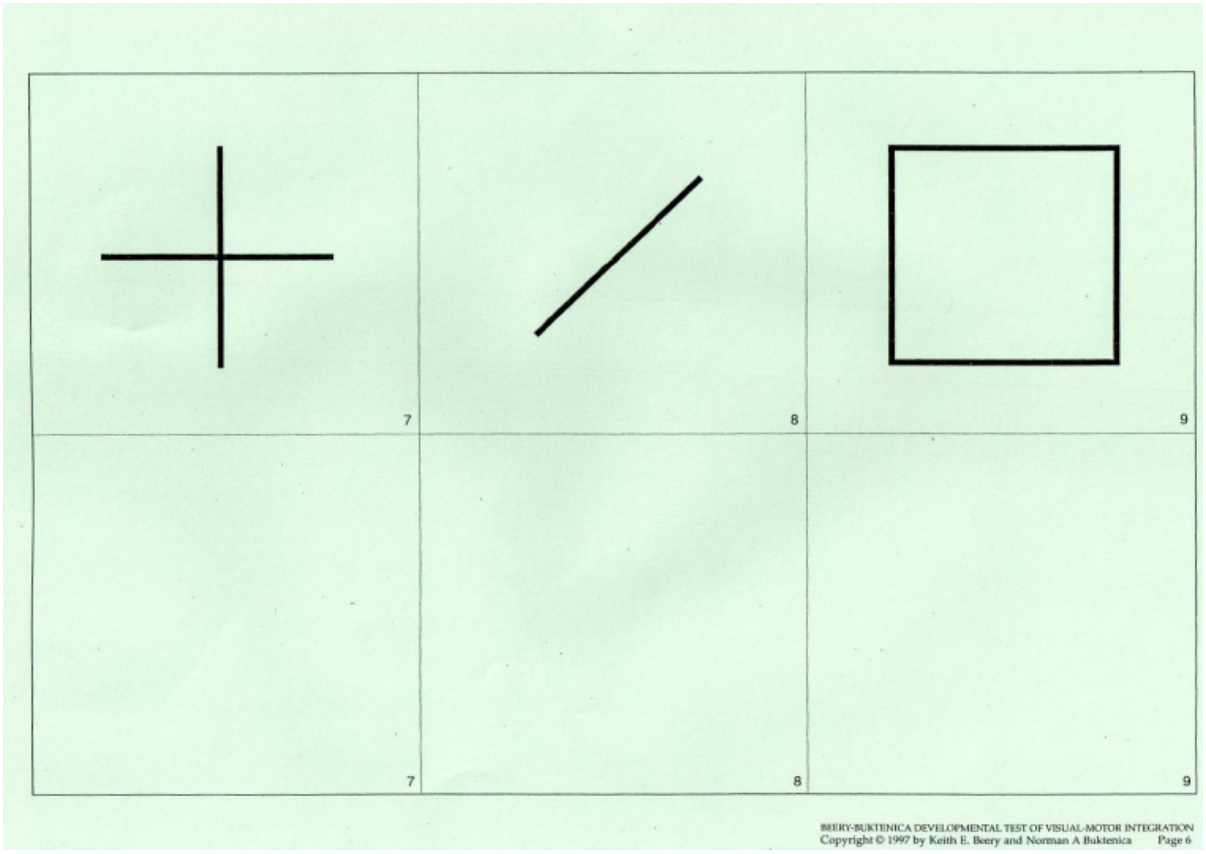

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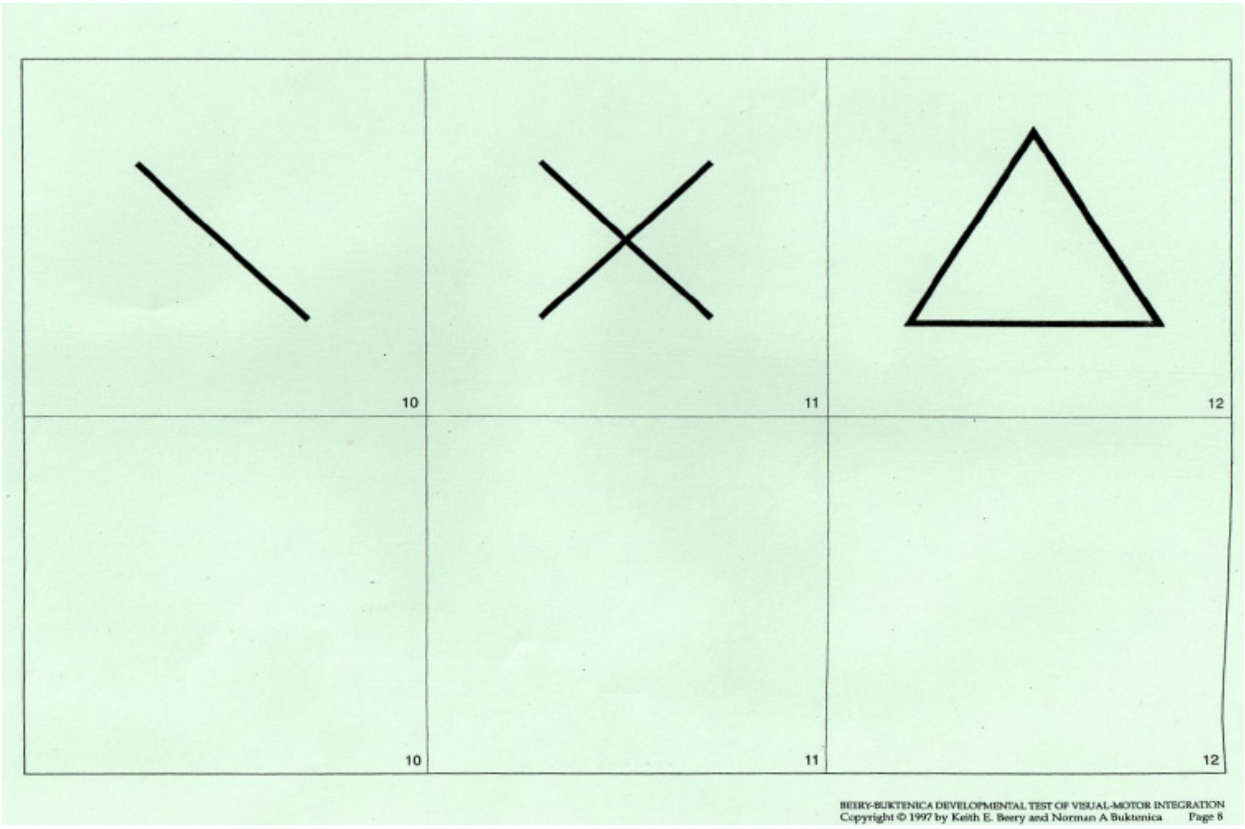

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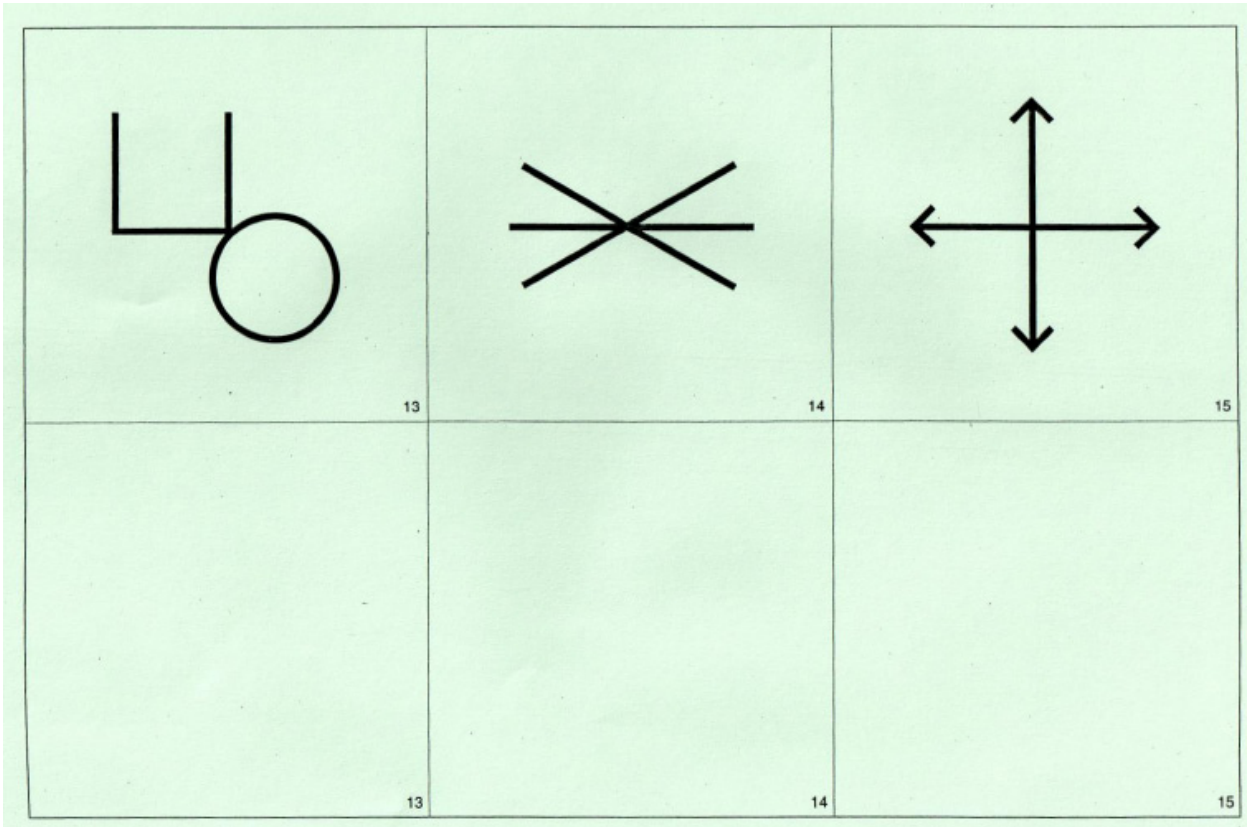

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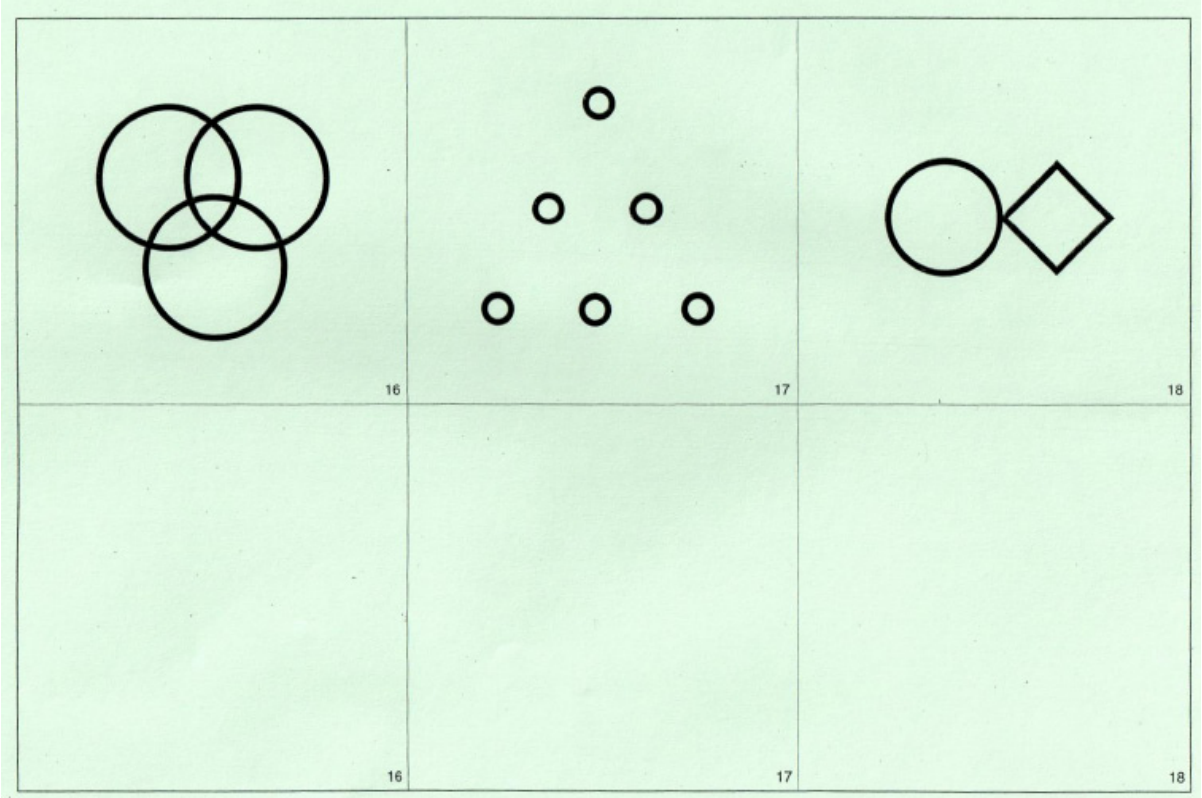

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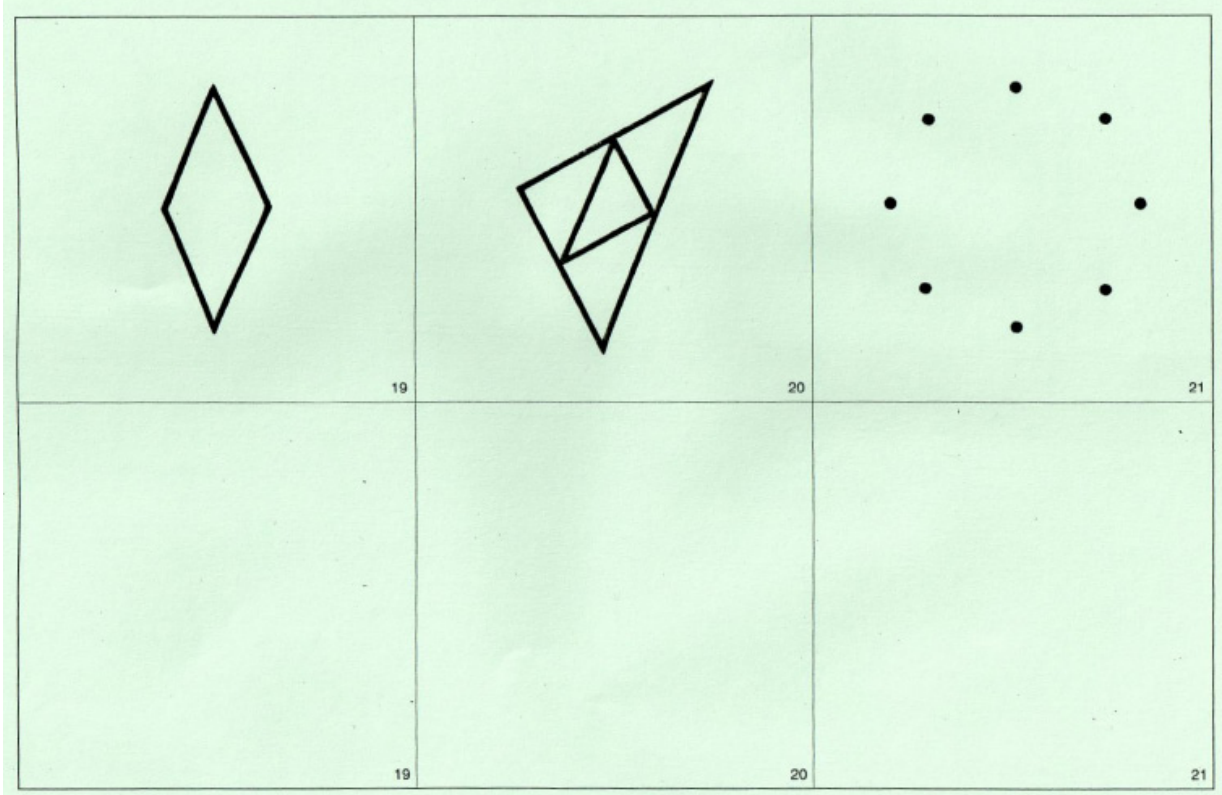

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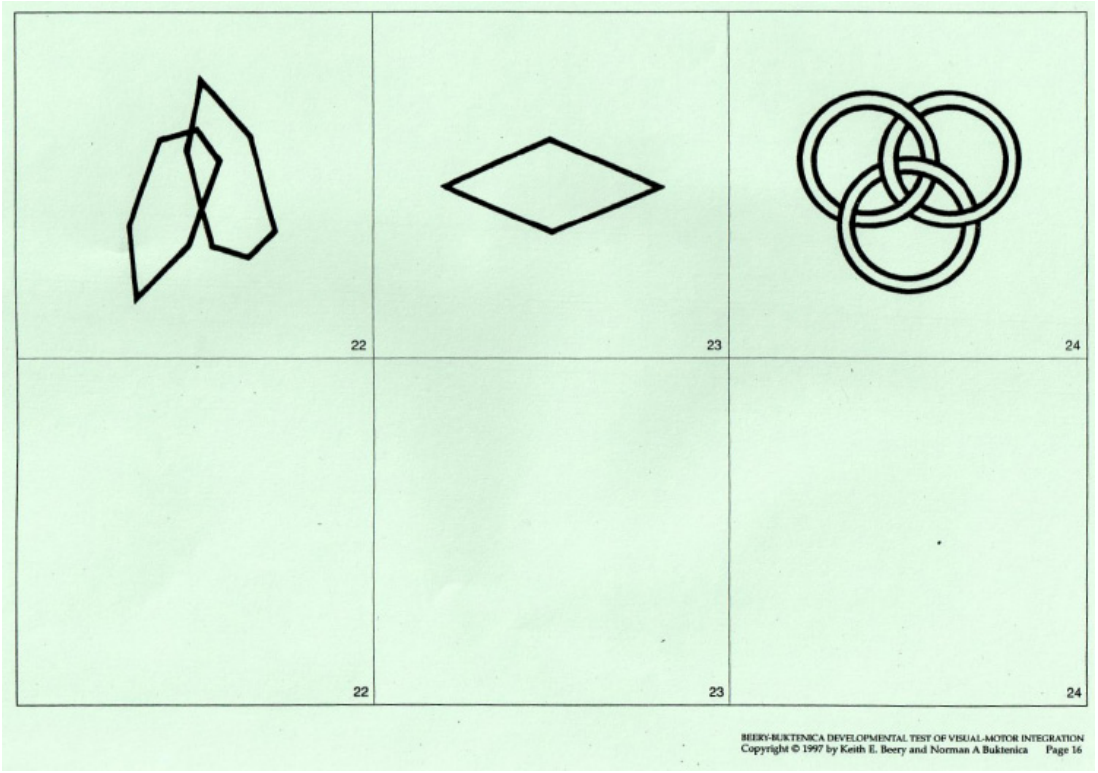

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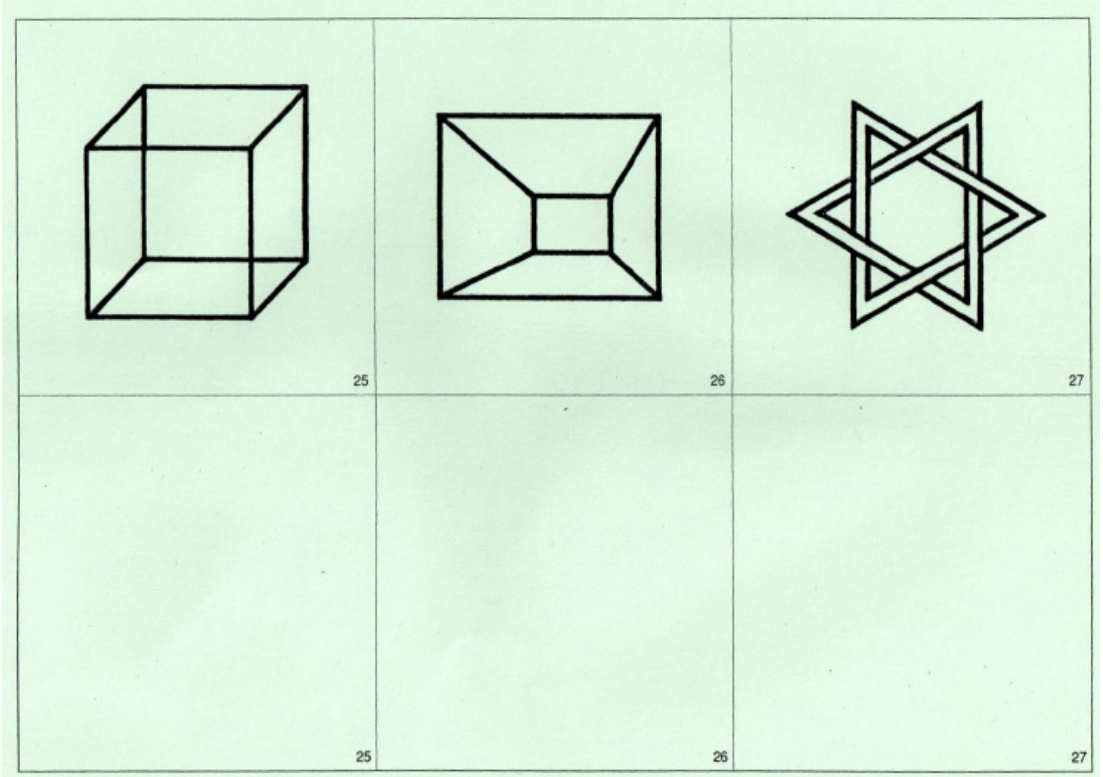

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Summary Comments and Recommendations

Visual Abilities

Motor Abilities

VMI Abilities

Retention/Extension

Other

See the 1997 VMI Manual for teaching recommendations

VMI Recording and Scoring

No.	Form	Age Norm (Yrs-Mons)	Score	Observations
1		2-0 Imitated		
2		2-6 Imitated		
3		2-9 Imitated		
4		2-10 Copied		
5		3-0 Copied		
6		3-0 Copied		
7		4-1		
8		4-4		
9		4-6		
10		4-7		
11		4-11		
12		5-3		
13		5-6		

VMI Raw Score = total points scored up to 3 consecutive No Scores
Record raw score on front page. See the 1997 VMI Manual for norms.

No.	Form	Age Norm (Yrs-Mons)	Score	Observations
14		5-9		
15		6-5		
16		6-8		
17		7-5		
18		7-11		
19		8-1		
20		8-11		
21		9-6		
22		10-2		
23		10-11		
24		11-2		
25		12-8		
26		13-2		
27		13-8		

Developmental Test of Visual-Motor Integration

VMI

Ages 3 through Adult (FULL FORMAT)

by Keith E. Beery and Norman A. Buktenica

Last First

School: _____ Grade: _____

Examiner: _____

Date of Test: ____ year ____ month ____ day

Birth Date: ____ year ____ month ____ day

Chronological Age: ____ years ____ months

(Count more than 15 days as one month.)

SUMMARY

See the VMI 1997 Manual for norms.

	VMI	Visual	Motor
Raw Scores:	____	____	____
Standard Scores:	____	____	____
Scaled Scores:	____	____	____
Percentiles:	____	____	____
Other Scaling:	____	____	____

Comments and Recommendations

PROFILE

Standard	VMI	Visual	Motor	Percentile
145	-	-	-	99.7
140	-	-	-	99.2
135	-	-	-	99
130	-	-	-	98
125	-	-	-	95
120	-	-	-	91
115	-	-	-	84
110	-	-	-	75
105	-	-	-	63
100	-	-	-	50
95	-	-	-	37
90	-	-	-	25
85	-	-	-	16
80	-	-	-	9
75	-	-	-	5
70	-	-	-	2
65	-	-	-	1
60	-	-	-	.8
55	-	-	-	.3

Begin testing at the back. Turn booklet over with bound edge toward the student. If subtests are used, always test in this order: VMI → Visual → Motor.

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The VMI Developmental Test of Visual Perception

Visual Perception

Ages 3 through Adult

by Keith E. and Natasha A. Beery

Name _____ Sex: ○ F ❑ M
Last First

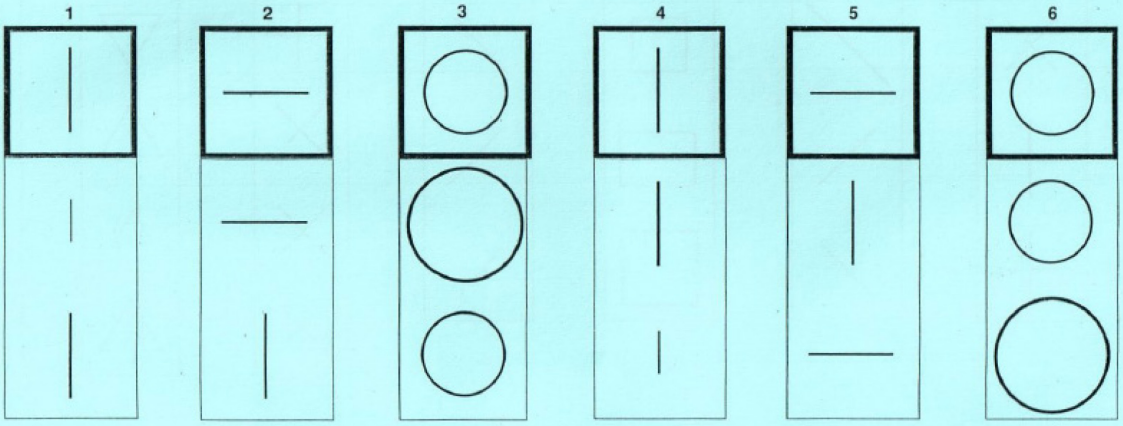
School: _____ Grade: _____

Examiner: _____

Date of Test: ____ year ____ month ____ day

Birth Date: ____ year ____ month ____ day

Chronological Age: ____ years ____ months
(Count more than 15 days as one month.)



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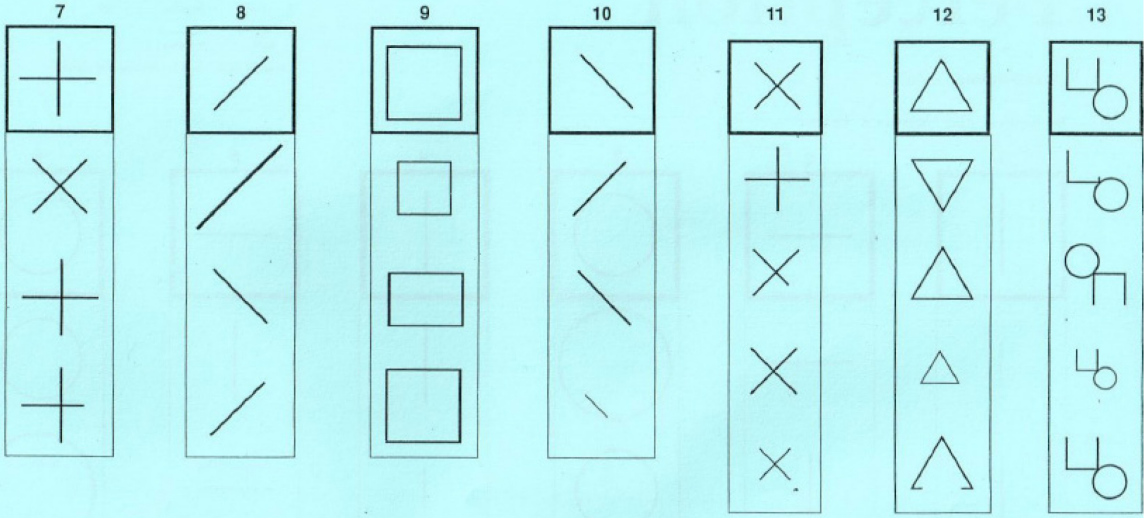

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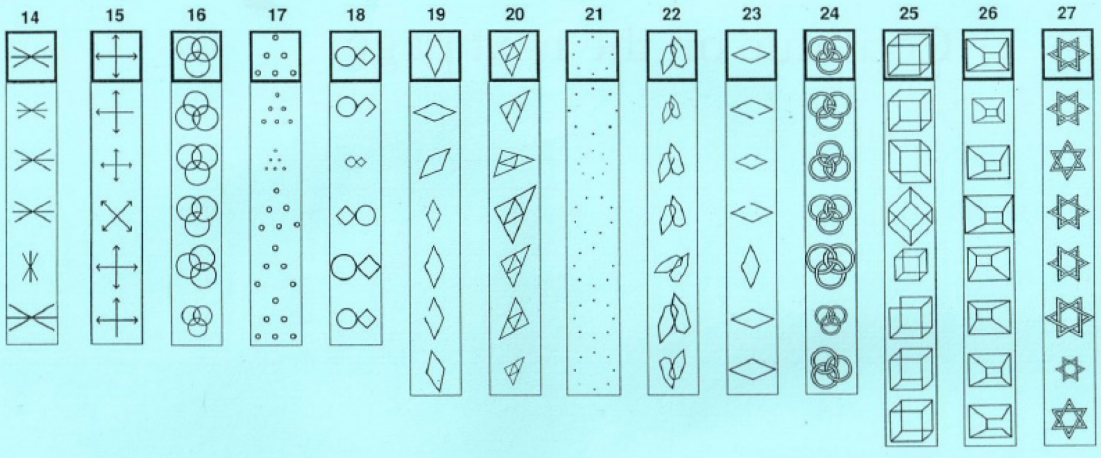

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The VMI Developmental Test of Visual Perception

Motor Coordination

Ages 3 through Adult

by Keith E. and Natasha A. Beery

Name _____ Sex: ○ F ❑ M
Last First

School: _____ Grade: _____

Examiner: _____

Date of Test: ____ ____ ____
year month day

Birth Date: ____ ____ ____
year month day

Chronological Age: ____ ____
years months

(Count more than 15 days as one month.)



Let's Draw!

Use a soft, black pencil or a black ball-point pen.
Remember, you get one try with no erasing.
Keep the booklet straight in front of you and don't tilt it.
Just do the best you can on both the easy ones and the hard ones.

Don't skip any!

Please turn the page from the top to begin.

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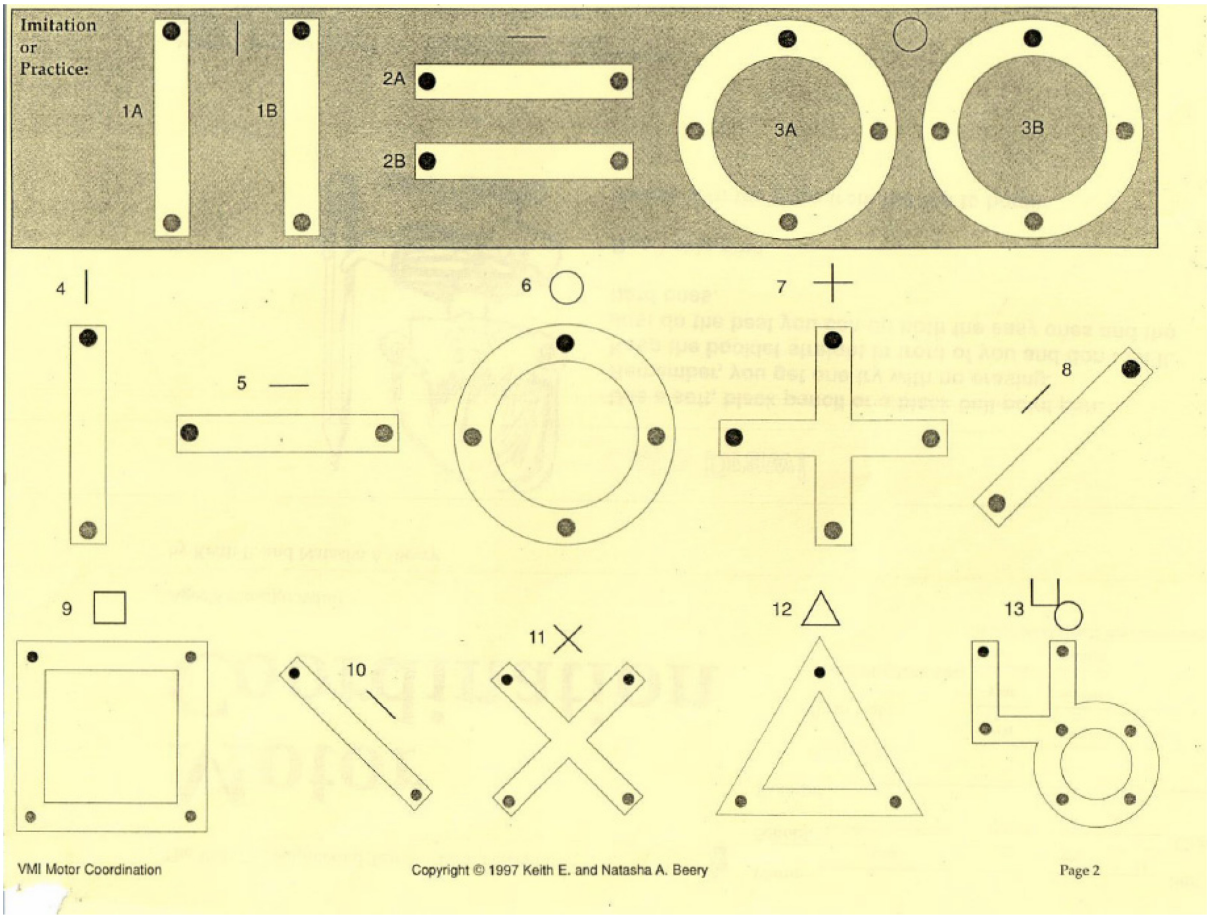

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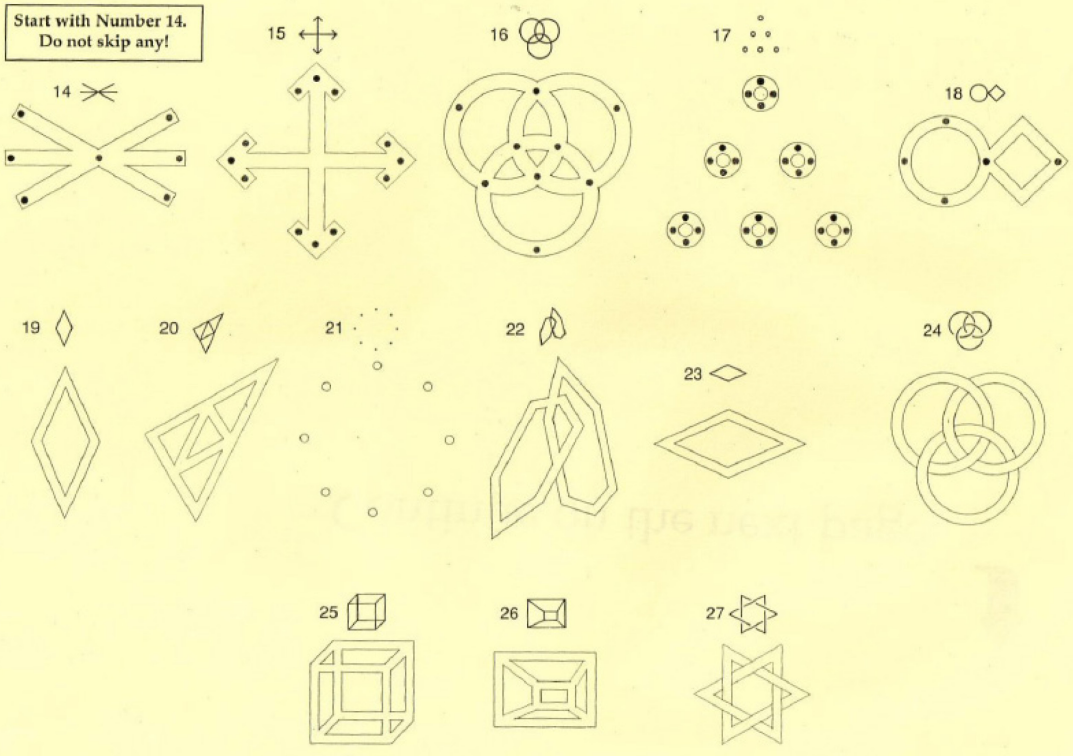

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Appendix 2

Faculty of Health Sciences
Medical School, 7 York Road, Parktown, 2193
Fax: (011) 717-2119
Tel: (011) 717-2745

Reference: Ms Tania Van Leeve
E-mail: tania.vanleeve@wits.ac.za
12 September 2008
Person No: 9800246A
TAA

Ms KL Schwenke
P O Box 30961
Braamfontein
2017
South Africa

Dear Ms Schwenke

Master of Science in Occupational Therapy: Change of title of research

I am pleased to inform you that the following change in the title of your Research Report for the degree of has been approved:

From:	**Record review and Visual Motor Integration in patients with Brain Abscess (BA) and Subdural Empyema (SDE) at Chris Hani Baragwanth Hospital**
To	**Record review of patients with brain abscess and empyema**

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Schwenke

CLEARANCE CERTIFICATE	PROTOCOL NUMBER M070431
PROJECT	Record Review and visual motor integrtion in patients with brain abscess (BA) and sub-dural Empyema (SDE) at CH Bara Hospital
INVESTIGATORS	Miss K Schwenke
DEPARTMENT	Occupational Therapy
DATE CONSIDERED	07.05.04
DECISION OF THE COMMITTEE*	APPROVED UNCONDITIONALLY

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

DATE 07.06.11 CHAIRPERSON .....
(Professors PE Cleaton-Jones, A Dhai, M Vorster, C Feldman, A Woodiwiss)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Franzsen D

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 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 3

Good Day,

My name is Kathy Schwenke from the Occupational Therapy Department at Chris Hani Baragwanath Hospital. I am investigating visual- motor integration (VMI) in patients with Subdural Empyema (SDE) and brain abscess (BA) and how this may affect their school results. I would be most grateful if you would allow your child to participate in this work.

Why are we doing this? Research in developed countries such as America has shown a link between VMI and school performance but no research has been done on the effects of SDE and BA and how these patients manage back at school. I would like to use this information to predict if patients with SDE and BA are not managing back at school.

What do we expect from your child? Your child would need to complete a test called the Developmental Test of Visual Motor Integration. This test takes between 30 minutes and a hour and a half to complete. Your child will need to copy the shapes on the test.

Are there any benefits for my child? Yes. If I notice any problem areas with your child I will continue to see them for Occupational Therapy. Also I will contact the school with recommendations to help your child at school.

May I withdraw my child from the study? Of course. You may do this at any time and without having to give a reason. This study is voluntary and withdrawing from it does not have a penalty. Your child will still receive OT if needed.

What about confidentiality? Your child's name will not appear in the results. A code will be used instead of the childs name. Only I, as the researcher will have the childs name.

If you have any queries, more information can be obtained from Kathy Schwenke at telephone number (011) 933 8294.

If you are happy to let your child take part in the study, please read and sign the attached consent form.

Thank you

Kathy Schwenke

Appendix 4

Consent form

I agree to allow my child _____

_____(childs name) to participate in the study outlined in the information sheet.

PARENT/ GUARDIAN

Name:_____

Signature:_____

DATE:_____

Appendix 5

Assent Form

I agree to participate in the study outlined in the information sheet

Name:_____

Signature:_____

Date:_____

Appendix 6

Interview form

Are you coping at school?

Subject: _____

_____

Caregiver: _____

_____

Have you failed at school since being hospitalised?

Subject: _____

_____

Caregiver: _____

_____

Are you struggling with anything that you previously found you could cope with?

Subject: _____

_____

Caregiver: _____

_____

Appendix 7

Summary of motor and process deficits

Tick if present and comment

Motor Deficits

Right Hemilpegia ☐ _____

Left Hemiplegia ☐ _____

Bilateral Hemiplegia ☐ _____

Balance ☐ _____

Coordination ☐ _____

Muscle strength ☐ _____

Motor planning ☐ _____

- Ideation ☐ _____
- Ideomotor ☐ _____
- Motor output ☐ _____

Speech deficits ☐ _____

- Dysarthria ☐ _____
- Aphasia ☐ _____

Process Deficits

Vision ☐ _____

Hearing ☐ _____

Concentration ☐ _____

Body concept ☐ _____

Basic concepts ☐ _____

Problem solving ☐ _____

Sequencing ☐ _____

Figure ground ☐ _____

Appendix 8

VMI pre and post test scores

	VMI	Z- score	Visual	Z- score	Motor	Z- score		VMI	Z- score	Visual	Z- score	Motor	Z- score
Subject A	89	-0.73333	108	0.533333	127	1.8		109	0.6	59	-2.73333	87	-0.86667
Subject B	73	-1.8	98	-0.13333	57	-2.86667		85	-1	100	0	76	-1.6
Subject C								93	-0.46667	99	-0.06667	95	-0.33333
Subject D	89	-0.73333						70	-2	76	-1.6	80	-1.33333
Subject E	76	-1.6	92	-0.53333	57	-2.86667		85	-1	91	-0.6	60	-2.66667
Subject F	77	-1.53333	65	-2.33333	47	-3.53333		106	0.4	91	-0.6	57	-2.86667
Subject G	91	-0.6	98	-0.13333	67	-2.2		100	0	95	-0.33333	91	-0.6
Subject H								58	-2.8	75	-1.66667	64	-2.4

REFERENCES

1. McGillicuddy J, Hoff J. Infections of the central nervous system. In: Crockard A, Hayward R, Hoff J (eds). Neurosurgery The scientific basis of clinical practice. Volume 2. Boston: Blackwell Scientific Publications, 1992.
2. Lindsay K, Bone I. Neurology and Neurosurgery illustrated. 3rd edition. Bath: Churchill Livingstone; 2002.
3. Beery K. The Beery- Buktenika developmental test of Visual- motor integration. 4th Edition, Revised. 4th ed. New Jersey: Modern Curriculum Press; 1997.
4. Kielhofner G. A model of human occupation. Theory and application. 2nd ed. Baltimore: Williams and Wilkins; 1995.
5. Online Medical Dictionary Accessed 2009 29/01/2009, 1997.
6. Schneck C. Visual perception. In: Case- smith J (ed). Occupational therapy for children. St. Louis: Mosby, 2005.
7. Saez- Llorens X. Brain Abscess in children. Seminars in paediatric infectious diseases. 2003 April 2003;14(2):108- 14.
8. Maertens P, Cohen M, Krawiecki N. The use of neuropsychological evaluation in the medical management of subdural empyema. Archives of clinical neuropsychology. 1987;2:145- 54.
9. Gormley W, del Busto R, Saravolatz L, Rosenblum M. Cranial and intracranial Bacterial infections. In: Youmans J (ed). Neurological Surgery 4th Edition. Volume 5. Philadelphia: W. B. Saunders Company, 1996.
10. Palmer J. Intracranial Abscess. In: Palmer J (ed). Neurosurgery '96 Manual of Neurosurgery. Edinburgh: Churchhill Livingstone, 1996.
11. Roley S, DeLaney J, Barrows C, et al. Occupational Therapy Practice Framework: Domain and process. 2nd edition. The American Journal of Occupational Therapy. 2008 November/ December;62(6):625- 83.
12. Gillen G. Cognitive and perceptual rehabilitation. Optimizing function. St Loius: Mosby Elsevier; 2009 (desk copy).
13. Zoltan B. Vision, perception and cognition. Third edition. Third ed. New Jersey: Slack incorporated; 1996.
14. Wagner F, Preuss J. Supratentorial Epidural abscess and Subdural empyema. In: Apuzzo M (ed). Brain Surgery Complication avoidance and management. Volume 2. New York: Churchill Livingstone, 1993.
15. Kulp M. Relationship between Visual Motor Integration skill and academic performance in kindergarten through third grade. Optometry and vision science. 1999 March 1999;76(3):159- 63.
16. Schneck C. Visual perception. In: Case- smith J (ed). Occupational therapy for children. St. Louis: Mosby, 2001.
17. Daly C, Kelley G, Krauss A. Relationship between visual- motor integration and handwriting skills of children in kindergarten: a modified replication study. The American Journal of Occupational Therapy. 2003;57(4):459- 62.
18. Dankert H, Davies P, Gavin W. Occupational therapy effects on visual motor skills in preschool children. The American Journal of Occupational Therapy. 2003;57(5):542-9.
19. Goldstand S, Koslowe K, Parush S. Vision, visual- information processing and academic performance among seventh- grade schoolchildren: a more significant relationship than we thought? The American Journal of Occupational Therapy. 2005;59(4).
20. The making of Soweto. Volume 2008, 2008.

21. Sheppard Z, Norris S, Pettifor J, Cameron N, Griffiths P. Approaches for assessing the role of household socioeconomic status on child anthropometric measures in urban South Africa. American Journal of Human Biology. 2008 September.
22. Brook I. Brain Abscess Accessed 2008 21/ 07/ 2008, 2008.
23. Leotta N, Chaseling R, Duncan G, Isaacs D. Intracranial suppuration. Journal of Paediatric Child Health. 2005;41:508- 12.
24. Domingo Z, Peter J. Brain abscess in childhood. South African Medical Journal. 1994 January 1994;84:13- 5.
25. Sichizya K, Fieggen G, Taylor A, Peter J. Brain abscesses- the Groote Schuur experience, 1993- 2003. South African Journal of Surgery. 2005;43(3):79- 82.
26. Sharma B, Gupta S, Khosla V. Current concepts in the management of pyogenic brain abscess. Neurology India. 2000;48(2):105- 11.
27. Hlavin M, Kaminski H, Fenstermaker R, White R. Intracranial suppuration: a modern decade of postoperative subdural empyema and epidural abscess. Neurosurgery. 1994 June 1994;34(6):974- 81.
28. Johnson D, Markle B, Wiedermann B, Hanahan L. Treatment of intracranial abscesses associated with sinusitis in children and adolescents. The journal of paediatrics. 1988;113(1 part 1):15- 23.
29. Tewari M, Sharma R, Shiv V, Lad S. Spectrum of intracranial subdural empyemas in a series of 45 patients: Current surgical options and outcome. Neurology India. 2004;52(3):346- 9.
30. Bannister G, Williams B, Smith S. Treatment of subdural empyema. Journal of Neurosurgery. 1981;55:82- 8.
31. Feuerman T, Wackym P, Gade F, Dubrow T. Craniotomy improves outcome in subdural empyema. Surgical Neurology. 1989;32:105- 10.
32. Yende A, Mohanty S. Massive falx cerebri empyema. Neurology India. 2003;51(1):65- 6.
33. Nielsen H, Harmsen A, Gyldensted C. Cerebral Abscess: a long term follow up. Acta Neurology Scandinavia. 1983;67:330- 7.
34. Ali A, Kurien M, Mathews S, Mathew J. Complications of acute infective rhinosinusitis: experience from a developing country. Singapore Medical Journal. 2005;46(10):540.
35. Sunil K, Madhuri K. Symposium on developmental and behavioural disorders. 2005:961- 7.
36. Sumison T. overview of client centred practice. In: Sumison T (ed). Client centred practice in Occupational therapy A guide to implementation Second Edition. Volume 1. Edinburgh: Elsevier Limited, 2006:1-18.
37. Klonoff H, Low M, Clark C. Head injuries in children: a prospective five year follow up. Journal of Neurology, Neurosurgery and Psychiatry. 1977;40:1211- 9.
38. Carey M, Chou S, French L. Long term neurological residua in patients surviving brain abscress with surgery. Journal of Neurosurgery. 1971 May 1971;34:652- 6.
39. Seydoux C, Francioli P. Bacterial brain abscess: Factors influencing mortality and sequelae. Clinical infectios disease. 1992 September;15:394-401.
40. Kulp M, Sortor J. Clinical value of the Berry- Visual Motor Integration Supplemental tests of visual perception and motor coordination. Optometry and vision science. 2003;80(4):312- 5.
41. Bonifacci P. Children with low motor ability have lower visual- motor integration ability but unaffected perceptual skills. Human movement science. 2004;23:157- 68.
42. Anderson R. 5th International symposium on brain functional genomics. 5th International symposium on brain functional genomics. Shanghai institute of brain functional genomics, 2007.
43. Rosenbaum D, Carlson R, Gilmore R. Acquisition of intellectual and perceptual- motor skills. Annual review of psychology. 2001;52:453- 70.
44. Dunn M, Loxton H, Naidoo A. Correlations of scores on the Developmental test of Visual-motor integration and copying test in a South African multi- ethnic preschool sample. Perceptual and Motor skills. 2006;103:951- 8.

45. Sortor J, Kulp M. Are the results of the Beery- Buktenika Developmental test of Visual Motor Integration and its subtests related to achievement test scores? Optometry and vision science. 2003 November 2003;80(11):758- 63.
46. Akshoomoff N, Feroleto C, Doyle R, Stiles J. The impact of early unilateral brain injury on perceptual organisation and visual memory. Neuropsychologia. 2002;40:539- 61.
47. Stiers P, van den Hout B, Haers M, et al. The variety of visual perceptual impairments in pre-school children with perinatal brain damage. Brain and development. 2001;23:333- 48.
48. Abercrombie M, Gardiner P, Hansen E, Jonckheere J, Lindon R, Solomon G. Visual perceptual and visuomotor impairment in physically handicapped children. Perceptual and Motor skills. 1964;18:561- 625.
49. Richardson P. Use of standardised tests in paediatric practice. In: Case- smith J (ed). Occupational Therapy for children. St. Louis: Elsevier, Inc., 2005.
50. Zona. Johannesburg: University of Witwatersrand:1-54.
51. Rens Z. The standardisation of the Beery- Buktenika Developmental Test of Visual Motor Integration with supplemental developmental tests of Visual Perception and coordination (4th edition, revised 1997) on an Eastern Cape population aged 7 years 0 months to 7 years 3 months. Johannesburg: University of Witwatersrand, 2008:1-54.
52. Hartlage L, Lucas T. Differential correlates of Bender- Gestalt and Beery Visual Motor Integration Test for black and for white children. Perceptual and Motor skills. 1976;43:1039-42.
53. HPCSA HPCoSA. Guidelines with regards to the records of patients. In: Africa HPCoS (ed). Volume Booklet 7, January 2002.
54. Badcock D, Kelly A, Kerr D, Reade T. The quality of medical record review studies in the international emergency medicine literature. Annals of Emergency research. 2005;45(4):444-7.
55. Worster A, Bledsoe R, Cleve P, Fernandes C, Upadhyne S, Eva K. Reassessing the methods of medical record review studies in emergency medicine research. Annals of Emergency research. 2005 April 2005;45(4):448- 251.
56. Lowenstein S. Medical record reviews in emergency medicine: the blessing and the curse. Annals of Emergency research. 2005;45(4):452- 5.
57. Petersen J. Designing a rigorous small study sample. Best Practices in quantitative methods. California: Sage Publishers Inc.
58. M'kumbuzi V, Amosun S, Stewart A. Retrieving physiotherapy patient records in an academic hospital in Johannesburg, South Africa. SA Journal of physiotherapy. 2005;61(4):19- 23.
59. M'kumbuzi V, Amosun S, Stewart A. Retrieving physiotherapy patient records in selected health care facilities in South Africa- is record keeping compromised. Disability and rehabilitation. 2004;26(18):1110- 6.
60. White Paper: transformation of the health system in South Africa. http://wwww.doh.gov.za/docs/policy/white_paper/health-sys97_02.html ed, 1999.
61. Wald N, Law M, Meade T, Miller G, Alberman E, Dickinson J. Use of personal medical records for research purposes. British Medical journal. 1994 November 1994;309:1422- 4.
62. Trochin B. Research methods tutorials- longitudinal studies.
63. Osborn M, Steinberg J. Subdural empyema and other suppurative complications of paranasal sinusitis. Lancet Infectious diseases. 2007 January 2007;7:62- 7.
64. Rogers S. Common conditions that influence children's participation. In: Case- smith J (ed). Occupational Therapy for Children. St. Louis: Elsevier. Inc., 2005.
65. Smith H, Hendrick E. Subdural empyema and epidural abscess in children. Journal of Neurosurgery. 1983;58:392- 7.
66. Davies H. What are confidence intervals? Accessed, 2001.
67. Lawes N. Neuroplasticity. In: Stokes M (ed). Physical Management in neurological rehabilitation 2nd edition. Edinburgh: Elsevier, 2004.