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Original Article (Pages: 2119-2130)

Comparing Two Methods of Enteral Nutrition in Terms of their Complications and the Time Needed to Reach Goal Calorie in Children Hospitalized in ICU

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Abstract

Background

Nutrition support and noticing the required goal calories in patients having critical conditions are essential aspects of medical care in preventing malnutrition in these patients.

Materials and Methods

This research is a clinical trial which was done on 60 children aging between 5 to 17 years old hospitalized in Intensive Care Unit (ICU) of Shiraz's Namazee hospital, South West of Iran, during April to September 2015. Patients were separated randomly into two groups. Enteral nutrition was done with infusion pump for one of the groups and intermittently for the other one. The data was collected for 7 days by a check list regarding enteral nutrition method, complications and the time needed to reach goal calories. Data analysis was done using SPSS-18 software through Chi-square and t-student test.

Results

The results of this study showed that there was a significant difference of the mean time needed to reach target goal calorie between the continuous and intermittent nutrition methods ($P<0.05$), so the time was less in continuous infusion method. Results showed that there was no significant difference between the GI complications of the two groups ($P>0.05$).

Conclusion

This study showed that continuous enteral nutrition method has better outcomes in children hospitalized in ICU than intermittent method.

Key Words: Children, Enteral Nutrition, Goal calorie, Intensive Care Unit, Nutrition Support.

*Please cite this article as: Fayazi S, Adineh M, Zahraei Fard S, Farokh Payam H, Ahmadie Batvandy Z. Comparing Two Methods of Enteral Nutrition in Terms of their Complications and the Time Needed to Reach Goal Calorie in Children Hospitalized in ICU. Int J Pediatr 2016; 4(7): 2119-30.

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Received date Feb 15, 2016 ; Accepted date: Mar 22, 2016

1- INTRODUCTION

Long terms experiences have shown that unbalanced nutrition or disorders in digesting, absorbing and metabolism of food, causes appearance of disease due to lack of nutrients(1). On the other hand, most of the diseases regarding infectious disease, traumatic injuries and metabolic disorders cause malnutrition even in patients having desired nutrition support (1). Thus, nutrition is one of the main parts in medical care of hospitalized patients (2), especially those with critical conditions hospitalized in ICU (3). Failure of attention to nutrition and food needs causes catabolism of skeletal muscles and metabolism of fat, also leading to weakness of muscles (10) especially respiratory muscles and long dependence to ventilator machine, disorders in deep breathing and cough and therefore causing infections and pneumonia in these patients (11,12). On the other hand, malnutrition can cause damage to vital organs (3) and decrease the speed of wound healing (12, 13) and therefore increasing the mortality rate of the patients 3.8 time more (14). In addition, this can not only increase the recovery period to 5 days more than normal (13,15), but also inflicts severe emotional loads regarding disappointment and discouragement to patient's family(16) and increase the treatment cost by 50% (3,13). Prolongation of treatment causes the other patients waiting for being hospitalized in ICU not to receive in-time medical care (16, 17).

As described, providing needed nutritional support for reaching goal calorie and reducing catabolism of protein and fat is one of the most important aspects of medical care in patients having critical conditions; and mostly applies to children hospitalized in ICU who receive more stress (18-20). Nutritional support is done inactively whether by enteral or parenteral nutrition. Although the best route of nutrition is oral, but sometimes cannot be done due to reasons, thus inactive methods are used instead (19-21). Nutrition by tubes (Naso Gastro Tube=NGT or Orophagial Gastro Tube=OGT) which are superior to parenteral nutrition are done for the groups of patients at least having the ability of digestion and absorption of foods (19, 22) who are not able to take the food orally (14, 23-25). Approximately 85-90 percent of hospitalized patients in ICU who need nutritional support are fed through OGT or NGT (20, 26). Generally use of OGT or NGT was expanded from 20^{th} century for nutritional support (18, 27) and was preferred to parenteral nutrition, because parenteral nutrition is assumed to be dangerous due to complications such as infection or liver failure (18). Additionally, the cost and complications of enteral nutrition though OGT or NGT are less than parenteral nutrition (28). As an example, using enteral nutrition in a hospital of Sweden had about 357$ cost benefits (29).

Enteral nutrition is done by two methods of intermittent and continuous. The intermittent method is known, because it is more similar to physiologic status of the body, but some scientists believe that its complications such as food intolerance, diarrhea, aspiration, abdominal distention and vomiting are higher (30). In continuous method, nutrition is done uninterruptedly with pumps (25, 30). This method is known because a small amount of food gradually enters the stomach and may increase food tolerance and reduce the complication (13, 30), but the results of studies which compared the two in terms of tolerance and complications are controversy. For example, there are studies showing that, the speed of reaching goal calorie and the rate of tolerance are higher in patients fed by continuous method and the complications are less(2). Conversely, other studies showed that the time of reaching goal calorie and complications of intermittent method are lower (2). Also,

some other studies reported no significant difference between these two methods (2). Thus, there is no adequate information to know which method of nutrition is preferred in patients having critical conditions especially for children hospitalized in ICU (31- 33), for example, it was shown in the study of Rabert Hacker et al. In Viscancine that the rate of food tolerance was higher in the group fed by intermittent method and the speed of reaching goal calorie was higher in this group than the group fed by continuous method (P=0.01) (34); but, other study showed that, there was no significant difference in the incidence of complications between the two groups of intermittent and continuous nutrition methods (P=0.05) (2). Thus, noticing the controversy results of studies comparing enteral nutrition by intermittent and continuous methods and lack of studying on children, this study was performed to compare intermittent and continuous methods of enteral nutrition in terms of reaching goal calorie and their complication (diarrhea and vomiting) in the children hospitalized in ICU Shiraz's Namazee hospital, Iran.

2- MATERIALS AND METHODS

2-1. The study design and participants

This study was a clinical trial which was performed on the children aging 5-17 who were hospitalized in ICU of Shiraz's Namazee hospital, South West of Iran, during April to September 2015. Noticing the criteria of studied units, and inclusion and exclusion criteria and also according to the previous studies and statistic formulas, 60 patients (30 in each group) entered the study by signing informed consent. The sample size was in accordance with the following formula.

$$n= \frac{(z1_{-\alpha/2} + z_{1-\beta})^2 [p_1 (1-p_1) + p_2 (1-p_2)]}{(P1-P2)^2}$$

Where,

P1= 0.9 **α**= 0.05 $\mathbf{n_1}$= 30
$\mathbf{P_2}$= 0.59 **β**=0.2 $\mathbf{n_2}$= 30,

P1: The outcome of interest or share in the first group and

P2: The outcome of interest or share in the Second group.

Patients were randomly assigned to 1 of *2 groups*: continuous groups and intermittent group nutrition method. If any one time one person of the study units was excluded from the study, the order of the table was preserved and finally, new units were replaced according to the respectively, deleted any of the units. The flow diagram had shown this study briefly (**Figure.1**).

2-2. Inclusion and exclusion criteria

Inclusion criteria included; age between 5-17 years old, not being able to take food orally, enteral nutrition for at least 7 days, using standard food formula, and exclusion criteria included; active Gastrointestinal (GI) bleeding at the beginning of nutrition, using nasojejunal tube or gastrostomy or jejunostomy, known disorders in food absorption, history of surgery for removing a part of GI tract and patients who can't elevate the head of their bed for 30 degrees (spinal injuries).

2-3. Clinical interventions

According to physicians order, patient's nutrition was given through pump in group C and intermittently in group I.

In the continuous nutrition method, initiation of nutrition was 20cc per hour. Residual volume of stomach was measured through aspiration by a 60cc syringe every 4 hours. If this volume had been less than 50cc, it meant that the patient tolerated the food, thus 20cc was added every 8 hours till reaching goal calorie. If this volume had been more than 100cc, it was assumed not tolerated, thus nutrition was stopped and after 4 hours the residual volume was rechecked, so that if it was less than 50cc,

nutrition restarted with half of the previous portion and added 10cc every 8 hours if tolerated. But being still high, the nutrition would continue to stop and restart after 4 hours with the previous protocol if tolerated. Food bags are replaced every 48 hours in this method.

In the intermittent nutrition method, initiation of nutrition was 50cc per 4 hours. Residual volume of stomach was measured through aspiration by a 60cc syringe every 4 hours. If this volume had been less than 50cc, it meant that the patient tolerated the food, thus 50cc/4 hours was added every 12 hours till reaching goal calorie. If this volume had been more than 100cc, it was assumed not tolerated, thus nutrition was stopped and after 4 hours the residual volume was rechecked, so that if it was less than 100cc, nutrition restarted with half of the previous portion and added 50cc every 12 hours if tolerated. But being still high, the nutrition would continue to stop and restart after 4 hours with the previous protocol if tolerated.

Following the residual volume being higher than 50cc or not tolerating food, an ampule of metoclopramide was given to both groups every 8 hours on physician's orders. The episodes of not tolerating food and the calorie consumption during 24 hours were recorded in the chart of each day. Thus the days required to reach goal calorie were estimated and episodes of not tolerating food were determined for each patient. During this period, incidents of vomit and diarrhea, duration of hospitalization in ICU and hospital were written everyday as secondary results in the chart of each day. Also, the calorie to which each patient reached in the 7^{th} day after initiation of nutrition (7^{th} day is the best day for evaluation of nutrition status) was determined by referring to the chart of that day (1). The duration of hospitalization in ICU and hospital and the date of discharge were determined by the patient's follow up after these 7 days.

2-4. Instruments

In this study, demographic information of the patients such as age, gender, weight and severity of the disease Acute Physiology and Chronic Health Evaluation (APACHEII) score of the time of arrival, drugs (sedatives, opioids and inotropes) and the required goal calorie of each patient being estimated by Harris benedict equation, the incidence of vomiting and diarrhea and the duration of hospitalization in ICU and hospital were determined by using researcher made check list. The check list consisted of two parts; the first part include 3 questions about demographic information (age, gender, weight), the second part include 8 questions about consumable drugs, required goal calorie, incidence of vomiting and diarrhea, food tolerance and the duration of hospitalization in ICU and hospital and APACHE score of the time of arrival. The information of the mentioned check list was prepared based on scientific books and articles and the advice of supervisor and advisor professors and also was given to 10 members of academic staff of nursery and midwifery faculty of Ahvaz Jundishapur University and their opinions were applied in the final version. In this study, the reliability of check list with test-re test a correlation coefficient of 0.92 was confirmed. APACHEII is a severity-of-disease classification system (35), one of several ICU scoring systems. It is applied within 24 hours of admission of a patient to an intensive care unit (ICU): an integer score from 0 to 71 is computed based on several measurements; higher scores correspond to more severe disease and a higher risk of death. The first APACHE model was presented by Knaus et al. in 1981(36).

2-5. Ethical Considerations

This study was approved by the Ethics Committee of Ahvaz Jundishapur University of Medical Science, Iran (ID

number: ETH-176), and registered in the Iranian Clinical Trial Website with the IRCT (IRCT201109287655N1-code). The objectives of the study were explained to all participants and all of them signed a written informed consent and were assured of the confidentiality of their individual information as well as the voluntary nature of participating in the study.

In all stages the researchers were committed to observe the ethical issues in accordance to the Helsinki ethical declaration. After the informed consents were obtained than Parents and the safety of the interventions was confirmed.

2.6. Statistical analysis

Data analysis was performed using SPSS-18 software with use of the descriptive and the Chi-square test was applied to compare the terms of the age, gender, severity of the disease (APACHE score), taking or note taking opioids or inotropic drugs, food tolerance and gastrointestinal complications in two group and the t-student-test to compare the means of estimated goal calorie, time required to reach goal calorie, consumed calorie in the 7^{th} day and duration of patients' hospitalization in ICU or hospital in the two group. P-value less than 0.05 were considered.

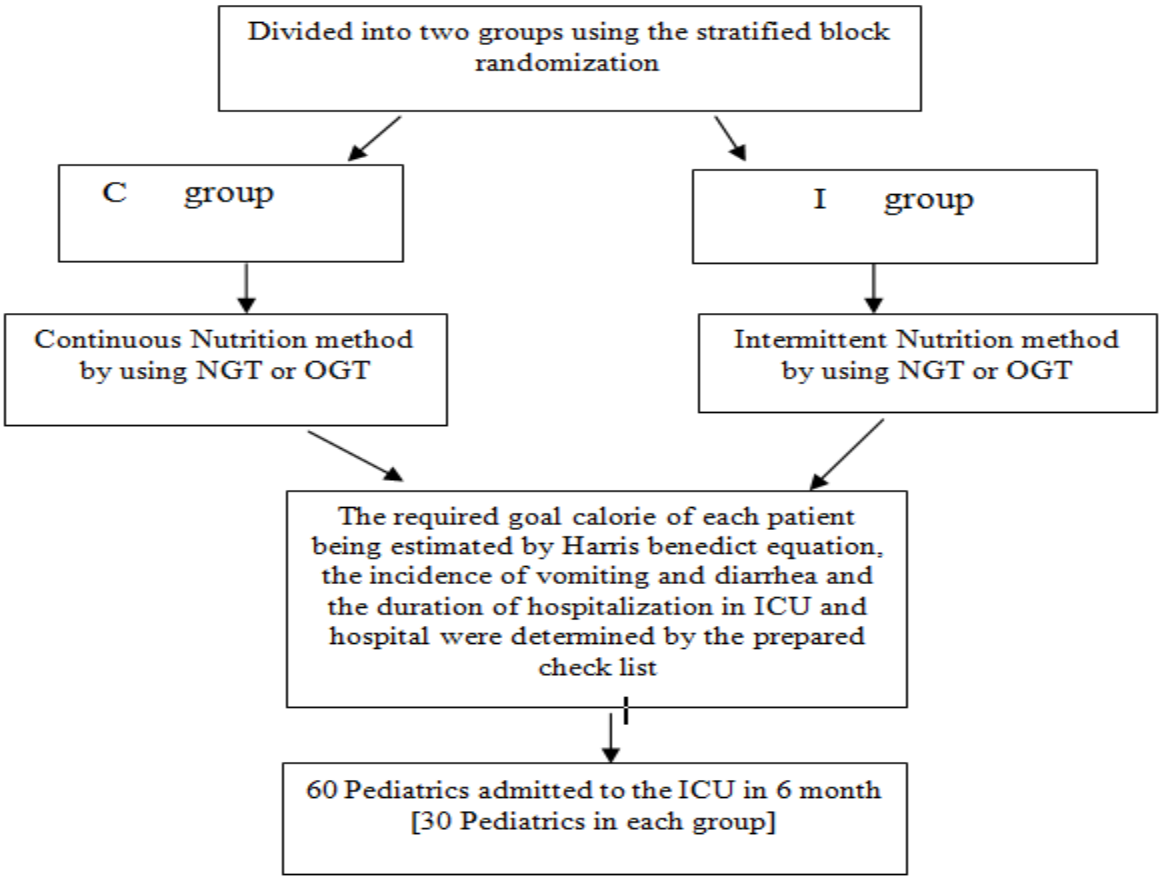

Fig.1: The flowchart of study groups

3- RESULTS

Results of the study showed that 70% of subjects in I group and 73.3% in C group were male and 30% of subjects in I group and 26.6% in C group were female. The majority of mean sample age (66.6%) in I group were 11 to 17 years and in C group (36.7%) were 14 to 17 years.

In this study, no significant difference was seen according to Chi-square test between two groups of continuous and intermittent methods in terms of age and gender (**Table.1**). Also, no significant difference was seen according to Chi-square test between two groups of continuous and intermittent methods in terms severity of the disease (APACHE score) and taking or notetaking opioids or inotropic drugs (**Table.1**). In addition, the result of t-student test showed that there was no significant difference in the mean estimated goal calorie between the nutrition the intermittent flow method group and Nutrition the continuous flow method group (**Table.2**). But the results of t-student test showed that there was a significant difference between the mean time required to reach goal calorie between the patients fed with continuous and intermittent method (P=0.001) (**Table.3**); so the mean time was less in the group fed by continuous method. Also the result of t-student test showed that there was a significant difference between the two groups in terms of the consumed calorie in the 7^{th} day (P=0.001), so the rate of calorie consumption was higher in continuous than the intermittent method (**Table.3**).
The result of Chi-square test showed that, there was a significant difference between the rate of food tolerance in continuous and intermittent groups (P=0.02), so the food intolerance was higher in intermittent method than continuous. But results of Chi-square showed no significant difference in incidence of GI complications such as vomiting and diarrhea between two groups of continuous and intermittent nutrition methods (**Table.4**). Moreover, the result of t-student test showed no significant difference between both groups in terms of the mean duration of patients' hospitalization in ICU or hospital (**Table.5**).

Table1: Frequency distribution and percentages of studied units in terms of age, gender and severity score of the disease and taking or note taking opioids or inotropic drugs

Variables		Group				P-value
		Nutrition the intermittent flow method		Nutrition the continuous flow method		
		Percent	Frequency	Percent	Frequency	
Gender	Male	70	20	73.3	22	0.32
	Female	30	10	26.7	8	
Age	5-8 Year	16.7	5	20	6	0.96
	8-11 year	16.7	5	13.3	4	
	11-14 year	33.3	10	30	19	
	14-17 year	33.3	10	36.7	11	
APACHE II score	16-20	50	15	60	18	0.33
	21-25	10	3	20	6	
	26-30	20	6	13.3	4	
	>30	20	6	6.7	2	
Prescription narcotic drugs	No	40	12	60	18	0.12
	Yes	40	12	60	18	

Table 2: The goal calorie in kilo calories for the two nutritional groups of continuous and intermittent method

Variables	Group	Mean(SD)	N	P-value
Calorie goal (kcal)	Nutrition the continuous flow method	2150 (305.97)	30	0.54
	Nutrition the intermittent flow method	2100 (315.14)	30	

SD: Standard Devietion.

Table 3: Comparing the mean time needed to reach goal calorie and the mean consumed calorie in the 7^{th} days for continuous and intermittent method groups

Variables	Group	Mean (SD)	P-value
Time needed to reach goal calorie (day)	Nutrition the continuous flow method	3.17 (1.56)	0.001
	Nutrition the intermittent flow method	4.35 (0.98)	
The mean consumed calorie (Kcal) in the 7^{th} days	Nutrition the continuous flow method	2090.33 (427.31)	0.008
	Nutrition the intermittent flow method	1777 (460.26)	

SD: Standard Devietion.

Table-4: Comparing frequency distribution and percentage of studied units in terms of incidence of intolerance food, diarrhea and vomiting between the continuous method and intermittent method group

Variables	Group	Yes		NO		P-value
		Percent	Frequency	Percent	Frequency	
Diarrhea	Nutrition the continuous flow method	60	18	40	12	0.31
	Nutrition the intermittent flow method	46.7	14	53.3	16	
	Total	53.3	32	46.7	28	
Vomiting	Nutrition the continuous flow method	16.7	5	83.3	25	0.1
	Nutrition the intermittent flow method	16.7	5	83.3	25	
	Total	16.7	10	83.3	25	
Incidence of intolerance food	Nutrition the continuous flow method	30	9	70	21	0.02
	Nutrition the intermittent flow method	40	18	40	12	
	Total	45	27	55	33	

Table-5: Comparing the mean duration of patients' hospitalization in ICU and mean time duration of patients' hospitalization in hospital in days for continuous method and intermittent method group

Variables	Group	Mean (SD)	P-value
duration of patients' hospitalization in ICU (day)	Nutrition the continuous flow method	15.77 (8.05)	0.31
	Nutrition the intermittent flow method	18.87 (14.35)	
duration of patients' hospitalization in hospital(day)	Nutrition the continuous flow method	20.77 (9.01)	0.67
	Nutrition the intermittent flow method	22.1 (14.5)	

4- DISCUSSION

Results containing lack of significant difference between both groups of continuous and intermittent nutrition methods in terms of age, gender, severity of the disease (APACHE score), taking or note taking opioids or inotropic drugs and estimated goal calorie eliminates the effectiveness of these parameters in the outcome of this study.

Results showed that there was a significant difference in terms of mean time needed to reach goal calorie in patients fed between continuous method and intermittent method group. The mean time to reach goal calorie was lower in continuous than intermittent group which is consistent to the result of Rhoney et al. study who evaluated food tolerance in two groups of continuous and intermittent nutrition methods (P<0.05) (37). But is not consistent to the study of Hacker R et al. who compared the methods of continuous and intermittent enteral nutrition (38), as in their study the patients fed by intermittent method reached sooner to the goal calorie (P<0.05). May be that's because the residual volume considered for food intolerance in hacker's was different from the present study (It was considered 200cc in hacker's study); on the other hand, the sample size of hacker's study was 2.5 times more than the present study. Moreover the speed and amount of changing the formula were different for both groups in hacker's study than ours.

Results showed that, there was a significant difference between methods of continuous and intermittent nutrition of patients in terms of consumed calorie in the 7^{th} day. The amount of consumed calorie was more in the continuous method. This finding is in consistent to the study of Rhoney et al. (37). In which patients who received continuous nutrition consumed more calorie (P<0.05). But this finding was not consistent to the study of Chen et al. (33) who evaluated the effects of continuous and intermittent nutrition methods. In the study of Yuchin, patients who received intermittent enteral nutrition consumed more calories (P<0.05). The reason of this difference may be due to the fact that, the residual volume considered in Yuchin study was 60cc; also, the speed and amount of increasing formula was different for both groups in Yuchin study than ours.

Results showed that food tolerance of children fed with continuous enteral nutrition method was higher than children given intermittent enteral nutrition. This finding was consistent to the study of Rhonet et al. (37). The episodes of food intolerance reported were fewer in Rhoney's study for continuous group (P<0.05); also this finding is consistent to the study of Steven et al. (39) who evaluated the effects of continuous

nutrition in improving enteral nutrition, in which the episodes of food intolerance was significantly higher in the intermittent nutrition group (P<0.05). But this finding of the present study is not consistent to the results of Yuchin et al. study (33) in which food tolerance of the intermittent nutrition groups was significantly fewer than continuous group (P<0.05). The reason of this difference may be the same as explained for consumed calorie of the 7th day. According to the results, it can be concluded that patients have fewer episodes of food intolerance in continuous nutrition method.

The results of this study showed that there was no a significant difference between the two groups of continuous and intermittent method in terms of the rate of GI complication incidence (diarrhea). This finding is consistent to the study of Hacker et al. (38) and the result of Cample et al. study (2) that compared enteral nutrition support with method of continuous and intermittent nutrition in studied units of Cats. In these studies, there was no significant difference in the incidence of diarrhea for continuous nutrition group compared to the intermittent nutrition, but this finding is non-consistent to the studies of Hibert et al. (40) who compared enteral nutrition support by continuous and intermittent methods in patients suffering from burns with critical conditions (P<0.05) and with Shekon et al. (41) who compared enteral nutrition support by continuous and intermittent methods in elderly patients having critical conditions (P<0.05) and neither with the results of the Steven et al. study (39).

In the mentioned studies, the incidence of diarrhea in continuous group was significantly fewer than intermittent group. But in the study of Tailor et al. that was done to determine the effect of enteral nutrition by continuous method in patients having critical conditions, the incidence of diarrhea was more in patients fed by continuous method than intermittent (42). May be the definition of diarrhea to be the changes in bowel habit or changes in the consolidation of faces have been effective in these outcomes. Also we cannot ignore the type of used formula, because the formula used in the present study was made in Iran which was different to the formula used in the world. Besides, patients were more homogenized in Hibert and Shakon's study, as the study was performed only on burnt patients in Hibert's and on elderlies in Shekon.

Results showed that there was no significant difference in the incidence of GI complication (Vomiting) between the two groups of continuous and intermittent nutrition. This finding is consistent to the studies of Hacker et al. (38), Campel et al. (2) and Sepra et al. (28), whom they compare enteral nutrition support by two methods of continuous and intermittent in patients having critical conditions.

At the end, results showed no significant difference between the two groups (continuous method and intermittent method group) in terms of the duration of hospitalization in ICU and hospital, so that this period can be considered the same for both groups. This finding is not consistent with the results of Chen et al. (33).

4-1. Limitations of the study

In nutrition the continuous flow method, food is placed in special bags at room temperature for some time, for this reason, there was the possibility of bacterial growth in this bags. So the bags were replaced every 48 hours and Patient Each food bag was given to a patient within maximum 4 hours.

5. CONCLUSION

Continuous method of the nutrition in children by using of infusion pumps through NGT or OGT methods decreases mean time to reach goal calorie and increases consumed calorie and food

tolerance. This result has similar results as adolescents and noticing the simplicity and positive results of this method such as increasing food tolerance, the finding of this study can be given to the medical staff especially nurses as a practical guideline for using these methods.

6- CONFLICT OF INTEREST

The authors had not any financial or personal relationships with other people or organizations during the study. So there was no conflict of interests in this article.

7-ACKNOWLEDGMENTS

This study is part of a student thesis for obtain a master's degree in nursing. We appreciate all family members and nursing staff for participation in this study, and also appreciate Deputy of Research and Technology of Ahvaz Jundishapur University of Medical Science. This study was approved and supported by Deputy of Research and Technology of Ahvaz Jundishapur University of Medical Science.

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