Received: 22 August 2019 | Revised: 24 January 2020 | Accepted: 23 May 2020
DOI: 10.1002/pri.1860

RESEARCH ARTICLE

WILEY

Physiotherapy in children hospitalized with traumatic brain injury in a South African tertiary paediatric hospital

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Abstract

Introduction: Physical impairments following traumatic brain injury (TBI) may limit participation in daily living. Physiotherapy could assist in managing these limitations, however, there is a paucity of literature on the physiotherapy management of children in the acute phase of TBI.

Objectives: To describe the characteristics, course and outcome of children hospitalized with TBI, with specific reference to the role of physiotherapy.

Methods: A retrospective folder review of all children (n = 130, median 5.37 years [IQR 1.88–7.88]) admitted in 2016 with a primary diagnosis of TBI was conducted at a tertiary paediatric hospital.

Results: Most cases presented with mild TBI (66.2%). The most common cranial manifestation of the TBI was brain bleeds (80%) and most occurred as a result of road traffic accidents (50%, including both pedestrian and motor vehicle accidents).
Physiotherapy was administered in 35 cases (26.9%), with functional interventions, such as mobilizations out of bed, the most common form of therapy (71.4%). Children involved in road traffic accidents, presenting with severe diffuse TBI, resulting in altered tone and coordination problems, admitted to intensive care, monitored with an intracranial pressure or Licox monitor, and receiving occupational therapy and/or been followed up by dieticians, were more likely to receive physiotherapy.
The duration of hospitalization (median 4 days [IQR 2–9]) was associated with infections, severity of TBI, presence of an intracranial monitoring, and parietal lobe injury.

Conclusion: This is the first study in South Africa investigating standard physiotherapy care in children admitted with TBI. Physiotherapy was provided in a small portion of children and appeared to be well tolerated. However, due to the limited information recorded in the physiotherapy notes, results of this study need to be confirmed in larger, more well-documented studies before generalizations can be made.

KEYWORDS
inpatient rehabilitation, paediatrics, physiotherapy, traumatic brain injury

1 | INTRODUCTION

Traumatic brain injuries (TBI) remain one of the leading causes of acquired disability in children (Katz-Leurer & Rotem, 2017; World Health Organization, 2006), often resulting in physical, cognitive, emotional and/or behavioural problems (Katz-Leurer & Rotem, 2017; Popernack, Gray, & Reuter-Rice, 2015). The acute trauma, secondary complications and long term disability can be more severe in children due to anatomical and physiological differences compared to adults (Figaji, 2017; Katz-Leurer & Rotem, 2017). On the other hand, children may have greater plasticity and therefore may respond better to rehabilitation care (Fiori & Guzzetta, 2015).

Physical impairments, including altered muscle tone, proprioception, balance and coordination, often limit the child's abilities to perform activities of daily living (Popernack et al., 2015). Timely initiation of physiotherapy is therefore recommended to improve functional recovery. Therapy should commence once the child is clinically stable and continue post-discharge to assist return to full participation in school and community life (Popernack et al., 2015; Tepas et al., 2009). However, guidelines for the management of patients with TBI focus mainly on the medical management, underestimating the importance of rehabilitation (NICE, 2014; World Health Organization, 2006). This could explain the small number of children (12–38%) admitted to hospital for TBI undergoing assessment for physiotherapy needs (Bennett, Niedzwecki, Korgenski, & Bratton, 2013; Gray, Woods, & Hadjikoumi, 2012); and the paucity of literature on the physiotherapy management of children with TBI. In particular, the definitions of stability, and therefore the timing of physiotherapy in this group, are poorly defined because of lack of data (Bennett et al., 2013; Tepas et al., 2009). More research has been done on the timing and intensity of neurorehabilitation in adults (Konigs, Beurskens, Snoep, Scherder, & Oosterlaan, 2018), however, these results cannot be generalized to a paediatric population.

This study aimed to describe the characteristics, course and outcome of children hospitalized with TBI at a tertiary paediatric hospital, with specific reference to the role of physiotherapy in these children. As children with severe TBI get screened for rehabilitation needs daily by the physiotherapists at the research site, it was hypothesized that they were more likely to receive physiotherapy.

2 | METHODS

2.1 | Study design

This was a retrospective folder review of routinely collected clinical data of children with the clinical diagnosis of TBI hospitalized at Red Cross War Memorial Children's Hospital (RCWMCH), Cape Town, South Africa, from January to December 2016.

Institutional ethical approval (HREC 181/2018) was obtained for the study. The need for written informed consent was waived owing to the retrospective study design.

2.2 | Subjects

Children from birth to 13 years (the age limit at the hospital) admitted to RCWMCH in 2016 with a primary diagnosis of TBI were eligible for inclusion. Folders were identified using primary diagnostic codes for a range of clinical signs of TBI (based on ICD-10 codes for fractures of skull and facial bones, and intracranial injuries). Children with a primary diagnosis of TBI without positive significant clinical and/or radiological findings of TBI were excluded from the study. A population sample was used; all children eligible for enrolment were included.

2.3 | Materials

A standard pre-structured data extraction form, validated for content by two experts, was used to record de-identified data on demographic information, health condition, physiotherapy administered and patient outcomes. Reliability of data extraction between researchers was ensured by a pilot study on five randomly selected folders. All but six items demonstrated 100% agreement between researchers. Any discrepancies (seen on the six items) were resolved by discussion and changes to the extraction sheet were made to improve reliability.

2.4 | Procedure

All data was collected by undergraduate physiotherapy students, trained by the project supervisor (paediatric physiotherapist) to extract data from the medical files. Data were entered in an online data collection tool (Magpi) and exported to Excel after completion. The project supervisor was available for assistance throughout the data extraction phase and reviewed the final data spreadsheet for missing data.

Data were analysed using SPSS (IBM SPSS Statistics for Windows, version 25.0, Armonk, NY). Data were tested for normality using the Shapiro–Wilk test. All numerical data are presented as median (interquartile range [IQR]) and categorical data as frequencies (*n* [%]). Chi square with Yates correction and odds ratios were calculated to identify associations between data. A Kruskal–Wallis test was used to determine age differences for various mechanisms of injury. Forward stepwise logistic and multiple regression analyses were performed to predict factors relating to physiotherapy and length of hospitalization. Non-parametric between groups analyses were used to compare length of hospitalization between patients admitted to ICU and those who were not (Mann–Whitney *U* test); and between TBI severity category based on the GCS score (Kruskal–Wallis test). A 95% significance level was chosen.

3 | RESULTS

In total, 549 cases were initially identified, of which 53 folders were duplicates, therefore 496 folders were screened for eligibility. Fortynine folders were missing and 317 folders were excluded as the child did not present with clinical and/or radiological signs of TBI (Figure 1). Therefore, a total of 130 children, median (IQR) 5.37 (1.88–7.88) years, were included in this retrospective folder review, with most being male (64.6%). The most frequent age groups were 1 year, 4 years and 6–7 years (Figure 2).

3.1 | Health condition

Table 1 shows a summary of the characteristics of the cases. Most presented with mild TBI (66.2%) (median GCS score of 14/15 [IQR 11–15] and 11/11 [IQR 10–11]); and road traffic accidents was the most common mechanism of injury (50%), due to pedestrian vehicle accidents (PVA) in 33.8% of the cases (child as a pedestrian being hit by a car) and motor vehicle accidents (MVA) in 16.2% (child being a passenger in the car) (Table 1). Road traffic accidents (MVA and PVA) were seen in all age groups (Figure 3), whereas other aetiologies differed among age categories. Bicycle related TBI, sports related TBI and penetrating brain injury were seen mainly in children older than 6 years of age, while (suspected) abuse was only found in babies and toddlers (Figure 3). Significant differences between age of children sustaining TBI due to (suspected) abuse and road traffic accidents (PVA and MVA) or bicycle accidents is seen (H = 24.0, p = .002). The parietal lobe was the most common neuroanatomical area affected on imaging (36.2%), followed by the frontal lobe (32.3%), with cerebral contusions or haemorrhages (65.4%) the most common radiological findings (Table 1). Twenty-eight children (21.5%) were admitted to ICU.

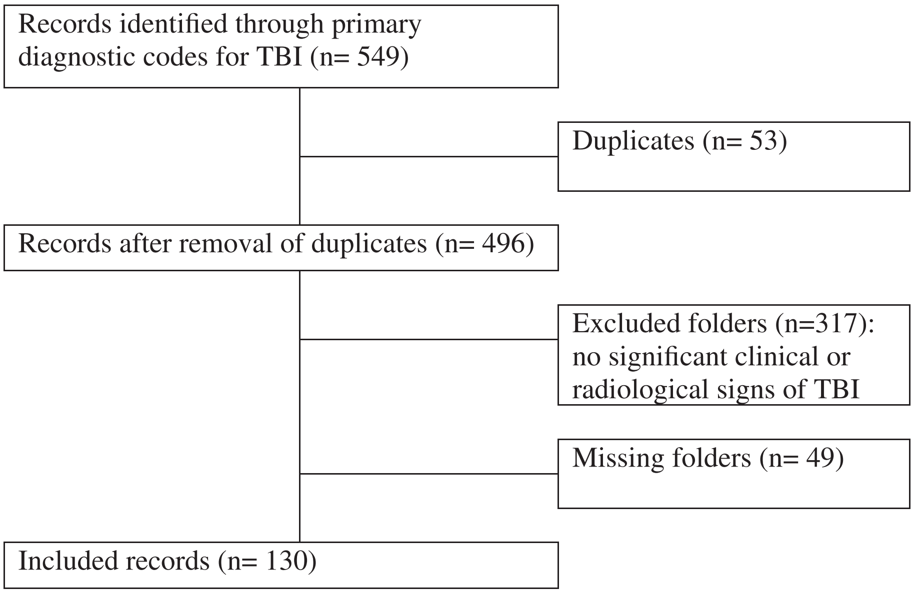

FIGURE 1 Study flow chart

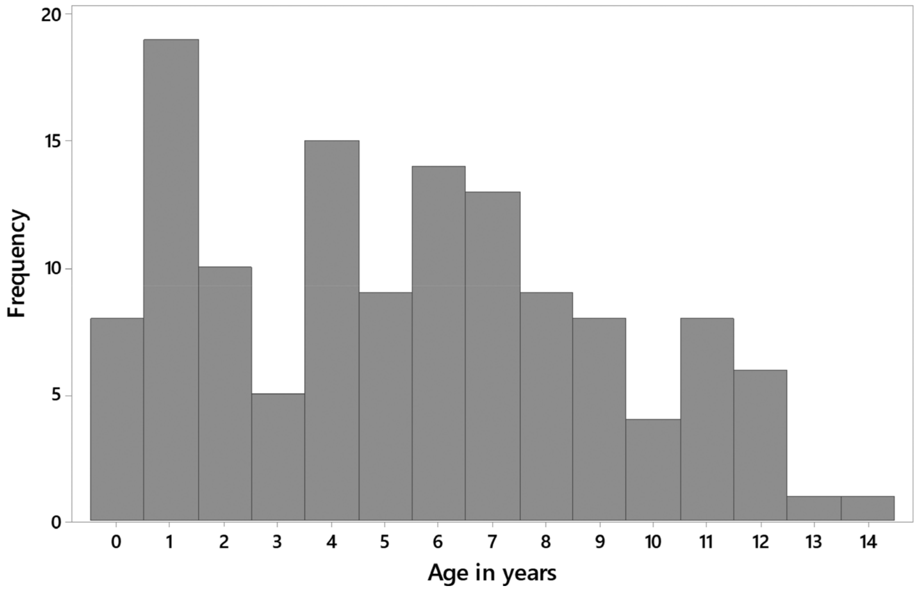

FIGURE 2 Histogram of age

TABLE 1 Characteristics of included cases

Category	Description	N (%)
Aetiology	PVA	44 (33.9)
	Fall	32 (24.6)
	MVA	21 (16.2)
	Other blunt force trauma	19 (14.6)
	(Suspected) abuse	6 (4.6)
	Bicycle accidents	3 (2.3)
	Other	5 (3.9)
Area of brain involved(more than 1 area of the brain could have been involved)	Parietal lobe	47 (36.2)
	Frontal lobe	42 (32.3)
	Occipital lobe	29 (22.3)
	Temporal lobe	22 (16.9)
	Cerebellum	3 (2.3)
	Other	3 (2.3)
	Unknown	33 (25.4)
Type of tissue damage(more than 1 type of damage could have been occurred)	Hematoma/ haemorrhage/ intracranial bleed	104 (80.0)
	Contusion	21 (16.2)
	Swelling	21 (16.2)
	Diffuse	15 (11.5)
GCS	Mild (score 13–15/ 15 or ≥ 9/11*)	86 (66.2)
	Moderate (score 9–12/15 or 7–8/11[a])	15 (11.5)
	Severe (score ≤ 8/15 or ≤ 6/11*)	21 (16.2)
	Unknown	8 (6.2)
Neurological signs (more than 1 neurological manifestation could have been present)	Altered tone	7 (5.4)
	Coordination problems	6 (4.6)
	Motor control impairment	5 (3.9)
	Neuropsychological impairment	4 (3.1)
	Cognitive impairment	3 (2.3)
	Abnormal reflexes	3 (2.3)
	Speech apraxia	2 (1.5)
	Myoclonus	2 (1.5)
Secondary events	Seizures	6 (4.6)
Surgeries(more than 1 surgery could have been performed)	Craniectomy/ Washout	13 (10.0)
	Monitor placed- ICP monitor- Licox monitor	9 (6.9)8 (6.2)6 (4.6)
	Craniotomy	8 (6.2)
	Debridement	6 (4.6)
	ORIF	3 (2.3)
	Cranioplasty	2 (1.5)
	Burr hole	2 (1.5)
	VP shunt	2 (1.5)
	Skin graft	2 (1.5)
	Exofix for fracture	1 (0.8)

Abbreviations: GCS, Glasgow Coma Scale; ICP, intracranial pressure; MVA, motor vehicle accident; ORIF, open reduction and internal fixator for limb fractures; PVA, pedestrian vehicle accident.
[a]An adapted score /11 for babies and infants% based on *n* = 130 cases.

All but one child (who received an MRI first), received a CT scan. Positive radiological findings were found in 118 patients (90.8%). Neurological signs were seen in 19 children (14.6%), with altered tone the most common (*n* = 7, 5.4%) followed by coordination problems (*n* = 6, 4.6%); seizures occurred in six children (4.6%). Seven children presented with associated extra-cranial fractures, five with infections, five with pneumonia and two developed hydrocephalus following their TBI.

Twenty-six children underwent a surgical intervention (20%), with the most common performed surgical procedures craniectomies for depressed fractures (7.7%), placement of intracranial pressure (ICP) monitors (6.9%), and craniotomies to evacuate mass lesions (6.2%) (Table 1).

3.2 | Physiotherapy

Physiotherapy was administered in 35 cases (26.9%), with a median (IQR) of 3.0 (2.0–6.0) sessions per admission. Approximately half the patients received daily treatment (51.4%); four received bi-daily physiotherapy (11.4%) and the remainder (37.1%) received less than daily treatment while being followed up by the physiotherapy department. Physiotherapy was commenced at median (IQR) of 4.0 (2.0–8.0) days from admission. Functional treatments were the most common type of interventions performed by the physiotherapists (71.4%) (Table 2). Patients remained under the supervision of the physiotherapy services for a median of 4.0 (1.0–10.0) days before discharge.

Two children experienced side effects of the physiotherapy treatment (5.7%); one child developed elevated blood pressure during transfer from the bed to the wheelchair, the other child experienced dizziness and headaches when mobilized from the bed into standing. No other adverse events related to physiotherapy were reported.

Significant associations were found between receiving physiotherapy and aetiology (Yates χ^2 = 17.1, p = .004). Physiotherapy was most often administered in children following PVA (54.3%) and MVA (25.7%) and least often in children with other blunt force trauma (2.9%). GCS classification also influenced physiotherapy (Yates χ^2 = 31.9, p < .0001): children presenting with low GCS scores were most likely to receive physiotherapy (percentage of children with mild, moderate and severe TBI receiving physiotherapy was 12.8, 40.0 and

FIGURE 3 Median and interquartile ranges for age per aetiology category ($H = 24.0$, $p = .002$)

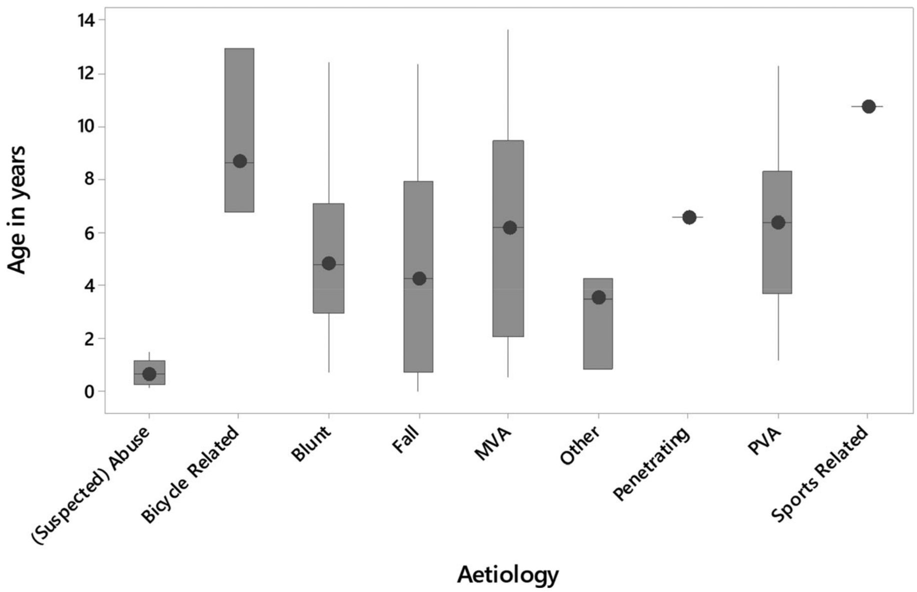

TABLE 2 Overview of physiotherapy techniques

Category	Technique	*N* (%)
Airway clearance	Vibrations	2 (5.7)
	Tracheal stimulation	2 (5.7)
	Positioning	1 (2.9)
	Manual cough assist	1 (2.9)
	Suctioning	1 (2.9)
	Manual hyperinflation	1 (2.9)
	Unknown	1 (2.9)
Functional treatment	Mobilizations out of bed	25 (71.4)
	Strengthening	15 (42.9)
	Balance	14 (40.0)
	Gait education	11 (31.4)
	Bed mobility	10 (28.6)
Other	Passive movements	11 (31.4)
	Stretching	9 (25.7)
	Caregiver education	9 (25.7)
	Developmental stimulation	7 (20.0)
	Deep pressure	4 (11.4)
	Shaking	2 (5.7)
	Neural movements	2 (5.7)
	Home program	2 (5.7)
	Weight-bearing through upper limbs	1 (2.9)

Note: % based on 35 cases.

76.2% respectively). There was also a higher likelihood for physiotherapy for children with diffuse brain injury (OR 10.43, 95%CI 3.05–35.66), altered tone (OR 19.45, 95%CI 2.25–168.23), coordination problems (OR 12.13, 95%CI 1.31–112.64), who were admitted to ICU (OR 14.50, 95%CI 5.41–38.87), or who had an ICP monitor (OR 23.50, 95%CI 2.77–199.21) or Licox monitor (OR 15.67, 95%CI 1.76–139.43) placed. Logistic regression showed that physiotherapy was the strongest associations with aetiology, severity of TBI, the presence of an ICP monitor and admission to ICU (likelihood of 94.25).

3.3 | Multidisciplinary team

Physiotherapists and social workers were the therapists most often involved in TBI cases ($n = 35$ each), followed by speech therapists in 24 cases (18.5%), and occupational therapists and dieticians in 18 cases (13.9%) each.

Table 3 presents the number of shared cases between the physiotherapists and other members of the multidisciplinary team.

Children who received speech therapy (OR 11.87, 95%CI 4.30–32.79), occupational therapy (OR 39.16, 95%CI 8.31–184.60) or were seen by a dietician (OR 88.78, 95%CI 11.10–709.82) were also more likely to receive physiotherapy.

3.4 | Patient outcomes

The median (IQR) length of hospitalization was 4.0 (2.0–9.0) days. Forward stepwise multiple regression analysis identified the following as predictors of length of hospitalization: infection, parietal lobe injury, GCS score and presence of an ICP or Licox monitor, accounting for 61.1% of the variance. Children with severe TBI were hospitalized for longer than the other categories ($p < 0.0001$), with a median (IQR) length of stay of: 14.0 (5.5–33.0) days for severe TBI days, 7.0 (4.0–14.0) days for moderate TBI, and 3.0 (2.0–7.0) days for mild TBI). ICU admission also determined length of hospital stay, as patients with severe TBI were typically managed in the ICU: (median (IQR) stay of 13.5 (6.3–24.0) days for ICU-admitted patients; and 3.0 (2.0–6.3) days if ICU was not required ($p < .0001$).

TABLE 3 Multidisciplinary team involvement

Other allied health professional Health professional	Involvement	Physiotherapy received		Total
		Yes (n = 35)	No (n = 95)	
Speech therapy	Yes	17	7	24
	No	18	88	106
Occupational therapy	Yes	16	2	18
	No	19	93	112
Dietician	Yes	17	1	18
	No	18	94	112
Social worker	Yes	6	29	35
	No	29	66	95

Most of the children who received physiotherapy during hospitalization were not referred for further treatment after discharge (57.1%), however, 25.7% were discharged to a physiotherapy outpatient programme, 14.3% were referred to a step down rehabilitation facility, and one was admitted in a long-term care facility.

One child (0.8%) died in hospital during the study period. This child presented with severe TBI according to the GCS, was admitted to ICU, and died on the day of admission. The child did not receive physiotherapy while in hospital. The child was included in all the statistical analyses presented.

4 | DISCUSSION

This study aimed to describe the characteristics, course and outcome of children hospitalized with TBI at a tertiary paediatric hospital, with specific reference to the role of physiotherapy in these children. The main findings of this study revealed that physiotherapy was provided in 26.9% of the cases, with functional treatment, such as mobilization out of bed, the most common form of therapy. Children with severe TBI, caused by road traffic accidents, who received an ICP monitor, and were admitted to ICU, were most likely to receive physiotherapy in the current study. However, due to the limiting information found in the physiotherapy notes and the lack of clarity on exclusion criteria for physiotherapy at the research hospital, these results cannot be generalized to a wider population. More research to confirm this study's findings is warranted.

4.1 | Characteristics of children hospitalized with TBI

The study found that the majority of admissions for TBI were for children 1 year old, similar to admission information reported by (Trefan et al., 2016). Other spikes in admission age at 4, 6 and 7 years of age are similar to results found by Schrieff, Thomas, Dollman, Rohlwink, and Figaji (2013) who investigated children admitted with severe TBI at RCWMCH.

The current study found a high male/female ratio for TBI, consistent with ratios found in literature (Buitendag et al., 2017; Gray et al., 2012; Okyere-Dede, Nkalakata, Nkomo, Hadley, & Madiba, 2013; Popernack et al., 2015; Schrieff et al., 2013; Trefan et al., 2016; World Health Organization, 2006). This is most likely due to risk-taking behaviour by boys (Granié, 2010; Udoh & Adeyemo, 2013). It is therefore recommended that prevention programs tackle this risk-taking behaviour and other risk factors for TBI (Gresham et al., 2001; Schwebel, Davis, & O'Neal, 2012), as the high male/female ratio has been described in literature for decades (Kibel, Bass, & Cywes, 1990; Knobel, de Villiers, Parry, & Botha, 1984).

Road traffic accidents accounted for half of the TBIs in the current study, with PVA the most common. Developing countries have faced the challenges of road traffic accidents for many years; therefore, it has often been the main cause of TBI (Okyere-Dede et al., 2013; Schrieff et al., 2013; Udoh & Adeyemo, 2013). However, the prevalence of TBI due to road traffic accidents is lower than previous studies (63 and 79.6% by Okyere-Dede et al. (2013) and Schrieff et al. (2013), respectively), and comparable to the more recent study by Buitendag et al. (2017) (43%), which may reflect the improved road safety awareness and the tightening of the law on car restrain systems implemented in South Africa since 2014 (South African Government, 2014). However, PVAs are still common, often occurring in children between 4 and 8 years of age, similar to the results of Buitendag et al. (2017). This could be because of the lack of safe playgrounds and secure travel to school for children in developing countries, placing them at increased risk for TBI due to PVAs (WHO & UNICEF, 2008).

The current study had a higher incidence of severe TBI (n = 21, 16.2%) compared to previous studies who found incidence rates between 1.9 and 7.6% (Buitendag et al., 2017; Trefan et al., 2016; World Health Organization, 2006). However, comparable numbers of admissions for sever TBI were found in the study by Schrieff et al. (2013) (approximately n = 27 per year). This may reflect admission practices, with limited bed availability resulting in prioritization of severe health conditions, which is likely in a resource-constrained environment. Furthermore, it may also be affected by scoring practices. The reliability of the GCS, particularly the verbal component in children younger than 3 years of age, has been questioned (DiBrito et al., 2018). Therefore, clinicians sometimes use an adapted 11-point score rather than the classic score out of 15, with cut off scores of ≥9/11 classified as mild, 7–8/11 as moderate, and ≤6/11 as severe. At RCWMCH the 11-point GCS was used in 31 cases.

Surgery was performed in 26 children (20%) in the current study. This is higher than Bennett et al. (2013) and Okyere-Dede et al. (2013), who reported 10.6 and 3.8%, respectively, but lower than the 37% found by Gray et al. (2012).

4.2 | Physiotherapy and multidisciplinary intervention in children hospitalized with TBI

Children with severe TBI caused by road traffic accidents were most likely to receive physiotherapy in the current study. Injury severity and motor vehicle accidents were also identified by Bennett et al. (2013) as a predicting factor for receiving therapies (either occupational therapy, physiotherapy or speech therapy). At RCWMCH children were referred to physiotherapy by the attending physician or identified by the physiotherapists when the child was admitted to ICU or high care wards. Children with TBI are screened daily by the physiotherapists, increasing their likelihood for receiving physiotherapy compared to less severely affected children. Therefore, children with mild TBI, admitted to general wards, were less likely to receive physiotherapy than children with moderate to severe TBI admitted to high care or ICU. The study by Gray et al. (2012) also found that children with severe TBI were more likely to be referred for rehabilitation assessment (50% of cases), compared to moderate (15%) and mild (5%) TBI. The presence of fractures, identified as a significant predictor for physiotherapy or occupational therapy by Bennett et al. (2013), was not confirmed by the current study. This could be due to the small amount of children presenting with fractures of the extremities in the current study (n = 7). The other factors identified by Bennett et al. (2013), such as higher energy injury mechanism, treatment with neuromuscular blocking agents or pentobarbital, were not investigated in the current study. No other studies, investigating predicting factors for early physiotherapy management in children with TBI, could be identified. Physiotherapy was provided in 26.9% of the cases, with functional treatment the most common form of therapy. Children received on average three sessions of therapy, once per day. Physiotherapy was initiated on average within 4 days of admission, once the patient was medically stable, in the current study. This is similar to the results of Bennett et al. (2013), where initial physiotherapy assessment was done on average 5 days after admissions. However, this is later than the study by Beaulieu et al. (2015) in adults, where interventions were started within the first 10 hr of hospitalization. Arguably, such an aggressive approach may be too early as patients need to be clinically stable before commencing rehabilitation; therefore, Tepas et al. (2009) recommended that initiation of physiotherapy for children with severe TBI starts from 24 hr after release from intensive care. As the current study did not record length of ICU stay, it is unclear whether physiotherapy commenced 24 hr after discharge from ICU and comparisons can therefore not be made. However, at RCWMCH, physiotherapy can start in ICU once cerebral monitoring parameters are stable, therefore it can be assumed that most interventions will have commenced within a similar timeframe. Further research is warranted to determine the best time for early initiation of physiotherapy, taking into account the effect on early indices of physiological and metabolic stability, length of hospitalization, and long-term functional outcome.

Adverse events were noted in the physiotherapy notes in two cases. One child with severe TBI, experienced elevated blood pressure during mobilization out of bed. The child had undergone a craniotomy, ICP monitoring, and eventual ventriculoperitoneal shunt insertion for hydrocephalus. The elevated blood pressure may have been a result of the dysautonomia related to the TBI and prolonged bed rest, rather than merely the physiotherapy intervention (Popernack et al., 2015). The other child had moderate TBI, and felt dizzy and had severe headaches when mobilized from the bed to walking. When adverse events had not subsided 10 min later, the child was referred to the physician. However, no actions were needed as symptoms disappeared spontaneously. These symptoms could be directly related to TBI and/or post-traumatic headaches (Abend, Younkin, & Lewis, 2010). The child was also anaemic which could have aggravated the response to therapy (Abend et al., 2010). Overall though, physiotherapy interventions appear safe for children with acute TBI in this study. Little research has reported on adverse events in early rehabilitation following paediatric TBI, therefore more data on the safety of physiotherapy in acute stage TBI in children is recommended.

The current data show a multidisciplinary team approach once children were seen by an allied health professional. Children who received occupational therapy, speech therapy or were seen by a dietician were more likely to also receive physiotherapy, similar to the findings of Bennett et al. (2013); an expected finding, given that different allied health professionals are involved in the care of children with TBI, as the consequences of the condition are multifactorial, affecting several different body systems (Katz-Leurer & Rotem, 2017; Popernack et al., 2015).

4.3 | Outcomes of children hospitalized with TBI

The median length of hospitalization of 4 days is similar to the 5 days found by Bennett et al. (2013) and Okyere-Dede et al. (2013). The current study found that the length of stay increases significantly with increasing levels of severity, with moderate to severe TBI resulting in an average of 7.0 and 14.0 days of hospitalization respectively. Infection, ICP monitoring, severity of TBI, and injury to the parietal lobe were the strongest factors in predicting length of hospitalization. Although severe TBI can result in death, the current study only reported one fatality during hospital stay. As no data has been gathered from the trauma register or on children declared dead before hospital admission, the overall mortality rate in the current study may have been underestimated. Furthermore, 49 files were missing, which may have biased the data. However, the mortality rate in the current study (4.8%), is similar to results found by Gray et al. (2012) (6%), and could therefore be a true representation of mortality rate for children with TBI admitted to hospital.

4.4 | Limitations of the study

RCWMCH only treats children younger than 13-year of age with TBI (Buitendag et al., 2017). This limits the generalizability of the results, as this study cannot make recommendations for older children. Another limitation of the current study is the retrospective nature of the data. Information that was omitted from the medical files could therefore not be retrieved. The physiotherapy notes often lacked comprehensive documentation of the sessions, with merely a note on basic assessment findings, intervention techniques applied and adverse events if present during the session. Therefore, no intensity or duration of sessions could be reported in this folder review. This may influence the short- and long-term outcomes. Future studies require better record keeping, including information on duration, frequency and intensity of interventions.

Finally, physiotherapists at the research site only perform therapy in patients who are stable, defined as an ICP of less than 20, brain oxygenation more than 20, cerebral perfusion pressure between 55 and 65, absence or control of seizures, and stable GCS. These parameters are continuously monitored in acute patients and only adverse changes in these parameters would be documented. Therefore, no further examination of changes in ICP or other physiological measures of stability were done unless specifically noted; therefore, we cannot comment definitely on the safety of all interventions. Furthermore, the lack of further information on stability of patients could have affected the analysis of the predicting factors for therapy, as it is unclear who and why patients were excluded from therapy.

5 | CONCLUSION AND IMPLICATIONS FOR PHYSIOTHERAPY PRACTICE

Physiotherapy was provided in a relatively small proportion of children with TBI admitted at RCWMCH and seems to be well tolerated with only two reported minor adverse events. However, due to the limited information recorded in the physiotherapy notes, results of this study need to be confirmed in larger, more well-documented studies, recording all assessment findings, intervention type, duration, frequency, intensity and tolerance, as well adverse events, before generalizations can be made. Multidisciplinary services were commonly employed together. Little literature is available on the benefits of physiotherapy in the acute stages of TBI. Physiotherapists therefore often use techniques they perceive as beneficial based on clinical expertise. This study is therefore the first study to investigate standard physiotherapy practice for the management of TBI in a tertiary paediatric hospital in South Africa. This study highlights the need for prospective, controlled clinical trials to determine the short- and long-term effects of early initiation of physiotherapy for children with TBI, including the effects of a multidisciplinary team approach.

AUTHOR CONTRIBUTIONS

All authors contributed to the development of the research study, creation of the research protocol and gave input in the manuscript write up. Jason Kleinsmith, Andrew Kleyn, Tia Kwinana, Nandi Ndaba, Emma Sillito, Jammi T. Smith and Nikita Williams extracted the data from the medical files and created the first draft of the manuscript. Lieselotte Corten conducted the statistical analysis and wrote the final manuscript. A. B. van As, Sameer Rahim and Anthony Figaji assisted with the interpretation of the results.

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How to cite this article: Corten L, AB van As, Rahim S, et al. Physiotherapy in children hospitalized with traumatic brain injury in a South African tertiary paediatric hospital. *Physiother Res Int*. 2020;e1860. https://doi.org/10.1002/pri.1860