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Comparison of Enteral and Parenteral Nutrition in Patients Admitted to the ICU: A Narrative Review Study

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Abstract

Context: Nutrition support is part of the standard care in the intensive care unit. There is a paradox in the use of enteral and parenteral nutrition methods in ICU patients.
Objectives: The aim of this study was to compare the effects of enteral and parenteral nutrition methods in patients admitted to the ICU.
Data Sources: This article is a narrative review. A total of 619 articles, were extracted during the years of 2000 - 2018, on nutrition methods in ICU patients, with keywords enteral nutrition, parenteral nutrition, and nutrition in critical patients in databases of internal (SID, Iran Medex, Medlib) and external publications (PubMed, Scopus, Web of Science, Google Scholar); finally, 19 articles were analyzed.
Results: Enteral administration reduced the associated infectious morbidity, hospitalization time, mortality, costs, non-infectious complications, multiple organ failure, systemic infections, local septic complications, and the need for surgery. It also causes early returning of intestinal movements, faster preoperative weight gain, easier fluid and electrolyte management, reduction of hyper metabolic responses, more complete nutrition, preservation of the gastrointestinal mucosa, and the ability to complete the program by the patient. Parenteral nutrition increases infectious complications, hyperglycemia, coagulation disorders and duration of hospital stay, as well as effects on invasive ventilation.
Conclusions: Enteral nutrition is safer and less complicated. By improving the awareness of careers through education, patients can be improved faster.

Keywords: Enteral Nutrition, Intensive Care Unit, Parenteral Nutrition

1. Context

For over two decades, various studies have shown that malnutrition is common in hospitalized patients (1). It should be acknowledged that the lack of adequate appetite due to illness, increased nutrient intake, and nutrient absorption in patients are among the most important factors in the incidence of malnutrition intensification in hospitalized patients (2). Medical treatment and nutritional nursing care are important for patients' nutritional condition and may prevent malnutrition. The nurses' skills and knowledge are crucial when creating secure care for the patient. This places nurses in a unique position to secure good nutritional nursing care (3). Several studies have shown that in patients who are admitted, malnutrition varies from 30% to 87% (4). According to existing research, about 50% of patients admitted to hospitals are at risk of malnutrition in advanced countries (5). Most patients in the intensive care unit (ICU) are unable to fulfill their own nutritional needs; thus, they are at a high risk in developing energy deficit. The prevalence of malnutrition is 44% - 88% in the ICU (6). Metabolic changes in response to stress lead to increased protein catabolism, a certain reduction in body mass, and an increase in the incidence of complications, especially infections and inappropriate outcomes in the patient. Malnutrition in ICU patients, due to weakness of the immune system and the use of ventilator, leads to prolonged dependence on ventilator and increased infectious morbidity and mortality (7).

Nutrition support has been recognized as essential therapies for maintaining the active mass of the body, balance in the immune system, and reducing metabolic complications (8). The first attempt in nourishing patients who were not able to eat was in the late 19th century; in 1872

a person called Clouston used a method for the intragastric tube and began infusing milk, eggs, alcohol, sugar, and jelly. At the beginning of the 20th century the digestive tract techniques were improved, and since 1937, Elman performed intravenous infusion of casein hydrolyzed, and then other materials such as amino acids, hypertonic glucose, and nitrogen were injected into the central vein (9). Since 1960, parenteral nutrition was accepted in the care of patients with chronic non-functional gastrointestinal tract (10).

There is a significant improvement in the care of patients receiving intestinal and venous nutrition; however, the effects and consequences of these methods are still not clear. Further studies are needed to understand the impact of these two methods and their complications (11). It is difficult to find a meaningful comparison between enteral and parenteral nutrition. There is a physiological difference between these two methods of nutrition. Appropriate nutritional clinical outcomes include mortality, morbidity, quality of life, and care costs that require large studies. On the other hand, it is easy to obtain some criteria, such as determining the serum protein or anthropometric measure, however, these are not the true criteria for achieving nutritional adequacy in patients; they can only be used as predictive factors (12).

The use of enteral method was reported as 92% - 93% and parenteral method to be between 12% - 71% in patients admitted in the ICU. Several factors are influence on the choice of enteral and parenteral methods, one of which is to estimate the usefulness of the nutritional method and its harm (13). In many articles, the use of the enteral method has been more beneficial than parenteral; however, the proof of such a claim requires studies based on evidence as well as information regarding the side effects of each of these nutritional methods (14). Safety interventions have reduced the rate of central venous catheter contamination; the acceptable level is now zero in hospitalized patients (15). This may improve the safety of intravenous nutrition due to the fact that the increase in infection in this method is the most common difference between the two methods of nutrition (16).

Using the enteral route is considered to be more physiologic, providing nutritional and various non-nutritional benefits including maintenance of structural and functional gut integrity as well as preserving intestinal microbial diversity (17). The disadvantage of enteral nutrition (EN) is related to a potential lower nutritional adequacy particularly in the acute disease phase and in the presence of gastrointestinal dysfunction (18). In contrast, parenteral nutrition (PN) may better secure the intended nutritional intake; however, it is associated with more infectious complications, most likely due to hyper alimentation and hyperglycemia, as consistently shown in earlier meta-analyses. These clinical data have translated into a widespread consensus among current international guideline recommendations and expert opinions where the enteral route is preferred in critically ill patients without a contraindication to EN (19). Recently, Harvey and coworkers conducted the largest randomized controlled trial (RCT) to date with respect to the effect of the route of nutrition on the outcome of critically ill adult patients. In this pragmatic RCT involving 2388 patients, neither a significant difference in mortality nor infectious complications was found between the patients receiving total PN or EN within 36 hours after admission and up to a maximum of five days. These results have challenged the paradigm that EN is superior to PN with regard to clinical outcomes in critical illness (20).

The data from the review of nutritional methods of intensive care units indicate that they are not properly observing the indications and contraindicating the administration of enteral and parenteral nutrition, and it seems that they are not taking into account the complications of each of these methods, especially the parenteral method; the patient's condition is prioritized care and treatment. The question being asked is which nutritional method is more effective in patients admitted to the ICU? To answer this question, we examined the indications, contraindications, complications, and the rates of each of these methods.

2. Objectives

The aim of this study was to compare the effects of enteral and parenteral nutrition methods in patients admitted to the ICU.

3. Data Sources

The design of this study is a narrative review. Articles were searched in the field of nutritional methods in ICU patients with keywords (enteral nutrition, parenteral nutrition, nutrition in critically patient), in databases SID, IranMedex, Medlib, as well as publications such as PubMed, Scopus, Web of Science, and Google Scholar. The inclusion criteria included: existence of a study in the field of nutrition of patients admitted to the ICU, research and review studies, consideration of time constraints (2000 - 2018), published articles in journals in or outside the country, and the focus of the study being on the comparison of enteral nutrition with parenteral. The exclusion criteria also

included non-English and Persian language, lack of access to the full text of the article, abstracts of congresses and seminars, a letter to the editor, a brief report, as well as a case report. Some articles searched in several phases and deleted. In the wider search, 215000 articles were obtained. Subsequently, 6160 articles were selected related to the nutrition in hospitalized patients, and then, 619 articles were obtained by focusing on the nutrition of patients admitted to the ICU and taking into account the inclusion and exclusion criteria. A total of 99 articles remained by limiting the search to the study purpose and considering the overlap of articles, which ultimately resulted in 19 full text articles. In order to evaluate the quality of the collected articles, two researchers reviewed the articles in terms of title, abstract, introduction, method, results, and discussion (Figure 1).

4. Results

The reviewed articles in this study were divided into a variety of studies (four clinical trials, two meta-analysis, three reviews, four prospectives, one retrospective, four cross-sectional descriptives, and one guideline). The reviewed studies presented different results and suggestions regarding the priority of using two methods of nutrition for patients who are hospitalized in the ICU, according to the type of illness and conditions of the patient. Patients' who cannot have more than three days of oral nutrition must be nutritionally supported (21). Intestinal nutritional support (enteral) should be initiated in ICU patients that are unable to receive food voluntarily, should also clearly state the ultimate goal of using it, and measured the energy requirements clearly at the start. Efforts should be made to provide more than 50% - 65% of the calorie target in order to reach the clinical goals of enteral nutrition during the first week of hospitalization (22).

The use of enteral nutrition method must be fitted into the nutrition tube in the ICU within the first 24 to 48 hours of admission, and should be started if the patient has intestinal sounds as well as gas and stool excretion, to reduce the food intolerance, the risk of dysfunction of the immune defenses, and infections. Enteral nutrition should provide 25 - 30 kcal/kg body weight per day (23). Indications for using an enteral nutritional method include: (1) in cases nutrition oral contraindication; (2) inability to meet nutritional needs of the patients by oral nutrition; and (3) the need for supportive nutrition due to reduced absorption (24).

Enteral nutrition is prescribed in patients who are prone to digestive disorders, sepsis, hypotension, and then an increased risk of ischemic injury and re-perfusion (25). Patients with hypotension (MAP < 60 mmHg), especially those who receive catecholamine (such as epinephrine, phenylephrine and dopamine) need to have these agents to maintain hemodynamic stability. Food should be infused into the small intestine. In addition, in ICU patients, if there is a risk of aspiration, or intolerance to stomach nutrition, it should be put in ways to get the enteral into the small intestine (26). Enteral nutrition method is also a preferred nutritional method in ICU patients with acute and chronic liver disease. Patients who have liver failure should avoid protein restriction. The patients who are ill and have acute pancreatitis should be fitted a gastrointestinal tract and fed more quickly by fluid regeneration. These patients can be fed by the method of feeding the enteral stomach or jejunum (27).

Of course, there are some limitations to the methods of feeding enteral. Absolute contraindications for using the enteral method include: Illness-related Ileus, multiple trauma associated with retroperitoneal hematoma, peritonitis, intestinal obstruction, active gastrointestinal hemorrhage, hemodynamic instability, and intestinal ischemia. Relative contraindications include diverticulum abscesses, early stages of small intestine syndrome, severe malabsorption, small intestinal fistulas, and the need for early nutrition support is not feasible for full feeding (28).

Enteral nutrition has side effects like any other invasive procedure. Complications of this nutritional method are divided into four categories, including mechanical effects (esophageal tracheal fistula, tube displacement and discharge, tube obstruction, food leak, and pulmonary aspiration), metabolic (such as hyperosmolaritis, hyperglycemia and hypoglycemia, electrolyte imbalance blood, refeeding syndrome, hypercapnia and hypertonic depression), infections (sinusitis, otitis, pneumonia, necrotic peritonitis, and enteritis), and digestive complications (diarrhea, constipation, vomiting, abdominal distension and hepatomegaly) (29).

Another method is parenteral for feeding patients in the ICU, whose indications are given in Table 1.

The use of parenteral nutrition is considered if the use of enteral nutrition is not available or not possible in the first seven days of admission to the ICU, the patient has a good health status before illness, and the patient has no malnutrition of protein and calories. However, the onset of parenteral at the administration time is allowed if there is evidence of malnutrition of calorie protein at the time of admission and the lack of available supply of enteral nutrition. In addition, if the patient is likely to have gastrointestinal surgery and it is not possible to feed the enteral, parenteral nutrition should be started under certain conditions (30).

In the malnourished, parenteral nutrition should be-

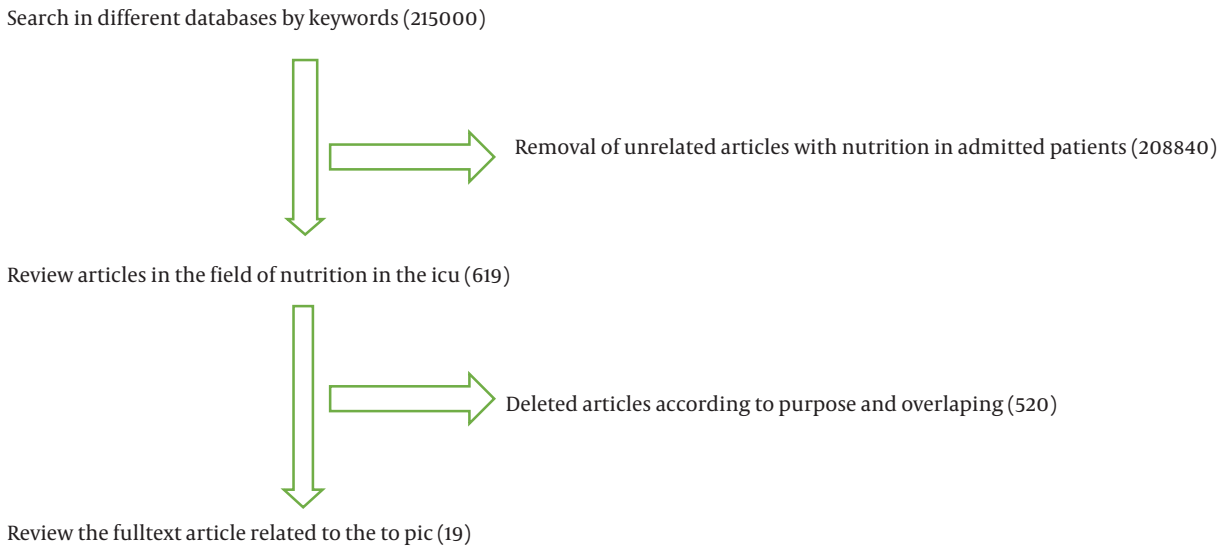

Figure 1. Review articles and data collection process

Table 1. Parenteral Nutrition Indications

Indication of Parenteral Nutrition	Related Studies
Inability to absorb enough digestive nutrition (large intestinal resection, short intestinal syndrome, enteritis caused by radiotherapy, severe diarrhea).	Pontes-Arruda et al. (30), "Influence of parenteral nutrition delivery system on the development of bloodstream infections in critically ill patients: An international, multicenter, prospective, open-label, controlled study"
Complete or false intestinal obstruction, acute abdomen, or ileus and persistent digestive hemorrhage.	Mundi et al. (31), "Management of parenteral nutrition in hospitalized adult patients"
Extreme catabolism when the digestive system is not usable for five to seven days.	Preiser et al. (32), "Metabolic and nutritional support of critically ill patients: consensus and controversies"
Failure to achieve enteral nutrition route.	Edmunds et al. (26), "The effects of different IV fat emulsions on clinical outcomes in critically Ill patients"
Disability to provide adequate food and fluids in the enteral method.	McClave et al. (27), "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 (A.S.P.E.N)"
Pancreatitis associated with jejunum intolerance.	Hvas et al. (25), "Quality and safety impact on the provision of parenteral nutrition through introduction of a nutrition support team"
Trauma requiring frequent gastrointestinal surgical procedures.	Justo et al. (28), "Enteral or parenteral nutrition in traumatic brain injury: A prospective randomized trial"

gin within five to seven days before surgery and continue in the postoperative period. Parenteral nutrition may have dangers for the patient in periods of less than five to seven days, thus, they should start for a treatment period of more than seven days. Of course, it is possible to begin the feeding of the parenteral before seven days if the energy requirements are not available after a week (31).

ICU patients with respiratory failure are not recommended for routine use high-fat and low-carbohydrate formulations designed for respiratory problems and CO_2 reductions; however, they should be considered for patient formulas with limited fluid and high calorie (32).

Table 2 shows the studies that carried out the benefits of enteral nutrition compared to parenteral.

In a study comparing enteral and parenteral nutrition patterns, by using an enteral method a definite reduction in infectious morbidity was demonstrated. The specified reduction has also been reported in non-infectious complications and the duration of hospitalization in the ICU. Some of the studies did not report the difference in the mortality of these two methods, and even showed a decrease of mortality despite the increased infectious complications by parenteral method (33).

In order to compare the complications of the two

Table 2. The Benefits of Enteral Nutrition Versus Parenteral

Benefits of Enteral Nutrition	Related Studies
Stimulating the performance of the defensive barrier.	Casaer et al. (16), "Early versus late parenteral nutrition in critically ill adults"
Reduction of hyper metabolic responses.	Singer et al. (33), "Pragmatic approach to nutrition in the ICU: Expert opinion regarding which calorie protein target"
Nutrition is more complete than the parenteral method.	Gungabissoon et al. (29), "Prevalence, risk factors, clinical consequences, and treatment of enteral feed intolerance during critical illness"
Maintaining the gastrointestinal mucosa.	Al-Omran et al. (34), "Enteral versus parenteral nutrition for acute pancreatitis"
Facilitate the management of fluids and electrolytes.	Ryu et al. (35), "Clinical outcomes comparing parenteral and nasogastric tube nutrition after laryngeal and pharyngeal cancer surgery"
Less infectious effects and associated costs.	Sadique et al. (36), "Cost-effectiveness of early parenteral versus enteral nutrition in critically Ill patients"
Irritation of the intestinal reverse performance.	Park et al. (37), "Postoperative nutritional effects of early enteral feeding compared with total parental nutrition in pancreaticoduodectomy patients: A prospective, randomized study"

methods of nutrition in this study, five papers were analyzed including two meta-analyses of clinical trials, one descriptive, and two clinical trials. There were five important and recurrent complications in the two groups of enteral nutrition and parenteral. The results are presented in Table 3.

5. Discussion

The aim of this study was to compare the effects of enteral and parenteral nutrition methods in patients admitted to the ICU.

According to the results of this overview, there are benefits for both enteral and parenteral nutrition and there is still a difference in the choice of a method as the preferred method. McClave et al.'s study reported that most articles indicate an effect of feeding enteral on reducing the morbidity of infections such as pneumonia, central venous infection, and abdominal abscess in surgical patients. Many articles have reported the reduction in hospitalization rate, the cost of nutritional support, and even the return of cognitive function to traumatic patients (27).

In a study by Yousefzadeh et al., in the Pursina Hospital during a 6-month period, 115 patients with head injuries, who ate at least 48 hours of enteral nutrition were examined. The results of this study showed that the duration of the mechanical ventilation was 13 days, the duration of admission to the special department 18 days, the hospital stay 24 days and the mortality rate 48% at 6 months (42). In the study of Petrov and Whelan less infectious complications have been reported in the enteral method. There was a significant difference in pancreatitis infection and the need for surgery. The results of this study showed that the enteral method increases the risk of diarrhea and the parenteral method causes more hyperglycemia in patients (39).

In the study of Yi et al., it was reported that the mortality rate was less (P = 0.001), infectious complications (P = 0.02), organ failure (P = 0.02), and need for surgery (P = 0.003) (38).

Al-Omran et al. reported a marked reduction in the death rate in a study of 348 adults with enteral intake. They also reported a decrease in the incidence of systemic insufficiency, systemic infection, surgical need, local septic complications, and hospitalization latency in patients who had an enteral nutrition. Particularly in patients with severe pancreatitis, the risk of death and multiple organ failure has fallen (34).

In a study by Sharifi et al., on nutritional support, there was no benefit in using the parenteral method in patients who could receive an enteral method (43). In another study on patients with parenteral technique, the mortality rate in the first 24 hours of admission in the ICU was reduced compared to the standard method (without nutrition within two to five days); however, it increased the rate of infection (44).

In a study by Harvey et al., a comparison of the early parenteral nutrition with standard method showed that there was a significant effect on general health status (P = 0.01), however, it did not have an effect on the other criteria including: physical performance criteria (P = 0.35), duration of stay in the ICU (P = 0.06), death before discharge from the ICU (P = 0.15), hospitalization time (P = 0.5), and death before hospital discharge (P = 0.51) (20).

Rice et al., examined the effects of parenteral nutrition on organ failure, and the results showed liver failure (P = 0.15), pulmonary failure (P = 0.88), renal failure (P = 0.98), effect on outcome renal transplantation (P = 0.25), cardiovascular failure (P = 0.11), other organs (P = 0.12), effect on

Table 3. Comparison of Eomplications in Enteral and Parenteral Nutrition Methods

Complications	Comparison Between Enteral and Parenteral Nutrition	Related Studies
Mortality	There is no difference between the two groups	Yi et al. (38), "Meta-analysis: total parenteral nutrition versus total enteral nutrition in predicted severe acute pancreatitis"
Infection	Decreased by the antral method versus parenteral	Petrov and Whelan (39), "Comparison of complications attributable to enteral and parenteral nutrition in predicted severe acute pancreatitis: A systematic review and meta-analysis"
Admitted to the ICU	Decreased by the antral method versus parenteral	Harvey et al. (20), "Trial of the route of early nutritional support in critically ill adults"
Length of stay in the hospital	There is no difference between the two groups	Seres et al. (40), "Parenteral nutrition safe practices: Results of the 2003American Society for Parenteral and Enteral Nutrition survey"
Connection time to ventilator	There is no difference between the two groups	Rice et al. (41), "Initial trophic vs full enteral feeding in patients with acute lung injury: The EDEN randomized trial"

compression wound treatment (P = 0.54), serum albumin (P = 0.15), use of antibiotics (P = 0.55), aspiration (P = 0.66), new pulmonary infiltration (P = 0.65), effect on coagulation status (P = 0.01), and invasive ventilation (P = 0.01). Among these complications, the effect on coagulation status and invasive ventilation was significant (41).

The effects of the parenteral nutrition method were investigated by Sadique et al., on the incidence of infectious complications. The results showed that the rate of catheter infections (P > 0.99), surgical wound infections (P = 0.56), blood infection (P = 0.47), abdominal infection (P = 0.34), urinary tract infection (P = 0.62), pulmonary and lung infections (P = 0.12), probable pneumonia (P = 0.26), definitive and confirmed pneumonia (P = 0.91), and any major infection and another important thing was not meaningful (P = 0.81) (36).

Comparison of enteral and parenteral nutritional methods has also been studied in certain diseases in some studies. For example, after the pancreaticoduodenectomy, in the Seres et al. study, patients had a longer stay in the hospital by a parenteral method (40). In a study by Park et al., on 38 patients, those who administrated their early enteral nutrition method had early bowel movement and acquired preoperative weight in 21 days. However, in patients fed with paranormal method, they gained weight over 90 days (37). In cases of head, neck, and esophagus surgery, the study by Ryu et al., showed that patients with enteral did not significantly increase the incidence of pneumonia (P = 0.06) (35). In the Seike et al. study on patients with esophagectomy, there was no difference in the leak of anastomosis, inflammation, and albumin, however, the difference in the ability to complete the program in patients with enteral (P = 0.03) and the reduction in hospital stay has been reported (P = 0.04) (45).

In general surgery, less septic complications in patients with enteral and in contrast to more hyperglycemia in parenteral feeding has been reported (46).

The lack of access for all databases due to cruel sanctions against the Islamic Republic of Iran and the problems of paying money was one of the limitations of the present study. The use of studies with various methods was one of the strengths of this study.

For future studies it is recommended that clinical trials be conducted through systematic review or meta-analysis.

5.1. Conclusions

Generally, the results of comparing the use of both enteral and parenteral methods showed that the administration of enteral reduces the morbidity of infections, decreases the specific length of hospitalization in the ICU, decreases in the cost of nutritional support, non-infectious complications, the need for surgery in pancreatitis multiple organ failure, systemic infection, and local septic complications. It also causes early return of intestinal movements, faster pre-operative weight gain, easier fluid and electrolyte management, reduction of hyper metabolic responses, more complete nutrition, gastrointestinal mucosal retention, ability to complete a patient's schedule, and faster return of cognitive function in traumatic patients; however, the enteral nutrition causes diarrhea. The beneficial results from parenteral nutrition have been more common in general health than in the normal diet. Thus, on the other hand, it increases infectious complications, hyperglycemia, and coagulopathy disorders. There is no difference between the two methods in terms of hospital stay, under ventilation, and mortality rates. Regarding the results, it seems that the use of enteral method is safer and less complicated for patients admitted to the ICU. It is suggested that adequate training be given to doctors, nurses, and nutritionists in the field of correct and timely use of enteral and parenteral nutrition methods.

Footnotes

Authors' Contribution: Mahdi Poornazari: searching, data gathering, and writing the manuscript; Mostafa Roshanzadeh and Somayeh Mohammadi: data analysis. Ali Tajabadi: study design, data gathering, and writing the manuscript.

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