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Research Article

Functional Status after PICU Hospitalization – A Six-Month Follow-Up: A Multicenter Study

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Keywords

- Pediatric Critical Care
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Abstract

Background: The evaluation of functional status and disability of the patients after critical disease are significant aspects to be measured. Therefore, we aimed to evaluate the functional status of critical pediatric patients after hospital discharge.

Methods: Prospective longitudinal observational study, with age between one month and <18 years old, who needed PICU admission. The functional status was evaluated with FSS-Brazil at baseline, PICU discharge, hospital discharge, three and six months after this and new morbidity was defined as a worsening in functional status in the FSS-Brazil of two or more points in the same domain compared with the baseline score. The Generalized Estimating Equation model was used to compare the FSS-Brazil scores. McNemar Chi-square test was used to evaluate the difference between the categories of functional status in each domain. Poisson regression was performed to determine associations between clinical variables and functional status.

Results: It was included 214 patients and 135 finished the follow-up. The majority of the sample was males (57.5%), with some chronic condition (76.2%), and 45.8% were readmitted to the hospital. We observed a higher incidence of moderate dysfunction at PICU discharge (42.1%), and the new morbidity was observed in 11.5% of the sample after hospital discharge. More days in invasive mechanical ventilation increases 1.02 the risk of new morbidity.

Conclusions: Patients who needed PICU recovered functional status after hospital discharge and remained stable in three and six months. The incidence of new morbidity was low and invasive mechanical ventilation was a risk factor for new morbidity.

ABBREVIATIONS

PICU: Pediatric Intensive Care Unit

INTRODUCTION

Nowadays, technological advances and the improvement of care in pediatric intensive care reduced the mortality rate in the pediatric intensive care units (PICU) to less than 5% [1]. However, the new and significant morbidities resulting from disease process and the care provided therapies in the PICU are common and increase the high incidence of new morbidity to rates twice as high as the mortality rate, prolonging the length of stay [2]. Therefore, the survival assessment is no longer the only outcome of interest [3,4].

The evaluation of functional status and the disability of the patients after a critical disease are significant aspects to be measured [5,6]. Patients with chronic conditions spend prolonged periods in the hospital, which can lead them to reduced functional independence [7], psychological disorders, cognitive dysfunction, impairment of lung function, and peripheral neuromuscular complications [4]. Moreover, these limitations and disabilities affect the performance and overall development of the child regarding physical, cognitive, emotional, and/or social dimensions [8].

The morbidity outcomes in pediatric studies were limited due to the lack of reliable assessment tools applicable to this population [9].Therefore, the Functional Status Scale (FSS), was developed and based on the concepts of activities of daily living (ADLs), and adaptive behavior [10], resulting in a functional scale that evaluates motor and cognitive domains and was specifically developed to hospitalized pediatric patients [10]. It is a quantitative method that is fast, reliable, regardless of subjective evaluations, applicable across a wide age range (from newborns to adolescents) and it is described as the most complete tool for evaluating these patient's profiles today [2,10]. Moreover, in 2019, the FSS was translated and validated for the Brazilian population [11].

A study from Pollack et al., showed that critical pediatric patients may have a functional status impairment and new

morbidities for up to three years after the discharge of PICU [12]. Moreover, the functional status impairment was associated with invasive therapies and disease severity indicators, such as use and duration of mechanical ventilation, use of vasoactive drugs, and length of stay at the PICU. Less than 10% of the patients had improvement in functional status over time [12].

Considering the afore mentioned, we hypothesize that a deterioration of functional status after critical disease affects the patients, and it remains after hospital discharge. Due to the lack of studies that evaluate the influence of hospital length of stay in pediatric functional status, including PICU length of stay, mainly in developing countries, such as Brazil, this study aimed to evaluate the functional status of pediatric patients before hospital admission and after three and six months of the hospital discharge. Furthermore, we aimed to determine associated factors with the worst functional status in six months.

MATERIALS AND METHODS

Study design

This a prospective longitudinal observational study.

Subjects

The participants were selected from April 2019 to March 2020 in the pediatric inpatient unit of two tertiary hospitals. The sample was composed of patients discharged from PICU and who were discharged from the respective units with the following criteria: a) both sexes; b) age between one month and less than 18 years old; c) length of stay in the PICU for a period ≥ 24 hours and d) those who were discharged from hospital. Those patients that depend on ventilatory technology before PICU admission and who had PICU readmission in a period less than 24 hours after discharge were excluded.

The study was approved by the Research Ethics Committee of HCPA and HCSA. Then, the selection of the study population was started after the parents and/or guardians of the participants sign the Informed Consent Form, according to resolution 466/12, which regulates research involving human beings.

Measurements

The clinical and demographic data of the patient were obtained from the electronic patient record, including: sex, age, baseline diagnosis, the reason for admission, chronic condition according to Meert et al [13]., (cardiac, musculoskeletal, neuromuscular, malignancy, chromosomal anomalies, respiratory conditions, gastrointestinal conditions, hematologic, congenital immune deficiencies, or other multiples congenital malformations), length of mechanical ventilation, length of stay in the hospital, and performed physical therapy.

The functional status was evaluated using the FSS-Brazil,[11] which was applied at the bedside of all study participants. The scale consists of the following six functional domains: mental status, sensory, communication, motor function, feeding, and respiratory. Each domain is categorized from normal (1) to very severe dysfunction (5), and the total score ranged 6–30, with lower scores indicating better functional status. The classification of global functional status could be as following: 6-7, adequate; 8-9, mild dysfunction; 10-15, moderate dysfunction; 16-21, severe dysfunction; >21, very severe dysfunction.[10]

The patients were evaluated by previously trained researchers on the first day after PICU discharge and the day of hospital discharge, always by the same researcher. By interviews with parents or guardians, the functional status of the hospitalization was registered to obtain the baseline (pre-hospitalization) functional status of the patients, according to Pollack et al. [2]. For three- and six-month follow-ups, the researchers were trained to apply a standardized phone script, with three or five attempts to call for each participant in order to minimize the number of losses.[12] The parents or guardians were asked about their child's current health condition, morbidity, and hospital readmissions, and the FSS-Brazil was reapplied.

We defined new morbidity of functional status as a worsening of the FSS-Brazil of two or more points in the same domain compared with the baseline score [2,12]. The last FSS-Brazil available was considered at least from hospital discharge, otherwise the variable was considered as a loss (n=6).

To evaluate the functional status difference in each domain of FSS-Brazil, it was compared the baseline and the last FSS available, considering at least from hospital discharge. The functional status classification was divided into an adequate function (FSS=1) or dysfunction (FSS>1).

Statistical analysis

With a power of 80% and a 5% significance level, a sample size of 73 subjects was calculated expecting a difference in the baseline score at six months after hospital discharge of 0.6 points in the FSS-Brazil and a standard deviation of 1.8, according to Pinto et al. [12]. Categorical variables were expressed as absolute values and percentages, whereas continuous variables were expressed as means and standard deviation or medians (25th and 75th percentiles), according to the data distribution (Shapiro-Wilk test or Kolmogorov-Smirnov test; $p<0.05$).

The Generalized Estimating Equation model was used to compare the FSS-Brazil global score obtained at different times (baseline to six-month follow-ups). Student t-test or Mann-Whitney U test were used for continuous variables in order to evaluate the differences between the sample that completed the follow-up and the sample that lost the follow-up, according to the data distribution. Chi-square test with continuity correction was used for categorical variables.

McNemar Chi-square test was used to evaluate the difference between the categories of functional status (adequate function *vs.* dysfunction), in each domain considering the last FSS-Brazil available and the baseline of FSS-Brazil.

Poisson regression with robust variance was performed to determine associations between new morbidity and clinical variables, univariate and multivariate. Variables with a $p \leq 0.10$ in the univariate regression were included in the multivariate analysis. The results were analyzed in SPSS (Statistical Package for the Social Sciences –Statistics version 18.0) and a 5% significance level was adopted.

RESULTS

During the data collection, a total of 454 patients were admitted in both PICUs, 214 were eligible according to the inclusion criteria. Over the study period, there were 72 (34.1%), losses, 35 (16.3%), in the three-month follow-ups, and 38 (17.7%), in the six-month follow-ups being a total of 135 patients at the end of follow-up (Figure 1). Most of the sample was composed of males (57.5%), with some chronic condition (76.2%), and 45.8% were readmitted to the hospital at least once in six months, the median age was 18 months and 2.8% died (Table 1). We did not observe differences among participants who completed the six-month follow-ups and who did not complete the follow-up (Table 2).

Figure 2 shows the incidence of functional status according to the categories of FSS-Brazil. The incidence of adequate function was higher at baseline, hospital discharge, after three and six months of hospitalization. At PICU discharge, we observed a higher incidence of moderate dysfunction.

We observed a higher incidence of dysfunction, comparing the baseline and the last FSS-Brazil available, in the following domains, respectively: sensory functioning (12.8% *vs.* 16.1%, p=0.039), communication (9.0% *vs.* 13.7%, p=0.013), motor functioning (13.8% *vs.* 23.8%, p<0.001), feeding (22.3% *vs.* 31.3%, p=0.002) and respiratory status (10.4% *vs.* 14.2, p=0.115).

The new morbidity was observed in 11.5% (n=23) of the sample after hospital discharge. Spending more days in mechanical ventilation increases the risk of new morbidity in 1.02. We did not observe other associated factors with new morbidity in this study (Table 3).

Table 1: Characteristics of the sample.

Characteristic	N = 214
Age (months)	18 (4.0-93.7)
Gender	
Male	123 (57.5)
Gestational age (weeks)	38 (36-39)
Parental Education	
Elementary School	80 (38.3)
High School	93 (44.5)
University	36 (17.2)
Diagnosis	
Respiratory	16 (7.5)
Gastrointestinal/Hepatic	36 (16.8)
Neurologic	29 (13.6)
Renal	7 (3.3)
Cardiovascular	23 (10.7)
Musculoskeletal	12 (5.6)
Oncological	7 (3.3)
Metabolic	6 (2.8)
Genetic Syndrome	25 (11.7)
Previously Healthy	44 (20.6)
Others	9 (4.2)
Chronic condition,	163 (76.4)
Death	6 (2.3)
Performed physiotherapy	166 (77.6)
Readmission	80 (37.3)
Use of sedative medication, yes	57 (26.6)
Ventilator days	0 (0-5)
PICU length of stay (days)	5 (3-10)
Total length of stay (days)	19 (10-42)

Abbreviations: PICU: pediatric intensive care unit; the data are expressed as the median (25 - 75% interquartile range) or n (%).

DISCUSSION

Our results suggest that most children who needed PICU hospitalization showed adequate functional status at baseline, moderate dysfunction after PICU discharge and at the moment of hospital discharge, the functional status returned to baseline and remained similar after three- and six-month of follow-up. Moreover, most of the sample had some level of dysfunction in almost all domains. More than 10% of the participants acquired a new morbidity after hospital discharge and the days in mechanical ventilation were associated with a higher risk of acquiring a new morbidity.

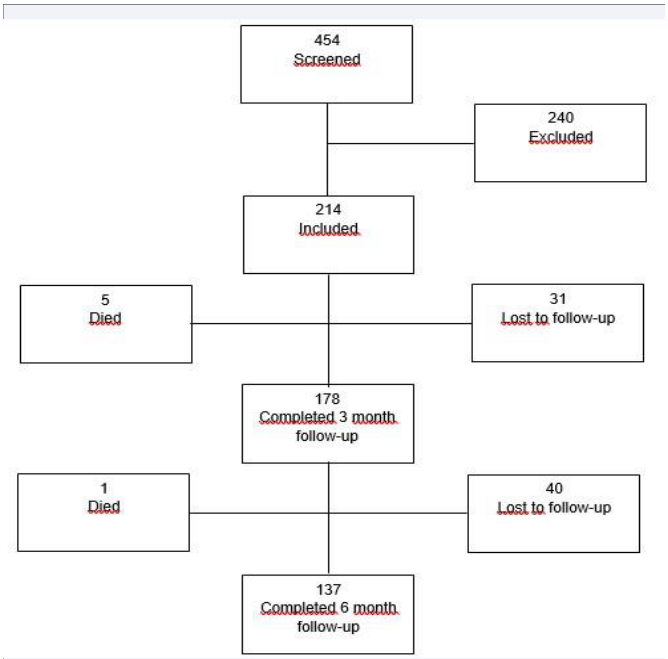

Figure 1 Flowchart of enrollment.

The high incidence of some dysfunction levels after PICU discharge and recovering of most participants to the baseline levels of functional status after a hospital discharged observed in this study corroborates with previous studies [2,14]. Pollack et al. [2], observed that the worst functional status profile was on discharge from the PICU but improved on hospital discharge. On hospital discharge, the adequate category decreased from a baseline of 72% to 63%, mild dysfunction increased from a baseline of 10% to 15%, moderate dysfunction status increased from 13% to 14%, severe status increased from 4% to 5%, and very severe was unchanged at 1%. Dannenberg et al. [14], described that 183 (61%), children were previously classified as having good functional status, and only 75 (25%), maintained this status at PICU discharge, indicating at least 108 children (36%), presented some functional decline. On the other hand, Choong et al. [15], also reported a high prevalence of decreased function

Table 2: Characteristics of the sample included and lost to follow-up.

Characteristic	Included n = 135	Lost to follow-up n = 73	*p*
Gender, male	57.0 (48.4-65.2)	58.9 (47.0-69.8)	0.886
Age (months)	56.1 (45.0-67.2)	48 (34.87-62.1)	0.304
Gestational age (weeks)	37.0 (36.4-37.7)	37.5 (36.7-38.5)	0.473
Parental education Elementary School High School University	 36.1 (28.3-44.7) 45.1 (36.7-53.7) 18.8 (13.0-26.4)	 41.6 (30.6-53.6) 44.4 (33.2-56.3) 13.9 (7.5-24.2)	0.619
Chronic condition	80.7 (73.1-86.6)	68.5 (56.7-78.3)	0.067
Ventilator days (days)	3.7 (2.1-5.3)	5.4 (2.1-8.8)	0.281
Total lenght of stay (days)	37.8 (22.2-53.4)	91 (38.9-143.3)	0.072
PICU lenght of stay (days)	8.7 (6.5-10.9)	11.7 (7.8-15.6)	0.137
FSS-Brazil baseline	7.4 (7.0-7.9)	7.3 (6.8-7.9)	0.610

Abbreviations: PICU: pediatric intensive care unit; FSS: functional status scale. The results are expressed as the median (confidence interval 95%) or percentage (confidence interval 95%).

Table 3: Associated factors with new morbidity after hospital discharge.

	Unadjusted Analysis		Adjusted Analysis*	
	RR (CI 95%)	*p-value*	RR (CI 95%)	*p-value*
Age	1.00 (0.99-1.01)	0.50	-	
Gestational age	0.99 (0.90-1.09)	0.84	-	
Gender				
Male	1			
Female	0.73 (0.43-1.23)	0.246	-	
Parental Education				
University	1			
High School	1.45 (0.65-3.27)	0.36	-	
Elementary	1.42 (0.62-3.24)			
Chronic Disease				
No	1		1	
Yes	1.85 (0.88-3.86)	0.10	1.71 (0.83-3.53)	0.14
Performed physical therapy No Yes	 1 2.10 (0.95-4.63)	 0.06	 1 1.55 (0.69-3.50)	 0.28
Readmission	1.15 (1.01-1.31)	0.039	1.10 (0.97-1.27)	
Use of sedative No Yes	 1 1.39 (0.83-2.32)	 0.21	 -	0.14
Ventilator days	1.02 (1.01-1.03)	<0.001	1.02 (1.01-1.02)	<0.001

Abbreviations: RR: relative risk; CI95%: confidence interval 95%.

(85%), at PICU discharge, however, a significant proportion (55.7%), still have not returned to baseline function during six months after PICU discharge.

According to the last FSS-Brazil available, the participants had some level of dysfunction in all domains, except mental status, after hospital discharge. Although most of them returned to their baseline functional level after discharge, the loss of functionality makes these individuals dependent on specific care, requiring a longer rehabilitation time to readjust their functions. However, this process depends on access to rehabilitation services, to social support, and to adequate care, which may lead the parents to the acquisition of new comorbidities in long term.

After three years of follow-up, Pinto et al. [12], observed that the risk of new morbidity was twice as high as that observed at hospital discharge. Moreover, 38% of children had a functional status impairment or died and less than 10% had functional gains over this time. Our study reports a lower incidence of acquired functional impairment at PICU discharge compared with previous studies using the FSS. This variability may have occurred because we consider the new classification proposed by Pollack, that is,

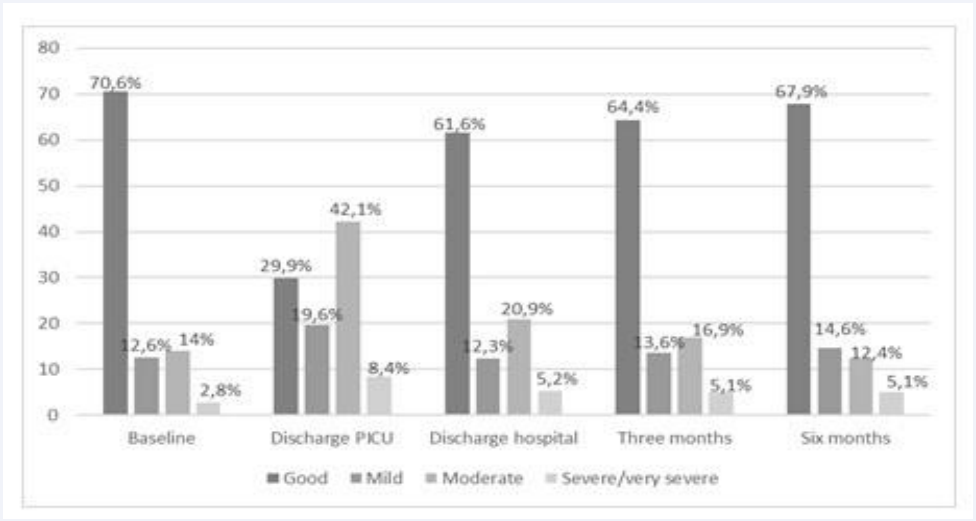

Figure 2 Global FSS- Brazil by categories in baseline, discharge, three and six month's follow-up.

an increase of two points or more in the score obtained in the same domain, or due to a shorter follow-up period after hospital discharge. Choong et al. [15], also observed that most children acquire new functional morbidities following a critical illness: 60.6% of participants experienced one or more PICU-acquired complications and 22.5% of whom developed PICU-acquired weakness. However, they used the Pediatric Evaluation of Disabilities Inventory Computer Adaptive Test (PEDI-CAT), for the evaluation of outcomes. The nature of the measurement tool used is an important factor to be considered, given that the assessment of functionality is complex and the most appropriate measurement tool in critically ill children remains unclear.

Watson et al. [16], studied children aged 2 weeks to 17 years after acute respiratory failure and they observed that the presence of comorbidities and clonidine use was associated with a higher risk to predict a decline in functional status six months after hospital discharge. We did not observe associations between chronic conditions, sedatives use, and functional status. This could be explained by the differences among clinical characteristics (such as ventilator days and total length of stay), the time of exposure to medications, and characterization of the patient's disease. Moreover, the sample size may also have been a determining factor to observe the associations. In the same study [16], the authors observed that patients who needed seven to 14 days of mechanical ventilation had 67% higher risk to decline functional status compared with patients who needed less than seven days. We also observed that invasive mechanical ventilation was a risk for functional impairment. The prolonged time in mechanical ventilation brings several consequences that influence functional capacity [12], such as reduced respiratory and peripheral muscle strength, and is associated with a greater need for sedation, prolonging the length of stay in the PICU [13,16,17].

Our study has some strengths. To the best of our knowledge, this is the first study using the FSS-Brazil to determine possible risk factors for functional impairment among patients who needed PICU admission and follows them up for six months. Moreover, we included patients of two tertiary PICUs to represent different PICU profiles. Another significant topic is that the call interview to evaluate the functional status was previously used [12], by the group that create the scale.

The present study has some limitations that should be considered in the analysis and interpretation of the results. First, 35% of patients were lost to follow-up, however, to minimize it, we included in the functional status analysis of the last FSS-Brazil available, considering at least the hospital discharge. Second, we did not observe differences between the participants who lost the follow-up and the participants who did not lose the follow-up. Although we followed the participants for six months, we emphasize the significance of long-term follow-up of PICU survivors to observe the functional status changes and quality of life of patients and parents.

CONCLUSION

In conclusion, the present results showed pediatria high incidence of functional impairment after PICU discharge in Brazilian children. They recovered after hospital discharge and remained stable in three and six months. The high incidence of new morbidity was low after hospital and the mental status was the only domain that had no change after hospital discharge. The invasive mechanical ventilation was a risk factor to emerge new morbidity. More studies are necessary to assess the added morbidities during intensive care hospitalization among the pediatric population.

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