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ORIGINAL ARTICLE

Evaluating the Impact of Enteral Nutrition on Pediatric Outcomes in PICU Patients: A Study of Morbidity and Mortality Effects

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Abstract

Background: Nutritional support plays a crucial role in the care of critically ill patients, requiring careful consideration to ensure the optimal method of delivery for nutrient absorption. Any kind of illness whether acute (e.g. infections, trauma) or chronic leading to inflammation can trigger catabolism dur to stress causing elevation in metabolic rate and nutrient breakdown. It leads to higher morbidity and mortality by involving various critical organs at the same time such as respiratory failure and cardiac arrhythmias. Malnutrition can be seen as a common phenomenon in paediatric age group especially in paediatric intensive care unit (PICU) patients often increasing the patient's stay, further impacting recovery. **Aim**: Evaluating the impact of enteral nutrition on pediatric outcomes in PICU patients: a study of morbidity and mortality effects. **Discussion:** Various studies have linked malnutrition among PICU patients to longer hospital stays, extended mechanical ventilation and poor clinical outcomes. Achieving full nutritional support in PICU patients is now recognized as a critical marker of effective PICU management. Factors such as minimizing feeding interruptions, presence of a dedicated dietitian, the use of a post-pyloric route, and early initiation of feeding have all been shown to improve enteral protein delivery. **Conclusion:** This study was conducted on children aged 1 to 18 years in the PICU of a tertiary care hospital. Among the total patients enrolled in the study, full feeds were not achieved in 71 cases (57.3%), while 53 patients (42.7%) successfully attained full feeds.

Keywords: Enteral Nutrition, Dyselectrolemia, Outcome

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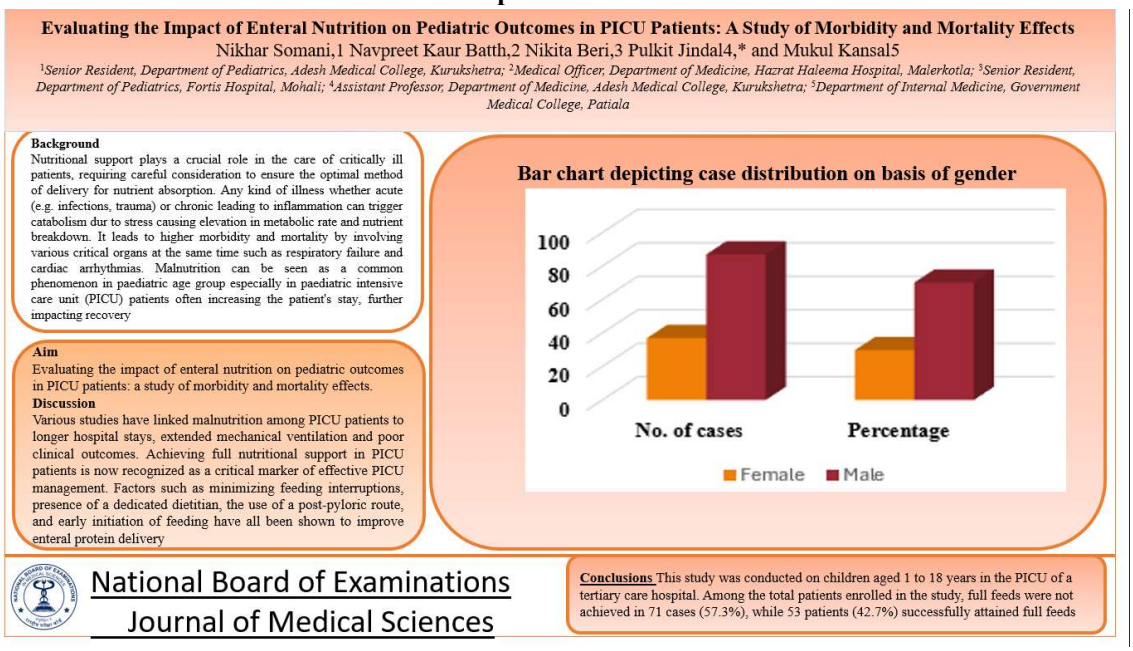
Graphical Abstract



Abbreviations

PICU : Paediatric Intensive Care Unit
EN : Enteral Nutrition
PN : Parenteral Nutrition
OG : Oro-Gastric
NG : Naso-Gastric
DAMA : Discharge Against Medical Advice

Introduction

Nutritional management in critically ill patients is a challenging and vital aspect of care. Malnutrition in patients within the Paediatric Intensive Care Unit (PICU) has been associated with prolonged mechanical ventilation, extended hospital stays, and poorer clinical outcomes [1]. Stress-induced catabolism, triggered by both acute and chronic illnesses, trauma, or inflammation, significantly raises the body's metabolic rate, leading to increased nutrient breakdown [2].

Additionally, certain medications may cause side effects like reduced appetite, nausea, and vomiting, further complicating nutritional intake [3]. Enteral nutrition (EN), which involves delivering a nutritionally complete formula through a tube into the stomach, duodenum, or jejunum, is commonly used for patients who are unable to meet their nutritional needs orally but still have a functioning gastrointestinal system [4].

Pathophysiology

Providing optimal nutritional therapy is a key objective in the PICU, as insufficient nutrition during critical illness in children is linked to an increased risk of multiple organ dysfunction, complications, prolonged hospital stays, and higher mortality rates [5]. The body's acute stress response to critical illness results in substantial protein breakdown, and inadequate protein intake exacerbates this by creating a negative nitrogen balance and leading to muscle loss [6].

In the Paediatric Intensive Care Unit (PICU), two methods are used to provide nutrition to critically ill children. The preferred method for those with a functioning gastrointestinal system is enteral nutrition (EN). EN involves

delivering a nutritionally complete feed through a tube placed in the stomach, duodenum, or jejunum [7]. It is suitable for patients who cannot eat enough orally but have a working digestive tract. EN plays a vital role in preserving gut function and integrity, and it boosts the production of immunoglobulin A, which may help protect against respiratory infections [8]. Delays in starting and progressing with enteral feeding can result in failing to meet energy and protein goals. Benefits of EN include maintaining the intestinal lining, reducing the risk of bacterial translocation, stabilizing hemodynamic, lowering infection rates, enhancing immune response, and ultimately decreasing morbidity and mortality in children [9].

However, some critically ill patients may not tolerate EN, leading to issues like nausea, vomiting, or, in rare cases, non-occlusive bowel necrosis. High volumes of gastric residuals can increase the risk of bacterial colonization and complications such as aspiration or ventilator-associated pneumonia [10].

The second method of feeding is parenteral nutrition (PN), which bypasses the digestive system by delivering nutrients intravenously. PN can be administered through a central or peripheral venous catheter and is used when the digestive system cannot handle nutrition. It is convenient since all nutritional components can be provided in one bag, without interrupting patient care [11].

However, PN comes with risks, such as hyperglycaemia, requiring glucose control, and a higher chance of infections like catheter-related bloodstream infections. PN may also be used alongside EN when the latter alone cannot meet the energy needs of the patient [12].

A study by Hamilton et al. assessed the impact of implementing an enteral nutrition guideline in the PICU, demonstrating a notable improvement in EN delivery and a reduced reliance on parenteral nutrition (PN). The study also found that a greater proportion of patients achieved their target energy intake goals earlier [13,14].

Materials and Methods

This was a prospective observational study done on 124 critically ill children having a PICU stay of at least 24 hours, to evaluate factors affecting enteral nutrition in children admitted in PICU of Department of Paediatrics, DMC&H, Ludhiana.

Inclusion criteria:

- Age between 1 to 18 years.
- Patients who gave Informed consent.
- Admission for more than 24 hours in PICU

Exclusion criteria

- Patients below 1 year.
- Duration of stay < 24 hours.

A total of 124 patients were enrolled during the study period. The initial steps involved determining the day feeds were started, selecting the appropriate feeding method, and inserting age-appropriate nasogastric (NG) or orogastric (OG) feeding tubes [15]. The volume of feeds in milliliters was recorded using a pre-structured proforma. Feed adjustments were made by the Chief Dietician based on the child's underlying medical condition. Full enteral nutrition (EN) was defined as 100% of the volume prescribed by the nutrition team [16]. If the prescribed volume could not be tolerated by the patient

during their stay in the PICU, it was classified as "full feeds not achieved." [17] Several factors were identified as barriers to effective enteral nutrition. Out of them, four factors were considered for comparison: dyselectrolemia, seizures, respiratory distress and shock [18,19].

Results

Table 1. Age distribution (in years)

Age (years)	No. of cases	Percentage
< 5	53	42.7%
5-10	36	29.0%
> 10	35	28.2%
Total	124	100%

Table 2. Gender distribution

Sex	No. of cases	Percentage
Female	37	29.8%
Male	87	70.2%
Total	124	100%

Table 3. Case distribution on basis of day of feed commencement

Days of starting feed	No. of cases	Percentage
< 3 days	56	45.2%
3-7 days	42	33.9%
> 7 days	6	4.8%
Not started	20	16.1%
Total	124	100%

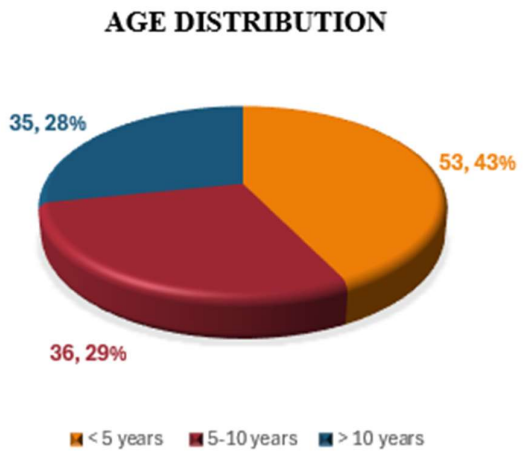


Figure 1. Pie chart depicting age (in years) distribution of cases and their percentage

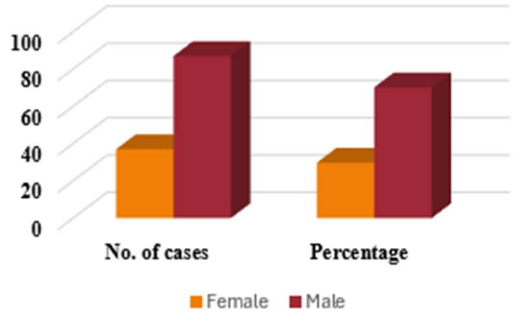


Figure 2. Bar chart depicting case distribution on basis of gender

Age distribution data analysis concluded 53 patients (42.7%) were under 5 years of age, 36 patients (29%) were aged 5 to 10 years, and 35 patients (28.2%) were over 10 years old as shown in Table 1 and Figure 1.

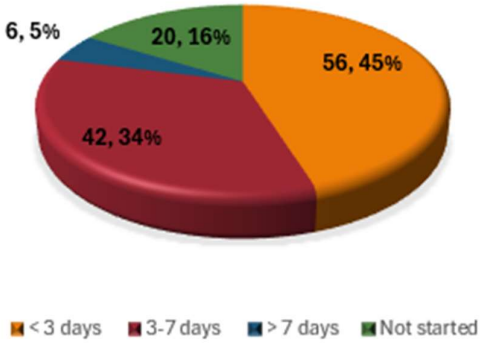


Figure 3. Pie chart depicting case distribution on basis of day of feed commencement

Among the 124 PICU subjects enrolled, 87 (70.2%) were male, while 37 (29.8%) were female as shown in Table 2 and Figure 2. Subsequently, feeding commenced within the first three days of admission for 56 patients (45.2%). An additional 42 patients (33.9%) began feeding between 3 and 7 days after admission, while only 6 patients (4.8%) started feeding after 7 days. Feeding was not initiated in 20 patients (16.1%) due to various reasons as shown in Table 3 and Figure 3.

Table 4. Case distribution on basis of mode of feeding

Mode of Feeding	No. of cases	Percentage
Oral	38	36.5%
NG	61	58.7%
OG	5	4.8%
Total	104	100%

Table 5. Case distribution on basis of full achievement of feeding

Full feed achieved	No. of cases	Percentage
< 3 days	24	19.4%
3-7 days	24	19.4%
> 7 days	5	4%
Not achieved	71	57.3%
Total	124	100%

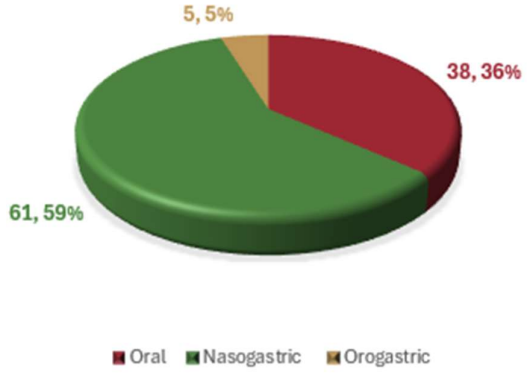


Figure 4. Pie chart depicting case distribution on basis of mode of feeding

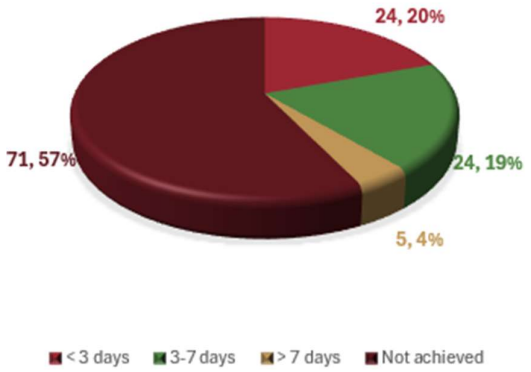


Figure 5. Pie chart depicting case distribution on basis of full achievement of feeding

Feeding was initiated in 104 out of 124 enrolled subjects (83.9%). Among these, 38 patients (36.5%) received direct oral feeds, 61 (58.7%) were fed via nasogastric tube, and 5 (4.8%) received Oro-gastric tube feeding as shown in Table 4 and Figure 4.

In this study, out of 124 enrolled PICU subjects, 71 patients (57.3%) did not achieve full feeding, while 53 patients (42.7%) successfully reached full feed. Among the total patients, full feeding was achieved within 3 days in 24 patients (19.4%), between 3 to 7 days in another 24 patients (19.4%), and after 7 days in 5 patients (4%). Of the 53 patients who achieved full feed, only 5 patients (9.4%) experienced a delay of more than 7 days as shown in Table 5 and Figure 5.

Table 6. Case distribution on basis of full achievement of feeding in different modes of feeding

Mode of feeding	Fully Achieved		Not Achieved		Total	P-value
	No. of cases	Percentage	No. of cases	Percentage		
Oral	28	52.8	10	19.6	38	0.001
NG	24	45.3	37	72.5	61	
OG	1	1.9	4	7.9	5	
Total	53	100	51	100	104	

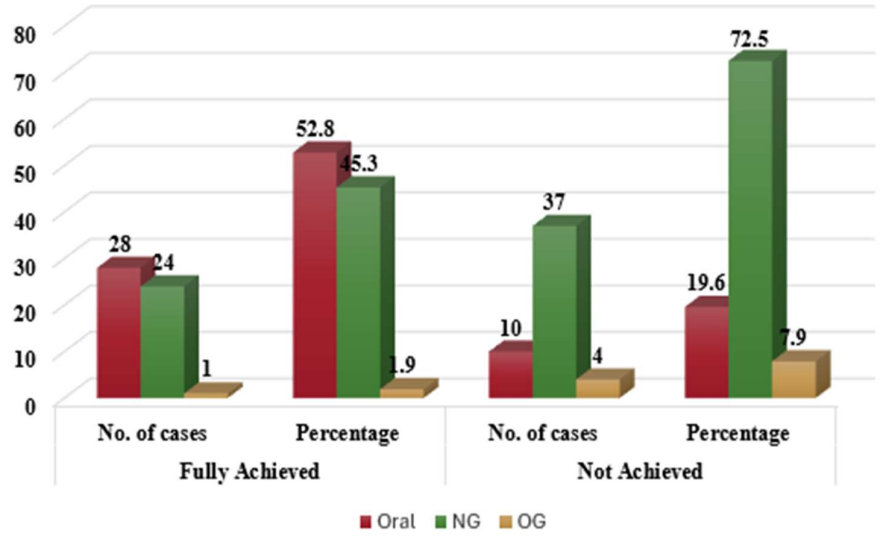


Figure 6. Bar chart depicting case and percentage distribution of achievement of feed in different modes of feeding

Out of 53 patients who achieved full feeding, oral feeding was initiated in 28 cases (52.8%), NG feeding in 24 cases (45.3%), and OG feeding in 1 case (1.9%). Among 51 patients who did not achieve full feeding, oral feeding was provided in 10 cases (14.1%), NG feeding in 37 cases (72.5%), and OG feeding in 4 cases (7.8%). The mode of feeding showed a statistically significant difference with a P value of 0.001 as shown in Table 6 and Figure 6.

Shock was observed in 24 cases (33.9%) where full feeding was not achieved, compared to 5 cases (9.5%) where full feeding was attained. The correlation between shock and the inability to achieve full feeding was statistically significant ($p = 0.002$) as shown in Table 7 and Figure 7. Additionally, respiratory distress was observed in 21 cases (29.6%) where full feeding was not achieved and in 18 cases (33.9%) where it was achieved. The correlation between respiratory distress and the inability to achieve full feeding was statistically significant ($p = 0.003$) as shown in Table 8 and Figure 8.

Table 7. Case distribution on basis of achievement of feeding in cases with shock

Feed	Fully Achieved		Not Achieved		Total	P-value
	No. of cases	Percentage	No. of cases	Percentage		
No shock	48	90.5	47	66.1	95	0.002
Shock present	5	9.5	24	33.9	29	

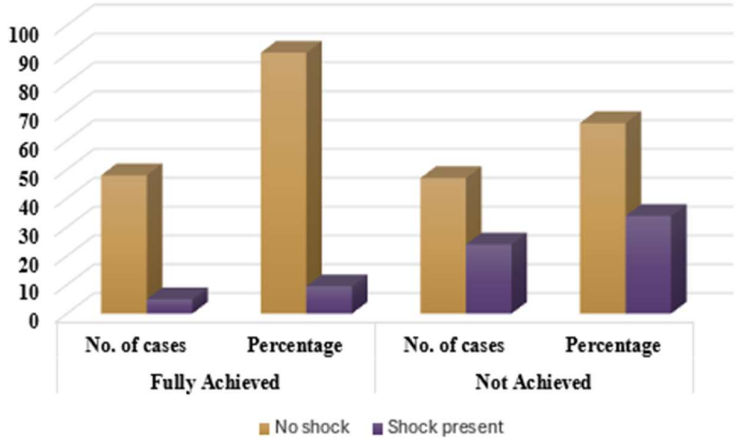


Figure 7. Bar chart depicting case and percentage distribution of achievement of feed in cases with shock

Table 8. Case distribution on basis of achievement of feeding in cases with respiratory distress

Feed	Fully Achieved		Not Achieved		Total	P-value
	No. of cases	Percentage	No. of cases	Percentage		
No Respiratory distress	35	66.1	50	70.4	85	0.003
Respiratory distress present	18	33.9	21	29.6	39	

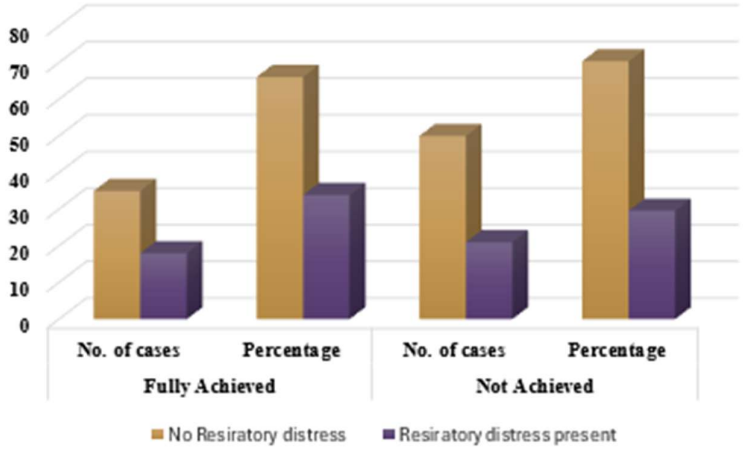


Figure 8. Bar chart depicting case and percentage distribution of achievement of feed in cases with respiratory distress

Table 9. Case distribution on basis of achievement of feeding in cases with dyselectrolemia

Feed	Fully Achieved		Not Achieved		Total	P-value
	No. of cases	Percentage	No. of cases	Percentage		
No Dyselectrolemia	45	84.9	64	90.1	109	0.001
Dyselectrolemia present	8	15.1	7	9.9	15	

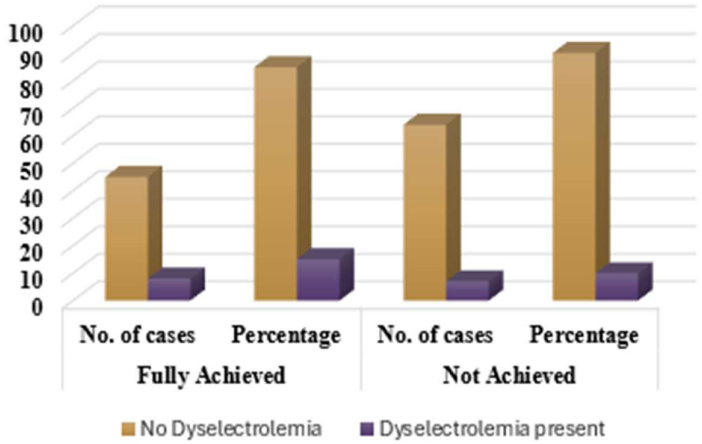


Figure 9. Bar chart depicting case and percentage distribution of achievement of feed in cases with dyselectrolemia

Table 10. Case distribution on basis of achievement of feeding in cases with seizures

Feed	Fully Achieved		Not Achieved		Total	P-value
	No. of cases	Percentage	No. of cases	Percentage		
No Seizures	49	92.4	65	91.5	114	0.005
Seizures present	4	7.6	6	8.5	10	

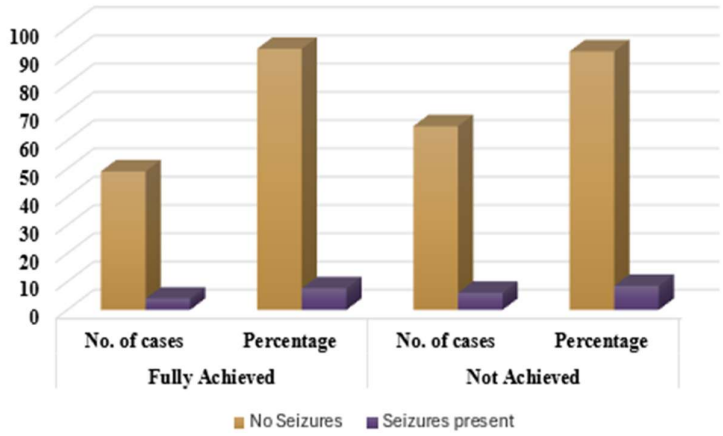


Figure 10. Bar chart depicting case and percentage distribution of achievement of feed in cases with seizures

Dyselectrolemia was observed in 7 cases (9.9%) where full feeding was not achieved, compared to 8 cases (15.1%) where full feeding was attained. The correlation between shock and the inability to achieve full feeding was statistically significant (p = 0.001) as shown in Table 9 and Figure 9. Additionally, seizures were observed in 6 cases (8.5%) where full feeding was not achieved and in 4 cases (7.6%) where it was achieved. The correlation between respiratory distress and the inability to achieve full feeding was statistically significant (p = 0.005) as shown in Table 10 and Figure 10.

Table 11. Outcome distribution

Outcome	No. of cases	%age
Discharged	95	76.60%
Died	14	11.30%
DAMA	15	12.10%
Total	124	100.00%

According to the study results, 95 cases (76.6%) were discharged, 14 cases (11.3%) succumbed, and 15 cases (12.1%) left against medical advice as shown in Table 11 and Figure 11.

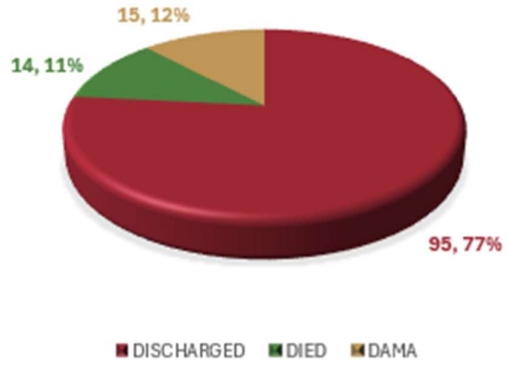


Figure 11. Pie chart of outcome distribution

Table 12. Cases and percentage distribution of outcomes on basis of achievement of feeding

Feed	Fully Achieved		Not achieved		Total	P-value
Outcome	**No. of cases**	**Percentage**	**No. of cases**	**Percentage**		
Discharged	53	100.00	42	59.2	95	0.001
Died	0	0.00	14	19.7	14	
DAMA	0	0.00	15	21.1	15	
Total	53	100.00	71	100	124	

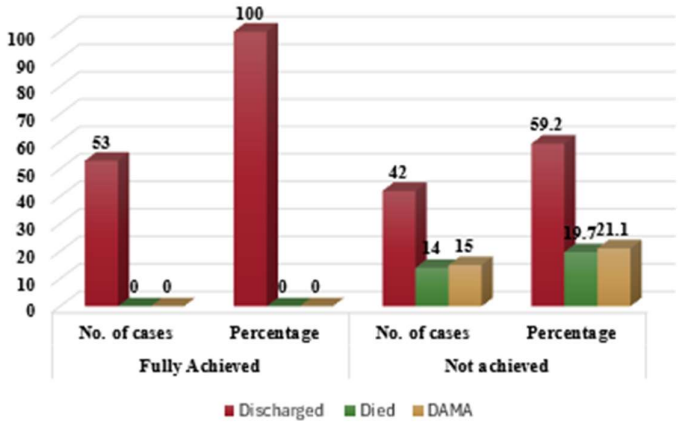


Figure 12. Bar chart depicting case and percentage distribution of outcomes

The association between enteral nutrition and outcomes showed a p-value of 0.0001. Among the 53 cases where full feeds were achieved, all 53 (100%) were successfully discharged. In contrast, of the 71 cases where full feeds were not achieved, 42 (59.2%) were discharged, 14 (19.7%) resulted in death, and 15 (21.1%) were discharged against medical advice as shown in Table 12 and Figure 12.

Conclusion

This study highlights that achieving full enteral nutrition plays a very critical role in improving outcomes for patients in the PICU. Among the total patients enrolled in the study, 53 patients (42.7%) successfully attained full feeds underscoring the importance of effective nutritional support in recovery. The findings emphasize the need for strategies to enhance feeding practices, optimizing care delivery and reducing interruptions which are integral to improving morbidity and mortality outcomes in critically ill pediatric population.

Future Scope

Enteral nutrition has been found and proven to have a positive impact on pediatric patients and therefore it provides us an opportunity of understanding and improving patient outcomes. Its scope can be widened via large multicenter trials to patients with specific conditions like sepsis, trauma, and chronic illnesses for its long-term effects on both mortality as well as morbidity in various pediatric populations. Additionally, valuable insights into optimizing nutritional strategies can be extracted by exploring the role of early versus delayed EN initiation and the impact of individualized feeding protocols. Studies focusing on the relationship between EN and immune function, infection rates, and recovery times may further enhance clinical practices. Furthermore, advancements in technology and precision medicine may allow for more tailored nutritional interventions, ultimately improving survival rates and quality of life for critically ill children.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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