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Periprocedural cessation of nutrition in the intensive care unit: opportunities for improvement

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Abstract *Purpose:* Delivery of enteral nutrition (EN) to ICU patients is commonly interrupted for diagnostic and therapeutic procedures. We investigated this practice in a cohort of trauma and surgical ICU patients. *Methods:* This was a retrospective single-center study conducted in a 15-bed trauma ICU of a university-affiliated teaching hospital. Descriptive statistics were used. *Results:* Of 69 patients assessed, 41 had 121 planned procedures over a mean ICU length of stay of 18.7 days (SD 9.6 days). EN was stopped prior to 108 (89 %, 95 % CI 82–94 %) of these 121 procedures, and 102 of these cessation episodes were related to the planned procedure. EN was stopped in 37 patients for a mean cumulative duration of 30.8 h (SD 22.7 h) per patient, which represented 7.9 % (SD 6.9 %) of the mean total time spent in the ICU leading to a mean energy and protein deficit of 7.2 % (SD 8.5 %) and 7.7 % (SD 9.6 %), respectively. Of the 121 planned procedures, 27 (22 %, 95 % CI 16–31 %) were postponed beyond the scheduled day. For 32 (31 %, 95 % CI 23–41 %) of the 102 EN cessation episodes, EN was stopped without a documented order and 23 (23 %, 95 % CI 16–32 %) episodes were not deemed necessary based on the institution's guidelines. *Conclusion:* In this ICU cohort, EN cessation for planned procedures was frequent and led to a nutritional deficit due to long periods without EN being delivered. Postponement of procedures and clinically unnecessary EN cessation were important factors that prevented delivery of planned nutrition. EN cessation practice should be a focus for improving EN delivery in ICU patients.

Keywords Nutrition · Enteral nutrition · Intensive care unit · Critical illness · Critically ill · Clinical study

Introduction

Nutrition therapy is an essential component of the standard management of critically ill patients. Although many studies have failed to demonstrate a positive effect on outcome, possibly due to the use of inadequate algorithms and goals not being known or reached, nutrition therapy has been shown to reduce disease severity and length of stay in the intensive care unit (ICU), reduce complications and improve other patient outcomes [1]. Enteral nutrition

(EN) is preferred over parenteral nutrition [1, 2], and is recommended to be started within 24 h of ICU admission [3, 4]. However, EN is commonly delivered in insufficient quantities, often due to interruptions for clinical procedures, with patients receiving on average 50–70 % of their predicted requirements over their ICU stay [5–7]. While gastrointestinal tract dysfunction is a major barrier to efficient delivery, planned cessation of EN for diagnostic or therapeutic procedures is also a common practice [6, 8].

The contribution of hypocaloric nutrition to poor outcomes is not well understood [9–11], but general recommendations vary from aiming to provide >50–65 % of goal calories over the first week of hospitalization [1] to aiming to provide ≥80 % of nutritional requirements by 72 h after ICU admission [2] to achieve the clinical benefit of EN. It also seems counterintuitive to have long periods of no EN (i.e. semistarvation) in the presence of critical illness and its inflammatory and multiorgan system complications [12, 13].

We investigated the practice of EN cessation related to planned procedures in a group of trauma and surgical ICU patients. We specifically wished to determine the frequency of EN cessation, its duration, its impact on nutritional intake and its relationship with the type and location of procedures.

Methods

This was a retrospective single-center observational study of patients admitted to the Trauma Intensive Care at The Alfred Hospital, a major tertiary referral teaching hospital in Melbourne, Australia. This unit is a 15-bed discrete section of a larger 45-bed mixed medical/surgical ICU mainly treating trauma and surgical patients. The Trauma ICU was selected, as patients would be expected to have EN cessation commonly due to the number of procedures these patients usually undergo.

The study was conducted in accordance with the ethical guidelines of the National Health and Medical Research Council of Australia. Approval from the Alfred Hospital Human Research Ethics Committee was obtained. The need to obtain individual patient informed consent was waived.

Patients were selected by reviewing the medical files of all inpatients who were present in the Trauma ICU on preselected days, starting with 1 June 2010, followed by 1 December 2010, 1 July 2010, 1 November 2010 and 1 August 2010 until at least 100 planned procedures had been identified, finishing the inclusion at the end of the preselected day during which the 100th planned procedure was included. All consecutive patients for each preselected day were included with none excluded, and their files were screened for the entire length of their ICU stay. The rationale for screening using this method was to include patients over a wider time frame for greater representation of true clinical practice variation. We believed a sample size of more than 100 procedures would provide reasonable estimates to subsequently determine the optimal size of a future prospective study. This sample size was considered large enough to be adequately representative of clinical practice and to provide reasonable precision for descriptive statistics.

All files were accessed from a computerized hospital patient data system after the patient's discharge. This allowed screening of all medical staff entries in the medical notes, all daily nursing observation charts and notes on surgical and anesthetic procedures. The medical files of eligible patients were screened to identify planned clinical procedures for which EN was either stopped or potentially stopped. These procedures were defined as appropriate planned procedures if EN was stopped in at least one patient included in the study on at least one occasion for that particular procedure and included invasive procedures such as interventional radiology, transesophageal echocardiography and gastroscopy, but excluded noninvasive imaging procedures such as plain radiography, CT and MRI. The reason for cessation of nutrition therapy was also noted.

Data collected were restricted to those variables already collected in routine clinical practice including basic demographics, Acute Physiology and Chronic Health Evaluation II (APACHE II) variables [14] and simplified organ failure assessment scores [15]. We collected detailed information about the planned procedures and periprocedural nutrition therapy practices: type of procedure, location, time away from ICU, timings and duration of EN cessation, estimated energy and protein requirements, type of EN, who ordered the EN cessation, where this was documented and whether patients were endotracheally intubated. FiO_2 requirements before and after the procedures were also assessed as surrogate indicators of periprocedural aspiration. For procedures performed outside the ICU, we used the time of arrival back in the ICU after a procedure to calculate the duration between the end of a procedure and the restarting of EN. Since EN was never restarted after a procedure before returning to ICU, we considered this to be a more useful and true duration of EN cessation in these procedures.

In general, prior to starting nutrition therapy all patients received a nutrition assessment by the unit dietitian. Energy and protein requirements were estimated using a weight-based predictive equation and adjusted for type and severity of critical illness. Nutrition therapy was delivered according to an evidence-based nutrition protocol, and the dietitian determined the type of formula and target rate in consultation with medical staff as required. For simplicity, we used the original nutrition requirements estimated, and assumed these to be constant over time during the entire ICU stay. Actual energy and protein

deficits caused by EN cessation episodes were calculated based on the type and rate of EN that was delivered prior to cessation. Deficit was defined as the difference between the estimated requirement and actual delivery. If oral nutrition was being received at the time of nutrition cessation, the daily requirement was divided by 24 h and multiplied by the number of hours nutrition was withheld to provide an estimate of nutrition that was missed.

The Alfred Hospital guidelines for the preoperative management of nutrition in ICU patients recommend that EN should be stopped 6 h prior to the procedure only in endotracheally intubated patients scheduled for cardiac surgery, abdominal surgery or tracheostomy and for all patients without endotracheal intubation, regardless of the type of surgery. Endotracheally intubated patients scheduled for other types of surgery are recommended to continue EN. Based on these guidelines we evaluated retrospectively whether EN cessation had been truly necessary, and we considered EN cessation less than 6 h prior to the planned procedure to be delayed EN cessation.

Descriptive statistical analysis was conducted using Microsoft Excel 2010. The results were generally normally distributed and outcomes are reported using means and standard deviations (SDs). Proportions are presented as percentages with 95 % confidence intervals (95 % CI).

Results

We screened 69 patients who were present in the Trauma ICU on the preselected 5 days (first day of June, July, August, November and December 2010) and identified 121 planned procedures in a total of 41 patients (1.8 episodes per screened patient and 3.0 episodes per "EN-cessation" patient). The baseline characteristics of these 41 patients are presented in Table 1.

Of these 121 planned procedures, EN was stopped in 108 (89 %, 95 % CI 82–94 %) prior to the procedure. In 12 (11 %, 95 % CI 6–18 %) of the 108 EN cessation episodes, EN was stopped only because the patient left the ICU rather than for the planned procedure itself. In 6 (6 %, 95 % CI 3–12 %) of the 108 EN cessation episodes, EN was stopped for reasons unrelated to the planned procedure (Fig. 1a).

EN was stopped in 37 of the 41 patients (90 %, 95 % CI 77–96 %) with planned procedures for one or more episodes (maximum of ten episodes per patient). These 37 patients had EN stopped for a mean cumulative total time of 30.8 h (SD 22.7 h) per patient during their ICU admission, equivalent to a mean of 7.9 % (SD 6.9 %) of their total time spent in the ICU. For one of these patients specific data on nutrition delivery were missing. The estimated cumulative mean percentages of energy and protein deficits due to EN cessation during their ICU admission in the remaining 36 patients were 7.2 % (SD 8.5 %) and 7.7 % (SD 9.6 %), respectively. In ten (27 %, 95 % CI 15–43 %) of these patients the cumulative EN cessation duration was more than 48 h, equivalent to a mean of 14.1 % (SD 6.1 %) of their total time spent in the ICU and an estimated cumulative mean percentage of energy and protein deficits due to EN cessation of 14.2 % (SD 10.3 %) and 14.5 % (SD 10.3 %), respectively, again with data on nutrition missing for one of these patients.

Table 1 Baseline characteristics of 41 EN-cessation patients

Characteristic	Value
Age (years), mean (SD)	45.0 (19.3)
Male gender, no. (%)	24 (59)
APACHE II score, mean (SD)	15.4 (6.1)
ICU length of stay (days), mean (SD)	18.7 (9.6)
Hospital length of stay (days), mean (SD)	38.6 (25.3)
Renal replacement therapy, no. (%) of patients	3 (7.3)
Inotropic support, no. (%) of patients	35 (85.4)
Diagnosis, no. (%)	
Cardiovascular	1 (2.4)
Musculoskeletal/skin	1 (2.4)
Neurological	5 (12.2)
Respiratory	3 (7.3)
Trauma	31 (75.6)

The mean duration of an individual EN cessation episode (from cessation to restarting) was 10.7 h (SD 7.1 h). The mean time between EN cessation and starting the procedure was 6.5 h (SD 6.2 h). Excluding the procedures for which EN cessation was delayed, the mean time between EN cessation and starting the procedure was 10.0 h (SD 6.3 h, 44 episodes). The mean time between the end of the procedure and EN restarting was 1.9 h (SD 3.0 h). The differences in EN cessation times for procedures performed in the ICU, in the operating theater, or in other locations, as well as the differences in the time between EN cessation and starting the procedure for these different locations were all nonsignificant.

Procedures for which EN was always stopped were surgical tracheostomy (11/11 procedures) and other procedures involving tracheostomy or endotracheal tube changes (6/6 procedures). EN was much more commonly stopped than not stopped for percutaneous tracheostomy (19/20 procedures), abdominal surgery (6/7 procedures), other surgery (42/50 procedures), miscellaneous procedures (21/22 procedures) and inferior vena cava filter insertion (4/6 procedures). Of the 121 planned procedures, EN was not stopped in the ICU in 13 (11 %, 95 % CI 6–18 %) prior to the procedure. However, 12 of these procedures were performed outside the ICU and for only 1 of these 12 procedures was EN specifically recorded as being continued during the procedure (Fig. 1a). These 13 planned procedures were: inferior vena cava filter insertion (two), percutaneous tracheostomy (one), abdominal surgery (one), 'other' procedures in the operating theater (eight) and 'other' procedure not in the operating theater or ICU (one).

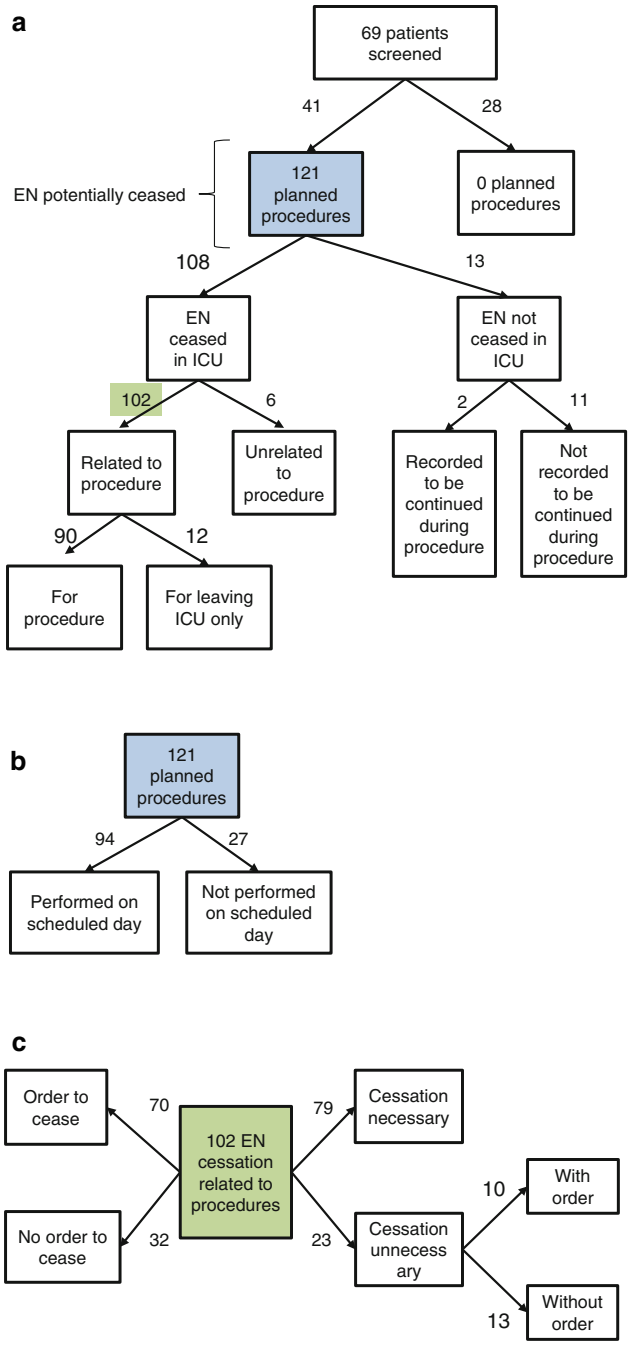

Fig. 1 Planned procedures: **a** characteristics of EN cessation episodes, **b** delays, **c** EN cessation orders and necessity

Of the 121 planned procedures, 27 (22 %, 95 % CI 16–31 %) were not performed on the scheduled calendar day because of either postponement or cancellation (Fig. 1b). In 87 (81 %, 95 % CI 72–87 %) of the 108 EN cessation episodes, patients had been receiving EN via a nasogastric or nasojejunal tube, and this was stopped prior to the procedure and restarted after the procedure. In 10 (11 %, 95 % CI 6–20 %) of these episodes, EN was started at a lower rate than the rate at which it had been stopped without a clear or documented reason, with a mean time to resumption of the precessation rate of 6.2 h (SD 7.8 h, range 1–28 h).

Explicit orders from a health-care practitioner to stop EN were documented for 70 EN cessation episodes. Hence, for 32 (31 %, 95 % CI 23–41 %) of the 102 EN cessation episodes related to a planned procedure, EN was stopped without a written order (Fig. 1c). This includes the 12 EN cessation episodes where EN was stopped only because the patient was leaving the ICU. Of the 70 EN cessation episodes with explicit orders, 19 (27 %, 95 % CI 18-39 %) were documented only by the ICU medical staff, 10 (14 %, 95 % CI 8–24 %) only by the ICU nursing staff, 9 (13 %, 95 % CI 7–23 %) only by other medical staff (surgical or anesthetic), and 32 (46 %, 95 % CI 35–57 %) by more than one of these groups. There was not one regular place to document these orders.

There was only one documented case of witnessed aspiration. This patient had EN stopped more than 12 h prior to the procedure and no adverse outcome (e.g. higher FiO_2) occurred. Postprocedural FiO_2 requirements did not increase due to aspiration in any of the 121 episodes.

Based on retrospective comparisons with the institution's guidelines, 23 (23 %, 95 % CI 16–32 %) of the 102 EN cessation episodes did not seem necessary (Fig. 1c). This again includes the 12 EN cessation episodes in which EN was stopped only because the patient was leaving the ICU.

Discussion

This study demonstrated that the majority of patients in this ICU had planned procedures for which EN was stopped. For the small group of planned procedures for which EN was not stopped in the ICU, continuation of EN during the procedure was rarely documented, suggesting that interruption of EN occurred even in this group. In a minor but significant number of EN cessation episodes EN was stopped in the ICU solely because the patient was leaving the ICU. Nearly a quarter of the planned procedures were not actually performed on the scheduled day leading to unnecessary and perhaps preventable EN cessation. Furthermore, nearly a quarter of EN cessation episodes did not seem necessary based on current institutional guidelines and in almost a third of the EN cessation episodes, EN was stopped without explicit orders. In patients who had one or more EN cessation episodes the mean cumulative duration of EN cessation was over 30 h during their ICU stay, and was over 48 h for over a quarter of these patients, affecting cumulative energy and protein deficit. When planned EN cessation was not delayed, cessation times were significantly longer than the recommended 6 h.

To our knowledge this is the first study specifically aimed at observing and describing the practice of EN cessation related to planned procedures in an intensive care population. Limited data on this topic have previously been

reported mainly related to prevalence: in a recent multicenter study regarding nutritional therapy in patients with acute pancreatitis EN interruptions occurred on 38 % of the days on which EN was delivered, with the most commonly recorded reason being procedures inside or outside the ICU [16]. Another group reported the two main problems preventing EN delivery as being gut dysfunction and elective stoppage for procedures [17]. In another study, EN cessation occurred in >85 % of patients for an average of 20 % of the infusion time, and >65 % of these cessations were avoidable. The reasons for cessation included the patient being made "nil by mouth after midnight" for diagnostic tests and procedures, which occurred in a third of patients [18]. Even though these studies were not specifically aimed at periprocedural nutrition practices, they confirm our findings that planned procedures have a significant and perhaps under-recognized impact on total nutrition therapy delivered to ICU patients.

The finding of our study that EN cessation for planned procedures in ICU patients led to an average cumulative duration of over 30 h per patient and an estimated nutrition deficit of over 7 %, indicates that EN cessation practice may have an important negative impact on clinical outcomes. It is important to note that our study only focused on one reason for nutrition interruption, and hence the total deficit per patient stay is likely to be significantly higher. Clinicians should better monitor and understand these interruptions so as to minimize EN cessation as much as possible and to consider if EN can be continued more frequently. Although some recent studies have shown that lower EN delivery might not be detrimental in some populations [10, 19, 20], others have shown the beneficial effects of greater overall EN delivery [11, 21]. There is also significant evidence that patient fasting (particularly preoperatively in elective surgery) can be problematic [22–24].

Even though some EN cessation for planned procedures is inevitable, adherence to guidelines which promote short cessation periods and agreement by all parties involved about which procedures really require EN cessation might assist in achieving greater amounts of EN delivery. An understanding of the risks and benefits of continuing EN right up to, or throughout, a surgical or diagnostic procedure, even outside of the ICU environment, is needed. For example, there is little evidence to support the assumption that cessation of EN will reduce the incidence of ventilator-associated pneumonia (VAP). Cessation may actually be counterproductive as the potential "benefit" of EN cessation (i.e. VAP avoidance) may be outweighed by the risk of decreased nutrition. Cessation periods both before and after planned procedures can be decreased, for example, by eliminating the 'fast from midnight' approach and putting more emphasis on restarting EN as soon as possible after the procedure and at the same rate as before cessation. More uniform documentation of EN cessation orders could perhaps improve communication and clarity and thus prevent unnecessary periods without EN. Another potential focus of improvement could be minimizing the number of postponed or cancelled procedures.

Our study had the limitations of a retrospective design. Since data collection was retrospective, we were dependent on the accuracy and completeness of the medical notes. Since data were only collected from one part of the ICU from a single institution, our conclusions may not be generalizable to other institutions. We also note that this cohort was not very large.

Conclusions

This study demonstrated that in patients in a trauma and surgical ICU, EN cessation was frequent for planned diagnostic and therapeutic procedures, causing long periods without EN which resulted in nutrition deficit. Postponed or cancelled procedures and clinically unnecessary EN cessation occurred commonly and contributed significantly to cumulative EN cessation duration. There appeared to be clinical practice variation as to which practitioner ordered EN cessation, the cessation of EN without written orders and when and at what rate EN was recommenced. In improving EN delivery in ICU patients, we believe there should be a greater focus on the true risks and benefits of EN cessation practice. Future research should also focus on improving guidelines for periprocedural EN delivery and the impact of all EN cessation reasons on a patient's overall nutrition therapy delivered and the impact on important clinical outcomes.

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