The impact of implementation of an enteral feeding protocol on the improvement of enteral nutrition in critically ill adults

Seoung-Hyun Kim MD, Chi-Min Park MD, PhD, Jeong-Meen Seo MD, PhD, Mingew Choi MD, PhD, Dae-Sang Lee MD, Dong Kyung Chang MD, PhD, Miyong Rha, Soyoung Yu, Seonhye Lee, Eunmee Kim, Young Yun Cho

Department of Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea
Department of Critical Care Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea
Division of Gastroenterology, Department of Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea
Department of Dietetics, Samsung Medical Center, Seoul, South Korea

INTRODUCTION
Adequate nutrition administered via enteral nutrition (EN) and parenteral nutrition (PN) is essential to critically ill patients and helps to prevent malnutrition and accompanying complications. The use of enteral nutrition and early enteral feeding has been shown to improve clinical outcomes in critically ill patients. Despite its benefits, not all eligible patients receive optimal enteral nutrition because of factors such as delays in physician decision-making, under-estimation of caloric requirements, and frequent interruption of feeding.

There are many ways in which the practice of enteral feeding can be improved. The development and use of an evidence-based protocol is one such example. A nutrition management protocol is known to help overcome the barriers to proper EN and play an essential role in improving nutritional support for critically ill patients. In addition, applying a protocol allows standardization of daily clinical practice. Therefore, it improves the quality and safety of EN feeding.

In countries with limited medical resources, it is difficult to deliver optimal nutrition support because of shortages in nutrition support team (NST) staff as well as lack

Corresponding Author: Dr Chi-Min Park, Department of Surgery, Department of Critical Care Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, 81 Irwon-dong, Gangnam-gu, Seoul, 135-710, Korea. Tel: 82-2-3410-0282; Fax: 82-2-3410-0040 Email: dr99.park@samsung.com
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of adequate medical insurance. In the present study, we evaluated the usefulness of an evidence-based enteral feeding protocol to improve the practice and clinical outcomes in an intensive care unit (ICU) that had previously had limited nutritional support structures in place.

METHODS

Study design and population
This was a retrospective study that evaluated the impact of an enteral nutrition protocol (Figure 1) on the nutrition practices and clinical outcomes in a medical and surgical ICU at a university teaching hospital. The institutional review board at our center approved the study protocol (2011-10-075).

Samsung Medical Center is a Sungkyunkwan University School of Medicine teaching hospital with 1,951 beds located in Seoul, Korea. There are 23 beds in the surgical intensive care unit and 30 beds in the medical ICU. Patients treated in the medical or surgical ICU were enrolled in this study.

This study reviewed the patients who were admitted to either the medical or surgical ICU from January 2010 to August 2011. The group prior to implementation of the program included patients admitted between January 2010 and May 2010. The post-implementation group included patients admitted between April 2011 and August 2011. Patients who were admitted between June 2010 and March 2011 were excluded because the protocol was developed during this time period.

The study population consisted of patients admitted to the medical and surgical ICU who received EN for more than 24 hours. All patients were adults (>18 yrs old) whose stay in the ICU was greater than 48 hours. Exclusion criteria included those who were under 18 years of age, patients eligible for oral diet or who were going to be put on an oral diet within 24 hours, those whose life expectancy was less than 24 hours, those who were going to be put on palliative care, and those who were brain dead or in imminent danger of becoming brain dead. Also excluded were those who were coded as Do Not Resuscitate.
Table 1. Proposed schema for defining adult protein-energy malnutrition based on the malnutrition codes of the ICD-9-CM

<table>
<thead>
<tr>
<th>Malnutrition</th>
<th>Code</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kwashiorkor</td>
<td>ICD-9-CM code 260</td>
<td>• Weight loss ≤10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Albumin level &lt;25 g/L</td>
</tr>
<tr>
<td>Malnutrition of moderate degree</td>
<td>ICD-9-CM code 263.0</td>
<td>• Weight loss &gt;15%</td>
</tr>
<tr>
<td>Mixed marasmus-hypoalbuminemia</td>
<td></td>
<td>• Albumin level ≤32 g/L</td>
</tr>
<tr>
<td>Nutritional marasmus</td>
<td>ICD-9-CM code 261</td>
<td>• Weight loss &gt;20% and &lt;80% ideal body weight or &lt;70% ideal body weight alone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Albumin level ≥25 g/L</td>
</tr>
<tr>
<td>Malnutrition of mild degree</td>
<td>ICD-9-CM code 263.1</td>
<td>• Weight loss 10% to 15%</td>
</tr>
<tr>
<td>Mixed marasmus-hypoalbuminemia</td>
<td></td>
<td>• Albumin level ≤32 g/L</td>
</tr>
<tr>
<td>Other severe protein-energy malnutrition</td>
<td>ICD-9-CM code 262</td>
<td>• Weight loss &gt;10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Albumin level ≤25 g/L</td>
</tr>
<tr>
<td>Other protein-energy malnutrition</td>
<td>ICD-9-CM code 263.8</td>
<td>1. Not depleted but stressed or septic</td>
</tr>
<tr>
<td>Anticipate prolonged length of stay (actual or predicted)</td>
<td></td>
<td>• Weight loss &lt;5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Albumin level ≤32 g/L</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Moderate weight loss with planned major surgery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Weight loss &gt;10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Albumin level &gt;32 g/L</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Moderate depletion with mild weight loss</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Weight loss &gt;5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Albumin level ≤32 g/L</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Inability to eat ≥7 days</td>
</tr>
</tbody>
</table>

If a patient could be classified with a major code (260, 261, or 262) and a minor code (263.0, 263.1, or 263.8), the major code was chosen. To convert g/L albumin to g/dL, multiply g/L by 0.1. To convert g/dL albumin to g/L, multiply g/dL by 10.

(DNR), pregnant or lactating women, those who were readmitted to the ICU, those who had been transferred from another ICU, and those whose length of stay (LOS) was <48 hr. Enteral nutrition was postponed if the patient was hemodynamically unstable.

**Enteral feeding protocol**

There was no standard protocol for enteral nutrition in our hospital until 2010. Until then, each physician and surgeon would administer enteral nutrition using his/her own clinical judgement. The multidisciplinary working group, which included NST physicians, dietitians, nurses, pharmacists, and intensive care specialists, developed an evidence-based protocol through extensive review of the literature and existing guidelines. We implemented the protocol for each patient that was admitted to the medical or surgical ICU after April 2011, after several rounds of staff education and iterative protocol revision.

The EN protocol encouraged early initiation of enteral feeding (24-48 hours after ICU admission) if there were no contraindications. These included hemodynamic instability and intravascular volume that was not fully resuscitated, because such cases may be predisposed to bowel ischemia. Other contraindications included bowel obstruction, severe and protracted ileus, major upper gastrointestinal bleeding, intractable vomiting or diarrhea, gastrointestinal ischemia, and a high-output fistula.

If EN was indicated, enteral feeding formula was given at a volume of 20 cc/hr at first and increased by 10 cc/hr every 24 hours until the caloric target was achieved. Caloric target estimates for each patient were 20-25 kcal/kg during the acute phase and 25-30 kcal/kg during the stable phase. Adjusted body weight was utilized for this calculation. Patients received enteral feeding through a nasogastric drainage tube (Levin tube) prior to implementation of the protocol because of health insurance regulations, but a nasogastric feeding tube was utilized upon implementation of the protocol. Continuous feeding was recommended during the acute phase in the ICU. If gastric residual volumes were 200 mL or more, a reduction in feeding rate or the use of motility agents was recommended. If high gastric residual volume persisted, or if aspiration risk was high, nasojejunal feeding was recommended. Metoclopramide was used as the motility agent of choice in this study.

**Data collection and statistical analysis**

This was a before-and-after implementation study with prospectively collected data. Basic demographic data were collected, including age, sex, nutritional status, height, weight, reason for admission, department of admission, laboratory test results, and initial Sequential Organ Failure Assessment (SOFA) score. A nutritional diagnosis was performed using the patient’s medical history, a physical examination, biochemical analysis, and functional testing. Protein-energy malnutrition was evaluated based on ICD-9-code (Table 1). A dietitian diagnosed extent of malnutrition in each patient using information such as IBW, weight loss, albumin, and total lymphocyte count. The details of ICD-9-code we applied are explained in Table 1.

The objective of this study was to compare the nutritional practices and clinical outcomes between pre- and post-EN protocol implementation. We evaluated protocol compliance and adequate nutritional practice by assessing time to EN initiation, achievement of target calories intake, feeding method and route, frequency of interruption of EN delivery, and the use of pumps and prokinetics.
during the study period. We also compared clinical outcomes and complications related to the protocol including 28-day and 60-day mortality, length of hospital and ICU stay, and the incidences of aspiration, diarrhea, constipation, and gastrointestinal bleeding.

Pulmonary aspiration was detected by monitoring its clinical manifestations (desaturation, tachycardia, and cyanosis) continuously and by inspecting tracheal secretions for any blue coloration during tracheal suctioning. Oxygen saturation was monitored using a pulse oximeter, and it was considered low (desaturated) if it was <90%. Heart rate was assessed by continuous cardiac monitoring and was considered tachycardia if it was >100 beats/min. Diarrhea was defined as 3 or more loose or watery stools per day or 1 or 2 loose stools in 24 h, accompanied by at least 1 of the following symptoms: nausea, vomiting, abdominal cramps, or fever of 38.9 degrees C or higher. Constipation was defined as per the Rome III criteria. Gastrointestinal bleeding was diagnosed when a patient showed symptoms like melena or hematochezia.

All variables were compared in patients before and after implementation of the protocol. The categorical data were compared using a Chi-square test or Fisher’s exact test. Continuous variables were compared with independent t-test or Mann Whitney test, using two-sided testing. p<0.05 was considered statistically significant. All data were analyzed with SPSS statistics 22 (IBM, Chicago, IL).

**RESULTS**

A total of 270 patients were enrolled in this study. Of them, 134 were treated before implementation of the protocol, and 136 were treated post-implementation. The baseline characteristics of the study subjects are summarized in Table 2. Basic characteristics including age, sex, department and cause of admission, and SOFA score were not significantly different between the two groups. The most common reasons for admission were pulmonary conditions; severe sepsis and/or septic shock were the second most common.

The overall nutritional status of the two groups was similar (Table 3). Target caloric intake for individuals in

### Table 2. Basic characteristics between before and after implementation

<table>
<thead>
<tr>
<th></th>
<th>Before implementation</th>
<th>After implementation</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>134</td>
<td>136</td>
<td></td>
</tr>
<tr>
<td>Sex (men: women)</td>
<td>94:40</td>
<td>94:42</td>
<td>0.854</td>
</tr>
<tr>
<td>Age (years), mean±SD</td>
<td>65.0±15.4</td>
<td>62.4±14.7</td>
<td>0.151</td>
</tr>
<tr>
<td>Initial SOFA score, mean±SD</td>
<td>7.75 ±3.3</td>
<td>7.24±3.9</td>
<td>0.308</td>
</tr>
<tr>
<td>Department, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastro</td>
<td>4 (1.5)</td>
<td>1 (0.7)</td>
<td>0.543</td>
</tr>
<tr>
<td>Cardiology</td>
<td>1 (0.7)</td>
<td>0 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Pulmonology</td>
<td>94 (41.8)</td>
<td>46 (32.4)</td>
<td></td>
</tr>
<tr>
<td>Nephrology</td>
<td>9 (4.5)</td>
<td>6 (4.4)</td>
<td></td>
</tr>
<tr>
<td>Oncology</td>
<td>68 (26.1)</td>
<td>46 (33.8)</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>28 (9.0)</td>
<td>9 (6.6)</td>
<td></td>
</tr>
<tr>
<td>general surgery</td>
<td>21 (8.9)</td>
<td>22 (16.2)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>13 (5.8)</td>
<td>6 (4.4)</td>
<td></td>
</tr>
<tr>
<td>Intensive care unit, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>121 (90.3)</td>
<td>113 (83.1)</td>
<td>0.081</td>
</tr>
<tr>
<td>Surgical</td>
<td>13 (9.7)</td>
<td>23 (16.9)</td>
<td></td>
</tr>
<tr>
<td>Cause of admission, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After scheduled surgery</td>
<td>5 (3.7)</td>
<td>12 (8.8)</td>
<td>0.471</td>
</tr>
<tr>
<td>After unscheduled surgery</td>
<td>6 (4.5)</td>
<td>7 (5.1)</td>
<td></td>
</tr>
<tr>
<td>Cardiac problem</td>
<td>9 (6.7)</td>
<td>5 (3.7)</td>
<td></td>
</tr>
<tr>
<td>Pulmonary problem</td>
<td>81 (60.4)</td>
<td>75 (55.1)</td>
<td></td>
</tr>
<tr>
<td>Neurologic problem</td>
<td>5 (3.7)</td>
<td>5 (3.7)</td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal problem</td>
<td>0 (0)</td>
<td>2 (1.5)</td>
<td></td>
</tr>
<tr>
<td>Severe sepsis/septic shock</td>
<td>22 (16.4)</td>
<td>22 (16.2)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>6 (4.5)</td>
<td>8 (5.9)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3. Comparative summary of overall nutritional status

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition status, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nourished</td>
<td>3.0</td>
<td>5.9</td>
<td>0.214</td>
</tr>
<tr>
<td>Mild</td>
<td>48.5</td>
<td>57.4</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>34.3</td>
<td>26.5</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>14.2</td>
<td>10.3</td>
<td></td>
</tr>
<tr>
<td>Anthropometric, mean±SD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165±8.5</td>
<td>163±8.2</td>
<td>0.151</td>
</tr>
<tr>
<td>Ideal body weight (kg)</td>
<td>59.0±6.9</td>
<td>58.0±7.0</td>
<td>0.255</td>
</tr>
<tr>
<td>Actual body weight (kg)</td>
<td>59.2±10.9</td>
<td>60.0±10.8</td>
<td>0.726</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.0±17.2</td>
<td>22.4±16.4</td>
<td>0.532</td>
</tr>
<tr>
<td>IBW percent (%)</td>
<td>101±3.6</td>
<td>103±3.6</td>
<td>0.201</td>
</tr>
<tr>
<td>Target calories (kcal), mean±SD</td>
<td>1,489±226</td>
<td>1,506±234</td>
<td>0.559</td>
</tr>
</tbody>
</table>

BMI: body mass index; IBW: ideal body weight.
both groups was not significantly different. Comparison of anthropometrics, such as height and weight, did not reveal significant differences. Only a small fraction of patients were well nourished: 3.0% in the cohort prior to implementing the protocol and 5.9% in the post-implementation group. Almost all patients in both groups were mildly to moderately malnourished at the time of admission.

Overall, enteral feeding protocol compliance was 72.1% after implementation (Table 4). The most common cause of protocol violation was noncompliance with the gastric residual volume (GRV) threshold. Other common causes of protocol violation were appropriate and timely increase in caloric content, use of prokinetics, and changing to jejunal feeding. Enteral feeding was initiated earlier (35.8 post- vs 87.1 hours pre-implementation, $p=0.001$) and more patients received EN within 24 hours (59.6% post-vs 41.0% pre-implementation, $p=0.002$) after implementation of the protocol (Figure 1). The interval between starting EN and reaching the caloric goal was not different between the two groups; however, more patients reached the caloric goal after implementation (52.2% post- vs. 38.3% pre-implementation, $p=0.037$). In the pre-implementation group, 56.0% of patients received both enteral and parenteral nutrition, but only 41.9% of patients received both enteral and parenteral nutrition in the post-implementation group ($p=0.021$). In the pre-implementation group a Levin tube was used for feeding almost all patients (there were two exceptions, one of whom received a feeding tube and the other a gastrostomy), but in the post-implementation group, every patient but one received a feeding tube. Feeding was intermittent before implementation of the protocol, but after implementation, patients received feeding more continuously. A pump was used for feeding post-implementation. The post-implementation group was given more motility agents (53.7% post- vs 34.3% pre-implementation, $p=0.001$). There were no differences in the number of

<table>
<thead>
<tr>
<th>Table 4. Nutritional practices</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Combined PN support, no. (%) of patients</td>
</tr>
<tr>
<td>Mean time from ICU admission to EN (hours)</td>
</tr>
<tr>
<td>Received EN within 24 hours from ICU admission, (%)</td>
</tr>
<tr>
<td>Interruption of EN, no. (%) of patients</td>
</tr>
<tr>
<td>Mean EN support days (days)</td>
</tr>
<tr>
<td>Patients who reached caloric goal during ICU stay (%)</td>
</tr>
<tr>
<td>Weight change, mean (kg)</td>
</tr>
<tr>
<td>Feeding route, no. (%) of patients</td>
</tr>
<tr>
<td>Feeding tube</td>
</tr>
<tr>
<td>Levin tube</td>
</tr>
<tr>
<td>Gastrostomy</td>
</tr>
<tr>
<td>Jejunostomy</td>
</tr>
<tr>
<td>Route, no. (%) of patients</td>
</tr>
<tr>
<td>Nasogastric</td>
</tr>
<tr>
<td>Nasojejunal</td>
</tr>
<tr>
<td>Delivery method, no. (%) of patients</td>
</tr>
<tr>
<td>Intermittent</td>
</tr>
<tr>
<td>Continuous</td>
</tr>
<tr>
<td>Use of feeding pump, no. (%) of patients</td>
</tr>
<tr>
<td>Use of motility agents, no. (%) of patients</td>
</tr>
</tbody>
</table>

patients whose feeding was interrupted more than once between the two groups (69.4% pre- vs 73.5% post-implementation, $p=0.473$).

Comparison of all-cause hospital mortality and 28-day death rate, 60-day death rate, and ICU death rate revealed no statistically significant differences (Table 5). However, this analysis showed that overall mortality rates decreased after implementation. The total length of ICU stay and hospital stay were not different between the two groups.

Comparison of aspiration rates revealed no difference between the pre- and post- implementation groups (0.7% pre- vs 1.5% post-implementation, $p=0.57$). The incidences of diarrhea and gastrointestinal bleeding were significantly reduced after implementation. On the contrary, however, constipation levels increased following enteral feeding protocol implementation (11.9% pre- vs 28.7% post-implementation, $p=0.001$).

We obtained patient laboratory data including WBC, lymphocyte, protein, albumin, bilirubin, AST, ALT, BUN, Cr, TG, cholesterol, and BST counts and

<table>
<thead>
<tr>
<th>Table 5. Clinical outcomes</th>
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<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Before</td>
</tr>
<tr>
<td>Hospital death</td>
</tr>
<tr>
<td>28-days death</td>
</tr>
<tr>
<td>60-days death</td>
</tr>
<tr>
<td>ICU death</td>
</tr>
<tr>
<td>ICU LOS (days)</td>
</tr>
<tr>
<td>Hospital LOS (days)</td>
</tr>
<tr>
<td>Aspiration</td>
</tr>
<tr>
<td>Diarrhea</td>
</tr>
<tr>
<td>Constipation</td>
</tr>
<tr>
<td>GI bleeding</td>
</tr>
</tbody>
</table>

Hospital death, 28-day death, 60-day death, ICU death, Aspiration, Diarrhea, Constipation, GI bleeding; chi-square test.

ICU LOS, Hospital LOS; Mann-Whitney test

LOS: length of stay; number of days in the ICU; number of days in the hospital.
Table 6. Laboratory test results

<table>
<thead>
<tr>
<th></th>
<th>Before implementation</th>
<th>After implementation</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC (×10^3/µL)</td>
<td>Admission</td>
<td>Day 4</td>
<td>Day 7</td>
</tr>
<tr>
<td></td>
<td>11.7</td>
<td>11.8</td>
<td>12.4</td>
</tr>
<tr>
<td></td>
<td>11.8</td>
<td>10.7</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>12.4</td>
<td>13.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Lymphocyte (×10^3/µL)</td>
<td>Admission</td>
<td>Day 4</td>
<td>Day 7</td>
</tr>
<tr>
<td></td>
<td>12.4</td>
<td>14.3</td>
<td>9.13</td>
</tr>
<tr>
<td></td>
<td>10.5</td>
<td>13.3</td>
<td>4.82</td>
</tr>
<tr>
<td></td>
<td>9.13</td>
<td>9.32</td>
<td>4.98</td>
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<tr>
<td></td>
<td>11.1</td>
<td>12.1</td>
<td>0.204</td>
</tr>
<tr>
<td>Protein (g/dL)</td>
<td>Admission</td>
<td>Day 4</td>
<td>Day 7</td>
</tr>
<tr>
<td></td>
<td>5.38</td>
<td>5.09</td>
<td>5.13</td>
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<tr>
<td></td>
<td>8.45</td>
<td>4.83</td>
<td>4.82</td>
</tr>
<tr>
<td></td>
<td>5.16</td>
<td>4.98</td>
<td>0.356</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>Admission</td>
<td>Day 4</td>
<td>Day 7</td>
</tr>
<tr>
<td></td>
<td>2.80</td>
<td>2.88</td>
<td>2.76</td>
</tr>
<tr>
<td></td>
<td>2.75</td>
<td>2.74</td>
<td>2.70</td>
</tr>
<tr>
<td>Prealbumin (mg/dL)</td>
<td>Admission</td>
<td>Day 4</td>
<td>Day 7</td>
</tr>
<tr>
<td></td>
<td>10.3</td>
<td>8.40</td>
<td>5.99</td>
</tr>
<tr>
<td></td>
<td>12.5</td>
<td>11.0</td>
<td>11.2</td>
</tr>
<tr>
<td></td>
<td>12.2</td>
<td>11.2</td>
<td>0.754</td>
</tr>
<tr>
<td>Bilirubin (mg/dL)</td>
<td>Admission</td>
<td>Day 4</td>
<td>Day 7</td>
</tr>
<tr>
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<td>Day 7</td>
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<tr>
<td>AST (U/L)</td>
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<td>Cholesterol (mg/dL)</td>
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<td>Day 7</td>
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<td>Mean BST (mg/dL)</td>
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compared these values between the groups (Table 6). Total bilirubin and ALT were statistically different between the two groups. Bilirubin levels were not different at baseline (p=0.44), but the post-implementation group showed higher values on the 4th and 7th ICU day and at discharge (p=0.38, 0.01, 0.23). ALT levels were higher at baseline and at discharge in the post-implementation group, but the difference was not statistically significant (p=0.17, 0.26). Albumin levels were significantly higher at discharge in the post-implementation group (p=0.04).

DISCUSSION

In the present study, we compared the improvement of enteral nutrition practices and clinical outcomes between pre- and post-entaler feeding protocol implementation groups. Overall protocol compliance was 72.1%. Initiation of enteral feeding was faster, more patients were started on enteral feeding within 24 hours of admission to the ICU after implementation of the protocol. The time interval between starting feeding and reaching the caloric goal was not different between the two groups, but more patients reached the caloric goal after implementation of the protocol. More patients were given feeding tubes and feeding pumps, and the use of prokinetics increased after implementation. The use of PN decreased because of improvements in EN practice. These finding suggest that implementation of a standardized enteral feeding protocol can lead to significantly improved enteral nutrition prac-
The impact of implementation of enteral feeding protocol

Figure 2. Mean time from admission to EN start (before, 87.1 vs. after, 35.8, p=0.001)

...in the duration of mechanical ventilation, ICU or hospital length of stay, or mortality after protocol implementation. Additional studies have confirmed these findings. However, other reports have found conflicting results. Barr et al reported that in the post-implementation group, the mean duration of mechanical ventilation was shorter and the risk of death was lower in patients who received enteral nutrition. Martin et al showed that in the post-implementation group, patients received more days of enteral nutrition, had a shorter mean length of stay in the hospital, and showed a trend towards reduced mortality. We expected that there could be differences between the two groups because the ratio of malnutrition was higher in this study, but trends towards clinical improvements were not statistically significant. Admittedly, the retrospective nature of our study leaves it with limited statistical power and, moreover, the study was not designed to assess mortality.

In Korea, use of the feeding tube is a rubber or plastic tube with a large-bore single lumen, typically used for decompression or lavage but not for feeding. It is possible that the Levin tube could be more irritating to the gastric or esophageal mucosa because of its stiffness. In Korea, use of the feeding tube is limited because medical insurance often does not cover it, but the feeding tube, nonetheless, should be made available to all critically ill patients. Continuous feeding may reduce the incidence of diarrhea. Stevens et al found that diarrhea occurred in more patients and for a longer duration in those receiving intermittent enteral nutrition compared with those receiving continuous feeding. In our study, diarrhea was decreased in the post-implementation group compared with the pre-implementation group.
implementation cohort. This is likely related to the fact that continuous feeding was used in the protocol.

The present study has several limitations. Firstly, retrospective data were used and, as such, the data is limited by inherent biases. Although there was an inevitable selection bias as it was a before-and-after intervention study, the clinical characteristics were shown not to be different between the two groups. Secondly, there was a significant time difference between the two treatment groups, and advancements in medical knowledge, procedures, or drugs may have contributed to better outcomes for those in the later study period. The experience level of medical personnel also likely increased over time, but given that the study periods were separated by only 10 months this effect should be minimal. Thirdly, implementation of the protocol may have focused on the topic of nutrition, which may have favoured the intervention group.

In conclusion, we found that implementation of an enteral feeding protocol had beneficial effects on enteral nutrition, including beginning EN early, quickly achieving target caloric goals, using PN less frequently, and decreasing complications such as GI bleeding and diarrhea. Despite its limitations, the present study has significant practical and policy implications that strongly support the implementation of an enteral feeding protocol in countries with limited resources.

AUTHOR DISCLOSURES
All authors agree that the main author and the corresponding authors have all legal rights. Financial support: no external funding.

REFERENCES
