Registered Dietitians Making a Difference: Early Medical Record Documentation of Estimated Energy Requirement in Critically Ill Children Is Associated with Higher Daily Energy Intake and with Use of the Enteral Route

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ABSTRACT

Background Establishing a caloric requirement or energy target is a recommended part of any nutrition care plan.

Objective Our objective was to describe early documentation of a caloric requirement in critically ill children, and to determine if this would have any effect on daily energy intake and route of nutrition.

Design We used a descriptive chart review of a subgroup of patients included as part of a larger, retrospective multicenter study. Variables of interest included nutritional intake information, as well as presence/absence and amount of a documented caloric requirement within 48 hours of admission.

Participants Five of the original 12 study centers collected the required supplementary data. Enrolled patients were those who were admitted to our pediatric intensive care unit (PICU) from January 1, 2007, through December 31, 2008; were between ages 30 days and 18 years; and had a length of stay in the PICU >96 hours.

Statistical analysis Energy intake among patients with and without a documented caloric requirement was analyzed using Mann-Whitney U tests. The difference of receiving enteral nutrition among patients with and without a caloric requirement was analyzed using a χ² test.

Results We studied 1,349 patients, of whom 644 (47.7%) had a caloric requirement documented (95.6% of caloric requirements were entered by a registered dietitian) in the medical record; these patients had higher total daily energy intake and were more likely to be fed enterally during the first 4 days of PICU admission than those without a documented caloric requirement (P<0.001 for all comparisons).

Conclusions Less than half of critically ill children studied had a caloric requirement documented in the medical record; when a caloric requirement was documented in the medical record of a critically ill child, a registered dietitian had likely made the note. Having a caloric requirement documented in the medical record is associated with a higher energy intake and the use of the enteral route.

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DELIVERING NUTRITION SUPPORT, PRIMARILY using the enteral route, and achieving nutritional requirements early, is a proactive strategy that has been successfully implemented in adults with critical illness. Providing this type of nutrition is also associated with improvements in clinical outcomes. Despite the paucity of data to support a similar proactive approach with critically ill children, many experts believe that early enteral nutrition should also be considered in most patients admitted to pediatric intensive care units (PICUs). In addition to enteral nutrition being safe and well tolerated in most critically ill children, it has also been shown to improve protein metabolism and energy deficits. Mehta and colleagues have recently published the results of their multicenter observational study of children with critical illness showing that the intake of a higher percentage of a prescribed energy goal using the enteral route was associated with lower mortality.

Because of the complexity of care being delivered to critically ill children, many clinicians might struggle with the decision to initiate nutrition support. Providing early and optimal enteral nutrition support to a critically ill child might
be difficult. There are several single-center studies that have reported barriers to achieving adequate or optimal nutritional targets in critically ill children. These barriers range from the inability to accurately estimate caloric requirements to barriers to delivering the actual prescribed or estimated daily caloric requirement because of patient factors such as fluid restriction, high inotrope requirement with the consequent fear for gut ischemia, or unavoidable interruptions to enteral feedings because of procedures.

Establishing a caloric requirement, or energy target, is a recommended part of any nutrition care plan. Available clinical guidelines for the nutritional support of critically ill adults and children recommend that these patients should have a nutrition assessment with the development of a nutrition care plan early in their course. In most studies focused on the factors influencing or identifying the barriers to optimal nutrition, there was a clearly identified caloric requirement (also known as a goal or prescription), which is either estimated or calculated. This might differ from the reality of daily practice where the complexity of care required by these critically ill children (or the lack of awareness of the potential benefits from adequate nutrition) might make nutrition a low priority for the providers taking care of these children. To our knowledge, there are no studies describing the potential benefits from adequate nutrition for critically ill children (or the lack of awareness of the reality of daily practice where the complexity of care required by these critically ill children (or the lack of awareness of the potential benefits from adequate nutrition) might make nutrition a low priority for the providers taking care of these children).

Our main objective was to examine the practice of early documentation of estimated caloric requirement in the medical record of critically ill children to determine whether this would have any effect on their daily energy intake and/or on the route of nutritional support used to feed them.

We hypothesized that there would be a higher total daily energy intake and more frequent use of enteral nutrition when a caloric requirement is estimated and documented in the medical record within 48 hours of PICU admission.

**MATERIALS AND METHODS**

### Setting and Design

We undertook a descriptive study using a retrospective chart review. It was performed in a cohort of PICUs that had participated in a previous multisite study (T. A. Mikhailov et al, unpublished data, December 2012). Five of 12 centers from the original study agreed to participate in our study and obtained additional approval from their respective institutional review boards to collect the supplementary data. The requirement for consent/assent was waived.

Four of five participating PICUs were located in a freestanding children’s hospital and the fifth was located in a children’s hospital that was part of a large community hospital. All PICUs were members of the Children’s Hospital Association (formerly known as National Association of Children’s Hospitals and Related Institutions) PICU Focus Group.

### Sample and Study Period

All patients admitted to the five participating PICUs from January 1, 2007, through December 31, 2008, were enrolled in the study if inclusion and exclusion criteria were met. Inclusion criteria included admission between January 1, 2007, and December 31, 2008; age between 30 days and 18 years at time of admission; and length of stay in the PICU >96 hours. Patients admitted from another intensive care unit (within the hospital or from another hospital) were excluded from the study.

Sample size for this subgroup was dependent on when institutional review board amendment approval was obtained relative to data collection for the larger project, but represented no less than 44% of the total patients studied at each participating site.

### Data Collection

Patient characteristics collected for this project, including type of PICU admission (eg, scheduled vs unscheduled, postsurgical or not, and trauma status) risk of mortality (calculated using the Pediatric Index of Mortality 2), and demographics were obtained from the VPS database (Virtual PICU Systems, LLC). (VPS is a multisite, clinical database dedicated to standardized data sharing and benchmarking among participant PICUs.) Specific nutritional intake information, including nutrition route, quantity, and content as well as presence/absence and amount of an estimated caloric requirement, was obtained from medical record abstraction. When an estimated caloric requirement was present, it was determined by signature which type of provider had entered it in the medical record (eg, a registered dietitian [RD], a physician, a nurse practitioner, or other provider). Nutritional intake data were gathered on only the first 4 days of PICU admission and documented caloric requirement data were obtained during the first 48 hours. This information was recorded on data collection tools generated by Verity TeleForm software (version 9.0, 2004, HP Autonomy) and scanned electronically to facilitate data entry (Panasonic KV-S2026C High Speed Scanner, Panasonic Corp).

All daily energy intakes are reported as a percentage of the estimated daily resting energy expenditure (REE) calculated by The World Health Organization (WHO) equation. The WHO equation is used to estimate REE based on sex, age, and weight of the child. Based on the obtained daily energy intake from medical record review, a percentage was calculated to indicate how much of the calculated daily REE was achieved.

### Data Analysis

Those patients with an estimated caloric requirement documented in the medical record within 48 hours of admission (referred to as patients with a caloric requirement) were compared with those patients without one. The difference of receiving enteral nutrition among patients with and without a caloric requirement was analyzed using a chi-squared test. Energy intake among patients with and without a caloric requirement was analyzed using Mann-Whitney U tests (due to skewed distribution of energy intake).

Analyses were conducted by using SAS version 9.1 (2002-2003, SAS Institute Inc), and SPSS, version 14.0 (2005, SPSS Inc). P values <.05 were considered statistically significant for all comparisons.

### RESULTS

A total of 1,349 patients from the five centers met inclusion criteria, and 644 (47.7%) had a documented caloric requirement. The rate of caloric requirement documentation ranged
ranged from 1.00 to 10.04 (mean ratio of estimated caloric requirement to calculated REE greater than the WHO-calculated REE. For these patients, the 90.1% had an estimated requirement that was equal to or greater than their calculated REE.

Compared with patients without a caloric requirement, patients with a caloric requirement were statistically significantly younger, had a higher risk of mortality, and were less likely to be postoperative. Patients without a caloric requirement did not differ from those with a caloric requirement with respect to sex, scheduled vs unscheduled admission status, or trauma status (see Table 2).

Patients with a documented caloric requirement were more likely to receive enteral nutrition than those without a caloric requirement, on each of the first 4 days of admission: 30.5% vs 16.8% on Day 1, 46.1% vs 33% on Day 2, 58.9% vs 44.7% on Day 3, and 62.1% vs 48.2% on Day 4 (P<0.0001 for all comparisons). Patients with a documented caloric requirement had higher total daily energy intake by enteral route (see Table 3) and by enteral and parenteral route combined (see Table 4) on each of the first 4 days of PICU stay.

Of those patients with a documented caloric requirement, 90.1% had an estimated requirement that was equal to or greater than the WHO-calculated REE. For these patients, the ratio of estimated caloric requirement to calculated REE ranged from 1.00 to 10.04 (mean=1.81). For the remaining patients, those who had an estimated caloric requirement that was less than the WHO-calculated REE, the ratio of the estimated REE to the calculated REE ranged from 0.27 to 0.99 (mean=0.81).

The documented caloric requirement (when present) was determined by an RD 95.6% of the time, by a physician or nurse practitioner 2.2% of the time, and by another provider 2.2% of the time.

**DISCUSSION**

This multi-institutional, retrospective study shows that estimation and documentation of a caloric requirement in the medical record within the first 48 hours of admission is significantly associated with both higher total daily energy intake and more frequent use of the enteral route for nutrition. We also showed wide between-center variation in both the practice of clearly identifying and documenting a caloric requirement in the medical record of critically ill children early in their PICU care among the five children’s hospitals studied. Less than half of patients had a documented caloric requirement. To our knowledge this is the first multicenter study describing the actual practice of documenting a caloric requirement in the medical record early in the course of PICU admission, and its association with their energy intake and use of the enteral feeding route.

We are aware of one pediatric and two adult prospective observational multicenter cohort studies conducted to show what the actual bedside nutrition practice is among patients with critical illness. In these three studies, the investigators compared the energy intake achieved by these patients with an established energy goal obtained during a baseline nutrition assessment. The way these observational studies were conducted and reported might imply that all critically ill patients routinely and uniformly undergo a baseline nutrition assessment that includes establishing an energy goal. In contrast, our multicenter retrospective study shows that in actual practice, a majority of patients in the PICU did not have a documented caloric requirement as part of their nutrition plan during their PICU admission. These differences in caloric requirement documentation rate could be explained by the conditions for study participation in the prospective projects, because all the centers participating in

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**Table 1. Percentage of critically ill children’s medical records in which a caloric requirement notation is present or absent,* by pediatric intensive care center**

<table>
<thead>
<tr>
<th>Center</th>
<th>No Caloric Requirement</th>
<th>Caloric Requirement</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>1</td>
<td>321</td>
<td>78.7</td>
<td>87</td>
</tr>
<tr>
<td>2</td>
<td>66</td>
<td>25.1</td>
<td>197</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
<td>31.5</td>
<td>61</td>
</tr>
<tr>
<td>4</td>
<td>139</td>
<td>49.1</td>
<td>144</td>
</tr>
<tr>
<td>5</td>
<td>151</td>
<td>49.2</td>
<td>155</td>
</tr>
<tr>
<td>Totals</td>
<td>705</td>
<td>644</td>
<td>1,349</td>
</tr>
</tbody>
</table>

*Caloric requirement was considered present if documented in the medical record within 48 h of admission to the pediatric intensive care unit.

**Table 2. Characteristics of critically ill children with and without a caloric requirement notation in the pediatric intensive care unit medical record**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No caloric requirement (n=705)</th>
<th>Caloric requirement (n=644)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys, n (%)</td>
<td>369 (52.4)</td>
<td>335 (52)</td>
<td>NSbc</td>
</tr>
<tr>
<td>Age (y), median</td>
<td>2.71</td>
<td>1.54</td>
<td>&lt;0.001d</td>
</tr>
<tr>
<td>Scheduled admission, n (%)</td>
<td>222 (31.5)</td>
<td>185 (28.7)</td>
<td>NSbc</td>
</tr>
<tr>
<td>Trauma patients, n (%)</td>
<td>71 (10.1)</td>
<td>66 (10.2)</td>
<td>NSb</td>
</tr>
<tr>
<td>Postoperative patients, n (%)</td>
<td>241 (34.2)</td>
<td>186 (28.9)</td>
<td>&lt;0.037c</td>
</tr>
<tr>
<td>Risk of mortality, median</td>
<td>0.016</td>
<td>0.025</td>
<td>&lt;0.019d</td>
</tr>
</tbody>
</table>

*Caloric requirement was considered present if documented in the medical record within 48 h of admission to the pediatric intensive care unit.

NS=not significant.

*Obtained by χ² test.

*Obtained by Mann-Whitney U test.
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lower severity of illness may be possible targets for improve-
gone surgery, older pediatric patients, and those patients with Our data do suggest, however, that patients who have under-
some centers performed better than others in this regard. practice model, resources, and or protocols/policies being

tunately, we did not collect centers’ characteristics (ie, size, practice model, resources, and or protocols/policies being used) that would allow us to draw conclusions about why some centers performed better than others in this regard. Our data do suggest, however, that patients who have undergone surgery, older pediatric patients, and those patients with lower severity of illness may be possible targets for improvement efforts.

The association between a documented caloric requirement in the medical record and energy intake found by our study suggests that increasing the rate of establishing and documenting a caloric requirement in the medical record early during PICU admission might be an effective strategy to improve the energy intake of critically ill children. Unfortunately, we did not collect centers’ characteristics (ie, size, practice model, resources, and or protocols/policies being used) that would allow us to draw conclusions about why some centers performed better than others in this regard. Our data do suggest, however, that patients who have undergone surgery, older pediatric patients, and those patients with lower severity of illness may be possible targets for improvement efforts.

To explain the association between a documented caloric requirement and higher energy intake, we must first look at the steps involved in the complex process of delivering care to any patient. One of the initial steps in this process is that to be treated or addressed, an issue must be recognized. The complexity of care (and multiple therapies) required by critically ill children might make nutrition and providing nutritional support a low priority for care providers. A caloric requirement documented in the medical record is evidence that at least a member of the health care delivery team included nutritional support/therapy in the treatment plan for that particular patient; likewise, not having a caloric requirement present in the medical record might be evidence that the subject of nutrition therapy was never addressed with those patients. This could explain the lower daily energy intake shown by those patients in our study. Another possible explanation is that even in those cases in which nutritional support is started, not establishing a clear target may delay escalation and, thus, result in the lower energy intake observed in these patients. Following the same thought, if there was clear intent to provide nutritional support (as evidenced by a caloric requirement documented in the medical record), given that most children can successfully be fed enterally, it is not surprising that the presence of a documented caloric requirement was also associated with a higher rate of receiving enteral nutrition.

Another interesting finding in our study is that almost all of the caloric requirements present early in the medical records were entered by an RD and not by an attending physician or other medical care provider (eg, a physician in training or nurse practitioner). This finding illustrates the favorable and important influence that RDs can have on the nutrition outcomes of patients in PICUs. There are several possible reasons for this finding. First, there could be insufficient knowledge

<table>
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<th>Table 3. Daily enteral energy intake in critically ill children with and without a caloric requirement notation in the pediatric intensive care unit medical record</th>
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<tbody>
<tr>
<td>Day</td>
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<tr>
<td>Mean±standard deviation</td>
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<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>3</td>
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<td>4</td>
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</tbody>
</table>

Energy intake was expressed as a percentage of the resting energy requirement calculated using the World Health Organization equation. P<0.001 for each comparison, obtained by Mann-Whitney U test.

<table>
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<tr>
<th>Table 4. Daily enteral and parenteral energy intake in critically ill children with and without a caloric requirement notation in the medical record</th>
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<tr>
<td>Day</td>
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<td>Mean±standard deviation</td>
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Energy intake expressed as a percentage of the resting energy requirement calculated using the World Health Organization equation. P<0.001 for each comparison, obtained by Mann-Whitney U test.

Caloric requirement was considered present if documented within 48 h of admission to the pediatric intensive care unit.
about nutrition to estimate caloric requirements among other PICU care providers. Studies have demonstrated that this is true among adult intensive care unit providers. Second, even though there is growing evidence of the value of early nutrition, especially early enteral nutrition, for patients in PICUs, there is still a lack of conclusive data on how such nutrition affects patient outcomes. In addition, it is possible that although PICU providers may have the knowledge to realize the importance of nutritional support, they may postpone nutrition therapy in deference to concentrating on other life-saving therapies. Our study is not the first evidence of the favorable effect that the presence of RDs might have on the nutrition-related outcomes of patients with critical illness. Other investigators have reported that following the hiring of a dedicated RD for their adult intensive care unit they had a more systematic recording of energy targets; more importantly, the RD in addition to implementing a multidisciplinary nutrition protocol resulted in reduction of energy deficits and hospital length of stay.

Even though there are now good data suggesting that equations do not accurately predict REE in children with critical illness, we needed a common denominator to compare energy intakes; and in practice, equations are used to estimate energy expenditure. Heights obtained in children in the PICU are often inaccurate, and we were unable to obtain heights in the children used in this study. Hence, we chose the WHO equation that utilizes only the child’s weight and age to estimate energy expenditure. Some patients in our study had energy intakes that were up to 10 times the REE calculated using the WHO equation. We do not have a good explanation for this other than the WHO equation does not address the energy required for the increase metabolic demands from some conditions and/or by the healing process.

Our study has several limitations. First, we did not link our nutritional outcomes to any significant clinical outcome (e.g., mortality or length of stay), thus limiting the clinical influence of our results. Second, we did not determine the accuracy of the caloric requirement documented in the medical record. Therefore, we cannot comment on how possible inaccuracy may affect the usefulness of established caloric requirements. Finally, given the retrospective and non-interventional nature of our study, we cannot establish any cause–effect relationship from our findings.

CONCLUSIONS

Less than half of the critically ill children studied had a caloric requirement documented early in their medical record; having a caloric requirement documented early in the medical record of children with critical illness is associated with higher energy intake and the more frequent use of the enteral route, which might improve clinical outcomes. When a caloric requirement was documented early in the medical record of a critically ill child, an RD had likely made the note. Future prospective studies evaluating interventions aiming to improve the rate and amount of early enteral nutrition and its effect on clinical outcomes of children with critical illness are warranted.

References


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STATEMENT OF POTENTIAL CONFLICT OF INTEREST
No potential conflict of interest was reported by the authors.

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