THE USE OF XBOX KINECT™ IN THE PAEDIATRIC BURNS UNIT AT CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Physiotherapy

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DECLARATION

I declare that this research is my own work. It is being submitted in partial fulfilment of the requirements for the degree of Master of Science in Physiotherapy. It has not been submitted before for any other degree or examination at this or any other university.

Eleonora Lozano

_____ day of _____, 20___

ABSTRACT

Background: Burns are a significant cause of paediatric injuries, particularly in low and middle-income countries, where more than 90% of burn-related paediatric deaths occur. Physiotherapy is an essential, sometimes painful, component of burn rehabilitation therapy. The popularity of the video game use in burns rehabilitation has grown because, in addition to facilitating range of motion (ROM) in an effort to prevent joint contracture formation, the virtual imaging characteristics of these games provides additional benefit of distraction from pain. Video games provide a more efficient, effective and enjoyable method training, and are a helpful adjunct to rehabilitation.

Aim: To investigate the effect of using the Xbox Kinect™ on discharge outcomes and early activity levels of children in the Paediatric Burns Unit (PBU) at Chris Hani Baragwanath Academic Hospital (CHBAH)

Methods: This non-equivalent post-test only control group design study took place over a period of time until the total number of children required was achieved for each group. The control group was the first group of children recruited to the study and received standard physiotherapy treatment and rehabilitation. The experimental group was the second group of children recruited to the study who received standard physiotherapy treatment and rehabilitation as well as the Xbox Kinect™.

Comparisons were made only after the intervention and analysed. Outcome measures for each participant were ROM, Activities Scale for Kids© participation (ASK©p) and a modified Wong-Baker FACES® enjoyment rating scale. On discharge from the unit, ROM assessments and the modified Wong-Baker FACES® enjoyment rating scale were administered. On follow-up one week post discharge, ROM re-assessments were done and the ASK©p was administered. A questionnaire regarding the use of the Xbox Kinect™ was completed by health professionals working within the PBU.

Results: Seventy children were recruited into the study of which the data for 66 were analysed. Thirty five children were part of the control group and 31 were part of the Xbox intervention group.

No significant difference was found between groups regarding demographic characteristics, the median age was seven years old and 55% of the participants were male. There was one mortality and five children in total were lost to follow up. The majority burns were as a result of hot water attributing to more than 50% of admissions, followed by flame burns (30%) and electrical burns (12%). This study population showed an overall total burn surface area (TBSA) of nine percent which were superficial partial in depth; this is seen as a minor burn injury. Forty percent were seen to have moderate-severe injury and three children were considered to have severe major burns > 30 % TBSA. We observed a greater proportion of injury involving the lower limbs (23.10%) and upper limbs (21.10%), followed by injury involving the trunk (11.40%), buttocks and genitalia (7.50%) and the head and neck regions (6.80%). There was no difference in length of stay (LoS) or the chance of Intensive Care Unit (ICU) stay between the two groups. In the intervention group 75% of the children received 2 or more Xbox Kinect™ sessions.

The Xbox Kinect™ was shown to be significant in achieving higher active range of movement (AROM) at discharge ($p< 0.01$) and at follow up ($p< 0.01$), and highlights the advantages it has in providing a more amusing and comfortable option as part of the burns rehabilitation process. By allowing the children to be more engaged in the Xbox Kinect™ experience and games, they were distracted and thus experienced less pain. In this study we found that TBSA% was a predictor of ASK©p scores ($p= 0.03$), thus the higher the burn percentage the lower the ASK©p scores. We also found that age ($p= 0.05$) and AROM ($p= 0.04$) were associated with ASK©p scores, thus the younger the child or a child with reduced AROM would have lower ASK©p scores. Fun and enjoyment ($p<0.01$) was found to be significant in this study, thus highlighting the fun and enjoyment factor the Xbox Kinect™ offers as part of therapy and as an adjunct to burns rehabilitation.

Thirty one questionnaires regarding the value and use of the Xbox Kinect™ were completed by health professionals working within the PBU. Many highlighted the value of fun, enjoyment and distraction the Xbox Kinect™ offered as part of the rehabilitation, as well as assisting in achieving more AROM but also indicated that the Xbox Kinect™ sessions still needed to be supervised and guided.

Conclusion: This study was the first study done in South Africa involving video game technology during physiotherapy within the paediatric burns population. The use of the Xbox Kinect™ as seen in this study has proven to be beneficial and a useful adjunct to burns rehabilitation within in the paediatric burns population. This distraction and decline in pain assists in reducing the fear associated with movement these burns children experience and assist in improvements related to activity and ultimately age-appropriate play and activities of daily living (ADLs).

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PRESENTATIONS

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LIST OF ABBREVIATIONS

ADLs:	Activities of daily living
AMPS:	Assessment of motor and process skills
AROM:	Active range of motion
ASK©:	Activities Scale for Kids
ASK©c:	Activities Scale for Kids- capability measure
ASK©p:	Activities Scale for Kids- performance measure
AVGCs:	Active video game consoles
BRT:	Burn rehabilitation treatment
CHBAH:	Chris Hani Baragwanath Academic Hospital
CP:	Cerebral palsy
FLACC:	Faces, Legs, Activity, Cry and Consolability
GMFM:	Gross motor function measure
HSC:	Hospital for sick children
ICF:	International classification of functioning
ICU:	Intensive care unit
IGCs:	Interactive gaming consoles
IQR:	Interquartile range
LoS:	Length of stay
PBU:	Paediatric Burns Unit
PROM:	Passive range of motion
RCT:	Randomised controlled trail
ROM:	Range of motion
SD:	Standard deviation
TBSA:	Total burn surface area
VAS:	Visual analogue scale
VR:	Virtual reality
WHO:	World Health Organisation

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Burns are a predominant cause of paediatric injuries and contribute to more than 90% of paediatric deaths due to injury primarily in low and middle-income countries (Wesson et al., 2013). Hot water and scald burns are the most common causes of burns in children younger than five years of age, with flame burns more common in older children (Lesher et al., 2011).

In a study conducted by Wesson et al., (2013) South Africa, which is defined as being an upper to middle-income country, experienced a rate of burn-related deaths of 2.8 per 100,000 children. When compared to other upper to middle-income countries, this rate was found to be five times higher, as these other countries only average 0.5 burn-related deaths per 100,000 children. It was shown that between 1996 and 2009, 9438 children presented to Red Cross War Memorial Children's Hospital's casualty department with burn injuries, nearly 80% of the burn injuries occurred in children less than four years of age, and more than one-third of injured children were one year of age (Wesson et al., 2013). In South Africa, the third most common external cause of death among children who are 18 years and younger is burns, with children being under the age of five at the greatest risk (Albertyn, Bickler and Rode, 2006).

Schmitt et al., (2011) describe physiotherapy as an essential, sometimes painful, component of burn rehabilitation therapy. Early and aggressive physiotherapy can facilitate and counteract the decreased ROM, and most importantly prevent severe contractures and potential disability that can develop secondary to burn or associated skin grafting. Thus burn rehabilitation therapy is fundamental to improving functional outcomes and decreasing long-term disability (Schmitt et al., 2011). Pain and anxiety are critical components and complications of burn injuries that considerably influence the course of recovery, and it is seen that acute pain is exacerbated by anxiety (Yohannan et al., 2012).

There has been a growing trend and interest to finding low cost and cost-effective therapeutic approaches for rehabilitation and burns rehabilitation. Part of this trend is the use of commercially accessible video games like the Nintendo® Wii™, the Playstation™II Eye Toy and the Microsoft® Xbox 360 Kinect™ as part of rehabilitation to enhance and aid physiotherapy treatments.

The popularity of the video game use in burns rehabilitation has grown because, in addition to facilitating and encouraging ROM in an effort to prevent the formation of joint contractures, the virtual imaging characteristics of these games provides the advantageous benefit of distraction from pain (Parry et al., 2012). Video games provide a more effective, efficient and enjoyable method training, and are a helpful addition to rehabilitation (Kho et al., 2012). Virtual reality (VR) and video games have demonstrated the willingness and enthusiasm of children with disabilities to engage with technology, and are highly motivating to improving the physical activities in these children for a longer period of time (Luna-Olivia et al., 2013). These systems aim to encourage movement and engagement while allowing the patient to observe the movement they are performing through the avatar's movement replicated on the screen (Sin and Lee, 2013).

Microsoft's Xbox Kinect™ is a video game device that uses an infrared camera and sensor to detect a user's movement. Unlike other gaming devices, there is no need for a special controller or hand-held device. The player's movement is captured in real time with immediate visual and auditory feedback being provided to the player (Sin and Lee, 2013). The Microsoft Xbox Kinect™ video games are promising rehabilitation and treatment options because they involve total body movements achieved in a motivating and fun manner (Levac et al., 2015).

The ASK© is a self-report measure for children with physical disability. It is designed for children aged 5-15 years who are experiencing limitations in physical activity due to musculoskeletal disorders. Young (2009, pp 1) states that 'the ASK© may be used to assess a child's status at a single point in time or to monitor changes associated with time or therapeutic interventions' (Young, 2009).

There are two versions of the ASK© scale: performance (ASKp©) which measures what the child 'did do' and capability (ASKc©) which measures what the child 'could do' during the previous week. The ASK© allows the child to reflect on their perspectives about disability and it requires no special training or equipment. The ASK© has been validated for children between the ages of five and 15 years. The ASK© has undergone thorough testing proving that it is a clinically useful assessment tool with sound reliability and validity (Young, 2009).

1.2 PROBLEM STATEMENT

The effect of using Xbox Kinect™ as an adjunct to physiotherapy in a PBU has not been established.

1.3 RESEARCH QUESTION

What is the effect of introducing the Xbox Kinect™ to the PBU at CHBAH on discharge outcomes and early activity levels?

1.4 AIM

To investigate the effect of using the Xbox Kinect™ on discharge outcomes and early activity levels in the PBU at CHBAH

1.5 OBJECTIVES

1. To compare the discharge outcomes of two groups of children, where one group received standard physiotherapy intervention and the other group received standard physiotherapy intervention plus Xbox Kinect™ during their admission stay in the PBU

   Outcomes: Range of motion, participation and enjoyment
   Measurement tools: goniometer, Wong-Baker faces scale

2. To compare the outcomes of two groups of children, where one group receives normal physiotherapy standard intervention and the other group receiving normal physiotherapy standard intervention plus Xbox Kinect™ on first follow up post discharge from the PBU

Outcomes: Range of motion, participation and enjoyment, ASKp©
Measurement tools: goniometer, Wong-Baker faces scale, ASK©p measure

3. To establish the perceptions of the interdisciplinary team on the value of introducing Xbox Kinect™ to the unit

   Measurement tool: questionnaire

4. To establish the demographic information of the two groups regarding length of hospital stay and degree of burn injury

1.6 SIGNIFICANCE OF STUDY

Currently there is limited information and research done in paediatric burns in South Africa and no research has been done with the use of video games during physiotherapy in South Africa. The paediatric burns unit at CHBAH receives and admits a large number of children, who each receive physiotherapy. Due to the high numbers and high turnover of children, it is essential all children return to normal function and have limited impairments and contractures post injury and discharge from the unit. There has been an increase in global burns research and the use of video games and interactive technology to facilitate range of movement activities and to help with distraction from pain. Interactive technology has not been used in paediatric burns units in South Africa

Thus the use of the Xbox Kinect™ as part of the burns journey these children admitted at the paediatric burns unit at CHBAH will be investigated. As video games have been shown to be highly motivating and improve social relationships between children in addition to helping them improve function and be distracted from pain. The ASKp© will be the outcome measure used to assess performance and function in the recruited burns children and will aid therapists in promoting health, preventing disability, improving or restoring functional ability and independence.

CHAPTER 2: **LITERATURE REVIEW**

This literature review covers articles related to current burns practise and information from South Africa, information about the Paediatric Burns Unit at CHBAH, morbidities and management associated with burns injuries, current video game technology and rehabilitation within the paediatric population of cerebral palsy as well as burns, influences on activity and participation then finishing off with opinions from parents and therapists using these gaming options. The articles span from 1996 to more recent research done and published in 2016. Key words used included 'paediatric burns', 'burns rehabilitation', 'video game technology' and 'burns management'. The search engines used include 'Pubmed', 'Clinicalkey' 'EBSCO Host' and 'ScienceDirect'.

2.1 BURN CLASSIFICATION

According to the American Burn Association burns are classified by the depth of injury, the extent of injury and by severity.

2.1.1 Depth of injury

Indicates how well the wound will heal and whether skin grafting is required. Superficial burns or 1st degree burns affect the epidermis of the skin and will present with intact, inflamed and painful red skin. These burns are normally treated with topical creams and analgesic medication for five days and will heal with no scarring (Ferri, 2017).

Superficial 2nd degree burns or superficial partial thickness burns affect the epidermal and papillary dermal layers of the skin; they will present with severe redness, blistering and intense pain. Healing time is between 5-21 days and no skin grafting is required. Deep 2nd degree burns or deep partial thickness burns affect the epidermal, papillary and reticular dermal layers; they will present with severe redness with deep blisters and varying pain depending if the nerve has been affected. Healing time ranges between 21-35 days and will require skin grafting. If these burns become infected they will convert into a full thickness injury (Ferri, 2017).

Full thickness burn or 3rd degree burns affect the dermal layers and subcutaneous tissue which could involve muscle, fascia and bone. They appear white or black in colour with possible eschar, the skin is dry and leathery in appeareance and depending on nerve damage may or may not present with pain. These burns required meticulous care, resuscitation, pain control and grafting of larger areas.

2.1.2 Extent of injury

This is best described using the TBSA %, by using the “rule of nines” chart and age-specific charts which indicate a part of the body having a percentage i.e. each leg 18%, the head 9% etc. all adding up to 100. Infants have a significantly larger heads relative to their body surface compared to adults; the “rule of nines” is not used but rather a different set of rules (Ferri, 2017).

2.1.3 Severity

Coupled with the TBSA %, burn depth, age, type of injury and location of patient the severity classification assists with planning management and care for the burns patient. Minor burns can be managed at an outpatient setting, moderate burns require admission to hospital with burns experience and major burns required referral and admission to a dedicated burn centre. Each burn centre follows guidelines and criterion for admission and care of the burns patient, which has been set by International Society for Burn Injury (ISBI) (ISBI, 2016)(Ferri, 2017)

2.2 BURNS IN SOUTH AFRICA

In South Africa it is estimated that 3.2% of the population is burnt annually (Allorto, 2013). In 2004, the World Health Organisation (WHO) stated that globally 11 million people who sustained burn injuries required hospitalization and medical attention; it is estimated that 265 000 deaths occur annually due to burns (WHO, 2016). In the USA more than half a million burn injuries take place annually (Jeschke and Herndon, 2014).

According to the WHO, Africa has the highest rate of paediatric burn-related deaths of 7.3 per 100 000 children, while the rate in South Africa is 2.8 per 100 000; this is five times higher than the rate of 0.5 per 100 000 in other upper middle-income countries (Wesson et al., 2013). In South Africa, burn injuries are the most common cause of trauma-related death in children under four years of age and the third most common cause of injury fatalities under 18 years of age (Rode et al., 2014).

Allorto (2013) states that in South Africa the above international average incidence of burns, is as a result of gross unemployment and extensive informal housing. Local data shows that people from lower socioeconomic circumstances suffer higher burn injury rates, and that domestic accidents are the leading cause of injury. Households that have low-income rates, overcrowding and low literacy of the mother are most affected. Children and young adults are predominantly affected by burns and if poorly managed the repercussions go further than the pain of the acute injury, leading to long-term permanent limitations caused by significant physical dysfunction and scarring (Allorto, 2013).

In a study done by Van Niekerk, Rode and Laflamme (2004), where they described the occurrence and patterns of childhood burns seen in the Western Cape, four burn patterns were indentified. Class 1 ‘infant scalding’ is characterised by scalding of infants in the home environment, examples of this include scalding from coffee, hot soups, tea and hot foods, and especially from hot water during preparation for bath time (Van Niekerk, Rode and Laflamme, 2004).

Class 2 ‘toddler scalding’ is characterised by the 2- 3 year old toddler group, with a large percentage of burns to the abdomen and lower limbs indicating the increased access to cooking equipment and hazards often found on floors and tables. The highest risk group are these toddlers, who are characterised by their natural curiosity, interest and exploration of their environment. This period illustrates the toddlers learning to walk but due to them being wobbly and shaky on their feet the tendency to grab onto objects to steady and balance themselves occurs. Kettle cords and table cloths are most commonly held onto (Van Niekerk, Rode and Laflamme, 2004).

Class 3 is represented and seen in older children of preschool and school- going age, who are exposed to activities such as cooking for girls and gathering of fire wood and lighting fires for morning and evening meals, this is commonly seen in low-income households and settings. There is an increased pattern of flame and fire related injuries. Class 4 is any other causes or combinations of burn exposures resulting in injury to the head, face and neck area, examples include risk of access to open fires, heating and cooking equipment (Van Niekerk, Rode and Laflamme, 2004).

In the Western Cape the average annual rate of burns amongst children is 6.0/ 10 000 and is particularly high for toddlers aged 2-3 years and infants (Cox et al., 2015). This high incidence and trend is likely attributed to their explorative nature, unsteady gait and obliviousness to danger (Teo, Van As and Cooper, 2012). Boys are more commonly burned than girls in the younger age groups, while in adolescences girls are more commonly burned due to their increased involvement in household and domestic chores (Albertyn, Bickler and Rode, 2006).

During the winter months an increase in burns injuries is seen and is linked to the increase use of paraffin stoves and shack fires (Teo, Van As and Cooper, 2012). In a retrospective case review done by Parbhoo, Louw and Grimmer-Somers (2010) the hospital profile of children with burn injuries admitted to Red Cross Children's Hospital in Cape Town was analysed. Data from 294 children was examined and found that a moderate correlation between hospital LoS and TBSA exists, but that this correlation is not influenced by the location of the burn injury or burn depth (Parbhoo, Louw and Grimmer-Somers,2010).

Despite advances in burns resuscitation, specialised critical care and early wound coverage, few patients in South Africa with major burns of more than 40% total body surface area survive compared to first world survival rates (Allorto, 2013). Patients who pass away from a burn injury generally pass away immediately or within a few weeks related to infection, sepsis or multiple organ system failure (Jeschke and Herndon, 2014). In the paediatric population sepsis, multiple organ failure and anoxic brain injury are the major causes of death (Jeschke and Herndon, 2014).

Successful outcomes for treatment of the burn patient relies heavily on the multidisciplinary team; surgeons, anaesthetists, intensive care specialists, nursing staff, dieticians, physiotherapists, occupational therapists, social workers and psychologists are key members of this team (Allorto, 2013).

2.2.1 Strategies and Care in South Africa

The cost of managing burns and burn care is one of the most expensive medical procedures and management globally, costing roughly $1000 US dollars per patient a day in developed countries (Gallaher et al., 2015). Recently the Western Cape government requested research and information regarding management of burns services within the province with the aim to try minimise the over-burden on tertiary institutions and strengthen the services at lower levels. Education and six other key areas, involving prevention strategies, transport of patients, analgesia, resuscitation, cooling and covering of the wound were identified, that could impact community management (Cox et al., 2015).

Continuous education regarding prevention strategies around safety and first aid procedures were deemed necessary. Immediate first aid for the burn injury is to remove the hot clothing item and cool the wound, by placing the injured area under a running tap for a minimum of 10-15 minutes. Ice cube use to achieve cooling has also shown benefit but prolonged application may be more harmful to the burn. Applications of toothpaste, butter, honey, oil and eggs have no benefit or effect on cooling and thus should not be used. The wound should be covered with a non-adhesive dressing to avoid contamination and assist in pain control (Cox et al., 2015).

At this stage, it is advised that pain medication and management be recognised as often parents and carers in the process of searching for medical assistance do not prioritise pain relief. When accessing health care, it has been shown there is a rather large delay in transportation mechanisms as patients are reliant on their own or public transport, by walking to the nearest clinic or ambulance services (Cox et al., 2015).

Great inaccuracies and discrepancies involving the calculation of TBSA were noted, which influences the fluid resuscitation management by doctors and were often over estimated (Cox et al., 2015).

Once admitted to the burn unit, management of the injury is guided by standard guidelines and protocols which focus on early and effective resuscitation, treatment of inhalation injuries, early enteral feeding, pain control, early excision and wound closure, wound management, prevention and treatment of infection and sepsis and functional rehabilitation (Rode et al., 2014).

2.2.2 Chris Hani Baragwanath Academic Hospital Paediatric Burn Unit

Jugmohan et al., (2016) released a retrospective review of the mortality rates and demographics of paediatric burn victims admitted to the PBU at CHBAH during the period of May 2009 to April 2012. Prior to 2009 the overall mortality rate was 20%; which was reported as being unacceptably high compared to the Shriners Hospital for Children in the USA (deemed as a high-income country) and SB Ankara Diskapi Paediatric Education and Research Hospital in Turkey (an upper middle-income country), being 2.7% and 5.8% respectively and two centres which the PBU follows regarding treatment protocols, standards and guidelines.

A collaboration between the paediatric ICU intensivists and the paediatric surgeons brought about a much needed change to the mortality figures, thus allowing for the children admitted to the burns ICU to be managed and cared for appropriately. During this period 1372 patients were admitted to the PBU, 283 requiring ICU management. Fifty five percent of the admitted children were male. While 63% of total admissions were younger than five years of age, the median age of all children admitted to the PBU was 4.1 years and the PBU ICU was three years.

Seventy six and-a-half percent (76.5%) of admissions were related to hot-water burns followed by 21.8% related to flame burns; the remaining 1.8% were related to contact burns, electrical burns and from hot liquids other than water such as oil or tea (Jugmohan et al., 2016).

During the 4-year period, 109 deaths occurred resulting in a reduced mortality rate of 7.9%, which is lower than other low-income countries but still higher than the upper-middle and high income countries. The majority of these deaths occurred in children younger than three years (50.4%) and five years (90.8%) of age (Jugmohan et al., 2016).

Attributions towards the decline in mortality rate were related to the ICU intensivists thorough and careful administration of correct fluid management and resuscitation, early wound coverage, improved understanding and usage of dressings, bi-daily ICU rounds and communication between all team members within the PBU (Jugmohan et al., 2016).

2.3 BURNS MORBIDITY AND MANAGEMENT

2.3.1 Pain

Chester et al., (2016) describe that while paediatric burn mortality rates are decreasing globally, the morbidity associated with burns due to pain, physical impairment and psychological distress are increasing. Burns and wound care management such as dressings, wound cleaning and debridement are often very painful for children and can often result in severe psychological distress (Chester et al., 2016).

In a review by Stoddard et al., (2002), it was found that 25 to 33% of children affected by burns develop posttraumatic stress disorder and more than half of them suffer with symptoms such as flashbacks, nightmares, behavioural problems and regression. Managing their pain and anxiety adequately helps to minimize and reduce these symptoms (Stoddard et al., 2002)

The use of pain assessment tools by paediatric healthcare workers and nurses has shown to be useful in assessing the presence of pain and determining the severity the child is experiencing (Quinn, Sheldon and Cooley, 2014).

Behavioural responses and distress in response to pain can be seen in younger children, thus the observational Faces, Legs, Activity, Cry and Consolability (FLACC) Behavioural Pain Assessment Tool can be used. The FLACC is used for children between the ages of two months and seven years and looks at the child's behavioural response to pain (Quinn, Sheldon and Cooley, 2014).

The Wong-Baker® FACES tool is a self-report pain scale for children between the ages of three and seven. This scale is very easy to use as it illustrates cartoon faces ranging from a smiling happy face representing 'no pain' to a tearful sad face representing 'worst pain' (Simons and Macdonald, 2006). For children aged seven years and older another self-report pain scale is the Visual Analogue Scale (VAS) which is a 10-cm line scale ranging from zero indicating 'no pain' to ten indicating 'worst pain' (Young, 2005).

Despite advances in burn wound care management, procedural pain is still the most intense and undertreated type of pain burns patients undergo. Many patients have indicated that wound care procedures are often as painful as the original burn injury; while in many cases the experience is more painful resulting in intense anticipatory anxiety (Chester et al., 2016).

Poor pain management, fear and anxiety all contribute to noncompliance and delayed healing. Reducing acute burn pain promotes faster wound healing and improves long-term scar outcomes; this is achieved by reducing local pain mediator release and limiting the inflammatory cellular and extracellular response and deposition of hypertrophic scars (Chester et al., 2016).

Specifically for burns patients adequate analgesia and medication to assist in alleviating pain, itching and anxiety should be provided throughout their hospital stay (Bonham, 1996).

Anxiety and stress result in higher pain responses thus strategies such as distraction, coping skills and education should be included in the child's treatment programme (Young, 2005).

Stoddard et al., (2002) explained the use of distraction for pain and anxiety with two case studies; whereby for the one child (aged five) the use of bubble blowing and 'blowing away the pain' was used and proved to decrease the experience and rating of pain reported by the child. For the other child (aged 12) the use of singing was used, as the child was part of her local church choir and loved to sing and play music. This imagery and distraction helped reduce the child's level of pain experience during dressing change and improved her own compliance with activities and therapy (Stoddard et al., 2002).

Even though this is only two case examples, it signifies each child is unique and different and a uniform approach isn't always the answer and therapists should aim in allowing the child to be in greater control and participation in the situation surrounding them (Stoddard et al., 2002).

2.3.2 Muscle Metabolism

Following a burn injury the body immediate response is by going into a hypermetabolic catabolic state, which can last for more than one year post injury. This increase in stress response is seen by the increased loss of skeletal muscle mass and protein breakdown and adversely increases the risk for infection and poor wound healing in burns patients (Merritt, Cross and Bamman, 2012).

Burns patients often suffer from fatigue and complain of weakness which will impact on their functional recovery, ADLs and return to work once discharged (Esselman, 2007). In order to combat this effect, nutrition and calorimetry procotols and guidelines are implemented and monitored closely by doctors and dieticians managing burns patients.

The Galveston formula is often used by many units, including the PBU at CHBAH, which suggests daily caloric intake of 3000 kcal/m² TBSA, which is broken down into 1500 kcal/m² TBSA for burn hypermetabolism and 1500 kcal/m² TBSA for maintenance and targets a caloric intake of 1.4 times the patients' resting energy expenditure (Chao et al., 2015). This is achieved through enteral feeding, oral intake or high protein/ high-caloric tube feeding (Merritt, Cross and Bamman, 2012).

Recommendations advise that within the first six to 12 hours after injury enteral feeding should be initiated; early enteral feeding is associated with several biological and clinical advantages, such as reducing stress hormone levels and the hypermetabolic response coupled with an increase in immunoglobulin production while minimizing the risk of energy deficiency and malnutrition and contributing to improved wound healing (Rousseau et al., 2013) (Rodriguez et al., 2011)

2.3.3 Range of Movement

Exercise and aggressive physiotherapy and occupational therapy aimed at maintaining joint ROM and prevention of contractures are the standard following a burn injury (Parry et al., 2015). Contractures are most likely associated with larger TBSA and increased depth of the burn, as well as a larger area requiring grafting (Webb et al., 2011).

Contractures of the upper limb are most commonly seen in children and are considered a serious complication following a burn injury (Sison-Williamson, Bagley and Palmieri, 2012) (Webb et al., 2011). They develop when the burn scar matures, tightens and thickens causing a reduction in the ROM of the joint and function. A higher incidence of contractures is seen with full-thickness injuries followed by deep partial thickness injuries (Webb et al., 2011).

Webb et al., (2011) demonstrated positive discharge and 12-week follow up outcomes following a shoulder treatment flowchart and guideline for 25 patients presenting with burns to the axilla and surrounding area. Dependent on the depth and severity of the burn patients were allocated into either a high-risk or low-risk group; both groups received daily physiotherapy assessment and treatments involving active and passive ROM exercises and strengthening along with the use of a shoulder abduction pillow or brace maintaining 90° of shoulder abduction. ROM was recorded on discharge as well as 12 weeks post discharge and patients in both groups showed improvements and almost achieving full active ROM despite the small sample size and study population. This flowchart and treatment guideline is thus useful in the management of preventing axillary burn contractures (Webb et al., 2011).

The use of splinting and positioning assists in preventing and limiting the formation of contractures and two schools of thought currently exist in the literature. Following a survey report by Holavanahalli et al., (2011), where 159 responses were received for a 51-question survey distributed amongst physiotherapists and occupational therapists working within burns centres and treating burns patient, it was found that splinting is either implemented, immediately and early for preventative measures or once the passive ROM is reduced and signs of contracture are present. The main contributing factors that affects the application and timing of splinting is related to the area of the body burnt and the burn depth (Holavanahalli et al., 2011).

Parry et al., (2015) describe the aims of exercise to preserve and restore movement and improve function; and these aims can be achieved by the use of age appropriate play activities, functional training and tasks, muscle strengthening and conditioning exercises alongside passive stretches and active ROM exercises and play. Children will often require more motivating strategies and treatment programmes as they are fearful to move their burnt limbs and refuse to do so due to pain, anxiety and fear (Parry et al., 2015).

In a randomised controlled trial, Parry et al., (2015) investigated the effects of exercise on ROM within a paediatric population; seventeen children took part in the study and children were either randomised into the control group or intervention group. The control group received standard therapy consisting of active and active-assisted exercises focusing on upper limb ROM activities and age-appropriate play involving the upper limb and trunk ROM. The intervention group received interactive videogame play using the Sony Playstation II Eye Toy™ focusing on games involving active and active-assisted upper limb ROM and play activities. It was found that regardless of the therapy chosen improvements in ROM were seen and demonstrated that the largest improvements of ROM were seen when exercise is initiated early in the rehabilitation programme (Parry et al., 2015).

2.3.4 Scar Management

Scarring following a burn injury is very common; of greatest concern is the risk that joint mobility and movement will be affected as a result of the poor elastic qualities of the scar, as well as the aesthetic outcome the scar poses. The excess collagen fibre deposition and disorganized layout during wound healing, results in scars appearing uneven in texture and abnormally raised, known as hypertrophic or keloid scarring (Rowley-Conwy, 2014).

To minimize the effects of scarring and to have better outcomes the following strategies are recommended: elevation of limbs and passive movements to help minimize the effects of oedema in the acute phase, splinting and immobilisation of affected joints and areas after skin grafts to help limit shearing forces and prevent graft loss followed by scar massage once the wound is healed, to help reorganise new immature collagen and soften the development tight bands of scar tissue. The use and wearing of pressure garments during the scar maturation phase is highly recommended. The value of using silicone gel sheeting for scar management is unclear due to the lack of quality research trials. There continues to be insufficient evidence surrounding the use of low pulsed ultrasound, laser therapy and intralesional corticosteroid injections for scar management (Rowley-Conwy, 2014).

Caregivers and patients are to be educated and advised to protect newly healed burns and fragile scars from the sun, with the use of a high factor sun block and wearing clothing covering the affected area. This is essential to prevent discolouration, blistering and breakdown of the healed skin within the first two years after injury (Rowley-Conwy, 2014).

2.3.5 Exercise and Endurance

A review done by Porter et al., (2015) examined the role of exercise in the long-term rehabilitation of severely burnt patients. Pulmonary function has been shown to be impaired for up to seven years post injury in the severely burnt adult population; these adults were shown to participate in less physical activity and have a lower exercise tolerance. Thus it is believed that restoring pulmonary function post burn will greatly influence the physical activity and functional capacity (Porter et al., 2015.

This effect was first identified in children when 31 children with large burns of >50% TBSA aged between seven and 18 were assessed. It was found that peak oxygen uptake was significantly lower six months post burn when matched with unburned children of the same age. Seventeen of the 31 children were recruited into a 12-week exercise programme which contained aerobic and resistance training, while 14 children continued with standard outpatient burn care rehabilitation and served as the control group. The peak oxygen uptake had significantly improved in the exercise group as well as improvements in all lung function parameters, while the control group's values remained unchanged. Thus highlighting the effect exercise training has on improving lung function in burn victims (Porter et al., 2015).

As mentioned before, burn injury has a significant impact on skeletal lean body mass, strength and endurance. Porter et al., (2015) reported that when assessing lower limb muscle strength in a cohort of 43 burnt children with >50% TBSA, the quadriceps contraction strength was 35% less compared to matched unburned children. Improvements in upper limb and lower limb strength were demonstrated following a 12-week progressive exercise programme, which started six months post-burn involving resistive exercises

compared to standard outpatient burn care rehabilitation programmes. What is further highlighted and important from this work is the safety and effectiveness of the exercise training, as it improved muscle mass and strength without worsening the catabolic hypermetabolic state the body is still under. Additional benefit of the exercise regimes for the burns patient is that individualised and supervised programmes are more effective in restoring muscle strength compared to generic home-based programmes (Porter et al., 2015).

2.4 BURNS REHABILITATION

Atiyeh and Janom (2014) describe that physical therapy and rehabilitation are a critical and fundamental part of the burns journey. Burns rehabilitation is dependent on the age, severity and extent of burns, presence of infection, amount of wound healing and the psychosocial status of the child and family.

Rehabilitation focuses on restoration of functional capacity, such as range of movement, muscle strength and length, independent mobility and ADLs; as well scar prevention, hypertrophic scar suppression and the management of heterotopic ossification, leukoderma and pruritis. Though physiotherapy may be painful, early and aggressive mobilisation can help limit and prevent the development of contractures (Atiyeh and Janom, 2014).

Joint ROM measurements, with the use of a goniometer, provide therapists with information on recovery and maintenance of movement throughout the burn recovery (Edgar et al., 2009). The key is to improve function outcomes and minimize long-term disability associated with the burn injury (Schmitt et al., 2011).

2.4.1 Physiotherapy Treatment Protocols

Okhivatian and Zoubine (2007) investigated the comparison between two burns treatment regimes implemented at a general hospital in Tehran. This is recognised as the first published paper to allow comparison of one country's practise to another.

The first protocol and treatment group involved routine standard physiotherapy. Routine standard physiotherapy is comprised of chest and exercise physiotherapy, involving active and passive movements and based on the therapist's own quality of work and skill implemented once a day lasting between 15-20 minutes. Physiotherapy was only started after two weeks when the patient's condition was considered improving and recommenced about 10-15 days post grafting. No clear programme involving management of secondary complications, splinting, ADLs and caregiver education was present; while ambulation of the patient was based on doctor's orders (Okhovantian and Zoubine, 2007).

The second protocol, the Burn rehabilitation treatment (BRT) protocol involved ordinary physiotherapy with the following additions: physiotherapy was started on the first day of admission and recommenced on the third day post grafting. Sessions were between 30-45 minutes taking place at least 2-3 times daily.

Chest physiotherapy was specific and focused to the affected lung segment and ambulation was commenced as soon as possible. Exercise therapy involved ankle pump exercises, active ROM exercises of all joints done twice a day and passive movements done once a day. Goniometry was used to measure ROM and limitations. Electrical stimulation of the calf muscles and quadriceps was done to help prevent muscle atrophy. Splinting of affected joints and to protect skin grafts was implemented to limit secondary complications. Education and time spent with the family and caregivers was done daily, which included ADL training specific to the patient's needs. (Okhovantian and Zoubine, 2007).

Following their investigation the most significant improvement was seen in the number of burn scar contractures with 73% of the first group developing contractures compared to 6% in the BRT group, and a reduction in hospital length of stay by four days for the BRT group, thus highlighting the necessity for rehabilitation for burns patients (Okhovantian and Zoubine, 2007).

2.4.2 Distraction

Distraction, as well as preparation techniques such as hypnosis and story-telling and devices such as tablets, has shown benefit in the paediatric burn population with relevance to pain reduction resulting in significant improvements in wound healing (Chester et al., 2016).

Typical distraction techniques include deep breathing, listening to soothing music or watching a favourite movie (Malloy and Milling, 2010). Where there has been an initial negative experience, the child will have increased levels of anxiety and pain towards the task and subsequent procedures; when a child is engaged in a meaningful task or play activity, their attention is diverted away from the pain and the experience becomes less traumatic (Atiyeh and Janom, 2014).

In keeping with the concept of distraction and the possible effect and reduction in pain levels, a greater use of virtual reality (VR) technology has been seen. The VR technology and system allows for the user to be completely immersed in the simulation world.

Results of a review done by Malloy and Milling (2010) found that when assessing experimental pain among healthy volunteers, whereby 77 participants took part in a study and were randomly assigned to the high-tech or low-cost VR system; it was found that when using more high-tech equipment compared to low-cost devices the participants experienced a greater level of immersion and distraction and lower levels of pain and unpleasantness were reported (Malloy and Milling, 2010)..

Another study which had 103 participants, found that with the combined use of VR distraction coupled with hypnosis techniques patient's levels of pain were again greatly reduced (Malloy and Milling, 2010). An investigation of the effect of VR distraction during wound debridement found the pain experienced and unpleasantness were both considerably lowered. Eleven burns participants aged 4-40 took part in this study, which used a custom VR helmet to engage in *SnowWorld* virtual environment during a period of wound debridement, the results showed that the more the patient was immersed into the game the

lower the levels of pain and unpleasantness were experienced. Despite the small sample size this method has been suggested to assist with reducing pain levels experienced during wound debridement (Malloy and Milling, 2010).

2.4.3 Play

Hospitalization of a child is a very difficult and challenging experience both for the child and the parent. The child is cut off from his natural environment and surroundings, while having to undergo painful and unpleasant procedures. In order to reduce anxiety and stress, play and games are used to improve skills and functional abilities that may have been affected by the injury and illness (Haiat, Bar-Mor and Shochat, 2003).

Play has been identified as one of the strongest and most effective tools in reducing anxiety, tension, anger, conflict and frustration which are accompanied by the loss of control and self-esteem related to hospitalization. Parents are also comforted when they see their sick child playing and enjoying a game and forgetting about their pain, distress and sadness for a while (Haiat, Bar-Mor and Shochat, 2003).

Haiat, Bar-Mor and Shochat (2003) discussed their opinions in a case report and overall play treatment approach with the above principles in mind being advocated and carried out at Schneider Children's Medical Centre in Israel; the hospital has its own educational activity centre in each department which children, parents and carers have access to. It is advised that no painful procedures or treatments take place in the child's bed or room nor while the child is in the activity centres but is rather done in a designated treatment room (Haiat, Bar-Mor and Shochat, 2003).

Should a child be very ill and bedridden or placed into isolation all play and activities can continue at the bedside. Prior to a child going to surgery the child is allowed to play with medical equipment and each piece of equipment and it's role is explained to help lessen anxiety and fear (Haiat, Bar-Mor and Shochat, 2003).

2.5 VIDEO GAME TECHNOLOGY

In younger people and those that can afford them, video games represent an important part of leisure time. Active video game consoles (AVGCs) have evolved from sedentary screen time and play into a more physical activity time and play (Robert et al., 2013). The rise in AVGCs use coupled with rising obesity rates, has allowed for the development of this technology as an alternative form of exercise and rehabilitation tool for healthcare providers and their patients (Templar, 2013).

Video games and VR gaming can play an important role in training function and functional performance. It is believed that when people with disabilities are performing activities and tasks in these virtual environments, there is transference of these skills into the real world and thus motor learning is possible (Winkels et al., 2013).

Three key elements for motor learning that are present in VR training are repetition, sensory feedback and motivation. With paediatric rehabilitation it is important in creating flexible and individualised treatment programmes; VR systems can do this as one is able to use the child's own preferences in the treatment programme thus improving their attention, motivation and sensory feedback which results in improved learning (Monge Pereira et al., 2011). VR systems require focus and attention; they aim to motivate the player to move and grant them a sense of achievement (Chaung et al., 2013).

Within rehabilitation settings, including those involving burns patients, an increased use of video game technology and interactive gaming consoles (IGCs) as an adjunct to standard care or alternative therapy options has been seen (Parker et al., 2015).

Using video games and IGCs allows for rehabilitation procedures and programmes to become more amusing and comfortable, as well as increase the healing process and speed up recovery (Mobini, Behzadipour and Foumani, 2014).

Video games look at providing a more effective, efficient and enjoyable method of training and can be a helpful adjunct without any adverse effects in the rehabilitation setting (Kho et al., 2012). Modern IGCs and technology has been able to combine aspects of VR with popular imagery to create a far greater immersive experience compared to earlier consoles and systems (Parker et al., 2015).

Player interaction with the IGC environment has changed, allowing more successful engagement and participation through improved sensitivity to gross and fine movement, by improvements in game controls and consoles, as well as by incorporating cameras to detect movement (Parker et al., 2015). Immediate visual and auditory feedback is given to the patient regarding their performance and this helps them improve their technique and participation within the game (Kho et al., 2012). These interactions and activities resemble those of daily living, including aspects of leisure and sport (Parker et al., 2015). Important motor learning opportunities and training for cardiovascular, musculoskeletal and balance systems are provided by video games and IGCs (Kho et al., 2012).

2.5.1 Nintendo® Wii™

The Nintendo® Wii™ allows people to engage with the virtual environment either via a handheld remote control motion sensor or a motion sensitive platform known as the Wii™ Fit. The player performs approximate movements which are often repetitive and similar to those in real life while receiving real time feedback during the task. Other positive aspects are that the Wii™ is performed in a safe environment and is highly motivating (Robert et al., 2013). Studies related to the use of the Nintendo® Wii™ are discussed under the points 2.4.3 and 2.4.4 to follow.

2.5.2 Xbox Kinect™

Another low cost commercially available video game is the Microsoft® Xbox 360 Kinect™, which is a motion sensing input gaming device and considered part of non-immersive virtual reality technology (Luna- Olivia et al., 2013).

The Xbox 360 enables its users to control and interact with the virtual environment without the use of a hand controller or remote (Chang et al., 2013). The Kinect™ records body movement with a camera via an infrared sensor and is very easy to use. The patient engages with the virtual environment seen as an avatar on the screen which moves when they do, thus constantly giving visual feedback for each movement (Luna-Olivia et al., 2013). When the task is not performed correctly or an error is present, visual and auditory feedback are provided immediately (Sin and Lee, 2013).The Kinect™ is able to distinguish the players' body parts and movements by identifying and tracking their joints (Mobini, Behzadipour and Foumani, 2014).

The Kinect™ is seen to be more advantageous in motor learning compared to other video games requiring a separate controller or handheld controller, which may provide less accurate and direct feedback on errors in movement (Sin and Lee, 2013). It has been shown that body movements incorporating all of the extremities produce higher intensity levels and elicit greater energy cost; the Kinect Sports boxing and Dance Central have been identified to significantly increase energy expenditure physiologically (Mellecker and McManus, 2014). Studies related to the use of the Kinect™ are discussed under the points 2.4.3 and 2.4.4 to follow.

2.5.3 Cerebral Palsy

An area showing an increase in video game technology and rehabilitation is within the field of Cerebral Palsy (CP). CP is the most common condition treated by paediatric physiotherapists and occurs in 2-2.5 per 1000 live births (Jelsma et al., 2013).

As with other paediatric conditions, there is a growing interest in finding cost-effective therapeutic approaches which involve high intensity training for adequately long time in children with CP (Luna-Olivia et al., 2013). Therapists are constantly finding ways to stimulate and encourage functional and meaningful activities for their patients to assist with carryover and compliance in rehabilitation programmes (Sandlund et al., 2012).

The aim of rehabilitation and treatment is to increase patient's participation and daily activities by improving function and to minimise the development and effects of secondary problems (Bonnechere et al., 2014). This is done by using motivating, repetitive, purposeful and task-specific training ensuring active participation and goal-orientated movements (Winkels et al., 2013) (Jelsma et al., 2013).

Winkels et al., (2013) examined the effect of training the upper limb function in CP children using the Wii™ sport games. They chose to investigate the boxing and tennis games, which were played for 30 minutes (15 minutes for each game); the most affected arm was trained using the Wii™ for a period of six weeks twice a week. Depending on the child's ability they performed the task either in sitting or standing and this was kept constant during all sessions. Their results found a significant increase and improvement in performance of ADLs using bilateral upper limbs. The study also showed high levels of enjoyment reported by the children and a possible improvement in social interaction was found, as children were more motivated to play together and against one another. A user satisfaction questionnaire was filled in by each child at follow-up and a modified VAS rating enjoyment was used after each therapy session, were used in this study.

Robert et al., (2013) investigated the exercise intensity levels in CP children with spastic diplegia while using the Wii™. The children played four games – skiing, jogging, snowboarding and bicycling, for 10 minutes each in a random order and each child was given a five minute rest period between games. These games were selected as they involve mostly lower limb movements, and that they were easy to understand and appeared appropriate to these CP children (Robert et al., 2013).

Heart rate, range of movement, strength and spasticity were assessed prior to the intervention. Their results showed that the greatest intensity achieved was during the jogging game compared to the others, and that the bicycling game was more physically demanding than the snowboarding game. They demonstrated that these games can be both strenuous and motivating at the same time. The children also showed no difference in their preference and

interest in the different games. The authors found that the Wii™ when supervised could complement clinicians in improving physical activity in their patients and also suggested that more long term research is required in this area (Robert et al., 2013).

Luna-Oliva et al., (2013) investigated the use of the Xbox 360 Kinect™ to support conventional physiotherapy treatments of CP children in a school environment. Eleven children took part in this preliminary study and all had significant improvements in their global motor function and ADL performance capacity. Measurements were done at baseline, post-treatment and on a follow-up assessment by a non-intervention therapist. All children took part in eight weeks of Kinect™ sessions which were held twice a week for 30 minutes supervised by their school physiotherapist. Significant differences were found between baseline assessment and post-treatment, as well as between baseline assessment and at follow up.

The improved GMFM (Gross Motor Function Measure) and AMPS (Assessment of Motor and Process Skills) scores were attributed to increased physical activity and increased use of the affected hemi side in hemiplegic children, as the game encourages and requires bilateral upper limb use. The high intensity and repetitive tasks involved in the Kinect™ video game are believed to have caused these improvements. No difference was found between post-treatment and at follow-up measurements indicating long term improvements achieved after the treatment sessions (Luna-Olivia et al., 2013).

In a pilot study done by Chang et al., (2011) they developed a physical rehabilitation system using the Kinect™ which they called Kinerehab™. Kinerehab™ was to be used and assist the rehabilitation of two young students with CP in a public school setting. The Kinerehab™ movements required the students to perform three different types of bilateral movements with their arms encouraging a wide ROM. This study helped indentify that both students responded well to the Kinerehab™ by being more interested and motivated during the intervention as well as achieve more movements in each session compared to their standard treatment sessions (Chang et al., 2011).

From this above pilot study Chaung et al., (2013) focused on improving the use of the Kinect™ to identify and customize rehabilitation programmes for individuals with a focus on upper limb movements for ADLs. This system allowed therapists to set specific angles of movements involving the shoulder and elbow they wanted their participants to achieve during upper limb movements. Using auditory and visual feedback motivation, interest and perseverance was improved and engaged during the therapy session. Again two participants with CP were included for this study and were required to perform three different asymmetrical arm movements. An improvement was seen during the intervention regarding the quality of movements and angles achieved, and both participants showed more motivation and interest to engage. From both pilot studies it was identified that the sample was too small and more research is needed (Chaung et al., 2013).

2.5.4 Video Game Technology and Burns

Parker et al., (2015) describe that following a burn injury, the integumentary feedback system has been disrupted and it has been shown that by combining movement with sensory and visual training the homuncular representation of the limb and body is restored, where pain has altered this body schema and mapping.

Video game play and IGCs have been shown to assist in dopamine release, and along with distraction provided by the game there is a decrease in pain sensation. This decrease in pain helps to limit the fear associated with movement and reduces guarding strategies (Parker et al., 2015).

With burns rehabilitation dependent on the location, severity and size of the burn, patients will often suffer regular pain in attempts to reduce the formation of contractures and complications of excessive scarring provided by movement strategies, return to function and exercise programmes. Thus using video game play and IGCs as part of a burns rehabilitation programme has become appealing to many therapists and institutions (Parker et al., 2015).

Despite a small sample size, this randomised controlled trial (RCT) pilot study found a 17% reduction in pain within the IGC session compared to the control group undergoing routine exercises. The IGC used in this study was the Nintendo® Wii™. Twenty two patients aged between 16-59 years with TBSA less than ten percent were recruited into the study. The control group took part in daily routine individualised exercise physiotherapy. The intervention group participated in WiiSports™ playing games, alternating between tennis and boxing for upper limb injuries and WiiFit™ exercises involving step up or sporting type activities for lower limb injuries. The participants needed to complete five days of bi-daily Wii™ sessions. Outcome measures addressed in this study were ROM, pain levels and fear avoidance strategies. A numeric VAS was used to assess pain, which was performed before and after each individualised therapy session and Wii™ sessions (Parker et al., 2015).

As previously mentioned a reduction in pain experienced was found in this study but no differences in ROM were found, which can be attributed to the small sample size. More studies with larger sample sizes involving IGC use are required to investigate the use and support of the Wii™ and other IGCs as part of rehabilitation (Parker et al., 2015).

2.5.5 Views and Perceptions of Parents

Sandlund et al., (2012) investigated the views and perceptions of parents of children with CP during a four week video game home programme. Nineteen parents in total expressed their opinions, who all expressed a positive response to the use of video game technology. They felt the games created a positive and fun experience for their children and did not require a constant reminder to do their exercises and play as seen with ordinary rehabilitation.

The games also helped create a better social engagement with other members of the family and the children were happy to compete and play with other siblings. Apart from seeing improvements with motor tasks the parents felt that cognitive training was also influenced as children had to understand and follow instructions given to them.

Parents were also able to identify that some games lacked specificity and more games need to be designed to address individualised problems and tasks. It was also noted that more disabled children struggled with balance tasks and the pace of the games were often too fast thus requiring more assistance from their parents.

2.5.6 Perceptions and Opinions of Therapists

A recent article by Tatla et al., (2015) looked at the perceptions and opinions of therapists working with patients with upper limb limitations and the use of social media and video game technology. Nine themes were identified and merged into three groups looking at the use, the barriers and potential benefits and desirable features involving social media and video game use. Therapists reported that patients became frustrated during activities involving upper limbs and affected limbs thus video games were used more often for lower limb tasks. The use of tablets or iPads, as well as video games, was seen other options instead of traditional therapy.

The type of games used depends on the personal preferences, interests, resources and values of the individual patients. Therapists acknowledged that despite the use of tablets and video games to encourage movement and activities it wasn't the same as being physically outside and engaging in their environment. Some therapists identified that not all video games were accessible to meeting the specific and unique needs of their patients. Some therapists felt that sensory feedback was necessary and potentially useful. A great variety of games is required to cater for varying ages, gender and interests of patients (Tatla et al., 2015).

There is increasing use and interest in using video game technology as a rehabilitative tool in both the paediatric and geriatric patient population (Howcraft et al., 2012). Video games have been shown to be highly motivating and improve social relationships between children (Chaung et al., 2011). VR technology has also been shown to improve motor function especially concerning gait, balance and posture control and upper limb movement quality (Monge Pereira et al., 2014).

Therapists agree that using video games to encourage ROM for therapeutic activities and ADLs can be achieved through distraction from pain (Fung et al., 2010). Caution has been raised to use these devices as an adjunct to physiotherapy intervention strategies rather than a replacement for conventional physiotherapy methods, due to the relatively small numbers involved in this area of research (Bonnechère et al., 2014) and that this is a new area of research (Monge Pereira et al., 2014).

2.6 PARTICIPATION LIMITATIONS

Studies have shown that children with disabilities show limitations in the amount of participation in activities and the variety of activities involving play, chores, recreation and social involvement compared to able-bodied children of the same age. In burn injury survivors, it was noted that participation involving school work and tasks and playing with peers, were more effected than participation involving family, the home environment and ADLs such as bathing and eating. Being active and activity participation is vital for a child's quality of life, thus children who are burns survivors battle more in this domain compared to non-burned children (Grice, Barnes and Vogel, 2015).

In a review done by van Baar et al., (2006) literature surrounding burns from 1966 to 2003 was reviewed and gathered information surrounding functional outcomes and burns as part of the International Classification of Functioning (ICF) framework. Fifty publications met their criteria and were analysed, of which 16 focused on the functional outcomes of children and teenagers affected by burns (van Baar et al., 2006)..

Regarding the body function and structure domain, 75% of the published work focused on mental function followed by pain and sensory functioning (50%). Related to joint ROM, limitations and contractures were frequently seen in 50% of children with major burns > 80% TBSA, followed by <5% in children with minor burns <10% TBSA. Within the activities and participation domains, 56% of the work focused on mobility and self-care followed by 44% of the work involving schooling and community life. One-third of children surviving

major burns >80% TBSA were completely dependent on assistance for ADLs up to 1-4 years post-injury (van Baar et al., 2006)..

Another study showed that up to 20% of patients with >70% TBSA had significant physical disability 15 years post discharge. Disturbance and interruption with play and seeing their friends was reported in 30% of cases. Returning to school varied from five weeks up to six months post injury and discharge. The greatest recovery period for activity and participation is seen within nine and 15 months post injury. Following a paediatric burn injury good family support, positive attitudes and relationships were shown to be a significant predictor for a good quality of life (van Baar et al., 2006).

2.6.1 Activities Scale for Kids

The use of an outcome measure has been deemed necessary in improving the functional ability as well as the quality of care of the patient. The ASK© has been identified as an outcome measure examining the functional ability of a child with musculoskeletal physical disability (Christakou and Laiou, 2014).

The ASK© is a 30-item self-report questionnaire for children aged five to15 years (Bagley et al., 2010). The ASK© has nine subdomains which address personal care, dressing, eating and drinking, miscellaneous, locomotion, stairs, play, transfers and standing skills. There are also eight additional information items which look at the use of assistive devices and the degree of assistance the child requires (Christkou and Laiou, 2014).

The ASK© has two versions: the ASK©-capability (ASK©c) and the ASK©-performance (ASK©p). The ASK©c measures physical function in a hypothetical or ideal setting of what the child ‘could do’ and the ASK©p, which is more commonly used, assesses what the child ‘does do’ (Piscione, Davis and Young, 2014) (Christkou and Laiou, 2014).

The ASK© has been designed to be completed by the child and not through clinical observation, as it has been shown that children are able to report and have an understanding on their own physical disability (Piscione, Davis and

Young, 2014). The ASK© has been shown to be reliable and valid and was developed as a need to evaluate therapeutic effectiveness (Christkou and Laiou, 2014) (Appendix 13).

The main advantage of using the ASK©p is it is a direct assessment of the child's function and measures limitations directly related to the child in their own environment (Young et al., 1996). The tool has age-appropriate words and phrases suitable for children and allows for the child's own perspective and parent's perspectives to be addressed (Christkou and Laiou, 2014) (Young et al., 2000). The use of the ASK© and other psychometric assessment tools aids therapists in promoting health, preventing disability, improving or restoring functional ability and independence for the children they treat and manage (Christkou and Laiou, 2014).

When interpreting the ASK© scores, a numeric score lying between zero and 100 is given where a score of zero indicates extreme disability. A disability is indicated by a score below 95. Data and scores have been collected from the Hospital for Sick Children (HSC) involving a large variety of musculoskeletal disorders which one can use to compare ASK© scores with or the clinician's own data collected from their facility. Average group comparison scores for the ASK©p and the ASK©c are 66.10 and 74.70 respectively (Young et al., 2000). (Appendix 8)

2.7 CONCLUSION OF LITERATURE REVIEW

From the above information and literature we are able to see that therapists and clinicians are using different ways to motivate and distract burns patients in order to minimise the effects of their injuries and return to normal ADLs. The use of video games has proven effective in some burns populations as part of an adjunct to therapy. There is no information and research regarding the use of video game technology in South Africa and within the paediatric burns population.

CHAPTER 3: **METHODOLOGY**

In this chapter the methodology used in this study will be described.

3.1 STUDY DESIGN

This study was a non-equivalent post-test only control group design.

It was not ethical to randomise the children admitted to the PBU, as they all sleep in the same room and are exposed to the same environment. The treatment offered to the children at any time point needs to be the same.

3.2 STUDY SETTING AND POPULATION

The research took place at the Johnson & Johnson PBU at CHBAH in Soweto. Soweto is the largest township in the Gauteng province in South Africa and has a population of 1.3 million people, which accounts for 40% of Johannesburg's population (Frith, 2011). The PBU admits children from birth to 12 years of age.

3.3 ETHICAL CLEARANCE

Prior to commencing data collection for this study, ethical clearance was obtained from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (No. M150727- Appendix 11). Permission was granted by CHBAH to conduct the research in the hospital's PBU (Appendix 12).

3.4 INCLUSION CRITERIA

Willing to participate
Children (boys and girls) aged 5-12 years
Burns of any percentage, severity and cause

3.5 EXCLUSION CRITERIA

Previous and current medical problems that may impair aspects of joint range e.g. haemophilia, previous contractures, septic arthritis, cerebral palsy
Refusal to participate
Re-admission of study participant

3.6 SAMPLE SIZE CALCULATION

The main aim of this non-equivalent post-test only control group design was to investigate the effect and use of the Xbox Kinect™ on discharge outcomes and early activity levels effects in children age 5 – 12 years of age in the PBU at CHBAH

In 2014, the PBU had 581 new burns admissions and these children were identified with screening for physiotherapy, of which 112 were > 5 years of age. The highest number of admissions was seen during the winter months of June-October 2014. To avoid Type 1 error and using the central limit theory a minimum of 30 children were required in each group (Pennsylvania State University, 2017).

3.7 OUTCOME MEASURES AND MEASUREMENT TOOLS

3.7.1 ROM

Range of movement of affected joints was assessed with the use of a goniometer. Despite limitations shown with goniometry measuring Gajdosik & Bohannon (1987) note that the goniometer is a valid clinical assessment tool. The passive ROM (PROM) and AROM were measured for all affected joints. Normal values for ROM of joints were compared and a percentage of AROM and PROM calculated compared to that joint's specific ROM (Moroz, 2013). For example shoulder flexion full ROM is 180°, if the AROM was 90° the AROM% was 50% (90/180) and if the PROM was 180° the PROM% was 100%.

ROM measurements were done on the day of discharge from the unit and at the follow up clinic. AROM and PROM were measured once the wounds had been checked by the doctors, without limitation by any bandages or dressings and adequate analgesia was provided. AROM was measured first followed by PROM measurement of the affected joint. Only one ROM measurement was recorded and used.

3.7.2 ASK©p

The ASK© is a self-report measure for children with physical disability. The performance component measures what the child 'did do'. The ASK© has been validated for children between the ages of five and 15 years. The ASK© has undergone thorough testing proving that it is a clinically useful assessment tool with sound reliability and validity (Young, 2009) (Appendix13). Refer to 2.5.1 in literature review chapter.

3.7.3 Enjoyment

A modified Wong-Baker FACES® enjoyment rating scale with points ranging from zero to five, with zero end 'no fun at all' represented by a sad face and five end 'extremely fun' represented by a very happy face. The original Wong-Baker® FACES scale was be downloaded for free off the Wong-Baker® FACES website without permission for small research studies (WONG-BAKER FACES, 2016) (Appendix 7).

3.8 PROCEDURE

3.8.1 Role clarification

3.8.1.1 Principle investigator was responsible for

Recruitment of eligible children
Explanation and information of study to parents and children
Coding of data
Outcome measure assessments on discharge and at follow-up
Analysis and storage of data

3.8.1.2 Physiotherapy assistant was responsible for

Assistance with language translation of study to parents and children

3.8.1.3 Physiotherapy staff

Daily screening of the unit and identification of eligible children for study
Conducting and implementing standard physiotherapy treatments as per unit protocol for both groups

3.8.1.4 Physiotherapy students

Conducted and implemented the Xbox Kinect™ sessions

The research began in October 2015 once ethical clearance was received in September 2015. Children that were eligible to participate were identified with daily screening of the unit by physiotherapy staff working in the unit. Their parents were approached during visiting times and informed about the study by the principle investigator; they all received information sheets explaining the study and its purpose (Appendix 1). Nursing staff and the physiotherapy assistant working in the unit who were aware of the research study assisted with translations where necessary.

Once parental consent (Appendix 2) had been given, the eligible children themselves were approached, the study was explained to them and they were also given an information sheet about the study by the principle investigator (Appendix 3). Once parental consent and minor assent (Appendix 4) was obtained the children were able to participate. Each child was assigned study codes (numbers one-seventy) by the principle investigator. All information and study related data was collected on the Data Collection form (see Appendix 5). The target number for each group was 30 children.

The control group was the first group of children recruited to the study. Thirty six children were recruited into the control group. These children all received standard physiotherapy treatment and rehabilitation carried out by the physiotherapy staff working in the unit.

The intervention group was the second group of children consisting of thirty four children, whom all received standard physiotherapy treatment and rehabilitation which was carried out by the physiotherapy staff, plus the Xbox Kinect™ which was carried out by the physiotherapy students working in the unit.

Comparisons were made only after the intervention and analysed by the principle investigator. The control group and intervention group occurred at different times thus the control group were not be able to receive the Xbox Kinect™ intervention.

Once discharged from the unit, a discharge summary form (Appendix 6) was filled out for each child by the principle investigator. ROM measurements were done, as well as comments about the risk of any contractures and the general engagement the child showed during their stay at the unit by the principle investigator.

Demographic information, burn depth and severity, surgical management and LoS were recorded on the discharge summary form and data collection form. LoS was the total number of days spent in the unit from admission to discharge. The number of physiotherapy treatment sessions and Xbox Kinect™ sessions were also recorded on the discharge summary form and data collection form. Each child was also asked an enjoyment question (Appendix 7) about the therapy sessions they received while in the unit and those that participated in the Xbox Kinect™ therapy sessions by the principle investigator.

Follow up of the recruited children took place at the PBU Outpatients clinic the following week Wednesday after discharge, here the doctors were able to assess their wounds and for dressings to be changed as well as necessary physiotherapy and occupational therapy follow up. The ASKp© (Appendix 8) was done with the child and parent before wound exposure and ROM assessments (Appendix 9) was done once the wounds and dressings were exposed and changed by the principle investigator.

All health professionals working in the burns unit who assisted with or observed the Xbox Kinect™ intervention were asked to fill out a short questionnaire (Appendix 10).

All data and information was coded and when obtained was confidentially stored in a research file which was only accessible to the principle investigator. Electronic data was also stored on a personal computer and only accessible to the principle investigator.

3.8.2 Treatments

As mentioned previously in chapter 2 by Okhovantian and Zoubine (2007) the physiotherapy treatment protocol in the PBU at CHBAH has many similarities to the standard physiotherapy protocol and the BRT protocol.

In the PBU at CHBAH physiotherapy is commenced on the first day of hospital admission and recommenced on the fifth day post grafting. Treatment sessions are between 30-45 minutes taking place at least 1-2 times daily (Monday to Friday). The suggested chest physiotherapy, ambulation, exercise therapy, goniometry use, splinting guidelines, caregiver education and ADL training are all the same as the BRT protocol.

The control group children received standard physiotherapy treatment and rehabilitation; which consisted of daily goal orientated therapy aimed to maintain normal ROM, muscle strength and prevent contracture formation and facilitate normal ADLs and activity based on the protocols set in the PBU.

On the days when the children had dressing changes, passive mobilisation and stretches were done in the dressing room under ketamine analgesia as set by protocols in the PBU. These treatment sessions were carried out by the physiotherapy staff working in the unit and took place in the mornings.

The Xbox Kinect™ sessions took place in the afternoons in the PBU therapy gym. A minimum of twice weekly Xbox Kinect™ sessions lasting 15-30 minute for each session took place. Each child in the intervention group received individualised physiotherapy and Xbox Kinect™ sessions, they were given the choice between Kinect Sports™ and Dance Central 3™ games to engage in. The activities were able to take place in sitting or in standing approximately 1.5-2m from the screen and infrared camera sensor. These Xbox Kinect™ sessions were carried out by the physiotherapy students working in the unit.

3.9 STATISTICAL ANALYSIS

Descriptive statistics e.g. mean, median, standard deviation (SD) and interquartile range (IQR) were used to describe the demographic characteristics of the population, as well as the length of stay (LoS) and number of physiotherapy treatment sessions for each group.

The level of significance was set at or below five percent (5%) thus 005. Paired t tests were used to analyse the ROM data between the two groups at discharge and follow up. A Spearmans correlation was run to establish any relationship or association between the two groups for ROM results. Paired t test was also used to analyse the ASK©p scores and activity domain data between the two groups. To establish the relationship and association found between TBSA% and ASK©p scores we used an F test and then a linear regression model. A Mann Whitney U test to analyse the fun and enjoyment data.

Chapter 4: **RESULTS**

Seventy children were recruited for the study. Only 66 were included following the exclusion of four children as no consent was obtained. Five children in total were lost to follow up, four from the control group and one from the Xbox intervention group. There was one mortality in this study and this child was part of the control group.

4.1 DEMOGRAPHIC DATA

Thirty five children were part of the control group and 31 were part of the intervention group. Table 4.1 below describes the demographic information of gender and median age of the control and Xbox intervention groups. No significant difference was found between the two groups.

Table 4.1: Demographic data showing gender and age for both groups where the total number of children was 66

Total n= 66	Control group n= 35	Xbox intervention group n=31	p value
Gender Male (n /%) Female (n /%)	 21 (60%) 14 (40%)	 15 (48.4%) 16 (51.6%)	 0.34
Median age (IQR)	7 (6-9)	7 (5-8)	0.32

Forty five percent of the total numbers of children were female. The median age for both groups was seven.

4.2 CLINICAL DATA

In Table 4.2 following, the clinical information relating to the burn percentage (TBSA %), burn depth and cause of burn for the control and Xbox intervention groups is described. There was no significant difference found between the two groups regarding TBSA %, burn depth and cause of burn.

Table 4.2: Demographic data showing TBSA%, burn depth, burn severity and cause of burn for both groups where the total number of children was 66

Total n= 66	Control group n= 35	Xbox intervention group n= 31	p value
Median burn TBSA% (IQR)	8 (4.5 – 16)	10 (8-15)	0.58
Burn depth (n /%)			
Superficial	3 (8.6%)	4 (12.9%)	
Superficial partial	20 (57.1%)	19 (61.3%)	
Deep partial	8 (22.9%)	4 (12.9%)	
Full	4 (11.4%)	4 (12.9%)	0.74
Burn severity (n /%)			
Minor	21 (60%)	15 (48.4%)	
Moderate- severe	11 (31.4%)	16 (51.6%)	0.78
Severe	3 (8.6%)	0 (0%)	
Cause of Burn (n /%)			
Hot Water	18 (51.4%)	17 (54.8%)	
Flame	11 (31.4%)	9 (29.0%)	
Electrical	5 (14.3%)	3 (9.7%)	
Other	1 (2.9%)	2 (6.4%)	0.84

The median TBSA % for the control group was eight percent and ten percent for the Xbox intervention group. The majority of burns in both groups were superficial partial depth. More than 50% of burns were as a result of hot water followed by flame burns accounting for 30%.

In view of the classification according to burn severity, the control group had majority 60% of minor burn injury followed by moderate-severe injury of 31.4% and 8.6% being a severe burn injury. In the Xbox intervention group the distribution between minor and moderate-severe was very similar being 48.4% and 51.6% respectively. No severe or major burns were seen in this group.

Apart from capturing TBSA %, the distribution and location of the burns between the two groups was captured. This is represented in Table 4.3 below.

Table 4.3: The most commonly injured areas for both groups where the total number of children was 66

Total n= 66	Control group n= 35	Xbox intervention group n= 31
Head & neck (n)	19	9
Trunk (n)	26	21
Upper limbs (n)	64	23
Lower limbs (n)	42	53
Buttocks & genitalia (n)	7	24
Shoulder (n)	11	9
Elbow (n)	16	6
Wrist & hand (n)	19	7
Hip (n)	6	0
Knee (n)	18	11
Ankle & foot (n)	17	4

A larger number of lower limb burns followed by buttocks and genitalia injuries were seen in the Xbox intervention group. While the control group showed a high number of upper limb injuries involving the elbow, wrist and hand compared to the Xbox intervention group. In Figure 4.1 below, we can see that a greater proportion of injury involved the lower limbs 23.10% and upper limbs 21.10%.

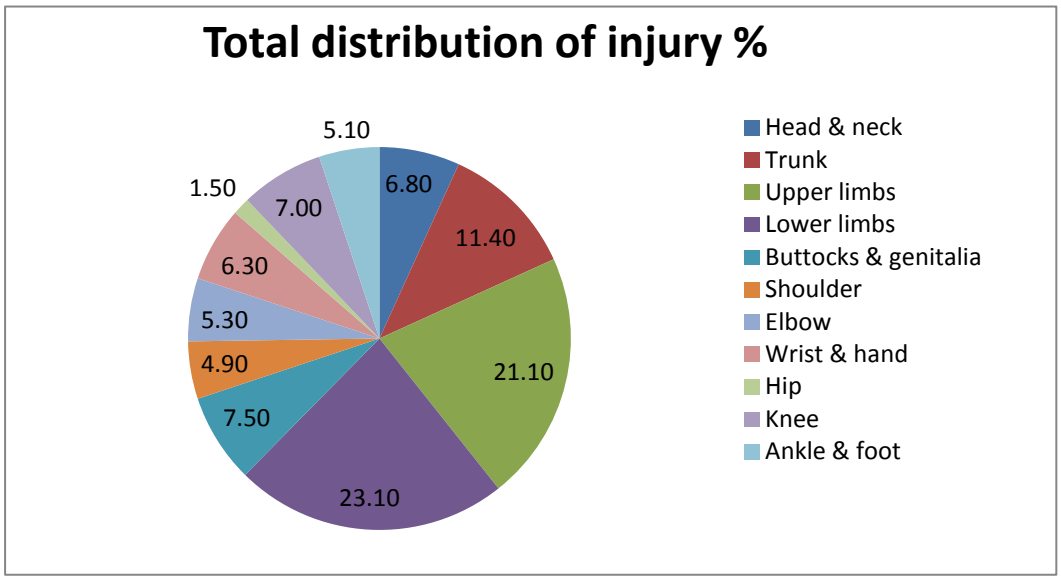

Figure 4.1 Pie chart showing the total distribution and location of burn injury for both groups where the total number of children was 66

Following on from Figure 4.1, injury involving the trunk is 11.40%, then similar involvement of the buttocks and genitalia (7.50%) and the head and neck regions (6.80%). The most affected joint was the knee joint (7%) followed by the wrist and hand (6.30%). The total number of surgeries and wound cover options used between the control group and intervention group are seen in Table 4.4 below.

Surgical management in this study involved procedures where the child was taken to theatre and the surgeons performed varying techniques required to manage the burns and wound bed. Biobrane® dressing and various skin graft techniques were also included as surgical options to cover the wound bed.

Table 4.4: The number of surgeries and wound covering options utilised for both groups where the total number of children was 66

Total n= 66	Control group n= 35 Total (average per patient)	Xbox intervention group n= 31
Surgery p =0.25	34%	48%
Surgeries (n /%)	15	11
Debridement	6 (1)	1 (1)
Escharotomy	2 (1)	1 (1)
Sloughectomy	4 (2)	6 (1)
Other	3 (1)	3 (2)
Wound covers (n /%)	14	20
Biobrane®	2 (1)	5 (1)
Split Skin Graft	8 (1)	13 (1)
Xenograft	2 (1)	1 (1)
Meek®	2 (1)	1 (1)

One child had nine surgeries and wound covering in total. There was no statistical difference in surgical management and wound coverage between the two groups

The mean number of ICU days between the two groups, as well as the total LoS in days were also recorded LoS was the total number of days spent in the unit from admission to discharge..This is described in Table 4.5 below.

Table 4.5: Number of ICU days, total LoS and number of physio treatment sessions for both groups where the total number of children was 66

Total n= 66	Control group n= 35	Xbox intervention group n= 31	p value
Mean ICU days (SD)	5 (±15)	1 (±3)	Too few to test
Median LoS days (IQR)	10 (7-18)	16 (10-29)	0.21
Median number of Physio sessions	7.5 (5-12)	11 (7-20)	0.23

The median LoS in days between the two groups was very similar with ten days for the control group and 16 days for the Xbox intervention group and was not found to be significantly different. The difference in the median number of physiotherapy sessions between the two groups was not significant (p = 0.23) and found to be similar with 7.5 for the control group and 11 in the Xbox intervention group.

The physiotherapy sessions were counted as treatment days the child had during their admission stay from Monday to Friday. Weekend treatments and sessions were not done nor required for both groups. As per protocols set by the PBU.

In the Xbox intervention group it was found that 75% of the children received two or more Xbox Kinect™ sessions. The remaining 25% only received and experienced the minimum two sessions as they were discharged from the PBU.

4.3 TREATMENT EVALUATION

4.3.1 ROM

For analysis of ROM between the two groups only areas that were burnt were analysed, as unaffected areas and joints had full AROM. On discharge, five patients had joint contractures. Three of these children were in the control group and two were in the Xbox intervention group. These five participants and their demographic information are presented in Table 4.6 following.

Table 4.6: Data from the five participants in the study presenting with joint contractures on discharge

Participant number	5	8	33	47	49
Treatment group	Control	Control	Control	Xbox	Xbox
Age	9	7	8	7	9
Gender	Male	Male	Male	Male	Female
Type of burn	Flame	Flame	Hot Water	Flame	Flame
TBSA %	40	33	16	10	16
Depth of burn	Full thickness	Full thickness	Superficial partial	Full thickness	Full thickness
ICU days (n)	17	56	0	0	0
LoS days (n)	77	152	23	26	106
Number of surgeries (n)	6	9	1	4	5
Area of joint contracture(s)	Bilateral knees	Left shoulder axilla & Left elbow	Bilateral hips	Right shoulder axilla	Bilateral knees
Limited ROM(joint and movement)	Bilateral knee extension	Shoulder flexion, shoulder abduction, elbow flexion and elbow extension	Bilateral hip extension	Shoulder flexion and shoulder abduction	Bilateral knee flexion

The average age of the five children was eight years old. The average TBSA% of the five children was 23%, this alongside the overall deeper burn injury sustained classifies these children as having severe injury. Two of the children developed unilateral axillary shoulder contractures, while the remaining three developed bilateral contractures involving the hip or knee joints.

Common trends seen between these five children were that there were more males, being four and one female. Four of the five children sustained flame burns and one sustained injury from hot water. Finally four of the five children sustained full thickness injuries. These three trends and similarities are in line with the association of larger TBSA% and deeper burn depth which contribute to the formation of contractures.

As seen in Table 4.7 below the total average number of areas affected was 3.90. This was similar in both groups with 3.70 represented for the control group and a slightly higher 4.2 in the intervention group.

Table 4.7: The percentage of PROM and AROM between the two groups at discharge and at follow up for both groups where the total number of children was 66

Treatment group	Total n= 66	Control group n= 35	Xbox intervention group n= 31	Difference between control and intervention (p value)
Average no. areas affected (n)	3.90	3.70	4.20	Too few
Average percentage of normal PROM at discharge (n / %)	66 (96.40)	35 (93.50)	31 (98.60)	4.40 (p= 0.19)
Average percentage of normal PROM at follow up (n / %)	66 (95.70)	35 (93.20)	31 (98.20)	5.10 (p= 0.22)
Difference from discharge to follow up (p value)	0.40 ↓ (0.50)	0.30 ↓ (0.73)	0.4 ↓ (0.33)	Too few
Average percentage of normal AROM at discharge (n /%)	66 (64.40)	35 (58.90)	31 (66.20)	4.90 (p= 0.53)
Average percentage of normal AROM at follow up (n / %)	66 (79.60)	35 (74.20)	31 (85.00)	10.90 (p= 0.18)
Difference from discharge to follow up (p value)	17.0 ↑ (<0.01)	15.3 ↑ (0.06)	18.8 ↑ (<0.01)	Too few

There was no significant difference between PROM scores at discharge and at follow up (ttest p = 0.50), as seen in Table 4.7 above. There was a significant difference in AROM between discharge and follow up overall between the two groups (ttest $p < 0.01$) but is also seen between the percentage of AROM from discharge to follow up in the Xbox intervention group (ttest $p < 0.01$).

Since no significant difference was seen in PROM, analysis was focused on AROM. The following tables below were used to confirm that improvements are consistent across different burn locations. The shoulder, elbow, trunk, hip and knee joints were identified as key areas of assessment. The total movement percentage seen at the shoulder, elbow, trunk, hip and knee between the two groups were analysed and compared. The shoulder range of movement at discharge and follow up is presented as the percentage of normal AROM in Table 4.8 below.

Table 4.8: The average percentage of normal AROM of shoulder flexion and abduction at discharge and follow up for both groups

	Control group Number of children with limited AROM	Average percentage of normal AROM (%)	Xbox intervention Number of children with limited AROM	Average percentage of normal AROM (%)
Shoulder flexion at discharge	18	66.80	12	71.15
Shoulder flexion at follow up	13	95.73	10	86.70
Shoulder abduction at discharge	16	69.30	8	70.50
Shoulder abduction at follow up	10	71.50	10	78.25

From Table 4.8 above we can see that the average percentage of the AROM of shoulder flexion in the control group is slightly lower (66.80%) than that compared to the Xbox intervention group (71.15%) at discharge. However on follow up average percentage of the AROM of shoulder flexion in the control group (95.73%) is much higher than the Xbox intervention group (86.70%). Improvements were seen in both groups from discharge to follow up. When looking at shoulder abduction the average percentage of the AROM at discharge was similar for both groups. At follow up a higher average percentage of the AROM of shoulder abduction was seen in the Xbox intervention group with 78.25% compared to the control group having 71.50%.

The elbow range of movement at discharge and follow up is presented as the percentage of normal AROM in Table 4.9 below.

Table 4.9: The average percentage of normal AROM of elbow flexion and extension at discharge and follow up for both groups

	Control group Number of children with limited AROM	Average percentage of normal AROM (%)	Xbox intervention Number of children with limited AROM	Average percentage of normal AROM (%)
Elbow flexion at discharge	7	69.80	6	83.30
Elbow flexion at follow up	6	93.30	6	100
Elbow extension at discharge	5	62.30	1	100
Elbow extension at follow up	4	81.10	1	100

Related to elbow flexion and extension AROM, which can be seen in the above Table 4.9, the average percentage of normal AROM achieved at discharge and at follow up was higher in the Xbox intervention group.

The trunk range of movement at discharge and follow up is presented as the percentage of normal AROM in Table 4.10 below.

Table 4.10 showing the average percentage of AROM of trunk flexion and extension at discharge and follow up for both groups

	Control group Number of children with limited AROM	Average percentage of normal AROM (%)	Xbox intervention Number of children with limited AROM	Average percentage of normal AROM (%)
Trunk flexion at discharge	6	75	9	79.20
Trunk flexion at follow up	5	71.30	9	97.20
Trunk extension at discharge	6	-8.30	8	8.40
Trunk extension at follow up	5	-8.80	8	71.90

Improvements in trunk flexion and trunk extension average percentage of normal AROM were again considerably higher in the intervention group.

The hip range of movement at discharge and follow up is presented as the percentage of normal AROM in Table 4.11 below.

Table 4.11 showing the average percentage of normal AROM of hip flexion and extension at discharge and follow up for both groups

	Control group Number of children with limited AROM	Average percentage of normal AROM (%)	Xbox intervention Number of children with limited AROM	Average percentage of normal AROM (%)
Hip flexion at discharge	12	78.10	34	80.60
Hip flexion at follow up	12	66.70	33	94.90
Hip extension at discharge	9	55.40	19	50.70
Hip extension at follow up	9	23.60	18	87.90

At discharge, we can see from Table 4.11 above that hip flexion and extension average percentage of AROM is very similar between the two groups. However on follow up a larger difference between the average percentage of AROM for hip flexion and extension between the two groups is seen. For hip flexion AROM, the control group fell to 66.70% at follow up from 78.10% at discharge, while the Xbox intervention group improved to 94.90% at follow up from 80.6% at discharge. For hip extension AROM, the control group average percentage of AROM fell to 23.60% at follow up from 55.40% at discharge. While the Xbox intervention group improved to 87.90% at follow up from 50.70%.

The knee range of movement at discharge and follow up is presented as the percentage of normal AROM in Table 4.12 below.

Table 4.12 showing the average percentage of AROM of knee flexion and extension at discharge and follow up for both groups

	Control group Number of children with limited AROM	Average percentage of normal AROM (%)	Xbox intervention Number of children with limited AROM	Average percentage of normal AROM (%)
Knee flexion at discharge	15	80.90	17	81.70
Knee flexion at follow up	13	73.00	16	90.80
Knee extension at discharge	13	54.10	15	55
Knee extension at follow up	11	30.10	12	82.40

When assessing the AROM of knee flexion and extension, again we see in Table 4.12 above, very similar average percentage of AROM at discharge between the two groups. As seen previously in the AROM of hip flexion and extension, the knee flexion and extension average percentage of AROM is lower at follow up in the control group compared to discharge. While an improvement in the average percentage of AROM for the Xbox intervention group at follow up compared to discharge was found.

In summary, from the above tables we can see that improvements in the average percentage of AROM for the elbow, trunk, hip and knee were associated with the Xbox intervention. When burn injuries involve the shoulder, the Xbox Kinect™ showed no benefit where as the standard physiotherapy treatment resulted in higher average percentage of normal AROM at discharge and at follow up.

4.3.2 ASK©p

No significant difference was found for the median ASK©p scores between the two groups at follow up, as seen in Table 4.13 below.

Table 4.13: ASK©p scores at follow up for both groups where the total number of children was 66

Total n= 66	Control group n= 35	Xbox intervention group n= 31	p value	ASK©p Comparison values (HSC study)
Median ASK©p score (IQR)	84.50 (79 – 93)	86.20 (82-92)	0.69 (ttest transformed var)	72.50
Max score	100	97.41		
Min score	9.26	54.34		
Mean ASK©p score	81.96	84.76		66.10
25th percentile	79.16	82.76		42
50th percentile	84.54	86.22		72.5
75th percentile	92.24	93.10		90

The median and mean ASK©p scores were slightly higher in the Xbox intervention group but this difference was not statistically significant. A score of less than 95 indicates disability, in comparison to the ASK©p scores from the HSC study the median and mean ASK©p scores in this study were shown to be much higher. In comparison to the HSC study, both groups scored much higher within the 25th and 50th percentiles and slightly higher in the 75th percentiles.

In the control group one child scored 9.26, which indicates severe disability, following a hot water burn injury of 22% being deep partial in burn depth. This child was subsequently readmitted for further burns management, rehabilitation and support as he was no longer mobilising and coping at home.

4.3.2.1 Activity domains

The 30 questions of the ASK©p are subdivided into nine domains- personal care, dressing, other skills, locomotion, play, standing skills and transfers. A comparison between these domains in the two groups was analyzed and is represented in Table 4.14 below.

Table 4.14: Domains of the ASK©p scores for both groups where the total number of children was 66

Total n= 66	Control group score n= 35	X box intervention group score n= 31	p value
Personal care	10.30 (1.90)	11.10 (0.90)	**0.04**
Dressing	12.70 (2.90)	13.80 (1.90)	0.08
Other skills	14.20 (3.00)	13.80 (3.00)	0.61
Locomotion	25.10 (5.60)	25.40 (4.10)	0.86
Play	7.50 (2.80)	6.10 (2.80)	**0.04**
Standing skills	15.30 (4.30)	16.60 (2.40)	0.18
Transfers	18.40 (4.10)	18.10 (2.90)	0.75

As seen from the Table 4.14 above the domains of 'personal care' and 'play' were shown to be significantly different between the two groups. The Xbox intervention group had a higher score of 11.10 in the 'personal care' domain compared to the control group of 10.30. While in the domain of 'play', the Xbox intervention group score of 6.10 was less than the control group of 7.50.

In the following two tables, Table 4.15 and Table 4.16 the total number of responses for "not applicable" and "none of the time" were analysed. In both groups the domain of 'other skills' was high. In the control group, for the 'play' domain more children responded that this activity was "not applicable" and that they weren't able to participate in any play or did not have the opportunity to play.

Table 4.15: Total number of "not applicable" answers in the ASK©p domains for both groups where the total number of children was 66

Total n= 66	Control group score n= 35	X box intervention group score n= 31
Personal care	0	0
Dressing	0	1
Other skills	47	35
Locomotion	4	5
Play	23	6
Standing skills	3	3
Transfers	2	4

From Table 4.16 below, we can see that more of the control group children were unable to participate in tasks involving 'locomotion', 'standing skills' and 'transfers'. While the Xbox intervention group showed they were unable to do more tasks associated with 'other skills'.

Table 4.16: Total number of "none of the time" answers in the ASK©p domains for both groups where the total number of children was 66

Total n= 66	Control group score n= 35	X box intervention group score n= 31
Personal care	2	1
Dressing	3	1
Other skills	7	10
Locomotion	10	6
Play	4	1
Standing skills	15	5
Transfers	7	5

Assistance with the questionnaire was similar between the two groups 7.4 and 7.7 p = 0.15, which represents the children reporting 'someone has read the questions to me' and 'someone had helped me with most of the answers'.

4.3.2.2 Burn percentage (TBSA %) as a predictor of ASK©p scores

When analysing the overall ASK©p scores at follow up, an outlier (as mentioned above) was identified and excluded as it was likely to influence the model unequally as seen in Figure 4.2 below.

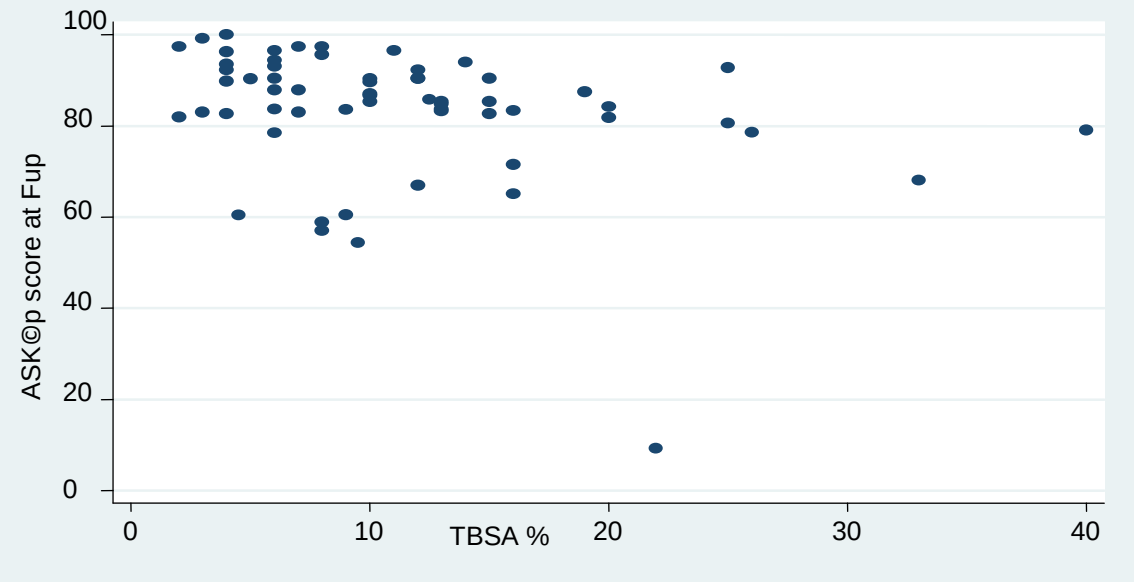

Figure 4.2: Scatter plot graph of all the ASK©p scores for both groups where the total number of children was 66

There were five participants identified with unexpectedly low ASK©p scores based on their TBSA% as seen in Figure 4.3 below.

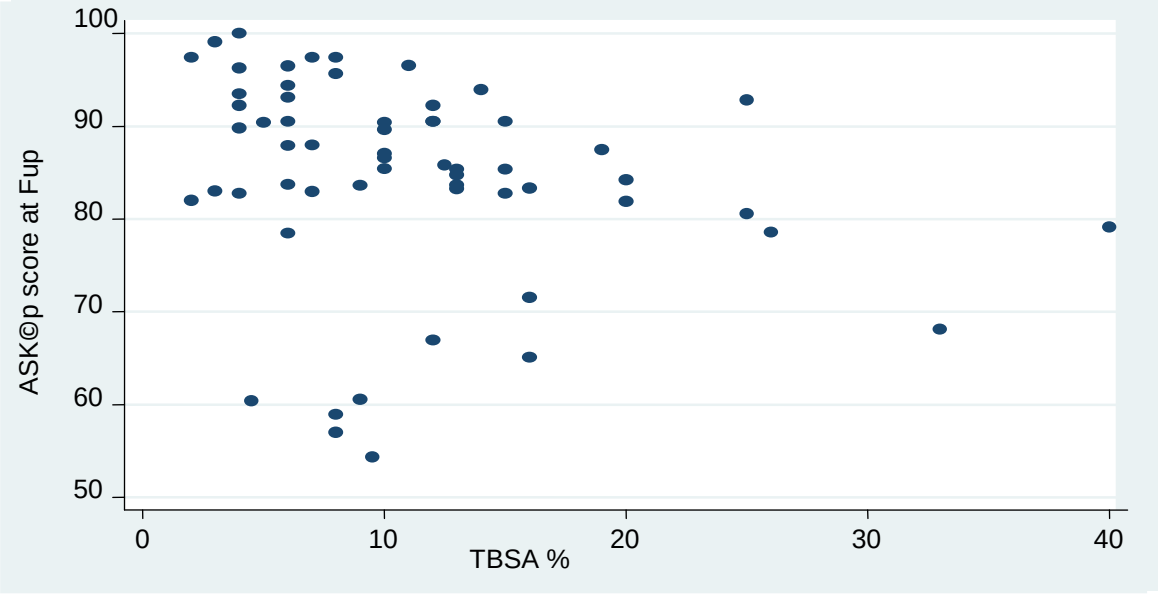

Figure 4.3: Scatter plot graph showing the ASK©p scores with the outlier removed

They were removed from the second model, the significance of the TBSA % of the burn remained a significant predictor of ASK©p score as demonstrated in Table 4.17 below.

Table 4.17: The two models used to show that TBSA % is a predictor of ASK©p scores

	Model with all participants excluding the outlier – p values n = 59 F = 1.99 p 0.11	Model minus the five and the outlier – p values N= 54 F= 4.87 p< 0.01
TBSA %	**p= 0.03**	**p= 0.00**
Age	p= 0.24	p= 0.25
Treatment group	p= 0.87	p= 0.71
Sex	p= 0.29	p= 0.34

A significant p value for the F test is required for the linear regression model to be of value in the first model with all participants (excluding the outlier) this was 0.11, showing a p value of 0.03 for TBSA% and ASK©p score. While in the second model with the five participants removed (all outliers) the p value for the F test was significant ($p < 0.01$) and provided a p value of 0.00 for TBSA% and ASK©p score. The relationship between TBSA% and ASK©p was significant in both models and can thus be accepted as a significant association.

4.3.2.3 ROM

Using Spearmans correlation, a correlation between the ASK©p score and overall ROM was found (roh 0.45) ($p < 0.01$). This can be seen in Figure 4.4 below

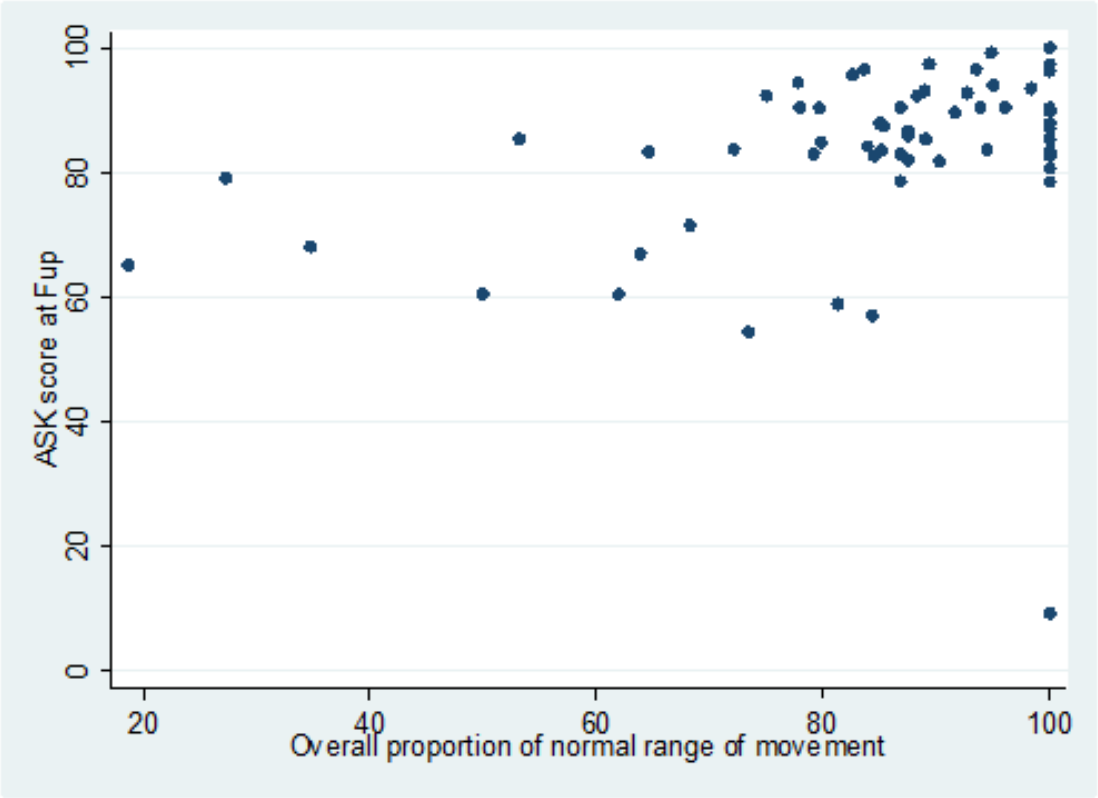

Figure 4.4: Scatter plot graph showing the correlation between the ASK©p score and overall ROM for both groups where the total number of children was 66

A moderate correlation was found to be significant, as seen in the above Figure 4.4

Again using Spearmans correlation, we wanted to investigate if any correlations existed between the two treatment groups and AROM. The correlation between ASK©p score and AROM for the control group receiving normal physiotherapy: r= 0.39; p = 0.03; while the correlation between ASK©p score and AROM for the group receiving Xbox intervention was r= 0.35; p = 0.05 and is demonstrated in Figure 4.5 below.

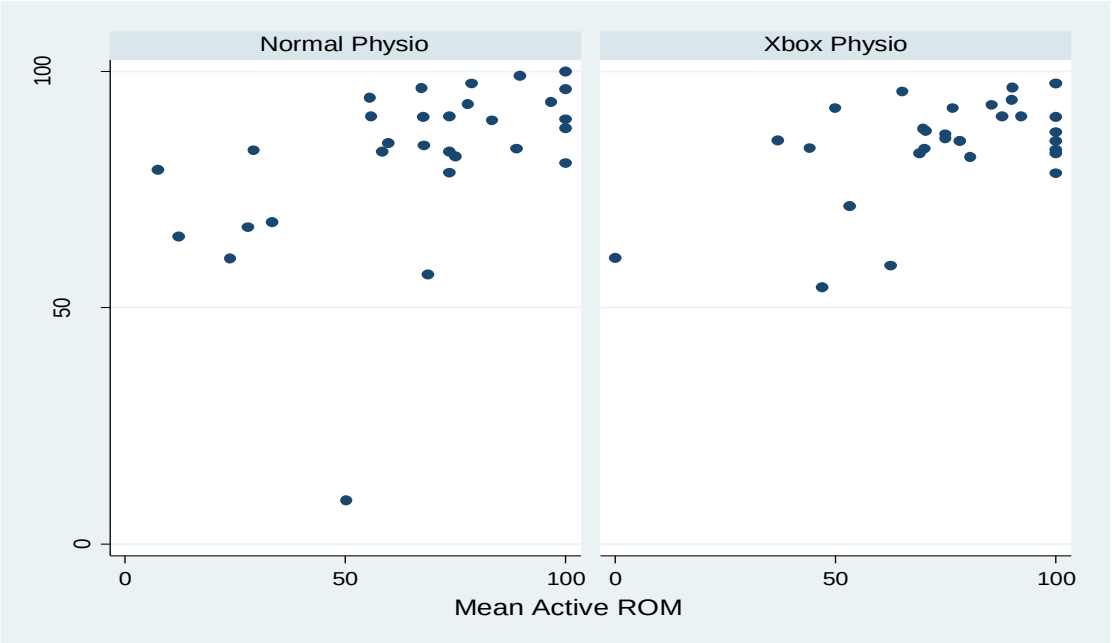

Figure 4.5: Scatter plot graph showing the correlations found between the ASK©p score and AROM for the two treatment groups

The Total Correlation between ASK©p score and AROM r= 0.39; p < 0.01 is viewed as a weak correlation for children receiving both forms of treatments.

A regression of the ASK©p score at follow up was done and results can be seen in the Table 4.18 below.

Table 4.18: Age and AROM as predictors of ASK©p scores

Total n= 66	Coefficient	p value
Sex	-2.86	p= 0.46
Treatment group	0.10	p= 0.98
Age	-1.89	**p= 0.05**
Burn depth	0.58	p= 0.46
AROM	0.22	**p= 0.04**

As seen from Table 4.18 above age (coef -1.8923) (p = 0.05) of the child and AROM (coef 0.2185) (p = 0.04) were significant predictors of ASK©p scores

4.3.3 Fun and enjoyment

Analysis of the modified Wong-Baker FACES® enjoyment rating scale used in the study showed that Xbox the intervention group significantly enjoyed this treatment and the use of the Xbox Kinect™ as part of their rehabilitation (p < 0.01) as seen in Table 4.19 below.

Table 4.19: Faces score on discharge for both groups where the total number of children was 66

Total n= 66	Control group n= 35	Xbox intervention group n= 31	p value
Median Face score (IQR)	3 (3-4)	5 (4-5)	0.00 (Mann Whitney)

This significance highlights the fun and enjoyment factor the Xbox Kinect™ offers as part of therapy and as an adjunct to burns rehabilitation compared to standard physiotherapy treatment used in this study.

4.4 HEALTH PROFESSIONALS QUESTIONNAIRE

The health professionals working within the PBU were asked to fill out a five questioned questionnaire related to the use of the Xbox Kinect™ in the PBU. The questions and answers are provided in Table 4.20 below.

Table 4.20: Questions and answers from the health professionals questionnaire

Questions **Total n = 31**	YES	Comments
Did you participate in any of the Xbox Kinect therapy sessions?	55%	Fun and enjoyment
Did you observe any of the Xbox Kinect therapy sessions?	100%	Fun and enjoyment
Do you feel the children enjoyed the Xbox Kinect therapy sessions?	100%	Fun and enjoyment (22%) More participation (13%) More movement experienced (10%)
Do you feel the children benefitted using the Xbox Kinect during therapy sessions?	100%	More movement experienced (20%) More participation (3%) Fun and enjoyment (3%)
Did you observe any negative experiences with the Kinect ?	13%	Technical problems (10%) Supervision needed (10%)
Do you think the Xbox Kinect helped distract the children into playing with their burnt injured limbs?	100%	Supervision needed (3%) Distraction from pain (6%) More movement experienced (10%) Fun and enjoyment (16%)

The mean age of the respondents was 28 years. Seventy-four percent were female. Thirty one questionnaires were answered. More than one third of the responses were from physiotherapists, followed by 26% for occupational therapists, 23% for nursing staff and 16% from doctors working within the unit.

More than half of the respondents took part and participated in the Xbox Kinect™ therapy sessions. All respondents felt that the children enjoyed and benefitted from the Xbox Kinect™ sessions.

Not all respondents commented on the questionnaire but of those that did the following were found: up to 20% of respondents felt the children experienced more movement and 13% felt the children engaged in more participation. The negative experiences associated with the Xbox Kinect™ were related to technical issues such as 'the device being too sensitive and loss of connectivity'. It was also noted by three percent of the respondents that supervision from therapists with these sessions was still required.

4.5 SUMMARY OF RESULTS

Data from 66 children were analysed. We found no significant difference between groups related to demographic characteristics. The median age was seven years old and 55% of the participants were male. The Xbox Kinect™ was shown to be significant in achieving higher AROM at discharge ($p < 0.01$) and at follow up ($p< 0.01$). We also found that TBSA% ($p = 0.03$) ($p < 0.01$), age ($p = 0.05$) and AROM ($p = 0.04$) were predictors of ASK©p scores. Fun and enjoyment ($p < 0.01$) was also found to be significantly different between the two groups. These results will be discussed further in chapter 5.

Chapter 5: **DISCUSSION**

The results presented in chapter 4 will be discussed in this chapter.

5.1. DEMOGRAPHICS

Of the 66 children analysed, the majority were male comprising of 55% which is in line with previous burns studies done by Jugmohan et al., (2016) and Albertyn, Bickler and Rode (2006) which reported that males were more commonly burnt.

In this Xbox Kinect™ study population the majority of burns were as a result of hot water accounting for more than 50% of admissions, followed by flame burns accounting for 30% and electrical burns involved in 12% of the admissions. When these resulted are compared to Jugmohan et al., (2016) which took place at the same facility, they found 76.50% of admissions were related to hot-water burns, 21.80% to flame burns and 1.80% to electrical, we can see that our study showed a much higher involvement of electrical burns and a lower influence from hot water causes during this study period.

On examination of the study period of Jugmohan et al., (2016), it took place over a period of four years as opposed to our study which only lasted 14 months. Thus the possible difference in numbers could be due to the overall average seen over the four years, which is influenced by a four winter periods which would typically seen more hot-water admissions, compared to one winter season experienced in our shorter study period.

Two children seen in this study had 40% TBSA full thickness burns caused from a shack fire and flame burns, one of which was discharged and the other demised. The child who passed away spent 71 days in the ICU and a total of 75 days in the PBU. This child underwent nine surgical procedures in attempts to cover the burn wounds but passed away from sepsis and multi-organ failure. This is in keeping with the analysis from Allorto (2013) where in South Africa few patients with major burns of more than 40% TBSA survive.

In this study we found that the median TBSA % was eight percent for the control group and ten percent for the Xbox intervention group. Both groups also had majority burns of superficial partial depth which indicates an overall injury severity of minor burn injury. Forty percent of this study population were seen to have moderate-severe injury and three children were considered to have severe major burns > 30 % TBSA. In comparison to the review done by Wesson et al (2013) where 56% of the injuries seen were moderate-severe, followed by minor injuries accounting for 39% and severe injuries being five percent; our study population was less severe in presentation.

Regarding LoS and ICU stay in this study there was no significant difference between the chance of staying in ICU between groups. The median LoS between the two groups was very similar with ten days for the control group and 16 days for the Xbox intervention group and was not found to be significant. In comparison to the review done by Parbhoo, Louw and Grimmer-Somers (2010) where the median LoS for TBSA of burns ten percent and less was eight days.

Similarly in a retrospective cohort study done in Colombia by Zúñiga et al., (2015) it was found that the median LoS for TBSA of burns ten percent and less was ten days. We can see that our study population spent similar LoS for the control group but a few more days for the Xbox intervention group.

When looking at the distribution and location of burn injury within this study population we observed a greater proportion of injury involving the lower limbs and upper limbs accounting for 23.10% and 21.10% respectively. This is followed by injury involving the trunk (11.40%), then similar involvement of the buttocks and genitalia (7.50%) and the head and neck regions (6.80%). This is In keeping with the burn patterns described by Van Niekerk, Rode and Laflamme (2004) as our study population involved Class 3 and Class 4 categories.

Overall we see the similar over-representation of burns to the lower limbs and lower body parts represented by children falling into the Class 3 category. As well as the involvement of the head, neck and upper limbs which constitute the higher proportion of upper body and head and neck injuries seen in the Class 4 category.

In comparison to Wesson et al., (2013) which is one of the few studies published in South Africa involving analysis of paediatric burns and distribution of injury. Data for 9438 children with burns injury was collected and analysed over a 15 year period. The distribution of injury showed that 28% had upper limb involvement, 27% involvement for the head and neck region as well as the trunk and 17% involvement of the lower limbs,

However this study population included a much younger distribution of children, aged zero to four accounting for 79% of the total number; compared to our study population which addressed children aged five and older, which only accounting 16% of the total number. This study demonstrates a higher proportion of injury involving Class 1 and Class 2 categories, which is represented by a far larger proportion of upper body and head and neck regions. This is due to the explorative nature of toddlers and a different mechanism of injury associated with the children younger than age four.

5.2. TREATMENT EVALUATION

As mentioned previously in chapter 2 by Okhovantian and Zoubine (2007) the physiotherapy treatment protocol in the PBU at CHBAH has many similarities to the ordinary physiotherapy protocol and the BRT protocol. In the PBU at CHBAH physiotherapy is commenced on the first day of hospital admission and recommenced on the fifth day post grafting. Treatment sessions are between 30-45 minutes taking place at least 1-2 times daily. The suggested chest physiotherapy, ambulation, exercise therapy, goniometry use, splinting guidelines, caregiver education and ADL training are all the same as the BRT protocol. The only exclusion is the lack of electrical stimulation use as we do not have access to this modality.

5.3. ROM

5.3.1. PROM and contractures

PROM scores at discharge and at follow up were not significantly different (ttest p= 0.50) between the two groups. Five children in our study population developed contractures, three from the control group and two from the Xbox intervention group. Despite the treatment methods used in this study of aggressive and early ROM exercises and the use of splinting two of the children in this study developed unilateral axillary shoulder contractures, while the remaining three developed bilateral contractures involving the hip or knee joints.

Three similarities and trends were noted between the five children; these were of the male gender, injury related to flame burns and a full thickness burn depth injury. These three trends and similarities could help to identify factors that contribute to the increased risk of contracture formation among burn injuries.

Jeschke and Herndon (2014) explain that with a full thickness injury the wound will not heal by itself. Should the wound heal via grafting and coverage it will heal alongside hypertrophic scarring thus increasing the risk for contracture formation (Jeschke and Herndon,2014). Overall these five children were seen to have major and severe burn injury. All of them required grafting, which again highlights the increased formation of contractures explained by Webb et al., (2011) where contractures are most likely associated with larger TBSA and increased depth of the burn, as well as a larger area requiring grafting (Webb et al., 2011).

5.3.2. AROM

There was a significant difference in overall AROM between discharge and follow up between the two groups (ttest p = 0.0004). Overall the AROM at discharge was 64.4% and at follow up was 79.6%.

This is in keeping with work done by Parry et al., (2015) when active therapy and supervised home exercise programmes all showed improvements in ROM, and the largest improvements of ROM were seen when exercise is initiated early in the rehabilitation programme.

There was also a significant difference found between the percentage of AROM from discharge to follow up in the Xbox intervention group (ttest p = 0.0004). The AROM at discharge in the Xbox intervention group was 66.2% compared to 58.9% in the control group; while the AROM at follow up was 85.0% in the Xbox intervention group compared to 74.2% in the control group. This highlights the advantages the Xbox Kinect™ has in providing a more amusing and comfortable option as part of the burns rehabilitation process as described by Mobini, Behzadipour and Foumani (2014).

By allowing the children to be more engaged in the Xbox Kinect™ experience and games, they were distracted and thus experienced less pain as previously described by Parker et al., (2015). This decline in pain assists in reducing the fear associated with movement these burns children experience and assist in improvements related to activity and ultimately age-appropriate play and ADLs.

In this study the shoulder, elbow, trunk, hip and knee joints were identified as key areas of assessment. The total movement percentage seen at these joints were analysed and compared between the two groups. It was found that improvements in the average percentage of AROM for all movements involving the elbow, trunk, hip and knee were associated with the Xbox intervention. This highlights the potential benefit to using the Xbox Kinect™ for burn injuries to the trunk and lower limbs.

However when burn injuries involve the shoulder, the Xbox Kinect™ showed marginal improvements within shoulder flexion and abduction movements at discharged and follow up compared to the control group.

The control group at follow up however had a much higher AROM of shoulder flexion which could be contributed to the supervised home exercise programmes. Thus the use of the Xbox Kinect™ identified here confirms the need to be a supervised activity rather than a replacement for conventional methods (Bonnechère et al., 2014).

We are also aware that in this study the games selected for the children to participate in may not have addressed the shoulder ROM specifically enough. In a pilot RCT study by Voon et al., (2016) where they examined the feasibility of using the Xbox Kinect™ as an adjunct to burns rehabilitation. They specifically investigated the Xbox Kinect™ use for upper limb injuries and games chosen were related to the burn location and joint involved. Thirty participants were involved and analysed in the study 15 from the control group and 15 from the Xbox intervention group.

The median TBSA was three percent for the control group and five percent for the Xbox intervention group. Participants in the control were required to perform 30 minutes of conventional burns physiotherapy daily, while the Xbox intervention group were required to perform 15 minutes of pre-determined physiotherapy exercises specific to the burn injury followed by 15 minutes of Xbox Kinect™ daily. All participants needed to perform a maximum of seven days worth of therapy. Results from this study found that a greater satisfaction is associated with the Xbox Kinect™ as a therapeutic adjunct. Due to the small sample and small TBSA, this study was unable to show any specific improvements to upper limb function but found no evidence to negatively influence upper limb function.

Recommendations about more studies involving burns patients and the Xbox Kinect™ with larger sample sizes, larger burn TBSA with longer interventions and follow-up would further benefit this field of research and video game technology (Voon et al., 2016).

In view of the above mentioned recommendations by Voon et al., (2016), this Xbox Kinect™ study involved a larger study group with a higher and larger median TBSA for both study groups and a follow-up period; but wasn't able to address a longer period focused on intervention.

5.4. ASK©p

In this study we found that TBSA% was a predictor of ASK©p scores, thus the higher the burn percentage the lower the ASK©p scores. We also found that age and AROM were predictors of ASK©p scores, thus the younger the child or a child with reduced AROM would have lower ASK©p scores. According to the ASK© guidelines and following the HSC study a score of less than 95 indicates disability, in our study the overall mean ASK©p was 83.36 which is acceptable but indicates disability. The ASK© does not have a grading or scale for severity but interpretation of scores is left up to the clinician (Young, 2009).

In comparison to the HSC study, both groups scored higher within the 25th, 50th and 75th percentiles. The 25th percentile represents the 'below average' scores for disability, the 50th percentile 'average' score and the 75th 'above average'. There is limited use of the ASK© studies comparing outcomes of children examined over a longer time frame involving follow-up and as highlighted its use is left up to the clinician and setting used (Young, 2009).

In this study, the ASK©p was used as an assessment measure of performance once the child was discharged and back in their familial home environment and used to identifying the activity domains the children performed worse in. Overall it was found that 'personal care' and 'play' were statistically significant between the two groups. 'Personal care' was found to be higher in the Xbox intervention group. 'Personal care' addresses tooth brushing, going to the toilet and washing the body. In the domain of 'play', the control group had a higher score compared to the Xbox intervention group. 'Play' looks at activities with other friends or alone, as well as keeping up with other children.

When analysing the responses of the “not applicable” answers, it was found that the ‘other skills’ domain was high for both groups but more so in the control group. Within this domain, the children were asked if they had done any painting, work or crafts, if they were able to take care of their medical needs, if they had made a snack and if they did their usual chores or jobs. Many children in this study did not participate in any painting, work or crafts and had not returned to school yet. Many were not allowed to make their own snacks as this activity was normally done for them by their parents or was a supervised activity. Some children also indicated that they did not have any chores or jobs as this was not part of their usual routine. Interesting the control group showed higher scores of “not applicable” within the play domain. Many of them found that they did not have an opportunity to engage in play with their friends or alone. Contributing factors that were reported affecting this involved pain and parental anxiety.

Looking at the “none of the time” answers, which indicates the child was unable to do the activity and task. We found that more of the control group of children were unable to participate in activities involving ‘locomotion’, ‘standing skills’ and ‘transfers’ compared to the Xbox intervention group. These domains address activities involving stair climbing, walking up a gradual gradient, standing for 10 minutes, carrying things with two hands, walking without any assistance, walking in a crowded area, getting in and out of bed, sitting on the floor and being able to get in and out of an automobile. These tasks involve the trunk and lower limbs, the higher scores seen in the Xbox intervention group coupled with the higher AROM found involving these joints in this group thus highlights the beneficial use of the Xbox Kinect™ as part of burns rehabilitation.

There is limited literature examining the use of the Xbox Kinect™ involving the trunk and lower limbs within the burns population thus literature amongst other AVGs was adopted. Fung et al., (2010) conducted a survey amongst physiotherapists and occupational therapist working with burns patients as well as non-burns patients to establish if there was a difference in their perspectives in the use of the Nintendo® Wii™.

It was found that majority of therapists agreed that the Nintendo® Wii™ should be used as an adjunct to individual therapy and the use of two times per week for up to 30 minutes was appropriate. It was reported that following these interventions which focused on task specific balance training, patients experienced fewer falls. Games involving tennis and bowling action required upper limb movements while challenging and activating dynamic standing balance. The weight shifting involved in performing these tasks aids in the recovery of balance. These games in addition improve standing tolerance, as patients perform these games whilst being distracted from pain and anxiety associated with moving their burnt limb (Fung et al., 2010). This could help explain our findings for the higher AROM involving the trunk and lower limbs in our intervention group, as the games chosen in our study and that the Xbox intervention group were exposed to address these tasks and balance demands.

Analysis of the domains and which areas the children scored lower in highlights the potential for treatment planning and goal setting the clinician and family can address to improve the overall scores and functioning of the child. Tyack and Ziviani (2003) conducted a longitudinal cohort design study investigating what factors influence the functional outcomes of children aged 5-14 years six month post-burn injury. The burn injury factors associated with TBSA, number of surgical procedures, type and cause of burn did not have a significant impact on functional outcomes. Age of the child was found to significantly affect the variance of the functional outcome, thus the younger the child the better the functional outcomes seen in this study.

This study found a large number of factors that significantly influence functional outcomes- these are attributed to demographic factors involving gender, socioeconomic status and number of previous hospitalizations, followed by pre-morbid factors such as behavioural problems, developmental delay or learning disability; lastly parental factors involving depression, anxiety, coping strategies and social support all significantly influence the variance in functional outcomes (Tyack and Ziviani, 2003).

Many of the above mentioned factors were observed within our study but further analysis and a larger study design would need to be investigated to contribute to this area of burns research.

5.5. FUN AND ENJOYMENT

In this study it was found that the children who took part in the Xbox intervention group had much higher and significant fun and enjoyment values when using a modified Wong-Baker® FACES enjoyment rating scale (p= 0.0000) compared to fun and enjoyment values of the control group. The original Wong-Baker® FACES pain scale has only been validated for assessment involving pain measures and not involving fun and enjoyment (Quinn, Sheldon and Cooley, 2014). The use modified Wong-Baker® FACES enjoyment rating scale has not been validated thus these findings are just observational. Not having a validated and reliable enjoyment scale is a limitation to this study.

5.6. HEALTH PROFESSIONALS QUESTIONNAIRE

Following the questionnaire given to the health professionals working within the PBU, they were asked to answer five questions related to the use of the Xbox Kinect™. The team was represented by physiotherapists, occupational therapists, doctors and nurses working within PBU.

Thirty one questionnaires were completed, of which 11 physiotherapists, eight occupational therapists, seven nurses and five doctors completed the questionnaire.

Comments extracted from the questionnaires demonstrated the value of fun, enjoyment and distraction the children experienced- “the children thoroughly enjoyed the sessions and showed great interest”, “they had alot of fun and were happy to be playing” and “the Xbox allowed for an 'escape' from an otherwise very clinic-based setting/ form of therapy”.

The effect the Xbox Kinect™ had on ROM was also mentioned- “children were eager to move limbs which they previously were apprehensive to move”, “the children engaged actively and achieved greater ROM” and “more movement achieved when focus is away from their painful limbs and more on play”.

The need for supervision was also highlighted in one of the responses “may still need some therapist to push the child slightly and supervise the activity”. Negative comments observed from the Xbox Kinect™ involved technical issues and problems related to sensitivity and connectivity “it loses connection during a game session which is very frustrating for everyone”.

As described in Tatla et al., (2015) therapists felt video games were used as an alternative way of motivating patients during therapy. They also highlighted the benefits of peer involvement and engagement during video games, which was also seen and commented on in this study where “More active ROM was achieved & the social aspect was a great distraction”.

5.7. LIMITATIONS

A single blinded randomised control trial would have been the most appropriate design for this study however due to the way the unit is run this was not an option ethically. Additionally due to the logistical constraints it was impossible for the researcher to be blinded to the group the children were in. It is possible that this introduced an element of bias to the study. The use of a blind assessor or research assistant not associated with CHBAH may have been more useful and valuable as part of this study; to assist with baseline measurements and language translations.

As the groups did not run concurrently it is possible that small differences in seasonal variation of burn presentation could have occurred. This could possibly explain the difference seen between the groups whereby more upper limb injuries occurred in the control group and more lower limb injuries seen in the Xbox Kinect™ intervention group.

This study was a preliminary exploratory study where all children were included for analysis, however this did make interpretation of the results difficult as the clinical presentation varied widely and so results cannot be generalised. Data analysis between the two groups could possibly have been more specific towards lower limb injury comparison to see the effect of the Xbox Kinect™ on outcomes. In view of the poorer outcomes seen in previous studies involving the upper limb and video game rehabilitation, these injuries could have been removed from the data analysis. In this particular study the numbers would have been too small and too few to see an effect.

Future studies should apply more rigorous inclusion criteria so that the sample is more homogenous in terms of clinical presentation. As previously mentioned poorer functional outcomes are associated with higher severity burn injury thus these injuries could be included as an exclusion criterion. The same applies for minor burn injuries based on the study by Voon et al., (2016) and be included as an exclusion criterion.

Hence a study and data analysis focusing on the outcomes of the majority burns of moderate severity or superficial partial with this type of intervention would be needed and beneficial.

A baseline assessment could have been included in this study to assist with analysis of 'in-hospital' treatment and change in ROM during admission; coupled with discharge information and assessment comparison. In this study we were unable to address the effect and relationship the number of physiotherapy sessions and LoS could have had in addressing the effect of treatment.

In most cases with the ASK©p questionnaire completion, assistance with language, translations and understanding what the questions meant was needed. The physiotherapy assistant or a research assistant could have been used or allocated for this role.

Using the modified Wong-Baker® FACES enjoyment scale in this study which isn't a validated measure designed for enjoyment, so using a validated measure which addressed enjoyment should've been used. In this study the principal investigator was not blinded to which groups the children were in.

Despite recommendations that a minimum twice weekly Xbox Kinect™ sessions would suffice, this number of sessions was too few to have a greater impact. Twenty-five percent of the children in the Xbox Kinect™ only received the minimum 2 sessions prior to being discharged from the unit. The probable reason for this was that these children were of a less severe burn injury and didn't require an extended stay allowing for them to experience more Xbox Kinect™ sessions.

In this study, we were unable to identify what factors pain and anxiety may have been involved as it was not a measure addressed and used. We were also unable to identify what role parental and family support, as well as beliefs and attitudes, may have been involved or may influence the rehabilitation process of these children.

5.8. RECOMMENDATIONS

A study involving longer time spent on follow up would greatly benefit the field of burns involving children focusing on reintegration to schooling, ADLs, activity and participation. This study focused on children aged 5 and upwards, thus a study for a younger age group with an appropriate outcome measure could be done.

Further studies involving more specific games to target the specific injured and burnt areas should be investigated. Investigations involving the influence of factors such as pain, anxiety as well as the role of parental and social support with a larger study design are needed to contribute to this area of burns research.

Future studies should apply more rigorous inclusion criteria so that the sample is more homogenous in terms of clinical presentation, especially toward moderate severity or superficial partial burn injuries. These studies should include a baseline assessment to assist in analysis of 'in-hospital' treatment and the effect of the intervention chosen.

Chapter 6: **CONCLUSION**

The aim of this study was to investigate the effect of using the Xbox Kinect™ on discharge outcomes and early activity levels in the PBU at CHBAH. The discharge outcomes were related to ROM, activity and participation measured with the ASK©p and enjoyment using a modified Wong-Baker FACES® enjoyment rating scale. Demographic data from this study population was also captured and recorded. All health professionals working in the burns unit who assisted with or observed the Xbox Kinect™ intervention were asked to fill out a short questionnaire. This was to capture the views and opinions of the health professionals regarding the use of the Xbox Kinect™ as part of the rehabilitation.

The majority of our study population was male comprising of 55%, which is in line with previous burns studies done by Jugmohan et al., (2016) and Albertyn, Bickler and Rode (2006). The majority burns were as a result of hot water attributing to more than 50% of admissions, followed by flame burns (30%) and electrical burns (12%) This study population showed an overall low severity minor burn injury, with nine percent TBSA % and superficial partial in depth. We observed a greater proportion of injury involving the lower limbs (23.1%) and upper limbs (21.1%), followed by injury involving the trunk (11.4%), buttocks and genitalia (7.5%) and the head and neck regions (6.8%).

The Xbox Kinect™ was shown to be significant in achieving higher AROM at discharge and at follow up and highlights the advantages it has in providing a more amusing and comfortable option as part of the burns rehabilitation process as described by Mobini, Behzadipour and Foumani (2014).

By allowing the children to be more engaged in the Xbox Kinect™ experience and games, they were distracted and thus may have experienced less pain as previously described by Parker et al., (2015). We found that improvements in the average percentage of AROM for all movements involving the elbow, trunk, hip and knee were associated with the Xbox Kinect™ intervention. This highlights the potential benefit to using the Xbox Kinect™ for burn injuries to the trunk and lower limbs.

However when burn injuries involved the shoulder, the Xbox Kinect™ showed marginal improvements within shoulder flexion and abduction movements at

discharge and follow up compared to the standard treatment group; but the standard treatment group at follow up had a much higher AROM of shoulder flexion which could be contributed to the supervised home exercise programmes. Thus the use of the Xbox Kinect™ identified here confirms the need to be a supervised activity rather than a replacement for conventional methods (Bonnechère et al., 2014)

In this study we found that TBSA% was a predictor of ASK©p scores, thus the higher the burn percentage the lower the ASK©p scores. We also found that age and AROM were predictors of ASK©p scores, thus the younger the child or a child with reduced AROM would have lower ASK©p scores. The ASK©p was used as an assessment measure of performance once the child was discharged and back in their familial home environment and used to identifying the activity domains the children performed worse in. Overall it was found that 'personal care' and 'play' were statistically significant between the two groups. Further analysis of the specific domains showed that more activities involving 'locomotion', 'standing skills' and 'transfers' were achieved and done by the children who took part in the Xbox Kinect™ sessions. These tasks involve the trunk and lower limbs, the higher scores seen in the Xbox intervention group coupled with the higher AROM found involving these joints in this group thus highlights the beneficial use of the Xbox Kinect™ as part of burns rehabilitation.

Fun and enjoyment was found to be significantly better for the intervention group in this study, thus highlighting the fun and enjoyment factor the Xbox Kinect™ offers as part of therapy and as an adjunct to burns rehabilitation.

Thirty one questionnaires regarding the value and use of the Xbox Kinect™ were completed, of which 11 physiotherapists, eight occupational therapists, seven nurses and five doctors completed the questionnaire whom all work within the PBU. Many highlighted the value of fun, enjoyment and distraction the Xbox Kinect™ offered as part of the rehabilitation, as well as assisting in achieving more AROM but also indicated that the Xbox Kinect™ sessions still needed to be supervised and guided.

This study was the first study done in South Africa involving video game technology during physiotherapy within the paediatric burns population. The use of the Xbox Kinect™ as seen in this study has proven to be beneficial and a useful adjunct to burns rehabilitation within in the paediatric burns population.

The use of the Xbox Kinect™ in this setting was shown to be fun, enjoyable and highly motivating to helping these children with burns improve function and be distracted from pain. This distraction assists in reducing the fear associated with movement these children with burns experience and assists in improvements related to activity and ultimately age-appropriate play and ADLs.

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Appendix 1

information Sheet

Dear Parent or Legal Guardian,

Good morning and thank you for taking the time to read this letter.

Your child has been invited to take part in a study at Chris Hani Baragwanath Hospital Paediatric Burns Unit which is being conducted by Eleonora Lozano,

I would like to find out what effect video game technology and physiotherapy has on burn injuries and rehabilitation. The results that I get from this study will help to develop a better service for future parents and children in the management of children with burn injuries, as well as benefit other physiotherapists in the management of children with burn injuries. The video game technology I will be using is an Xbox Kinect™ which uses an infrared camera to pick up movements while playing, no special controller or hand-held device is needed.

This study is split up into two groups which will take place over a period of time. In the first group, the first 30 children who participate in the study will get the usual physiotherapy treatment during their hospital stay in the burns unit. In the second group, which are the next 30 children who participate in the study, will get the usual physiotherapy treatment and they will be able to play with an Xbox Kinect™ during their hospital stay in the burns unit.

I will also be asking your child a few questions after he/she has left the hospital about tasks and things they can or can't do at home after being burnt. The name of the questionnaire I will use is the Activity Scales for Kids© and I will look at the performance component. None of the above video games and questionnaire will cause harm to you or your child. It will take about 30 minutes to fill in the questionnaire if your child is able to complete this form by themselves, and if you are able to help them complete this questionnaire it will take 10 minutes to complete. I will ask you and your child the questions before your child is washed and dressed so your child should not be in any pain. If you agree to help me, I will ask you to sign a consent form before any questions and rehabilitation will be asked and started. If your child is over the age of 6 years, we will also ask them to sign an assent form where they will write their name. I will explain what I will be doing and why to your child verbally in a language he/she understands.

If you have any questions or worries about this study, please don't hesitate to ask me. Whether or not your child takes part in this study, he/she will still receive physiotherapy during their hospital stay and follow up visits. You may choose to withdraw from the study at any time and your child will still receive physiotherapy.

I, Eleonora Lozano, am employed at Chris Hani Baragwanath Hospital and work in the paediatric burns unit daily. Your name and your child's name will not be used on the data collection form, thus your child's patient confidentiality will be respected.

Participation in this study is voluntary and you may withdraw your child from the study at any time.

Thank you for your time. Please feel free to contact me if you have any questions at all, here are my contact details 0829033813 or 0119338309

Wits HREC (Medical) contacts: Chairperson Professor Peter Cleaton-Jones 011 717 2301 peter.cleaton-jones1@wits.ac.za or the secretary Ms Zanele Ndlovu 011 717 1252/1234/2700 zanele.ndlovu@wits.ac.za

Appendix 2

Parent or Legal Guardian Consent Form

I_____ understand the purpose of this project and give consent for my child _____ to participate in the research. I have read and understand the information provided to me and my questions have been answered. I am fully aware of the procedures and the fact that they will not harm my child in any way. I am aware that I may withdraw my child from the research without any prejudice towards my child or myself.

_____	_____
Parent or Legal Guardian	Researcher
_____	_____
Date	Date

Appendix 3

Information sheet for child

Dear Child,

Hello, sawubona, dumela. You have been chosen to take part in a project which Eleonora, a physiotherapist working at Chris Hani Baragwanath Hospital in the Children's Burns Unit is doing. I have chosen you, as you are between the ages of five and twelve years, and have been recently burnt.

Why am I doing this? I want to find out if using an Xbox Kinect™ can help you play and engage with me to help prevent you from getting stiff joints. An Xbox Kinect™ uses a special infrared camera to pick up your movements while playing, no special controller or hand-held device is needed for this. I also want to find out once you've gone home what you are and aren't able to do since being burnt. I will also ask you if you enjoyed the physiotherapy you received during your hospital stay. All the information I get from you and the other children in this study will help me and other physiotherapists to see if we can help you any more than we do now.

What am I going to do? During your stay you may or may not be able to use the Xbox Kinect™ as part of your physiotherapy treatment depending on when you are admitted to the PBU. When you are discharged from hospital and come back for your first follow up with the doctors I will ask you a few questions; if you don't understand your parents will help you answer these questions on a piece of paper. The name of the questionnaire is the Activity Scales for Kids© and I will look at the performance component. None of the physiotherapy treatment you receive and the questionnaire will not cause you any harm. I will ask you these questions before you get bathed so you will not be in any pain and it will take 30 minutes to answer these questions by yourself, but it can take 10 minutes to complete if your parents help you with the questions.

If you don't want to take part in this project you must tell the physiotherapist and she will get you to write your name on a piece of paper and then we won't ask you any questions. Your mom or dad will also have to sign a piece of paper saying that they don't want you to be included in the project.

Just to make sure that the information stays a secret, I won't put your name on the piece of paper with all the results. If you do not want to take part in this project and study it does not matter and you will still get all your physiotherapy treatment.

Thank you and have a good day

Please feel free to contact me if you have any questions at all, here are my contact details 0829033813 or 0119338309

Wits HREC (Medical) contacts: Chairperson Professor Peter Cleaton-Jones 011 717 2301 peter.cleaton-jones1@wits.ac.za or the secretary Ms Zanele Ndlovu 011 717 1252/1234/2700 zanele.ndlovu@wits.ac.za

Appendix 4

Child Assent Form

I _____say that it is okay for the physiotherapist to test me in this project. I understand what this project is about and understand what I am expected to do as part of it. I understand what has been explained to me about answering some questions. My questions have been answered. I know that taking part in this project will not harm me in any way. I am aware that I may say that I do not want to be tested in the project at any time.

_____	_____
Patient	Researcher
_____	_____
Date	Date

Appendix 5

DATA COLLECTION SHEET – PAEDIATRIC BURNS

Age:

Child no:

Cause (& detail) of burn injury:

_____
_____

_____

_____

_____

_____

_____

% burn: (body chart next page)

Depth of burn:

Date of admission:

Date of discharge:

Any sibling's admitted as well:

Attending crèche/school:

Surgical history:

- Sloughectomy dates and area's:_____
  _____
- SSG dates, area's of graft and donor site: _____
  _____
- Other surgical procedures (eg: Escharotomy):_____
  _____

Consent signed:

o Consent

o Assent

Information sheet received:

o Parent or Legal Guardian

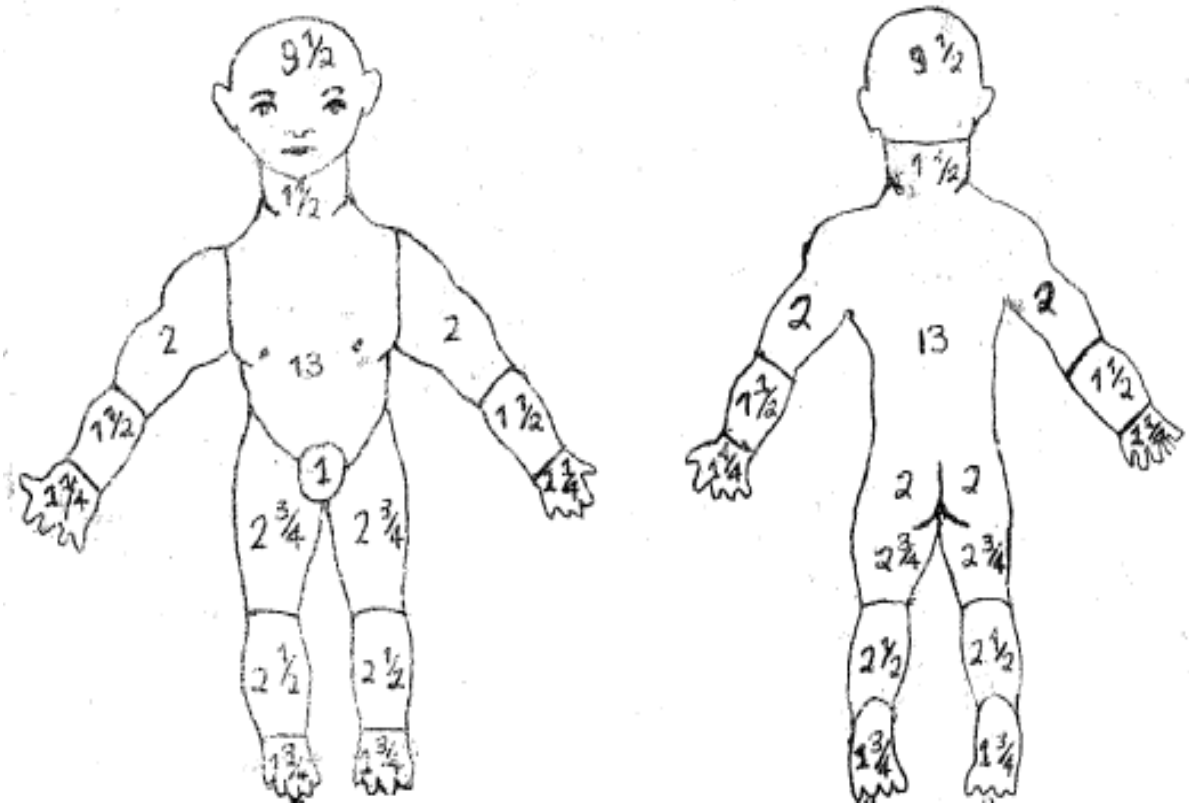
o Child

Standard Physiotherapy intervention/ Standard Physiotherapy intervention + Xbox Kinect™

Administered Questionnaire:

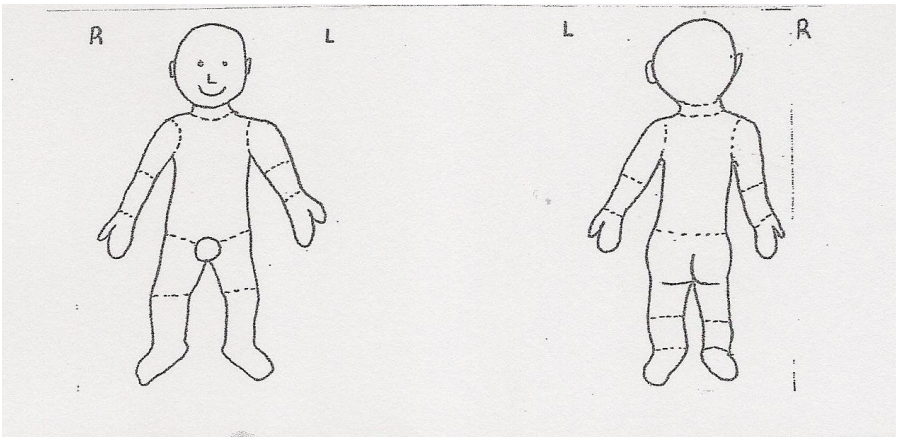
- Activity Scales for Kids© participation (ASKp©)

- 1st visit follow up date:



Appendix 6 **Paeds Burns AMD Discharge Summary**

Name:				**Age:**	**GT:**
Date of burn:				**Discharge PBU:**	
HWB	**Flame**		**Other**	**ICU:**	**LoS:**
TBSA:	**Sup**	**Partial thick**	**Full thick**	**PG's:**	
Operations:				**Splinting:**	



Developmental Milestones				
Sat	**Crawled**	**Stood**	**Walked**	**First words**
Pre-morbid functioning				
Sat	**Crawled**	**Stood**	**Walked**	
Educational History				
Creche/ Day-care		**Primary School**		

Face	**Mouth**	**Eyes**	**Trunk flexion**	**AROM**	**PROM**
Neck	**AROM**	**PROM**	**Trunk rotation**	**AROM**	**PROM**
L shoulder	**AROM**	**PROM**	**L hip**	**AROM**	**PROM**
L elbow	**AROM**	**PROM**	**L knee**	**AROM**	**PROM**
L wrist	**AROM**	**PROM**	**L ankle**	**AROM**	**PROM**
L hand	**AROM**	**PROM**	**R hip**	**AROM**	**PROM**
R shoulder	**AROM**	**PROM**	**R knee**	**AROM**	**PROM**
R elbow	**AROM**	**PROM**	**R ankle**	**AROM**	**PROM**
R wrist	**AROM**	**PROM**			
R hand	**AROM**	**PROM**	**Sitting**	**Rolling**	**Standing**
WB 4 pt prone	**Decreased**	**Full**	**WB/Standing**	**Decreased**	**Full**
Bilateral hand use	**Avoidance**		**Gait:**		

Comments: _____

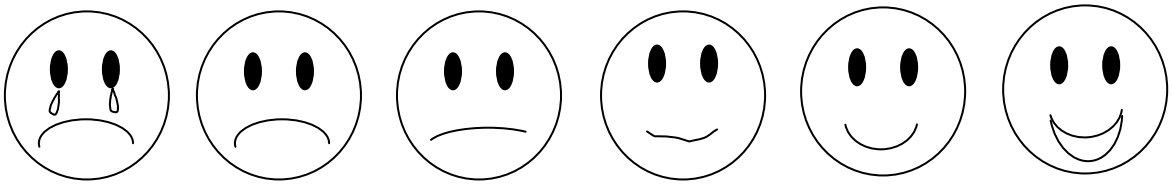
Therapist's Concern: _____ Therapist: _____

Appendix 7

Modified enjoyment scale

How much fun did you have during your physiotherapy sessions?

No fun at all	Little bit of fun	Some fun	Moderately fun	Lots of fun	Extremely fun
0	1	2	3	4	5



Appendix 8

Activities Scale for Kids©

PERFORMANCE VERSION

30 ITEMS

(ASKp©)

INSTRUCTIONS

This is a new booklet that asks you how often you did activities on your own last week. For each question **think about what you really did last week.** Try to remember the things you did at home, at school, and when you were with your friends. Record your answer by putting an X in the most correct box.

It is important that you answer all of the questions.

What do the answers mean?

Answers	Meaning
❑ **all of the time**	I did it every time I needed to
❑ **most of the time**	I did it almost all of the time I needed to, but once in a while I didn't do it
❑ **sometimes**	I did it about half of the time I needed to, but about half of the time I didn't do it
❑ **once in a while**	I did it at least once last week when I needed to, but most of the time didn't do it
❑ **none of the time**	I didn't do it at all when I needed to

Example:

Terry's hands were very sore 3 days last week, so his mom helped him get dressed. He dressed himself without help the other 4 days.

One of Terry's answers looked like this:

I **fastened my clothes** by myself . . .
(fastened means doing up buttons & zippers)

❑ all of the time
❑ most of the time
☒ sometimes
❑ once in a while
❑ none of the time
or ❑ *I did not need to because none of my clothes have fasteners*

Last Week . . .

1 I **put toothpaste on my toothbrush then brushed my teeth** by myself . . .
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

2 I **used the toilet** at home by myself . . .
(includes getting on and off the toilet)
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

3 I **washed my whole body** by myself . . .
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

4 I **put my shirt on** by myself . . .
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

Last Week . . .

5 I **put my pants on** by myself . . .
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

6 I **fastened my clothes** by myself . . .
(fastened means doing up buttons and zippers)
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

or ❑ *I did not need to, none of my clothes have fasteners*

7 I **put my shoes on and did them up** by myself . . .
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

or ❑ *I did not need to wear shoes*

8 I **did my printing** (or script writing) by myself . . .
(Example: to do my school work)
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

Last Week . . .

9 I **took care of my medical needs** . . .
(Examples: put on splints or took medication)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

or ❑ *I did not have special medical needs*

10 I **walked without any support** . . .
(Examples: no crutches or canes)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

To get around INSIDE I usually used . . .

- ❑ no special support
- ❑ an artificial leg (or legs)
- ❑ one cane
- ❑ two canes
- ❑ crutches
- ❑ my hands and knees
- ❑ a walker
- ❑ a wheelchair
- ❑ a scooter
- ❑ brace, splint or orthosis
- ❑ other, please describe: _____

(Please choose as many of these as you use)

Answer the questions on <u>the next few pages</u> by telling how you did with the support you marked on this list.

<u>Example</u>: If you said "I usually used one cane", then answer the next questions by telling us how you did with one cane last week.

Last Week . . .

11 I **made a snack** (or prepared breakfast or lunch) by myself . . .

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

or ❑ *I was not allowed to make a snack or my own meals*

12 I **did my usual job or chores** . . .
(Examples: doing the dishes, cleaning my room, babysitting)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

or ❑ *I did not have a job or chores*

13 I **got around inside** my home without anyone to help me . . .
(Examples: walked or wheeled to the bathroom or to the kitchen)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

Last Week . . .

14 I **walked** (or wheeled) **in crowded areas** . . .
(Examples: school hallways between classes or at a shopping mall)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

or ❑ *I tried to stay away from crowds*

15 I **walked up and down a flight of stairs** even when other people were using them . . . *(a flight is about 14 stairs)*

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

or ❑ *I did not need to, because I did not come across a flight of stairs*

WOW!

YOU ARE DOING VERY WELL.

TAKE A SHORT REST IF YOU LIKE,

BUT PLEASE TRY TO FINISH THIS TODAY.

Last Week . . .

16 I **stood still for 10 minutes** without resting . . .
(Examples: waiting in line or talking with friends in the school hallway)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

17 I **carried things in 2 hands** by myself . . .
(Examples: big or heavy things like stuffed animals, family pet)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

or ❑ *I had no reason to carry anything in 2 hands*

18 I **stretched to reach** a high shelf (or to see over the person in front of me) . . .

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

or ❑ *I did not need to stretch for anything*

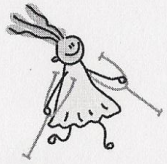
Last Week . . .

19 I **carried a drink or food** to the table by myself without spilling . . .
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time
- *or* ❑ *I am not allowed to do this*

20 I **got in and out of a chair** (or wheelchair) by myself . . .
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

21 I **sat on the floor** . . . *(Examples: at a school assembly or watching TV)*
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time
- *or* ❑ *I did not have any reason to sit on the floor*

22 I got **in and out of my bed** by myself . . .
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time



Last Week . . .

23 I **got down onto the floor from standing**, and got back up again by myself . . .
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time
- *or* ❑ *I did not need to get onto the floor*

24 I **got through heavy doors** by myself . . .
(Examples: the front door at home or at school)
- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time

To get around OUTSIDE I usually used . . .

❑ no special support	❑ a walker
❑ an artificial leg (or legs)	❑ a wheelchair
❑ one cane	❑ a scooter
❑ two canes	❑ brace, splint or orthosis
❑ crutches	❑ other, please describe:
❑ my hands and knees	_____

(Please choose as many of these as you use)

Answer the questions <u>on the next few pages</u> by telling how you did with the support you just marked on the list.

<u>Example</u>: If you said "I usually used crutches", then answer the questions that follow by telling us how you did with crutches last week.

Last Week . . .

25 I **got around outside without anyone to help me** . . .
(Examples: walked or wheeled to a friend's house, to school, or to the park)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time
- *or* ❑ *I never had the chance to go outside*

26 I **played some sports** by myself or with a few friends . . .
(Examples: dribbling and shooting a basketball)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time
- *or* ❑ *I did not have the chance to play sports by myself or with a few friends*

27 I **walked** (or wheeled) **on rough or slippery surfaces** by myself . . .
(Examples: gravel driveways or wet sidewalks)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time *(I stayed away from rough and slippery surfaces or was helped)*
- *or* ❑ *I did not come across a rough or slippery surfaces*

Last Week . . .

28 I **walked** (or wheeled) **up a gentle hill** or slope by myself . . .

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time
- *or* ❑ *I always tried to stay away from hills*

29 When I ran (or wheeled) around outside, I **kept up** with my friends . . .

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time
- *or* ❑ *I did not have a chance to be outside with friends*

30 I **got in and out of an automobile** by myself . . .
(opened the door, got in, closed the door, and got out again)

- ❑ all of the time
- ❑ most of the time
- ❑ sometimes
- ❑ once in a while
- ❑ none of the time
- *or* ❑ *I did not need to go anywhere by automobile*

How much help did you have with these questions?

- ◇ I have done the questions all by myself.
- ◇ Someone has read the questions to me.
- ◇ Someone has helped me with some of the answers.
- ◇ Someone has helped me with most of the answers.
- ◇ Other, please describe:

YOU ARE ALL DONE! THANK YOU!

Please feel free to write any comments or suggestions you or your family would like to share with us in the space below

ASK30p© - Performance SCORE SHEET

	Item #	Item Description	all of the time 4	most of the time 3	sometimes 2	once in a while 1	none of the time 0
PERSONAL CARE	1	prepared for and brushed teeth	❑	❑	❑	❑	❑
	2	used the toilet	❑	❑	❑	❑	❑
	3	washed whole body	❑	❑	❑	❑	❑
DRESSING	4	put shirt on	❑	❑	❑	❑	❑
	5	put pants on	❑	❑	❑	❑	❑
	6	fastened clothes	❑	❑	❑	❑	❑
	7	put shoes on and did them up	❑	❑	❑	❑	❑
OTHER SKILLS	8	wrote or printed	❑	❑	❑	❑	❑
	9	took care of medical needs	❑	❑	❑	❑	❑
	11	made a snack	❑	❑	❑	❑	❑
	12	did usual job or chores	❑	❑	❑	❑	❑
LOCOMOTION	10	walked without any support	❑	❑	❑	❑	❑
	13	got around inside home	❑	❑	❑	❑	❑
	14	walked (or wheeled) in crowded areas	❑	❑	❑	❑	❑
	15	walked up and down a flight of stairs	❑	❑	❑	❑	❑
	25	got around outside without help	❑	❑	❑	❑	❑
	27	walked (or wheeled) on rough surfaces	❑	❑	❑	❑	❑
	28	walked (or wheeled) up a gentle hill	❑	❑	❑	❑	❑
PLAY	26	played some sports alone or with a few friends	❑	❑	❑	❑	❑
	29	kept up with friends outside	❑	❑	❑	❑	❑
STANDING SKILLS	16	stood still for 10 minutes	❑	❑	❑	❑	❑
	17	carried things in 2 hands	❑	❑	❑	❑	❑
	18	stretched to reach a high shelf	❑	❑	❑	❑	❑
	19	carried a drink or food to the table	❑	❑	❑	❑	❑
	24	got through heavy doors	❑	❑	❑	❑	❑
TRANSFERS	20	got in and out of a chair	❑	❑	❑	❑	❑
	21	sat on the floor	❑	❑	❑	❑	❑
	22	got in and out of bed	❑	❑	❑	❑	❑
	23	got down onto floor and back up again	❑	❑	❑	❑	❑
	30	got in and out of an automobile	❑	❑	❑	❑	❑

ASK©p Summary Score = average of all ASK©p questions answered x 25
Note: summary scores should only be calculated when at least 23 questions (75%) have been completed.

Appendix 9

PBU Follow up 1st assessment

Date:

ROM reassessment:

Face	**Mouth**	**Eyes**	**Trunk flexion**	**AROM**	**PROM**
Neck	**AROM**	**PROM**	**Trunk rotation**	**AROM**	**PROM**
L shoulder	**AROM**	**PROM**	**L hip**	**AROM**	**PROM**
L elbow	**AROM**	**PROM**	**L knee**	**AROM**	**PROM**
L wrist	**AROM**	**PROM**	**L ankle**	**AROM**	**PROM**
L hand	**AROM**	**PROM**	**R hip**	**AROM**	**PROM**
R shoulder	**AROM**	**PROM**	**R knee**	**AROM**	**PROM**
R elbow	**AROM**	**PROM**	**R ankle**	**AROM**	**PROM**
R wrist	**AROM**	**PROM**			
R hand	**AROM**	**PROM**	**Sitting**	**Rolling**	**Standing**
WB 4 pt prone	**Decreased**	**Full**	**WB/Standing**	**Decreased**	**Full**
Bilateral hand use	**Avoidance**		**Gait:**		

Problems:

Plan:

Appendix 10

Health professional questionnaire

Dear Colleague,

Good day and thank you for taking the time to read this questionnaire. You have been invited to take part in a study which is taking part at Chris Hani Baragwanath's Paediatric Burns Unit being conducted by Eleonora Lozano.

In my study I would like to find out what effect video game technology and physiotherapy has on burn injuries and rehabilitation. The results that I get from this study will help to develop a better service for future parents and children in the management of children with burn injuries, as well as benefit other physiotherapists in the management of children with burn injuries.

By doing this questionnaire I also would like to gain your view and perception of the use of the Xbox Kinect™ in the Paediatric Burns Unit at CHBAH.

Thank you for your time. *Please feel free to contact me if you have any questions at all, my contact details are 0829033813 or 0119338309*

Please fill in the following and mark 'X' for your answer, and please comment if needed.

Occupation:_____

Age:_____ Sex: _____

1. Did you participate in any of the Xbox Kinect™ therapy sessions?

    - ☐ YES
    - ☐ NO
    - ☐ Comment:_____

2. Did you observe any of the Xbox Kinect™ therapy sessions?

    - YES
    - NO
    - Comment:_____

3. Do you feel the children enjoyed the Xbox Kinect™ therapy sessions?

    - YES
    - NO
    - Comment:_____

4. Do you feel the children benefitted using the Xbox Kinect™ during therapy sessions?

    - YES
    - NO
    - Comment:_____

5. Did you observe any negative experiences with the Xbox Kinect™?

    - YES
    - NO
    - Comment:_____

6. Do you think the Xbox Kinect™ helped distract the children into playing with their burnt injured limbs?

    - YES
    - NO
    - Comment:_____

Thank you again for your time and input.

Appendix 11

R14/49 Miss Eleonora Lozano

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M150727

NAME: (Principal Investigator)	Miss Eleonora Lozano
DEPARTMENT:	Physiotherapy Chris Hani Baragwanath Academic Hospital, Paediatrics Burns Unit
PROJECT TITLE:	The Use of Xbox Kinect in the Paediatric Burns Unit at Chris Hani Baragwanath Academic Hospital
DATE CONSIDERED:	31/07/2015
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Prof Joanne Potterton
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	09/09/2015

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

Appendix 12

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
PA TO THE CEO
Enquiries: Ms. Thabile Ndlovu
Tel : (011) 933- 9145
Fax: (011) 938-1005
Email: Thabile.Ndlovu2@gauteng.gov.za

To : **Ms Eleonora Lozano**
M150727

From : **Dr. Sandile Mfenyana**
CEO: CHBA hospital

Date : **23 September 2015**

Re : **Application for Permission to conduct a study in the Use of Xbox Kinect in the Paediatric Burns Unit at CHBAH**

Your application for permission to conduct study in the Use of Xbox Kinect in the Paediatric Burns Unit at Chris Hani Baragwanath Academic Hospital has been approved by the CEO: Dr. Sandile Mfenyana.

Hoping that the Institution (CHBAH) will meet the requirements of the study concerned.

Wishing you well in your future endeavors

Regards,

Dr. SCB Mfenyana
CEO : CHBAH

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 3 July 2015

TITLE OF PROJECT: The use of Xbox Kinect™ in the paediatric Burns Unit at Chris Hani Baragwanath Academic Hospital

UNIVERSITY: Witwatersrand

Principal Investigator: E Lozano

Department: Physiotherapy

Supervisor (If relevant): L Godlwana

Permission Head Department (where research conducted): Yes

Date of start of proposed study: July 2015
Date of completion of data collection: Dec 2017

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

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

.....
Recommended
(On behalf of the MAC)
Date: 03 July 2015

.....
Approved/Not Approved
Hospital Management
Date: 06/07/15

Appendix 13

Summary of Reliability for ASK©

Criterion	Adequate	Determined by…
Preliminary validity	✓	Significant differences between children with mild, moderate and severe disabilities ANOVA p<0.0001 (n=28)
Test-retest reliability	✓	Summary scores at time one were concordant with those at time two for ASK©p and ASK©c. ICC=0.97 (n=18)
Inter-rater reliability	✓	Children's summary scores were consistent with parents' summary scores ICC=0.96 (n=28)
Internal consistency	✓	Correlation between items Cronbach's alpha = 0.99 (n=28)

Summary of Validity for ASK©

Type of Validity	Adequate	Determined by…
Content validity	✓	Parent's importance ratings (n=20), children's importance ratings (n=20), and expert panel consensus (n=7 & n=4) Consensus obtained on item content
Convergent validity	✓	Relationship between the ASK© and related measures of health and disability Pearson's correlation with the CHAQ *performance* r=0.81; *capability* r=0.82 (n=194) Spearman's correlation with HUI^3 ambulation rho=0.73; dexterity rho=0.13 (n=195)
Divergent validity	✓	Relationship between the ASK© and unrelated health measures Spearman's correlation with HUI^3 emotion rho=0.02; speech rho=0.09 (n=195)
Discriminant validity	✓	Comparison of ASK©p and ASK©c scores across groups with different global ratings of disability (global ratings made by the referring clinician) p<0.0001 (n=173)
Criterion validity	✓	Comparison of child-reported ASK©c scores (30 item version) to clinician-ratings of ASK©c (30 item version) based on observation (n=24)
Responsiveness	✓	Calculated standardized response means (SRMs) for the ASK©p and ASK©c. Computed the SRM on the ASK©p and ASK©c to CHAQ to determine ability to detect small changes (n=34)

Appendix 14

Turnitin report

Xbox Kinect Research Report

ORIGINALITY REPORT

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SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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