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INTERMITTENT ENTERAL NUTRITION FOR CRITICAL PATIENTS METHOD: SCOPING REVIEW

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ABSTRACT

Background: Nutritional therapy is a crucial component of clinical therapy for critically ill patients. Each method of enteral nutrition (EN) delivery has its advantages and disadvantages, necessitating broader identification to uncover more relevant literature on EN delivery. This literature aims to identify the benefits of the intermittent method as an appropriate EN delivery approach for adult patients in the ICU.
Methods: Scoping review. Databases used: CINAHL, Pubmed, Scopus, ScienceDirect. The PRISMA extension for scoping reviews was utilized in this study, and the quality assessment of the literature was conducted using the JBI Quality Appraisal.
Results: Ten articles from nine countries—South Korea, Iran, India, Switzerland, Lebanon, Brazil, Egypt, the United Kingdom, and China—were reviewed, involving 702 adult ICU patients. All articles were Randomized Controlled Trials.
Conclusion: Intermittent EN administration achieves protein and calorie intake targets faster than continuous methods and reduces the increase in GRV compared to bolus feeding Modifying the drip rate using feeding pumps and syringe pumps effectively reduces disruptions in EN delivery and gastrointestinal complications. However, some studies show inconsistent results, and the use of pumps incurs higher costs. Therefore, further high-quality research is needed to evaluate which method best achieves nutritional goals and recovery.

Keywords: Critically ill patients, Enteral feeding, Intermittent feeding, ICU

ABSTRAK

Latar Belakang: *Terapi nutrisi bagian terapi klinis bagi pasien kritis. Setiap metode pemberian nutrisi enteral (EN) ada kelebihan dan kekurangannya, identifikasi lebih luas diperlukan untuk mengetahui literatur yang lebih relevan untuk pemberian EN. Tujuan dari literatur ini untuk mengidentifikasi manfaat metode intermittent sebagai salah pemberian EN yang tepat untuk pasien dewasa di ICU.*
Metode: *Scoping review. Database yang digunakan: CINAHL, Pubmed, Scopus, ScienceDirect. PRISMA extension scoping review digunakan dalam studi ini, penilaian kualitas literatur mennggunakan JBI Quality Appraisal.*
Hasil: *Didapatkan 10 artikel dari 9 negara yaitu Korea Selatan, Iran, India, Switzerland, Libanon, Brazil, Mesir, Inggris, Tiongkok, melibatkan 702 pasien dewasa di ICU. Semua artikel merupakan uji Randomized Controlled Trial.*
Kesimpulan: *Pemberian EN intermittent mencapai target protein dan asupan kalori lebih cepat dibandingkan continuous, mengurangi peningkatan GRV dibanding bolus. Modifikasi kecepatan tetesan menggunakan feeding pump dan syringe pump secara efektif mengurangi gangguan pemberian EN serta komplikasi gastrointestinal. Namun, masih ditemukan studi yang tidak konsisten, serta penggunaan pump memerlukan biaya lebih besar, sehingga dibutuhkan penelitian berkualitas lebih lanjut untuk mengevaluasi metode mana yang dapat mencapai tujuan nutrisi dan pemulihan lebih baik.*

Kata Kunci: Critically patient, Enteral feeding, Intermittent feeding, ICU

INTRODUCTION

Critically ill patients often experience various physiological changes and system disruptions. These patients have complex energy expenditure and needs (Wu et al., 2015), which can lead to malnutrition, fluid and electrolyte imbalances, and continuous intravascular fluid loss (Debora et al., 2009), suppressing the immune system (Sukarata & Kurniyanta, 2017), resulting in multi-organ failure (MOF) (de Araujo et al., 2014).
The critical condition causes high stress on the body (Zhang et al., 2019), leading to gastrointestinal system disturbances, where patients cannot tolerate normal dietary intake (Menezes et al., 2012). This is marked by high gastric residual volume (GRV), vomiting, bloating, diarrhea, pain/discomfort, and increased plasma lactate (Blaser et al., 2021; Mutias et al., 2020). These conditions can trigger malnutrition in critically ill patients, where the goal of adequate caloric intake is not achieved, leading

to prolonged length of stay (LOS) in the ICU, reduced immunity, poor wound healing, multiple organ failure, and higher mortality rates (Lee et al., 2022; Zhang et al., 2019).
Proper management of the impacts of critical conditions is essential, one of which is through adequate nutritional provision. Nutrition can be administered orally, enterally, or parenterally (Mutias et al., 2020). For critically ill patients who cannot maintain their nutritional intake (McClave et al., 2016), those who are intubated, post-surgery, dysphagic, or have neurological disorders (Anandika et al., 2022), enteral nutrition (EN) is currently the first choice (Anandika et al., 2022; McClave et al., 2016; Menezes et al., 2012). EN can be delivered using various methods, with intermittent, continuous, and bolus feeding being the common methods for critically ill patients. Many factors need to be considered when choosing an EN delivery method, including illness severity, tolerance to EN, nutritional target achievement, therapy usage, patient mobility, and cost.
Nutritional delivery techniques are nursing actions, so nurses must be able to determine and implement the best care actions for patients promptly and accurately (Coltman et al., 2015). Currently, intermittent EN delivery is an attractive alternative. The metabolic benefits of intermittent delivery include increased protein synthesis and autophagy in skeletal muscles. The intermittent method is more physiological and suitable than continuous methods. Additionally, it allows for greater patient mobility (Bear et al., 2018). The intermittent method is also better tolerated than bolus feeding (Anandika et al., 2022; Mousazadeh, 2012; Nasiri et al., 2017). However, limited data are available to provide strong recommendations regarding the choice of intermittent enteral feeding over other methods. This literature aims to identify intermittent methods as an appropriate enteral nutrition delivery for adult ICU patients.

METHOD

Design

This research uses a scoping review design, which presents a broad overview of a broad study topic, more flexibly covering literature and studies and various research methods to answer broader questions (Peterson et al., 2017). The scoping review framework is used to compile this literature through 5 stages: determining review questions, identifying meaningful and essential research, selecting meaningful research, mapping data, summarizing data, and reporting data (Peterson et al., 2017). This scoping review follows the Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist in determining findings.

Eligibility Criteria

All authors use PRISMA Extension for Scoping Reviews (PRISMA-ScR) to select articles relevant to the research (Figure 1). The research questions are formulated using PCC (population, concept, context). The search is filtered using inclusion and exclusion criteria. Inclusion criteria: 1) articles used with ten-year publications, period 2013 – 2023, 2) articles in English, 3) research design of randomized controlled trials, pseudo-randomized controlled trials, which discussed methods of administering EN to critical patients, 4) age over 18 years old, 5) full-text article in PDF format, 6) This article only includes articles whose samples are adult critical patients in the intensive care unit and receiving enteral nutrition therapy. Search exclusion criteria include: 1) the article is not from a secondary research source, 2) the article is not from an accredited journal, and 3) the article is less than 2013 and not in English.

DATA SOURCES AND ANALYSIS

Search Strategy

The database used for searching articles consists of four, namely CINAHL, Pubmed, Scopus, and ScienceDirect, done systematically. The time limit used is 10 years, from 2013 to 2023. The keywords

were obtained after developing an extensive search strategy in CINAHL Plus with full text via EBSCOhost, Scopus, and PubMed. However, to make it easier to determine articles, a search uses keywords and boolean operators (OR or AND), synonyms for keywords using MeSH (Medical Subject Headings). Search using the keywords critical patient OR critical illness OR critical illness AND enteral nutrition OR enteral feeding OR intermittent feeding OR feeding method AND Intensive Care Unit OR ICU.

Study Selection and Quality Appraisal

The selection of research articles was carried out systematically and independently by three authors (NR, EE, HSM) to determine the quality of the study. After searching for articles using a filter, the obtained articles are collected and entered/uploaded to the Mendeley online application to be filtered for duplicate articles, which are deleted. Titles and abstracts were screened by the authors independently, and articles that did not meet the inclusion criteria and were incomplete were reported in the Flow diagram of PRISMA. Three authors (NRH, EE, HSM) extracted articles that met the criteria using the Joanna Briggs Institute study quality instrument (JBI) (Joanna Briggs Institute (JBI), 2017) . The quality of articles is assessed and evaluated through thirteen questions in the JBI instrument; articles that receive a score < 60% are eliminated by the author. After agreeing on articles that meet quality, further analysis is carried out.

Data Extraction and Synthesis

Data extraction on each included article was carried out by NRH, EE, and HSM using a customized Excel form (Microsoft), which had been tried out previously. The summarized data included the following: literature characteristics, authors, year, country, characteristics related to research methods, variables related to characteristics of clinical patients, interventions, clinical outcomes, factors identified, and main findings analyzed. As the data extraction process progressed, the author also refined the data extraction form, which was more precise according to needs.

Data analysis was carried out by summarizing the data descriptively quantitatively, and synthesizing the data quantitatively. Findings are presented in narrative form, where data is identified and presented in tables and figures to assist in the presentation and interpretation of data if necessary. The methods of EN feeding for critical condition patients found from the studies analyzed are continuous, intermittent, and bolus methods.

RESULTS

a. Literature Selection

The initial search yielded 577 articles. Of these, 202 were duplicates, and 129 were excluded. Full-text review was performed on 246 articles, and 236 were excluded because they did not meet our criteria. This review included and analyzed the remaining 10 articles meeting the inclusion criteria.

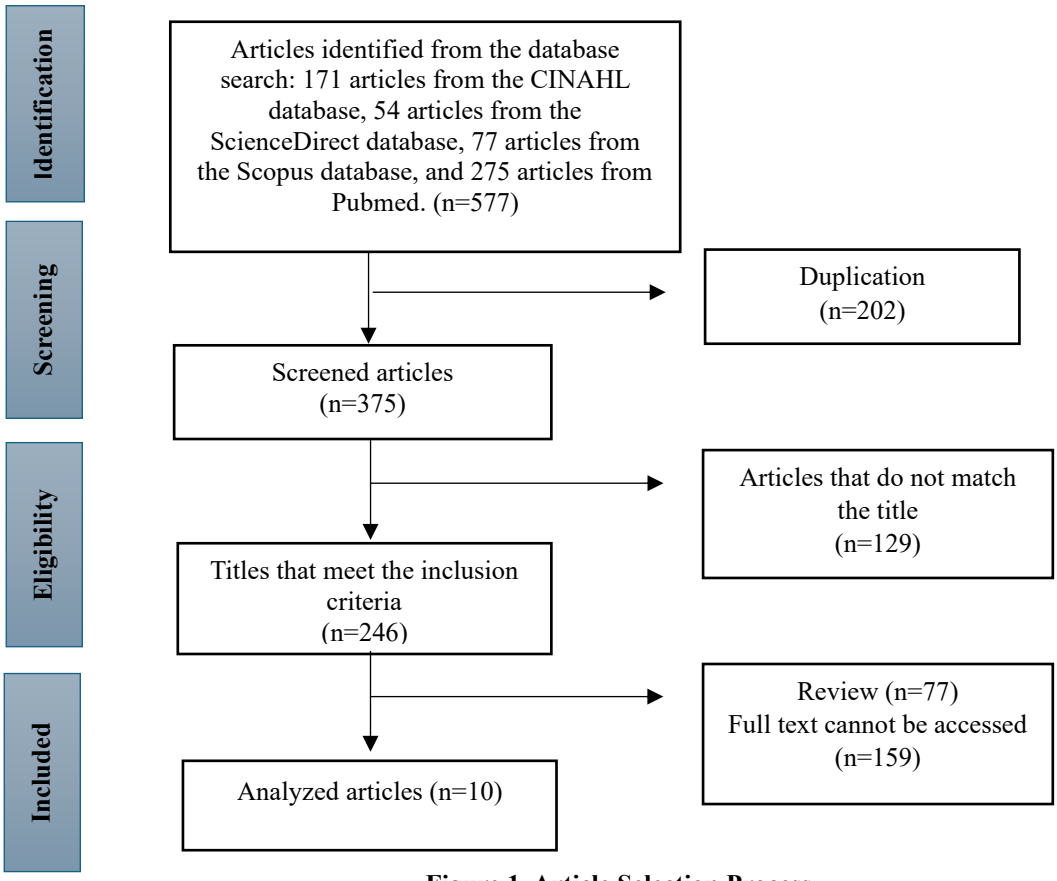

Figure 1. Article Selection Process

b. Characteristics of Literature

Table 1 summarizes the main characteristics of the included articles. The articles used described patients from 9 different countries; 2 articles came from Iran, and the rest were from South Korea, India, Switzerland, Lebanon, Brazil, Egypt, England, and China. In Table 1, it can also be seen that all articles are original articles with a Randomized Controlled Trial. The articles compared several methods of providing enteral nutrition, especially intermittent methods.

Table 1.
Review Articles

No.	Author and Year	Study Type	Location	Participants	Intervention	Result
1	Lee et al. (2022)	Randomized Controlled Trial	South Korea	99 mechanically ventilated adult ICU patients. IG (n=49) CG (n=50)	IG and CG each received enteral nutrition for 227 and 226 days, respectively.	The continuous method significantly improved the achievement of target nutritional needs. However, the caloric intake target could not be determined.

No.	Author and Year	Study Type	Location	Participants	Intervention	Result
2.	Nasiri et al. (2017)	Triple-blind randomized controlled trial	Iran	60 ICU patients with sepsis. BG (n=20) IG (n=20) CTG (n=20)	EN was administered for 3 days, observing GRV, abdominal distension, vomiting, constipation, and diarrhea.	There were no significant differences among the three groups ($p > 0.05$).
3.	Anandika et al. (2022)	Randomized Controlled Trial	India	80 adult ICU patients. BG (n=40) FPG (n=40)	From day 1 to day 7 and on the fourteenth day for both BG and CG.	The increase in gastric aspiration volume was lower with the intermittent method compared to the bolus method.
4.	Reinhold et al. (2020)	Randomized Controlled Trial	Switzerland	60 critically ill patients, within the first 48 hours of ICU admission. IIG (n=30) CCG (n=30)	IIG received EN for 30 minutes, with the next feeding after 4.5 hours, and a 4-hour night rest. CCG received EN for 5 hours, with a 1-hour feeding break.	IIG achieved protein targets faster than CCG. The intermittent method reduced skeletal muscle degradation and facilitated the secretion of essential hormones for metabolic function.
5.	Kadamani et al. (2014)	A pseudo-randomised controlled trial	Lebanon	30 critically ill patients on mechanical ventilation.CIG (n=15) BCG (n=15)	EN was administered for 24 hours in CIG, while BCG received EN for 15 minutes every 4 hours, for a 3-day intervention period. Aspiration, high GRV, vomiting, diarrhea, and constipation were identified.	No significant differences between CIG and BCG for aspiration, high GRV, diarrhea, or vomiting ($p > 0.05$). Constipation was significantly higher in BCG ($p = 0.025$).
6.	Oshvandi et al. (2020)	A Single-Blind, Randomized, Controlled Trial	Iran	63 ICU patients. 2 HI (n=21) 3 HI (n=21) 4 HI (n=21)	Patients were randomly divided into three groups receiving bolus EN at 2, 3, and 4-hour intervals.	The 4-hour interval group showed a lower risk of gastrointestinal complications.
7.	de Araujo et al. (2014)	Randomised controlled trial	Brazil	41 ICU patients. IG (n=18) CG (n=23)	IG received EN for 18 hours with a 6-hour night break, while CG received continuous EN for 24 hours.	No significant differences in vomiting, abdominal distension, or diarrhea ($p = 0.57$).
8.	EL-Aziz et al. (2020)	Randomised controlled trial	Egypt	70 critically ill patients (general and trauma). ISFG (n=35) IFBG (n=35)	Both groups received 2000 ml of EN daily with the same formula, differentiated by method and speed of EN administration.	Significant differences were found, with lower complications in ISFG compared to IFBG, including gastrointestinal ($P < 0.001$), mechanical ($P = 0.033$), and metabolic complications ($P = 0.005$).

No.	Author and Year	Study Type	Location	Participants	Intervention	Result
9.	McNely et al. (2020)	Randomised controlled trial	United Kingdom	121 adult patients with mechanical ventilation and multiple organ failure (MOF). IIG (n=62) CCG (n=59)	IIG received EN every 4 hours over 24 hours, while CCG received the intervention over 10 days.	No differences between groups in terms of safety profile, gastric intolerance, physical function, and discharge.

Abbreviations : IG, Intermittent group; CG, Countinous group; CTG, control group; FPG feeding pump group; IIG, intermittent intervention group; CCG, continous control group; CIG, continous intervention group; BCG, bolus control group; 2 HI, 2 hour intervals; 3 HI, 3 hour intervals; 4 HI, 4 hour intervals; ISFG, intermittent syring pump group; IFBG, intermittent feedng bag group

c. Literature Review Results

From Table 1 we can see that all articles used the characteristics of adult patients in the ICU. More specifically, all articles conducted studies on mechanically ventilated patients. A total of 702 patients were analyzed in this review. The patients were divided into three groups during their respective study periods: receiving bolus, intermittent, and continuous enteral feeding. For the continuous group, patients received enteral feeding for 24 hours without stopping. In the bolus group, there was a difference in administration time, Oshvandi et al. (2020) provided enteral nutrition at intervals of 2 hours, 3 hours, and 4 hours, and Nasiri et al. (2017) provided it every 3 hours. In almost every article, time differences were also found in intermittent group enteral nutrition. According to the study of Kadamani et al. (2014); Lee et al. (2022); McNelly et al. (2020); Nasiri et al. (2017); Dhandapani et al. (2022) administered intermittent enteral feeding every 4 hours, Reinhold et al. (2020) intermittent administration of EN every 4.5 hours. Another study by Zhu et al., (2020) used predetermined times, namely 06.00, 11.00, 17.00, and 21.00. In comparison, de Araujo et al. (2014) use a standard feeding time of 18 hours and are given a break/rest at night for 6 hours. Moreover, in the study of EL-Aziz et al. (2020) the intermittent EN administration method is carried out alternately over 24 hours, with three-hour feedings and a two-hour rest interval.

The effectiveness results for each article vary greatly. In the study of Lee et al. (2022) the continuous enteral feeding group obtained significant results. Compared to the intermittent method group, the target nutritional needs are met by≥80%, but the target for meeting calorie needs cannot be known. Reinhold et al. (2020) found that patients' protein targets were achieved more quickly by administering EN using the intermittent method compared to the continuous method. Other results found that most articles revealed no significant differences between groups regarding constipation, diarrhoea, vomiting, abdominal distension, and gastric residual volume (GRV). Anandika. et al. (2022) found a difference where GRV and the number of eating disorders decreased more in the intermittent method than in the bolus method.

Giving EN using the equipment of bolus method is easier and cheaper (Nasiri et al., 2017), provides physiological nutrition (Chowdhury et al., 2016; Anandika. et al., 2022) and is practical if it is started to be used after the total achievement of enteral feeding has been achieved (Anandika. et al., 2022). However, the complication rate is higher than that of the intermittent method (Mousazadeh, 2012), and GRV is higher than that of the intermittent method (Anandika. et al., 2022).

DISCUSSION

Patients in critical condition often experience catabolic stress (McClave et al., 2016; Singer et al., 2023). These patients require nutritional therapy as part of their clinical treatment (Zhang et al., 2019). Adequate and appropriate nutrition is crucial for maintaining body metabolism and should be initiated as soon as possible (PERDICI, 2012). Early enteral feeding provides physiological benefits (McClave et al., 2014) and reduces the severity of the condition (Zhang et al., 2019). To mitigate catabolism and enhance gastrointestinal function, the appropriate protein must be administered to critically ill patients (Patel et al., 2016).

Enteral nutrition (EN) is preferred for providing nutrition to patients (Mascarenhas & Wallace, 2011; McClave et al., 2016; Singer et al., 2019). EN is the primary choice for critically ill patients because it offers physiological benefits to the gastrointestinal tract (Griffiths & Bongers, 2005; Singer et al., 2019), improves gastrointestinal function (Singer et al., 2019), and benefits the immune system (Griffiths & Bongers, 2005; Lewis et al., 2018). Although EN is commonly provided to support the recovery of critically ill patients, there are still differing opinions on the optimal method and quantity of nutrition (Heffernan et al., 2022).

The continuous method is recommended for EN administration (Lee et al., 2022a) and is chosen for critically ill patients (Ichimaru, 2018). However, patient mobility may be hindered, gastrointestinal hormone secretion can be altered, and prolonged metabolic complications may lead to hyperglycemia and insulin resistance (Marik, 2015).

The bolus method can still be considered a standard approach to reduce the risk of aspiration when used correctly, though it has more complications compared to the intermittent method (Mousazadeh, 2012). Gastric residual volume (GRV) is higher with the bolus method than with the intermittent method (Anandika et al., 2022), and significantly higher than with the continuous method, due to rapid EN delivery causing increased incidence of gastric distension, nausea, and vomiting (Marik, 2015).

Intermittent enteral nutrition is an attractive alternative. Patients receiving the intermittent method achieve calorie intake and nutritional goals faster than those fed by the continuous method (McNelly et al., 2020; Ma et al., 2021). It does not increase the risk of complications in critically ill patients (Hooper and Marik, 2015) and causes less vomiting (McNelly et al., 2020). However, it may increase the incidence of diarrhea, feeding intolerance, and the risk of aspiration in critically ill patients.

The aim of this literature review is to identify the intermittent method for providing enteral nutrition in adult ICU patients. The outcomes evaluated include the effectiveness of the intermittent method compared to other methods. Analysis of the articles in this review found that intermittent enteral nutrition achieves protein targets faster than continuous feeding (Reinhold et al., 2020). This is supported by Ma et al. (2021), who found that patients on the intermittent method received calorie intake and nutritional goals faster than those on the continuous method, and 80% or more of the protein could be absorbed by patients using the intermittent method compared to the continuous method (McNelly et al., 2020).

Nutritional goals with the intermittent method can be achieved more quickly, considering that continuous enteral nutrition is delivered slowly. According to Anandika et al. (2022), nutritional needs are better met in the early phase with the intermittent method. It also potentially offers additional metabolic benefits, although research is still limited. For instance, intermittent enteral nutrition compared to continuous does not increase the risk of complications in critically ill patients, improves glycemic conditions, preserves muscle mass and liver, bile, and intestinal function (Hooper and Marik, 2015), and increases autophagy of skeletal muscle due to stable ghrelin and insulin levels (Bear et al., 2018). In studies on healthy humans, the bolus method stimulates increased protein synthesis compared to the continuous method (Chowdhury et al., 2016).

However, this is inconsistent with Lee et al. (2022), who found in their study that nutritional needs were significantly met around 80% of the time with the continuous method compared to the intermittent method. Differences in findings are due to various factors, including the selection of

heterogeneous patient criteria, research methods used, and sample sizes. This inconsistency warrants further research with better management and larger sample sizes. Additionally, all three enteral nutrition methods can cause short-term gastrointestinal complications in critically ill adults. Studies by de Araujo et al. (2014), Kadamani et al. (2014), Nasiri et al. (2017), Reinhold et al. (2020), and Anandika et al. (2022) revealed no statistically significant differences among the three EN methods in reducing vomiting, abdominal distension, diarrhea, and other gastrointestinal complications. Critically ill patients have a high risk of feeding intolerance. Research has shown that among critically ill patients, the rate of feeding intolerance can exceed 30 percent (Gungabissoon et al., 2015; Qu et al., 2023).

However, an interesting study by EL-Aziz et al. (2020) found significant statistical differences between the two methods. The intermittent enteral nutrition group had lower complication rates compared to the continuous group, including gastrointestinal (p<0.001), mechanical (p=0.033), and metabolic (p=0.005) complications. This study used a syringe pump for intermittent enteral nutrition, and the results indicated that reducing the rate of intermittent enteral nutrition administration using a syringe pump effectively reduced gastrointestinal complications. This is supported by Anandika et al. (2022), who found that patients in the bolus group had a significant increase in gastric aspiration volume of 57% compared to 26% in the feeding pump group (p=0.02). This aligns with Preiser et al. (2021) and Singer et al. (2023), who stated that slow enteral feeding reduces the risk of refeeding syndrome and complications such as vomiting and diarrhea.

Oshvandi et al. (2020) compared complications arising from EN administered via bolus at three different time intervals: 2 hours, 3 hours, and 4 hours. There were statistically significant differences among the three groups in terms of regurgitation and high gastric residual volumes. Regarding feeding tolerance, patients fed at 4-hour intervals exhibited minimal issues. This is supported by earlier research (MacLeod et al., 2007) which compared continuous and intermittent feeding in critically ill trauma patients, showing that those receiving intermittent enteral nutrition every 4 hours achieved their caloric intake targets faster than those on continuous feeding. Golin Anieli et al. (2023) further reinforced this by demonstrating that intermittent EN with a 4-hour interval was more effective in fulfilling nutritional requirements and provided better glycemic control than continuous EN.

A study conducted in Egypt on the effects of two enteral nutrition methods on stomach bacterial colonization found that intermittent enteral nutrition every 4 hours was a beneficial way to feed critically ill patients as it prevented bacterial colony growth in the stomach (Mohamed et al., 2013).

In practice, various factors can influence the choice of nutritional therapy for critically ill patients. Interruptions in enteral nutrition due to patient care or diagnostic testing can result in varying research outcomes. Moreover, intermittent feeding allows for faster achievement of nutritional goals, especially when continuous feeding is gradually introduced. Intermittent enteral nutrition might also have additional benefits in minimizing patient immobility associated with nasogastric tube (NGT) placement.

CONCLUSION AND RECOMMENDATIONS

This scoping review found that intermittent enteral nutrition achieves protein targets faster than continuous feeding. Patients receiving intermittent enteral nutrition every 4 hours reached their caloric intake targets more quickly than those on continuous feeding. Modifying the speed of intermittent enteral nutrition using feeding pumps and syringe pumps was significantly effective in reducing enteral nutrition interruptions and gastrointestinal complications. However, inconsistent results were still observed in some studies, potentially due to heterogeneous patient criteria, varied interventions, research methodologies, and sample sizes.

High-quality, long-term studies are needed to evaluate which feeding method best achieves nutritional goals and recovery, optimizes metabolic function, and minimizes short-term complications, as well

as to validate the effectiveness of continuous, intermittent, and bolus feeding methods for critically ill patients.

ETHICAL CONSIDERATION

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Conflict of Interest Statement
There is no conflict of interest and no relationship with any party in writing this article.

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