Effectiveness of Early Mobilization Protocol on Critically Ill Children Outcomes and their Activities of Daily Living

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Abstract

Children who are critically ill are a diverse group with numerous comorbidities. Children's data on early mobilization interventions is scarce. Moreover, there is inadequate research on mobilization interventions in the critically ill pediatric patients. The aim of this study was to evaluate the effectiveness of early mobilization protocol on critically ill children outcomes and their activities of daily living. The study was carried out at pediatric intensive care unit (PICU) affiliated to Mansoura University Children's Hospital. Quasi experimental research design was used. A purposive sample was included 60 children. The total sample was divided into two groups (study and control group); each group contains 30 children. Data were collected by a structured interview sheet was concerned with collecting data related to: demographic data, homodynamic parameters, outcomes criteria to assess the efficacy of early mobilization protocol. Barthal Index Scale to assess activities of daily living after implementation of early mobilization protocol. In relation to hemodynamic parameters, there was a statistically significant difference between the study and control groups, all items of Barthal index score and outcomes criteria. Conclusion: based on the research hypotheses; homodynamic parameters and daily living activities of critically ill children were better after implementation of early mobilization protocol. Days of mechanical ventilation and length of stay in the PICU were shorter. Recommendations: early mobilization should be considered essential in the overall management of pediatric critically ill patients. Further studies with standardized intervention protocols and randomized clinical trials are required to evaluate the effectiveness of early mobilization in this population.

Keywords: Early mobilization protocol, critically ill children, pediatric intensive care unit.

Introduction

Children with critical illnesses are at risk of developing long-term conditions that may include cognitive impairment, mental health disorders and neuromuscular impairment. These conditions, recognized as Post-Intensive Care Syndrome (PICS), may lead to functional deficits, social and school difficulties, and decrease quality of life (**Herbsman et al., 2020)**. One of the major **problems** in pediatric with post-intensive care syndrome is physical impairment. Sepsis, mechanical ventilation for a long time, neuromuscular blocking medications, glucocorticoids, and immobility are all associated risk factors for physical disability. Pressure sores and muscle contracture are also more likely to occur as a result of ineffective movement and position **(Inoue et al., 2019)**.

The optimum care in intensive care unit (ICU) has centered on preventing long-term complications of immobilization and chronic sedation. These include as early mobilization, prevention of acquired weakness in the ICU, reduction of anesthesia, delirium and post-traumatic stress disorder (PTSD) may improve the critically ill children's clinical outcomes and functional recovery **(Thabet, Sayed, Yousef & Marzouk, (2020)**. Generally, because of concerns about the safety of critically ill children, they were sedated and immobile. Recently, there is a trend aimed at preventing these morbidities by allowing critically ill children to be as interactive, aware, and mobile as possible **(Herrup, Wieczorek & Kudchadkar, 2017)**.

Maintain maximal hemodynamic and ventilatory stability is the primary aim in the management of critically ill children in PICU **(Piva, Ferrari & Schaan, 2019)**. Newly, critical care of the pediatric has mostly focused on management in order to improve short-term consequences such as organ dysfunction and survival. While, clinicians support the cause for early mobilization, there are numerous safety concerns and obstacles at the provider and institutional levels. The lack of information about who, when, and how to implement early

mobilization in critically ill children, limitations of resources (i.e., a lack of dedicated physical or occupational therapy staff),a lack of knowledge of existing evidence, and practice guidelines deficiency specifically for the PICU population are all major obstacles to mobilizing critically ill children **(Choong, 2015)**.

While most clinicians believe that, bed rest for a long time is unsuitable, many are concerned about children's safety when they are mobilized. As a result, there are differing viewpoints on whether, when, and how to mobilize those children in the intensive care unit **(Choong et al., 2018)**. Early mobility can prevent or reduce the risks of acquiring ICU vulnerability, neuropsychiatric disease, and other complications associated with immobility **(Agency for Healthcare Research & Quality, 2017**).

It's difficult to create a conventional rehabilitation strategy in the PICU because of the wide diversity of ages, developmental stages, and diagnoses of patients. At present time, there is no early mobilization's traditional definition in the PICU. The term "early mobilization" refers to a range of clinically safe and developmentally appropriate rehabilitation exercises performed in varied levels started within the first 48 to 72 hours of admission to ICU based on the clinical stability of the patient and mechanical support, with increasing the rehabilitation levels as the clinical condition of the patient develops, it includes everything from passive range of motion activities for the children who are critically ill to ambulation if suitable **(Walker & Kudchadkar, 2018)**.

Early mobility play basic role to improve several of these negative impacts, such as strength of muscles, reduced delirium duration, reduced length of stay in hospital and in intensive care unit, and improve quality of life for pediatric patient (**Gupta et al., 2021)**. The nursing care aims to return the child to his or her daily routine before hospitalization (bedtime/wake time, bedtime/arousal routine, nap time, feeding schedule, active periods), cycled day-night lighting and modulation of sound to match the routine of the child, reduced the effective sedation by using a nurse-implemented, goal-directed sedation plan, nighttime fasting with bolus enteral daytime feedings, early, developmentally-appropriate, progressive exercise and mobility, and consistency in nursing care **(Perry et al., 2021)**.

Significance

In children with critical illnesses, prolonged immobility is linked to serious short- and long-term disease states. In the critically ill pediatric patients, there is limited research on mobilization interventions. Case reports and pilot data are the only sources of published evidence. **(Choong et al, 2015)**. Although early mobilization in the PICU is getting popular, substantial randomized control studies, functional and psychological result data are still lacking. Although, there is evidence that mobilizing of children who are critically ill is safe and possible, more research is required to determine both physical and psychosocial outcomes. Early movement of critically ill children follows a nurse-determined plan to reduce staying in PICU, motor dysfunction, and ventilator support days (**Choong et al., 2018 and Chaiyakulsil, & Thippanate, 2021)**.

Aim:

To evaluate the effectiveness of early mobilization protocol on critically ill children outcomes and their activities of daily living

Operational definitions

Early mobilization: was defined as any passive or active activity that occurred within the first 3 days of PICU admission and was intended to maintain or restore musculoskeletal strength and function. **Critically ill children outcomes**: Is mechanical ventilation duration, PICU duration of stay, time of moved out of bed: (days), mortality, and PICU-acquired morbidities.

Research Hypotheses:

To achieve the study's aim, the following research hypotheses were developed:

H1: The study group's post mean homodynamic parameters will be better than the control group.

H2: The study group's post-mean daily living activities will be better than the control group.

H3: The time spent on mechanical ventilation and in the PICU in the study group will be shorter than in the control group.

Subjects and method

Research design:

Quasi experimental research design using two groups (study and control group) was used for this study.

Sample:

A convenience purposive sample was included 60 children. The total sample was randomly divided into two groups (each group contains 30 children) using simple random technique by using a coin (king and writing) for each child admitted to the pediatric intensive care, the study group was the king (received in-bed and mobility therapies) and the control group was the writing which received standard or "on - mobility" interventions as passive range of motion exercise, chest physiotherapy and stretching exercises.

Inclusion criteria were children aged 12 to 18 years who required 3 or more days in a PICU, were oriented, able to communicate, and capable of dealing with the intervention utilized in the study.

Exclusion criteria and contraindications to mobilization included cardio respiratory instability, intracranial hypertension, spinal instability, extracorporeal membrane oxygenation (ECMO) therapy, open chest or abdomen, unstable fractures, or a medical orders specifying alternate activities.

Sample size calculation

By using G*power analysis program, the required sample size was calculated by taking into account the differences in the continuous primary outcomes. For detecting a large standardized difference between the immediate intervention of both study groups (i.e. a difference of at least 0.8 SD), with 80% power and $\alpha = 0.05$, 26 children would be necessary in each group. Assuming 15% non-response rate, the required sample size was calculated as 60 participants.

Setting

The study was carried out at Mansoura University Children's Hospital (MUCH) pediatric intensive care unit (PICU) over a six-month period beginning in September 2020 and ending in February 2021

Tool of data collection:

Data were obtained using a standardized interview sheet that the researchers prepared after evaluating related literature and previous studies on the problem **(Wieczorek et al, 2016; Choong et al, 2018; Walker & Kudchadkar, 2018 and Treble-Barnaet, 2019)**.

Tool 1: A Structured Interview Sheet was concerned with gathering data related to:

Part A: Demographic data of study subjects including their age, gender, weight, birth order, level of education, residence, and diagnosis.

Part B: Homodynamic parameters; which included: oxygen saturation, blood pressure, heart and respiratory rates.

Part C: Outcomes criteria assesses the efficacy of early mobilization protocol based on: mechanical ventilation duration, PICU duration of stay, time of moved out of bed: (days), mortality, and PICU-acquired morbidities.

Tool II: Activities of daily living using **Barthal Index (BI) (Hsueh, Lee & Hsieh, 2001):** The Barthel activities of daily living (ADL) index (BI) scale was used to assess child's independence in term of ADL. It includes 10 fundamental items of ADL: feeding, grooming, bathing, dressing, bowel and bladder care, toilet use, ambulation, transfers, and stair climbing. The BI is equivalent to the sum of 10 items ranging from 0 to 100, i.e. from totally dependent to independent to basic ADL. The higher the BI means the higher the level of independence.

Data Collection Procedure

Ethical considerations:

This study was approved by ethical committee at Faculty of Nursing, Mansoura

University. Agreement was taken from the Board of Pediatric Intensive Care Unit affiliated to Mansoura University Children's Hospital (MUCH) to carry out the study after describing the study's aim and content of the study. After describing the study's purpose to the director of the unit, an official permission was obtained. The study's goal was explained to each child (based on his condition) and/or parent, and written consent was obtained. To gain their cooperation, confidentiality, privacy, anonymity, and the opportunity to withdraw at any time were ensured.

Validity and Reliability

A panel of five pediatric nursing experts evaluated the content validity of a Structured Interview Sheet. Crombach Alpha was used to determine the reliability of Tool II and it gave an internal consistency of (r = 0.674) which was acceptable.

Pilot Study

A pilot study was carried out on 10% of the total sample size (6 children). No modification was done so children who participated in the pilot study were included in the study.

Intervention / Procedure:

- The researchers used to go to the previous mentioned setting all days of week except Friday.
- The child was assessed according to the eligibility criteria within the first 72 hours of admission and reassessed daily.
- The early mobilization protocol was built on individualized interventions, planned according to development of the child, requirements and cooperation. Mobilization began within the first 72 hours of being admitted to the pediatric intensive care unit.
- Early mobilization intervention was implemented no later than 2 or 3 days after children's admission at the PICU and was delivered after cardio-respiratory and neurological stabilization of children.
- At the first meeting, each child's parent in the previous setting was questioned individually at the beginning of the mobilization session in PICU to collect the demographic and medical history data using Tool I- Part A. The questions were posed in an Arabic language in a simple manner and the responses were recorded immediately. For each child, it took about 5-10 minutes to fill out the sheet. This information could also be gathered from the child's sheet.
- The researchers provided an explanation of the study's purpose and methodology. The parents of the children who were studied gave their written informed consent. The researchers promised that the research data would be kept private.
- The control group was received standard or "on - mobility" interventions as passive range of motion exercise, chest physiotherapy and stretching exercises.
- Before starting each mobilization session; the researchers assess the stability criteria of each child (homodynamic parameters) by measuring and recorded blood pressure, heart and respiratory rates for each child using Tool I- Part B as a base line to detect any changes during intervention, in addition to identify the readiness of the child to start the sessions of mobilization protocol. Furthermore, to compare homodynamic parameters in both groups after the early mobilization protocol was implemented.
- **Early mobilization protocol in pediatric ICU by Clark et al., (2013)**. There are a total of five levels on the protocol, ranging from head of the bed at thirty degrees, turning, and passive range of motion in level one to ambulating in level five. The five progressive levels are implemented by the researchers.
  - ✓ **Level one of activity** (passive range of motion) which includes the following activity: Turn every 2hr with an assist, splinting from 5-10 minute**,** passive range of motion three times /day 5-10 minute, and head of bed ≥30 (5-10 minute).
  - ✓ **Level two of activity** (Moderate cooperation):Turn every 2hr with assist, splinting from 5-10 minute, passive range of motion three time /day 5-10 minute, progressive bed setting, (head of bed 45◦×15 min) if tolerate then, head of bed 45◦, legs lowered position

×15 min if tolerate then, head of bed 65◦, legs lowered position ×15 min if tolerate then, chair position within bed (head of bed 90◦), legs lowered position × 20 min ×3/days if tolerate then, full assist in chair.

- ✓ **Level three of activity** (Close to full cooperation):Turn every 2hr with assist, splinting from 5-10 minute, passive and active range of motion three time /day 5-10 minute, achieve progressive bed setting 45-60 min three time /day, and setting on edge of the bed with an assist.
- ✓ **Level four of activity:** Turn every 2hr with an assist, active, active/assist active range of motion three times /day, full chair position three time /day×60 min, setting on edge of bed stand at the bedside with nurse assist, active transfer to chair out of bed 30 min three times /day (mealtime).
- ✓ **Level five of activity:** Turn every 2hr with assist or self, active range of motion 3 times /day, active transfer to a chair out of bed 30 min three times /day (mealtime), ambulate with an assist, ambulate with assist progressive with distance.

- If the intolerance signs were present and not resolved within 10 minutes; suspend activity and re-evaluate within 6 hours and if not present, re-assess mobility level every 12 hours and continue with mobilization protocol as indicated by appropriate level.
- Continuous monitoring of hemodynamic status to determine that passive motion did not have a negative impact on physiological response and safety.
- The efficacy of early mobilization protocol was assessed at the end of early mobilization protocol using Tool I (part C) & Tool II.

Statistical analysis

Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA), version 20 for Windows, was used to calculate all statistics. To describe the sample background characteristics, descriptive statistics were calculated. Number and percent were used to describe categorical variables. Continuous variables were presented as mean ± SD (standard deviation). The Kolmogorov–Smirnov test was used to test the normality of the distribution of the continuous variables. For normally distributed variables, Paired sample t test was used to indicate differences between pre and post-tests mean scores. While, an independent t-test was used to determine differences between the study and control groups mean scores. All tests were considered statistically significant if the level of significance (P-value) was equal to or less than 0.05.

Results

Table (1): It was found that, the highest percentage of the studied children had aged ranged between 12 to less than 14 years old and females in both groups, Mean ± SD of weight (42.31±3.54 & 43.09±4.41) in study and control groups respectively, regarding birth order (40.0% & 46.7%) of them is second and first in study and control groups respectively, and the majority of them had preparatory education and living at urban areas. Concerning medical diagnosis, 36.7% & 30.0 % of the studied children had diabetes mellitus coma & acute respiratory failure in study and control groups respectively.

As regard hemodynamic parameters before the intervention (at baseline), table (2) illustrated that there is no statistical significant difference between both groups.

In relation to hemodynamic parameters table (2) displayed that, as indicated by p values 0.008, 0.025, 0.038, 0.016, and 0.001) respectively, highly statistically significant difference was found between the study and control groups in relation to hemodynamic parameters (systolic and diastolic blood pressure, heart and respiratory rate, oxygen saturation).

As regard activities of daily living; table (3) revealed that ,there was statistical significant difference between both groups in relation to all items of Barthal index score (except bathing) including: feeding, bathing, grooming, bowels, bladder, toilet use, transfers, mobility & stairs as evidenced by (P-value = 0.014, 0.02, 0.002,0.005,0.002,0.004,0.005,0.006)

respectively. In addition, there is highly statistical significant difference within the study group (pre and post implementation of early mobilization protocol) as evidenced by P-value < 0.001. Moreover, there is statistical significant difference between both groups as regard to total Barthal index score (P-value=0.002). This means that the children in the study group became more independent in their activities of daily living than control group.

According to outcomes criteria to evaluate efficacy of early mobilization protocol; table (4) presented that there was statistically significant difference between both groups as regard (PICU-acquired morbidities, time of moved out of bed, PICU duration of stay & duration of mechanical ventilation) at p value (0.028, 0.005, 0.039 & 0.048) respectively.

Table (1): Distribution of the studied critically ill children according to their socio-demographic characteristics

Scio- demographic characteristics	Total number = 60			
	Study N=(30)		Control N= (30)	
	No.	%	No.	%
Age				
▪ 12-<14	20	66.7	18	60
▪ 14-<16	6	20	8	26.7
▪ 16-18	4	13.3	4	13.3
Mean ± SD	**14.00 ±1.26**		**13.51±1.59**	
Gender				
▪ Male	11	36.7	10	33.3
▪ Female	19	63.3	20	66.7
Weight				
Mean ±SD	**42.31 ± 3.54**		**43.09 ± 4.41**	
Birth order				
▪ The first	11	36.7	14	46.7
▪ The second	12	40	10	33.3
▪ The third	7	23.3	6	20
Education				
▪ Preparatory	26	86.7	27	90
▪ Secondary	4	13.3	3	10
Residence				
▪ Urban	25	83.3	21	70
▪ Rural	5	16.7	9	30
Medical diagnosis				
▪ Acute renal failure	----	----	4	13.3
▪ Shock	3	10	2	6.7
▪ Acute respiratory failure	6	20	9	30
▪ DM coma	11	36.7	5	16.7
▪ Postoperative	4	13.3	4	13.3
▪ CNS problems	6	20	6	20

Table (2): Comparison between the study & control groups as regard hemodynamic parameters before the intervention (at baseline):

Hemodynamic parameters	Total number =60				P- value
	Study N=(30)		Control N= (30)		
	Mean	SD	Mean	SD	
Systolic Blood pressure	109.31	16.14	108.29	14.66	*t=0.67 P-value=0.463*
Diastolic Blood pressure	72.07	14.75	71.55	13.37	*t=0.563 P-value=0.592*
Heart rate	126.12	20.04	123.60	22.94	*t=1.20 P-value=0.310*
Respiratory rate	35.44	9.20	35.04	12.36	*t=0.664 P-value=0.524*
Spo_2	91.45	3.90	90.13	3.62	*t= 0.303 P-value =0.421*

Independent t test P >0.05 non-significant *P<0.05 significant

Table (3): Comparison between the study & control groups as regard hemodynamic parameters after implementation of early mobilization protocol

Hemodynamic parameters	Total number =60				P- value
	Study N=(30)		Control N= (30)		
	Mean	SD	Mean	SD	
Systolic Blood pressure	120.5	15.65	110.40	14.44	***t=2.76*** ***P-value****=0.008*
Diastolic Blood pressure	77.50	9.50	71.53	10.50	***t=2.30*** ***P-value****=0.025*
Heart rate	118.84	16.24	125.38	25.03	***t=2.14*** ***P-value***=0.038
Respiratory rate	40.26	6.07	32.30	11.53	***t=2.47*** ***P-value***=0.016
Spo_2	92.45	3.90	89.13	3.62	***t= 4.003*** ***P-value =0.001***

Table (4): Mean and standard deviation of study and control group as regard Barthal index for measuring activities of daily living after implementation of early mobilization protocol.

Items	Total number =60				*Independent t test between two post tests*
	Study N=(30)		Control N= (30)		
	Pre	*Post*	*Pre*	*Post*	
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	
Feeding	1.5±2.67	8.00±3.10	4.33 ±4.68	5.50±4.42	***t****=2.53* ***P-value***=0.014
Paired t test	***t= 10.14*** ***P-value****<0.001*		***t****=1.270* ***P-value***=0.214		
Bathing	0.66±1.72	4.00±2.03	2.16±2.52	3.00±2.49	***t****= 1.70* ***P-value***=0.094
Paired t test	***t= 7.61*** ***P-value****<0.001*		***t****=1.720* ***P-value=0.****096*		
Grooming	0.500**±1.52**	4.33**±1.72**	1.66±1.33	2.44±2.49	***t****= 2.50* ***P-value****=0.02*
Paired t test	***t= 9.76*** ***P-value****<0.001*		***t****=0.701* ***P-value****=0.489*		
Dressing	1.166**±2.15**	7.16±3.13	4.00±4.62	4.66±4.72	***t****= 2.417* ***P-value***=0.019
Paired t test	***t= 9.20*** ***P-value****<0.001*		***t****=0.724* ***P-value****=0.475*		
Bowels	1.50**±2.97**	8.16**±3.07**	4.16±4.79	4.83±4.82	***t****= 3.19* ***P-value***=0.002
Paired t test	***t= 9.63*** ***P-value****<0.001*		***t****=0.701* ***P-value****=0.489*		
Bladder	1.50**±2.97**	8.16**±3.07**	4.16±4.74	5.16±4.63	***t****= 2.95* ***P-value***=0.005
Paired t test	***t= 9.63*** ***P-value****<0.001*		***t****=1.03* ***P-value****=0.312*		
Toilet Use	1.33**±2.24**	8.00**±3.10**	3.66±3.72	4.66±4.33	***t****= 3.23* ***P-value***=0.002
Paired t test	***t= 10.26*** ***P-value****<0.001*		***t=0.494*** ***P-value=0.625***		
Transfers (bed to chair and back)	2.16**±2.00**	12.00± **4.66**	6.66 ±6.35	7.33±7.15	***t****=2.99* ***P-value***=0.004
Paired t test	***t= 7.97*** ***P-value****<0.001*		***t=0.494*** ***P-value=0.625***		
Mobility (on level surfaces)	2.83**±2.20**	12.16**±4.48**	6.66±6.35	7.66±7.03	***t****=2.95* ***P-value***=0.005
Paired t test	***t= 7.26*** ***P-value****<0.001*		***t=0.665*** ***P-value=0.512***		
Stairs	2.50±2.08	8.33±3.003	4.66±4.09	5.33±4.90	***t= 2.85*** ***P-value***=0.006
Paired t test	***t= 6.48*** ***P-value****<0.001*		***t=0.701*** ***P-value=489***		
Total	15.66±16.69	80.6±28.9	42.00±40.0	49.66±44.68	***t=3.19*** ***P-value***=0.002
Paired t test	***t= 9.95*** ***P-value****<0.001*		***t=0.845*** ***P-value=0.405***		

Independent t test between groups, Paired t test within group, P >0.05 non-significant, *P<0.05 significant

Table (5): Comparison between study and control group as regard efficacy of early mobilization protocol at discharge (outcomes criteria)

Outcomes criteria	Total number =60				P- value
	Study N=(30)		Control N= (30)		
	No.	%	No.	%	
▪ **Mortality**	1	3.3	4	13.3	0.161
▪ **PICU-acquired morbidities**	3	9.9	10	33.3	**0.028**
▪ **Time of moved out of bed: (days)**					
Mean ±SD	4.28 ± 1.59		6.38 ± 2.10		**0.005**
▪ **PICU duration of stay**					
Mean ±SD	11.46±2.17		13.80±2.39		**0.039**
▪ **Duration of mechanical ventilation**					
Mean ±SD	3.70 ± 0.79		4.11 ± 0.78		**0.048**

Discussion

Long after being discharged from the pediatric intensive care unit, pediatric patients who have survived a serious illness are at risk of developing physical, cognitive, and functional problems, as well as a lower quality of life. Furthermore, due to neurocognitive deficiencies and/or psychosocial disease, children who survive critical illness may struggle in school and social settings. Children who are critically ill are a diverse group with numerous comorbidities. Their physical therapy and rehabilitation requirements are great, but the resources available to achieve those requirements are limited. Moreover, there is little research on mobilization interventions in critically ill children. Data on early mobilization interventions for children is limited **(Hopkins, Choong, Zebuhr, & Kudchadkar, 2015; Herrup, Wieczorek & Kudchadkar, 2017)**. Early mobilization protocols for pediatrics may take developmental and age-based exercise goals into consideration. Although some protocols incorporate passive range of motion activities, some people believe that early mobility is only about active range of motion **(Betters & Kudchadkar, 2021)**. The aim of this study was to evaluate the effectiveness of an early mobilization protocol on critically ill children at pediatric intensive care unit.

Regarding the studied children's age, the current result presented that, the age of the highest percentage of the studied children was ranged between 12 to less than 14 years old (table 1), this result is in same line with **Thabet, Sayed, Yousef & Marzouk, (2020)** who conducted a study to " investigate the effect of early mobilization intervention on controlling acquired muscle weakness among pediatric critically ill patients" and found that the age of the highest percentage of the studied children was ranged between 12 to less than 14 years old. Concerning medical diagnosis, this result displayed that highest percentage of the studied children had diabetes mellitus coma & acute respiratory failure in two groups. This result matched with **Ames et al., (2021)** who conducted a study entitled "Development and Implementation of Pediatric ICU-based Mobility Guidelines: A Quality Improvement Initiative" and reported that main medical diagnosis among studied children was respiratory disorders. On other hand, this finding inconsistent with **Meligy, Kamal & El Sherbini, (2017)** who conducted study in Egypt under title "Mechanical ventilation practice in Egyptian pediatric intensive care units" and stated that coma is not most common medical diagnosis among children in PICU.

In this study, it is clear from the findings that, there was highly statistically significant difference between study and control groups in relation to hemodynamic parameters (systolic and diastolic blood pressure, heart and respiratory rate, oxygen saturation (table 3). This result is in agreement with the results of very recent study done by **Atrous et al., (2021)** who found that, there was highly significant difference between study and control groups related to respiratory and heart rate, systolic and diastolic blood pressure and SO_2. While

this outcome is in contrast with **Ahmed, (2019)** who reported that, no statistical significant difference was detected between the two groups in hemodynamic parameters.

Concerning activities of daily living; the results of the current study clarified that, there is statistical significant difference between both groups in relation to all items of Barthal index score (except bathing) including: feeding, bathing, grooming, bowels, bladder, toilet use, transfers, mobility & stairs (table 4). This is in accordance with **Alaparthi, Gatty, Samuel, & Amaravadi, (2020)** who conducted study about "effectiveness, safety, and barriers to early mobilization in the Intensive Care Unit" and revealed that early mobilization had effective role in performing daily living activities with high statistically significant difference between the two groups. From the researchers' point of view, this could be explained by early mobilization lead to improve children's muscle weakness, improve skin and physical integrity, and neuro cognitive health, thus reducing the advanced life support duration, and improved self-perception of functional status. On other hand, this result was in disagreement with **Alderson, (2021)** who reported that, there is no significant difference between both groups regarding Barthal index mean score.

Furthermore, the study done by **Tsuboi et al., (2019)** to assess the "Benefits of early mobilization after pediatric liver transplantation" showed no significant differences after early mobilization intervention in relation to daily living activities.

Early mobilization has been proven to be safe, feasible, and have potential valuable benefits in children in previous studies **(Abdulsatar, Walker, Timmons, & Choong, 2013; Hopkins et al, 2015; Wiezcorek et al, 2016; Tsuboi et al, 2017; Zheng et al, 2018; Fuest & Schaller, 2018)**. According to outcomes criteria to evaluate efficacy of early mobilization protocol; the current study results illustrated that, there was statistically significant difference between both groups as regard PICU-acquired morbidities, time of moved out of bed, PICU duration of stay & duration of mechanical ventilation and there is no significant difference between two groups as regard mortality (table 5). These outcomes are similar to more recent studies conducted by **Herbsman et al., (2020); Thabet, Sayed, Yousef & Marzouk, (2020) and Perry et al., (2021)**.

According to all of those studies, early mobilization decreases muscle atrophy and PICU-acquired weakness, decreases PICU stay of length and correlated with an increased percentage of children discharged home. Moreover, the child who received early mobility therapy was moved out of bed sooner than those who did not receive mobility therapy. Shorter bed stays can help reduce ICU and length of hospital stays, thus reducing health care expenses. According to the researchers' point of view, this result may be related to, when the strength of children's muscle improves; this becomes an incentive for children to get out of bed early. Additionally, **Zhang et al., (2019)** who conducted study entitled "Early mobilization of critically ill patients in the intensive care unit: a systematic review and meta-analysis" they confirmed that there was no significant difference between both groups and hospital mortality.

Conclusion

Based on the results of the current study it was concluded that: early mobilization of critically ill children in a pediatric intensive care unit can be safe, feasible, and effective. After implementing the early mobilization protocol it was found that PICU-acquired morbidities, duration of mechanical ventilation and hospitalization decreased and daily living activities improved (Barthel Index Scale) and regard hemodynamic parameters, early mobilization had positive effect with a statistically significant difference between both groups.

Recommendations

The following recommendations were done based on the results of this study:

- Using a bundled approach that includes minimization of sedation, recognition of a delirium, and interaction of the family must be the initial step in mobilization promotion, then creating an organized,

tiered mobilization plan that prioritizes the safety of children.

- Further studies with standardized intervention protocols and randomized clinical trials are required to evaluate the effectiveness of early mobilization in this population.
- Guidelines for various levels of mobilization based on the child acuity should be developed to promote child safety and prevent adverse consequences.
- Pediatric intensive care culture should be shifted from keeping patients on restrict bed rest to mobilizing patients as early as possible.
- Early mobilization protocol should be incorporated into daily clinical practice of PICU.
- Early mobilization should be considered essential in the overall management of pediatric patients who are critically ill.
- More research is required in PICU to detect the most effective methods for early mobilization.

Limitations

The main limitations were inadequate sample size and the single setting study which limits generalizability to diverse range of children treated in PICUs.

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