Combined enteral feeding and total parenteral nutritional support improves outcome in surgical intensive care unit patients

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Abstract

Background: For intensive care unit (ICU) patients with gastrointestinal dysfunction and in need of total parenteral nutrition (TPN) support, the benefit of additional enteral feeding is not clear. This study aimed to investigate whether combined TPN with enteral feeding is associated with better outcomes in surgical intensive care unit (SICU) patients.

Methods: Clinical data of 88 patients in SICU were retrospectively collected. Variables used for analysis included route and percentage of nutritional support, total caloric intake, age, gender, body weight, body mass index, admission diagnosis, surgical procedure, Acute Physiology and Chronic Health Evaluation (APACHE) II score, comorbidities, length of hospital stay, postoperative complications, blood glucose values and hospital mortality.

Results: Wound dehiscence and central catheter infection were observed more frequently in the group of patients receiving TPN calories less than 90% of total calorie intake \((p = 0.004\) and \(0.043\), respectively). APACHE II scores were higher in nonsurvivors than in survivors \((p = 0.001)\). More nonsurvivors received TPN calories exceeding 90% of total calorie intake and were in need of dialysis during ICU admission \((p = 0.005\) and 0.013, respectively). Multivariate analysis revealed that the percentage of TPN calories over total calories and APACHE II scores were independent predictors of ICU mortality in patients receiving supplementary TPN after surgery.

Conclusion: In SICU patients receiving TPN, patients who could be fed enterally more than 10% of total calories had better clinical outcomes than patients receiving less than 10% of total calorie intake from enteral feeding. Enteral feeding should be given whenever possible in severely ill patients.

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1. Introduction

Parenteral nutritional support, since its introduction by Dudrick et al\(^1\) in the late 1960s, has been considered a standard supplement for hospitalized patients who need aggressive treatment, especially patients in the intensive care unit (ICU). In these patients, the postoperative hypermetabolic state may lead to an increased energy expenditure and impaired wound healing, and may result in organ dysfunction.\(^1\)\(^–\)\(^4\) Although the preferred route of providing nutritional support to these patients is enteral, most of the time, enteral nutrition (EN) alone is not able to meet the energy needs of these patients because of gastrointestinal intolerance,
which induces protein-energy malnutrition and poorer clinical outcomes.\textsuperscript{5–8} Combined supplemental parenteral nutrition and enteral feeding was able to meet the energy and protein targets when enteral feeding alone failed to achieve the caloric goal recommended in some studies.\textsuperscript{9–13} Many patients in the ICU experience malnutrition due to gastrointestinal dysfunction, which results from severe infection or postoperative complications. At admission, these patients are usually in need of total parenteral nutrition (TPN).\textsuperscript{4,14} However, TPN has been reported to be associated with hyperglycemia, development of mucosal atrophy and a loss of epithelial carrier function, impaired immune system, and increased risk of infection in critical illness.\textsuperscript{15–19} Some authors have suggested that, regardless of the route and formula of nutrition given, supplying adequate nutrition is important in severely ill patients.\textsuperscript{20–23} De Jonghe et al.\textsuperscript{21} pointed out that physicians need to pay more attention to providing appropriate nutritional support for critical illness, and that inadequate delivery of EN and a low rate of nutrition prescription resulted in low caloric intake in ICU patients. Recently, Klek et al.\textsuperscript{23} in their study investigating a group of 167 malnourished surgical patients, concluded that postoperative nutritional intervention generated comparable results regardless of the route of the formula used. For ICU patients with gastrointestinal dysfunction and in need of TPN for nutritional support, the benefit of additional enteral feeding is not clear. The aim of this study was to investigate whether combined TPN with enteral feeding is associated with better outcomes in surgical intensive care unit (SICU) patients.

2. Methods

The clinical data of 88 patients who were admitted to the SICU in Taipei Veterans General Hospital from January 2007 to December 2009 requiring TPN supply in the postoperative period were retrospectively reviewed. The ethics committee of the Taipei Veteran General Hospital approved this study. The type of nutrition (enteral or parenteral) and the amount of nutrient calories prescribed for each patient were recorded. TPN supplement was given if the patient could not tolerate EN due to gastrointestinal dysfunction or complications for more than 7 days or if 60% of the caloric requirements could not be achieved via the enteral route. EN was allowed to be given to the patients when possible if the patients were able to tolerate it. The total calories of TPN were determined by using the Harris–Benedict equation,\textsuperscript{21} consisting of 50% dextrose associated with 10% amino acid (moriamine-SN) and 20% fat emulsion (lipovenous or SMOF lipid). Additional fluids, electrolytes, vitamins, and trace elements were provided as clinically indicated. Parenteral nutrition was infused via a central venous catheter. The 88 patients were divided into two groups according to the percentage of TPN calories to be received over the patients’ total daily calories. Forty-two patients received TPN as 60% to 90% of total calories, and 46 patients had TPN supplement of more than 90% of total calories. Demographic data and clinical outcomes of these patients were collected by chart review, including the route of nutritional support (enteral, parenteral, or both), daily caloric intake (appropriate TPN and EN received), age, gender, body weight, body mass index (BMI), basal energy expenditure, admission diagnosis, surgical procedure, Acute Physiology and Chronic Health Evaluation (APACHE) II score, comorbidities (hypertension, diabetes mellitus, cardiovascular disease, chronic obstructive pulmonary disease, chronic kidney disease), TPN indication, central venous catheter insertion days, length of hospital stay, length of stay in ICU, length of ventilation, length of TPN supplied, postoperative complications, blood glucose values, and hospital mortality.

2.1. Statistical analysis

Statistical analysis was performed with SPSS 16.0 (SPSS Inc., Chicago, IL, USA). Data are presented as means and standard deviation, and categorical variables as percentages. Student’s t test and chi-square test were used to compare continuous variables and proportions. Clinical factors related to hospital mortality were analyzed in a multivariate regression model. A $p$ value $<0.05$ was considered statistically significant.

3. Results

Table 1 shows the demographic data of 88 patients in the SICU. More patients had comorbidities including cardiovascular disease and chronic renal disease in the group of patients receiving TPN calories exceeding 90% of total calories given ($p = 0.035$). No significant differences were found in nutritional parameters, including body weight, BMI, and serum albumin, between groups. Moreover, the mean blood glucose levels were not different between groups during the period in which TPN was given. Patients receiving TPN calories exceeding 90% of total calories had lower total calorie intake than did patients receiving TPN calories less than 90% of total calories given ($p < 0.005$). The postoperative complications are shown in Table 2. The most common complications encountered in these patients were septic shock and pneumonia. Wound dehiscence and central catheter infection were observed more frequently in the group of patients receiving TPN calories less than 90% of total calorie intake ($p = 0.004$ and 0.043, respectively). More patients (56.5%) receiving TPN calories more than 90% of total calorie intake developed renal failure during their stay in the ICU compared with patients receiving TPN calories less than 90% of total calorie intake. The results of comparison between survivors and nonsurvivors are shown in Table 3. The hospital stay was longer among survivors. The APACHE II scores were higher in nonsurvivors than in survivors ($p = 0.001$). More nonsurvivors received TPN calories more than 90% of total calorie intake and were in need of dialysis during admission to ICU than survivors ($p = 0.005$ and 0.013, respectively). Multivariate analysis revealed that the percentage of TPN calories over total daily calories and APACHE II scores were independent predictors of ICU mortality in patients receiving TPN supplement after surgery (Table 4).
Our study again confirmed the importance of EN in critical illness. Determining the role of EN in surgical patients who could not tolerate enteral feeding had a remarkably high mortality. Elke et al. in their observational study enrolling 415 patients concluded that the use of parenteral nutrition was associated with an increased risk of death and that EN should be provided even for the most severely ill patients. In an animal study, Omata and colleagues found that EN could reverse TPN-induced impairment of hepatic immunity. They suggested that enteral feeding should be given to induce recovery of hepatic immunity and reduce infectious complications.

One of the most common complications during parenteral nutritional support is catheter and bloodstream infection. Increased parenteral caloric intake is also an independent risk factor for bloodstream infection in patients receiving TPN. Recently, in a randomized and multicenter trial enrolling more than 4000 critically ill patients, Casaer et al. reported that patients receiving early initiation of parenteral nutrition to supplement insufficient EN had increased ICU infections and higher incidence of cholestasis. Sena et al. reported that in critically ill trauma patients who were able to tolerate some EN, early parenteral nutrition administration was associated with increased infectious morbidity and poorer clinical outcomes. The authors pointed out that patients in the combination EN and PN group might have received more calories, which resulted in the increased infection rate. In our study, the patients receiving more calories from enteral feeding also had an increased rate of catheter tip infection in comparison with the patients receiving fewer calories from enteral feeding, although the mean blood glucose values were not different between groups.

In this study, we observed that patients receiving more calories from enteral feeding had better outcomes but stayed longer than patients receiving nutrition only from TPN. These findings are consistent with those of Elke et al. In their study, length of hospital stay was significantly different among the nutrition groups, which included groups of exclusively parenteral nutrition, exclusively EN, and mixed parenteral and enteral feeding.
Table 3
Comparison of clinical data between survivors and nonsurvivors.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Survivors (n = 31)</th>
<th>Nonsurvivors (n = 57)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>70.5 ± 17.1</td>
<td>73.3 ± 14.0</td>
<td>0.414</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>60.5 ± 12.3</td>
<td>64.7 ± 16.6</td>
<td>0.127</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.7 ± 4.9</td>
<td>23.8 ± 4.9</td>
<td>0.355</td>
</tr>
<tr>
<td>Serum blood</td>
<td>172.3 ± 43.8</td>
<td>165.0 ± 44.5</td>
<td>0.461</td>
</tr>
<tr>
<td>Serum glucose (g/dL)</td>
<td>9.7 ± 6.4</td>
<td>10.7 ± 4.6</td>
<td>0.393</td>
</tr>
<tr>
<td>TPN calories (kcal/d)</td>
<td>1519.6 ± 220.0</td>
<td>1530.7 ± 221.7</td>
<td>0.823</td>
</tr>
<tr>
<td>Total calorie intake (kcal/d)</td>
<td>1797.2 ± 257.1</td>
<td>1725.4 ± 235.3</td>
<td>0.189</td>
</tr>
<tr>
<td>Hospital length of stay (d)</td>
<td>83.5 ± 49.0</td>
<td>42.4 ± 31.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ICU length of stay (d)</td>
<td>22.9 ± 14.6</td>
<td>24.0 ± 16.6</td>
<td>0.762</td>
</tr>
<tr>
<td>Ventilator duration (d)</td>
<td>33.3 ± 31.4</td>
<td>26.2 ± 19.2</td>
<td>0.265</td>
</tr>
<tr>
<td>TPN duration (d)</td>
<td>11.7 ± 5.0</td>
<td>13.7 ± 9.7</td>
<td>0.220</td>
</tr>
<tr>
<td>Serum albumin (mg/dL), mean</td>
<td>8.1 ± 2.3</td>
<td>9.1 ± 3.3</td>
<td>0.124</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>26 (83.9)</td>
<td>40 (70.2)</td>
<td>0.122</td>
</tr>
<tr>
<td>Female</td>
<td>5 (16.1)</td>
<td>17 (29.8)</td>
<td></td>
</tr>
<tr>
<td>APACHE II score ≤ 21</td>
<td>15 (51.7)</td>
<td>7 (14.3)</td>
<td>0.001</td>
</tr>
<tr>
<td>APACHE II score &gt;21</td>
<td>14 (48.3)</td>
<td>42 (85.7)</td>
<td></td>
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<tr>
<td>Percentage of TPN calories/total daily calories ≤ 0.9</td>
<td>21 (67.7)</td>
<td>21 (36.8)</td>
<td>0.005</td>
</tr>
<tr>
<td>Percentage of TPN calories/total daily calories &gt;0.9</td>
<td>10 (32.3)</td>
<td>36 (63.2)</td>
<td></td>
</tr>
<tr>
<td>Need for dialysis, (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>24 (77.4)</td>
<td>29 (50.9)</td>
<td>0.013</td>
</tr>
<tr>
<td>Yes</td>
<td>7 (22.6)</td>
<td>24 (49.1)</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as n or means ± SD. APACHE = Acute Physiology and Chronic Health Evaluation; BMI = body mass index; CRP = C-reactive protein; CVC = central venous catheter; TPN = total parenteral nutrition.

Our study has limitations because it was a retrospective study lacking certain detailed information about parenteral and enteral nutrition, including components of nutrition formulation used, the competence of gastrointestinal function in each patient, detailed information on drug or antibiotics used during ICU admission. Further investigation is warranted to elucidate the role of enteral feeding in critically ill patients who have moderately impaired gastrointestinal function and are in need of parenteral nutritional supplement.

In conclusion, our study showed that in patients who sustained postoperative complications and were in need of TPN, those patients who could be fed enterally more than 10% of total calories had better clinical outcomes than patients who received less than 10% of total calorie intake from enteral feeding during hospitalization in the SICU. Enteral feeding should be given whenever possible for these severely ill patients.

Acknowledgments

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References


