

Implementation of a Proactive Nutrition Protocol Improves Enteral Nutrition in Mechanically Ventilated Patients Admitted to the Neuro-Intensive Care Unit

Dear Editor,

The enteral mode of nutrition delivery in the critically ill confers gastrointestinal, immunologic and survival advantages over parenteral nutrition (PN), especially when initiated early. Intensive care unit (ICU) patients with traumatic brain injury (TBI) exhibit hypercatabolism, needing higher energy requirements. The focus of TBI management is cardiorespiratory resuscitation (CPR) and neuroprotective strategies, often resulting in the neglect of nutrition as an important physiologic requirement.

A retrospective study was performed to determine the effectiveness of an evidence-based proactive nutrition protocol in improving the nutrition of mechanically ventilated neurosurgical patients admitted to the neuro-ICU (NICU).

Materials and Methods

In 2010, a multidisciplinary workgroup consisting of neurointensivists, nurses and dietitians developed an enteral nutrition protocol aiming to reduce inadequate nutrition amongst NICU patients. Before implementation, ICU staff were briefed and relevant information were made readily accessible on the ICU intranet. This protocol comprised 4 different interventions.

1. Electronic Nutrition Charting

Electronic nutrition charting with clear display of hourly and cumulative caloric intake per day was introduced (Fig. 1).

2. Protocolised Management of Enteral Nutrition (Early Initiation and Minimising Interruptions)

Previously, preprocedure fasting was often excessive and timely resumption of feeding postprocedurally was often forgotten. Figure 2 illustrates the stepwise workflow to circumvent both delays in starting and interruptions to enteral nutrition. Advisory alerts on the electronic charts were introduced to remind physicians to resume feeding 2 to 4 hours following procedure or successful extubation.

3. Consensus Definition and Practice Guideline on Management of High Gastric Residual Volumes

There had been no clear definition and management guideline for patients with gastric residual volume (GRV) in neurocritical, ventilated patients, but following the Ministry of Health (MOH) nursing best practice guidelines promulgated in 2010, the workgroup recommended patients who developed feeding intolerance (defined GRV as ≥ 150 mLs) to be actively managed by the intensivist as outlined in Figure 3. Enteral feeding, provided via oro-nasogastric route, was 1 kcal/mL, high protein, fibre-containing, polymeric formula (Jevity as default) via closed-system given continuously over 24 hours.

4. Dietician Review

The protocol mandated a dietician review within 24 hours of admission of all newly admitted NICU patients receiving mechanical ventilation to optimise the nutrition prescription.

ICU Flowsheet	29/03/2011 09:00	10:00	11:00	12:00	13:00	14:00	15:00
Estimated Target kcal/day	1500	1500	1500	1500	1500	1500	1500
⊕ Enteral Feeds kcal/hr	0	30	30	30	30	30	30
⊕ Parenteral kcal/hr				0	50.4	50.4	50.4
Total kcal/hr	0	30	30	30	80	80	80
Cumulative kcal (24hrs)	0	30	60	90	170	250	330
Deficit kcal (24hr)	1500	1470	1440	1410	1330	1250	1170
Cumulative kcal (LOS)	0	30	60	90	170	250	330

Fig. 1. Caloric deficits were computed on a daily basis and flagged up as a reminder to the physicians on the electronic chart.

Minimising Feeding Interruptions in Intubated Patients

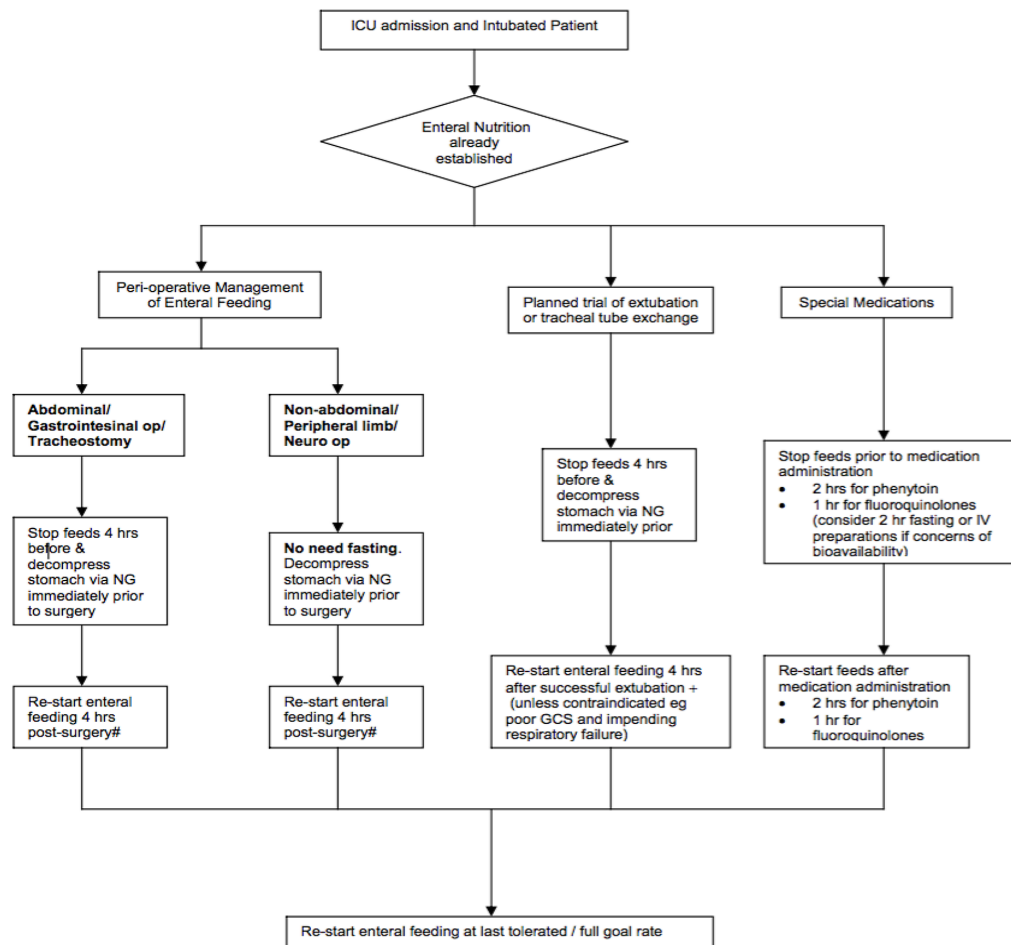


Fig. 2. The protocol recommended at most 6 hours of fasting prior to tracheostomy or trial of extubation. Intubated patients undergoing non-airway, non-abdominal procedures necessitated only 2-hour fasting with gastric decompression via aspiration of feeding tube prior to procedure.

After approval from the local ethics committee, power analysis was performed using a power of 80% and alpha value of 0.05 to detect a 50% improvement in the incidence of adequate feeding after protocol implementation. A sample size of 74 per group was required, with an additional 10% added to sample size in order to account for loss to follow-up. In total, 169 consecutive neurosurgical patients admitted to our NICU from July 2010 to June 2011 were studied. Of these, 83 patients were admitted 6 months before protocol implementation and 86 patients were admitted 6 months postimplementation. Inclusion criteria include: 1) mechanical ventilation ≥ 48 hours, 2) ≥ 18 years of age, and 3) suitable for enteral nutrition. Exclusion criteria include contraindications to enteral nutrition, such as gastrointestinal haemorrhage.

Statistical Analysis

The primary outcome was the incidence of adequate feeding as defined by the proportion of patients who met $\geq 80\%$ of their energy goal requirements (25 kcal/kg/day) during their stay in NICU or till cessation of enteral nutrition and conversion to oral diet, or discharge from NICU or death. Secondary outcomes include the average caloric intake (kcal/kg/day), time to initiation of enteral nutrition, ICU and hospital length of stay (LOS) and mechanical ventilation days. Reasons for underfeeding and incidence of infection (as diagnosed by positive bacteriology and clinical correlation) were studied.

The independent sample t-test was used for normally distributed data, Mann-Whitney U test for non-normally distributed data and Pearson chi-square tests for categorical variables.

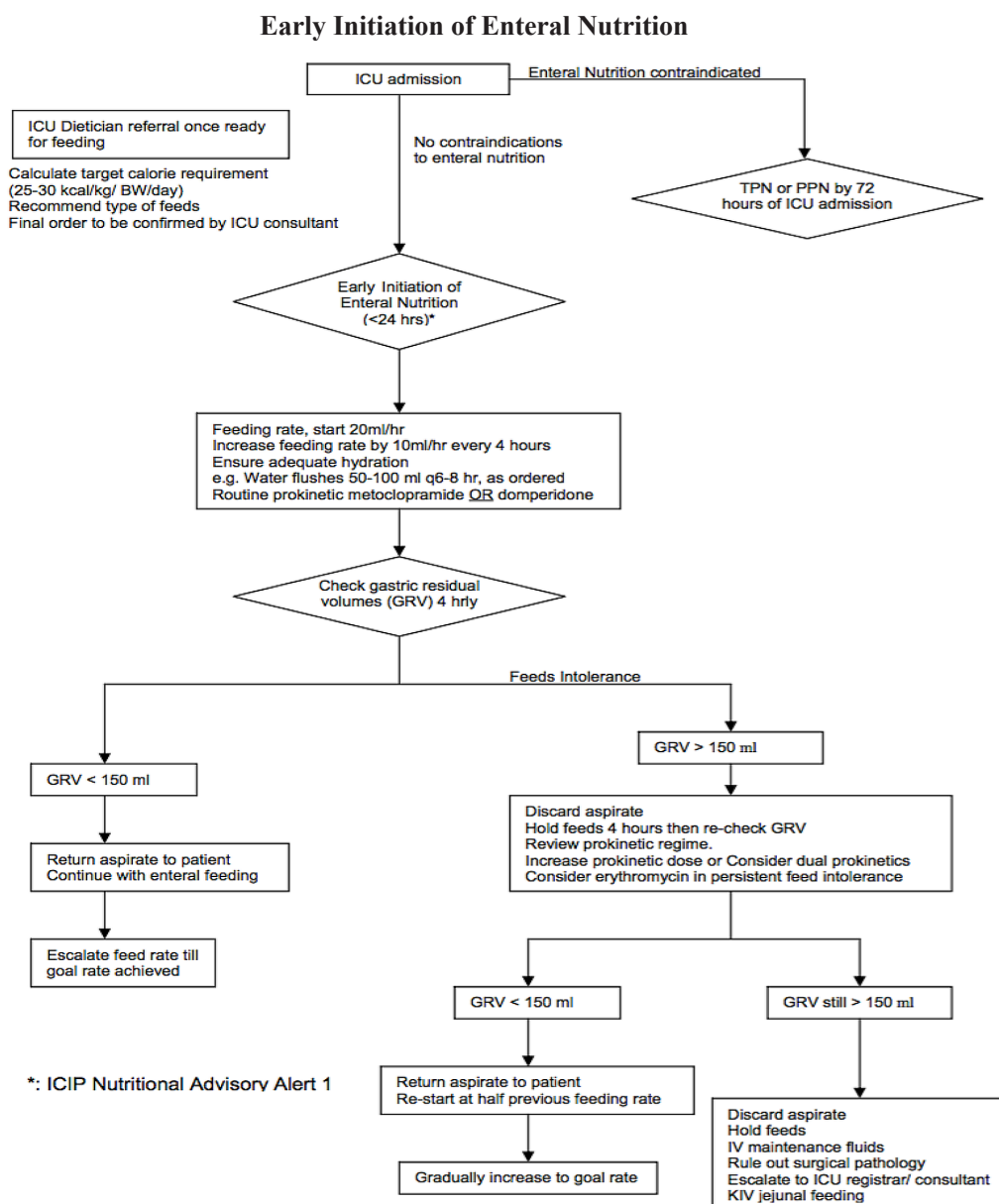


Fig. 3. Workflow which addresses early enteral nutrition initiation, intensive care unit (ICU) dietician review and management of high gastric residual volume (GRV).

Multivariate logistic regression model using a backwards stepwise elimination method was used to identify factors affecting enteral nutrition. Two-sided P value <0.05 was considered statistically significant for all comparisons. Stata v.10.1 (Statacorp, College station, Texas) was used in the statistical analysis of the results.

Results

There were no significant differences in patient demographics between the pre and postimplementation groups (Table 1).

There was significant improvement in the primary outcome of incidence of adequate feeding in the postimplementation group (39.5%) compared to the preimplementation group (25.3%), $P=0.048$. No significant differences in secondary outcomes were detected (Table 2).

Pre/postimplementation, patient's weight, postsurgical status, ICU LOS and ICU mortality were significant factors that affected nutrition in the study population.

Patients from postimplementation period (OR = 3.71; 95% CI, 1.42 to 9.62) and greater ICU LOS (OR = 1.28; 95% CI: 1.14 to 1.43) were more likely to have adequate

Table 1. Baseline Patient Characteristics by Implementation Groups

Patient Characteristics	Preimplementation (n = 83)	Postimplementation (n = 86)	P Value
Age (years) [†]	55.6 (17.1)	59.7 (15.0)	0.10
APACHE score [‡]	24.7 (5.11)	24.3 (5.21)	0.58
Admission Glasgow Coma Scale (GCS) [†]	4 (4)	4 (4)	0.60
Gender [*]			
Male	49 (59.04%)	48 (55.81%)	0.76
Female	34 (40.96%)	38 (44.19%)	
Weight [†]	58.0 (10.0)	56.8 (10.8)	0.46
Postsurgical [*]			
Yes	52 (62.65%)	56 (65.88%)	0.75
No	31 (37.35%)	29 (34.12%)	
Neurological diagnosis [*]			0.51
Subarachnoid haemorrhage	22 (28.57%)	27 (32.53%)	
Spontaneous cerebral haemorrhage	35 (45.46%)	27 (32.53%)	
Traumatic brain injury	12 (15.58%)	16 (19.28%)	
Brain tumour	5 (6.49%)	4 (4.82%)	
Ischaemic stroke with haemorrhagic conversion	3 (3.9%)	8 (9.64%)	
Arteriovenous malformation	0 (0%)	1 (1.2%)	

*Frequency (%) for categorical variables.

[†]Mean standard deviation (SD) for normally distributed data.

[‡]Median interquartile range (IQR) for non-normally distributed data.

feeding. Patients with lower body weight (OR = 0.89; 95% CI, 0.84 to 0.93), having postsurgical status (OR = 0.14; 95% CI, 0.05 to 0.39), and those who died in ICU (OR = 0.21; 95% CI, 0.06 to 0.70) were more likely to be underfed. Receiver operating curve (ROC) analysis with the area under the curves (AUC) 0.91 (95% CI, 0.86 to 0.95) indicated the final model exhibited excellent discriminatory property to differentiate between patients with and without adequate feeding.

Amongst the reasons for underfeeding, the 2 commonest were fasting for surgical procedures and investigations (37.5%) and patients deemed too ill to initiate enteral nutrition (22%) (Fig. 4).

Discussion

This study showed that implementation of a proactive nutrition protocol improved the delivery of enteral nutrition in mechanically-ventilated NICU patients. These findings were

Table 2. Primary/Secondary Outcomes by Implementation Groups

Patient Characteristics	Preimplementation (n = 83)	Postimplementation (n = 86)	P Value
Adequate feeding [*]			
Yes	21 (25.3%)	34 (39.53%)	0.048
No	62 (74.7%)	52 (60.47%)	
Kcal/kg/day [†]	15.6 (8.36)	17.5 (7.1)	0.12
Days of ICU stay [‡]	6.9 (8)	7.35 (6)	0.96
Days of mechanical ventilation [†]	4.6 (4.7)	5.2 (5.4)	0.80
Feed lapse time (days) [‡]	0.95 (0.9)	0.8 (0.7)	0.1
Infection [*]			
No infection	29 (55.77%)	29 (50%)	0.19
Airway/lung	13 (25%)	8 (13.79%)	
Wound	0 (0%)	2 (3.45%)	
Urinary tract	8 (15.38%)	17 (29.31%)	
Blood	2 (3.85%)	2 (3.45%)	
ICU mortality [*]			
Yes	25 (30.12%)	29 (33.72%)	0.616
No	58 (69.88%)	57 (66.28%)	
Glasgow Coma Scale (GCS) at end of study [†]	7 (4.29)	6 (3.82)	0.65

ICU: Intensive care unit

*Frequency (%) for categorical variables.

[†]Mean standard deviation (SD) for normally distributed data.

[‡]Median interquartile range (IQR) for non-normally distributed data.

consistent with others. For example, Mackenzie showed that nutrition support protocol implementation in their adult ICU improved patients achieving their predetermined caloric goal from 20% preimplementation to 60% postimplementation.¹

Delay in enteral nutrition initiation is commonly perceived to cause underfeeding. However, the time to initiation of enteral nutrition was ≤24 hours across the study population. This was compatible with the European Society For Clinical Nutrition And Metabolism (ESPEN) guideline of early enteral nutrition initiation within 24 hours of admission.² Frequent interruption of feeding was the most common reason for underfeeding. This highlights a unique aspect in the management of neurosurgical patients who often require fasting for repeated neuro-imaging and procedures including placement of external ventricular drain(s) or tracheostomy. Although these procedures were crucial to neurocritical care, 52% of these patients had unjustified reasons for delayed resumption of feeding. Common reasons include either physicians forgetting to re-order enteral feeding postprocedure or allowing excessive periods of fasting to monitor patients' condition postprocedure.

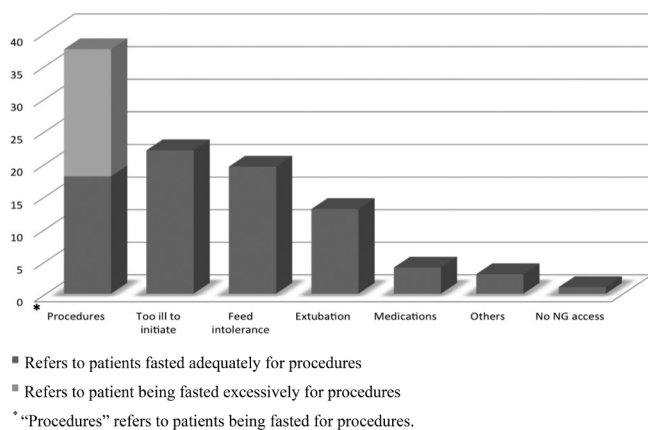


Fig. 4. Reasons for underfeeding in NICU.

A significant proportion of underfed patients were deemed too ill to commence enteral nutrition. These include multitrauma patients with severe TBI and/or concurrent abdominal/visceral injuries, or those receiving barbiturate coma therapy thus potentially developing ileus. Another group of patients suffered severe spontaneous intracranial haemorrhage with demise shortly after admission before enteral nutrition could be initiated.

Multivariate analysis showed that patients from post-implementation period and those with greater ICU LOS were more likely to have adequate feeding. This supported the finding that the nutrition protocol implementation improved EN in our patients. Also, patients who stayed in ICU for a longer time period were likely to allow more time for physicians to catch up with their nutrition requirements. Conversely, patients having postsurgical status (requiring perioperative fasting), lower body weight and those who died in NICU were more likely to be underfed.

Despite the protocol implementation, the rate of adequate feeding remained challengingly low at 40%. Similarly, Spain found that enteral nutrition delivery was improved with a nutrition support protocol but the compliance rate by physicians was only 58%.³ Continued education and raising awareness amongst ICU staff regarding the importance of nutrition in improving patient outcome is instrumental in enhancing protocol compliance.

The threshold of ≥ 150 mLs as high GRV in our protocol may be deemed too conservative. The North American Summit on Aspiration in the Critically Ill Patient advocated defining 400 mLs to 500 mLs as high GRV.⁴

Despite evidence of benefits of early enteral nutrition in the critically ill,^{5,6} our study detected no difference in secondary outcomes such as infection rates and mortality. This could be due to the study not being powered to detect a difference in secondary outcomes and being a retrospective observational

study without randomisation, there may be confounders not accounted for between the groups.

Conclusion

Implementation of a proactive nutrition protocol has improved nutrition delivery in ventilated neuro-ICU patients. However, the success of protocol implementation can be further enhanced with the continued education of ICU staff, accompanied by a mindset change that nutrition support in ICU patients is no longer merely an adjunctive care but rather proactive therapy that can improve patient nutrition.

Acknowledgement

The authors would like to thank Ms Lau Meng Tuan for her help in extraction of data from the patients in NICU as well as Mr Wilson Low Cong Jin for his help in statistical analysis of our data.

REFERENCES

1. Mackenzie SL, Zygun DA, Whitmore BL, Doig CJ, Hameed SM. Implementation of a nutrition support protocol increases the proportion of mechanically ventilated patients reaching enteral nutrition targets in the adult intensive care unit. *JPEN J Parenter Enteral Nutr* 2005;29:74-80.
2. Kreymann KG, Berger MM, Deutz NE, Hiesmayr M, Jolliet P, Kazandjiev G, et al. ESPEN Guidelines on Enteral Nutrition: Intensive care. *Clin Nutr* 2006;25:210-23.
3. Spain DA, McClave SA, Sexton LK, Adams JL, Blanford BS, Sullins ME, et al. Infusion protocol improves delivery of enteral tube feeding in the critical care unit. *JPEN J Parenter Enteral Nutr* 1999;23:288-92.
4. McClave SA, Snider HL. Clinical use of gastric residual volumes as a monitor for patients on enteral feeding. *JPEN J Parenter Enteral Nutr* 2002;26:S43-8.
5. Marik PE, Zaloga GP. Early enteral nutrition in acutely ill patients: a systematic review. *Crit Care Med* 2001; 29:2264-70.
6. Heyland DK, Dhaliwal R, Drover JW, Gramlich L, Dodek P; Canadian Critical Care Clinical Practice Guidelines Committee. Canadian clinical practice guidelines for nutrition support in mechanically ventilated, critically ill adult patients. *JPEN J Parenter Enteral Nutr* 2003;27:355-73.

Beatrice CL Lim, ¹MBBS, MMED (Anaes), Chin Ted Chong, ¹MBBS, MMED (Anaes), FANZCA, Sean Lim, ²MBBS

¹Department of Anaesthesiology, Intensive Care and Pain Medicine, Tan Tock Seng Hospital, Singapore

²Department of Anaesthesiology, National University Health System, Singapore

Address for Correspondence: Dr Beatrice Lim CL, Department of Anaesthesiology, Intensive Care and Pain Medicine, 11 Jalan Tan Tock Seng, Singapore 308433.

Email: limchinling@gmail.com