
# Provision of Physiotherapy services for children in Intensive Care Units in Uganda: A descriptive study

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## Declaration

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## Abstract

**Background:** Child morbidity and mortality are still high in Uganda but the provision of critical care services is sub-optimal, characterized by limited accessibility and minimum standardization of services provided in the intensive care units (ICU). The nature and extent of the provision of physiotherapy services for children in ICUs in Uganda is not known, as no published studies have described this before.

**Aims:** This study aimed to describe the provision of physiotherapy services for children in ICUs in Uganda, to lay a foundation for future practice improvements.

**Methodology:** Routinely collected data documented in the medical files and specific data relating to physiotherapy service provision within the preceding 24 hours were extracted for all infants and children admitted to three participating Ugandan ICUs- the national referral hospital, a public tertiary level health facility, and a private hospital, on two study days per week, from January to June 2023. Demographic and clinical admission data were collected as well as specific details regarding referral to physiotherapy, frequency of treatment, and modalities used. One on-site physiotherapist was trained in research methodology and collected data for the specific study site. The data were analyzed using IBM SPSS Statistics version 28.0.1.1 (14). The data were tested for normality using the Shapiro Wilks W test. Continuous data are presented in the results as median (interquartile range), as appropriate for non-parametric data. Categorical data are presented as frequencies and percentages of total.

**Results:** 326 patients were enrolled in this study, 161(49.1%) of which were male. 190 (58.2%) patients received any form of physiotherapy throughout the study period, and 164 (50.3%) patients received treatment in the preceding 24 hours before data collection on the study day. 68.1% of children had a good health status before the ICU admission, and 65.6% of the children were invasively mechanically ventilated on the study day. In 80.5% of patients, physiotherapy referrals were made by the attending doctor. On multivariable analysis, neither the study site nor any specific admission diagnostic category was independently associated with being referred for physiotherapy. Chest physiotherapy (CPT), using passive manual techniques of percussions (89.6%) and vibrations (88.8%), was the most common form of physiotherapy. Passive limb exercises in bed were the most common type of mobilization exercises given (63.4%), more commonly in younger children ≤6 years of age ($p = 0.002$). Active out-of-bed mobilization activities were provided in <20% of cases and were more common among older children >6 years of age ($p < 0.05$). Out of bed mobilization activities were associated with low

or no respiratory support requirements ($p < 0.001$). The majority of children (71.3%) were treated once over the 24 hours preceding the study day. On multivariable analysis, being admitted for the management of an infection (adjusted OR 10.4, 95% CI 1.7 – 63.1; $p = 0.01$) and increased duration of ICU stay (aOR 1.4; 95% CI 1.2 – 1.5; $p < 0.001$) were independently associated with increased odds of being treated by a physiotherapist in the 24 hours preceding the study day.

**Conclusion**: Physiotherapy was only provided to approximately half the children admitted to ICUs in Uganda, mostly following a referral from a doctor. Chest physiotherapy using passive manual techniques was the most common technique administered, followed by passive mobilization techniques. Active out-of-bed activities were performed in a minority of cases, more commonly in older children. These findings suggest that physiotherapy practice for children in ICUs in Uganda does not currently meet internationally recommended standards. Practice improvement initiatives are recommended, through research, training, and protocol development, to reach a minimum standard of acceptable physiotherapy care amongst this vulnerable population.

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To my loving family, my children, and my husband who have kept me grounded and supported me immensely throughout my studies, your sacrifices are not in vain, we shall partake of the enormous rewards that lie ahead, together.

## List of Abbreviations and Acronyms

| Abbreviation | Definition |
|---|---|
| ABCDEF | Intensive care unit liberation bundle: Assess, prevent, and manage pain, Both spontaneous awakening trials and spontaneous breathing trials, Choice of analgesia and sedation, Delirium, Early Mobility, and Family engagement |
| ACBT | Active Cycle of Breathing Technique |
| ACT | Airway Clearance Techniques |
| AKI | Acute Kidney Injury |
| ARDS | Acute Respiratory Distress Syndrome |
| ARF | Acute Respiratory Failure |
| AW | Acquired Weakness |
| ABG | Arterial Blood Gas |
| BMD | Bone Mass Density |
| BR | Bed Rest |
| CAPD | Cornell Assessment of Pediatric Delirium |
| CCCU | Cardiac Critical Care Unit |
| CI | Critically Ill |
| CICU | Cardiac Intensive Care Unit |
| CIM | Critical Illness Myopathy |
| CIN | Critical Illness Neuropathy |
| CINM | Critical Illness Neuromyopathy |
| CIP | Critical Illness Polyneuropathy |
| CME | Continuous Medical Education |

| | |
|---|---|
| CMV | Conventional Mechanical Ventilation |
| COPD | Chronic Obstructive Pulmonary Disorder |
| CPAP | Continous Positive Airways Pressure |
| CPT | Chest Physiotherapy |
| CVL | Central Venous Line |
| DA | Diaphragmatic Atrophy |
| DBE | Deep Breathing Exercises |
| EBP | Evidence Based Practice |
| ED | Emergency Department |
| EM | Early Mobilization |
| ERT | Extubation Readiness Testing |
| ETT | Endotracheal Tube |
| FET | Forced Expiratory Technique |
| $FEV_1$ | Forced Expiratory Volume in one second |
| FM | Face Mask |
| FVC | Forced Vital Capacity |
| GCS | Glasgow Coma Scale |
| GOR | Gastro-oesophageal Reflux |
| GM | Grey Matter |
| HDT | Head Down Tilt |
| HR | Heart Rate |
| HSSP | Health Sector Strategic Plan |
| ICD | Intercostal Drain |
| ICF | International Classification of Function |

| | |
|---|---|
| ICU | Intensive Care Unit |
| ICUAW | Intensive Care Unit Acquired Weakness |
| IME | Inspiratory Muscle Efficiency |
| IQ | Intelligence Quotient |
| IQR | Interquartile Range |
| LOS | Length of Stay |
| LV | Left Ventricle |
| MDT | Multidisciplinary Team |
| MH | Manual Hyperinflation |
| MHI | Manual Hyperinflation |
| MNRH | Mulago National Referral Hospital |
| MOF | Multiple Organ Failure |
| MoGLSD | Ministry of Gender Labour and Social Development |
| MRC | Medical Research Council |
| MV | Mechanical Ventilation |
| NAK | Nakasero Hospital |
| NDT | Neurodevelopmental Therapy |
| NIV | Non Invasive Mechanical Ventilation |
| NMB | Neuromuscular Blockade |
| OBM | Out of Bed Mobility |
| OT | Occupational Therapist |
| PARDS | Paediatric Acute Respiratory Distress Syndrome |
| PCCU | Paediatric Critical Care Unit |
| PD | Postural Drainage |

| | |
|---|---|
| PEP | Positive Expiratory Pressure |
| PICS | Post Intensive Care Syndrome |
| PICU | Paediatric Intensive Care Unit |
| PN | Polyneuropathy |
| PSV | Pressure Support Ventilation |
| PT | Physiotherapy |
| PTS | Post Traumatic Stress |
| PTSD | Post Traumatic Stress Disorder |
| PU | Pressure Ulcer |
| QOL | Quality Of Life |
| RBC | Red Blood Cell |
| RCT | Randomized Controlled Trial |
| ROM | Range Of Motion |
| RRT | Renal Replacement Therapy |
| RV | Right Ventricle |
| SAT | Spontaneous Awakening Trials |
| SBT | Spontaneous Breathing Trials |
| SCCM | Society of Critical Care Medicine |
| SIRS | Systemic Inflammatory Response Syndrome |
| SV | Stroke Volume |
| TF | Thickening Fraction |
| UBOS | Uganda Bureau Of Statistics |
| UG | Uganda |
| UHI | Uganda Heart Institute |

| | |
|---|---|
| UK | United Kingdom |
| UNFPA | United Nations Population Fund |
| UTI | Urinary Tract Infection |
| VIDD | Ventilator Induced Diaphragmatic Dysfunction |
| $VO_2max$ | Maximal oxygen consumption |
| VTE | Venous Thromboembolism |
| WHO | World Health Organization |

## Glossary of Terms

| | |
|---|---|
| Intensive Care Unit Acquired Weakness | Acute muscle weakness associated with critical illness |
| Critical Illness Polyneuropathy | One of the classifications of Intensive Unit Acquired Weakness primarily characterized by sensorimotor axonopathy and reduced compound muscle and sensory nerve action potentials, with normal nerve conduction |
| Early Mobilization | Early application (within 2-5 days of critical illness/PICU admission) and intensification or progression of physical activity in critically ill patients |
| Delirium | Alteration in neurotransmission, which results in an acute and fluctuating change in awareness and cognition |
| Post Intensive Care Syndrome | The physical, cognitive, and mental disorders that occur as a result of a long stay in the Intensive Care Unit |

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# CHAPTER ONE: INTRODUCTION

## 1.0 Introduction

This chapter will describe the premise of this study, including a description of the background or context in which the study was conducted, a statement of the problem, purpose of the study, as well as the aims and objectives of the study.

## 1.1: Background

Uganda is located in the east of Africa with a size of 241 559 $km^2$ and a current population of 48.4 million (M) people (United Nations Population Fund, 2022). There are still many gaps in the delivery of health services in the country. Uganda's health system comprises public, private not for profit, private for profit as well as traditional and complementary medicine practitioners. Almost 50% of health services in the country are delivered by the private sector and the Ugandan health system has adopted a strategy to work with private health providers to address gaps in public health facilities (Ministry of Health, 2010). The health worker to population ratio in the public sector is 1.92 per 1000 population, which is below the World Health Organization (WHO) recommendation of 2.28 per 1000 population target (Uganda Bureau of Statistics, 2021). The government budget allocation to the health sector as a percentage of the total budget for the financial year 2019/2020 was 7.2%, which is lower than the Abuja Declaration of 15% (Uganda Bureau of Statistics, 2021).

Child morbidity and mortality remain high in Uganda despite mitigation efforts. According to the most current Demographic and Health Survey (2016), infant mortality is 43 deaths per 1000 live births, and under five mortality is 64 deaths per 1000 live births (Uganda Bureau of Statistics & Inner City Fund, 2018). Malaria has been the leading cause of death among children under five years of age for the last several years, followed by anemia (Uganda Bureau of Statistics, 2021). In the 2019/2020 financial year, the top four causes of death among children under five also included pneumonia and neonatal conditions such as prematurity (Uganda Bureau of Statistics, 2021).

The first study to comprehensively describe the capacity and characteristics of intensive care units (ICU) in Uganda, reported that Uganda has 12 functional ICUs with a total bed capacity of 55 (Atumanya et al., 2020). The Uganda Bureau of Statistics (2020) projected the population of Uganda to be 41.6M people by mid-2020. This means there is about one ICU bed for every 700,000 people in Uganda. 92% of the ICUs are shared adult and paediatric ICUs, with only one unit exclusively admitting adults. In 2021, a 6-bedded paediatric ICU (PICU) opened in a

new children's surgical hospital (Emergency, 2022), and this is the only dedicated PICU in the country. Atumanya et al. (2020) concluded that there is limited accessibility to critical care services in Uganda and added that there is a need to standardize ICU care in the country to ensure an equitable, minimum standard of care (Atumanya et al., 2020).

Physiotherapy is considered an important component of the care of critically ill or injured children, focussing on cardiopulmonary management and the prevention of secondary complications of critical illness and associated medical interventions (Hawkins and Jones, 2015). Although 92% of ICUs in the country offer physiotherapy services (Atumanya et al., 2020), it is the researcher's impression that this is generally only provided after specific referral by the intensivist or other doctors treating the patient. The doctors' understanding of a patient's need for physiotherapy will therefore determine whether the patient is treated by a physiotherapist. The appropriateness of this referral system as well as potential delays to referral have not been described in Uganda. Furthermore, the nature of physiotherapy practice in Uganda has not been previously described in the PICU context, in relation to internationally recommended standards. In most outpatient settings, physiotherapists in Uganda are first line practitioners and can assess, diagnose and manage patient conditions with no referral from a doctor, however, in inpatient settings, it varies from one institution to another, some settings may allow physiotherapists to address patient problems with no referral others may not and this is not well streamlined. There is very minimal usage of protocols in physiotherapy practice in Uganda. In the ICU specifically, the researcher is not aware of any protocols being used currently to guide practice.

### 1.1.2: Problem statement

Provision of critical care services (of which physiotherapy is considered an essential component) for both adults and children in low resource settings such as Uganda remains wanting, and currently a single "best" care model of delivery may not exist (Losonczy et al., 2021). Notwithstanding, research has been suggested as one of the core pillars to strengthen provision of paediatric critical care services in low resource settings. (Turner et al., 2016, Losonczy et al., 2021). Worldwide, physiotherapy is considered an integral part of the care for children in the ICU (Brownson et al., 2007, Pountney, 2007, Hawkins and Jones, 2015), however the practice of physiotherapy for critically ill or injured children admitted to ICU in Uganda has not previously been studied and is therefore not known.

This study therefore aimed to describe the provision of physiotherapy services for children admitted to ICUs in Uganda, to lay a foundation for future practice improvement initiatives.

### 1.2: Study aim

This study aims to describe the provision of physiotherapy for children admitted to intensive care units in Uganda.

### 1.3: Study Objectives

1. To describe the patient profile of children admitted to ICU in Uganda, comparing those who received and did not receive physiotherapy treatment during their admission as well as those who did or did not receive physiotherapy during the preceding 24 hours.
2. To describe the proportion of children admitted to ICU who received any physiotherapy intervention/s during their admission.
3. To categorize the physiotherapy techniques used in treating children in ICU.
4. To describe the frequency of physiotherapy treatments for children admitted to ICU.
5. To describe the referral practices for physiotherapy for children admitted to ICU

# CHAPTER TWO: LITERATURE REVIEW

## 2.0 Introduction

This literature review aims to describe the effects of paediatric critical illness and immobilization on the body systems during admission to the ICU and after discharge from the health facility. The practice of physiotherapy in paediatric critical illness will also be described, according to internationally accepted standards. Where paediatric specific studies are available, these are prioritized, but adult studies are included owing to the relative paucity of paediatric research in the field.

### 2.0.1 Literature review methodology

The methodology was that of a narrative review. A search was performed to identify studies about the different topics in this literature review that is: Effects of bed rest and immobility on different body systems and physiotherapy practice in the intensive care unit. A number of databases were searched with relevant search terms. The searched databases include Google Scholar, PubMed, PeDRO, Cochrane Library, CINHAL, and ClinicalKey. Some search terms used included one of or a combination of some of the following terms: “Bed rest effects”, “Critical illness effects”, “Immobility effects”, Immobility effects on body systems”, “ICUAW children”, “PICS”, “PICS-p”, “Physiotherapy in the PICU”, “ABCDEF liberation bundle”, among others

The summary table of included literature is presented in Appendix A.

## 2.1: Effects of paediatric critical illness and immobilization on different body systems

Prolonged immobilization of critically ill patients as well as the critical illness itself, negatively affects multiple body systems including: musculoskeletal; cardiovascular; and respiratory systems as well as brain function and skin integrity, and many of these adverse effects could be prevented or minimized by early and appropriate physiotherapy intervention (Calvo-Ayala et al., 2013, Hawkins and Jones, 2015).

Historically, bed rest and immobility were extensively practiced in the treatment of critically ill patients but have now been found to have numerous adverse effects (Allen et al., 1999) on multiple body systems, discussed below:

### 2.1.1: Cardiovascular system

Adult studies describe changes in heart function secondary to prolonged bed rest. There is remodeling of the heart muscle causing changes in volume and mass, with marked atrophy of the left ventricle, possibly due to decreased physiological loading (Perhonen et al., 2001). There

is a marked reduction in exercise stroke volume immediately after prolonged bed rest, with only partial improvement even after one month of recovery (Spaak et al., 2005) as well as increased heart rate at rest (Convertino et al., 1982) and decreased cardiac reserve (Dittmer and Teasell, 1993). Reduced plasma and blood volume have also been observed after prolonged bed rest (Convertino, 2007).

The first systematic review and meta-analysis investigating the effect of prolonged bed rest on maximal oxygen consumption ($VO_{2max}$), concluded that $VO_{2max}$ decreases with prolonged bed rest and that it does so more for individuals with a higher baseline $VO_{2max}$ (Ried-Larsen et al., 2017). Furthermore, Barbic et al (2019) found that three weeks of bed rest reduced orthostatic tolerance in healthy young men, and this was associated with impaired baroreceptor control of vascular sympathetic drive (Barbic et al., 2019). Bed rest and critical illness have also been associated with a predisposition to venous thromboembolism in adults (Dittmer and Teasell, 1993).

In a study of children admitted to PICU after severe trauma, Hanson et al. (2010) reported that 6.2% of patients developed venous thrombo-embolism, related to risk factors including poor perfusion, immobility, and presence of a central venous line (Hanson et al., 2010). Critical illness and bed rest in children are associated with anemia, possibly caused by occult blood loss, underlying disease, or treatments causing bone marrow suppression, perhaps requiring frequent Red Blood Cell (RBC) transfusions. (Bateman et al., 2008). However, transfusions are associated with many adverse effects including transfusion transmitted infections, haemodynamic compromise, and intravascular volume overload (Bateman et al., 2008).

### 2.1.2: Respiratory system

Adult studies report several pulmonary sequelae following extended bed rest. In a study about physiological determinants of ventilator dependence, Purro et al. (2000) found that patients who could not be weaned off the ventilator had common respiratory pathophysiological characteristics including small tidal volume, high neuromuscular drive, and reduced inspiratory muscle strength (Purro et al., 2000).

Paediatric studies have reported that some critical illness survivors are left with chronic obstructive or restrictive lung disease, long-term dyspnoea and pulmonary dysfunction, and upper airway obstruction after endotracheal intubation and invasive mechanical ventilation, which in turn affects exercise capacity, the ability to participate in age-appropriate activities including sport, play and other social participation. (Knoester et al., 2008, Boucher et al., 2020).

Although there is still little paediatric data, a pilot study by Ward et al. reported that up to one-third of children with paediatric acute respiratory distress syndrome (ARDS) had pulmonary function deficits 12 months post-illness (Ward et al., 2017). Respiratory muscle weakness is a common complication of critical illness and immobility in children (Crulli et al., 2021, IJland et al., 2020). All of these consequences may impact substantially on normal development, emotional wellbeing and quality of life.

Others studies in both adults and animals have found that prolonged mechanical ventilation leads to diaphragmatic atrophy and contractile dysfunction (Powers et al., 2009, Hudson et al., 2012) as well as respiratory muscle degeneration indicated by cell ultrastructure degeneration as a result of muscular inactivity during mechanical ventilation (Bernard et al., 2003). In children, ventilator-induced diaphragmatic dysfunction occurs in up to 35% of ventilated children, caused by unloading of the diaphragm during mechanical ventilation and related to prolonged and mandatory mechanical ventilation (Glau et al., 2018, Petrof et al., 2010). The diaphragm loses about 3.4% thickness per mechanical ventilation day (Glau et al., 2018). Diaphragmatic weakness is associated with increased risk of extubation failure, prolonged mechanical ventilation and ICU/ hospital length of stay. (Khemani et al., 2017, Wolf et al., 2011).

Atelectasis of lung segments, especially the lower lobes, following prolonged bed rest has also been reported (Brower, 2009). Several studies in adults with ARDS report that pulmonary function may return to nearly normal six to twelve months after recovery, except for persistence in the reduction of carbon monoxide diffusion capacity (Herridge, 2003, Herridge et al., 2011).

### 2.1.3: Musculoskeletal and nervous system effects

Extended bed rest is associated with loss of calcium and phosphate from bone as well as loss of bone mass (Hall and Guyton, 2011). LeBlanc et al. add that bed rest reduces formation of bone but increases its resorption (LeBlanc, 2007, Watanabe et al., 2004). Zerwekh et al. found marked increases in cortical and cancellous bone resorption after twelve weeks of immobilization supported by a significant increase in the biochemical markers of bone resorption during the period of immobilization with subsequent decrease of the same after remobilization (Zerwekh et al., 1998). Watanabe et al. reported changes that suggested that there was a shift of bone minerals from major weight bearing bones like the femur to other parts of the skeleton like the skull after 90 days of bed rest (Watanabe et al., 2004).

Adult studies show that mechanical unloading, which occurs in patients who are bedridden for prolonged periods of time, stimulates skeletal muscle atrophy (Chambers et al., 2009), with a loss in net protein content caused by down regulation of protein synthesis (Bajotto and Shimomura, 2006). Atrophy increases over the time that muscles remain immobile and consequently atrophied muscles become more easily fatigued when attempting to complete tasks, because more muscle fibers and motor units are needed to complete the task (Roy et al., 1991). There is also reduced thin filament density in atrophied muscles following bed rest, which increases the average stress on the remaining thin filaments, increasing the susceptibility of atrophied muscles to weightbearing- induced damage during reloading. (Riley et al., 2000). Chambers et al. propose an interrelationship in the adaptive processes that cause weakness in unloaded muscle whereby unloading directly affects the degradation, synthesis, and apoptosis of muscle, and these in turn reduce the specific force and mass of muscle, thereby collectively causing muscle weakness (Chambers et al., 2009).

Prolonged ICU stay is associated with long term physical impairments commonly associated with Intensive Care Unit Acquired Weakness (ICUAW), which is defined as "clinically detected weakness which has no other plausible etiology other than the critical illness itself or its treatment" (Stevens et al., 2009, Lad et al., 2020). Intensive Care Unit Acquired Weakness is classified as Critical Illness Polyneropathy (CIP), Critical Illness Myopathy (CIM), Critical Illness Neuromyopathy (CINM) and muscle deconditioning (Inoue et al., 2019). Critical Illness Polyneuropathy is characterized by sensorimotor axonopathy and reduced compound muscle and sensory nerve action potentials, with normal nerve conduction velocity (Schweickert and Hall, 2007, Bolton et al., 1984, Farhan et al., 2016). CIM is an acute primary myopathy characterised by short duration low amplitude compound muscle action potentials with normal sensory nerve action potentials (Schweickert and Hall, 2007, Farhan et al., 2016). Muscle deconditioning is characterized by normal nerve velocity and compound muscle action potential but with absence of spontaneous activity (Farhan et al., 2016). Clinical differentiation between CIP and CIM may be challenging and at times impossible and forced categorization into myopathy and polyneuropathy may lead to misinterpretation of the abnormalities (Bednarik et al., 2003). When CIP and CIM co-exist they are referred to as Critical Illness Polyneuromyopathy (CINM) (Farhan et al., 2016, Bednarik et al., 2003).

Diagnosing Paediatric Intensive Care Acquired Weakness (PICU-AW) is challenging because some of the most commonly used methods for screening muscle weakness in critically ill adults, like the Medical Research Council (MRC) score, are not feasible in young children (Siu

et al., 2015). Paediatric Intensive Care Unit Acquired Weakness (PICU-AW) is therefore often conceptualized as a loss or deterioration of physical function (Choong et al., 2015a, Namachivayam et al., 2010, Als et al., 2015) as there is a scarcity of studies investigating the specific mechanisms of PICU-AW (Ong et al., 2016) The mechanisms of ICUAW in children seem similar to those described in adults, however, the lower incidence in children may be related to fewer physical comorbidities in children, which may make them less susceptible to development of neuropathy or myopathy and/or might facilitate more rapid recovery (Williams et al., 2007, Thabet Mahmoud et al., 2018, Kasinathan et al., 2021). Some of the cited examples of physical impairment in critically ill children include impairments in mobility, self-care, pain, and sensation (Ong et al., 2016, Knoester et al., 2008, Als et al., 2015).

#### *2.1.3.1: Clinical features of ICUAW*

In adults, CIP and CIM both present with flaccid paralysis that is usually symmetrical and may be severe enough to cause quadriplegia (Hermans et al., 2008, Witt et al., 1991). Other clinical signs may include a reduction in or absence of deep tendon reflexes, a distal loss of sensitivity to pain, temperature, and vibration even when patients are fully alert as well as proximal and distal muscle weakness. (Bolton et al., 1984, Kukreti et al., 2014, Hermans et al., 2008, Schweickert and Hall, 2007). Critical Illness Polyneuropathy and or Critical Illness Myopathy may affect the phrenic nerve, the diaphragm, intercostal muscles, and the accessory muscles of breathing, leading to problems with weaning patients off mechanical ventilation (Bolton et al., 1984, Witt et al., 1991). Muscle loss due to immobility may begin within 48 hours of critical illness onset (Hermans et al., 2008).

#### *2.1.3.2: Risk factors for ICUAW*

In adults, Witt et al. reported that there is a strong link between sepsis, multiple organ failure, and critical illness polyneuropathy (Witt et al., 1991, Puthucheary et al., 2013). Systemic Inflammatory Response Syndrome (SIRS) and hyperglycemia have been added as risk factors in adults (Hermans et al., 2008). Field-Ridley et al. (2016) in a retrospective study on ICUAW in critically ill children, reported results similar to those found in adults in that ICUAW is associated with older age, a primary respiratory or infectious diagnosis, prolonged mechanical ventilation, and long hospital stay (Field-Ridley et al., 2016). However, they caution that older age as a risk factor in children could be due to challenges in diagnosing infants and very young children rather than a biological susceptibility in older children. In children, it has been hypothesized that previously healthy children experience greater manifestations of PICU-AW

as compared to those with underlying comorbidities, however, previously healthy children may recover quicker from PICU-AW symptoms than the latter (Choong et al., 2015a).

#### 2.1.3.3: Short and long-term outcomes of ICUAW

Polyneuropathy may take weeks to recover in mild cases, and months in moderate cases but may never recover in severe cases (Witt et al., 1991). Guarneri et al. (2008) in a prospective cohort study, found that patients with a definitive diagnosis of CIM have a better prognosis than patients with CIP, with the majority of CIP survivors remaining severely disabled one year after hospital discharge (Guarneri et al., 2008, Koch et al., 2014). Field-Ridley et al found that diagnosis of PICU-AW in children is associated with high rates of invasive therapies, high resource use, and poor outcomes for critically ill children (Field-Ridley et al., 2016). Children admitted to the PICU may develop difficulties in physical functioning, with mild to severe disabilities persisting for years after PICU discharge (Bossen et al., 2021, Namachivayam et al., 2010, Als et al., 2015)

#### *2.1.3.4: Specific effects on the Nervous system*

Prolonged bed rest affects the central, autonomic, and peripheral nervous systems (Winkelman, 2009). Studies done in adults have demonstrated that prolonged bed rest is associated with volumetric grey matter changes in sensorimotor brain regions, affecting mostly the primary motor cortex, the somatosensory cortex, and the cerebellum, and leads to deterioration in functional mobility and balance (Koppelmans et al., 2017, Teasell and Dittmer, 1993).

### 2.1.4: Renal system

As a result of increased and sustained bone resorption during prolonged bed rest, there is increased excretion of calcium and phosphorous in the urine (Zerwekh et al., 1998, Watanabe et al., 2004). This may lead to the formation of calcium oxalate, calcium phosphate, and calcium phosphate stones in the kidneys (Okada et al., 2008), which can exacerbate acute kidney injury (Winkelman, 2009). Prolonged bed rest may lead to loss of sensation of urinary urgency because of loss of ability of stretch receptors in the bladder from being stimulated following prolonged stretching of an over-distended bladder. The absence of gravity acting on the muscles may hinder the complete emptying of the bladder, thereby predisposing it to infection (Guedes et al., 2018). Although direct causation has not been determined in children between kidney injury and immobilization, Acute Kidney Injury (AKI) is a common health complication among critically ill children (Sanderson and Harshman, 2020, Kaddourah et al.,

2017) and is associated with poor outcomes including increased mortality (Kaddourah et al., 2017).

### 2.1.5: Skin effects

Prolonged bed rest may result in skin ulcers as a result of the breakdown of skin at points of pressure between the bed and the skin (Brower, 2009). Other factors that may lead to the formation of skin ulcers include impaired microcirculation, malnutrition, shear forces applied to pressure points, and humidity (Brower, 2009). Skin ulcers create an entry point for disease-causing microorganisms like bacteria, thereby predisposing the patient to infections. The formation of skin ulcers may result in further immobility of the patient (Guedes et al., 2018), creating a vicious cycle. Pressure ulcers are a recognized complication in children managed in the PICU (Schluer A-B et al., 2012, Schluer et al., 2014). Additional risk factors that may lead to the formation of pressure ulcers in children include the presence of external medical devices on the skin, limited activity/ mobility, and reduced skin sensation (Schluer et al., 2014). The most common sites for pressure ulcers in children include ears, occiput, heels, ischial tuberosities, and heels (Schluer et al., 2014).

### 2.1.6: Neuro-cognitive effects

Intensive care unit-acquired delirium is common in critically ill children (Traube et al., 2017b, Traube et al., 2017a, Cano Londono et al., 2018, Silver et al., 2015). Delirium may be defined as "a disturbance of consciousness and cognition that develops over a short period (hours to days) and fluctuates over time" (Girard et al., 2008, Winkelman, 2009) and encompasses other forms of brain dysfunction including ICU psychosis, acute brain failure, encephalopathy, acute confusional state (Girard et al., 2008) or as "alteration in neurotransmission, which results in an acute and fluctuating change in awareness and cognition" (Traube et al., 2017b). Some identified risk factors for delirium in children include young age, deep sedation, prescription of benzodiazepines and anticholinergics (Traube et al., 2017b, Alvarez et al., 2018), as well as use of restraints and invasive mechanical ventilation (Yontem et al., 2021, Dhingra, 2021). Many children develop delirium in the first three days of PICU admission (Traube et al., 2017b, Alvarez et al., 2018, Cano Londono et al., 2018). Traube et al (2017) reported that it was harder to assess for delirium in children with developmental disabilities as it was difficult to differentiate it from the pre-existing neurological disorder, and suggested that this group of children requires a more nuanced approach to diagnose delirium (Traube et al., 2017b). Delirium in critically ill children is independently associated with in-patient mortality (Traube et al., 2017b), and is also associated with prolonged PICU length of stay, increased PICU costs

(Traube et al., 2016, Alvarez et al., 2018) and poor functional outcomes for critically ill children (Creten et al., 2011). Therefore, early screening and intervention are recommended to minimize adverse effects (Smith et al., 2013, Brummel et al., 2013). A three-pronged approach is recommended to manage delirium in children including investigating for underlying illness, iatrogenic causes, and abnormal environment (Traube et al., 2017b). Performing early mobilization when safe and feasible is recommended to prevent the development of delirium in critically ill children (Smith et al., 2022).

Adult literature has suggested that neurocognitive disability following critical illness may present with memory, attention, and executive dysfunction, as well as psychiatric disorders such as depression, anxiety, and post-traumatic stress disorder (Herridge et al., 2008). Similarly, paediatric studies have shown that children exhibited cognitive and developmental deficits following admission to the ICU manifesting as low scores in cognitive testing for intelligence, memory, and executive function (Procter et al., 2021), as well as a deterioration in school performance, intelligent quotient (IQ) scores, visual-motor integration, and Attention Motor Coordination (Procter et al., 2021, Mesotten et al., 2012, Als et al., 2015).

### 2.1.7: Gastrointestinal system

Adult studies show various effects on the gastrointestinal system associated with bed rest. Dooley et al. (1989) reported increased transit of non-viscous materials in the oesophagus in the upright position as compared to the supine position (Dooley et al., 1989), which may lead to reduced peristalsis. Bed rest is also associated with reduced appetite, peristalsis, and rate of absorption (Thomas et al., 2002), as well as an increase in symptoms of gastroesophageal reflux (Newton et al., 1999) and constipation (Thomas et al., 2002).

## 2.2: Paediatric Post Intensive Care Syndrome

Post Intensive Care Syndrome (PICS) refers to the physical, cognitive, and mental disorders that occur as a result of a long stay in the ICU. PICS was first conceptualized in adults, (Needham et al., 2012) and has been widely studied in that population. More recently, the exploration of PICS in children led to the development of the PICs-p framework. This framework, as proposed by Manning et al. (2018) aligns the PICS to the unique needs of children (Manning et al., 2018). The PICS-p framework explores 4 main aspects:

#### i) Childhood

This looks at the dynamicity of the childhood stage, during which substantial growth and development take place. It also considers the heterogeneity of children and how diverse their

baseline can be before a PICU admission e.g. some children may have disabilities or chronic illnesses that influence the trajectory of their recovery and may impact the quality of the child's survival for years.

**ii) Family**

This aspect recognizes that the child invariably belongs to a family unit that differs in composition and dynamics. A child's critical illness may affect family members as they too may experience psychosocial issues and consequently, the responses of the family members may in turn affect the outcomes for the child following paediatric critical illness. The PICS-p framework aims to recognize the family unit as central to the child with critical illness and the interdependences between family members and the outcomes for the child.

**iii) Core but interrelated domains**

Similar to the PICS framework, PICS-p looks at how critical illness can affect the child's physical, cognitive, and emotional health domains. These consequences may affect the child's well-being in isolation, or they may interact with each other. PICS-p adds a fourth domain "social health" in recognition of the fact that PICS affects the child's as well as their family's social functioning.

**iv) Recovery**

This recognizes several recovery trajectories that are dependent on the individual child and their family as evidence points to more heterogeneity in reported outcomes for critically ill children and their families as compared to adult ICU patients and their spouses. Children's recovery trajectories may not only be domain-specific with variable recovery across the health domains but are also affected by developmental factors as the child matures, as well as the social and emotional impact on the family around them.

### 2.2.1: a) Physical health impairment

Admission of children to the ICU is associated with an increased risk of death for at least ten years after admission (Procter et al., 2021), pointing to a need for continued vigilance to maintain good Health Related Quality of Life (HrQOL) following ICU admission of children. Literature suggests that physical functioning in children who are critically ill or survive critical illness should not only focus on motor capacity, impairment, and disability but rather assess levels of functioning when children are performing activities that they need and want to do as part of their everyday lives (Choong et al., 2015a). The International Classification of Function, Children and Youth framework, is therefore suitable and feasible to measure physical function

in critically ill children (Choong et al., 2015a, Bossen et al., 2021), more so because some measures that are commonly used to measure muscle strength in critically ill adults are not feasible in children (Siu, K, et al 2015). Studies report that critically ill children are at risk of physical impairments and may survive critical illness with moderate to severe long term physical disabilities including impairments in mobility, sensation deficits, pain, challenges with self-care, sleep difficulties, impaired lung function and fatigue (Namachivayam et al., 2010, Herrup et al., 2017, Knoester et al., 2008, Bossen et al., 2021, Choong et al., 2015a, Als et al., 2015), although there is little evidence about the extent and type of physical functional impairments (Ong et al., 2016).

### 2.2.2: b) Cognitive health impairment

Several cognitive deficits are reported in children after critical illness, including lower IQ; deficits in attention and memory, which adversely affect academic performance compared with health controls (Als et al., 2015, Knoester et al., 2008); poor visual motor integration, attention problems, and inhibition control (Watson et al., 2018, Tang et al., 2021).

### 2.2.3: c) Mental health impairment

Most studies evaluating the psychological well-being of children after a PICU stay report on the presence of Post-Traumatic Stress Disorder (PTSD) (Colville et al., 2008, Colville and Pierce, 2012). These report on the presence of post-traumatic stress symptoms like anxiety, depression, hallucinations, delusional memories, fear of the medical environment, and irritability. (Colville and Pierce, 2012, Manning et al., 2018, Tang et al., 2021, Watson et al., 2018).

### 2.2.4: d) Social health impairment

The well-being of children directly affects the well-being of the parents and other relatives. Consequently, critical illness in children has been linked with several psychosocial problems among family members (Watson et al., 2018). Colville & Pierce (2012) found that parents still experienced post-traumatic stress symptoms one year after the discharge of their child from the PICU and many parents continue to seek professional care for anxiety and depression after their child's stay in the PICU, as psychological symptoms may persist for many months, (Colville and Pierce, 2012, Watson et al., 2018, Tang et al., 2021). Children and their families may face several social problems including loss of work opportunities because of time spent looking after the sick child leading to unemployment, loss of relationships amongst family members, and difficulties making new friends (Tang et al., 2021).

### 2.3: Physiotherapy in critical illness

Despite physiotherapy being an integral part of care for critically ill patients in many contexts, its practice in this setting is still grappling with limited standardization of practice and little high-level empirical research, especially regarding appropriate indications and optimal treatment techniques, (Hawkins and Jones, 2015, Stiller, 2013). In the Ugandan context, physiotherapy practice in the ICU includes both rehabilitation/mobilization intervention and respiratory physiotherapy, therefore the literature regarding both types of interventions will be discussed below.

#### 2.3.1: Respiratory physiotherapy

Respiratory or "chest physiotherapy (CPT)" is the most widely applied type of physiotherapy in the PICU (Hawkins and Jones, 2015, Shkurka et al., 2023) and techniques used vary depending on context, physiotherapist training, expertise, and local policies (Shkurka et al., 2023, McCord et al., 2013). Some of the most commonly used techniques include positioning, manual hyperinflation, percussions, vibrations, and endotracheal suction (Pathmanathan et al., 2015, Walsh et al., 2011, McIlwaine, 2006). Other airway clearance techniques used include mobilization and active exercises as well as breathing exercises such as deep and localized breathing exercises, Positive Expiratory Pressure (PEP) therapy, oscillatory PEP, Active Cycle of Breathing Technique (ACBT), autogenic drainage, and Forced Expiratory Technique (FET) (Morrow, 2019). Given the differences in physiology, anatomy, and disease processes between adults and children, respiratory physiotherapy for children should be customized to their unique needs (Schechter, 2007).

One of the main aims of chest physiotherapy in the treatment of critically ill children with respiratory conditions is to remove obstructive endotracheal secretions to reduce airway resistance and improve the work of breathing as well as gaseous exchange. This may in turn prevent or resolve respiratory complications, re-expand collapsed lobes, facilitate weaning off the ventilator, and hasten recovery (Morrow, 2015). Except for acute lobar atelectasis, for which there is some evidence of efficacy (Stiller, 2000, Stiller, 2013), there is limited evidence supporting the efficacy of chest physiotherapy techniques for various disease conditions (Hawkins and Jones, 2015, Stiller, 2000, Stiller, 2013, Morrow, 2019, Schechter, 2007). However, there are many documented concerns that chest physiotherapy may be a useless yet harmful intervention (Elizabeth et al., 2017, Wallis and Prasad, 1999). Some of the complications that have been associated with chest physiotherapy in neonates and infants include brain damage (Harding et al., 1998), increasing bronchospasm, repositioning of a

foreign body, pulmonary hypertension, (Wallis and Prasad, 1999), hypoxia, increased metabolic and oxygen consumption demand, rib fractures, atelectasis, gastroesophageal reflux, pneumothorax and death (Morrow, 2015). Routine chest physiotherapy may be beneficial in the management of children living with advanced neuromuscular disease and chronic obstructive lung conditions such as cystic fibrosis lung disease, but otherwise, given the potential adverse effects, there is a strong recommendation to avoid routine physiotherapy in children who are acutely and severely ill and rather use this intervention to address a specific problem, having carefully weighed risk against benefit (Schechter, 2007, Morrow, 2015, Morrow, 2019, McIlwaine, 2006). It has also been recommended that chest physiotherapy in children should not be done in isolation but rather integrated into other activities, for example targeting stimulation or neuromotor development of the child (Morrow, 2019, Choong et al., 2018).

### 2.3.2: Early Mobilization

#### *2.3.2.1: Definition*

Early mobilization is still largely undefined and involves several heterogeneous interventions whose use may depend on context. Mobilization may be defined as "physical activity sufficient to elicit acute physiological effects that enhance ventilation, central and peripheral perfusion, circulation, muscle metabolism, and alertness and are countermeasures for venous stasis and deep vein thrombosis" (Gosselink et al., 2008). Other scholars suggest that early mobilization is simply early application (within 2-5 days of critical illness) and intensification or progression of the active physical therapy that is given to critically ill patients (Hodgson et al., 2014). "Early" has also been defined in children as within 48 hours (Choong et al., 2012) or 72 hours (Wieczorek et al., 2016, Cuello-Garcia et al., 2018) of a PICU admission.

#### *2.3.2.2: Activities*

Activities involved in mobilization may differ between adults and children, although they may all be derived from conventional physical therapy (Hodgson et al., 2014). Gosselink et al. (2008) suggest an approximate order of progressing mobilization activities in adults: passive mobilization and movement in bed, active assisted exercises, active exercises in bed e.g. cycling in bed, sitting at the edge of the bed, standing, stepping in place, transferring from bed or chair, exercises in the chair and walking (Gosselink et al., 2008). Some authors suggest that mobilization interventions should involve only active exercises and as such activities such as repositioning, passive range of motion, and stretching are regarded as non-mobility interventions (Cuello-Garcia et al., 2018). However, other authors recommend the use of

passive mobilization and positioning in children who are unable to actively participate in mobility interventions (Choong et al., 2018), (Wieczorek et al., 2016). In children, neurodevelopmental play and pre-gait activities are recommended as part of mobilization activities (Wieczorek et al., 2016), (Choong et al., 2015b). Play is important for children when they have a life-threatening condition as it boosts their adaptability to stress and stimulates their cognitive, emotional, social, and psychomotor functioning, thereby laying a good foundation for their future health (Nijhof et al., 2018). Play when integrated into early mobilization activities has numerous physical benefits and may improve patient and family cooperation and thus improve the effectiveness of therapy (Morrow, 2021).

#### *2.3.2.3: Barriers*

Several studies in both adults and children have found that mobilization interventions in critically ill patients are feasible and appear to be safe (Ista et al., 2020), (Kudchadkar et al., 2020), (Denehy et al., 2017), (Cuello-Garcia et al., 2018), (Wieczorek et al., 2015), (Stiller, 2013). However, there is still limited implementation of early mobility in the ICU in many places (Ista et al., 2020), and the (perceived) barriers to early mobilization could be contributing to this hesitation in implementation. Morris (2007) identified potential barriers to early mobilization including safety concerns and the potential of causing more harm to the patient in the process of mobilizing them; multiplicity of vascular access; sedation; cost barriers especially about human resources; patient obesity and time constraints (Morris, 2007). In children, other cited barriers to early mobilization include the presence of invasive mechanical ventilation; younger age; the requirement in some centers for a physician referral; moderate or severe baseline functional or cognitive disability; conflicting views regarding patient's readiness for therapy and a lack of practice guidelines are all associated with reduced likelihood of receiving early mobilization interventions (Choong et al., 2012), (Wieczorek et al., 2015). Notwithstanding, there is a belief that many of these perceived barriers are modifiable and can be overcome (Denehy et al., 2017), (Morrow, 2021). To facilitate the implementation of safe mobilization practice a group of multidisciplinary experts formulated practice guidelines for the early mobilization of critically ill children (Choong et al., 2018).

#### *2.3.2.4: Benefits*

The benefits of early mobilization in critically ill children are not conclusive owing to the paucity of empirical research in this population (Cuello-Garcia et al., 2018), (Cameron et al., 2015). However, studies done in adults reported that mobilization interventions are associated with improved functional outcomes and reduced ICU and hospital length of stay (Hodgson et

al., 2014), (Kress and Hall, 2014), (Mendez-Tellez and Needham, 2012). Physical rehabilitation (which includes early mobilization) is also associated with shorter periods of mechanical ventilation and improved physical function at hospital discharge (Mendez-Tellez and Needham, 2012). Active mobilization improves body function, reduces activity limitation, and improves participation (Brahmbhatt et al., 2010). It is therefore generally accepted that mobilization should be included as an integral part of the interdisciplinary team managing critically ill children. Studies done in children have reported benefits similar to those seen in adults, including shorter PICU and hospital lengths of stay (Jacobs et al., 2001). A retrospective before-after study investigating the benefits of early mobilization after paediatric liver transplantation reported a quicker return of independent walking ability in patients who could walk before surgery after the implementation of an early mobilization intervention as compared to before this intervention was implemented (Tsuboi et al., 2019).

### 2.3.3: ABCDEF bundle

This best practice bundle represents evidence-based guidelines for clinicians to optimize recovery and functional outcomes for patients admitted to the ICU and PICU (Marra et al., 2017), (Ely, 2017). This bundle is an important consideration to effectively practice physiotherapy in the intensive care unit. The ABCDEF bundle incorporates the following:

A: Assess, Prevent, and Manage Pain

Most critically ill patients experience pain from the critical illness itself or procedures done in the ICU (Erstad et al., 2009), (Payen et al., 2007), and clinicians are encouraged to err on the side of assuming the pain is there when patient input in pain assessment is difficult (Erstad et al., 2009). To successfully implement early mobilization of critically ill children there should be optimization of pain management and sedation (Saliski and Kudchadkar, 2015), and it is therefore recommended that analgesia is administered before mobility activities where there is a possibility of causing pain (Morrow, 2021).

B: Both Spontaneous Awakening (SAT) and Spontaneous Breathing Trials (SBT)

Continuously titrating sedation to maintain a light level of sedation may provide a good opportunity to do active mobility activities with an alert and cooperative patient (Marra et al., 2017), (Saliski and Kudchadkar, 2015). In children, a careful risk-benefit analysis is recommended before undertaking SATs (Engel et al., 2022). Spontaneous Breathing Trials are

a reliable method of weaning children off MV and preparing them for extubation (Ghaffari et al., 2015).

C: Choice of Analgesia and Sedation,

This refers to making the best choices for analgesia and sedation to maximize patient outcomes, in terms of choice of actual medications, dosage, titration, and discontinuation of analgesia and sedation (Marra et al., 2017). Goal directed titration is especially important in children for whom sedation is a necessary part of medical management. (Saliski and Kudchadkar, 2015). In the paediatric population, the "gold standard" of early mobilization would be to encourage an active state during the day with frequent mobilization and stimulation, which may promote restorative sleep at night. This can only be effectively achieved if there is an appropriate balance between over- and under- sedation (Saliski and Kudchadkar, 2015). If benzodiazepines must be used, the child should still be assessed for passive mobility interventions (Saliski and Kudchadkar, 2015) such as passive range of motion or positioning.

D: Delirium: Assess, Prevent and Manage

Early and progressive mobilization is one of the strong recommendations to reduce the incidence and duration of ICU delirium and improve functional outcomes. However, delirium can also affect the ability of children to participate in physical activity (Morrow, 2021) and prolonged immobilization is one of the risk factors for delirium (Marra et al., 2017). Early mobilization is therefore important in both the prevention and management of delirium.

(E: Early mobility and Exercise) – discussed previously

F: Family Engagement and Empowerment

Family presence is strongly associated with out-of-bed mobility (Ista et al., 2020), (Kudchadkar et al., 2020). There are many benefits to encouraging family engagement in the mobilization activities of critically ill children, including reducing parental anxiety and improving satisfaction levels (Bastani et al., 2015), tapping into the parents' special understanding of the child to improve the child's cooperation and motivation (Morrow, 2021), facilitating bonding between parent and child and sustaining of some mobilization activities beyond the designated therapy sessions (Morrow, 2021).

## Conclusion

Paediatric critical illness and immobility are associated with multiple complications, affecting both short- and long-term outcomes. Indeed paediatric critical illness adversely affects both patients and their families. Physiotherapy is often indicated to target the prevention and management of these complications, as well as the presenting symptoms of acute or comorbid disease conditions. Despite a paucity of high level empirical evidence supporting physiotherapy practice in PICU, consensus guidelines have provided “best practice” guidance, for both respiratory and rehabilitation physiotherapy practice, based on currently available best evidence. The described search strategy yielded no literature describing paediatric physiotherapy practice in low-income African ICU settings, highlighting the need for research in this field, to inform future educational and practice development, to ultimately improve the care and outcomes of critically ill children managed in these settings.

# CHAPTER THREE: METHODOLOGY

## 3.0 Introduction

This chapter describes the methods used to carry out the study as well as the study sites that were used for the study.

## 3.1: Study aim

This study aimed to describe the provision of physiotherapy for children admitted to intensive care units in Uganda to lay a foundation for practice improvement.

## 3.2: Study Objectives

1. To describe the patient profile of children admitted to the ICU, comparing those who received and did not receive physiotherapy treatment during their admission.
2. To describe the proportion of children admitted to the ICU who receive any physiotherapy intervention/s during their admission.
3. To describe and categorize the physiotherapy techniques used in treating children in the ICU on study days.
4. To describe the frequency of physiotherapy treatment for children admitted to ICU.
5. To describe the referral practices for physiotherapy for children admitted to ICU.

## 3.3: Methodology

### 3.3.1: Study design

The study followed a pragmatic, descriptive, prospective design. Data were collected on two days per week (Monday and Thursday) for each study site over six consecutive months.

After initial training in data collection, an on-site physiotherapist documented study data in real-time on the given study days at each study site. Data were extracted from routinely collected data in the patients' medical files to describe demographic data, admission characteristics, the patient's condition and level of ventilatory support on the study day, whether or not they received physiotherapy over the preceding 24 hours, specific treatment modalities used and how many times physiotherapy was received over the preceding 24-hour period (see Appendix A- data collection sheet). The on-site physiotherapist was also asked to complete the questionnaire regarding any reasons for not receiving physiotherapy. On the study day, data from folders were extracted for the entire admission, as well as specifics related to the previous 24 hours. The granular data were only obtained for the previous 24 hours, from a combination of patient folders, nursing notes, and physiotherapy reports (written and verbal), to reduce the risk of recall bias

A one-month pilot study was conducted to test the feasibility of this method of data collection, during which the student investigator made physical visits to the study sites on the days of data collection, to evaluate the utility of the research tool and make any necessary adaptations to the case record form.

#### 3.3.1.1: Justification of the study design

A prospective study design was chosen for this study whereas perhaps a retrospective design would have yielded more data over a longer study period. This is because medical record-keeping practices in this setting are still rudimentary and sub-optimal for example paper files are still the only means of storage of patient records in all the facilities that took part in the study, with very questionable storage mechanisms and regulation of documentation practices. There was a very high risk of inaccurate and missing data if a retrospective folder review was done. The prospective design was the only way to capture this data while the patient's folder was still at the bedside or freshly stored and easily retrievable. In addition, a prospective design had the provision of asking the parent or caregiver of the child at the bedside, or the health care worker to clarify data if it was not captured in the folder, which was not possible with a retrospective design

#### 3.3.1.2: Pilot Study

This was conducted for the first month of data collection (January to February 2023). During the pilot, the student investigator physically visited the study sites on data collection days to oversee the data collection process. One change was made to the data collection tool during the pilot. Under the section of "Baseline health status before this hospitalization", a sub-section of "Moderate disability", the description was amended to read "Conscious and able to perform most age-appropriate activities of daily living but cannot do all physical activities because of a mild physical/ mental disability". The reason for this change was because the pilot highlighted a group of children who would be left out with the initial formatting of this description and yet they did not fit in any of the other categories either. No other changes were made to the data collection tool and data collected during this period was included in the final study sample and analysis.

#### 3.3.1.3: Sampling

***Inclusion criteria***

This was a sample of convenience of all children being managed in the study site ICUs on data collection days, aged 1 month to 18 years.

***Exclusion criteria***

Neonates in the first 28 days of life were excluded because they are a different group biologically and their physiotherapy needs may differ from older infants and children.

### 3.3.2: Study sites

The research study was planned to be conducted in five health facilities within the central region of Uganda:

#### *3.3.2.1: Mulago National Referral Hospital*

This is a government hospital and the biggest health facility in the country, with the highest level of specialization and consultants. It is a teaching hospital attached to Makerere University, and a center of excellence for patient care, training of health professionals, and research. The hospital has a 41-bed intensivist-led shared ICU with 14 beds dedicated to paediatric patients. Ventilator support for paediatric beds fluctuates based on ICU demand and there are no dedicated ventilators for children.

#### *3.3.2.2: Uganda Heart Institute*

This is a public, tertiary, specialized medical facility managed by the Uganda Ministry of Health and located in Kampala. It specializes in treating cardiovascular conditions for both adults and children. It has a 4-bed intensivist led shared ICU. All beds have ventilator support.

#### *3.3.2.3: Lubaga Hospital*

This is a private not-for-profit hospital funded mostly by donors, with some funding from the government to provide services at a subsidized rate to the general population. It is a teaching hospital with training programs for different health professionals. It has a 4-bed intensivist led shared ICU. All beds have ventilator support.

#### *3.3.2.4: Nakasero Hospital*

This institution is a private for-profit hospital in Kampala, with a 4-bed intensivist-led, shared adult/paediatric ICU and full ventilator support.

#### *3.3.2.5: Children's Surgical Hospital Entebbe*

This is a private non-profit hospital that specializes in surgeries for children. It is partially funded by the government and other donors to give free paediatric surgical care and is a point of reference for elective paediatric surgery in Uganda and nearby countries. It has a 6-bed intensivist led PICU with ventilator support on all the beds

### 3.3.2.6: Study sites participation

All proposed study sites were approached for administrative clearance to take part in the study. Four of the five study sites accepted to take part in the study and gave proof of administrative clearance (Appendix B). Children's Surgical Hospital Entebbe did not respond to the invitation to be part of the study.

Lubaga Hospital accepted to take part in the study and gave administrative clearance however, no eligible participants were admitted to this ICU during the study period. This may have been partly because the ICU was closed during the last two months of data collection for renovations. As such, no data were collected from this study site.

### 3.3.2.7 Physiotherapy practice at the study sites

At all the sites that took part in this study, there is no specific guidance on how physiotherapists get involved in the management of patients in the ICU. For certain patients, referrals or "permission" may be required from physicians before intervention from the PT but sometimes physiotherapists may assess and manage patients without referral from physicians. None of the study sites have protocols in place to streamline practice.

### 3.3.3: Data analysis

The data were analyzed using IBM SPSS Statistics version 28.0.1.1 (14). The data were tested for normality using the Shapiro Wilks W test. Continuous data are presented in the results as median (interquartile range), as appropriate for non-parametric data. Categorical data are presented as frequencies and percentages of total. Descriptive results are also presented graphically where appropriate.

Univariate comparisons between patients who ever or never received physiotherapy during their ICU admission, and between those who received or did not receive physiotherapy in the preceding 24 hours, were conducted using Mann-Whitney U tests for continuous variables and chi-square tests, or Fishers exact tests where appropriate, for categorical variables. Chi-square tests were also used to evaluate the effect of age category and level of respiratory support on the physiotherapy interventions received. Variables found to be significantly associated with the outcomes of ever/never received physiotherapy and received physiotherapy in the past 24 hours, on univariate analysis, were entered into a best-fit multivariable stepwise regression model, to determine independent associative factors for receipt of physiotherapy. Considerations were made to avoid multi-collinearity and only appropriate variables were accordingly entered into the final regression model.

A p-value of less than 0.05 was considered significant ($p < 0.05$).

### 3.3.4: Ethical considerations

This study adhered to the requirements set out in the Declaration of Helsinki (2013), as well as the South African Department of Health: Ethics in Health Research: Principles, Structures and Processes, 2015.

#### 3.3.4.1: Recruitment and enrolment

The researcher motivated for and received a waiver of the need for informed consent from the parents/guardians of the children who took part in the study, considering this was a non-interventional study of routinely collected data, and the study would not have been feasible to conduct without the waiver. On-site physiotherapists were trained in the data collection method and asked to complete the data collection forms according to current admissions on study days. Where guardians were present at the bedside, verbal explanation and assent was obtained by the site research assistants, with the option to verbally opt out of the study.

#### 3.3.4.2: Independent review

Permission to conduct the research was received from the University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee, HREC REF: 768/2022 (Appendix C); in addition, the researcher was granted ethical approval and institutional approval from the Ugandan study sites. (Appendix C)

#### 3.3.4.3: Confidentiality and privacy

Only data relevant to the research topic was extracted and identifiers were coded to conceal any linkages to actual patients. All other patient anonymity procedures were followed to ensure patients' identities were protected. Completed data collection tools were collected by the researcher from the study sites every week and stored in a secure facility. The researcher pledged to uphold participants' privacy and confidentiality in writing. The anonymity of participants' information was ensured by not capturing individual participants' identities on the data collection tools. Participant identifiers were replaced by a code (study number) for all data analysis and sharing. The findings of the study will be communicated to all participating study sites.

#### 3.3.4.3: Risks and benefits

The study was purely descriptive of standard practice, with no participant interventions, which minimizes the risk of physical research-related harm to patients. The only foreseeable risks

involve potential breaches of confidentiality; however, measures were in place to minimise this risk.

Although there was no direct benefit to study participants, the findings of this research provide a foundation for the improvement of the provision of physiotherapy to critically ill children in Uganda, thereby potentially improving care for future patients. By understanding the current situation, paediatric physiotherapy practice in Ugandan ICUs can be benchmarked against practices and evidence-based recommendations from other parts of the world, to identify areas to target for practice improvement.

#### 3.3.4.4: Reimbursement for participation

Participants were not reimbursed for their study participation as the research did not require any additional patient time, inconvenience, or interventions.

### 3.4: What happens at the end of a study?

At the end of the Master's study, a summary report will be compiled, including its purpose, findings, and conclusions. This report will be circulated to the health facilities that took part in the study, specifically the respective physiotherapy departments and all institutions training physiotherapists in the country.

Mechanisms will be created to communicate the findings of this study to the multidisciplinary team managing patients in critical care settings, including doctors, nurses, and intensivists, to facilitate better integration of physiotherapy in Ugandan PICU practice.

The study findings will be submitted to a peer-reviewed Journal for publication, and presented at a local and/or international congress.

# CHAPTER 4: RESULTS

The results of the study are presented in this chapter.

The study aimed to describe the provision of physiotherapy services for children in ICUs at five study sites in Uganda. One study site did not consent to the study, and another study site did not have any children admitted to the ICU throughout the study period. Therefore, the results presented are from three study sites namely: Mulago National Referral Hospital (MNRH), Uganda Heart Institute (UHI), and Nakasero Hospital (NAK).

## 4.1: Characteristics of children admitted to ICUs

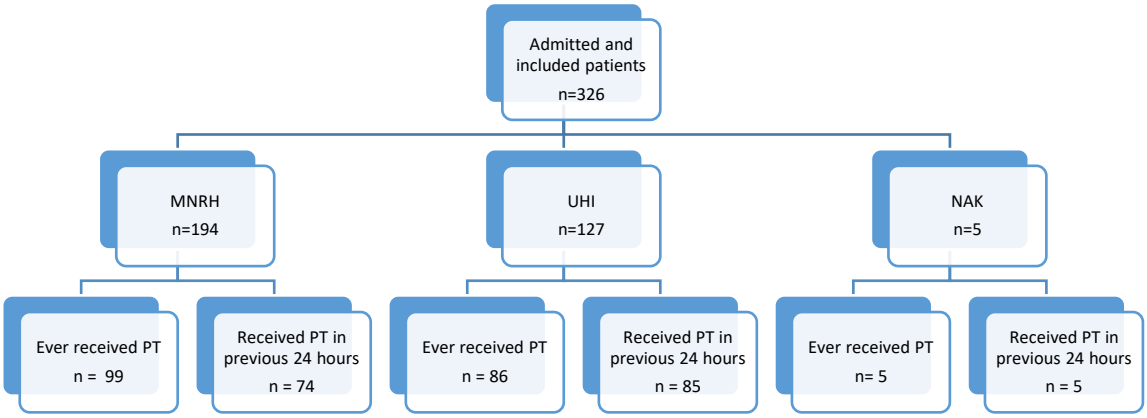


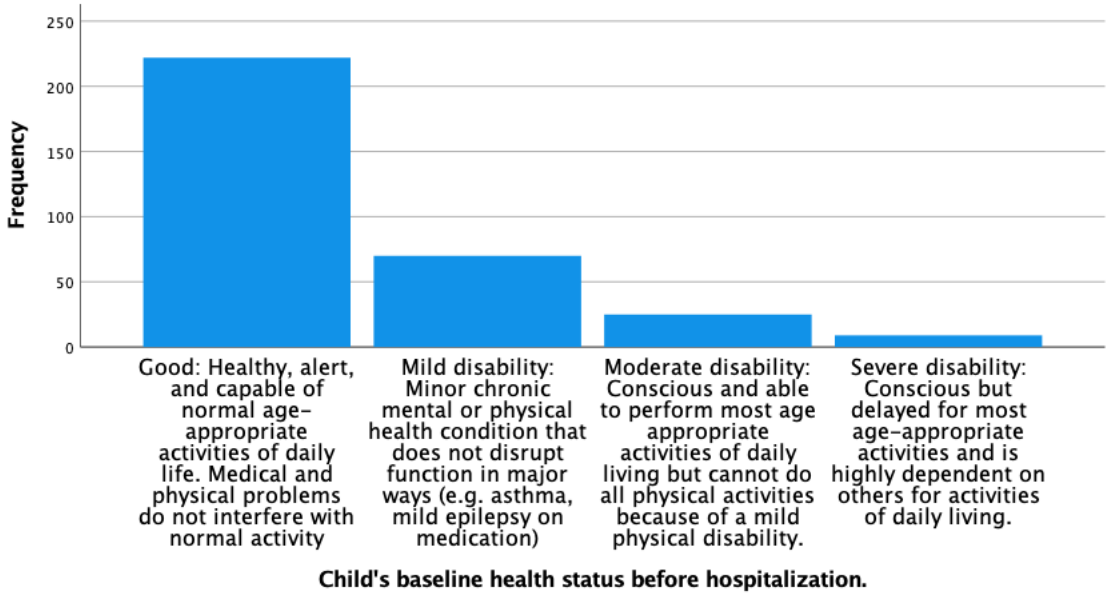

**Figure 4.1: Participant flow through the study.**

MNRH = Mulago National Referral Hospital; UHI = Uganda Heart Institute= ; NAK = Nakasero Hospital

A total of 326 patients (n=161; 49.4%) male); were enrolled in the study, on median (IQR) ICU Day 4.0 (2.0 – 8.0) (Figure 4.1; Table 4.1). The majority of children (n=207; 63.5%) were two years of age or younger. Mulago National Referral Hospital (MNRH) received the highest number of admissions (n=194, 59.5%) out of the total number of patients recruited into the study (n=326), followed by Uganda Heart Institute (n=127, 39.0%), and Nakasero hospital (NAK) (n=5, 1.5%) (Figure 4.1).

Most of the children had a good health status before admission (n=222, 68.1%); very few children had a severe disability before admission (n=9, 2.5%) (Figure 4.2; Table 4.2). The majority of children were admitted for management of a neurological condition (n=134,

41.1%), followed by cardiac surgery (n=106, 32.5%) and respiratory disease (n=89, 27.3%). Most patients were receiving invasive mechanical ventilation (IMV) on study days (n= 214, 65.6%) and the majority (n= 139; 42.6%) had Glasgow Coma Scores (GCS) of 11-15. Of the 326 included patients, 190 (58.3%) had received at least one physiotherapy treatment during their ICU admission, at a median (IQR) ICU day 3 (1-7) (Table 4.1; Figure 4.3), with 164 (50.3 %) having received physiotherapy within the preceding 24 hours (Table 4.2).




***Baseline health status adapted from the Pediatric Cerebral Performance Category Scale***

**Figure 4.2: Pre-admission health status**

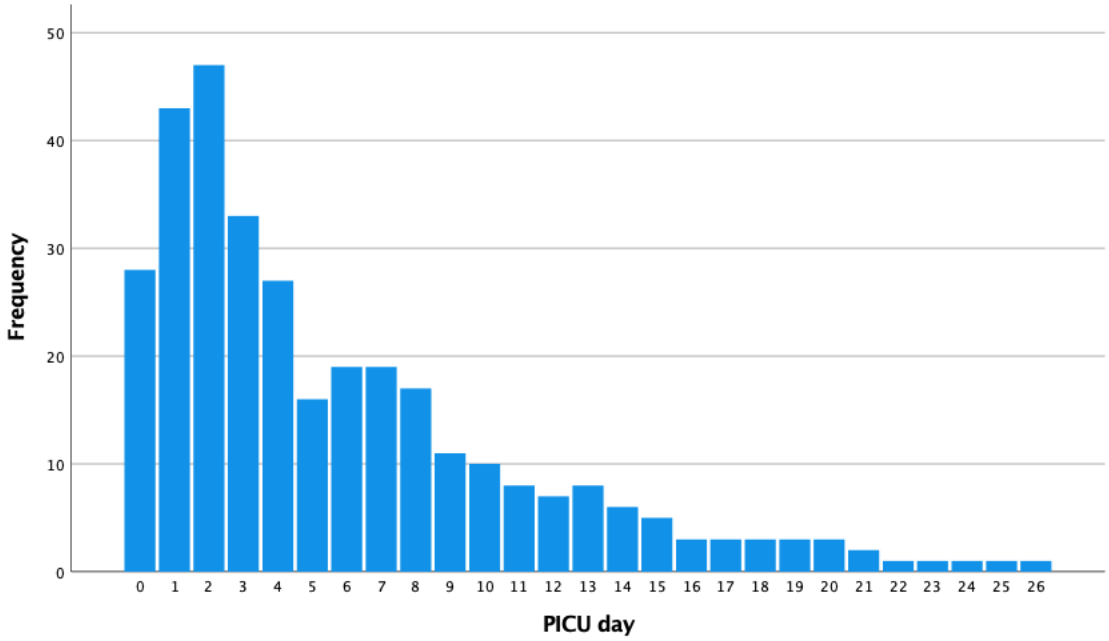



**Figure 4.3: Frequency of receiving physiotherapy treatment based on PICU day of first treatment, in those who ever had PT treatment during their ICU stay (n=190)**

There was a significant association between both study sites ($p = 0.002$) and primary admission diagnosis ($p < 0.001$) and the likelihood of ever having received physiotherapy during the ICU admission (Table 4.1).

A multivariable binary regression analysis was done to determine the association between the study site and primary admission diagnostic category on the likelihood of ever receiving physiotherapy treatment during the ICU admission. The model was significant ($p < 0.001$), a reasonable fit for the data (Nagelkerke $R^2 = 0.26$), and it was able to correctly predict 65% of cases. Neither the study site nor any specific admission diagnostic category was independently associated with receiving physiotherapy at any time during the ICU admission.

**Table 4.1 – Admission characteristics comparing patients who ever vs. never received physiotherapy treatment during their admission.**

| | **All patients n=326** | **Ever received PT n= 190** | **Never received PT n= 136** | **p (ever vs never received PT)** |
|---|---|---|---|---|
| **Study site** | | | | |
| MNRH | 194 (59.5) | 99 (52.1) | 95 (69.9) | 0.002 |
| UHI | 127 (39.0) | 86 (45.3) | 41 (30.1) | |
| NAK | 5 (1.5) | 5 (2.6) | 0 | |
| **Age group** | | | | |
| 0-2 years | 207 (63.5) | 121 (63.7) | 86 (63.2) | 0.1 |
| 3-6 years | 66 (20.2) | 43 (22.6) | 23 (16.9) | |
| 7-12 years | 36 (11.0) | 15 (7.9) | 21 (15.4) | |
| 13 – 18 years | 17 (5.2) | 11 (5.8) | 6 (4.4) | |
| Male sex | 161 (49.4) | 96 (50.5) | 65 (47.8) | 0.6 |
| **Pre-admission health status** | | | | |
| Good | 222 (68.1) | 139 (73.2) | 83 (61.0) | 0.09 |
| Mild disability | 70 (21.5) | 33 (17.4) | 37 (27.2) | |
| Moderate disability | 25 (7.7) | 12 (6.3) | 13 (9.6) | |
| Severe Disability | 9 (2.8) | 6 (3.2) | 3 (2/2) | |
| **Primary admission diagnostic category*** | | | | |
| Cardiac surgery | 106 (32.5) | 84 (44.2) | 22 (16.2) | <0.001 |
| Neurosurgery | 28 (8.6) | 18 (9.5) | 10 (7.4) | |

| | | | | |
|---|---|---|---|---|
| Cardiology | 25 (7.7) | 6 (3.1) | 19 (13.9) | |
| Infection/sepsis | 38 (11.7) | 12 (6.3) | 26 (19.1) | |
| Respiratory | 89 (27.3) | 40 (21.0) | 49 (36.0) | |
| Neurology | 134 (41.1) | 65 (34.2) | 69 (50.7) | |
| Renal | 4 (1.2) | 4 (2.1) | 0 (0) | |

**Some patients had more than one primary admission diagnosis*

**MNRH**- Mulago national Referral Hospital, **UHI**- Uganda Heart Institute, **NAK**- Nakasero Hospital

**Table 4.2 - Patient characteristics comparing those who received PT in the past 24 hours vs those who were not treated**

| | **All patients n=326** | **Received PT in the past 24 hours n=164** | **Did not receive PT in the past 24 hours n=162** | **P (PT in the past 24 hours)** |
|---|---|---|---|---|
| **Study site** | | | | |
| MNRH | 194 (59.5) | 74 (45.1) | 120 (74.1) | <0.001 |
| UHI | 127 (39.0) | 85 (51.8) | 42 (25.9) | |
| NAK | 5 (1.5) | 5 (3.0) | 0 | |
| **Age group** | | | | |
| 0-2 years | 207 (63.5) | 97 (59.1) | 110 (67.9) | 0.03 |
| 3-6 years | 66 (20.2) | 39 (23.8) | 27 (16.7) | |
| 7-12 years | 36 (11.0) | 15 (9.1) | 21 (13.0) | |
| 13 – 18 years | 17 (5.2) | 13 (7.9) | 4 (2.5) | |
| Male sex | 161 (49.4) | 85 (51.8) | 76 (46.9) | 0.4 |
| PICU day | 4.0 (2.0 – 8.0) | 5.0 (2.0 – 12.0) | 3.0 (1.0 – 7.0) | <0.001 |
| Underwent surgery during PICU admission | 133 (40.8) | 97 (59.1) | 36 (22.2) | <0.001 |
| Postop day | 2.0 (1.0 – 6.0) | 3.0 (2.0 – 7.0) | 1.0 (0 – 3.0) | <0.001 |
| **Pre-admission health status** | | | | |
| Good | 222 (68.1) | 117 (71.3) | 105 (64.8) | 0.3 |
| Mild disability | 70 (21.5) | 31 (18.9) | 39 (24.1) | |

| | | | | |
|---|---|---|---|---|
| Moderate disability | 25 (7.7) | 10 (6.1) | 15 (9.3) | |
| Severe Disability | 9 (2.8) | 6 (3.7) | 3 (1.9) | |
| **Primary admission diagnostic category** | | | | |
| Cardiac surgery | 106 (32.5) | 81 (49.4) | 25 (15.4) | <0.001 |
| Neurosurgery | 28 (8.6) | 17 (10.4) | 11 (6.8) | |
| Cardiology | 25 (7.7) | 6 (3.7) | 19 (11.7) | |
| Infection/sepsis | 38 (11.7) | 10 (6.1) | 28 (17.3) | |
| Respiratory | 89 (27.3) | 27 (16.5) | 62 (38.3) | |
| Neurology | 134 (41.1) | 49 (29.9) | 85 (52.5) | |
| Renal | 4 (1.2) | 4 (2.4) | 0 | |
| **Type of respiratory support on study day** | | | | |
| Invasive mechanical ventilation | 214 (65.6) | 83 (50.6) | 131 (80.9) | <0.001 |
| Nasal cannula or FM oxygen | 68 (20.9) | 53 (32.3) | 15 (9.3) | |
| NIV-CPAP or BiPAP | 23 (7.1) | 12 (7.3) | 11 (6.8) | |
| None | 21 (6.4) | 16 (9.8) | 5 (3.1) | |
| **Glasgow coma score** | | | | |
| 1-4 | 6 (1.8) | 0 | 6 (3.7) | <0.001 |
| 5-10 | 119 (36.5) | 40 (24.4) | 79 (48.8) | |
| 11-15 | 139 (42.6) | 86 (52.4) | 53 (32.7) | |
| Sedated | 23 (7.1) | 4 (2.4) | 5 (3.1) | |

| | | | | |
|---|---|---|---|---|
| Not recorded | 39 (12.0) | 34 (20.7) | 5 (3.1) | |
| **Attachments on study day** | | | | |
| Arterial line | 321 (98.5) | 159 (97.0) | 162 (100) | <0.001 |
| Surgical drain | 31 (9.5) | 21 (12.8) | 10 (6.2) | |
| Urinary catheter | 261 (80.1) | 119 (72.6) | 142 (87.7) | |
| ICD | 69 (21.2) | 49 (21.7) | 20 (12.3) | |
| Central venous line | 258 (79.1) | 123 (75.0) | 135 (83.3) | |
| Hemodialysis catheter | 4 (1.2) | 4 (100) | 0 | |
| ETT | 201 (61.6) | 71 (43.3) | 130 (80.2) | |
| Tracheostomy | 17 (3.2) | 17 (4.5) | 0 | |
| | | | | |

***Continuous data are presented as median (IQR) and categorical data as n (%)***

**PICU**- Paediatric Intensive Care Unit, **FM**- Face Mask, **NIV**- Non Invasive Ventilation, **CPAP**- Continuous Positive Airway Pressure, **BiPAP**- Bilevel Positive Airway Pressure, **ICD**- Intercostal Drain, **ETT**- Endotracheal Tube

### 4.2: Characteristics of patients who received physiotherapy in the 24 hours preceding the study day (Table 4.2)

Uganda Heart Institute had the highest number of children receiving physiotherapy treatment in the 24 hours preceding data collection (n=85, 51.8%; $p < 0.001$) (Figure 4.1). A greater proportion of children in the 0-2 years age group (n=97, 59.1%) received physiotherapy compared to other age groups ($p = 0.03$). Children who received physiotherapy during the preceding 24 hours had spent longer in ICU (median (IQR) 5 (2-12) days vs. 3 (1-7) days; $p < 0.001$) and a greater proportion had undergone surgery (59.1% vs. 22.2%; $p < 0.001$) compared to those who did not receive physiotherapy. For patients who had undergone surgery, those who received physiotherapy were at a significantly longer duration post-operatively on study days (3 (2-7) days vs. 1 (0 – 3) days; $p <0.001$). Primary admission diagnostic categories were

significantly different between those who did and did not receive physiotherapy during the preceding 24 hours ($p < 0.001$), with post-cardiac surgery, followed by neurology and respiratory categories as the most common admission diagnostic categories amongst children receiving physiotherapy. Glasgow coma scores (GCS) also differed significantly between treated and untreated groups, with a lower proportion of children with GCS <11 receiving treatment in the preceding 24 hours. Only six children had a GCS score range of 1-4 (1.8%) and none of these had received physiotherapy treatment within the previous 24 hours (Table 4.2).

The type of respiratory support differed significantly between patients who received physiotherapy during the preceding 24 hours ($p < 0.001$) and those who did not, with fewer patients in the physiotherapy group on IMV (50.6% vs. 80.9%) and a greater proportion of those on nasal cannula or facemask oxygen (32.3% vs. 9.3%). Invasive attachments also differed significantly between groups who had received physiotherapy during the preceding 24 hours and those who had not ($p < 0.001$), with a greater proportion of patients receiving physiotherapy having intercostal drains (ICD) and a lower proportion being intubated compared to the group who had not received physiotherapy (Table 4.2).

A multivariable stepwise backward binary regression analysis was conducted to determine the association between study site, age group, primary admission diagnostic category, attachments, GCS, type of respiratory support, and PICU day on the likelihood of referral to physiotherapy services. The model was significant ($p < 0.001$) and a good fit for the data (Nagelkerke $R^2 = 0.63$) and was able to correctly predict 81% of cases.

Being admitted for the management of infection was independently associated with increased odds of being treated by a physiotherapist in the 24 hours preceding the study day (adjusted OR 10.4, 95% CI 1.7 – 63.1; $p = 0.01$) and increasing time in the ICU was also independently associated with increased odds of receiving PT (OR 1.4; 95% CI 1.2 – 1.5; $p < 0.001$). None of the other variables in the initial model were significantly associated with having received physiotherapy over the previous 24 hours.

**4.3: Details of physiotherapy referral and treatment practice (Table 4.3)**

*Referral patterns*

Of the 164 (50.3%) patients who had received physiotherapy during the previous 24 hours, the majority (132; 80.5%) were referred by attending doctors, with only one child seen by a physiotherapist at the request of the caregiver (Table 4.3). Patients were referred for

physiotherapy assessment and treatment on median (IQR) ICU day 3 (1-7) (Figure 4.4). More than 60% of patients were referred for physiotherapy within 48 hours of admission (Figure 4.4).

*Frequency*

Most patients had received physiotherapy treatment once during the past 24 hours (n=117, 71.3%), with 26.8% (n = 44 ) of patients receiving physiotherapy twice and 1.8% (n= 3) receiving physiotherapy three times over the past 24 hours (Table 4.3).

*Perceived barriers or contraindications*

Being considered "medically unstable" was the most common reason for patients not having received physiotherapy (n=79, 48.8%), followed by there being "no physiotherapist available" (n =28; 17.3%), and doctors' orders ("doctor forbade physiotherapy") (n =14; 8.6%). "Perceived risk of dislodging attachments" was the least common reason for patients not receiving physiotherapy treatment (n =1; 0.6%) (Table 4.3).

*Treatment modalities*

Treatment modalities from each of the categories of "chest physiotherapy" and "rehabilitation", were used to treat patients in varying quantities. Multimodal therapy was common. Nearly all patients who had received treatment in the preceding 24 hours were treated with at least one technique from each of the two categories of CPT and rehabilitation (n=161; 98.1%), and no patient was treated with just one treatment technique. Only four patients were treated with two modalities and the highest number of treatment modalities used on one patient was 13 (n=1). Most patients were treated with 3 modalities and above; 3 modalities (n= 10), 4 modalities (n= 31), 5 modalities (n= 46), 6 modalities (n= 39), 7 modalities (n= 14), 8 modalities (n= 10), 9 modalities (n= 5), 1 patient was treated with 10, 11, 12 and 13 modalities respectively. Percussions and vibrations were the most common treatment modalities used in 147 (89.6%) and 145 (88.4%) cases respectively, followed by suctioning (n= 114; 69.5%) and positioning for respiratory management (n= 105; 64.0%). None of the patients received manual or ventilator hyperinflation and only one patient received cough assistance/augmentation. One patient was positioned in a head-down inverted postural drainage position.

Passive limb exercises in bed were the most frequently used mobilization exercises (n=104, 63.4%) followed by sitting up in bed (n=63, 38.4%). In-bed mobility exercises and transfer out

of a unit in bed or chair were the least commonly performed rehabilitation activities (n=1, 0.6% each) (Table 4.3; Figure 4.5).

**Table 4.3: Details of physiotherapy referral and treatments in those who had received physiotherapy in the preceding 24 hours (n=164)**

| | |
|---|---|
| **Person making PT referral (n=164)** | |
| Doctor | 132 (80.5) |
| Self-referral by PT | 28 (17.1) |
| Other ICU staff | 3 (1.8) |
| Patient/caregiver request | 1 (0.6) |
| **Number of PT treatments in the past 24 hours (n=164)** | |
| Once | 117 (71.3) |
| Twice | 44 (26.8) |
| Three times | 3 (1.8) |
| **Reason for not receiving PT n=162** | |
| Perceived contraindication | 5 (3.1) |
| Documented as medically unstable | 79 (48.8) |
| No clinical indication | 10 (6.2) |
| No PT available | 28 (17.3) |
| No referral received | 10 (6.2) |
| Doctor forbade PT | 14 (8.6) |
| Post-op restrictions | 11 (6.8) |
| Perceived risk of dislodging attachments | 1 (0.6) |
| Other – patient just back from theatre | 4 (2.5) |
| **CPT intervention received (n=164)** | |

| | |
|---|---|
| Percussions | 147 (89.6) |
| Vibrations | 145 (88.4) |
| Rib springing | 3 (1.8) |
| Positioning | 105 (64.0) |
| Head-down PD | 1 (0.6) |
| ACBT | 11 (6.7) |
| PEP | 24 (14.6) |
| Autogenic drainage | 1 (0.6) |
| Suctioning | 114 (69.5) |
| Assisted cough | 1 (0.6) |
| DBE | 15 (9.1) |
| Incentive spirometry | 12 (7.3) |
| MH | 0 |
| **Rehab/mobilization activities** | |
| Passive limb ex in bed | 104 (63.4) |
| Active limb ex in bed | 19 (11.6) |
| In-bed mobility (rolling, bridging, up/down, etc) | 1 (0.6) |
| Sitting up in bed | 63 (38.4) |
| Sitting over the edge of the bed | 19 (11.6) |
| T/F out of bed to sit in a chair | 20 (12.2) |
| Standing out of bed | 17 (10.4) |
| Pre-gait exercises (e.g. crawling, cruising, supp. Standing, etc) | 3 (1.8) |
| Walking in PICU | 21 (12.8) |

| | |
|---|---|
| Walking out of the PICU | 18 (11.0) |
| Transfer out of PICU in w/chair or bed | 1 (0.6) |
| Resisted exercises | 2 (1.2) |
| NDT | 2 (1.2) |
| Splinting | 11 (6.7) |
| Passive stretches | 13 (7.9) |
| Repositioning | 3 (1.8) |

***Data are presented as n (%)***

PT- Physiotherapy, CPT- Chest Physiotherapy, PD- Postural Drainage, ACBT- Active Cycle of Breathing Technique, PEP- Positive Expiratory Pressure, DBE- Deep Breathing Exercises, MH- Manual Hyperinflation, T/F- Transfer, NDT- Neurodevelopmental Therapy

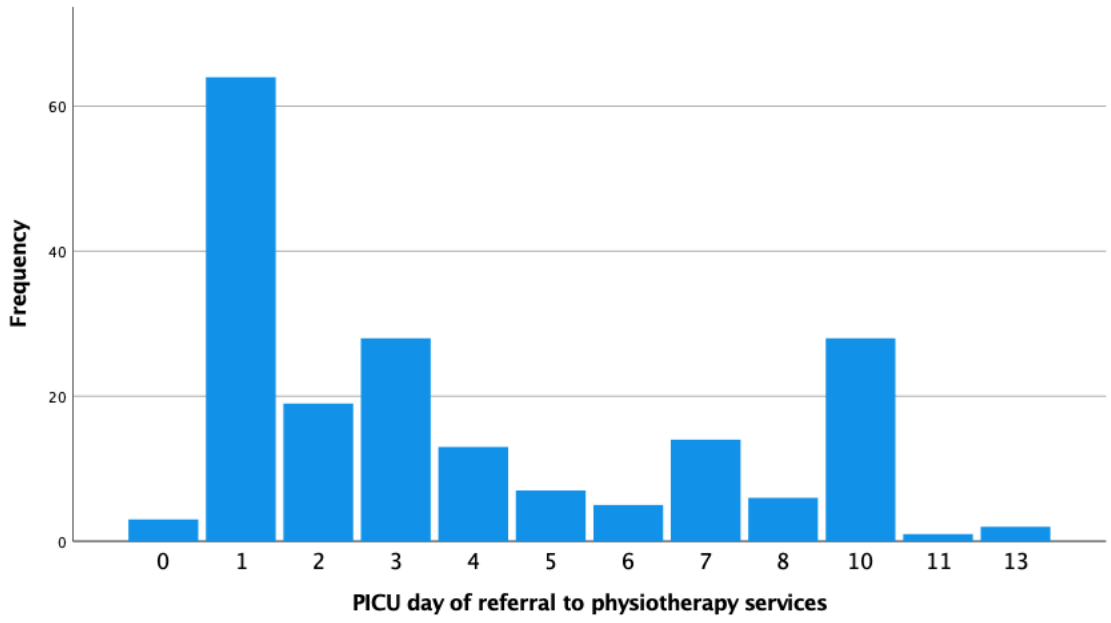



**Figure 4.4: PICU day of referral for physiotherapy services**

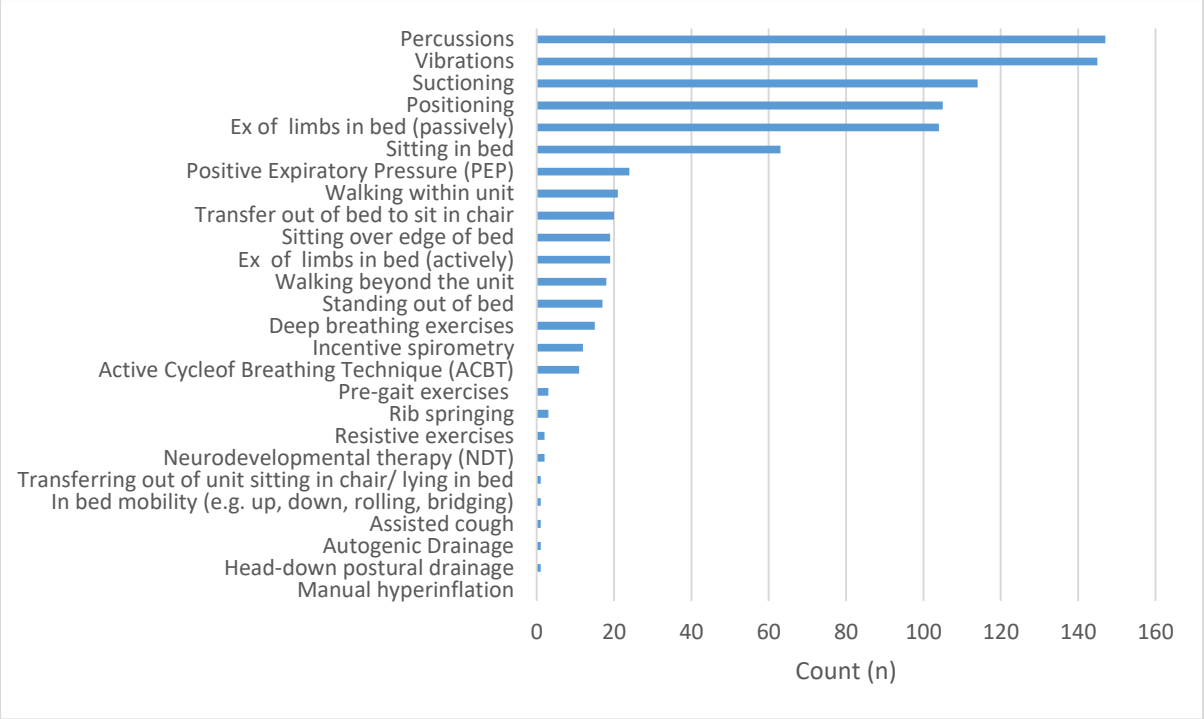



**Figure 4.5: Physiotherapy techniques used**

### 4.4: Chest Physiotherapy modalities by age group (Table 4.4)

Conventional chest physiotherapy techniques (percussions and vibrations), were common among all age groups. Active chest physiotherapy techniques, including ACBT, PEP therapy, deep breathing exercises, and incentive spirometry were all more common among older children in the 7- 12 years and 13- 18 years age groups ($p < 0.001$) (Table 4.4; Figure: 4.6)

**Table 4.4: "Chest physiotherapy" modalities by age group**

| | **0-2 years n=207** | **3-6 years n=66** | **7-12 years n=36** | **13-18 years n=17** | **P** |
|---|---|---|---|---|---|
| Percussion | 91 (44.0) | 34 (48.5) | 14 (38.9) | 8 (47.1) | 0.62 |
| Vibrations | 89 (43.0) | 34 (51.5) | 14 (38.9) | 8 (47.1) | 0.57 |
| Rib springing | 2 (1.0) | 1 (1.5) | 0 | 0 | 0.86 |
| Positioning | 65 (31.4) | 26 (39.4) | 9 (25) | 5 (29.4) | 0.47 |
| Head down PD | 0 | 0 | 1 (2.8) | 0 | - |

| | | | | | |
|---|---|---|---|---|---|
| ACBT | 1 (0.5) | 1 (1.5) | 4 (11.1) | 5 (29.4) | <0.001 |
| PEP therapy | 9 (4.3) | 6 (9.1) | 4 (11.1) | 5 (29.4) | 0.001 |
| Autogenic drainage | 1* (0.5) | 0 | 0 | 0 | - |
| Suctioning | 71 (34.3) | 32 (48.5) | 7 (19.4) | 4 (23.5) | 0.02 |
| Assisted cough | 0 | 0 | 1 (0.5) | 0 | - |
| DBE | 1 (0.5) | 1 (1.5) | 5 (13.9) | 8 (47.1) | <0.001 |
| Incentive spirometry | 0 | 3 (4.5) | 4 (11.1) | 5 (29.4) | <0.001 |

**PD**= Postural Drainage, **ACBT**= Active Cycle of Breathing Technique, **PEP**= Positive Expiratory Pressure, **DBE**= Deep Breathing Exercises

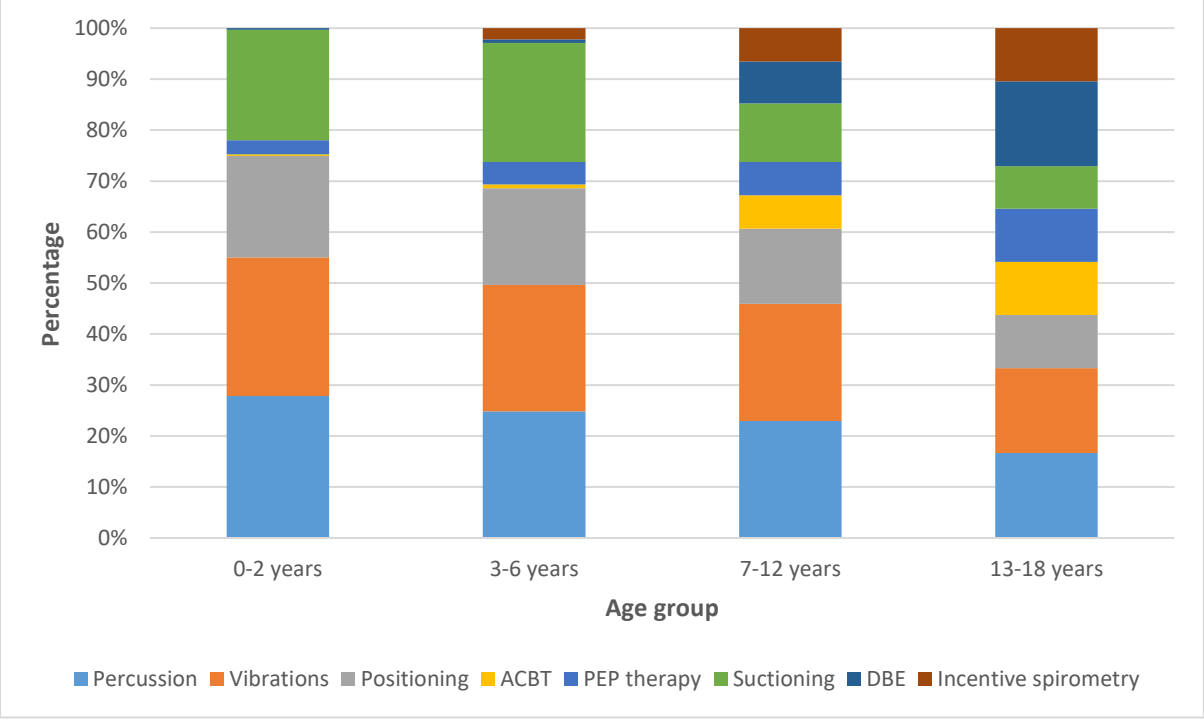



**Figure 4.6: Chest physiotherapy techniques by age group.**

**ACBT =** Active Cycle of Breathing Technique**; PEP =** Positive Expiratory Pressure**; DBE =** Deep Breathing Exercises

### 4.5: Rehabilitation/ Mobilization activities by age group (Table 4.5)

Passive limb ROM exercises were more commonly performed in the two younger cohorts ($p = 0.002$), whilst out-of-bed mobility activities were more common in the older patient groups ($p < 0.05$) (Table 4.5; Figure 4.7.).

**Table 4.5: Rehabilitation activities by age group**

| | **0-2 years n=207** | **3-6 years n=66** | **7-12 years n=36** | **13-18 years n=17** | **P** |
|---|---|---|---|---|---|
| Passive limb ROM in bed | 73 (35.3) | 26 (39.4) | 4 (11.1) | 1 (5.9) | 0.002 |
| Active limb ROM in bed | 9 (4.3) | 5 (7.6) | 2 (5.6) | 3 (17.6) | 0.14 |
| In-bed mobility ex (eg rolling, bridging, up and down bed) | 0 | 0 | 1 (2.8) | 0 | - |
| Sitting in bed | 39 (18.8) | 12 (18.2) | 7 (19.4) | 5 (29.4) | 0.75 |
| Sitting over the edge of the bed | 9 (4.3) | 4 (6.1) | 4 (11.1) | 2 (11.8) | 0.29 |
| Transfer out of bed to sit in a chair | 6 (2.9) | 4 (6.1) | 5 (13.9) | 5 (29.4) | <0.001 |
| Standing out of bed | 7 (3.4) | 3 (4.5) | 4 (11.1) | 3 (17.6) | 0.03 |
| Pre-ambulatory exercises (eg crawling, cruising, etc) | 0 | 0 | 2 (5.6) | 1 (5.9) | - |
| Walking within PICU | 8 (3.9) | 4 (6.1) | 6 (9.1) | 3 (17.6) | 0.007 |
| Walking beyond the unit | 4 (1.9) | 4 (6.1) | 5 (13.9) | 5 (29.4) | <0.001 |
| Resistive exercises | 0 | 0 | 2 (5.6) | 0 | - |
| NDT | 2 (1.0) | 0 | 0 | 0 | - |

**ROM**= Range of Motion; **PICU**= Paediatric Intensive Care Unit; **NDT**= Neurodevelopmental Therapy

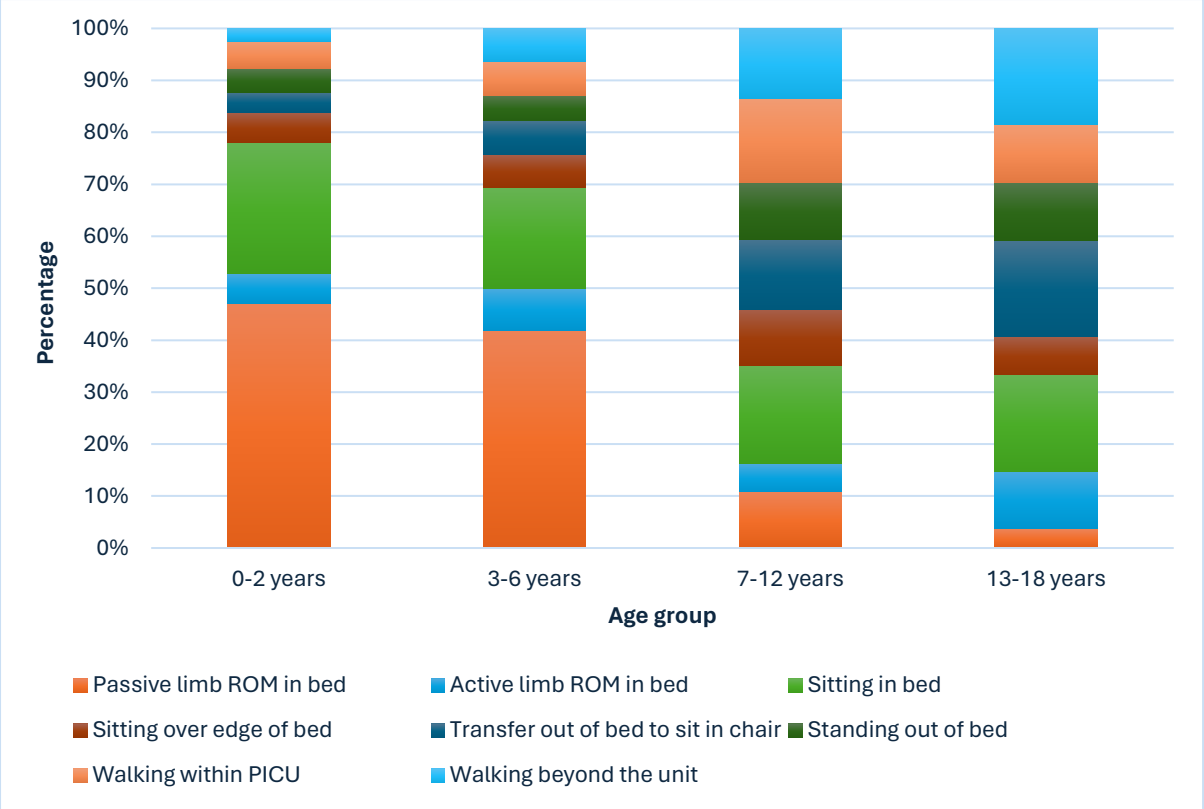



**Figure 4.7: Rehabilitation activities by age group.**

**ROM=** Range of Motion, **PICU=** Paediatric Intensive Care Unit

### 4.6: Chest Physiotherapy activities for children requiring respiratory support (Table 4.6)

There was a significant difference between the proportion of children on different levels of respiratory support receiving manual CPT techniques of percussion and ventilation, with fewer invasively ventilated children receiving these techniques ($p = 0.001$; Table 4.6; Figure 4.8). Active CPT techniques such as ACBT, DBE, PEP therapy, and incentive spirometry were performed more frequently amongst non-ventilated patients ($p < 0.001$). There was no difference in the proportions of children on different levels of ventilator support receiving suctioning. One child on NIV (4.3%) and eight children (11.8%) on face mask oxygen received incentive spirometry as a CPT activity.

**Table 4.6: Chest Physiotherapy activities by respiratory support**

| | **Invasive mechanical ventilation n=214** | **NIV (CPAP/BiPAP) n=23** | **Nasal cannula or face mask oxygen n=68** | **No respiratory support n=21** | **P** |
|---|---|---|---|---|---|
| Percussion | 83 (38.8) | 10 (43.5) | 45 (66.2) | 9 (42.9) | 0.001 |
| Vibrations | 78 (36.4) | 11 (47.8) | 45 (66.2) | 11 (52.4) | <0.001 |
| Rib springing | 0 | 0 | 2 (2.9) | 1 (4.8) | - |
| Positioning | 61 (28.5) | 11 (47.8) | 26 (38.2) | 7 (33.3) | 0.17 |
| Head down PD | 0 | 1 (4,3) | 0 | 0 | - |
| ACBT | 0 | 2 (8.7) | 6 (8.8) | 3 (14.3) | <0.001 |
| PEP therapy | 0 | 2 (8.7) | 15 (22.1) | 7 (33.3) | <0.001 |
| Autogenic drainage | 0 | 0 | 1 (1.5) | 0 | - |
| Suctioning* | 81 (37.9) | 7 (30.4) | 23 (33.8) | 3 (14.3) | 0.17 |
| Assisted cough | 1 (0.5) | 0 | 0 | 0 | - |
| DBE | 1 (0.5) | 0 | 11 (16.2) | 3 (14.3) | <0.001 |
| Incentive spirometry | 0 | 1 (4.3) | 8 (11.8) | 3 (14.3) | <0.001 |

**PD=** Postural Drainage; **ACBT**= Active Cycle of Breathing Technique; **PEP**= Positive Expiratory Pressure; **DBE**= Deep Breathing Exercises

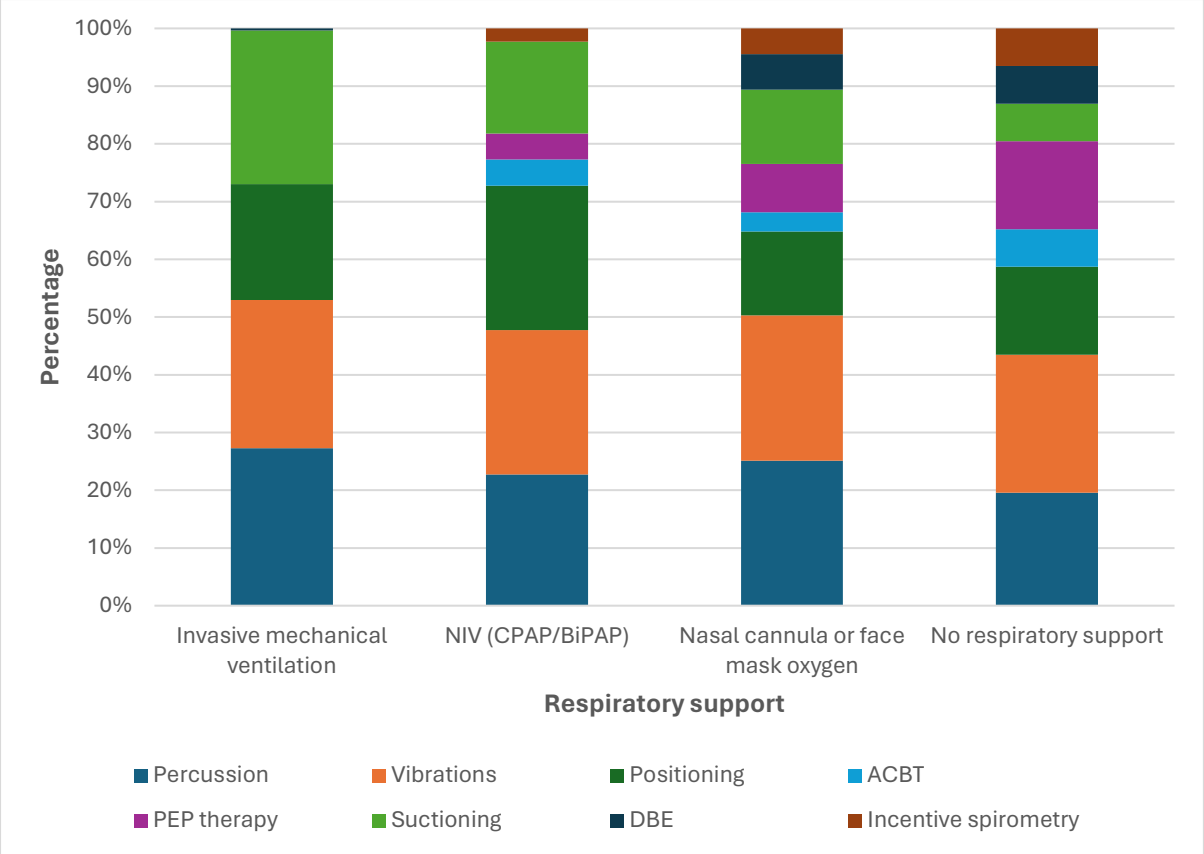



**Figure 4.8: Chest Physiotherapy techniques by respiratory support.**

**DBE =** Deep Breathing Exercises; **ACBT**= Active Cycle of Breathing Technique; **PEP**= Positive Expiratory Pressure

### 4.7: Rehabilitation activities by respiratory support (Table 4.7)

Although there was no significant difference in the proportion of children receiving different levels of respiratory support and receipt of passive mobilization (p = 0.4); the proportion of children receiving active limb exercises as well as out-of-bed activities increased with decreasing levels of respiratory support (Table 4.7; Figure 4.9). No patients on IMV and very few on NIV were mobilized out of bed. Sitting in bed was the highest level of functional mobilization in patients receiving IMV, but was only achieved in 10.7% (n=23) of this group; whilst only one invasively ventilated patient was mobilized to sitting over the edge of the bed.

**Table 4.7: Rehabilitation activities per respiratory support**

| | **Invasive mechanical ventilation n=214** | **NIV (CPAP/BiPAP) n=23** | **Nasal cannula or face mask oxygen n=68** | **No respiratory support n=21** | **P** |
|---|---|---|---|---|---|
| Passive limb ROM in bed | 75 (35.0) | 6 (26.1) | 17 (25.0) | 6 (28.6) | 0.4 |
| Active limb ROM in bed | 5 (0.8) | 2 (8.7) | 8 (11.7) | 4 (19.0) | 0.001 |
| In-bed mobility ex (eg rolling, bridging, up and down bed) | 0 | 0 | 1 (1.5) | 0 | - |
| Sitting in bed | 23 (10.7) | 8 (3.8) | 29 (42.6) | 3 (13.6) | <0.001 |
| Sitting over the edge of the bed | 1 (0.5) | 5 (21.7) | 10 (14.7) | 3 (13.6) | <0.001 |
| Transfer out of bed to sit in a chair | 0 | 3 (13.0) | 14 (20.6) | 3 (13.6) | <0.001 |
| Standing out of bed | 0 | 1 (4.3) | 13 (4.4) | 3 (13.6) | <0.001 |
| Pre-ambulatory exercises (eg crawling, cruising, etc) | 0 | 0 | 3 (4.4) | 0 | 0.009 |
| Walking within PICU | 0 | 1 (4.3) | 15 (22.1) | 5 (22.7) | <0.001 |
| Walking beyond the unit | 0 | 0 | 10 (14.7) | 8 (36.4) | <0.001 |
| Resistive exercises | 0 | 0 | 2 (2.9) | 0 | - |
| NDT | 0 | 0 | 2 (2.9) | 0 | - |

**NIV**= Non Invasive Ventilation, **CPAP**= Continous Positive Airway Pressure, **BiPAP**= Bilevel Positive Airway Pressure , **ROM**= Range of Motion, **NDT**= Neurodevelopmental Therapy

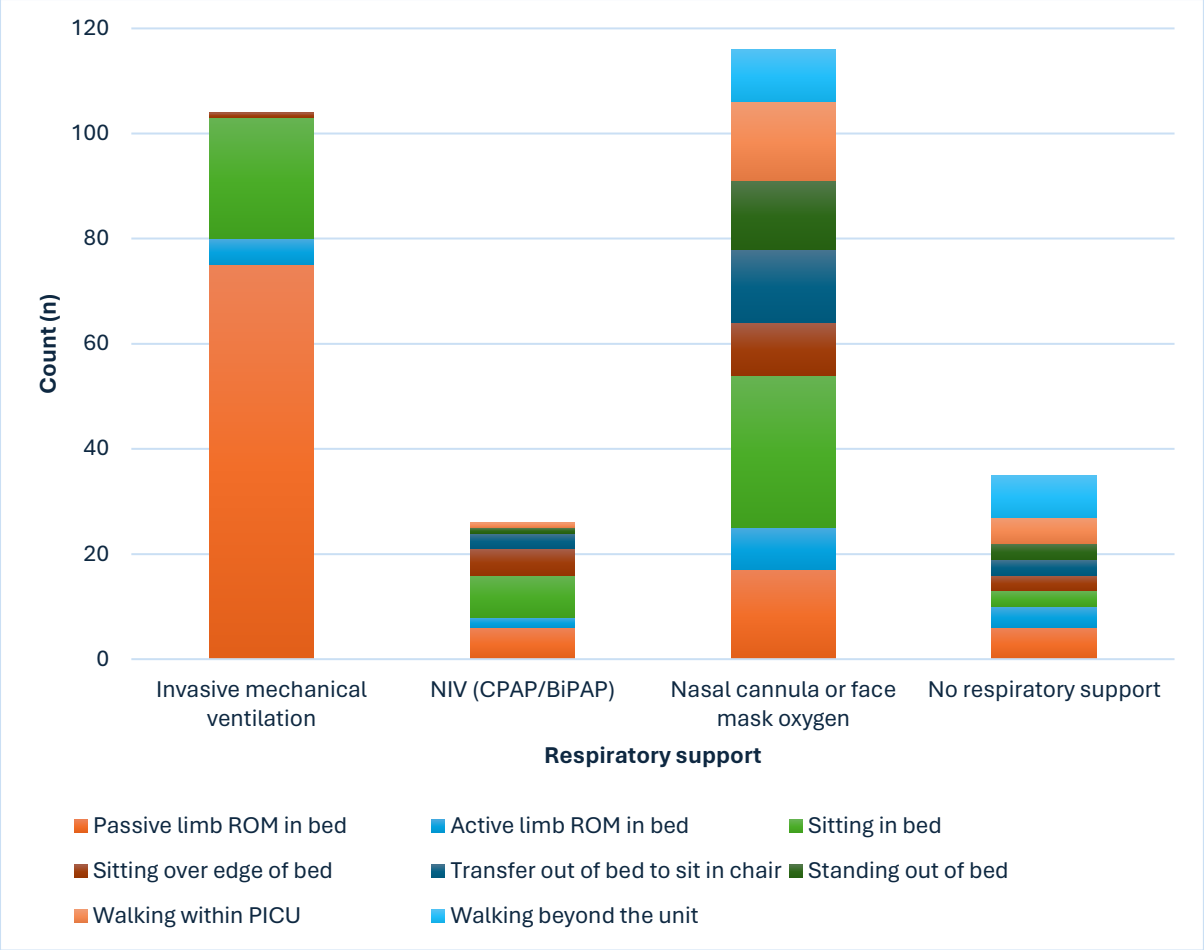



**Figure 4.9: Rehabilitation activities per respiratory support. ROM= Range of Motion**

# CHAPTER 5: DISCUSSION

This chapter discusses the findings and significance of the study in relation to existing literature, study limitations, and translation to clinical practice. In this chapter, the words rehabilitation and mobilization may be used interchangeably when referring to physiotherapy interventions

This study found that physiotherapy was only provided to nearly half the children admitted to the ICUs in the preceding 24 hours, with referral mostly by the ICU doctor. Physiotherapy treatment mostly comprised passive or manual techniques for both chest physiotherapy and rehabilitation/ mobilization activities, with out-of-bed mobilization activities preferred for older children, and no out-of-bed mobilization amongst children on invasive mechanical ventilation.

## 5.1: Patient characteristics

The majority of children were in the 0-2 year age group, with only 5% older than 13 years of age. This is an accurate reflection of the regional burden of disease in Uganda, where the under-five mortality is still unacceptably high at 64 deaths per 1000 live births (Uganda Bureau of Statistics, 2021), (UBOS and ICF, 2017). In other contexts, trends of age of children admitted to the ICU are mixed but the majority of studies from both high-income (Ista et al., 2020), (Kudchadkar et al., 2020), (Choong et al., 2021) and low-income settings (Nupen et al., 2016), (Musharraf et al., 2022) report the majority of PICU admissions are between 0- 5 years of age. The young age of this cohort highlights the need for strengthening public health measures to promote health and health seeking behaviors for young children.

Most of the children enrolled in the study had good baseline health status before admission to the ICU, (68.1%) and children with a pre-existing severe disability were the least frequently admitted (2.8%). Considering the number of children living with disability in Uganda (estimated at 5.82% of the paediatric population (MoGLSD, 2016), this low proportion of children admitted to the PICU with a pre-existing disability is concerning. Access to health care in Uganda is inequitable and expensive (Mugyenyi, 2023), more so critical care services. Children with disabilities face substantial socioeconomic challenges (Adugna et al., 2020), (Bannink et al., 2015) that may pose major barriers to accessing critical care services compared to children without disabilities. This requires further study to elucidate. Disparities in health care provision exist in other contexts as well (Goddard and Smith, 2000), however having a form of universal health coverage is a major step towards ensuring equitable access to health

care (Doorslaer et al., 2000), (Gulliford et al., 2002). There is currently no universal health scheme in Uganda, making access to health care services, particularly for vulnerable groups of people like children with disabilities very difficult (Adugna et al., 2020). Data related to pre-existing chronic conditions such as chronic lung and heart disease, were not collected and this is recommended for future study.

### 5.2: Provision of physiotherapy services

Just over half the admitted patients (58.2%) received any form of physiotherapy during their PICU admission by the study day. The most commonly cited reason for not receiving treatment was the child being "medically unstable" (48.8%), followed by there being "no physiotherapist available" (17.3%) and restriction of physiotherapy intervention by the medical doctor (8.6%). All study sites have low physiotherapist to patient ratios (MNRH- 1:105; UHI- 1:30 and NAK- 1:20), which likely explains the low proportion of treatments given (Monitor, 2021).

### 5.3: Referral and initiation of physiotherapy treatment

The majority of referrals for physiotherapy were made by the ICU doctor (80.5%), with only 17.1% of self-referrals by the physiotherapist. This may be problematic as patient referral to the physiotherapist would be dependent on the doctors' understanding of the role of physiotherapy in different patient conditions, and this understanding may vary based on doctors' training and experience. Research to establish doctors' knowledge about physiotherapy in this context is therefore warranted. A study done to assess the knowledge, attitudes, and practices of physicians and physiotherapists about the early mobilization of critically ill adults in Canada found significant gaps in knowledge about ICUAW and its incidence, with knowledge deficits unassociated with the level of experience and region or field of practice (Koo et al., 2016). Physiotherapists in Uganda are considered to be independent practitioners who can assess, diagnose, and treat patients without referral. In the inpatient setting, different institutions may have different ways of involving physiotherapists in patient care. None of the institutions involved in this study had protocols in place to streamline the involvement of physiotherapists in patient care. Protocols would be very helpful in this setting, especially because, the current training of physiotherapists in the country is only at the undergraduate level and this does not include paediatric critical care, which may affect their ability to appropriately assess and manage patients in this context. A recent survey among physiotherapists in the UK found a two-tiered/ combined approach where the physiotherapist makes the primary decision about patients who should be treated through routine daily screening in consultation with the MDT during ward rounds, as well as individual clinical

assessments to establish indications and contraindications to treatment, and weighing risk against benefit for patients whose condition is thought to be unstable (Shkurka et al., 2023). However, for physiotherapists to take the lead in deciding which patients need treatment in the PICU context, a high degree of knowledge and experience is required (Shkurka et al., 2022). Choong et al. (2018) have similar recommendations, that assessment should be done by the MDT team, including the physiotherapist, who knows mobilizing patients, and the clinicians, who are ultimately responsible for decision-making in the patient's overall care (Choong et al., 2018). This finding highlights the need for further research to establish the barriers and facilitators to self- or team referral and assessment practices amongst physiotherapists in Uganda, to inform practice improvement.

Patients were referred to physiotherapy services on median (IQR) ICU day 3 (1-7). It is recommended that assessment for physiotherapy treatment be commenced within the first 24 hours of admission, with treatment progressed according to individual patient needs and condition (Choong et al., 2018), (Johnston et al., 2019). Although over 60% of patients in this study were referred for physiotherapy within 48 hours of admission, in line with current recommendations, earlier referral to, and assessment by a physiotherapist could be a focus of practice improvement in the study setting.

### 5.4: Physiotherapy treatment techniques

#### 5.4.1: Chest physiotherapy techniques

Chest physiotherapy was the most common type of physiotherapy given, with manual or passive CPT techniques such as percussions, vibrations, positioning, and suctioning being the most common techniques used. One child received head-down postural drainage, which is no longer recommended owing to several potential complications as well as poor evidence base (Morrow, 2019). Passive CPT techniques were common among all age groups, while active CPT techniques like ACBT and DBE were more commonly used amongst older children, which is likely appropriate given the need for patient participation. The use of multiple CPT techniques is also common in other settings (Shkurka et al., 2023). Whereas CPT is a common focus of physiotherapy intervention in the PICU (Hawkins and Jones, 2015), the evidence supporting its efficacy is very limited (Morrow, 2019), with some literature suggesting that routine CPT may have no significant benefit for mechanically ventilated children (Elizabeth et al., 2017) and other scholars pointing to the detrimental effects of routine CPT in the PICU (McIlwaine, 2006), (Wallis and Prasad, 1999), (Morrow, 2015). As a result, it is now not recommended to do chest physiotherapy routinely for children in the PICU as it is not a benign

procedure, instead, treatment should follow the thorough assessment of patients with symptoms for which CPT could be potentially beneficial and careful weighing of risks against benefits as well as individualization of treatment. (Morrow, 2015), (Morrow, 2019). The nature of the study limits our ability to determine the indications, if any, for the interventions provided, but in alignment with current evidence and given the high ratio of physiotherapists to patients, it may be more beneficial for physiotherapists to use only techniques supported by a high level of evidence for the best outcomes.

### 5.4.2: Rehabilitation/ Mobilization activities

Mobilization activities were less frequently performed than CPT activities and included both passive and active activities. Nearly half the patients in this study population had received no mobilization activities in the preceding 24 hours (41.2%). Several factors could be contributing to this, including staffing resource limitations, as indicated by a 17.3% "no PT available" reason for not receiving PT.

Passive limb exercises were the most common form of mobilization exercises given in this study. Passive mobilizations are safe and beneficial in instances where active movement is not possible (Cameron et al., 2015), (Phillips et al., 2011), (Choong et al., 2018). However, there are several recommendations that mobilization should target the highest level of functional mobility appropriate for the patient's developmental age, having ruled out contraindications, for both adults and children (Choong et al., 2021), (Perme and Chandrashekar, 2009), (Hodgson et al., 2014), and as such passive mobilization should not be used where active mobilization is possible.

Where active mobilization exercises were undertaken, gross movements and activities such as limb exercises, sitting, standing, and walking were more common than transitionary activities such as in-bed mobility exercises and pre-ambulatory exercises. This may suggest poor progression of mobilization exercises, where more difficult activities are attempted before simpler ones can be accomplished. Good progression is an important aspect of early mobilization in the PICU (Cameron et al., 2015), (Choong et al., 2018) as this may help minimize the occurrence of adverse effects in this vulnerable patient group.

More active mobilization activities were performed in older children as compared to younger children. Choong et al. (2014) suggest that older children may be mobilized more than younger children in the PICU because: 1) their maturity may allow them to better understand instructions and therefore comply with the mobilization activity, and 2) a perception by

therapists of better safety in mobilizing older children (Choong et al., 2014). Kudchadkar et al. (2020) had a similar finding, that children above three years of age were more likely to receive PT or OT led mobilization as compared to younger children, who were routinely mobilized by nurses (Kudchadkar et al., 2020). Choong et al. (2021) also reported that younger age (< 3 years) was the only independent predictor of not receiving therapist- led mobility (Choong et al., 2021).

The likelihood of mobilizing out of bed increased with decreasing respiratory support in this study, and no patients on IMV were mobilized out of bed. Invasive mechanical ventilation has been reported as a perceived barrier to mobilization in many other settings, for both adults and children (Thompson et al., 2022), (Kudchadkar et al., 2020). Choong et al. (2021) reported that mobilization of children in Canadian PICUs had improved compared to ten years ago when a similar study was done, but still found that mechanical ventilation or respiratory support was a limitation to mobilization out of bed (Choong et al., 2021). Notwithstanding, many studies have reported on the successful implementation of early mobilization programs in the PICU involving children with varying degrees of respiratory support and registering minimal adverse effects (Wieczorek et al., 2016), (Kudchadkar et al., 2020), (Cameron et al., 2015). This is another area of potential focus for future educational and practice improvement initiatives in Uganda.

#### 5.4.2.1: Mobilization as a Chest Physiotherapy technique

Despite the popularity of CPT in PICU physiotherapy practice, its benefits as well as limitations have already been discussed. Several scholars have suggested that mobilization and physical training can be safely implemented in the ICU and may have several benefits to the respiratory system, including improving Forced Expiratory Volume ($FEV_1$), Forced Vital Capacity (FVC), $VO_{2\ max}$, V/Q mismatch and thoracic mobility (McIlwaine et al., 2014), (Reix et al., 2012), (Elbasan et al., 2012). Moreover, mobilization has added benefits of aiming to restore functional movement and preventing other adverse effects of immobility on all the body systems (Hodgson et al., 2014), (Stiller, 2013). On this basis, mobilization is being recommended as a better area of focus for physiotherapists in the ICU (Stiller, 2013). Reix et al. (2012) found that exercise and manual CPT techniques had a similar effect on sputum clearance, yet the immediate effects on lung function and treatment satisfaction were greater with exercise in children with cystic fibrosis (Reix et al., 2012). Conversely, other scholars recommend that exercise should be combined with other CPT techniques to get a better effect (McIlwaine et al., 2014), (Elbasan et al., 2012). 98.1% of patients in this study had been treated

with a combination of CPT and rehabilitation/ exercise activities in the preceding 24 hours, which is consistent with this trend.

### 5.5: Limitations of the study

This study had the following limitations:

The study design was a prospective record review where most data were collected from the patients' folders. As with most record review studies, there is a risk of inaccuracy as a result of poor record-keeping practices, with the potential for information bias.

Data was collected on only two days a week excluded a weekend day. Weekend practice (which is likely to differ from weekday practice) and practice on the other days of the week on which data were not collected may not be fully represented in this study.

Having the people collecting data in this study being part of the team delivering the service may have led to a change in practice, which is a source of potential bias.

The geographical location of the study was in central Uganda, where the majority of the ICUs in the country are located, but there are a few other ICUs in other regions of the country that were not represented in the study and therefore the findings of this study may not be generalizable for the whole country or other African regions.

The research assistants who collected the data were part of the team managing the patients in the respective health facilities, which may have introduced a risk of reporting bias. This was at least partly mitigated by training in data collection methods.

This study focused on assessing the provision of physiotherapy by physiotherapists and therefore some physiotherapy interventions like mobilization may have been performed by other categories of staff and therefore missed. This requires further research.

Some other variables that are relevant to physiotherapy provision in the PICU were not assessed in this study, for example: family involvement in physiotherapy activities; other staff members such as nurses that may have carried out specific mobilization activities; level of training/experience of physiotherapists treating patients in the PICU, among others. Future research could consider including these data.

# CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

## 6.1: Summary of findings

This study aimed to describe the provision of physiotherapy services for children in ICUs in Uganda, to lay a foundation for future practice improvements. Data were collected via a prospective study design where the collection was done two days a week on Monday and Thursday, for the previous 24 hours, by an onsite physiotherapist who had been trained in the data collection method.

The main findings of this study were:

1) Over 40% of children admitted to the Ugandan ICU sites had never received any form of physiotherapy, including any mobilization activity, during their admission, suggesting a potential practice gap;

2) Chest physiotherapy using passive manual techniques was the most common form of physiotherapy given to children in the ICU

3) Passive mobilization modalities were used more frequently than active techniques

4) No patients receiving invasive mechanical ventilation had been mobilized out of bed

5) The majority of patients who received physiotherapy over the preceding 24 hours had only one contact with the physiotherapist

6) Most referrals to physiotherapy were made by the ICU doctor, and it is not clear what the rationale or indications were for referring or not referring.

## 6.2: Recommendations

### 6.2.1: Clinical recommendations

Successful implementation of rehabilitation for critically ill children admitted to ICUs in Uganda will require a culture change, where rehabilitation is acknowledged as a crucial service for children in the ICU, requiring cooperation from all team members and the administration of the health facility (Morrow, 2021). Some proposed practical considerations that may aid this cultural change include:

- Training key staff members about the need for timely referral for assessment and rehabilitation for children in this setting, what it entails, and their role in making it successful. These may include physiotherapists, nurses, physicians, other therapists (e.g. occupational therapists), and hospital management

- Identifying early mobilization champions in each center to educate and promote rehabilitation activities and lead practice improvement initiatives.
- Establishing processes in which daily rehabilitation goals are set for patients, guided by the PT in consultation with the MDT, and deciding which members of the team will be responsible for the execution of the set goal
- Developing and using standardized, regionally relevant protocols/ procedures to guide goal setting and treatment of patients daily

To improve the understanding of the role of physiotherapy in the care of critically ill children, in alignment with internationally recommended standards, there is a need to train different stakeholders on the continuum of care for critically ill children in Uganda, including:

*i)* *Physiotherapists:* Already qualified physiotherapists can be trained about the current standards of treating children in the ICU through refresher courses, Continuous Medical Education (CME) trainings, etc.

*a.* *Student Physiotherapists:* Revising the curriculum for undergraduate physiotherapy students to include a specific component on physiotherapy for children who are acutely and critically ill, to improve the translation of this knowledge into practice

*ii)* *Clinicians in the MDT:* Other clinicians can be trained continuously about the role of physiotherapy for critically ill children and the current practices of the same at the currently recommended standard. This may aid in better integration of physiotherapy in the care plan of children in the ICU especially in a mixed adult/ paediatric ICU setting

*iii)* *Healthcare facility managers:* The administrators and managers of healthcare facilities with ICUs that admit children or PICUs should be sensitized about the need, benefits, and current international trends of physiotherapy for children in ICUs so that they can support better provision of physiotherapy treatment for children in this context. The support of management would be instrumental in the successful implementation of PT programs for children in the ICU, for example, they could fund the implementation of said programs.

iv) *Family members and caregivers:* Family participation has been strongly associated with the successful implementation of rehabilitation activities for critically ill children in many settings. Family members and caregivers of children admitted to the ICUs need to be sensitized about the benefits of physiotherapy for children in this context, and involved in the goal setting and plan for rehabilitation of patients consistently.

Procedures or protocols should be designed to guide the practice of physiotherapy for children admitted to ICU in Uganda, as well as continued rehabilitation after ICU discharge, based on current recommendations and guidelines, while considering the local context. These are not currently available and could help minimize the inconsistencies in practice as a result of different levels of experience and training, and ensure that practice is current and evidence-based.

Nurses typically spend the most time with patients, after their parents or guardians. Nursing staff should ideally be fully integrated and made partners in the provision of PT services for children in the ICU. This may help with early referral to physiotherapy services and nurses may also implement or sustain some rehabilitation activities, for example, positioning and passive movements, so that scarce physiotherapy services are only required when patients need to be progressed to more complex rehabilitation activities. This would ensure that more patients receive treatment, and certain rehabilitation activities like mobilization become part of routine care. Rehabilitation goals should be set by the PT together with the MDT, with agreement on what aspects the PT and nurses could perform.

### 6.2.2: Research recommendations

This was the first study to describe the practice of physiotherapy for children in ICUs in Uganda, to lay a foundation for future practice improvements. This study did not exhaust the components or determinants of physiotherapy practice in this context, therefore the researcher recommends that future research around this topic is conducted to:

i) Investigate other determinants that were not included in this study but are essential to understanding and improving physiotherapy practice in this context, such as:
   a. Family involvement in providing PT for children in ICU;
   b. Level of training/ knowledge amongst PTs treating children in the ICU;
   c. Knowledge about PT practice amongst other MDT clinicians in this context
   d. Availability of the physiotherapy service for example staffing of physiotherapists, availability of PT equipment, among others

ii) Purposively investigate the barriers (perceived and actual) impacting ICU rehabilitation practice

iii) Cover a wider geographical area including ICUs in other regions in the country to make the findings more generalizable

iv) Investigate the long-term functional outcomes of child survivors of critical illness, as well as potentially modifiable ICU-related factors

v) Design country-specific guidelines, recommendations, or procedures to guide the practice of physiotherapy for children in Ugandan ICUs

vi) Implement targeted quality improvement initiatives, with appropriate clinical outcome measures, to:

   a. Improve referral practices and communication amongst members of the interprofessional team
   b. Promote early patient assessment and activity goal setting by physiotherapists
   c. Improve adherence to internationally recommended early mobilization and ICU rehabilitation goals

**Conclusion**

The findings of this thesis suggest that the practice of physiotherapy for children in ICUs in Uganda does not currently meet internationally recommended standards, and efforts are needed to improve practice to meet the minimally acceptable standards of care for critically ill and injured children in this region, to ultimately optimize patient outcomes.

It is recommended that quality improvement projects be implemented at the study sites to improve physiotherapy practice in these Ugandan ICUs, focusing on identifying barriers and facilitators to the delivery of optimal physiotherapy practice; establishing regionally relevant clinical protocols; targeted education and training initiatives; and optimizing interprofessional communication.

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# Appendices

## Appendix A: Studies included in the literature review

| Author (year) | Country | Study design | Main Objective | Study population | Methods | Main outcomes |
|---|---|---|---|---|---|---|
| **Calvo - Ayala (2013)** | United States of America | Systematic review of RCTs evaluating the efficacy of interventions targeting Physical Functioning among ICU survivors | To identify effective interventions that improve long term Physical Functioning (PF) in ICU survivors. | 14 studies included | | • Exercise/PT is the only effective intervention in improving long term PF among ICU survivors<br>• Outcome may be better if intervention is started earlier |
| **Hawkins & Jones (2015)** | Australia | Systematic review | To determine the role of physiotherapists in the management of mechanically ventilated patients in PICU. | 6 studies included n=418 | | • CPT is the focus of PT treatment for MV patients in the PICU<br>• CPT is effective in secretion clearance in this setting |

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| | | | | | • MHI and vibrations are effective CPT techniques in this population<br>• CPT and suction should not be used routinely |
| **Allen et al (1999)** | Australia | Systematic review | To determine the effects of bed rest in different conditions | 39 studies included<br>n= 5777<br>15 different conditions | • Little support for bed rest (BR) as a form of management of various patient conditions<br>• BR may delay recovery and even harm the patient<br>• BR should only be ordered for specific indications and discontinued as soon as possible. |

Cardiovascular system

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| **Perhonen et al (2001)** | United States | Case control | To determine cardiac responses after bed rest and space flight | **Case** (n= 5) healthy men aged 31 ± 5 years subjected to 6 weeks (n=5) and 12 weeks (n=3) of horizontal bedrest<br>**Control** (n= 5) aged 31 ± 5 years studied at baseline and at 6 weeks of uncontrolled daily activity<br>4 male astronauts aged | • LV and possibly RV atrophy occurs during prolonged supine bed rest<br>• Deconditioning may occur after space flight<br>• Atrophy and deconditioning are normal physiological adaptations to reduced myocardial work and loading conditions |

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| | | | | 40± 2 yrs studied after 10 days of space flight | |
| **Spaak et al (2005)** | Moscow | Case control | To evaluate the functional importance and relative contributions of reflex dysfunctions, plasma volume reduction, or cardiac impairments on cardiovascular deconditioning during rest and exercise in supine and upright postures. | n=6 subjects, studied before (baseline), during (day 60 & 113) and after 120 days of $-6^0$ head down tilt (HDT) bed rest | • 120 days of HDT bed rest causes progressive decrease and delayed partial recovery of stroke volume (SV) during exercise<br>• Largest SV changes demonstrated during supine exercise<br>• Cardiac remodeling is the main contributing factor behind cardiovascular deconditioning during exercise, persisting |

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| | | | | | even after prolonged HDT bedrest. |
| **Convertino et al (1982)** | United States of America | Case control | To evaluate the magnitude of cardiorespiratory conditioning due to bedrest in healthy middle-aged men and to differentiate two effects of prolonged recumbency: physical inactivity and lack of exposure to orthostatic stress. | n=12 male subjects, 50 ± 4 years, underwent supine and upright graded maximal exercise testing before and after BR. | • Decrease in peak oxygen uptake after bedrest was greater during upright exercise than during supine exercise<br>• Ventilation volume was significantly elevated ($p < 0.05$) after BR during maximal and submaximal effort in both the supine and upright positions.<br>• Peak heart rate (HR) increased 5.7% and 5.9% during supine and upright |

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| | | | | testing, respectively ($p < 0.05$). |
| **Dittmer et al (1993)** | United Kingdom | Review | To review the effects of prolonged bed rest on the musculoskeletal and cardiovascular systems | • Cardiovascular complications include an increased HR, decreased cardiac reserve, orthostatic hypotension, and venous thromboembolism. |
| **Convertino (2007)** | United States of America | Review | To analyze the blood volume response to physical inactivity | • Physical activity causes expansion of plasma and blood volume which provides a protective effect against development of cardiovascular disease |

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| **Ried-Larsen et al (2017)** | United States of America | Systematic review and Meta analysis | To assess the effects of strict prolonged bed rest on maximal oxygen uptake ($VO_{2max}$) and to explore the variations therein. | n=80 studies included in systematic review<br>n=72 studies included in meta-analysis | | • $VO_{2\ max}$ decreases as a function of the duration of the bed rest in a linear manner<br>• Pre study $VO_{2max}$ levels were inversely associated with change in $VO_{2max}$ independent of the bed rest duration |
| **Barbic et al (2019)** | Germany | Case control | To examine the effects of prolonged HDBR on cardiac and vascular baroreceptor modulation and orthostatic tolerance in healthy individuals | n=10 healthy males | Subjects studied before and after 21 days of $-6^0$ HDBR | • 3 week HDBR significantly reduced orthostatic tolerance in healthy young men |
| **Hanson et al (2010)** | United States of America | Case control | To measure the incidence of and risk factors for venous thromboembolism | n=144 children younger than 18 years, | Subjects were followed up prospectively for | • 9 of 144 children admitted to the PICU |

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| | | | (VTE) in critically ill children after trauma | admitted to the PICU at a level I trauma center | 14 months for development of VTE. The next 3 sequential patients in the registry were selected as controls for each case | after trauma developed VTE (6.2%, 95% confidence interval [CI] 2.3–10.2)<br>• Presence of a CVL, poor perfusion, immobility were major risk factors for development of VTE |
| **Bateman et al (2008)** | United States and Canada | Case series (Prospective observational study) | To understand anemia development, blood loss, and red blood cell (RBC) transfusions in the PICU. | n=977 children <18 years old, in PICU for 48 hours or more | Prospective, multicentre, 6-month observational study in 30 PICUs. | • Critically ill children are at significant risk for developing anemia and receiving blood transfusion<br>• Transfusion in the PICU was associated with worse outcomes. |

RCTs= Randomized Control Trials, (P)ICU= Paediatric Intensive Care Unit, PF= Physical Functioning, CPT= Chest Physiotherapy, MV= Mechanical Ventilation, BR= Bed Rest, LV= Left Ventricle, RV= Right Ventricle, HDT= Head Down Tilt, SV= Stroke Volume, HR= Heart Rate, HDBR= Head Down Bed Rest, VTE= Venous Thromboembolism, CVL= Central Vascular Line

**Respiratory system**

| Author (Year) | Country | Study design | Main Objective | Study population | Methods | Main Outcomes |
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| **Purro et al (2000)** | Italy | Case control | To investigate the pathophysiologic mechanisms hindering the liberation from mechanical ventilator in long-term ventilator-dependent patients | Total subjects, n=59<br>n=28 COPD & n=11 post cardiac surgery patients on long term MV<br>n=20 stable spontaneously breathing patients (SBPs) matched for age and disease | Physiologic measurements were taken for all subjects on MV during a spontaneous breathing trial, and the same measurements taken for the SBPs | • Patients who could not be liberated from the ventilator had some common pathophysiologic characteristics, like small tidal volume; high neuromuscular drive; abnormal lung mechanics; reduced inspiratory muscle strength, as compared to SBPs |

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| **Knoester et al (2008)** | Netherlands | Cohort | To investigate the prevalence and nature of physical and neurocognitive sequelae in PICU survivors | n=186 previously healthy children, unexpectedly admitted to PICU | Structured medical examination of children 3 months after discharge | • 69% of children had physical sequelae<br>• 9% had abnormalities in pulmonary auscultation<br>• 4% had hoarsness after endotracheal intubation |
| **Boucher et al (2020)** | Canada | Retrospective Cohort | To describe the respiratory symptoms, pulmonary function, and health resource use of PARDS survivors at 3 months post discharge. | n=38 children <18 years of age. | Children evaluated at 3 months post discharge for respiratory symptoms, age appropriate PFTs, ED visits or rehospitalizations since discharge | • PARDS survivors experience persistent abnormal respiratory symptoms, recurrent health problems and pulmonary deficits requiring medical attention in the short-term following hospital discharge. |
| **Ward et al** | United States | Prospective Cohort | To determine the feasibility of | Children <18 years of age, | Subjects diagnosed with ARDS in a PICU were | One-third of children with ARDS exhibit |

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| **(2017)** | | | pulmonary function and quality of life evaluations in children after ARDS. | n=17 completed PFTs, n=23 completed QOL testing | prospectively evaluated during admission and followed up at 6-month intervals for 2 years after discharge | pulmonary function deficits and 12-month post-illness QOL scores are lower than in children with chronic asthma. |
| **Crulli et al (2021)** | Canada | Case control | To describe the evolution of inspiratory muscle function in children during MV | Children 1 week to <18 years n=20 in PICU, n=10 in OR | Function of the inspiratory muscles was assessed on various modes of MV | • IME decreased slightly over time during MV in a group of CI children with preserved respiratory drive<br>• IME in CI children after 21 h of MV was significantly lower than in children undergoing elective surgery |
| **Ijland et al (2020)** | Netherlands | Cohort study | To determine the impact of CI on the muscles of the respiratory muscle | n=34 children >1 month <18 years on MV in PICU | Thickness of the diaphragm and EMs (obliquus interna, obliquus externa, | • Changes in thickness of the EMs develop rapidly after MV in CI children |

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| | | | pump, especially on the expiratory muscles in children during MV. | | transversus abdominis and rectus abdominis) was assessed daily using ultrasound. | • Changes in thickness of the EMs are not correlated with changes in diaphragm muscle thickness. |
| **Powers et al (2009)** | United States | Literature review | To review current knowledge about the impact of prolonged MV on diaphragmatic function and biology | | A summary of the knowledge about the impact of prolonged MV on diaphragmatic function and biology | • Prolonged MV can promote diaphragmatic atrophy (DA) and contractile dysfunction<br>• As few as 18 hrs of MV results in DA in both laboratory animals and humans |
| **Hudson et al (2012)** | United States | Case control | To test the hypothesis that high level PSV decreases the diaphragm pathology associated with CMV | Animals (rats) | Sprague-Dawley rats were randomly assigned to four groups of different modes of M for varying times, plus one | • Prolonged high level PSV promotes DA and contractile dysfunction.<br>• Similar to CMV, high level PSV-induced DA is associated with both |

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| | | | | | acutely anaesthetized control group (no MV) | diaphragmatic oxidative stress and protease activation |
| **Bernard et al (2013)** | France | Case control | To investigate in rabbits whether PMV leads to ultrastructural changes in respiratory muscles and alters diaphragm mitochondrial respiration. | n=17<br>n=7 rabbits on MV<br>n=10 rabbits as control | Respiratory muscles of seven rabbits after 49±1h of controlled MV were studied. Ten non ventilated rabbits were used as a control group | • PMV leads to respiratory muscle cell degeneration and minor changes in oxidative phosphorylation coupling in diaphragmatic mitochondria. |
| **Glau et al (2018)** | United States | Cohort | To test for the presence of diaphragm atrophy in children with acute respiratory failure (ARF). | n=52 children <18yrs old requiring IMV > 24hrs | Subjects underwent diaphragm measurements by US within 36 hrs of initiation of MV, repeated 48–72 hrs after the initiation of MV, after one week of MV and weekly for the duration of MV | • Progressive diaphragm atrophy occurs in pediatric ARF<br>• Diaphragm TF was strongly correlated with SBF during MV.<br>• Exposure to NMB was associated with greater rate of diaphragm |

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| | | | | | | atrophy when SBF was low |
| **Petrof et al (2010)** | Canada | Review | • To present evidence that MV can be a cause of diaphragmatic dysfunction,<br>• To present current understanding of the cellular mechanisms of this phenomenon | | | • MV may be an important cause of diaphragmatic weakness<br>• It is likely that several factors can converge with VIDD to exacerbate diaphragmatic weakness in CI patients |
| **Khemani et al (2017)** | United States | Retrospective cohort study | To identify risk factors for pediatric extubation failure, with specific attention to respiratory muscle strength | n=409 children, < 18 yrs old, intubated ≥ 12 hrs | Respiratory measurements using esophageal manometry and respiratory inductance plethysmography were made pre-extubation | • Neuromuscular weakness at the time of extubation was common in children and was independently associated with re-intubation, particularly when post-extubation effort was high. |

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| **Wolf et al (2011)** | United States | Case series | To investigate the electrical activity of the diaphragm during extubation readiness testing (ERT) | n=20 children, > 1 day old < 18 years in a medical-surgical PICU | Subjects underwent a standardized ERT using a minimal pressure support ventilation strategy. | • Higher diaphragmatic activity<br>• in relation to tidal volume may indicate better preserved diaphragmatic function and a higher chance of passing the ERT |
| **Brower (2009)** | United States | Review | To review complications of bed rest that are relevant and potentially important to CI patients | | | • In many CI patients, partial or complete atelectasis of the left lower lobe is apparent on chest radiographwithin 48 hrs of recumbency |
| **Herridge et al (2003)** | Canada | Cohort | To characterize long-term pulmonary and extrapulmonary | N=109 adults at 4 medical-surgical ICUs | Survivors of ARDS were evaluated 3, 6, and 12 | • Survivors of ARDS have persistent functional disability |

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| | | | function in a prospectively identified cohort of patients who survived ARDS | | months after discharge from the ICU | one year after discharge from the ICU<br>• Most patients have extrapulmonary conditions, like muscle wasting and weakness. |
| **Herridge et al (2011)** | Canada | Cohort | To catalogue, quantify, and describe the extent of physical, mental, and QOL impairments after ARDS and to determine factors associated with poor outcomes and increased health care utilization | n=83 patients reconsented to an additional 4 year follow up | Survivors of ARDS were evaluated at 3, 6, 12, and 24 months and then yearly for up to 5 years after they were discharged from the ICU. | • Exercise limitation, physical and psychological sequelae, decreased physical QOL, increased costs and use of health care services are important legacies of severe lung injury. |

COPD= Chronic Obstructive Pulmonary Disorder, SBP= Spontaneously Breathing Patients, MV= Mechanical Ventilation, PARDS= Paediatric Acute Respiratory Distress Survivors, PFTs= Pulmonary Function Tests, ED= Emergency Department, QOL= Quality of Life, IME= Inspiratory Muscle Efficiency, CI= Critically Ill, EMs= Expiratory Muscles, DA= Diaphragmatic Atrophy, PSV= Pressure Support Ventilation, CMV=

Continuous Mechanical Ventilation, ARF= Acute Respiratory Failure, IMV= Invansive Mechanical Ventilation, TF= Thickening Fraction, SBF= Spontaneous Breathing Fraction, NMB= Neuromuscular Blockade, VIDD= Ventilator Induced Diaphragmatic Dysfunction, ERT= Extubation Readiness Test, ARDS= Acute Respiratory Distress Syndrome

**Musculoskeletal and Nervous System**

| Author (Year) | Country | Study Design | Main Objective | Study Population | Methods | Main Outcomes |
|---|---|---|---|---|---|---|
| **LeBlanc et al (2007)** | United States | Review | To summarize the skeletal responses to space flight and bed rest | | | • The lack of mechanical forces on the skeleton in microgravity leads to increased bone remodelling.<br>• Bone resorption is increased while formation is little changed |
| **Watanabe et al (2004)** | France | Case control | To compare the effects of pamidronate with resistive exercise | n=25 males, 26-45 years old | Subjects were randomly assigned to the | • Resistive exercise increased bone formation but could not reduce bone resorption |

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| | | | on BMD and renal stone formation during prolonged bed rest | | control (n= 9), exercise (n=9), and pamidronate (n=7) groups and underwent 90-day 6° head-down tilt bed rest | • Inhibition of bone resorption by pamidronate could preserve bone mineral during prolonged bed rest |
| **Zerwekh et al (1998)** | United States | Case control | To examine the effects of 12 weeks of skeletal unloading on parameters of calcium homeostasis, calcitropic hormones, bone histology, and biochemical markers of bone turnover | n=11 adults, n=9 men, n=2 women; 34 ±11 years of age | All subjects underwent 12 weeks of bed rest. | • The human skeleton appears to respond to unloading by a rapid and sustained increase in bone resorption and a more subtle decrease in bone formation |

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| **Chambers et al (2009)** | United States | Review | To review the adaptive response of skeletal muscle to mechanical unloading in CI patients | | | • Mechanical unloading stimulates a complex adaptive response that results in muscle atrophy and loss of specific force |
| **Bajotto & Shimomura (2006)** | Japan | Review | To provide a window into the molecular processes that underlie skeletal muscle remodeling | | | • Disuse/ inactivity induced skeletal muscle protein loss occurs by differential modulation of proteolytic and synthetic systems |
| **Riley et al (2000)** | United States | Case control | To assess decreased thin filament density and length in human atrophic soleus muscle fibers after spaceflight. | n=4 male adults, 43 ± 4 | Soleus muscle fibers were examined electron microscopically from pre- and postflight biopsies of subjects orbited for | • Thick filament density and spacing were unchanged by spaceflight<br>• Preflight thin filament density (2,976/$\mu m^2$ ) decreased significantly (P< 0.01) to 2,215/$\mu m^2$ in the overlap |

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| | | | | | 17 days | |
| **Inoue et al (2019)** | Japan | Review | To outline the pathophysiology, prevention, and future directions of PICS. | | | • PICS includes physical, cognition, and mental impairments that occur during ICU stay or after ICU discharge<br>• PICS maybe prevented by carrying out the ABCDEFGH bundle |
| **Schweickert and Hall, (2007)** | | Review | A review of ICUAW, it's presentation, risk factors and possible prevention measures | | | • Identifying risk factors early may help minimize the impact of ICUAW |
| **Bolton (1984)** | Canada | Cohort | To describe clinical, electrophysiological and morphological | n= 5 adult males admitted in the ICU | Subjects were studied after developing signs of sever motor and | • PN is among the causes of neuromuscular RF in CI patients |

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| | | | characteristics, of polyneuropathy (PN), it's possible causes and suggest approaches to management. | | sensory PN at the peak of CI | • Key features of PN are major systemic illnesses especially sepsis, and RF |
| **Farhan (2016)** | United States | Review | To review the nosology, epidemiology, diagnosis, and prevention of ICUAW in surgical ICU patients. | | A search of key terms related to ICUAW was done using PubMed for the period January 1 2009 to December 1 2014 | • ICUAW weakness is a direct consequence of the underlying systemic disease and its treatment.<br>• Treatment of the underlying disease, and muscular inactivity are key to prevention. |
| **Bednarik (2003)** | Czech Republic | Cohort | To evaluate the spectrum and time profile of electrophysiological | n=46 adults, n=19 females, n=27 males aged | Subjects underwent clinical evaluation including assessment of reflexes and muscle | • Characterisation of the electrophysiologicalcomponents of a complex PN is preferred to the strict categorisation of abnormalities into CIM and PN |

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| | | | parameters in the detection of neuromuscular involvement in CI patients and establish their correlation with biopsy findings. | between 33- 81 years, with signs of failure of at least 2 organ systems | atrophy daily for 28 days | |
| **Siu et al (2015)** | Canada | Cohort | To determine the feasibility of using the MRC score for muscle strength testing in critically ill children. | n=33 children, >12 months < 17 years with at least one organ dysfunctio n | Subjects were assessed for muscle strength using the MRC scoring weekly until discharge | • The MRC test of muscle strength is not feasible in the majority of CI patients as an early screening tool for PICU-AW in children |
| **Choong et al (2015)** | Canada | Prospective Pilot study | To determine the feasibility of | n=33 children, | | • Applying the ICF-CY framework to measure function |

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| | | | conducting a longitudinal prospective study to evaluate functional recovery and predictors of impaired functional recovery in CI children. | >12 months < 17 years with at least one organ dysfunction | | is feasible and relevant to CI children |
| **Namachivayam et al (2010)** | Australia | Retrospective Cohort | To describe the characteristics of children admitted to intensive care over three decades, and their long term outcome. | n=4010 children admitted on 5250 occasions | Information about admissions for 1982, 1995 and 2005-2006 were obtained from the database and compared. Long term outcome was ascertained through telephone calls. | • Over three decades, PICU mortality reduced substantially.<br>• There was a significant increase in survivors with moderate or severe disability |

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| **Als et al (2015)** | United Kingdom | Prospective Cohort | To assess mental and physical wellbeing in school-aged children following admission to PICU and to examine risk factors for worse outcome | n=188 children aged 5- 16 years<br>n= 88 cases<br>n=100 controls | Subjects were assessed a median of 5 months after discharge and outcomes were compared with healthy controls | • School-aged children are at risk for reduced mental and physical wellbeing in the short term after PICU discharge.<br>• Vulnerability and critical illness factors may contribute to poor mental wellbeing |
| **Ong et al (2016)** | Singapore | Review | To appraise literature on functional outcome measurement tools, prevalence, and risk factors for physical impairments in pediatric critical care survivors | | Relevant databases were searched for all human studies reporting functional outcomes in children 0–18 years old admitted to the PICU | • Functional impairment may be persistent in pediatric survivors of critical illness<br>• Evidence is scarce in this population about the type and extent of functional impairment. |

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| **Tang et al (2021)** | China | Concept analysis | To investigate the specific attributes of PICS-p, and determine the empirical references to measure these attributes. | 24 studies out of selected 762 met inclusion criteria | Studies from various databases were reviewed using key words related to PICS-p | • PICS-p includes physical, psychological, cognitive, and social deficits that persist long after the onset of critical illness and discharge from the PICU |
| Clinical features of ICUAW | | | | | | |
| **Hermans et al (2008)** | Belgium | Review | A clinical review of polyneuropathy and myopathy in critical illness | | | • Critically ill patients frequently develop CIP/CIM, which delays weaning, compromises rehabilitation, and is associated with increased hospital and ICU stays and increased mortality rates |
| **Witt et al (1991)** | Canada | Cohort | To investigate peripheral nerve function in sepsis | n=43 patients, > 16 years old, with | Subjects got initial neurologic and electromyographic examination, and | • There's a strong link between sepsis and MOF with critical illness PN |

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| | | | and multiple organ failure (MOF) | evidence of sepsis and MOF, and without previous peripheral neuropathy | follow up at 1, 3 and 6 months if they survived | • Prolonged ICU stay, increasing blood sugar and decreasing serum albumin were closely corelated with decreasing peripheral nerve function and severe PN |
| **Kukreti et al (2014)** | Canada | Review | To summarize the pathophysiology, clinical presentation, diagnosis and treatment of CIP and CIM with special reference to the pediatric age group | | Studies were identified through MedLine and Embase using relevant key words for both adult and pediatric studies | • ICUAW due to CIP/CIM alone or in combination causes delay in ventilator weaning, and rehabilitation and is associated with significant morbidity and mortality<br>• Understanding of ICUAW in pediatrics is limited |
| Risk factors for ICUAW | | | | | | |
| **Puthucheary et al., (2013)** | England | Cohort | To characterize skeletal muscle | n=63, 59% male, mean | Muscle mass loss was assessed | • Muscle wasting occurred early and rapidly during the first week |

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| | | | wasting, defining the pathogenic roles of altered protein synthesis and breakdown. | age 54.7 years | ultrasonographically , histologically,and biochemically on days 1, 3, 7, and 10. | of critical illness and was more severe among people with MOF compared with single organ failure. |
| **Field-Ridley et al (2016)** | United States | Retrospective Cohort study | To investigate the incidence and risk factors for ICU-AW in PICUs in the Virtual PICU Systems (VPS) database | n=203,875 admissions were identified | VPS database was searched for CIM and CIN between 1/2009 and 11/2013. | • Incidence of CIM was 0.02%<br>• ICU-AW was associated with diagnoses of respiratory illness and infection, need for MV, renal replacement therapy, extracorporeal life support, tracheostomy and longer PICU LOS. |
| Short and long term outcomes of ICU-AW | | | | | | |
| **Guarneri et al (2008)** | Italy | Prospective Cohort study | To investigate the long-term outcome in patients with CIM or CIN | n=18 adult patients | Subjects who were diagnosed with CIM and CIP that persisted beyond ICU discharge were | • CIM has a better prognosis than CIP<br>• Differential diagnosis is important to predict long-term outcome. |

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| | | | | | followed up for one year | |
| **Koch et al (2014)** | Germany | Cohort | To determine whether early identification of, and distinction between, CIP and CIM permits prediction of long-term neuromuscular outcome. | n=26 n=7 ICU controls, n=8 CIM, and n=11 CIM/CIP patients | Functional health status was assessed at 2 weeks, and at 1, 2, 3, 6, and 12 months after ICU discharge, and evaluation was done 1 year after discharge from ICU | • Patients without neuromuscular involvement or with isolated CIM have a better prognosis than patients who develop CIM/CIP.<br>• Early assessment is important in predicting long-term outcome like physical activity, return to work, and sensory function in CI patients. |
| **Bossen et al (2021)** | | Scoping review | To describe findings and determinant of PF in children during and after ICU stay and identify which domains of PF are measured | | 68 studies were included | • Post PICU/ hospital discharge scores show that children admitted to the PICU report difficulties in PF years after PICU discharge, ranging from mild to severe disabilities. |

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| **Koppelmans et al., (2017)** | United States | Case control | To investigate how microgravity affects focal gray matter (GM) brain volume. | n=30 adult males<br>n=18 right-handed males as cases<br>n=12 control subjects | Case subjects underwent 70 days of $6^0$ HDBR<br>Assessment was done for control subjects for the same metrics over 90 days | • HDBR results in significant volumetric GM changes in brain structures that regulate planning, control and execution of voluntary movement, sensorimotor coordination, and that process sensory inputs<br>• HDBR leads to deterioration in functional mobility and standing balance performance. |

BMD= Bone Mass Density, PICS= Post Intensive Care Syndrome, ICUAW= Intensive Care Unit Acquired Weakness, PICU-AW= Paediatric Intensive Care Unit Acquired Weakness, PN= Polyneuropathy, RF= Respiratory Failure, CIM= Critical Illness Myopathy, PICS-p= Post Intensive Care Syndrome in Paediatrics, CIP= Critical Illness Polyneuropathy, CIM= Critical Illness Myopathy, MOF= Multiple Organ Failure, MV= Mechanical Ventilation, GM= Grey Matter

**Renal System**

| Author (Year) | Country | Type of Study | Main Objective | Study Population | Methods | Main Outcomes |
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| **Zerwekh et al (1998)** | United States | Case control | To examine the effects of 12 weeks of skeletal unloading on parameters of calcium homeostasis, calcitropic hormones, bone histology, and biochemical markers of bone turnover | n=11 adults, (9 men, 2 women; 34 ± 11 years of age) | All subjects underwent 12 weeks of bed rest | • Increase in serum calcium, hypercalciuria, are physiologic sequelae of increased bone resorption due to skeletal unloading |
| **Watanabe et al (2004)** | United States | Case control | To compare the effects of pamidronate with resistive exercise on BMD and renal stone formation during prolonged bed rest. | n=25 adult males, randomly assigned to control (n = 9), exercise (n= 9), and pamidronate (n= 7) groups | Subjects underwent 90-day 6° HDBR. | • Urinary Ca excretion increased during bed rest, and the peak values exceeded 340 mg/day in the control group.<br>• Increase in urinary Ca excretion by bed rest was |

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| | | | | | | not prevented by resistive exercise, and marked hypercalciuria developed in the exercise and control groups |
| **Okada et al (2008)** | Japan | Case control | To clarify the influence of long-term bed rest on renal stone formation and analyze the mechanism of bed-rest-induced stone formation and prevention by bisphosphonate and bed-rest exercise. | n= 25 males aged 26- 48 years, divided into n= 9 control, n=9 exercise and n= 7 pamidronate groups | Subjects were assessed before, during and after 90 days of $6^0$ HDBR and 90 days of reloading. | • Bed rest induced renal stone formation and bisphosphonate had a preventive effect on stone risk<br>• Resistive exercise had no beneficial effects on preventing renal stone formation, but seemed to increase the risk. |
| **Guedes et al (2018)** | Brazil | Review | To describe the deleterious effects of prolonged bed rest on the body systems of the elderly. | | An integrative-narrative review was carried out | • Urinary complications caused by immobilization include the development of renal calculi and UTI |

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| **Sanderson and Harshman (2020)** | United States | Review | To discusses the use of RRT for pediatric patients in the ICU. | | | • Data indicate that upward of 27% of children in the ICU develop AKI and 6% require RRT. |
| **Kaddourah et al (2017)** | | Multinational prospective observational study | to define the incremental risk of death and complications associated with severe AKI in children and young adults | n= 4683 patients aged 3 months to 25 years | Subjects admitted to 32 participating units were screened during 3 consecutive months | • AKI developed in 1261 patients (26.9%; 95% [CI], 25.6 to 28.2),<br>• AKI is common and is associated with poor outcomes, including increased mortality, among CI children and young adults |

Ca= Calcium, UTI= Urinary Tract Infection, AKI= Acute Kidney Injury, RRT= Renal Replacement Therapy, CI= Critically Ill

**Skin effects**

| **Author (Year)** | **Country** | **Type of study** | **Main Objective** | **Study Population** | **Methods** | **Main Outcome** |
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| **Brower (2009)** | United States | Review | To review complications of bed rest that are relevant to critically ill patients | | | CI patients are prone to skin ulcers because of prolonged periods of BR, poor nutrition, and impaired microcirculatory function |
| **Guedes et al (2018)** | Brazil | Integrative-narrative review | To describe the deleterious effects of prolonged BR on the body systems of the elderly. | | | • Immobility places the individual at risk of disorders in skin integrity<br>• The formation of PUs usually results in further immobilization, initiating a negative cycle of sequelae |
| **Schluer et al (2012)** | Switzerland | Cross sectional study | To assess the prevalence and risk factors for PUs in pediatric care settings | n=412 children, 0-18 years of age in 14 pediatric hospitals | A standardized data collection instrument was used, and each patient was assessed by a previously instructed rater pair | • Overall prevalence of PUs was 35%<br>• Department, patient age, Braden scale score, and institution have to be considered additional risk factors for PU occurrence |

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| **Schluer et al (2014)** | Switzerland | Multicenter cross-sectional, descriptive study | To identify factors for the development of PUs in hospitalized patients | n=204 children 1-18 years old | The Dutch National Prevalence Measurement of Care Problems (LPZ) was used to assess the prevalence, severity, location, and risk factors, as well as factors associated with the occurrence of PUs. | • PU prevalence rate was 26.5%.<br>• The risk factors, anatomical locations, and the risk of PUs due to external devices differ from those in adults |

BR= Bed Rest, Pus= Pressure Ulcers

**Neuro-cognitive effects**

| Author (Year) | Country | Type of study | Main Objective | Study population | Methods | Main outcomes |
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| **Traube et al (2017)** | United States, the Netherlands, New Zealand, Australia, and Saudi Arabia. | Multi-institutional point-prevalence study. | To determine prevalence of delirium in CI children and explore associated risk factors. | n=994 from 25 PICUs in the United States, the Netherlands, New Zealand, Australia, and Saudi Arabia. | Children were screened for delirium using the Cornell Assessment of Pediatric Delirium (CAPD) by the bedside nurse | PD was a common complication of critical illness, with a prevalence of 25% and identifiable risk factors |
| **Traube et al (2017)** | United States | Prospective longitudinal cohort study. | To describe the incidence of delirium in CI children, its duration, associated risk factors, and effect on in-hospital outcomes, including mortality | n=1547 children | Children were screened for delirium twice daily throughout their ICU stay. | Delirium occurs frequently in critically ill children and is independently associated with mortality. |
| **Cano Londono et al (2018)** | Columbia | Cross sectional descriptive study | To describe the prevalence and characteristics of delirium | n=77 children, 5-14 years old | Patients were evaluated for delirium within the first 24–72 | About 1 in 5 children aged 5–14 years had delirium during the first 24–72 h of admission, and prevalence |

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| | | | | | hours for 6 months | was about 80% if they were on MV. |
| **Silver et al (2015)** | United States | Prospective observational study | To describe a single-institution pilot study regarding prevalence and risk factors for delirium in CI children | n=99 patients, 0-21 years old | Subjects underwent a psychiatric evaluation for delirium based on the DSM-IV criteria. | • Prevalence of delirium was 21%<br>• Risk factors were developmental delay, MV, and age 2-5 years. |
| **Girard et al (2008)** | United States | Review | To provide a general overview of the epidemiology, diagnosis, and pathophysiology of ICU delirium, and its association with health outcomes | | | • Delirium is a common manifestation of acute brain dysfunction in CI patients that is associated with poor short-term and long-term outcomes |
| **Alvarez et al (2018)** | United States | Prospective Cohort study | To determine incidence, associated risk factors, and characteristics of | n=99 children 0-21 years old in a Paediatric cardiac ICU | Subjects were screened for delirium using the Cornell | • Incidence of delirium was 57%<br>• Median time to development of delirium |

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| | | | delirium in a pediatric cardiac ICU | | Assessment for Pediatric Delirium each 12-hour shift over a 10 week period | was 1 day (95% CI 0, 1 days)<br>• Delirium is common in the pediatric CICU and is associated with longer LOS |
| **Yontem et al (2021)** | Turkey | Cohort | To evaluate patients for PD, to determine the frequency and risk factors of PD. | n=142 children in a PICU | Subjects were followed up and evaluated for delirium for over 48 hours | • Severity of illness, LOS in PICU, respiratory support, narcotic, benzodiazepine, vasoactive and corticosteroid treatments, & use of physical restraints were higher in patients with delirium. |
| **Dhingra et al (2021)** | India | Review | To review the frequency, causes and interventions of delirium in the PICU | | | • Treatment of delirium involves looking for underlying illness, iatrogenic causes, environmental and pharmacological |

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| | | | | | exposures and dealing with them |
| **Smith et al (2013)** | United States | Review | To present a brief overview of PD and propose a model for implementation of delirium monitoring | | • PD can be a complication of critical illness<br>• PD may be managed with use of nonpharmacologic and, if necessary, pharmacologic interventions |
| **Brummel et al (2013)** | United States | Review | To review delirium screening tools available for use in the adult and pediatric ICU, and evidence-based delirium screening implementation | | • Implementation of effective delirium screening is feasible but requires attention to implementation methods |
| **Smith et al** | United States | Guidelines | To develop comprehensive clinical | 29 experts collaborated to | • EM should be performed when feasible to reduce |

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| **(2022)** | | | practice guidelines for critically ill infants and children, with specific attention to seven domains of care | | develop the guidelines | the development of delirium |
| **Procter et al (2021)** | South Africa | Systematic Review | To describe the long-term health outcomes of children admitted to a PICU | n=111 studies were included | | • Scores of cognitive testing worsened after PICU admission |
| **Mesotten et al (2012)** | Belgium | Randomized Control Trial | To evaluate the effect of Tight Glucose Control on neurocognitive development | n=569 children, 16 years old or younger | Subjects were followed up almost 4years after PICU admission | • There was reduction in IQ scores, visual-motor integration, Attention Motor Coordination and Memory in children admitted to PICU |

PD= Paediatric Delirium, LOS= Length of Stay, EM= Early Mobilization, IQ= Intelligence Quotient, MV= Mechanical Ventilation

**Gastrointestinal System**

| Author (Year) | Country | Type of Study | Main Objectives | Study Population | Methods | Main Outcomes |
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| **Dooley et al (1989)** | Germany | Case control | To determine if alterations in bolus movement, induced by differing body positions, are reflected in specific changes of esophageal peristaltic parameters. | n=6 normal adult male volunteers aged between 30-51 years | Subjects were given a series of swallows of a water and a viscous bolus in both the supine and upright positions | Increased transit of nonviscous boluses through the esophagus in the upright position is accompanied by specific changes in esophageal peristaltic parameters. |
| **Thomas et al (2002)** | United States | Review | To review the effects of CI on different body systems and the rehabilitation of CI patients | | | BR results in decrease of appetite, reduced peristalsis, slower rate of absorption, and an increase in symptoms of GER |

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| **Newton et al (1999)** | England | Cross sectional study- survey | To determine the prevalence and severity of reflux like symptoms in a series of consecutive unselected patients admitted acutely and to study the effect of hospitalization on these symptoms. | n=275 adult admissions to the acute unit and orthopedic ward of a district general hospital | Patients were interviewed by questionnaire on two occasions: immediately following admission and again 7- 10 days later. | Patients on prolonged BR are at increased risk of reflux like symptoms and may require antireflux measures. |

GER= Gastroesophageal Reflux, BR= Bed Rest

| Paediatric Post Intensive Care Syndrome | | | | | | |
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| **Author (Year)** | Country | Study Design | Main Objective | Study Population | Methods | Main Outcomes |
| **Needham et al (2012)** | United States | Invited experts and SCCM members presented a summary of existing data regarding potential long-term physical, cognitive and mental health problems after intensive care | To report on a 2-day SCCM conference aimed at improving the long-term outcomes after CI for patients and their families. | 31 invited stakeholders from key professional organizations participated in the conference | | Post Intensive care syndrome was agreed upon as the recommended term to describe new or worsening problems in physical, cognitive, or mental health status arising after a critical illness and persisting beyond acute care hospitalization. |

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| **Manning et al (2018)** | United Kingdom | Review | To develop a conceptual framework describing PICS in pediatrics that includes aspects of the experience that are unique to children and their families | PICS in pediatrics will help illuminate the phenomena of surviving childhood critical illness and guide outcomes measurement in the field |

Physical health impairments

**(majority of studies have already been described under Musculoskeletal system effects.)**

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| **Herrup et al (2017)** | United States | Systematic Review | To synthesize the available evidence focusing on morbidities in pediatric survivors of critical illness that fall within the construct of PICS described in the adult literature. | n=19 studies were included in review | A comprehensive search was conducted in relevant data bases using controlled vocabulary and key word terms to identify studies reporting characteristics of PICS in PICU patients. | Survivors of pediatric critical illness have physical morbidities, which may decrease over time |

Cognitive Health Impairment **(majority of studies already discussed under nervous system effects)**

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| **Watson et al (2018)** | United States | Review | To review the current state of what is known about pediatric PICS-p, presenting areas of uncertainty and key knowledge gaps. | | Cognitive impairment after critical illness in children can be significant and may persist for years |
| **Tang et al** | China | Concept analysis/ Review | To define the concept of PICS-p to help practitioners and researchers understand the syndrome in detail | 24 publications met inclusion criteria | • Disturbance in the development of neurocognitive function can have a significant impact on the child.<br>• Cognitive impairments affect memory, executive function, language, attention, and visuospatial functions |

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| Mental Health Impairment | | | | | | |
| **Colville et al (2008)** | United Kingdom | Cross sectional study (Retrospective interview) | To establish the nature and extent of factual and delusional memories, in children after PICU discharge | n=102 children, > 7 years old admitted to an ICU of a tertiary children's hospital | Subjects were interviewed by an experienced clinical psychologist 6 weeks after discharge | Delusional memories were reported by almost one-third of children and were associated with both the duration of opiates/benzodiazepines and risk of PTS. |

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| **Colville & Pierce (2012)** | United Kingdom | Prospective longitudinal Cohort study | To establish longitudinal rates of post-traumatic stress and associations with poorer outcome in a cohort of child–parent pairs | n=66 children aged 7- 17 years | Subjects were screened with one parent at 3 and 12 months post-discharge. | • Nearly half of families were still experiencing significant symptoms of PTS 12 months after discharge<br>• Distress was predicted more by subjective than by objective factors |

PICS-p= Post Intensive Care Syndrome in Paediatrics, SCCM= Society of Critical Care Medicine, PTS= Post Traumatic Stress

**Physiotherapy in Critical Illness**

| Author (Year) | Country | Type of study | Main Objectives | Study population | Methods | Main Outcomes |
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| **Stiller (2000)** | Australia | Review | To review the evidence | Intubated, mechanically | | Limited recommendations can |

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| | | | regarding the effectiveness of physiotherapy for patients in the ICU and provide a framework for EBP | ventilated adults | be made regarding EBP of PT in the ICU because of the lack of data evaluating the effectiveness of PT in this setting. |
| **Hawkins & Jones (2015)** | Australia | Systematic review | To determine the role of PTs in the management of mechanically ventilated patients in the PICU | n=6 studies met the selection criteria | Evidence about rehabilitation among the mechanically ventilated PICU population is still lacking and requires further research |
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| Respiratory Physiotherapy | | | | | |
| **Hawkins & Jones (2015)** | Australia | Systematic Review | To determine the role of PTs in the management of mechanically | n= 6 studies on CPT met the selection criteria | CPT is still the focus of PT intervention in PICU for patients on MV, and supports its use for secretion |

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| | | | ventilated patients in the PICU | | | clearance in this setting |
| **Shkurka et al (2023)** | United Kingdom | Cross sectional study | To describe CPT practices for mechanically ventilated children in the UK and explore clinical decision making related to its delivery | n=72 qualified PTs working in UK NHS PICUs. | A cross-sectional observational study was conducted using a bespoke anonymous electronic survey | • A range of CPT treatments and adjuncts were used by PTs for ventilated children in UK PICUs<br>• Variation was apparent and may be due to individual preferences or local policies. |
| **McCord et al (2013)** | Canada | Retrospective Case series (chart review) | To describe current cardiopulmonary physical therapy practices in a | n=111 children, < 18 years old | A retrospective chart review was done in the CCCU | • Manual hyperinflation with expiratory |

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| | | | pediatric cardiac critical care unit (CCCU) and a PICU | and PICU at a specialist acute tertiary pediatric facility | vibrations were preferred treatment techniques |
| **Pathmanathan et al (2015)** | United Kingdom | Review | To provide an overview of techniques used in respiratory physiotherapy in the critical care unit. | | |
| **Walsh et al (2011)** | United States | Review | To review ACT in the pediatric patient with acute respiratory disease in the hospital environment, and the differences in physiologic processes unique to children | | ACTs may be of benefit in maintenance or prevention of respiratory-related neuromuscular disease complications and in treating atelectasis but maybe |

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| | | | | of little /no benefit in the treatment of acute asthma, bronchiolitis, neonatal respiratory distress, and they may not prevent postoperative atelectasis. |
| **Morrow (2019)** | South Africa | State of the art Review | To critically synthesize published evidence, expert opinion and pathophysiological principles to describe the indications, effects, precautions and application of commonly used | ACTh should not be performed routinely in children with acute respiratory conditions, rather patients should be clinically assessed and treatment individualized, when signs and symptoms |

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| | | | ACTh modalities for managing infants and children with acute pulmonary disease. | are potentially amenable to ACTh |
| **Schechter (2007)** | United States | Review | To review the physiologic and pathophysiologic consideration of ACTh in children, plus the impact of ACTh on disease outcomes specific to childhood | ACTh may impact children differently than adults, because of differences in airway mucus characteristics, airway mechanics, patient size, maturity, and fragility, and different susceptibility to diseases between children and adults. |
| **Morrow (2015)** | South Africa | Review | To review CPT in critical illness, including effects, | There is lack of strong evidence |

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| | | | indications, precautions, and specific treatment modalities and techniques. | | | supporting CPT and it has potential for serious adverse consequences. CPT should not be done routinely in the PICU and comprehensive individual clinical assessment should precede intervention |
| **Elizabeth et al (2017)** | Indonesia | Single blind Randomized Control Trial | To determine the efficacy of CPT and suctioning vs. suctioning alone for improving the MV and BGA parameters | n=40 children aged 1-204 months on MV. n=24 got CPT and suctioning n=16 got suctioning alone | Subjects underwent treatment, followed by monitoring of ventilation parameters and blood gas analyses. | MV parameters and blood gas analysis values were not significantly different between patients who received CPT and suctioning, compared to those who received suctioning alone |

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| **Wallis and Prasad (1999)** | United Kingdom | Expert Opinion | To review the efficacy of CPT in different disease conditions | | | Careful assessment should be done before giving CPT to ensure that it is beneficial and effective rather than hazardous |
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| **Harding et al (1998)** | New Zealand | Retrospective case control | To determine whether encephaloclastic porencephaly was associated with CPT treatment in preterm babies | n=454 cases of children birth weight > 1.5kg. n= 26 controls matched for age and weight | Subjects received 2-3 as many treatments with CPT in the second, third, and fourth weeks of life as did control infants | Encephaloclastic porencephaly may be a complication of CPT in vulnerable extremely preterm infants. |
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| Early Mobilization | | | | | | |
| **Gosselink et al (2008)** | | Review | To review the | | | Active or passive mobilization |

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| | | | evidence available for the use of PT in the adult CI patient and to make recommendations for assessment, monitoring and best practices | | and muscle training should be instituted early |
| **Hodgson et al (2014)** | Australia | Recommendations and Expert consensus | To develop consensus recommendations on safety parameters for mobilizing adult, mechanically ventilated, ICU patients. | A systematic literature review was followed by a meeting of 23 multidisciplinary ICU experts to seek consensus regarding the safe mobilization of MV patients | Consensus recommendations have the potential to guide ICU rehabilitation whilst minimizing the risk of adverse events |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Choong et al (2012)** | Canada | Retrospective Cohort study | To evaluate acute rehabilitation practices and potential barriers to mobilization in a tertiary care pediatric critical care unit (PCCU) | n=91 children, < 18 years old, > 24 hours LOS | | Immobilization is common in the PCCU particularly amongst the sickest and youngest children who may in fact be at highest risk of morbidity |
| **Cuello-Garcia et al., 2018** | Canada | Systematic Review | To characterize how EM is defined in the published literature and describe the evidence on safety and efficacy on EM in CI children. | n=11 studies included, 2 pilot trials, 9 observational studies. | PRISMA guidelines and the Cochrane Handbook for conducting systematic reviews and meta-analysis were followed | Definition of EM varies, but it seems to be feasible and safe in CI children. Efficacy of EM in children is still undetermined because low strong evidence. |
| **Wieczorek et al** | United States | Observational, pre-post design | To determine the safety and feasibility | n=200 children aged 1 day to | Project involved a usual-care baseline | EM program was feasible and resulted |

| | | | | | | |
|---|---|---|---|---|---|---|
| **(2016)** | | | of an EM program in a PICU. | 17 years, admitted for at least 3 days | phase, followed by a quality improvement phase to promote EM of CI children | in no adverse events. PICU Up! increased PT and OT involvement in the children's care and increased EM activities. |
| **Choong et al (2015b)** | Canada | Prospective cohort study | To evaluate the feasibility and safety of implementing two methods of in-bed mobilization in critically ill children | n=31 children aged 3- 17 years | Two methods of mobilization were applied for a maximum of 2 days, respectively | In-bed cycling can enhance physical activity, and appears to be safe and feasible in CI children |
| **Nijhof et al (2018)** | Netherlands | Review | To provide an overview of the role of play behaviour in the physical, social, emotional and cognitive | | | Stimulating play behaviour enhances the adaptability of a child to a stressful condition and promotes cognitive, social, |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | development, with a focus on chronically diseased children who | | | emotional and psychomotor functioning. |
| **Morrow (2021)** | South Africa | Narrative review | To describe the basic, practical considerations and essential elements required to build and sustain a successful and safe EM program in the PICU. | | A combination of available evidence from current literature, clinical experience and expert opinion | EM should be considered as part of the standard PICU "package of care" for all CI and injured children. Most perceived barriers to EM can be overcome through practice change the MDT |
| | | | | | | |
| Barriers to Early Mobilization | | | | | | |
| **Ista et al (2020)** | Europe | Cross-sectional, multicenter point prevalence study | To determine the prevalence of and factors associated with physical | n= 456 children admitted to one of 38 participating PICUs from 15 | Clinical data and data on patient mobility, potential mobility safety events, and | • 25% of CI children across Europe were completely immobile |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | rehabilitation in PICUs across Europe. | European countries | mobilization barriers were prospectively collected in patients admitted for ≥72 h. | • Potential safety events occurred in 6% of documented mobilization events. |
| **Kudchadkar et al (2020)** | United States | National 2-day point prevalence study. | To evaluate the prevalence of rehabilitation for critically ill children and associated barriers. | n=1769 children in 82 PICUs in 65 hospitals across the United States | Data was collected on timing of initial rehabilitation team consultation, clinical and patient mobility data, potential mobility-associated safety events, and barriers to mobility | OBM was negatively associated with presence of an ETT (aOR, 0.13; 95% CI, 0.1–0.2) and urinary catheter (aOR, 0.28; 95% CI, 0.1–0.6). |
| **Denehy et al (2017)** | Australia | Review | To describe reasons why patients should receive EM and rehabilitation in the ICU. | | | These reasons provide support for continued implementation and evaluation of EM and |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | rehabilitation in the ICU |
| **Wieczorek et al (2015)** | United States | Systematic Review | To summarize current evidence about rehabilitation therapies in the PICU highlighting the knowledge gaps on EM in the PICU. | n=6 studies included | Early rehabilitation in the PICU is safe and feasible with potential short- and long-term benefits. |
| **Stiller (2013)** | Australia | Systematic Review | To examine the evidence concerning the effectiveness of PT for adult, intubated patients who are on MV in the ICU | n=85 studies included, n=55 clinical studies n=30 non clinical studies included | Early progressive mobilization is beneficial for adult patients in the ICU may improve functional ability and reduce ICU and hospital LOS. |
| **Morris (2007)** | United States | Review | To explore how ICU | | Despite the documented potential |

| | | | | |
|---|---|---|---|---|
| | | | mobilization may benefit patients and how usual practice may inhibit the delivery of mobilization. | barriers to EM there are many documented benefits, pointing to a need to overcome perceived barriers |
| | | | | |
| Benefits of Early Mobilization | | | | |
| **Cameron et al (2015)** | Canada | Review | To emphasize the practicality and effectiveness of EM and its impact on recovery from a critical illness in both adults and children | Adult patients receiving EM have fewer ventilator-dependent days, shorter ICU and hospital stays, and better functional outcomes. |
| **Kress & Hall (2014)** | United States | Review | To provide an overview of ICUAW and its effect on | EM of patients in the ICU, has become established |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | recovery after critical illness | | | as a strategy to reduce the deconditioning and dysfunction commonly seen in survivors of CI. |
| **Mendez-Tellez and Needham (2012)** | United States | Review | To summarize the impact of both physical inactivity and MV on skeletal and diaphragmatic muscles structure and function | | | Early physical rehabilitation has been associated with shorter periods of MV, decreased ICU and hospital stay, and improved PF at hospital discharge. |
| **Brahmbhatt et al (2010)** | United States | Open label Randomized Control Trial | To assess efficacy of combining daily interruption of sedation with PT and OT on functional outcomes in patients on MV in ICU | n=104 patients on MV in ICU n=49 intervention group n=55 control group | Intervention group got early PT and OT, control group got therapy as ordered by primary care team | Early whole body rehabilitation was safe and well tolerated, and resulted in better functional outcomes, |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | a shorter duration of delirium, and more ventilator-free days compared with standard care |
| **Jacobs et al (2001)** | United States | Retrospective Case control | To report the safety and efficacy of a postoperative approach that avoids pharmacologic and physical restraints and allows liberal physical activity after single-stage laryngotracheal reconstruction in children. | n=133 children aged 2-336 months Group 1 (n=54) were tracheally intubated, awake, and unrestrained Group 2 (n=79) were tracheally intubated, awake, and restrained | Five-year period of data collection regarding postoperative care and complications | PICU LOS was less in group 1 compared to group 2 (11.2 ± 0.5 days vs. 13.7 ± 0.6 days; p = .007) Adverse events were fewer in group 1 compared with group 2: atelectasis, 44% vs. 73% (p < .001); post extubation stridor, 22% vs. 53% (p < .001); withdrawal syndromes, 0% vs. 43% (p <.001). |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Tsuboi et al (2019)** | Japan | Retrospective before after study | To evaluate the impact of EM after pediatric liver transplantation in the PICU. | n=75 children 2–18 years old who underwent liver transplantation and could walk before surgery | An EM intervention was evaluated using a before-after design on patients undergoing liver transplantation who could walk before surgery. | Patients in the Post EM period were able to walk again earlier (28 [16–66] vs 23 [19–31] postoperative days; p = 0.015 |
| ABCDEF Bundle | | | | | | |
| **Marra et al (2017)** | United States | Review | To review the core evidence and features behind the ABCDEF bundle | | | The ABCDEF bundle is one path to well-rounded patient care and optimal resource utilization resulting in more interactive ICU patients with better pain control |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Ely (2017)** | United States | Review | To explain the science and philosophy of liberating ICU patients and families from harm that is both inherent to CI and iatrogenic. | | | The most productive aspect of the philosophy of ICU Liberation for us as clinicians is that it shifts our focus from the monitors, beeps and buzzers to a human connection |
| **Erstad et al (2009)** | United States | Review | To provide an overview of the important principles governing pain management in the ICU setting. | | | Combined use of pharmacologic and nonpharmacologic interventions may provide more effective pain control than when each is used alone |
| **Payen et al (2009)** | France, Luxembourg | Prospective Cohort study | To establish whether an association exists between pain | n=1144 patients on MV > 15 years old. | Duration of MV and duration of ICU stay was compared | Patients who got pain assessment had shorter duration of MV (8 Vs 11 days; |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | measurements, MV duration, and duration of ICU stay | n=533 patients assessed for pain<br>n=631 not assessed for pain | between the 2 groups of patients. | p< 0.001) and shorter reduced duration of ICU stay (13 Vs 18 days; p<0.001) |
| **Saliski and Kudchadkar (2015)** | United States | Review | To review currently available sedation strategies for mechanically ventilated children for successful implementation of EM in the PICU | | | Optimizing sedation is integral to the successful implementation of EM programs for critically ill children |
| **Bastani et al (2015)** | Iran | Randomized Control Trial | To determine the effect of family-centered care including maternal participation, presence, and | n=110 primiparous mothers of preterm infants. n=55 mothers in Family | FCC was implemented in the FCC group, while the control group was provided with routine care | Mean score of satisfaction increased after program from 22.36 to 59.28; p<0.001 |

| | | | |
|---|---|---|---|
| | information about neonatal care, on maternal satisfaction and neonatal readmission; | Centered Care (FCC) group n=55 mothers in routine care group | Mean duration of hospitalization was 6.96 and 12.96 in FCC and control groups respectively, p< 0.001 |

EBP= Evidence Based Physiotherapy, PT= Physiotherapy, CPT= Chest Physiotherapy, ACT= Airway Clearance Techniques, ACTh= Airway Clearance Therapy, EM= Early Mobilization, PF= Physical Function, OBM= Out of Bed Mobilization, FCC= Family Centered Care, ICUAW= Intensive Care Unit Acquired Weakness, LOS= Length of Stay

## Appendix B: Budget

| Item | Unit cost | Total cost (UGX) |
|---|---|---|
| Research site fees | 1. Mulago National Referral hospital- $400<br>2. Uganda Heart Institute- $200<br>3. Children's Surgical hospital Entebbe- $100<br>4. Lubaga hospital- $100<br>5. Nakasero hospital- 100 | **3,300,000** |
| Research and Ethics committee fees/ Institutional Review Board | 200,000 UGX | **200,000** |
| Stationary costs | 500 UGX printing per page | **500,000** |
| Transport costs | 50,000 UGX fuel for trip to furthest study site | **1,000,000** |
| Communication costs | 90,000 UGX monthly internet bundle<br>50,000 UGX monthly phone calls bundle | **900,000**<br>**300,000** |
| Research assistants (on site physiotherapists collecting data) | 20,000 UGX each study day | **1,800,000** |
| **TOTAL** | | **7,100,000** |

### Budget motivation

The study sites all charge a set rate for being used as research sites, and this is non-negotiable. Similarly, the sites have costs for institutional review.

Stationary costs are required for the printing of the data collection tools

Communication costs are for communicating with: the research assistants at the study sites about progress with the data collection and any matters that may arise; study site administrators in case of need during the data collection process; internet is necessary for frequent communication with the supervisor (as I am studying by long distance)

Research assistant costs are based on estimates provided by some physiotherapists who have previously worked as research assistants in research at a level similar to this study

# APPENDIX C: Clearance certificates

**UNIVERSITY OF CAPE TOWN**
**Faculty of Health Sciences**
**Human Research Ethics Committee**

**Room 45 E-52-E-Floor- Old Main Building**
**Groote Schuur Hospital**
**Observatory 7925**
**Telephone** [021] 406 6492
**Email:** hrec-submissions@uct.ac.za
**Website:** www.health.uct.ac.za/home/human-research-ethics

28 November 2022

**HREC REF: 768/2022**

**Prof B Morrow**
Division of Paediatrics
5th Floor, ICH Building- Red Cross War Memorial Children's Hospital
Email: brenda.morrow@uct.ac.za
Student: SNDIDA001@myuct.ac.za

Dear Prof Morrow

**PROJECT TITLE: PROVISION OF PHYSIOTHERAPY SERVICES TO CHILDREN IN INTENSIVE CARE UNITS IN UGANDA: A DESCRIPTIVE STUDY-**
**(MASTERS CANDIDATE-MS IDAH SENDAGALA)**

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study, subject to the following : -

1. The placement of notices in the PICU informing all parents/guardians that research will be occurring and that all will be confidential.
2. Local REC and Regulatory approvals.

**Approval is granted for one year until the 30 November 2023.**

Please submit a progress form, using the standardised Annual Report Form (FHS016) if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

***The HREC acknowledge that the student: Ms Idah Sendagala will also be involved in this study.***

**Please quote the HREC REF 768/2022 in all your correspondence.**

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

HREC/ref 768.2022

TELEPHONE: +256-41554008/1
FAX: +256-414-5325591
E-mail: admin@mulago.or.ug
Website: www.mulago.or.ug

IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTES NO.....

MULAGO NATIONAL REFERRAL HOSPITAL
P. O. Box 7051
KAMPALA, UGANDA

APPROVED
APPROVAL DATE EXPIRY DATE
08 DEC 2022 07 DEC 2023
MULAGO RESEARCH ETHICS COMMITTEE
IRC

9th December 2022.

Ms. Idah Sendagala
Principal Investigator
Faculty of Health Sciences
University of Cape Town

Dear Ssendagala,

**Re: Approval of Protocol MHREC 2402: "Provision of Physiotherapy Services to Children in Intensive Care Units in Uganda: A Descriptive Study".**

The Mulago Hospital Research and Ethics Committee reviewed your proposal referenced above and granted approval of this study on 8th December 2022. The conduct of this study will therefore run for a period of one (1) year from 8th December 2022 to 7th December 2023.

This approval covers the protocol and the accompanying documents listed below;

- Consent form
- Data collection tool

This approval is subjected to the following conditions:

1. That the study site may be monitored by the Mulago Hospital Research and Ethics Committee at any time.
2. That you will be abide by the regulations governing research in the country as set by the Ugandan National Council for Science and Technology including abiding to all reporting requirements for serious adverse events, unanticipated events and protocol violations.
3. That no changes to the protocol and study documents will be implemented until they are reviewed and approved by the Mulago Hospital Research and Ethics Committee.
4. That you provide quarterly progressive reports and request for renewal of approval at least 60 days before expiry of the current approval.
5. That you provide an end of study report upon completion of the study including a summary of the results and any publications.
6. That you will include Mulago Hospital in your acknowledgements in all your publications.

I wish you the best in this Endeavour.

Signed by candidate

DR. NAKWAGALA FREDERICK NELSON
**CHAIRMAN- MULAGO HOSPITAL RESEARCH & ETHICS COMMITTEE.**

TELEPHONE: +256-41554008/1
FAX: +256-414-5325591
E-mail: admin@mulago.or.ug
Website: www.mulago.or.ug

IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTES NO.....

MULAGO NATIONAL REFERRAL HOSPITAL
P. O. Box 7051
KAMPALA, UGANDA

9th December 2022.

**Ms. Idah Sendagala**
Principal Investigator
Faculty of Health Sciences
University of Cape Town

Dear Ms. Sendagala,

**RE: RECOMMENDATION FOR ADMINISTRATIVE CLEARANCE TO CONDUCT A STUDY AT MULAGO NATIONAL REFERRAL HOSPITAL.**

The Administration and Management of Mulago National Referral Hospital is pleased to inform you that you have been offered clearance to conduct the study titled **MHREC 2402: "Provision of Physiotherapy Services to Children in Intensive Care Units in Uganda: A Descriptive Study".**

The above clearance is granted to you on the following conditions;

- That you will follow the research ethical processes
- Agreed to comply with all institutional policies and regulations of Mulago National Referral Hospital
- Agreed to provide end of study report and acknowledge Mulago hospital in all publications

Administrative clearance is valid for one (1) year effective from 8th December 2022 to 7th December 2023.

The Investigator should ensure to get final approval of the protocol and all accompanying documents from UNCST before starting the study. In case of studies involving drug, approval is obtained from National Drug Authority and for those studies involving medical devices, seek approval from Director General, Ministry of Health.

By copy of this letter, we reiterate our commitment to support this study.

Signed by candidate

DR. BYANYIMA ROSEMARY
**AG. EXECUTIVE DIRECTOR**
**MULAGO NATIONAL REFERRAL HOSPITAL.**

# UGANDA HEART INSTITUTE

*First Floor, Block C, Mulago Hospital Complex P.O. Box 37392 Kampala, Uganda*
*Telephone: 0417720350 E-mail: info@uhi.go.ug: website: https://www.uhi.go.ug*


*Our Ref:* ...**ADM/100/110/01**

*Your Ref:* .....

12th December, 2022

Ms. Idah Sendagala,
Faculty of Health Sciences,
University of Cape Town.

**RE: PERMISSION TO CARRYOUT A RESEARCH STUDY AT UGANDA HEART INSTITUTE (UHI)**

Reference is made to your letter dated **6th December, 2022** seeking for permission to carry out a study at Uganda Heart Institute (**The Research study titled: "Provision of physiotherapy services to children in the Intensive Care Units in Uganda: A descriptive Study"**).

Following approval of your Research Proposal by the Research Committee, you are hereby granted permission to carry out the study at **UHI**.

Signed by candidate

Dr. Sebatta Elias
**CHAIRMAN RESEARCH COMMITTEE**

Cc: Senior Hospital Administrator

# LUBAGA HOSPITAL

Trustees of the Archdiocese of Kampala

12 December 2022

**Ref: LHSC/2022/018**

Ms. Ida Sendagala
5th Floor, ICH Building – Red Cross War Memorial Children's Hospital
Groote Schuur Hospital
Observatory 7925
University of Cape Town

Dear Ida,

**ADMINISTRATIVE APPROVAL OF STUDY FWA00001637 PROVISION OF PHYSIOTHERAPY SERVICES TO CHILDREN IN INTENSIVE CARE UNITS IN UGANDA: A DESCRIPTIVE STUDY.**

This is to acknowledge receipt of your proposal, introduction letter from University of Cape Town Human Research Ethics Committee All that you require from the Lubaga Hospital Scientific Committee is an administrative clearance. We hereby grant you the administrative approval, continued approval is conditional upon your compliance to the following requirements:

1. Significant changes to the study site and significant deviations from the research protocol and all unanticipated problems that may involve risks or affect the safety or welfare of subjects or others, or that may affect the integrity of the research must be promptly reported to the LHSC.
2. Any problems or serious or unexpected adverse events, whether related to the study article or not, must be reported to the LHSC in a timely manner as specified in the National Guidelines for Research Involving Humans as Research Participants 2014 Edition.
3. Please send the report upon completion or termination of the study to the LHSC. The study cannot continue after 11 December 2023 until re-approved by the UTAMU Business School.

Yours Sincerely,

Signed by candidate ( 13th/12/2022

Sr Dr Grace Nanyondo
**MEDICAL DIRECTOR**
**For: LHSC CHAIRMAN**

P.O. Box 14130, Kampala-Ug.
0200244800
info@lubagahospital.org
www.lubagahospital.org
Toll Free: 0800 388 888
*Service with love*

Nakasero Hospital

NHL\ADMIN\20230116\01

16th January 2023

Dear Ms Sendagala,

**RESEARCH APPROVAL LETTER TO UNIVERSITY OF CAPE TOWN PHYSIOTHERAPY SERVICES STUDY AT NAKASERO HOSPITAL.**

I am pleased to inform you that the above mentioned research study has been approved by the Professionalism, Standards and Ethics Committee of Nakasero Hospital (PSEC).

You are required to pay the Research study fee at the Main Cash Office and then proceed with your Research.

We wish you a fruitful study.

Yours Sincerely,

Signed by candidate

.....

**Dr. David Nsibambi**
**Chairman, PSEC**
**Nakasero Hospital**

0312531400| 0312346159
P.O.BOX 16595
Plot 14A Akii Bua Road
www.nakaserohospital.com

## Appendix D: Data Collection Tool

**DATA COLLECTION TOOL**

This is a study about the provision of physiotherapy to children in intensive care units in Uganda. The aim of the study is to understand current physiotherapy and physiotherapy referral practice in order to lay a foundation to improve practice. The researcher really appreciates your participation in the research team- good data collection is key to the success of the study! Please do not include any identifiers (like the child's name) on this form, but do please keep a list corresponding to the study number so we can double check results if we need to.

**Note: Data must be collected within 24 hours of every study day.**

**Date**

**Study site ID**

**Study number**

Age

Sex

How many days has the patient been in the PICU? (Zero (0) is the first PICU day)

Has the patient had surgery during this PICU admission?

If yes, what is the postoperative day from the most recent surgery? (Zero (0) is day of surgery)

…….

……

……

☐ 0-2 years

☐ 3-6 years

☐ 7-12 years

☐ 13-18 years

☐ Male

| | |
|---|---|
| ☐ Female | ☐ Yes |
| | ☐ No |
| …… | ……..... |
| What statement best describes the child's baseline health status before this hospitalization? | ☐Good: Healthy, alert, and capable of normal age-appropriate activities of daily life. Medical and physical problems do not interfere with normal activity |
| | ☐Mild disability: Minor chronic mental or physical health condition that does not disrupt function in major ways (e.g. asthma, mild epilepsy on medication) |
| | ☐Moderate disability: Conscious and able to perform most age appropriate activities of daily living but cannot do all physical activities because of a mild physical disability |
| | ☐Severe disability: Conscious but delayed for most age-appropriate activities and is highly dependent on others for activities of daily living |
| Primary reason for ICU admission | |

☐Post-Surgical: Ortho

☐Post-Surgical: Urology

☐Post Surgical: Other

☐Medical: Haem/Oncology

☐Medical: Cardiac

☐Medical: Infectious / Inflammatory

☐Medical: Neurologic

☐Medical: Renal

☐Medical: Respiratory

☐Trauma

☐Post-Surgical: Neuro

Other……

☐Post-Surgical: Cardiac

Has a referral been made to physiotherapy for this patient ever during their admission?

☐ Yes

☐ No

If yes, on what day of PICU admission was the first referral for physiotherapy made?

What PICU day was the first treatment of physiotherapy done?

What type of respiratory support is the child receiving today?

What is the child's GCS score?

…….

……..

…….

☐No respiratory support

☐Nasal cannula or face mask oxygen

☐NIV- CPAP or BiPAP via face mask

☐Mechanical ventilation via tracheostomy or endotracheal tube (including CPAP only)

☐ 1- 4

☐ 5- 10

☐ 11- 15

☐ Not recorded

Does the child have any of these in place? (Select all that apply)

☐ Endotracheal tube

☐ Tracheostomy

☐ Central venous line (including PICC, NOT including hemodialysis)

☐ Arterial line

☐ Urinary catheter

☐ Haemodialysis catheter

☐ Chest tube

☐ Surgical drain

☐ Intracranial pressure monitor

Did the patient receive any physiotherapy treatment in the last 24 hours?

If no, what was the reason for the patient not receiving physiotherapy?

☐ Yes

☐ No

☐ Physiotherapy forbidden by doctor

☐ Terminally ill patient

☐ No referral from doctor or other ICU staff

☐ Medically unstable patient

☐ Risk of dislodging attachments

☐ No physiotherapist available

☐ Lack of necessary equipment

☐ Medical contraindication

☐ Isolation precautions

☐ Post operation restrictions

☐ No clinical indication for PT

Other……..

If yes, how many times did the patient receive physiotherapy in the last 24 hours?

☐ Once

☐ Twice

☐ Three times ☐

☐ More than three times

If yes, who made the referral for the patient to receive physiotherapy?

☐

☐ Doctor

☐ Other ICU staff e.g. nurse

☐ Physiotherapist identified patient

Other……

☐ Self-referral by patient/ caregiver

What physiotherapy was done and which techniques were used for treatment in the last 24 hours?

| ☐ Chest physiotherapy | ☐Rehabilitation activities |
|---|---|
| ☐ Percussions<br>☐ Vibrations<br>☐ Rib springing<br>☐ Positioning<br>☐ Head-down postural drainage<br>☐ Active Cycle of Breathing Technique (ACBT)<br>☐Positive Expiratory Pressure (PEP)<br>☐Autogenic drainage<br>☐Suctioning,<br>☐Assisted cough,<br>☐Deep breathing exercises,<br>☐Manual hyperinflation<br>Other…… | ☐Of limbs in bed (passively)<br>☐Of limbs in bed (actively)<br>☐In bed (e.g. up, down, rolling, bridging)<br>☐Sitting in bed<br>☐Sitting over edge of bed<br>☐Transferred out of bed to sit in chair<br>☐Standing out of bed<br>☐Pre-gait exercises e.g. crawling, bottom shuffling, walking while holding onto things (cruising), standing up from kneeling<br>☐Walking within unit<br>☐Walking beyond the unit<br>☐Transferring out of unit sitting in chair/ lying in bed<br>☐ Resisted exercises<br>☐ Neurodevelopmental therapy (NDT)<br>If NDT was done please explain what was done<br>……<br>……<br>Other…… |