Original Article

Comparison of the effects of enteral feeding through the bolus and continuous methods on blood sugar and prealbumin levels in ICU inpatients

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ABSTRACT

Background: Appropriate nutritional support is effective on achievement of expected outcomes in intensive care unit (ICU) patients. Although several studies have suggested different conclusions about the effectiveness of tube feeding methods, there is no specific program of nutritional support for patients who have been hospitalized. There is a possibility for complications due to an inadequate nutrition. The aim of our study is to compare the effects of enteral feeding through the bolus and continuous methods on blood sugar and prealbumin level among the ICU inpatients. **Materials and Methods:** Fifty subjects were selected by convenient sampling from April to Aug 2013 in the ICU wards of Alzahra Hospital, Isfahan, Iran, and randomly assigned to study and control groups in this clinical trial. The subjects in the study group received infusion pump feeding while the control group received bolus feeding for 72 h. Blood sugar was checked for every 4 h for 72 h and the prealbumin level was assessed on the first and the fourth day in two groups. **Results:** In the study group, the mean blood sugar significantly decreased on the fourth day, compared with the first ($P = 0.03$, $F = 3.85$) and third ($P = 0.01$, $F = 3.15$) day. In the control group, the mean blood sugar increased from the first day. It was significantly higher in the control group on the second day ($P = 0.02$, $F = 3.55$), compared with the study group. In the study group, there was a significant difference in the mean prealbumin before and after intervention ($P = 0.048$, $t = 1.97$), but no significant difference was observed in the control group. There was a significant difference between two groups after intervention ($P = 0.04$, $t = 2.05$). **Conclusion:** The obtained results showed that supportive nutrition through a continuous method had an effect on critical patients' blood sugar control and made a better nutritional status for these patients through an increase of prealbumin level. Positive effects of this feeding method can result in appropriate outcomes for patients' recovery and reduce the complications.

Key words: Blood sugar, bolus feeding, continuous feeding, intensive care unit, prealbumin

INTRODUCTION

Adequate and appropriate nutritional intake is one of the basic needs in humans to run cellular metabolism, preserve

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and promote health, and improve recovery. Therefore, provision of appropriate nutrition and nutritional support is a key aspect of patients' care and treatment, especially among the patients hospitalized in intensive care units (ICUs).[1] Research studies show that timely and appropriate nutritional support is effective on achievement of expected outcomes in ICU patients.[2,3] Nowadays, nutritional support has been accepted as a standard clinical intervention.[4] Lack of appropriate dietary intake leads to complications and prolonged hospitalization in ICUs, and consequently, an increase in treatment costs and a longer need for mechanical ventilation.[5-7]

Nutritional support is conducted to prevent malnutrition, modify the nutritional defects, lower katabolic reactions, speed up healing of the wounds, and improve outcomes in the treatment of ICU patients. It can be conducted in enteral and intravenous feeding methods on the basis of patients' conditions and the hospital regulations.[8] According to American Intensive Care Association, over 5 million people are admitted in ICUs in the United States every year. About 2 million people refer to medical care centers in Iran every year and of whom 20–30% need intensive care. Research works showed that 12–71% of the patients undergo intravenous feeding and 33–92% enteral feeding in ICUs.[9] Tube feeding is administrated through three routes of orogastric, nasogastric, and gastrostomy tubes.[10] To maintain tube feeding, continuous, intermittent and bolus methods are used, and it is possible to select each of them for patients.[11]

There are various comments on continuous and bolus feedings. Several studies have shown different results about the effectiveness of nutritional support methods. Kocan and Hickisch, on 34 children in the ICU, showed that continuous and bolus feeding methods had no effect on frequency and viscosity of stool. They also found that the level of aspiration or calorie intake was not different in two groups.[12] On the other hand, Marino reported that bolus gavage is more similar to the natural process of eating food in humans, but increases the risk of aspiration and diarrhea. Meanwhile, continuous infusion is tolerated better and leads to more weight gain and positive nitrogen balance.[13] Duggan showed that continuous tube feeding is effective on the control of blood sugar through making a change in a usual pattern of insulin and glucagon secretions.[14]

In a study on burned children, Williams *et al*. showed that appropriate nutrition is accompanied with an increase in prealbumin. In traumatic patients and those with a head injury, prealbumin is the most reliable indicator to check adequacy of the nutrition. Serial measurements of prealbumin, as a precise monitoring tool, and evaluation of nutrition are applicable to modify the condition.[15]

Although provision of nutrition and fulfillment of patients' nutritional needs are among nurse's duties, research shows that various methods are used in patients' nutritional support in ICUs.[16] In the clinical setting of the study, different methods of feeding tubes were used and there in no specific program of nutritional support for critical patients who have been hospitalized, which may lead to complications from an inadequate nutrition. To determine the effectiveness of two methods of nutritional support, this study aimed to compare the effects of enteral feeding through bolus and continuous methods on blood sugar and prealbumin in the patients hospitalized in the ICU.

MATERIALS AND METHODS

This clinical trial study involves the study and control group in which the data were collected through five stages (before intervention, the first day, second day, third day, and fourth day after intervention). In our study, sampling was performed from April to August 2013 in the ICU wards of Alzahra Hospital, Isfahan, Iran. Based on the study of Serpa *et al*.[17] and using statistical formula $(\frac{(z_1+z_2)^2(2s^2)}{d^2})$ with $z_1 = 1.96$, $z_2 = 0.84$, $s = 1$, $d = 0.8$, 50 subjects from all patients admitted in three ICUs were selected. They fulfilled the inclusion criteria and selected initially through convenient sampling and then randomly assigned to the study and control group equally. One of the subjects in the study group passed away, and the study was performed with 49 subjects. In the following study, there was no sample loss.

Inclusion criteria included that the patients should be hospitalized in the ICU, aged 18–65 years, had healthy digestive system, unable to swallow food orally but had the possibility of bolus or continuous feeding methods, had similar indications for both methods and had no fistula, necrosis or obstruction and surgery of gastrointestinal system, peritonitis and diabetes or history of glucose intolerance.

After confirmation of nasogastric tube fixation, feeding started in both groups. The subjects in both groups received an already made complete diet (1 kcal/cc), through a gavage tube. On the basis of previous studies,[17-20] the prescribed nutritional material was Enchur powder of which seven measure cups are mixed with 90 cc water and makes 100 cc of nutrition. The total number of calories and the required volume were calculated by a nutritionist through the Harris–Benedict equation, and patients' condition.

In the control group, feeding was administrated by the bolus method as routine method of the ward. In this group, the needed calories were divided into six portions, which were gavaged within 10–20 min by a syringe sequentially and the volume of gavage increased by 50 cc according to patients' tolerance and the residual volume of patients' stomach (<150 cc) every 6 h to achieve the targeted volume and calories. Before each gavage, the residual volume of stomach was measured and recorded. The experiment solution was kept at room temperature for 30 min to be modified regarding its temperature before being gavaged.[18]

In the study group, feeding was administrated to the patient through the continuous method by a pump syringe for 24 h.

The gavage volume increased by 20–50 cc every 4–6 h to reach the calculated calories and the volume for the patient. Subjects' residual volume of the stomach was measured and recorded every 4 h by using a syringe.[19]

Subjects' blood sugar was measured by patients' nurse using a glucometer every 4 h and was recorded in the checklist of the control and study groups. In this checklist, patients' file number, feeding method, type of baseline disease, and mean blood sugar before the intervention were recorded. The prealbumin serum level was an important criterion for determining the adequacy of nutrition and it was measured and recorded for all the subjects in the study and control groups before intervention and 3 days after. Reliability of the laboratory test was ensured using calibration of the setting. Content validity of the checklist was performed through viewpoints of 10 experts of anesthesiology, nutritionist, and nurses.

In our study, letter of introduction issued by Isfahan Nursing and Midwifery School was delivered to the authorities of research environment. An informed consent form was completed for each patient by one of their immediate family members (as most of the subjects were unable to communicate and complete the consent form themselves), and they were explained about the possible complications.

The data, obtained from each group, were analyzed by SPSS version 18. First, through descriptive statistics, the obtained demographic data such as age, sex, type of baseline disease, and hospitalization cause, other disease history, feeding method and the feeding route were collected. Finally, the hypotheses were tested by the paired *t*-test, independent *t*-test and repeated measures ANOVA.

RESULTS

The obtained results showed no significant difference in age, sex, history of diabetes, cause of hospitalization, connection to ventilator, and tube feeding route revealing that the subjects were homogenous in both groups [Table 1]. Comparison of the mean blood sugar on the first and fourth day ($P = 0.03$), and the third and the fourth day ($P = 0.01$) showed a significant difference in the study group. The mean blood sugar on the fourth day had significantly decreased, compared with the first and third day in the study group, but there was no significant difference in other time points ($P > 0.05$). Repeated measures ANOVA showed a significant difference in the mean blood sugar at various time points in the study group so that the mean blood sugar had decreased on the other days, compared with the first day ($P = 0.03$).

In the control group, the mean blood sugar significantly increased on the second day, compared with the first day ($P = 0.02$). However, it decreased on the fourth day, compared with the second ($P = 0.045$) and third day ($P = 0.04$). There was no significant difference at other time points ($P > 0.05$). Repeated measures ANOVA showed a significant difference in the mean blood sugar at various time points in the control group ($P = 0.04$), so that the mean blood sugar increased on the other days, compared with the first day [Table 2].

Independent *t*-tests showed no significant difference in the mean blood sugar between the two groups on the first ($P = 0.96$), third ($P = 0.26$) and fourth ($P = 0.15$) days, but on the second day ($P = 0.04$), the mean blood sugar was significantly higher in the control group, compared with the study group.

In the study group, there was a significant difference in the mean prealbumin level before and after intervention ($P = 0.048$) so that the mean prealbumin level had increased. However, in the control group, there was no significant difference in the prealbumin level before and after intervention ($P = 0.92$). The mean prealbumin levels showed no significant difference in the two groups before intervention ($P = 0.75$), but after intervention, a significant difference was observed in the two groups ($P = 0.04$) [Table 3].

DISCUSSION

The obtained results showed that the mean blood sugar significantly decreased on the sequential days in continuous tube supportive feeding (the highest reduction was observed on the fourth day). However, in bolus supportive feeding, not only no reduction in blood sugar was observed but also there was a notable increase in blood sugar on the second and fourth day. The results showed that continuous tube feeding had been more effective on the management and stability of blood sugar. So the patients faced no instability in their blood sugar, and an increase in blood sugar was less observed among patients undergoing continuous feeding.

The speed and volume of nutrients has a direct effect on the management of blood sugar.[20] Research showed that continuous tube feeding influences blood sugar control

Table 1: Comparison of demographic characteristics of the subjects in the two groups

Group	Cause of hospitalization			Mechanical ventilation		Route		Sex		Age (year)
	Internal medicine disease	Neurosurgery	Neurology	No	Yes	Orogastric tube	Nasogastric tube	Male	Female	
Study group	3 (12%)	17 (68%)	5 (20%)	2 (8%)	23 (92%)	3 (12%)	22 (88%)	18 (72%)	7 (28%)	41.4 15.3
Control group	5 (20%)	14 (56%)	6 (24%)	2 (8%)	23 (92%)	5 (20%)	20 (80%)	20 (80%)	5 (20%)	41.1 12.4
Test			P=0.32		P=1		P=0.35		P=0.508	P=1

Table 2: Comparison of the mean blood sugar of the subjects in the two groups before and after the intervention

Time	Control group		Study group		*T* test	
	SD	Mean BS	SD	Mean BS	*P*	*t*
First day	23.31	140.25	21.59	139.98	0.96	0.04
Second day	29.93	151.85	21.88	139.26	0.04	2.05
Third day	33.27	148.6	27.13	143.09	0.26	1.12
Fourth day	36.73	140.26	21.42	131.31	0.15	1.27
Repeated measure ANOVA						
F	3.15		3.55			
P	0.04		0.03			

Table 3: Comparison of the mean blood prealbumin of the subjects in the two groups before and after the intervention

Prealbumin	Control group		Study group		*T* test	
	SD	Mean	SD	Mean	*P*	*T*
Before study	4.3	22.84	5.4	23.27	0.75	0.31
After study	7.29	22.71	6.38	25.66	0.04	2.05
T paired test						
T	0.09		1.97			
P	0.92		0.048			

through formation of a normal pattern of insulin and glucagon secretions.[14]

An excessive intake of nutrients in one time causes blood sugar to increase, while in continuous feeding, the level of blood sugar is controlled better.[21] Control of blood sugar level can prevent occurrence of complications in patients. Capes *et al*., in their systematic over view, showed that an increase in blood sugar affected the rate of patients' mortality and illness among the patients with hard and acute diseases such as myocardial infarction (MI) and cerebral vascular accident CVA).[22] Baker *et al*. showed that an increase in blood sugar in the hospitalized patients with no history of diabetes had a high impact on complications development and poor outcomes in patients.[23] Van Den Berghe *et al*. showed that an increase in blood sugar and insulin resistance in critically ill patients, even those with no history of diabetes, is common, and a special care concerning blood sugar control and prevention of its increase is essential to prevent brain ischemia in traumatic patients.[24]

In the control group, blood sugar increased from the second day onward, which showed a poor outcome in the management of patients' condition. This increase in blood sugar was observed following increasing the volume of gavage feeding so that higher volumes enhanced the difference in blood sugar day after day. No control on blood sugar leads to several complications in the patients. On the other hand, in the study group, the mean level of blood sugar decreased from the second day to an acceptable level, which is effective on prevention of complications. This reduction was observed due to a gradual and continuous increase in the volume of gavage feeding.

On the basis of the obtained results, the prealbumin level significantly increased in the study group, while no change was observed in the prealbumin level in the control group. Although there was no significant difference in the level of prealbumin before intervention in the two groups, the mean prealbumin level showed a significant increase in the continuous feeding group after intervention. The findings of our study showed that continuous supportive feeding can be applied for an appropriate nutrition. An increase in the level of prealbumin in response to feeding, followed by provision of nutrients for the patients' body cells, is an indicator for modification of metabolism condition.[25] In a clinical trial (2011) on burned children in Russia, it was shown that appropriate nutrition was accompanied with an increase in the prealbumin level.[15] In another study on the ICU patients, a notable increase in the level of patients' prealbumin level was observed after adequate and appropriate nutrition, compared with the subjects without adequate nutrition.[26]

Prealbumin is counted as a maker for the nutrition status. In our study, the serum level of prealbumin increased by the absorption of the nutrients. Prealbumin levels were normal in both groups before intervention. In the control group, although no reduction was observed, there was no modification in patients' protein condition, possibly due to the delayed time of reaching to target calories in the control group. In the study group, a notable increase was observed in the prealbumin level, possibly due to lower speed of nutrients transition through gastrointestinal system which gave the nutrients a better chance of absorption. The patients reached target calories sooner in this group, compared with the study group.

It is recommended that a similar study with a larger sample size under other clinical environments should be conducted.

CONCLUSION

The results of this study showed that the subject undergoing nutrition through infusion feeding not only had their blood sugar controlled better, but also had an increase in their prealbumin serum level. The subjects undergoing bolus feeding had neither their blood sugar controlled nor an appropriate level of the prealbumin serum level. The results showed that supportive nutrition through continuous feeding has a direct and efficient impact on critical patients' blood sugar control and can have direct and indirect effects on disease outcomes and their hospitalization. Continuous feeding is effective on improvement of patients' nutrition status and prevention of delayed treatment through its direct effect on pre albumin serum level. If there was any contraindication to use of these two nutritional support methods, it is suggested to apply continuous supportive feeding for the patients admitted in ICU.

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Conflicts of interest

There are no conflicts of interest.

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