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Physical and Occupational Therapy Utilization in a Pediatric Intensive Care Unit

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Abstract

Purpose—To characterize the use of physical therapy (PT) and occupational therapy (OT) consultation in our pediatric intensive care unit (PICU).

Materials and Methods—We studied children aged 1 week – 18 years admitted to a tertiary care PICU for 3 days. Patient characteristics, details of PT and OT sessions and adverse events

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were collected. A multivariable logistic regression was performed to determine factors associated with receipt of PT and OT consultation with propensity analysis followed by a regression for factors associated with outcome.

Results—Of 138 children studied, 40 (29%) received PT and OT consultation. Services were initiated 6.9 ± 10.0 (mean \pm standard deviation) days after PICU admission. Range of motion (83%) was the most common therapy provided and 28% of patients were ambulated. Sixty-four of 297 (21.5%) sessions were deferred and 7 (2.4%) sessions were terminated early due to physiologic instability with no serious adverse events. Children who received PT and OT were older, more likely to require neuromuscular blocking agents, and had lower pre-PICU POPC scores (all $p < 0.05$).

Conclusions—Data are needed to inform on the efficacy of rehabilitative therapies initiated in the ICU to improve outcome for critically ill children.

Keywords

Pediatric; critical illness; physical therapy; occupational therapy; rehabilitation; post-intensive care syndrome

Introduction

Over 230,000 children under 18 years old are estimated to be admitted annually to pediatric intensive care units (PICUs) in the United States¹. While PICU mortality rates have declined to below 4% at tertiary care centers in the USA, the frequency of physical, cognitive and other morbidities has doubled according to one recent study²⁻⁸.

Risk factors for disability associated with intensive care include severity and type of medical condition, developmental stage, and pharmacological interventions⁷. Mobility and cognitive interventions in adults with critical illness have led to sooner return to function, decreased lengths of stay, and improved quality of life⁹⁻¹². Small pediatric studies highlight the uncertainties and challenges of incorporating rehabilitative services into clinical PICU practice while other centers are translating data from adult studies into pediatric practice¹³⁻¹⁵. There is a vital need for prospective interventional trials in critically ill children to inform guidelines for the optimal consultation for physical (PT) and occupational therapy (OT) and other rehabilitative and supportive services to demonstrate efficacy in improving outcome^{13,15-19}.

In order to begin to understand our center's practices and inform prospective interventional study design, we sought to characterize the utilization of PT and OT resources at our tertiary-level PICU with regards to consultation timing, therapy intensity and duration, reasons for deferral, and need for post-ICU rehabilitation, focusing on mobility and cognitive disability.

Materials and Methods

Design and Setting

The Quality Improvement Committee at the University of Pittsburgh approved this study as a quality assurance project and its submission for publication. We performed a prospective study of children admitted consecutively to the PICU at the Children's Hospital of Pittsburgh (CHP) between March 1, 2011 and May 1, 2011. Children between age 2 weeks and 18 years of age and who had length of stay \geq 3 days were included.

Data Collection

Patient demographics were obtained from medical records including age, sex, race, primary diagnosis for admission to the PICU and chronic (lasting at least 3 months) diagnoses. The Pediatric Risk of Mortality III (PRISM-III) score was used to quantify severity of admission in the first 24 hours of stay²⁰. Risk factors for ICU acquired disability were collected including use of mechanical ventilation, pharmacological interventions (i.e., continuous sedation agents, continuous neuromuscular blockade agents, intermittent scheduled or continuous corticosteroids), and hospital and PICU lengths of stay. PT and OT details were collected for patients with PT and OT consultation orders placed while in the PICU and collected only for PICU stay. Data collected included timing of therapy initiation (days after ICU admission), session duration, and type of therapy provided and defined as: range of motion (passive), exercise (active range of motion which includes encouraging the patient to move on his or her own as well as resistive exercise), developmental (prone and sitting progression skills, typically for non-ambulatory patients), ambulation (in bed, progression to sit, transfer to stand, out of bed ambulation), activities of daily living (dressing and eating skills), and feeding (oral-motor skills). We also recorded reasons for session deferral or early termination, and final PT and OT disposition for the PT and OT group only (i.e., prescription for outpatient or recommendation for inpatient rehabilitation). Because PT and OT are nearly always consulted together and shared therapeutic time, data on duration of therapy appointments of the two disciplines were combined. Once consulted, therapists determine which PT and or OT therapies are indicated for individual patients. The amount of functional disability was determined at admission and discharge using the Pediatric Overall Performance Category scale (POPC)²¹. The POPC is scaled from 0 to 6 and defined as 1, normal; 2, mild disability; 3, moderate disability; 4, severe disability; 5, coma or vegetative state; 6, death.

PT and OT consultations are placed by PICU physicians into the computerized physician order entry system. There were no standard protocols or automated orders for PT and OT consultation at the time of data collection. However, all pediatric trauma patients are mandated by the Pennsylvania Standards for Trauma Center Accreditation to be screened with the goal of formulating a rehabilitation plan within 72 hours of admission, followed by referral when indicated²². There are no dedicated PT or OT personnel dedicated solely to the PICU.

Objectives

The primary objective of this study was to characterize the utilization of PT and OT consultation and treatment in the PICU with respect to consultation timing, therapy type and duration, and reasons for deferral. Secondary objectives were to determine factors associated with receiving PT and OT and patient outcome.

Statistical analysis

Descriptive statistics are presented as mean \pm standard deviation (SD). Statistical comparisons between children who did and did not receive PT and OT consultations were performed using Fisher's exact tests for categorical variables, *t*-tests for continuous variables, and Mann-Whitney rank sum test for non-parametric continuous variables. Multivariable regression was performed using propensity score as a linear term, to minimize bias from pre-consultation variables and estimate output as probability of receiving PT/OT consultation. Patients were then matched by propensity scores and logistic regression was performed with outcome being unfavorable functional disability at PICU discharge, which we defined as POPC score 4–6. All *p* values were two-sided and *p*<0.05 was considered significant. Missing data were not imputed. Data analysis was performed using Stata software version 12 and SPSS.

Results

Patient characteristics

PT and OT were consulted in 40 of 138 (29%) children with an ICU length of stay 3 days (Table I). Children in receipt of PT and OT consultation were older (7.3 ± 5.9 vs. 4.2 ± 5.1 years, *p*<0.005), more commonly required mechanical ventilation (85% vs. 57%), and were more frequently prescribed continuous sedation (64% vs. 40%) and neuromuscular blockade agents (38% vs. 5%) than children who did not receive PT and OT consultation (all *p*<0.05). There were no between-group differences in primary PICU diagnosis, chronic condition, or PRISM III score.

PICU and hospital lengths of stay were longer for children with vs. without PT and OT consultation (15.1 ± 13.8 vs. 5.9 ± 4.0 days and 21.8 ± 15.6 vs. 12.8 ± 17.5 d, both *p*<0.05) (Table 1). Children receiving PT and OT had worse baseline (pre-ICU) functional status by POPC scores at ICU admission (*p*=0.013) and at hospital discharge (*p*=0.001) than children who didn't receive PT and OT consultation. More children who received PT and OT consultation had a worsening of their POPC score at hospital discharge (13/40 [33%] vs. 10/98 [10%], *p*=0.003). Of patients receiving PT and OT consultation in the ICU, 50% were prescribed outpatient PT and OT and 15% were admitted to an inpatient rehabilitation facility at hospital discharge.

Details of PT/OT consultations

Of children receiving PT and OT, consultations were initiated 6.9 ± 10.0 (median 3.5 (range 0–35) days after PICU admission (Table 2). There were a total of 297 PT and OT encounters during PICU admission (7.6 ± 13.1 per patient). The average session duration was 20 ± 6 minutes. Range of motion was the most frequently performed therapeutic intervention

(provided in 83% of sessions), followed by exercise (45%), developmental (33%), ambulation (28%), activities of daily living (23%), and feeding (5%) (Figure). Of children who were ambulated, 1 of 10 children with PT or OT consultation had pre-POPC = 1, 4 of 8 had pre-POPC = 2, 5 of 11 had pre-POPC = 3, 1 of 11 had pre-POPC = 4, and the only child with pre-POPC = 5 did not receive a consultation. Using POPC at hospital discharge (HD), 0 of 2 children with PT or OT consultation had HD-POPC = 1, 4 of 11 had HD-POPC = 2, 5 of 14 had HD-POPC = 3, 2 of 12 had pre-POPC = 4, and 0 of 1 had HD-POPC = 5.

Sixty-four (21.5%) of PT and OT sessions were deferred and 7 (2.4%) were terminated early. The primary reasons given for deferral were upon request from nursing (50%), deference to a sleeping patient (28%), and patient absent from hospital room (16%) (Table 2). Early termination of PT and OT encounters were due to sustained tachycardia and/or oxygen desaturation but there were no instances of severe adverse events (e.g., accidental loss of vascular access, invasive airway, falls, death, or syncope) due to PT and OT. A single patient who later died due to underlying illness accounted for 4 of 7 events.

Propensity analysis for receipt of PT and OT and logistic regression for unfavorable outcome

Older age (odds ratio (OR) 1.10, 95% confidence interval (CI) [1.02–1.19]), worse POPC pre-admission (1.74, [1.15–2.62]), and receipt of neuromuscular blocking agents (16.17, [4.56 – 57.30]) were associated with PT/OT consultation (all $p < 0.05$). (Table 3).

After matching patients by propensity score and performing a logistical regression for unfavorable outcome, more mechanical ventilation days (1.36, [1.16 – 1.59]), less sedation days (0.67, [0.56–0.80]), and propensity score (316.88, [22.91–4382.77]) remained significant (all $p < 0.05$) while receipt of PT and OT consultation was not significant (0.74, [0.19–2.96], $p = 0.675$).

Discussion

We found that less than one-third of children at increased risk of disability post-ICU received PT and OT consultation. Of children who received PT and OT consultation, the order was frequently placed days to weeks later than that recommended in adults with critical illness. Children who received PT and OT consultations were older, had worse baseline functional disability, and had more neuromuscular blockade exposure than children without consultations. Finally, while over a quarter of PT and OT sessions were deferred, no serious adverse events were documented during PT and OT sessions.

As PICU mortality rates have decreased, morbidities including physical, cognitive, and emotional disabilities and their impact on patients and families are being increasingly recognized^{2,4,5}. However, risks for and presence of these sequelae, many of which can have lifelong impact, are not routinely assessed for in the ICU or post-discharge. This contrasts with the neonatal and cardiac ICU populations, in which longitudinal neurodevelopmental evaluations and individualized prescriptions for intervention are standard of care^{8,23,24}.

In critically ill adults, prospective evidence has changed the status quo from bedrest to the implementation of team-based early (typically defined as within 3 days of ICU admission) mobility programs. Mobility programs expedite return to activities of daily living and reduce lengths of stay and cost, without affecting safety events, but they have not been adequately prospectively studied in children^{10,25,26}. A single center quality initiative has shown that mobility interventions for critically ill children can be increased without negative safety effects¹⁹.

In our center, we suspect that a combination of the absence of a PICU-based PT and OT protocol (and prospective evidence to support one), low prioritization by ICU clinicians, and an unclear risk to benefit ratio contributed to the variation in the initiation and timing of consultation. Our results differ from a prospective multicenter Canadian PICU rehabilitation practice report that found the median time to first intervention was the first PICU day, but interventions in that study were largely for pulmonary toilet (not assessed in our study)¹³. They found wide center variation in the initiation and type of rehabilitation therapies delivered, reflecting lack of care pathways for critically ill children. In a multicenter study in children with severe traumatic brain injury, who are at high-risk of long-lasting cognitive and physical disabilities, data suggested under-utilization of PT and OT (41% consultation)¹⁸.

With regards to the population of children who received PT and OT consultation, Choong et al had similar age-based findings, perhaps reflecting challenges in recognizing disability or risk of disability and benefits of treatment for infants¹³. However, the neonatal ICU population has evidence supporting guidelines for disability risk assessment and interventions, some of which may translate to the younger PICU population²⁶⁻²⁹. Neuromuscular junction blockade agents are associated with ICU-acquired weakness, with patients demonstrating decreased motor evoked response amplitudes on nerve conduction studies^{30,31}. Finally, it is likely that children with prior disability have received PT and OT interventions in the past, with their increased consultation frequency reflecting either increased comfort level with PT and OT, request by family for interventions, or concern for worsened disability.

The most common interventions provided by PT and OT practitioners were passive range of motion followed by exercise and developmental activities. In addition, children who received PT and OT consults had an average of 0.36 sessions per day, or about 1 session for every 3 ICU days, for an average of 20 minutes. Small studies support the use of passive range of motion therapy to prevent or treat joint contracture and return to function outside of the PICU^{32,33}. Nearly a third of children in our study underwent active mobility interventions. Active mobility interventions progress from in-bed maneuvers to sitting at the side of the bed, standing, transfer to a chair, and walking (it is not our general practice to mobilize tracheally intubated children). Individual centers have reported mobilizing adolescent and young adult patients requiring extracorporeal therapy and the use of video games to promote mobility^{17,34}. Developmental activities focus on sensory and cognitive stimulation, prescribed based on the child's developmental and illness status. Delivery methods and efficacy of developmental activities to improve outcomes for critically ill children are unknown. Although practitioners frequently comment on patient response to these therapies,

effectiveness was not assessed with standardized tools. We suggest that the development and implementation of standardized assessment tools and metrics could be helpful in ascertaining effectiveness of specific therapies in PICU patients. The incorporation of family-centered care into the PICU may be an opportunity to educate and encourage families to learn and apply appropriate rehabilitation interventions, especially when PT and OT resources are under-resourced³⁵⁻³⁷.

Similar to Choong et al^{13,14} we experienced a very high frequency of session deferrals, categorized into institutional, patient, and provider barriers to care. In their survey, only 3% of respondents reported having guidelines for patient mobility due to lack of guidelines and evidence-based data for safety and efficacy¹⁴. Similar to adult early mobility studies, only a few PT and OT sessions were ended early due to sustained changes in heart rate or oxygen saturation, and no serious adverse events were noted³⁸. PICU nursing frequently deferred PT and OT sessions¹⁴. From the nursing perspective, reasons for deferral included the need for other nursing interventions or diagnostic studies at the same time, interruption in sedation in a child that is difficult to keep calm, interference with sleep, and family request to postpone. Mobility guidelines in adults typically employ sedation interruption, but this strategy may not translate directly to children³⁹. In addition, evidence to support the optimal use of pain and sedation medications to minimize impact on delirium and neurodevelopmental disability are needed elements to support PICU rehabilitation therapies⁴⁰⁻⁴². To address these barriers and ultimately change ICU culture, centers have implemented multidisciplinary care pathways that include best practices with room for individualized care, coordination of care to optimize session scheduling between the bedside nurse and therapist, and curricula to educate healthcare and family providers on the potential benefits and safety measures of ICU rehabilitation⁴³⁻⁴⁵. In general, we find that nursing input and collaboration is important to discerning appropriateness and success of therapy delivery in our unit.

Finally, the propensity score was developed using covariates known to be associated with prescription of PT and/or OT, with the goal of reducing bias in treatment effect. We were able to demonstrate that receipt of PT and OT consultation was not associated with unfavorable outcome, an additional test of safety. While it is not surprising that more days of mechanical ventilation were associated with unfavorable outcome, we suspect that the association of less sedation days with unfavorable outcome may be related to the fact that patients requiring more sedation means that they were active enough to require it in the ICU compared to a patient who is naturally sedate. An important limitation of propensity score matching is that there remains a possibility of bias as not all covariates associated with receipt of PT and/or OT may be known (anecdotally or published) and its robustness depends on sample size.

In summary, prospective study of the safety, feasibility, and efficacy of PT and OT therapies in critically ill children is essential to change PICU culture and optimize patient outcomes^{38,46}. Similar to adult efforts, complementary data to support the optimization of sleep hygiene, nutrition, and sleep and sedation and other supportive care should be incorporated to achieve the most comprehensive approach and impact^{41,47}.

Study Limitations

Our study had several limitations, including the brief sampling period and single center approach, limiting generalizability. In most cases, PT and OT are consulted simultaneously, possibly due to physician misconception of proper utility, thus we combined PT and OT consultation and session frequency in our reporting and data analysis, which may not translate elsewhere. However, we attempt to get at the uniqueness of each profession's interventions by further defining categories in the methods and results. In addition, PT and OT initiated after transfer from ICU to ward was not studied. Long term outcomes and more detailed neuropsychological and physical functioning outcomes testing were not performed. POPC scores were assigned using data available in the medical chart. We did not collect data on other types of rehabilitation therapies such as pulmonary toilet or speech and language therapy.

Conclusions

Less than one-third of children at increased risk of post-intensive care syndrome related disabilities received PT and OT consultation in the ICU. Prospective data are needed to inform on the efficacy of rehabilitative therapies initiated in the ICU to improve outcome for critically ill children.

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Highlights

- Physical and occupational therapy were consulted for 29% of critically ill children
- One-fifth of sessions were deferred and 2% were terminated early
- Data are vitally needed to prove efficacy of rehabilitative therapies in the PICU

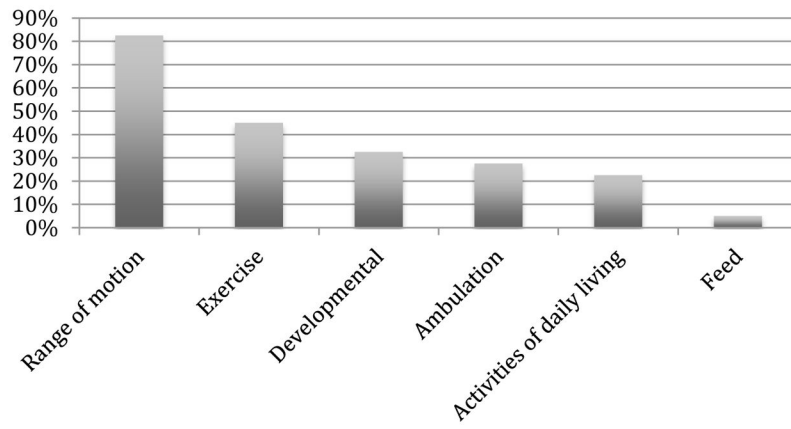


Figure. Frequency of specific PT/OT therapeutic interventions provided in patients during ICU admission.

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Table 1

Demographic, admission, and treatment characteristics of participants

Data presented as mean ± SD or n (%)	Overall n=138	(-) PT/OT n=98	(+) PT/OT n=40	<i>p</i>
Age, years	5.1 ± 5.5	4.2 ± 5.1	7.3 ± 5.9	.005
Sex, male	79 (57)	57 (58)	22 (55)	.850
Primary admission category				
Pulmonary	81 (59)	56 (57)	25 (63)	.268
Gastrointestinal	12 (9)	11 (11)	1 (2.5)	
Sepsis	11 (8)	8 (8)	3 (8)	
Neurologic	9 (7)	6 (6)	3 (8)	
Other	25 (19)	17 (17)	6 (20)	
Chronic condition				
None	28 (20)	20 (20)	8 (20)	.524
Pulmonary	39 (28)	31 (32)	8 (20)	
Brain injury	25 (18)	15 (15)	10 (25)	
Cancer	8 (6)	6 (6)	2 (5)	
Transplant	7 (5)	5 (5)	2 (5)	
Neuromuscular weakness	5 (3)	2 (2)	3 (8)	
Other	26 (19)	19 (19)	7 (18)	
PRISM III score	7.5 ± 7.8	6.8 ± 7.5	9.3 ± 8.5	.059
Post-operative	28 (20)	18 (18)	10 (25)	.484
Mechanical ventilation	90 (65)	56 (57)	34 (85)	.002
Continuous sedation agent	64 (47)	39 (40)	25 (64)	.013
Neuromuscular blockade agent	20 (14)	5 (5)	15 (38)	<.001
Corticosteroid	71 (53)	45 (48)	26 (65)	.089
ICU length of stay, d	8.6 ± 9.11	5.9 ± 4.0	15.1 ± 13.8	<.001
Hospital length of stay, d	15.4 ± 17.4	12.8 ± 17.5	21.8 ± 15.6	<.001
Pre-ICU POPC				
1	41 (29.7)	31 (31.6)	10 (25.0)	0.013
2	49 (35.5)	41 (41.8)	8 (20.0)	
3	24 (17.4)	13 (13.3)	11 (27.5)	
4	23 (16.7)	12 (12.2)	11 (27.5)	
5	1 (0.7)	1 (1.0)	0 (0.0)	
Post-ICU POPC				
1	25 (18.1)	23 (23.5)	2 (5.0)	0.001
2	55 (39.9)	44 (44.9)	11 (27.5)	
3	30 (21.7)	16 (16.3)	14 (35.0)	
4	25 (18.1)	13 (13.3)	12 (30.0)	
5	1 (0.7)	1 (1.0)	0 (0.0)	
6	2 (1.5)	1 (1.0)	1 (2.5)	
Final Disposition, n (%)				.008

Data presented as mean \pm SD or n (%)	Overall n=138	(-) PT/OT n=98	(+) PT/OT n=40	<i>p</i>
Home	121 (87.7)	91 (92.9)	30 (75.0)	
Home with outpatient PT/OT	n/a	n/a	24 (50.0)	
Home without outpatient	n/a	n/a	8 (25.0)	
PT/OT	8 (5.8)	2 (2.0)	6 (15.0)	
Inpatient rehabilitation	3 (2.2)	1 (1.0)	2 (5.0)	
Ronald McDonald House	2 (1.4)	1 (1.0)	1 (2.5)	
Still in hospital	2 (1.4)	1 (1.0)	1 (2.5)	
Deceased Other	2 (1.4)	2 (2.0)	0 (0.0)	

n/a, not available; ICU, intensive care unit; LOS, length of stay; PT/OT, physical/occupational therapy; PRISM, Pediatric Risk of Mortality Score; POPC, Pediatric Overall Performance Category

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Table 2

Details of PT/OT sessions.

	n=40 subjects
Number of PICU days until initial consult, d	6.9 ± 10.0
Total number of total PT/OT sessions	297
No. sessions per patient during PICU admission	7.6 ± 13.1
Average therapy duration per visit, min	20.2 ± 6.0
Session deferral	64/297 (21.5)
Nursing request	32 (50.0)
Patient sleeping	18 (28.1)
Patient absent from room	10 (15.6)
Patient already had PT/OT that day	4 (6.3)
Session termination due to physiologic instability	7/297 (2.4)
Serious adverse events	0 (0.0)

PICU, pediatric intensive care unit; PT/OT, physical therapy/occupational therapy

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Table 3a

Logistic regression for patient variables associated with PT or OT consultation.

	Univariable			Multivariable		
	Odds Ratio	95% Confidence Interval	p-value	Odds Ratio	95% Confidence Interval	p-value
Age	1.14	1.04–1.25	0.004	1.10	1.02–1.19	0.013
PRISM-III	0.95	0.89–1.03	0.200			
Mechanical ventilation	2.51	0.78–9.23	0.167			
Sedation	1.16	0.36–3.81	0.802			
Neuromuscular blockade	19.78	4.12–95.04	<0.001	16.17	4.56–57.30	<0.001
Steroid	0.76	0.29–1.99	0.575			
Pre-ICU POPC	1.62	0.93–2.82	0.091	1.74	1.15–2.62	0.008
Sex	1.10	0.43–2.83	0.839			
Race	0.99	0.39–2.56	0.994			
Chronic illness	0.73	0.80–1.80	0.494			

Table 3b

Multivariable regression for unfavorable outcome at hospital discharge including propensity for PT and OT consultation score.

	Odds Ratio	95% Confidence Interval	p-value
PT and OT consult	0.74	0.19–2.96	0.675
Propensity score	316.88	22.91–4382.77	<0.001
Mechanical ventilation days	1.36	1.16–1.59	<0.001
Sedation days	0.67	0.56–0.80	<0.001
Neuromuscular blockade	0.85	0.60–1.19	0.846
Steroid days	0.89	0.74–1.06	0.193
PICU days	0.91	0.82–1.02	0.912

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