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Nutritional Screening and Enteral Feeding Timing in Critically-Ill Children: Insights from STRONGkids and a Prospective Study in Egypt

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ABSTRACT

Background: Malnutrition is a major concern in children in paediatric intensive care units (PICUs) who are in serious condition. It worsens during hospitalization due to metabolic stress and inadequate feeding, predisposing children to infections, delayed recovery, and poor outcomes. Early enteral nutrition (EN) has been linked to improved outcomes, but implementation remains inconsistent, especially in resource-limited settings**.**

Objective: This study aimed to assess nutritional risk among critically-ill pediatric patients using the STRONGkids tool upon PICU admission, and to compare nutritional outcomes between early (within 24–48 hours) and delayed (> 48 hours) initiation of enteral nutrition.

Methods: A prospective observational study was conducted in a tertiary PICU in Egypt over six months. Fifty critically-ill children (aged 1 month–15 years) were enrolled and divided equally into early and delayed EN groups. Nutritional risk was screened at admission using the STRONGkids tool. Nutritional outcomes included time to full caloric intake, frequency of feeding interruptions, weight changes, and biochemical markers [serum albumin, total protein, and C-reactive protein (CRP)].

Results: STRONGkids identified a high prevalence of nutritional vulnerability: 64% high risk, 30% moderate risk, and only 6% low risk. Nutritional outcomes significantly favored the early EN group: faster attainment of caloric goals (median 2 vs. 6 days, $p < 0.001$), fewer feeding interruptions (20% vs. 72%, $p < 0.001$), greater weight gain (0.8 ± 0.2 vs. 0.1 ± 0.1 kg, $p < 0.01$), higher serum albumin (3.9 ± 0.3 vs. 2.8 ± 0.4 g/dL, $p < 0.01$), higher total protein (6.8 ± 0.5 vs. 5.2 ± 0.8 g/dL, $p < 0.01$), and lower CRP (12.5 ± 5.1 vs. 45.3 ± 18.7 mg/L, $p < 0.01$).

Conclusion: STRONGkids proved valuable for early detection of malnutrition risk in PICU patients. Early EN within 24–48 hours led to markedly better nutritional outcomes compared with delayed feeding, highlighting the importance of structured screening and timely nutritional intervention.

Keywords: Early enteral nutrition, Delayed feeding, Critically-ill pediatric patients, PICU, nutritional outcomes, Infection.

INTRODUCTION

Malnutrition is one of the most widespread issues in Pediatric Intensive Care Units (PICUs), with prevalence rates ranging between 8% and 71% globally **(1).** In critically-ill children, metabolic stress, inflammation, and inadequate intake contribute to rapid nutritional decline. Malnutrition not only impairs growth but also weakens immune function, delays wound healing, and prolongs hospital stays (2).

A protracted "flow phase" of hypercatabolism follows an early "ebb phase" in the metabolic response to serious disease. Elevated stress hormones and cytokines accelerate protein breakdown and reduce lean body mass (3).

Without timely nutritional intervention, this catabolic state leads to worsened clinical outcomes (4).

To prevent deterioration, it is crucial to do nutritional risk screening early. The STRONGkids (Risk Assessment Tool for Growth and Nutritional Status) instrument is a validated pediatric nutrition screening tool that categorizes children into low, moderate, or high risk of malnutrition based on clinical assessment, nutritional history, and disease severity (5).

In addition, the timing of enteral nutrition (EN) is crucial. Early initiation within 24–48 hours has been shown to preserve gut integrity boost protein synthesis and the immunological system. Delayed feeding, however, is often associated with poor tolerance, inadequate energy delivery, and worse outcomes (6).

AIM OF THE WORK

This study was designed to explore two key nutritional aspects:

(1) The frequency of risk for malnutrition identified by STRONGkids in a tertiary PICU in Egypt and (2) the comparative nutritional outcomes of early versus delayed initiation of EN in critically-ill children.

SUBJECTS AND METHODS

Study design and setting: This was a prospective observational cohort study that was conducted over six months at the Pediatric Intensive Care Unit, Children's Hospital, Ain Shams University, Cairo, Egypt.

Study population: A total of 50 critically-ill children aged 1 month to 15 years were enrolled. They were divided into:

Early Feeding Group (n=25): EN started 24–48 hours after PICU admission.

Delayed Feeding Group (n=25): EN initiation started after 48 hours.

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Exclusion criteria: Inborn errors of metabolism and those switched to total parenteral nutrition.

Nutritional risk screening: At admission, nutritional risk was evaluated using the STRONGkids tool, which classified patients into: Low risk (0 points), moderate risk (1–3 points) and high risk (4–5 points). Nutritional Outcomes Measured as time to full caloric intake (days to reach target energy needs). Feeding interruptions (frequency and causes). Weight changes (measured during PICU stay). Biochemical markers: Serum albumin, total protein, and CRP.

Ethical considerations: The study was approved by The Local Research Ethics Committee of Faculty of Medicine, Ain Shams University. The FMASU REC is organized and operated according to guidelines of the international Council on Harmonization (ICH), the Islamic Organizations for Medical Sciences (IOMS), The United States for Human Research Protections and the United States Code of Federal Regulations and operates under Federal Wide Assurance No. FWA 000017585.

Statistical analysis

Data were analyzed using SPSS version 27. Descriptive statistics summarized continuous and categorical data. Group comparisons used t-tests, Mann–Whitney U, Chi-square, or Fisher's exact tests, where applicable. At $p \leq 0.05$, statistical significance was established.

RESULTS

Baseline Characteristics of study participants:

A total of 50 critically-ill pediatric patients were enrolled and evenly divided into two study groups: Early feeding (n=25) and delayed feeding (n=25). The overall median age was 2 years (IQR: 1–8 years), and the cohort exhibited a slight male predominance, with 52% of participants being males. Baseline comparisons between the two groups demonstrated no statistically significant differences in key demographic or anthropometric parameters, including age, sex, weight, length/height, and body mass index (BMI) ($p > 0.05$). This equivalence in baseline characteristics supports the internal validity of the study, ensuring that any differences in clinical outcomes can be more reliably attributed to the timing of enteral nutrition rather than underlying group disparities (Table 1).

Nutritional risk screening:

Using the STRONGkids tool at PICU admission, the majority of patients were identified as being at substantial nutritional risk. Specifically, 64% of children were classified as high risk, 30% as moderate risk, and only 6% as low risk. This distribution underscores the high prevalence of nutritional vulnerability among critically ill pediatric patients in this cohort (Table 1).

Table (1): Participants' baseline characteristics by feeding group

Characteristic	Early-feeding group (n=25)	Delayed-feeding group (n=25)	p-value
Age (median, IQR)	2 (1–7) years	2 (1–8) years	>0.05
Gender (Male, n/%)	13 (52%)	13 (52%)	>0.05
Weight (mean ± SD)	10.5 ± 4.2 kg	10.8 ± 4.5 kg	>0.05
Length/Height (mean ± SD)	80.1 ± 15.3 cm	81.5 ± 16.0 cm	>0.05
BMI (mean ± SD)	16.3 ± 2.1 kg/m²	16.5 ± 2.3 kg/m²	>0.05
STRONGkids risk (%)			> 0.05
Low risk	1 (4%)	2 (8%)	
Moderate Risk	8 (32%)	7 (28%)	
High risk	16 (64%)	16 (64%)	

NUTRITIONAL OUTCOMES

Time to achieve full caloric intake: Children in the early enteral nutrition group achieved their target caloric requirements significantly faster than those in the delayed group. The median time to reach full intake was 2 days (IQR: 2–3) in the early group versus 6 days (IQR: 4–6) in the delayed group ($p < 0.001$) (Table 2).

Feeding interruptions: Feeding interruptions were substantially fewer in the early feeding group, affecting only 20% of patients, compared to 72% in the delayed feeding group ($p < 0.001$). The primary causes of interruptions in the delayed group were feeding intolerance and prolonged mechanical ventilation (Table 2).

Weight changes: The early EN group demonstrated significantly greater weight gain during PICU stay, with an average increase of 0.8 ± 0.2 kg, compared to only 0.1 ± 0.1 kg in the delayed feeding group ($p < 0.01$) (Table 2).

Biochemical markers: Biochemical indices further confirmed the nutritional benefits of early EN: **Serum albumin**: Early EN patients had higher levels (3.9 ± 0.3 g/dL) versus delayed EN (2.8 ± 0.4 g/dL, $p < 0.01$). **Total protein:** Early group levels averaged 6.8 ± 0.5 g/dL compared to 5.2 ± 0.8 g/dL in the delayed group ($p < 0.01$). **C-reactive protein (CRP):** Early EN was associated with markedly lower inflammatory response (12.5 ± 5.1 mg/L) versus delayed feeding (45.3 ± 18.7 mg/L, $p < 0.01$) (Table 2).

Table (2): Nutritional outcomes of early vs. delayed enteral feeding

Outcome measure	Early-feeding group (n=25)	Delayed-feeding group (n=25)	p-value
Time to full caloric intake (median, IQR, days)	2 (2–3)	6 (4–6)	<0.001
Feeding interruptions (n/%)	5 (20%)	18 (72%)	<0.001
Total protein (mean ± SD, g/dL)	6.8 ± 0.5	5.2 ± 0.8	<0.01
Serum albumin (mean ± SD, g/dL)	3.9 ± 0.3	2.8 ± 0.4	<0.01
CRP (mean ± SD, mg/L)	12.5 ± 2.1	45.3 ± 8.7	<0.01
Weight gain (mean ± SD, kg)	0.8 ± 0.2	0.1 ± 0.01	<0.01
Nasogastric tube dependence (n/%)	4 (16%)	12 (48%)	0.012
Mortality rate (n/%)	1 (4%)	0 (0%)	>0.05

DISCUSSION

This study highlighted two central nutritional findings in critically-ill pediatric patients: (1) The high prevalence of malnutrition risk as identified by the STRONGkids tool, and (2) the significant benefits of early initiation of enteral nutrition (EN) compared to delayed feeding as regards nutritional outcomes and consequently clinical outcomes especially hospital stay, infections and, mortality.

Nutritional risk assessment with STRONGkids

The STRONGkids screening tool revealed that nearly two-thirds (64%) of our cohort were at high nutritional risk, with only a small minority (6%) classified as low risk. This finding is consistent with international reports, where critically-ill children frequently present with heightened vulnerability to malnutrition due to the metabolic stress of illness, reduced intake, and increased energy demands. Our prevalence exceeds the global pooled estimate of 37.2% for malnutrition in critically ill children and reflects a heightened vulnerability in this Egyptian PICU setting [(7)]. Contributing factors in this cohort may include underlying socioeconomic disparities, limited access to pre-hospital nutrition, and delayed health-seeking behaviors. Our study demonstrated that STRONGkids is a practical and effective method for rapidly identifying children at risk and prioritizing nutritional intervention.

Our findings align with those of **Castro *et al.*** [(8)] who identified moderate or high nutritional risk in more than 83% of their PICU patients. For early risk stratification in this setting, the STRONGkids tool proved to be a useful tool, as it showed excellent predictive value for hospital stay duration in Egyptian paediatric populations. Because it enables prompt action that can improve results, early identification of nutritional risk is crucial.

However, research in several clinical groups indicates a significantly reduced risk of malnutrition. According to **Durakbaşa *et al.*** [(9)], only 35.7% of paediatric surgery patients were classified as moderate or high risk by STRONGkids and 13.4% of them suffered from malnutrition. The impact of clinical environment and patient acuity on baseline nutritional status is shown by these disparities. Children who are admitted to general intensive care units (PICUs) are more vulnerable to nutritional deficiencies than those who are having elective surgery because they frequently have complicated multi-organ involvement or severe systemic disorders.

This emphasises the need of early nutritional evaluation as a crucial component of comprehensive critical care and the need for context-specific nutritional screening techniques, especially in high-risk groups. Compared to more stable elective surgery patients, critically-sick PICU patients are at greater nutritional risk because of their complicated diseases and metabolic instability. This emphasises how urgently critical care units require early, focused dietary treatments.

Feeding intolerance and interruptions: Our results demonstrated that early EN within 24–48 hours was associated with superior nutritional outcomes across multiple parameters. Children in the early feeding group achieved caloric goals more rapidly, with a median of two days compared to six days in the delayed group. They also experienced fewer feeding interruptions, gained more weight, and showed significantly better biochemical profiles. This result confirms the findings that early gut stimulation improves nutrition absorption, encourages peristalsis, and preserves mucosal integrity. The data also showed that PICU feeding procedures need to be updated to avoid being too cautious, including holding meals based just on gastric residual volumes (GRVs). The current guidelines stress that GRV is not a reliable indicator of the risk of aspiration or stomach emptying, and that GRV-based needless interruptions can result in delayed nutritional objectives and energy deficits [(10)].

Rizk *et al*. [(11)] showed that the length of hospital stay and the duration of NG tube reliance are both statistically significantly increased when enteral nourishment is delayed. This suggests that early initiation of enteral feeding may facilitate quicker transition to oral intake and reduce reliance on NG tubes.

Wang *et al.* [(12)] found that early initiation (within 48 hours) of enteral nutrition, regardless of the tube type, was associated with improved patient outcomes. While, the study did not specifically compare NG tube usage between early and late feeding groups, it highlights the

importance of early enteral nutrition in enhancing patient recovery [12].

Taken together, our study reinforces the importance of early EN in improving nutritional outcomes and reducing complications associated with feeding intolerance and prolonged PICU stay. Early EN introduction, within 24 to 48 hours of PICU admission, has been linked to better nutritional delivery and fewer feeding interruptions, according to **Mehta *et al.* [13]** leading to better clinical outcomes. Delays in EN initiation can exacerbate nutritional deficits and increase the risk of complications such as feeding intolerance and prolonged hospital stays. Implementing standardized feeding protocols and multidisciplinary approaches can mitigate these risks and promote timely advancement to full feeds [13].

We did observe significantly lower levels of total protein, serum albumin, and hemoglobin in the late feeding group during follow-up. CRP levels were also significantly higher in the late group, indicating a greater inflammatory burden. These biochemical disparities reinforce the metabolic advantages of initiating EN early. **Li and Chen [14]** similarly noted immunologic and nutritional improvements after one week of early EN in pediatric ICU patients.

LIMITATIONS

Statistical power and generalizability are restricted by the single-center study methodology and limited sample size. Given that it is an observational research, bias and confounding may be present. Subjective rating on the STRONGkids tool may generate diversity. Despite these drawbacks, the study offered insightful information, especially for PICUs with low resources.

CONCLUSION

Early enteral feeding within 24–48 hours improved nutritional results, including higher protein status, weight growth, and lower inflammation. These advantages decreased susceptibility to infections by preserving gut integrity and boosting immune function. A stronger immune system resulted in fewer problems, shorter hospital stays, and a quicker clinical recovery.

Conflict of interest: None.
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