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Original article

The Incidence and Characteristics of Gastrointestinal Intolerance on Mechanically Ventilated Patients with Continuous versus Intermittent Feeding Method in The Intensive Care Unit: A Randomized Controlled Trial

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Abstract: Background: Enteral nutrition therapy via nasogastric tube can be administered through continuous or intermittent feeding methods for critically ill patients. However, there has not been existing consensus on the superiority of either method for mechanically ventilated patients due to insufficient evidence comparing the effectiveness of the two methods. The present study aimed to compare the impact of continuous versus intermittent feeding methods on gastrointestinal intolerance in mechanically ventilated patients. Methods: 41 mechanically ventilated patients in the intensive care unit, University Medical Center, Ho Chi Minh City, Vietnam from 3/2017 to 5/2017 were enrolled in a randomized controlled trial. They were randomly and equally assigned to the two study groups and monitored for 4 consecutive days on incidence of gastrointestinal intolerance including high gastric residual volume, abdominal distention, diarrhea, and tube occlusion. Results: There was statistically significant difference when comparing the gastric residual volumes between two groups with a median at 0.93ml (0.09-1.93) versus 11.61ml (7.61-17.28) ($p < 0.001$). The mean number of abdominal distention episodes in the continuous group was significantly lower than in the intermittent group (2.8 ± 2.66 versus 8.29 ± 5.1 episodes, respectively, $p < 0.001$). The diarrhea scores were not significantly different ($p < 0.05$) and there were no cases of occlusion recorded in the two groups. Conclusions: Continuous feeding method offered less gastrointestinal intolerance than intermittent feeding method by reducing gastric residual volumes and limiting abdominal distention. The feeding method did not increase the risk of tube obstruction if it was flushed regularly.

Keywords: Continuous feeding, intermittent feeding, mechanically ventilated patient.

1. INTRODUCTION

Enteral nutrition has long been used as a routine practice in energy provision for patients to perform cell metabolism, and to maintain and improve the health or recovery from their pathological conditions in Intensive care unit (ICU). Enteral nutrition therapy through nasogastric tube can be administered in some methods including continuous feeding with the feeding speed at 10-40 mL/h [1] or 20-50 mL/h [2-5] for 4 first hours and advanced by 10-20 mL/h every 8-12 hours [6] and intermittent feeding with the average amount of feeding delivered from 150-200 mL within 30 minutes every 3-4 hours. The advantages and disadvantages of each method are reviewed and their effectiveness is compared based on individual patient needs. Many factors must be taken into consideration including patient acuity, patient tolerance for each method and the availability of enteral feeding pumps. Intermittent feeding is more natural and physiological and allows patients greater mobility between feeding episodes [4] while continuous feeding ensures adequate nutrition. Patients on continuous enteral feeding will reach nutrition goals sooner, maintain appropriate weight, and be able

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to reduce the risks of digestive complications including nausea, vomiting or aspiration pneumonia. They also have a lower mortality rate and shorter length of stay in the ICU [6-11]. Although there have been some research studies [6-8, 12, 13] comparing the effectiveness of continuous and intermittent feeding, there were few studies comparing the incidence and characteristics of gastrointestinal intolerance between two methods in critically ill patients at the ICU.

2. METHOD

Study design: Randomized controlled trial

Setting and subjects

The study was conducted at the ICU, University Medical Center, Ho Chi Minh City, Vietnam from 3/2017 to 5/2017 using a convenience sample of patients available during the study period. *Inclusion criteria*: All patients aged 18 years or more who were machenically ventilated and nourished with enteral nutrition through nasogastric tube for 4 consecutive days or longer. *Exclusion criteria*: Patients who were connected to gastric aspiration system; with gastrointestinal tract problems such as reflux disease or cancer; who had had recent surgery on their digestive tracts; those with diabetes or hemodynamic instability, requiring inotropic medications or dialysis; patients suffering diarrhea or being prescribed with laxatives in the previous 72 hours.

Intervention

After the informed consents were signatured, the nurses collecting data assigned randomly and equaly patients either to group 1 or group 2 according to a rule that the first patient would be enrolled in the continuous feeding group (group 1), the second other would be enrolled in the intermittent group (group 2). The next patients were assigned according to this rule until the end of the study period. After randomizing the patients, the nurses collecting data requested that physicians order enteral nutrition prescription with continuous or intermittent feeding. In the continuous group, feeding would be administered through a feeding pump with a speed at 20 mL/h for 4 first hours and advanced gradually by 20 mL/h after every 4 hours until the highest rate at 100 mL/h or reach the nutrition goal as the prescription. In the intermittent group, nutrition would be delivered through an enteral feeding set up used routinely in the hospital. The patients were monitored for 4 consecutive days. All patients were nourished with the same commercial feeding formula.

Data collection

Data were collected by four nurses using a study tool composed by the authors. These four nurses with bachelor's degree and 2 years of experience in this ICU were equally and well trained at the same time to ensure consistent data collection and accurate measurements. The gastrointestinal tolerance has been evaluated in terms of 4 components: the amount of gastric residual volumes (GRV), diarrhea score, and frequency of abdominal distention and tube occlusion events. The nurses aspirated and measured the amount of GRV every 4 hours in the continuous group and before each feeding in the intermittent group by a 50 mL-syringe until no more fluid could be withdrawn. The amount of GRV > 200 ml was considered an indicator of intolerance [14]. Tube occlusion's presence was checked every shift by the data-collecting nurses. Patient's waist circumference was measured at the beginning of the study and every 3 hours after feeding. The nurses also assessed feces' characteristics of patients and recorded the scores for 24 hours daily for 4 consecutive days according to the guideline of King's stool chart.

Data analysis

Data was analyzed in SPSS 20.0. The dependency between feeding methods and occurrence of abdominal distension or diarrhea was verified by Pearson's Chi-squared test or Fisher exact test. The overtime fluctuation of GRV was evaluated by a repeated measure ANOVA. Student's independent sample t-test was used to analyze the effect of two feeding methods on diarrhea scores. Median value of GRV was compared using Mann-Whitney test. P value less than 0.05 was chosen as a statistically significant threshold.

3. RESULTS AND DISCUSSION

3.1 Results

Forty-two out of one hundred-fifty-three patients meeting all the sampling criteria participated in the study. One patient from the continuous group was discharged and removed from the study on the 3rd day. There were 41 subjects, who completed the study with 20 subjects in the continuous feeding group and 21 subjects in the intermittent feeding group.

The characteristics of the study subjects

The results in Table 1 showed no statistically significant differences in age, gender, cause of hospitalization and ICU length of stay prior to study between the two groups.

Gastric residual volume

The amounts of GRV for both groups at the beginning of the study were not significantly different with a median of 10 ml (2.5-17.5) in the continuous feeding group and 10 ml (10-20) in the intermittent feeding group ($p = 0.189$) (Man-Whitney Test). During the study, the GRV measured at every 4-hour interval were consistently lower in the continuous feeding group (0.93, 95%CI = 0.63-1.83) compared to the intermittent feeding group (11.61, 95%CI = 8.53-19.16). There was a statistically significant difference when comparing the GRV between the two groups with $p < 0.001$ (Man-Whitney Test).

The patients in the continuous feeding group showed a significantly reduction in GRV during the study with a pooled median of 0.93 ml (0.09-1.93) compared to baseline value of 10 ml (2.5-17.5), $p<0.001$ by paired sample T test). In contrast, no significant change in GRV has been observed during the study in the intermittent feeding group with no significant difference in comparison with $p = 0.511$ (Paired sample T-test).

In the intermittent feeding group, there were measureable GRV before each feeding in all patients with one notable case experiencing a gastric emptying delay with 230ml of GRV existing on the 4th day. In contrast, only 5/20 (25%) of patients in the continuous feeding group showed no GRV for the entire 4 days of study. The proportion of no GRV was significantly dependent on the choice of feeding methods, as confirmed by Fisher exact test ($p=0.021$).

The amount of GRV at baseline between the two groups was not statistically significantly different. However, the amount of GRV of patients fed continuously was significantly reduced and controlled at low values, compared to those fed intermittently over 4 consecutive days. Moreover, no interaction between time and feeding method could be expected, based on the longitudinal response graph (Figure 1).

Abdominal distention

There were 20% (4/20) of cases in the continuous feeding group that did not experience any distention episodes at throughout the 4 days, compared to 0% (0/21) of those in the intermittent feeding group. There was a statistically significant difference when comparing the proportion of abdominal distention episodes between the two groups with $p = 0.048$, as confirmed by Fisher exact test. The mean number of distention episodes over the 4-day period of patients in the continuous feeding group was significantly lower than in the intermittent feeding group (2.8 ± 2.66 vs 8.29 ± 5.1, $p <0.001$, T-test).

Diarrhea and tube occlusion

In the continuous feeding group, although, the mean diarrhea scores were higher in the 1st and the 2nd day and lower than in the intermittent feeding group for the last 2 days, no significant difference was found in comparing the mean diarrhea scores of two groups every day and during 4 day of follow-up ($p = 0.488$, T-test). In addition, one case of diarrhea was recorded in the intermittent feeding group on the 3rd and the 4th day of study and no case of tube obstruction was recorded in either group after 4 days of study.

3.2 Discussion

The results demonstrated that under continuous feeding method, Gastric Residual Volume (GRV) measured every 4 hours during the study was significantly reduced compared to the baseline level, and consistently lower than that in the intermittent feeding method. In addition, there was a notable gastric emptying delay presented in one patient fed intermitently who had 230 ml of GRV at one point of checking. The volume and speed of feeding affected the gastric emptying speed and GRV of patients, especially those on mechanical ventilation. In each intermittent feeding, the patients received as much as 200ml within 30 minutes exacerbating gastric emptying. The larger amount of food patients received, the more stomach function decrease they developed. This contributed to the high GRV in these patients. Consequently, high GRV was reported in 100% of patients fed intermittently with the maximum amount of GRV of 230 ml found in one checking in one patient. Whereas, patients in the continuous feeding group recieved a continous and stable speed of feeding at 20-62.5 ml/hr that considerably improved their digestive function. In this group, GRV was diminished or eliminated.

Compared to study results by Serpa [13] with no significant differences between the two groups, the results of this study vigorously demonstrated the effectiveness of continuous feeding compared to intermittent feeding on the ability to empty the stomach and improve the absorption and tolerance of patient.

Similar to the study by Serpa [13], in this study, abdominal distention was determined when the patient's waist circumference increased by 3cm or more compared to pre-intervention measurements. Abdominal distention is closely associated to the amount of food the patient receives in each feeding and the GRV, especially in poor digestive function. Therefore, in patients fed intermittently with high GRV, abdominal distention was likely to be more severe and happen more frequently. The study's results illustrated that the rate of patients experiencing abdominal distention and the mean number of this occurrence were significantly lower in the continuous feeding group than those in the intermittent feeding group who experienced high GRV ($p = 0.048$ vs $p < 0.001$, respectively). Although all patients in this study were mechanically ventilated by endotracheal intubation which is one of most common causes of gas-induced bloating relating to endotracheal insertion, they were regularly evaluated by doctors and nurses for abdominal distention whenever there were any symptoms to confirm the causes of abdominal distention related to gas-induced bloating or impaired digestion. During the study period, we did not record any abdominal distention episodes caused by endotracheal intubation in any subjects. Compared to the study results by Serpa [13] with no significant differences between two groups, the results of this study clearly demonstrated the effectiveness of continuous enteral feeding compared to intermittent enteral feeding in decreasing patients' abdominal distention.

In the continuous feeding group, the mean diarrhea scores were higher for the first two days and lower for the last two days compared to the intermittent group. This can be explained

in part by the fact that when patients were admitted into the ICU, instead of being maintained on a normal physiological diet, the patients are fed with nutritional formulas that include fat and other elements. Therefore, they might experience changes in digestive physiological responses to the changes of environment as well as their food intake, resulting in changes to their fecal characteristics. The results of this study, although, were not statistically significantly different in the diarrhea scores as was also found in Ciocon's study [8] where diarrhea was identified by the abnormal occurrence in the frequency of bowel movements. This study did show that continuous feeding had a better effect in controlling the digestive function of patients therefore limiting diarrhea. Moreover, similar to the study by MacLoed [6] and by Serpa [13], although there was no significant differences between the two groups on the diarrhea scores, the incidence of diarrhea in the continuous feeding group was lower than that in intermittent feeding group.

In the study by Ciocon [8], the rate of tube obstruction in a total of 30 subjects in each group was 50% (15/30) in the continuous group and 16.7% (5/30) in the intermittent group ($p = 0.01$). However, the results of this study did not find any cases of obstruction in either group over 4 days and three additional follow-up days up to the time of tube replacement per hospital policy. This could be explained by the fact that all patients with nasogastric tubes in both study groups had their tubes regularly flushed every 4 hours. In addition, none of the patients in this study was prescribed with powdered or oral soluble medications that could increase tube obstruction during the study period. This was also consistent with the general trend of most other patients at the ICU, University Medicine Center. The researchers in this study were not able to identify the type of food products used in Ciocon's study [8]. Therefore, it could be deduced that tube obstruction might not be affected by the delivery method if it was regularly flushed before and after feeding or taking medication according to standard procedure.

Table 1 The characteristics of the study subjects (n=41)

Characteristics	Continuous (n=20)	Intermittent (n=21)	Test	p value
Age (years)				
Mean ± SD (range)	72.25±11.6 55-95	73.05 ± 17.4 26-99	t=-0.172	0.865
Gender (%)				
Male	9 (45)	11 (52.4)	$\chi 2$=0.223	0.636
Female	11 (55)	10 (47.6)		
ICU Length of stay (days)†				
Median (interquartile range)	9 1.25-26.5	13 3-26.5	Z=-0.72	0.472
Primary diagnosis (%)				
Respiratory disorder	11 (55)	11 (52.4)		
Neurological disorder	4 (20)	3 (14.3)		
Cardiac disorder	3 (15)	3 (14.3)		
Multiple trauma	0 (0)	0 (0)	$\chi 2$=1.119	0.891
Septic shock/septicemia/multiple organ failure	1 (5)	1 (4.8)		
Others	1 (5)	3 (14.3)		
Total input food/24h (ml)				
(Mean ± SD)				
First day	1040 ± 0	1200 ± 0		
Second day	1200 ± 0	1200 ± 0		N/A
Third day	1200 ± 0	1200 ± 0		
Fourth day	1200 ± 0	1200 ± 0		

ICU: intensive care unit;
SD: standard deviation
†Mann-Whitney Test; N/A: non applicable

Table 2 Comparison the incidence and characteristics of gastric residual volumes (n=41)

Characteristics	Continuous (n=20)	Intermittent (n=21)	Test	p value
GRV before intervention† (ml) Median (Interquartile range)	10 (2.5-17.5)	10 (10-20)	Z= -1.314	0.189
GRV after intervention† (ml) Median (Interquartile range)	0.93 (0.09-1.93)	11.61 (7.61-17.28)	Z= -5.248	<0.001*
Pair T Test				
t	4.597	0.669		
p	<0.001*	0.511		
No GRV‡ (%)				
No	15 (75)	21 (100)	χ2= 5.979	0.021*
Yes	5 (25)	0 (0)		

GRV before intervention: Gastric residual volume before the first feeding after enrollment
GRV after intervention: Gastric residual volume before the next feedings after being fed continuously or intermittently
No GRV: Gastric residual volume is 0 ml at every checking before feeding
SD: standard deviation
*†Man-Whitney Test; ‡Fisher Test; * statistically significant difference (p<0.05)*

Table 3 Comparison the incidence and characteristics of abdominal distention and diarrhea (n=41)

Characteristics	Continuous (n=20)	Intermittent (n=21)	Test	p value
Abdominal distention† (%)				
No	4 (20)	0 (0)	χ2= 4.654	0.048*
Yes	16 (80)	21 (100)		
Distention episodes Mean ± SD	2.8 ± 2.66	8.29 ± 5.10	t= -4.283	<0.001*
Mean diarrhea score				
(Mean ± SD)				
Day 1	4.90 ± 2.6	3.19 ± 3.3	t= 1.808	0.078
Day 2	5.35 ± 3.0	4.95 ± 4.5	t= 0.333	0.741
Day 3	5.10 ± 2.6	6.81 ± 4.4	t= -1.518	0.139
Day 4	3.60 ± 2.6	5.52 ± 3.9	t= -1.809	0.078
Average of 4 days	4.73 ± 1.4	5.11 ± 1.9	t= -0.701	0.488
Diarrhea† (%)				
No	20 (100)	20 (95.2)	χ2=0.976	1
Yes	0 (0)	1 (4.8)		

SD: standard deviation
*†Man-Whitney Test; ‡Fisher Test; * statistically significant difference (p<0.05)*

4. CONCLUSION

The study's results showed that using continuous enteral feeding versus intermittent enteral feeding may enable health care providers more ability to manage and control the incidence and characteristics of gastrointestinal intolerance in mechanically ventilated patients including promoting gastric emptying, decreasing abdominal distention, and improving fecal characteristics of patients. In addition, neither feeding method increased the risk of gastric tube obstruction as long as the tubes were well managed and regularly flushed according to protocol. It is recommended that this study be duplicated with larger sample size to further compare other feeding issues such as the ability to stabilize blood glucose levels in enteral fed patients.

Strengths: The study used validated and reliable measurement tools with detailed scale, which provided specific quantitative variables, consistent with ICU patients' characteristics and appropriate for conducting research. This randomized controlled trial is a valuable research design. Therefore, the reliability and validity of the results are useful. This sample size though not sufficiently large, was equivalent to previous studies. This study adds to the body of nursing knowledge as we work to improve patient outcomes.

Limitations: Because of the short duration allowed for this study, and the number of rigorous sampling criteria, the study could only be conducted for 3 months with a small sample size. In addition, because the study was not conducted in non-mechanical ventilated patients, the results did not completely represent those who were non-invasively ventilated in the ICU.

Medical ethics: The study was approved by the Ethics Council of University of Medicine and Pharmacy at Ho Chi Minh City. Approval number was 466-ĐHYD-HĐ.

CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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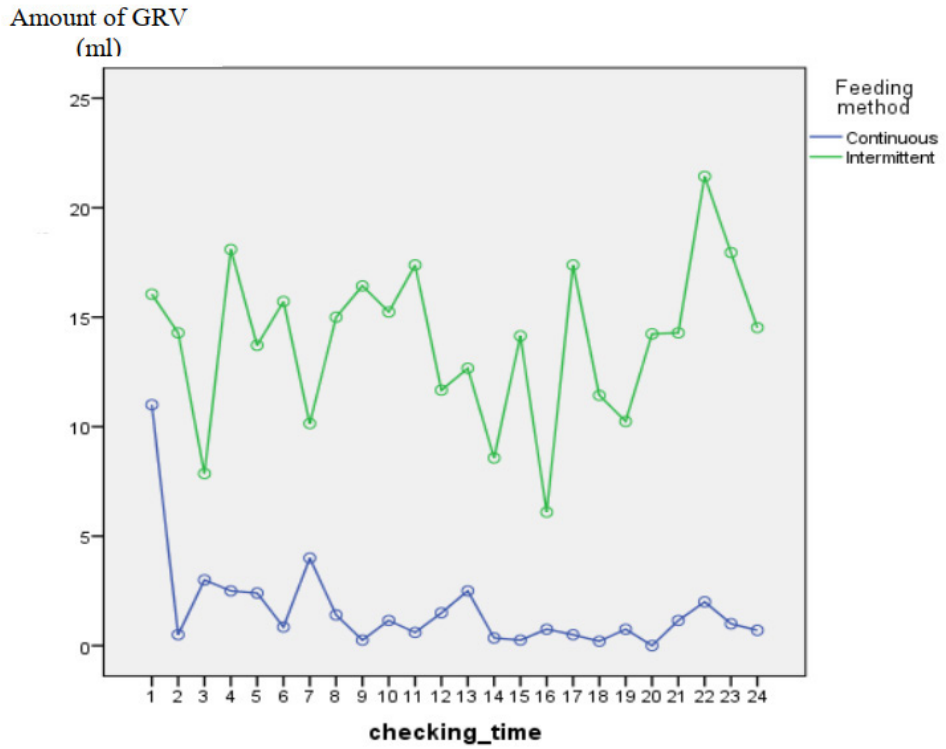

Checking time: the first time at baseline; the remaining times as during the study
Amount of GRV: the amount of gastric residual volume at each checking

Figure 1: Comparison the mean gastric residual volume between two groups over the 4 consecutive days

REFERENCES

1. McClave SA, Martindale RG, Vanek VW, et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (ASPEN). Journal of Parenteral and Enteral Nutrition. 2009; 33(3):277-316.

2. Parrish CR. Enteral feeding: the art and the science. Nutrition in clinical practice. 2003; 18(1):76-85.

3. Thibault R, Graf S, Clerc A, Delieuvin N, Heidegger CP, Pichard C. Diarrhoea in the ICU: respective contribution of feeding and antibiotics. Critical Care. 2013; 17(4):R153.

4. Ichimaru S, Amagai T. Intermittent and Bolus Methods of Feeding in Critical Care. Diet and Nutrition in Critical Care. 2015:533-48.

5. McClave SA, Taylor BE, Martindale RG, et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (ASPEN). Journal of Parenteral and Enteral Nutrition. 2016; 40(2):159-211.

6. MacLeod JB, Lefton J, Houghton D, et al. Prospective randomized control trial of intermittent versus continuous gastric feeds for critically ill trauma patients. Journal of Trauma and Acute Care Surgery. 2007; 63(1):57-61.

7. Kocan MJ, Hickisch SM. A comparison of continuous and intermittent enteral nutrition in NICU patients. Journal of Neuroscience Nursing. 1986; 18(6):333-7.

8. Ciocon JO, Galindo-Ciocon DJ, Tiessen C, Galindo D. Continuous compared with intermittent tube feeding in the elderly. Journal of Parenteral and Enteral Nutrition. 1992; 16(6):525-8.

9. Bonten M, Gaillard C, Van der Hulst R, et al. Intermittent enteral feeding: the influence on respiratory and digestive tract colonization in mechanically ventilated intensive-care-unit patients. American journal of respiratory and critical care medicine. 1996; 154(2):394-9.

10. Steevens EC, Lipscomb A, Poole GV, Sacks GS. Comparison of continuous vs intermittent nasogastric enteral feeding in trauma patients: perceptions and practice. Nutrition in Clinical Practice. 2002; 17(2):118-22.

11. Duggan C, Watkins JB, Walker WA. Nutrition in pediatrics: basic science, clinical applications. PMPH-USA. 2008.

12. Beau P, Labat J. Continuous vs discontinuous enteral nutrition: compared effects on serum lipids and lipoproteins in humans. Journal of Parenteral and Enteral Nutrition. 1994; 18(4):331-4.

13. Serpa LF, Kimura M, Faintuch J, Ceconello I. Effects of continuous versus bolus infusion of enteral nutrition in critical patients. Revista do Hospital das Clinicas. 2003; 58(1):9-14.

14. August D, Teitelbaum D, Albina J, et al. Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. Journal of Parenteral and Enteral Nutrition. 2002; 26(1):1SA-138SA.