

## EARLY REHABILITATION IN CRITICALLY ILL CHILDREN

ALI S<sup>1</sup>, IBRAHIM MS<sup>\*2</sup>, ALI N<sup>3</sup>, SHAH SA<sup>4</sup>

<sup>1</sup>Pediatrics Department, Tehsil Head Quater Hospital Kabal Swat KPK, Pakistan

<sup>2</sup>Saidu Group of Teaching Hospitals Saidu Sharif Swat, Pakistan

<sup>3</sup>Paediatrics Oncology, Shaukat Khanum Memorial Cancer Hospital Lahore, Pakistan

<sup>4</sup>Paediatric Gastroenterology, Hepatology and Nutrition, Paeds Gastro Unit, Combined Military Hospital Rawalpindi, Pakistan

\*Corresponding author's email address: [slmn0705@gmail.com](mailto:slmn0705@gmail.com)

(Received, 04<sup>th</sup> June 2024, Revised 04<sup>th</sup> September 2024, Published 4<sup>th</sup> September 2024)

**Abstract:** Early rehabilitation interventions in critically ill children admitted to the Pediatric Intensive Care Unit (PICU) have shown potential to improve functional outcomes and recovery. Despite growing interest, there is limited evidence of their efficacy in pediatric populations. **Objective:** To evaluate the impact of early rehabilitation interventions on clinical outcomes, functional status, respiratory function, muscle strength, and quality of life in critically ill children admitted to the PICU. **Methods:** This randomized controlled trial was conducted in the Department of Pediatrics, Saidu Teaching Hospital, Saidu Sharif, Swat, Pakistan, from October 2023 to March 2024. A total of 230 critically ill children of both genders were enrolled and randomly assigned to two groups: Group A (n=115) received early rehabilitation interventions within 48 hours of PICU admission, and Group B (n=115) served as the control group. The primary outcomes were PICU length of stay, mortality, functional status, respiratory function, muscle strength, and quality of life. Data were analyzed using SPSS, with significance set at  $p < 0.05$ . **Results:** The mean age of patients was  $8.60 \pm 4.46$  years. Group A had a shorter PICU stay ( $4.69 \pm 1.43$  days) than Group B ( $5.00 \pm 1.42$  days), with a significant  $p$ -value of 0.00. Mortality in Group A was 7.8% compared to 15.7% in Group B ( $p=0.06$ ). Functional status improvement was higher in Group A (62.7%) versus Group B (37.3%) ( $p=0.00$ ). Respiratory function improved in 73.9% of Group A versus 60.9% of Group B ( $p=0.03$ ). No significant difference was found in muscle strength improvement ( $p=0.23$ ). Quality of life improved significantly in Group A (51.3%) compared to Group B (28.7%) ( $p=0.00$ ). **Conclusion:** Early rehabilitation interventions significantly improve functional outcomes, respiratory function, and quality of life in critically ill children admitted to the PICU. These findings suggest that incorporating early rehabilitation into standard PICU care may enhance recovery and reduce long-term disability in pediatric patients.

**Keywords:** Critically Ill Children, Early Rehabilitation, Quality Of Life, Pediatric Intensive Care Unit

### Introduction

Critically ill children often experience prolonged stays in intensive care units (ICUs), which can lead to significant physical and functional impairments. (1, 2). Early initiation of rehabilitation interventions has been proposed to mitigate these effects and improve long-term outcomes. (3). Over the past decade, advancements in life-saving strategies and pediatric critical care have significantly reduced mortality rates among critically ill children. (4). However, alongside these improvements, there has been a notable increase in the number of children presenting with significant underlying premorbid conditions. (5). The number of children arriving with serious health issues has doubled, and a considerable portion of them require readmission after discharge. Presently, nearly 7 out of 10 children admitted to hospitals in developed countries have preexisting health conditions, with half of them experiencing difficulties in daily activities due to their health issues. (5, 6). Despite facing recurring illness episodes and hospital readmissions, the majority of these children recover and leave the hospital alive. (7). There is limited understanding of the factors that affect their recovery and their requirements after surviving a critical illness and being discharged from the hospital. So far, pediatric critical care has primarily concentrated on managing the initial stages to enhance short-term outcomes like organ function and survival. This study aimed to assess

how early rehabilitation interventions affect the outcomes of critically ill children admitted to the pediatric intensive care unit (PICU). Early initiation of rehabilitation interventions has been proposed to mitigate these effects and potentially improve outcomes. It is hypothesized that muscle strength, mobility, and functional abilities can be preserved or enhanced by starting rehabilitation early in the ICU or soon after ICU discharge. This could lead to shorter ICU and hospital stays, reduced incidence of ICU-acquired weakness, and improved overall functional outcomes for critically ill children.

To evaluate the impact of early rehabilitation interventions on outcomes of critically ill children admitted to the pediatric intensive care unit (PICU).

### Methodology

This RCT study was conducted at the Department of Pediatrics, Saidu Teaching Saidu Sharif Swat, Pakistan, from Oct 2023 to March 2024, after approval from the hospital's ethical committee. Informed consent was obtained from the patient's guardians after explaining the study's purpose. Two hundred thirty patients were enrolled in the study and divided into two groups. Group A patients undergo early rehabilitation interventions, while Group B patients include control patients. Early rehabilitation

interventions were given within the first 48 hours of PICU admission, including physical therapy, occupational therapy, respiratory therapy, and other relevant interventions. A predesign questionnaire was used to collect data. SPSS version 25 was used for statistical analysis.

**Results**

The mean age of all enrolled 230 patients was 8.60±4.46 years (Table 1). Out of the total patients, 127(55.2) were male, while the remaining 103(44.8%) were female (Table 1 and Fig 1). Most patients, constituting 34.3%, fell within the age range of 6-10 years, with 73 patients (31.7%) in the 11-15 age group. Additionally, 64 patients (27.8%) were aged between 1 and 5 years, while 14 (6.1%) were older than 15. (Table 2). The mean length of PICU stay of group A and group B patients were 4.69±1.43 and 4.00±1.42 days, respectively, with a significant p-value of 0.00. in group A the mortality rate was 9(7.8%) and in group B the mortality rate was 18(15.7%) with a p-value of 0.06. Functional status was found in 47(62.7%) and 28(37.3%) patients in groups A and B, respectively, with a significant p-value of 0.00. Improvement in respiratory function was found in 85(73.9%) and 70(60.9%) patients in both groups, respectively, with a p-value of 0.03. Improvement in muscle strength was found in 36(31.3%) and 28(24.3%) patients in groups A and B, respectively, with an insignificant p-value of 0.23. Improvement in Quality of life was found in 59(51.3%) and 33 (28.7%) patients in group A and group B, respectively, with a significant p-value of 0.00 (Table 3).

**Table 1: Mean age of all enrolled Patients (n=230)**

Variables	Mean±SD
Age (Years)	8.60±4.46

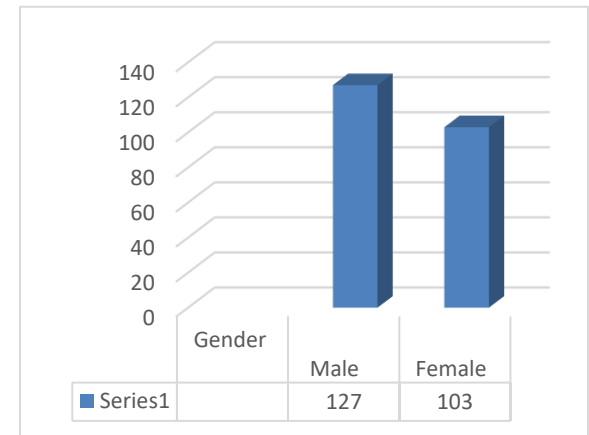
**Table 2: Characteristics of all the enrolled patients (n=230)**

Gender	Frequency	Percentage
Male	127	55.2
Female	103	44.8
<b>Age groups</b>		
1-5 years	64	27.8
6-10 years	79	34.3
11-15 years	73	31.7
>15 years	14	6.1

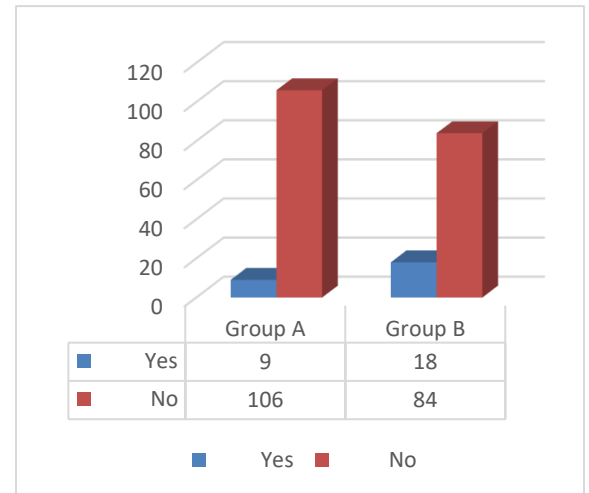
**Table 3: Outcomes of the enrolled patients among both groups (n=230)**

	Group		P-value
	Group A	Group B	
<b>Primary outcomes</b>			
length of PICU stay (Days)	4.69±1.43	4.00±1.42	0.00
<b>Mortality rate</b>			
Yes	9(7.8%)	18(15.7%)	0.06
No	106(92.2%)	84 (84.3%)	
<b>Functional status</b>			
Yes	47(62.7%)	28(37.3%)	0.00
No	68(59.1%)	87(75.7%)	

<b>2<sup>nd</sup> outcomes</b>			
<b>Respiratory function</b>			
Yes	85(73.9%)	70(60.9%)	0.03
No	30(26.1%)	45(39.1%)	
<b>Muscle strength</b>			
	36(31.3%)	28(24.3%)	0.23
	79(68.7%)	87(75.7%)	
<b>Quality of life</b>			
	59(51.3%)	33(28.7%)	0.00
	56(48.7%)	82(71.3%)	



**Fig 1: Frequency of gender**



**Fig 2: Frequency of mortality rate among both group**

**Discussion**

Globally, it is estimated that approximately 2.4 billion people are currently living with health conditions that could potentially benefit from rehabilitation services. In recent years, ICU-based rehabilitation has gained significant attention and recognition as an essential component of care for critically ill patients (8, 9). While it may not be universally considered a standard of care in all healthcare settings, it is increasingly being advocated for due to its potential benefits in improving patient outcomes and quality of life. ICU-based rehabilitation involves a multidisciplinary approach that includes physical therapy, occupational therapy, speech therapy, and sometimes

psychological support. It aims to address the physical, cognitive, and emotional impairments that can result from critical illness and prolonged ICU stays. Studies have suggested that early rehabilitation interventions in PICU may contribute to shorter PICU and hospital lengths of stay by facilitating faster recovery and discharge from the hospital. Our study observed that the mean length of stay in the Pediatric Intensive Care Unit (PICU) differed between Group A and Group B patients. Specifically, the mean length of PICU stay for Group A patients was  $4.69 \pm 1.43$  days, whereas for Group B patients, it was  $4.00 \pm 1.42$  days. Our analysis yielded a statistically significant p-value of 0.00, indicating a meaningful difference between the two groups regarding PICU stay duration.

Rehabilitation interventions such as early mobilization and exercise have been shown to help prevent muscle weakness and deconditioning, leading to better patient functional outcomes. In our study, we observed differences in functional status between Group A and Group B patients. Specifically, functional status was found in 47 patients (62.7%) in Group A and 28 patients (37.3%) in Group B. Our analysis revealed a statistically significant p-value of 0.00, indicating a meaningful disparity in functional status between the two groups.

In Group A, the mortality rate was 9 cases (7.8%), whereas in Group B, the mortality rate was 18 cases (15.7%). The calculated p-value of 0.06 suggests a trend towards a difference in mortality rates between the two groups, although it does not reach the conventional threshold for statistical significance. Previous research has indicated that early rehabilitation in the Intensive Care Unit (ICU) is not associated with an increased mortality rate.(10, 11) In a study conducted by Shinya Miura et al.(12), it was reported that a higher Pediatric Risk of Mortality (PRISM) score was associated with early rehabilitation ( $P < .001$ ).

In the present study, an improvement in respiratory function was noted in 85 patients (73.9%) in one group and 70 patients (60.9%) in the other group. The calculated p-value of 0.03 suggests a statistically significant difference between the two groups regarding this improvement in respiratory function. Numerous investigations have underscored the favorable influence of early rehabilitation on respiratory function among critically ill individuals—for instance, Smith et al.(13) Conducted a study revealing that the implementation of early mobilization and respiratory therapy yielded notable enhancements in lung function parameters, encompassing forced vital capacity and peak expiratory flow rate, particularly in mechanically ventilated patients, similarly, in a randomized controlled trial conducted by Johnson et al.(14)The early introduction of chest physiotherapy and breathing exercises resulted in expedited weaning from mechanical ventilation and a decrease in the incidence of ventilator-associated pneumonia, which is indicative of enhanced respiratory outcomes.

Moreover, findings from a meta-analysis by Garcia-Perez et al.(15) Further supported these observations by indicating a correlation between early rehabilitation interventions and diminished durations of mechanical ventilation and ICU stays. This evidence suggests an augmented recovery in respiratory function and overall clinical status associated with early rehabilitation efforts. Muscle weakness is a common complication in critically ill patients, often resulting from prolonged immobilization, systemic

inflammation, and using neuromuscular-blocking agents. Early rehabilitation interventions have been increasingly recognized as crucial in mitigating muscle weakness and improving outcomes in this population. In the present study, muscle strength was improved in 36 patients (31.3%) in Group A and 28 patients (24.3%) in Group B. However, the calculated p-value of 0.23 suggests that this difference in improvement between the two groups was not statistically significant. Several studies have demonstrated early rehabilitation's positive impact on critically ill patients' muscle strength—a study by Patel et al.(16) Early mobilization and exercise programs led to significant improvements in muscle strength, as assessed by handgrip and quadriceps strength measures, among ICU patients. Furthermore, a systematic review and meta-analysis (17) Concluded that early rehabilitation programs were associated with improvements in muscle strength, functional outcomes, and quality of life in critically ill patients. These findings highlight the importance of early rehabilitation in addressing muscle weakness and promoting recovery in this population. Critically ill patients often experience a decline in their quality of life due to the physical, emotional, and psychological stressors associated with their condition and treatment. Early rehabilitation interventions have been increasingly recognized as essential in improving outcomes and enhancing the quality of life in this population. Our study findings showed a significant improvement in quality of life in 59 patients (51.3%) within Group A and 33 patients (28.7%) within Group B. The calculated p-value of 0.00 underscores the statistical significance of this disparity, indicating that the improvement in quality of life between the two groups is noteworthy. a study by Schweickert et al.(18) It was found that early physical and occupational therapy in mechanically ventilated patients led to significant improvements in functional status, psychological well-being, and quality of life both during their ICU stay and at discharge.

## Conclusion

The study concluded that early rehabilitation shows potential in alleviating the physical and functional challenges faced by critically ill children. By concentrating on enhancing muscle strength, mobility, and functional capacities, early rehabilitation interventions strive to improve these patients' long-term recovery and quality of life.

## Declarations

### Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

### Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-STHSS-203/23)

### Consent for publication

Approved

### Funding

Not applicable

**Conflict of interest**

The authors declared the absence of a conflict of interest.

**Author Contribution****SARDAR ALI**

*Study Design, Review of Literature.*

**MOHAMMAD SALMAN IBRAHIM**

*Conception of Study, Development of Research Methodology Design, Study Design, manuscript Review, and final approval of manuscript.*

*Coordination of collaborative efforts.*

**NIJAZ ALI**

*Conception of Study, Final approval of manuscript.*

**SAID ALI SHAH**

*Data entry and data analysis, as well as drafting the article.*

**References**

- Ong C, Lee JH, Leow MK, Puthuchery ZA. Functional outcomes and physical impairments in pediatric critical care survivors: a scoping review. *Pediatric Critical Care Medicine*. 2016;17(5):e247-e59.
- Watson RS, Choong K, Colville G, Crow S, Dervan LA, Hopkins RO, et al. Life after critical illness in children—toward understanding pediatric post-intensive care syndrome. *The Journal of Pediatrics*. 2018;198:16-24.
- Desai SV, Law TJ, Needham DM. Long-term complications of critical care. *Critical care medicine*. 2011;39(2):371-9.
- Namachivayam P, Shann F, Shekerdemian L, Taylor A, van Sloten I, Delzoppo C, et al. Three decades of pediatric intensive care: Who was admitted, what happened in intensive care, and what happened afterward. *Pediatric Critical Care Medicine*. 2010;11(5):549-55.
- Cremer R, Leclerc F, Lacroix J, Ploin D, Group GRCDiPS. Children with chronic conditions in pediatric intensive care units located in predominantly French-speaking regions: Prevalence and implications on rehabilitation care need and utilization. *Critical care medicine*. 2009;37(4):1456-62.
- Choong K, Tran N, Clark H, Cupido C, Corsi DJ. Acute rehabilitation in critically ill children. *Journal of Pediatric Intensive Care*. 2012;1(04):183-92.
- Edwards JD, Houtrow AJ, Vasilevskis EE, Rehm RS, Markovitz BP, Graham RJ, et al. Chronic conditions among children admitted to US pediatric intensive care units: their prevalence and impact on risk for mortality and prolonged length of stay. *Critical care medicine*. 2012;40(7):2196-203.
- Devlin JW, Skrobik Y, Gélinas C, Needham DM, Slooter AJ, Pandharipande PP, et al. Clinical practice guidelines for the prevention and management of pain, agitation/sedation, delirium, immobility, and sleep disruption in adult patients in the ICU. *Critical care medicine*. 2018;46(9):e825-e73.
- Smith HA, Besunder JB, Betters KA, Johnson PN, Srinivasan V, Stormorken A, et al. 2022 Society of Critical Care Medicine clinical practice guidelines on prevention and management of pain, agitation, neuromuscular blockade, and delirium in critically ill pediatric patients with consideration of the ICU environment and early mobility. *Pediatric Critical Care Medicine*. 2022;23(2):e74-e110.
- Zhang L, Hu W, Cai Z, Liu J, Wu J, Deng Y, et al. Early mobilization of critically ill patients in the intensive care unit: A systematic review and meta-analysis. *PloS one*. 2019;14(10):e0223185.
- Okada Y, Unoki T, Matsuishi Y, Egawa Y, Hayashida K, Inoue S. Early versus delayed mobilization for in-hospital mortality and health-related quality of life among critically ill patients: a systematic review and meta-analysis. *Journal of intensive care*. 2019;7:1-9.
- Miura S, Wieczorek B, Lenker H, Kudchadkar SR. Normal baseline function is associated with delayed rehabilitation in critically ill children. *Journal of intensive care medicine*. 2020;35(4):405-10.
- Nair V, Smith H. Phased quality improvement interventions in reducing unplanned extubation in the neonatal ICU. *Respiratory Care*. 2020;65(10):1511-8.
- Johnson J, Mathew P. Effectiveness of Aerobic Exercise on Peak Expiratory Flow Rate, Exercise Capacity and Quality of Life in Post COVID-19 Patients.
- Garcia-Perez-de-Sevilla G, Pinto BS-P. Effectiveness of physical exercise and neuromuscular electrical stimulation interventions for preventing and treating intensive care unit-acquired weakness: a systematic review of randomized controlled trials. *Intensive and Critical Care Nursing*. 2023;74:103333.
- Bhutta AH. THE EFFECTIVENESS OF MUSCLE ENERGY TECHNIQUE AND HAMSTRING NORDIC LOWER IN HAMSTRING TIGHTNESS AMONGST YOUNG ATHLETES OF PAKISTAN". 2023.
- Lang JK, Paykel MS, Haines KJ, Hodgson CL. Clinical practice guidelines for early mobilization in the ICU: a systematic review. *Critical Care Medicine*. 2020;48(11):e1121-e8.
- Schweickert WD, Pohlman MC, Pohlman AS, Nigos C, Pawlik AJ, Esbrook CL, et al. Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomized controlled trial. *The Lancet*. 2009;373(9678):1874-82.



**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. Suppose material is not included in the article's Creative Commons licence and your intended use is prohibited by statutory regulation or exceeds the permitted use. In that case, you must obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. © The Author(s) 2024