

# A Study of Early Parenteral Nutritional Support and Factors Associated with Clinical Outcomes in Major Pediatric Burn Patients

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## ABSTRACT

**Objectives:** to study parenteral nutrition within 7 days post admission (early PN) and factors affecting clinical outcomes in major pediatric burn patients.

**Materials and Methods:** A retrospective study was conducted regarding pediatric burn patients who had over 15% of their total body surface area (TBSA) with second- or third-degree burns. All the patients were classified as requiring early PN support or non-early PN support.

**Results:** 124 major pediatric burns were reviewed. Eighty-six patients (65.2%) were male, and their median age was three years (0.3-15 years). Early PN showed no association with LOS ( $p=0.480$ ) or a 30-day mortality ( $p=0.529$ ). The children's age, wound infections, and abdominal distension were the independent associated factors of LOS ( $p=0.025$ ,  $0.001$ , and  $0.003$  respectively). Pneumonia and urinary tract infection were independent factors associated with 30-day mortality ( $p=0.025$  and  $N/A$ , respectively).

**Conclusions:** Early PN in acute pediatric burns was not associated with LOS or 30-day mortality. It can be considered as options of nutritional support in acute, major pediatric burns. Effective management of wound infections and abdominal distension may reduce LOS.

**Keywords:** Early PN; EN; major pediatric burn; nutritional support; treatment outcomes (Siriraj Med J 2022; 74: 34-39)

## INTRODUCTION

Optimal nutritional support is considered one of the key treatments of major pediatric burns, since malnutrition and inadequate nutrient delivery have been associated with bad clinical outcomes.<sup>1,2</sup> Moreover, children have limited macronutrient stores and relatively higher energy requirements than adults who are admitted into the intensive care unit; these factors can lead to substantial caloric and macronutrient deficits.<sup>3,4</sup> Feeding is thought to

attenuate the metabolic stress response, prevent oxidative cellular injury, and modulate immune responses. This has led to a shift from nutritional support as adjunctive care to an actual therapy in cases of major pediatric burns. The enteral route is preferred for providing nutrition.<sup>5</sup> However, major pediatric burn patients are often too ill to be fed normally by mouth, and nasogastric or nasoduodenal tube-feeding is often not well-tolerated due to gastric dysmotility or ileus from acute, severe

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stress. Interruption of enteral feeding also frequently occurs for various reasons, such as medical or surgical contraindications, or radiologic, bedside, or surgical procedures.<sup>6</sup> Severe burn injury causes a persistent and prolonged hypermetabolic state and increased catabolism, which result in increased muscle-wasting and cachexia. The metabolic rates of burn patients can surpass twice the norm, and failure to supply these energy requirements causes impaired wound healing, organ dysfunction, and susceptibility to infection. Accurate assessment and provision of nutritional needs is essential for these patients.<sup>7</sup> Therefore, parenteral nutrition (PN) is often initiated to supplement the insufficient enteral intake. Published guidelines on the timing and thresholds of initiation, as well as the composition and doses of supplemental PN, vary widely.<sup>8-10</sup> Moreover, concerns about overfeeding have led to even more uncertainty. A recent survey showed significant differences in nutritional practices in PICUs worldwide, in terms of macronutrient goals, estimation of energy requirements, timing of nutrient delivery, and thresholds for starting supplemental PN. The latest guideline suggests late initiation of PN support (after 7 days) in PICU due to the result of better treatment outcome and lower PN related complication which studied mainly in non-burn population.<sup>11,12</sup>

### Objective

To study parenteral nutrition within 7 days post admission (early PN) and any factors with clinical outcomes in major pediatric burn patients

## MATERIALS AND METHODS

### Study design and population

This was a retrospective study involving the review of pediatric burns charts for patients admitted to the Burn Unit at Siriraj Hospital in Bangkok from January, 1999 to September, 2019. This study was conducted under the Siriraj Institutional Review Board's (SIRB) approval (COA no. Si 834/2019). Patients age  $\leq 15$  years who were injured  $\geq 15\%$  of their total body surface area (TBSA) with second- or third-degree burns were enrolled. All patients were given enteral nutrition (EN) as soon as they had a stable hemodynamic within 24 hours after admission with calculated goal of daily caloric requirement by using Curreri junior formula. The patients received all types of parenteral nutrition within seven days after admission to achieve calculated goal of daily caloric requirement; those children were classified as being in the early PN group. The others were in the non-early PN group. Patients with an incomplete medical record were excluded from analysis.

### Statistic analysis

The data was analyzed by SPSS, version 18.0. The demographic data was presented in frequency, percentage, and median. The length of hospital stay (LOS) and 30-day mortality between the early PN and non-early PN groups were determined using the odds ratio (OR). The independent factors associated with the LOS were analyzed by using the linear regression coefficient, and adjusted factors were analyzed using the backward multiple linear regression model. Fisher's exact test and the Mann-Whitney U test statistical analysis were performed with a univariable analysis of factors associated with 30-day mortality. The independent factors associated with 30-day mortality were reported in OR using binary logistic regression analysis, and the adjusted factors by using the backward multiple linear regression model. A P value of 0.05 was considered statistically significant.

## RESULTS

124 patients' data were analyzed. Twenty-two patients (17.7%) were identified in the early PN group, and 102 patients (82.3%) were in the non-early PN group. The medium age was three years old. The degree of burns were as follows: second-degree burns: 120 (96.8%) patients; third-degree burns: 1 (0.8%) patient; and mixed second- and third-degree burns: 3 (2.4%) patients. The median percentage of those with whose total body surface area was burned (%TBSA) was 30 (15, 90). The type of burns consisted of scald burns (87, or 70.2%); flame burns (36, or 29.0%); and other (1, or 0.8%). (Table 1)

The comparisons of 30-day mortality and the LOS of patients who were early PN (n=22) vs. non-early PN (n=102) are reported in Table 2. There was no statistically significant difference in the 30-day mortality [1 (4.5%) vs 4 (3.9%),  $P=1.000$ ] and median LOS [42 (12, 70) vs. 49 (2, 143),  $P=0.086$ ] between the groups. The early PN group had a slightly shorter LOS.

A multivariate logistic regression with forward selection revealed that early PN [-3.564 (-13.516, 6.388) ( $p=0.480$ )] had no statistically significant effect on the LOS, while wound infection [13.567 (5.734, 21.399) ( $p=0.001$ )], abdominal distension [13.460 (4.528, - 22.391) ( $p=0.003$ )], and age  $<1$  year [0.817 (0.104, 1.530) ( $p=0.025$ )] significantly affected the LOS. (Table 3)

The overall 30-day mortality of pediatric burns in our center was 17.7%. A univariate analysis with Fisher's exact test or the Mann-Whitney U test forward selection showed that the early PN group had no statistically significant effect on 30-day hospital mortality, in contrast to the non-early PN group [1 (20.0%) vs. 21 (17.6%) ( $p=1.000$ )]. However, a few factors did have a statistically

**TABLE 1.** Characteristic of major pediatric burn patients.

Characteristics	N = 124
Sex, male, n (%)	82 (66.1%)
Median age (min, max) (years)	3 (0.3, 15)
Groups, n (%)	
Early PN	22 (17.7%)
Non-early PN	102 (82.3%)
Degree of burn, n (%)	
Second-degree	120 (96.8%)
Third-degree	1 (0.8%)
Second- & third-degree	3 (2.4%)
Median % TBSA (min, max)	30 (15, 90)
Burn type, n (%)	
Scald burn	87 (70.2%)
Flame burn	36 (29.0%)
Other	1 (0.8%)

**Abbreviations:** PN = parenteral nutrition, % TBSA = % Total body surface area

**TABLE 2.** Length of hospital stay (LOS) and 30-day mortality in the early PN vs. non-early PN groups of major pediatric burn patients.

Outcome	Groups		p-value
	Early PN (n=22)	Non-early PN (n=102)	
<b>LOS (days)</b>			
<b>Median (min, max)</b>	42 (12, 70)	49 (2, 143)	0.086
<b>30-day mortality, n (%)</b>	1 (4.5%)	4 (3.9%)	1.000

**Abbreviations:** PN = parenteral nutrition

**TABLE 3.** Independent factors associated with Length of hospital stay (LOS).

Factors	Unadjusted coefficient (95%CI)	p-value	Adjusted coefficient (95%CI)	p-value
Early PN	-8.778(-19.077, 1.521)	0.094	-3.564 (-13.516, 6.388)	0.480
Age < 1 year	1.248(0.525, 1.971)	0.001	0.817 (0.104, 1.530)	0.025
Wound infection	16.652(8.887, 24.417)	<0.001	13.567 (5.734, 21.399)	0.001
Abdominal distension	16.208(6.571, 25.846)	0.001	13.460(4.528, - 22.391)	0.003

**Abbreviations:** PN = parenteral nutrition

significant effect on 30-day mortality: the duration of ventilator use [8 (1, 34) vs. 0 (0, 55) ( $p < 0.001$ )]; pneumonia [5 (100%) vs. 12 (10.1%) ( $p < 0.001$ )]; sepsis [5 (100%) vs. 16 (13.4%) ( $p < 0.001$ )]; urinary tract infection [4 (80.0%) vs. 8 (6.7%) ( $p < 0.001$ )]; and percentage of burn area [70 (43,90) vs. 28 (15,80) ( $p = 0.002$ )]. (Table 4)

A multivariate logistic regression with forward selection revealed that the early PN group [0.356 (0.014, 8.901) ( $p = 0.529$ )] had no statistically significant effect on 30-day mortality, but urinary tract infection (UTI) [34.750 (1.641-735.686) ( $p = 0.023$ )] and pneumonia did. (Table 5) Pneumonia had a statistically significant effect on 30-day mortality, but the number calculator reported this as non-shown (N/A) because the program could not identify this data.

## DISCUSSION

Major pediatric burns in our center found more common in preschool age. They got injury from hot water and liquid more than flame. These findings are reported the same around the world except in our center male victims are more common.<sup>13,14</sup> They may cause from normal pattern of preschool children development to explore new thing with touching and gripping anything without fear of danger due to lack of experience. Most of small children love to play with water, so kettle, pot and pan are thought to be one of the favorite toys for them. This awareness should be raised in parents for injury prevention purpose.

Feeding intolerance is one of the common problems in critically ill trauma patients. Instability of hemodynamic,

**TABLE 4.** Univariable analysis of factors associated with 30-day mortality in major pediatric burn patients.

Factor	30-day mortality		p-value <sup>a</sup>
	Yes (n=5)	No (n=119)	
Early PN, n (%)	1 (20.0%)	21 (17.6%)	1.000
Duration of ventilator use			
Median (min, max)	8 (1, 34)	0 (0, 55)	<0.001
Pneumonia	5 (100%)	12 (10.1%)	<0.001
Sepsis	5 (100%)	16 (13.4%)	<0.001
UTI	4 (80.0%)	8 (6.7%)	<0.001
% TBSA Burn			
Median (min, max)	70 (43,90)	28 (15,80)	0.002

<sup>a</sup>Fisher's exact test or the Mann-Whitney U test

Abbreviations: PN = parenteral nutrition, %TBSA = % Total body surface area

**TABLE 5.** Independent factors associated with 30-day mortality.

Factors	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Early PN	1.167(0.124, 10.974)	0.893	0.356(0.014, 8.901)	0.529
UTI	55.500(5.532, 556.775)	0.001	34.750(1.641-735.686)	0.023
Pneumonia	N/A	N/A	N/A	N/A

Abbreviations: PN = parenteral nutrition, UTI = urinary tract infection

ileus from massive fluid and electrolytes disturbance from post resuscitation aftermath of exsanguinating bleeding combining with post injury response by inflammatory cytokines flush worsen intestinal continuity and mobility. Major burn is considered as severe injury that create systematic change in all system of body. Abrupt change of extravascular electrostatic pressure and intravascular oncotic pressure result in rapid decrease of intravascular volume which partly pathophysiology of burn shock. Adequate fluid resuscitation lessen outcome of end organ failure like kidney injury and dead.<sup>15</sup> Intestinal dysfunction of acute major burns can cause from non-burn tissue edema effect from post burn systemic response, electrolytes imbalance and hypoalbuminemia. Major burns standard nutrition recommendation of very early enteral nutrition initiation and caloric goal achievement in a week<sup>16-18</sup> might not success in every case.<sup>19</sup>

PN is one of the options to supply calories to reach daily goal in enteral intolerance and offer some specific nutrients support. For energy providing purpose, it can be used as partial caloric supplement or main supply source of daily energy requirement. In adult critically ill patient including adult major burns, late initiation of PN after first 7 days is recommended in low nutritional risk patient that did not achieve caloric goal via enteral route or contraindicated of enteral nutrition (EN). Early PN is encouraged only when EN is not feasible in high nutritional risk or severely malnourished patients.<sup>12,16,17</sup> Standard nutritional guideline for critically ill children patient also recommend the same, but specialized population like major pediatric burns cannot apply into this guideline.<sup>5</sup> This exception cause from the lack of evidence in the treatment outcome of supplement PN support in this group of patient. The threshold of PN initiation in pediatric is lower (1-3 days in infants and 4-5 days in older children) than adult due to low energy reserve and growth and development effect.<sup>20</sup> The current recommendation based on the evidence that most studies reported no significant improving outcome, but trend to increase complication from PN such as infection like catheter related blood stream infection (CRBSI).<sup>21-23</sup>

PN role in major adult burn is limited that was reported increased mortality without modulate inflammatory response.<sup>24,25</sup> The outcomes of comparing the early and late initiation of PN in major pediatric burn patients are lack of evidence biggest trial like a multicenter PEPaNIC RCT (Early versus Late Parenteral Nutrition in the Pediatric ICU) conducted in 2016 enrolled only 10 cases of burn. The study conclusion from PEPaNIC RCT is not good to apply in major pediatric burn population. No previous studies in Thailand had reported the compared outcomes

of early PN support in major pediatric burn patients. Our study found no statistically significant difference in LOS and 30-day mortality between the groups of major pediatric burn patients with and without early PN support. Our findings support the less restricted use of early PN in major pediatric burn patients who, according to the recent guidelines, qualify as critically ill pediatric patients were preserved and recommended PN only for high nutrition risk patients and their trend in late initiation more than early.<sup>11,26</sup>

We found that the main factors associated with LOS are age less than one year, wound infection, and abdominal distension. Burn injury in infants is more complicated to treat than the injury in the same severity in older child patient. Abdominal distension can lead to feeding problem that can prolong disease natural history and LOS. The duration of ventilator use, and/or the presence of pneumonia, sepsis, and/or urinary tract infection, and the percentage of burned skin affects 30-day mortality. Overall, the 30-day mortality rate in our center was 17.7%, compared with 21.3%<sup>27</sup> and 31.3%<sup>28</sup> from other studies.

There are a few limitations in this study. First, as this is a retrospective, observational, single-center study, our findings may not be generalizable to other institutions or ethnic populations. The investigators relied on available documentation to determine the number of days of poor nutrient intake prior to patients' PN initiation. Also, a prior power-analysis calculation was not conducted, and the small number of in-hospital deaths may have affected the outcomes analysis.

## CONCLUSION

Early parenteral nutritional support for major pediatric burn patients had no effect on their length of hospital stay or 30-day mortality rate. The patients' age, wound infection, and abdominal distension were independent factors associated with their length of hospital stay. The duration of ventilator use, along with pneumonia, sepsis, urinary tract infection, and the percentage of burned skin were independent factors associated with 30-day mortality.

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