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Original Article

Success Rate of Volume Based Feeding in Intensive Care Unit, An Observational Study

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Abstract
Background: *Administration of early enteral feeding in critically ill patients was shown to improve outcome. However achieving target calorie and protein is found to be sub optimal in a proportion of critically ill patients. Fixed rate feeding and frequent feed interruptions for interventions are a major contributing factor for suboptimal energy and protein delivery. However volume based feeding in which target volume delivered over a given time with adjustable infusion rate is recommended by American Society of Enteral and Parenteral Nutrition. In this study we tried to find out the success rate of volume based feeding.*
Methods: *This was a prospective observational study. Proportion of feed days in which more than 80 % feed volume achieved was the primary objective and proportion of feed days in which more than 80 % calorie and protein achieved was the secondary objective. A volume based feeding protocol was implemented in the unit. Patients were followed up until they were transferred out from intensive care unit or until tube feeding stopped. Daily feed volume, calorie and protein achieved were audited.*
Results: *More than 80% prescribed volume, calorie and protein were delivered in 95%, 85.7% and 56.12% of enteral nutrition days respectively. In 98.7% of enteral nutrition days volume based feed is tolerated without any adverse events.*
Conclusions: *Volume based feed is safe and with prompt training of staff in delivering volume feeds, adequate nutrition can be delivered for patients in case of any interruption of feed.*
Keywords: *calorie, enteral nutrition, feed protocol, protein, volume based feeds.*

Introduction

Enteral nutrition in critically ill patients has shown to maintain the integrity and function of gastrointestinal mucosa.[1] It has many advantages over parenteral nutrition.[1] This form of nutrition can be provided through nasogastric or orogastric feeding tubes in intubated patients as a short term measure. Providing adequate nutrition as per

requirement is necessary because under-nutrition is detrimental. As per American Society of Parenteral and Enteral Nutrition (ASPEN) recommendations, critically ill patients are in hyper metabolic state and should receive at least 80% of ideal calorie requirement[1]. Critically ill patients in whom feeds started within 24 hours were shown to have better outcomes.[2] Formula feeds are administered in these patients on hourly basis and during any procedure or intervention there is high chance for interruption of feeds for an average of 2 to 6 hours[3] and such interruptions lead to under-nutrition. The relatively new concept of volume based feeding protocol designed to adjust infusion rate of the feed to compensate for interruptions in feed delivery should provide greater volume than fixed hourly rate based feeding methods.[4] At the same time administering such larger volumes may lead to aspiration and feed intolerance. ASPEN suggested further audits to find effectiveness, compliance and safety of volume based approach[5]. This study was designed to determine the success rate of our volume based feeding approach which was recently introduced in the unit.

Methods

The hospital had formulated a volume based feeding protocol several months prior to implementation of the study. Objective of the study was to find out the success rate of this volume based feeding with a primary objective to determine the proportion of total enteral nutrition (EN) days in which we could achieve minimum 80% of prescribed volume and secondary objective to determine the proportion of enteral nutrition days in which we could achieve a minimum of 80% of prescribed calorie and protein. After getting clearance from ethical committee, this record based observational study was done in patients admitted in a multidisciplinary intensive care unit of a tertiary level hospital who were more than 18 years of age and expected to stay for more than 48hrs. Pregnant patients, those who had contraindications to enteral nutrition and patients with high vasopressor requirement (>0.5 microgram/kg/min of noradrenaline) were excluded.

Based on the individualized feeding protocol, physicians prescribed the feed volume for 24 hours, daily calorie requirement (25kcal/kg body weight) comprising of 65-70% carbohydrate and 30-35% fat and daily required protein (1.5gm/ kg body weight).The feed volume was notified to the nurse who was taking care of patient. The total feed volume was displayed on a board in the intensive care unit which was visible to all the staff. The clinical nutrition staff were notified about the order through an electronic order who prepared a balanced isocaloric or hypercaloric feed as per the daily allowed fluids.

Feed preparation was handed over to nursing staff every 4 hours attaching a tag mentioning time for feed administration and volume of feed. The tag was separated from the feed preparation when initiating and it was kept at the bedside for further auditing. Nurses administered the feed through infusion bags using gravity bags and in case of interruption for any procedure feed volume was adjusted over remaining hours to compensate for the interrupted volume; however maximum infusion rate was limited to 150 ml per hour. For planned procedures feed volume was adjusted before and after the procedure so that the prescribed entire daily feed volume was ensured to be delivered. Gastric residual volume was checked every 4 hours, if it was more than 300 ml physician was notified about it and a gastric residual volume (GRV) protocol was implemented [fig 2].

Data on implementation of the feeding protocol was done every 24 hours since this was a new protocol being implemented and the hospital wanted to assess the compliance with the protocol. Two physicians and clinical nutrition staff cross checked the feed volume administered in the past 24 hours from monitoring chart and the tag sent along with feed. Also calorie and protein

administered in last 24 hours and events like vomiting, diarrhea, high GRV were noted. During this assessment process, nurses were trained again about volume based feeding and feeding protocol. Also the forthcoming planned procedure was noted in advance and if so subsequent plan for feed compensation was notified to the staff.

The records of the assessment of feeding protocol were accessed by the study team without accessing the patient identifiers. The records of only those patients in whom 24 hour feed was completed were included in data collection. If nasogastric or orogastric tube was removed without giving 24 hour prescribed volume they are excluded from data collection. This observational study assessed data of patient over a 50 day period covering 50 patients and data was collected from records for all included patients until they were transferred or expired.

Expecting that 63% of patients would achieve the required feeding based on a review of previous studies, it was calculated that records of about 164 patient feeding days would have to be extracted for determining this proportion with 95% confidence.[6] Data entry was done in Excel and analyzed using EpiInfo7. Continuous variables were expressed as mean and standard deviation and categorical variables were expressed as proportions with 95% confidence limits. Significance of difference in means assessed by student-t test / ANOVA for normally distributed variables or non-parametric tests for variables which were not normally distributed and significance of proportion between groups were tested by Chi-square test / fisher exact, wherever applicable.

Data collection was done every 24 hours during which two physicians and clinical nutrition staff cross checked the feed volume administered in last 24hours from monitoring chart and the tag sent along with feed. Also calorie and protein administered in last 24 hours and events like vomiting, diarrhea, high GRV were noted. Only those patients in whom 24 hour feed was completed were included in data collection. If nasogastric or orogastric tube was removed without giving 24 hour prescribed volume they are excluded from data collection. During this data collection process also nurses were trained again about volume based feeding and feeding protocol. Also the forthcoming planned procedure was noted in advance and if so subsequent plan for feed compensation was notified to the staff. This observational study was done over 50 days covering 50 patients and was completed when all included patients were transferred or expired.

Expecting that 63% of patients will achieve the required feeding based on a review of previous studies, it was calculated that about 164 patient feeding days would have to be observed for determining this proportion with 95% confidence.[6] Data entry was done in Excel and analyzed using EpiInfo7. Continuous variables were expressed as mean and standard deviation and categorical variables were expressed as proportions with 95% confidence limits. Significance of difference in means assessed by student-t test / ANOVA for normally distributed variables or non-parametric tests for variables which were not normally distributed and significance of proportion between groups were tested by Chi-square test / fisher exact, wherever applicable.

Results

50 patients comprising 37 males (74%) and 13 females (26%) were studied over a period of 50 days for a total 196 enteral nutrition days. The unit for analysis in the study was the enteral nutrition days. Mean enteral nutrition days were 3.9 $\pm$ 3.49 per patient. 10 patients had sepsis (20%) and 11 patients (22%) had polytrauma which constituted majority of patients.

The total number of enteral nutrition days achieved was 196 days. Mean feed volume delivered was 1387 $\pm$ 220.15 ml per feed day, mean calorie delivered was 1428 $\pm$ 172.6 per feed day and mean protein delivered was 77 $\pm$ 10.9 gram per feed day . In 95% of total enteral nutrition days we could achieve more than 80% of

prescribed volume [91.46 - 97.88%]. In 85.71% of Enteral Nutrition (EN) days more than 80% of prescribed calorie was delivered [80.02% - 90.29%]. More than 80% of prescribed protein was delivered in 56.12% of EN days [48.87% - 63.18%] (*table 1*).Protocol was tolerated well without any events, vomiting occurred on two occasions and hiccup on one occasion. Gastric residual volume was less 300ml in 98.97% of feed days. When comparing feed days with interruption due to procedures and feed days without interruption, means of volume, calorie and protein didn't differ significantly (P value 0.79, 0.44, 0.87) (table 2). In both groups feed days requiring fluid restriction were excluded.

Protocol violation was the only identified cause for inadequate volume delivery. Prescription error in calculating calorie was the major contributing factor for inadequate delivery of calorie. Non availability of an exclusive protein formulation to supplement the balanced polymeric formula was the main cause for inadequate protein delivery (Table 3) .When comparing two feed volumes, if feed volume was less than 1500 cc/day more than 80% of calorie and protein were delivered in 63 feed days and 27 feed days respectively. If feed volume was more than or equal to 1500 cc per day, more than 80% of calorie and protein were delivered in 105 and 83 feed days respectively. This was statistically significant (OR 13.9, p value <0.001) (table 4).

TABLE 1: Percentage of feed days achieving >80% volume, calorie, protein

>80%	*Frequency	Percent	Cum. Percent	95% Conf Limits
VOLUME	187	95.41%	95.41%	91.46 - 97.88%
CALORIE	168	85.71%	85.71%	80.02 - 90.29%
PROTEIN	110	56.12%	56.12%	48.87 - 63.18%

*Frequency in feed days.

TABLE 2: Mean volume, calorie and protein delivered when there is interruption of feed versus no interruption

	MEAN VOLUME±SD*	MEAN CALORIE±SD*	MEAN PROTEIN±SD*
FEED INTERRUPTION	1388.8 ± 205	1409.9 ± 127	77.6 ± 6.5
NO FEED INTERRUPTION	1404.2 ± 202	1444.5 ± 153	78.1 ± 10.1
P VALUE	0.79	0.44	0.87

*SD: standard deviation

TABLE 3: Reason for delivering less than 80% prescribed volume, calorie and protein

	REASON	FREQUENCY	PERCENT	95% CONFIDENT INTERVAL
VOLUME	PROTOCOL VIOLATION	9	4.60%	2.12 - 8.54%
CALORIE	PROTOCOL VIOLATION	7	3.57%	1.45 - 7.22%
	PRESCRIPTION ERROR	16	8.16%	4.74 - 12.92%
PROTEIN	*NON AVAILABILITY	60	30.61%	24.24 - 37.58%
	PROTOCOL VIOLATION	10	5.10%	2.47 - 9.18%
	PRESCRIPTION ERROR	16	8.16%	4.74 - 12.92%

*Non availability of exclusive protein formula

TABLE 4: Relationship between volume of feed and calorie, protein delivered

VOLUME OF FEED DELIVERED	CALORIE		PROTEIN	
	<80%	>80%	<80%	>80%
<1500ML	25 (28.41%)	63 (71.59%)	61 (69.32%)	27 (30.68%)
≥1500ML	3 (2.78%)	105 (97.22%)	25 (23.15%)	83 (76.85%)
TOTAL	28	168	86	110
	*OR 13.9 (4, 47.9), p value - <0.0001		*OR 7.5 (3.9, 14.1), p value <0.0001	

*OR- Odds ratio

Fig 1: Volume based feed protocol

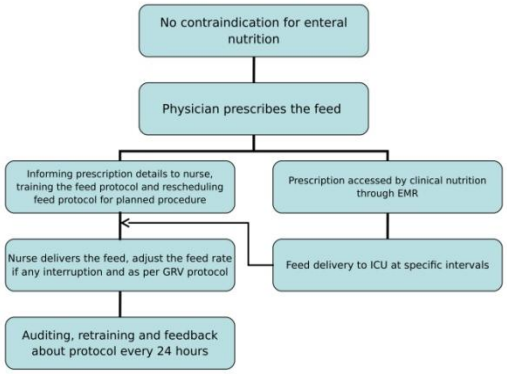
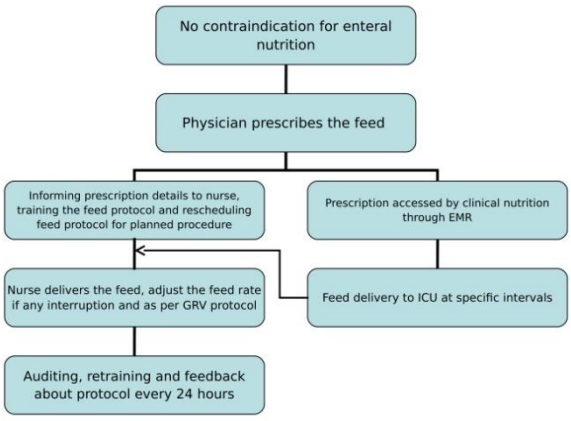


Fig.2. Gastric residual Volume Protocol.



The importance of enteral nutrition has been addressed in many studies. Enteral nutrition by maintaining gut integrity minimizes translocation of organisms, thereby reducing complications, length of stay and decreased risk of death.[7,8] Heyland etal showed that many patients didn't receive adequate nutrition while in ICU[9] and there was delay in initiation of feed in some patients. Feed interruptions while in ICU has been attributed to procedures in 55.9%, gastrointestinal symptoms in 24.2%, while procedures outside intensive care unit accounted for 18.4%[3], some of which can be avoided. Study by Heyland etal[9], Mckenzie etal[10] proved that protocol based feeds have positive strategy in optimizing delivery of nutritional support. American Society of Enteral and Parenteral nutrition also recommends volume based feeding protocol to optimize nutrition delivery based on Feed Early Enteral Diet for Maximal Effect' (FEED ME) protocol which showed that volume 'based approach improved nutrition and health care outcomes for ICU patients.[1,11] Similar results have been achieved with implementation of volume protocol in critically ill trauma patients[12] and Canadian study about implementing Enhanced Protein Energy Provision via Enteral Route Feeding Protocol(PEP uP protocol) in ICU proved that more than 80% of protein has been delivered in study group compared with control population.[6] Implementation and application of these volume based feeding protocol is also easy due to simplicity and through multiple teaching formats.[13]

Our results showed that more than 80% of prescribed volume and more than 80% of prescribed calorie and protein were achieved in 95%, 85.7%, 56.12% of feed days respectively. Guidelines suggest that achieving 80% of goal

energy reduces mortality.[1] So with isocaloric feed delivering minimum 80% prescribed volume can deliver at least 80% calorie. In case of any interruption of feed, following volume based feeding protocol can deliver adequate nutrition. In this trial calorie delivery was much higher than that from previous trials[6,9,12] in which 63-75% of goal calorie was met . This may be due to intense training, daily monitoring and feedback given by ICU physician and clinical nutrition team. In addition to workshops conducted, bed side training was given every day while collecting data and if any forthcoming interruptions were noted subsequent adjustment for feed volume was notified to concerned staff. In all cases in which the target volume not achieved, reason was protocol violation. Main reasons for inadequate delivery of calorie were protocol violation and prescription error.

Our study revealed inadequate protein delivery when balanced enteral nutrition formula was used More than 80% protein requirement was met in 56.12% of total feed days only. Main reason for this inadequate delivery was non availability of exclusive protein formulation to supplement the polymeric balanced enteral feed formula. Other reasons were prescription error (8.16%) and protocol violation (5.1%) in delivering the prescribed feed volume. Feed volume was also found to be a limiting factor in delivering calorie and protein. Among those feed days in which feed volume was less than 1500 cc per day, delivery of calorie was significantly less .There was a reduction in protein delivery when feed was limited to less than 1500 cc per day. When comparing feed days with interruption and without interruption for various ICU procedures the volume, calorie and protein delivered didn't differ significantly. This may indirectly indicate success of volume based feeding protocol. Adverse events noted with volume based feeding were also low in number.

Major drawbacks of our study were, we excluded sick patients receiving more than 0.5ug/kg/min of noradrenaline. Also the mean length of enteral feed days per patient was 3.9 days indicating probably less sick patients. Number of interruptions related to procedure was also less. Only in 56.12% of enteral nutrition days we could achieve more than 80% protein requirement. This was due to the non availability of exclusive protein enteral formulation to supplement the balanced polymeric feed. Feed volume was also a limiting factor in achieving the target calorie in this trial.

Conclusions

Volume based feeding along with intense training, daily monitoring and feedback can produce optimum energy delivery in majority of critically ill patients without much adverse events. Trials including sicker patients, undergoing frequent procedures and feed interruptions and with higher feed volume may give better idea about success rate of volume based feeding.

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