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Care Bundle for Prevention of Enteral Feeding Complications in Critically Ill Patients

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Abstract: **Background: Complications associated with enteral feeding can have various impacts including malnutrition and gastrointestinal complications, which further compromise the patient's health status and leading to prolonged recovery. Care bundle of enteral feeding integrates evidence-based practice to improve nutritional status, prevent enteral feeding complications and decrease duration of MV and ICU length of stay. Purpose of the study: to examine the effect of implementing care bundle for prevention of enteral feeding complications in critically ill patients. Setting: Intensive Care Units at Menoufia University Hospital. Sample: A convenient sample of 80 critically ill patients who were admitted to the ICU. Design: A quasi-experimental design was used. Instruments: (1) Demographic and clinical data sheet, (2) Modified Nutrition Risk Assessment in Critically ill (mNUTRIC), (3) Acute Physiology and Chronic Health Evaluation II (APACHE II), (4) Sequential Organ Failure Assessment (SOFA) score and (5) Observational Sheet. Results: there was a statistically significant improvement in nutritional status in the study group (2.75 ± 1.17) compared to the control group (4.65 ± 1.406) (p< 0.000) post-intervention. Additionally, after the intervention, the study group saw a highly statistically significant decrease in the frequency of enteral feeding complications as compared to the control group (P value<0.05). Also, the study group's mechanical ventilation duration was statistically significantly shorter than that of the control group (4.13 ± 1.43) and (6.18 ± 2.17), respectively (P value <0.000) post intervention. Furthermore, post intervention, the study group's mean ICU length of stay was lower than that of the control group's (7.13 ± 1.95) and (9.05 ± 2.12) respectively (p value<0.000). Conclusion: Care Bundle of Enteral Feeding has a positive effect on improving nutritional status and decreasing enteral feeding complications among critically ill patients. Recommendation: The Care Bundle of Enteral Feeding should be incorporated as a routine practice in the ICU to promote nutritional status and prevent the serious complications of enteral feeding among critically ill patients.**

Keywords: **Care Bundle, Critically Ill Patients, Enteral Feeding Complications and Nutritional Status.**

1. INTRODUCTION

Critically ill patients are usually unable to maintain adequate oral intake to meet their metabolic demands. They cannot be fed orally because of their disease or condition (e.g., gastrointestinal, trauma, Mechanical Ventilation (MV), risk of aspiration). These physical stressors induce a catabolic response, leading to muscle wasting and weakness, longer Intensive Care Unit (ICU) length of stay and poor outcome. Thus, these patients need their basic energy supplemented

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through enteral or parenteral nutrition. Nutritional support therefore plays an important role in caring for critically ill patients (Lee et al., 2023).

Enteral nutrition (EN) is the most widely used method of providing nutritional support because it is practical, safe, and efficient. It can also lower the risk of serious complications, minimize the number of inflammatory cytokines in the blood by reduce the transmission of bacteria from the gastrointestinal tract to the blood, help patients restore normal intestinal function, and shortening the ICU length of stay (Jeong et al., 2023; O'Connor et al., 2023).

Although EN provides patients many benefits, a condition known as feeding intolerance (FI) develops. This condition includes increased gastric residual volume, digestive intolerance and several gastrointestinal disorders, such as diarrhea, constipation, abdominal distension and vomiting had been shown to be the most common complications of EN and developed in about 80.2 % to 85 % of patients with enteral feeding on mechanical ventilation (Wang et al., 2023; Zhang et al., 2023).

Feeding intolerance raises the risk of mortality and consequences from malnutrition, and inadequate nutrient intake leads to body mass loss, excessive weight loss, infection development, pressure ulcers, a longer duration of mechanical ventilation and higher costs. (Yu et al., 2022).

Diarrhea is one of the most prominent gastrointestinal adverse effects of EN. In critically ill patients, enteral nutrition-associated diarrhea ranges from 29% to 72% (O'Connor et al., 2023). Severe diarrhea can lead to a decrease in the circulating blood volume; metabolic acidosis with loss of electrolytes and bicarbonate by excretion of large quantities of digestive juices; electrolyte abnormalities with loss of potassium, magnesium, zinc; and pressure ulcers (Adam et al., 2020).

Vomiting is another gastrointestinal symptom related to EN and often causes EN to be held, increases the risk for electrolyte disturbance and hemodynamic instability. The incidence of vomiting in patient with EN ranged between 11% to 36% (Liu et al., 2022; Parrish, 2019).

Constipation related enteral feeding incidence is between 16% and 83% and can lead to numerous problems such as overgrowth of bacteria in the digestive tract which had negative effects on the colon mucosa and tolerance of an enteral diet. These problems may increase mortality through intestinal obstruction, perforation and aspiration. Other problems associated with constipation in critically ill patients involve gastrointestinal problems, abdominal pain, increase intra-abdominal pressure that may limit diaphragmatic movement, decrease lung compliance and increase respiratory effort, which lead to delayed weaning from mechanical ventilation and prolongs the ICU length of stay (Younis et al., 2023).

Additionally, high gastric residual volume including decreased gastric emptying and intestinal dysmotility, is a major complication of EN and has a prevalence of up to 40%, it may lead to regurgitation or vomiting of gastric contents, elevated probability of aspiration and VAP (ventilator-associated pneumonia) (Lindner et al., 2023).

Enteral feeding complications disrupt the feeding process, which delays nutrition management in 60% of critically ill patients and results in an insufficient daily calorie target in 42% of these patients. The diaphragm, which is required for breathing and may weaken and atrophic, is one of the body muscles affected by these disorders. Additionally, malnutrition may prolong a patient's stay in the intensive care unit, making it more difficult for them to wean off of mechanical ventilator, and increase the duration of mechanical ventilation (Koontalay et al., 2020).

The Institute for Healthcare Improvement (IHI) developed the concept of care bundles to improve the quality of care and reduce variation in practice inside intensive care units. Care bundles consist of three to five evidence-based practices which must be applied collectively and consistently in order to improve patient outcomes (Hassan, 2022).

Care bundle of enteral feeding that critical care nurses can carry out to avoid complications from enteral feeding in critically ill patients is a safe, inexpensive, and noninvasive intervention that minimizes side effects, reduces gastric residual volume, reduces gastric distension, reduces constipation and facilitates patient well-being, indicating an improvement in gastrointestinal function, reduces the occurrence of enteral feeding complications and optimize nutrition in critically ill patients (Thong et al., 2022).

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Care bundle of enteral feeding include elevating head of bed by 30 to 40 degrees; ensuring that nasal feeding tube is stable and unblocked; determining the correct position of the tube; evaluating gastric residual volume; performing abdominal massage; controlling the amount of nasal feeding; rinsing nasal feeding tube after nasal feeding (Yan et al., 2017).

SIGNIFICANCE OF THE STUDY

Recently, nutritional support has emerged as a major therapeutic priority to combat the catabolism and negative nitrogen balance from the systemic inflammation of critical illness. The subsequent malnutrition results in significant morbidity, exacerbation systemic inflammation, catabolic state, nosocomial blood stream infections, increased duration of MV and ICU length of stay and increased costs; however, prompt enteral nutrition can lower the risk of these serious side effects (Holyk et al., 2020; Sachdev et al., 2020)

The European Society of Clinical Nutrition and Metabolism (ESPEN) recommended early enteral nutrition within 48 h of ICU admission for critically ill patients who are unable to eat (Singer et al., 2019). Although, enteral nutrition t has been demonstrated that enteral nutrition maintains or restores gastrointestinal integrity, lowers bacterial translocation and sustains the immune and metabolic responses of the gut (Al-Dorzi & Arabi, 2021). However, problems and intolerance of the digestive tract, including gastric distention, bloating, diarrhea, and vomiting, are common in patients receiving EN (Jiao et al., 2022).

Despite that, the interventions associated with enteral feeding are already known; however, the elements that can influence the incidence of enteral feeding-related complications have not been determined. Additionally, there is inconsistency and a wide range of variation in implementing these interventions across critical care units and healthcare facilities. Thus, knowing the enteral feeding related complications is crucial to guarantee the optimum and safety administration of enteral feeding (Kahraman et al., 2020).

Critical care nurses have a crucial role in identify the patient's feeding requirements, as well as planning and implementing feeding safely and efficiently. The role of critical care nurse in providing nutrition, continuous monitoring, and evaluating the patient is critical to the success of enteral feeding (Abdelhafez & Abd Elnaeem, 2019).

Care bundle of enteral feeding is a safe, inexpensive, non-pharmacological and noninvasive nursing intervention. One of the numerous benefits of using non-pharmacological nursing intervention for managing and preventing enteral feeding issues is that it is free from side effects and may be used by nurses independently and with ease (Mohamed et al., 2021).

The results from the present study will allow nurses to better understand and implement the best practice to prevent complications of enteral feeding and help critically ill patients to achieve an adequate target calorie requirement and improve nutritional status and also promote respiratory muscle function which ultimately enables a successful weaning from ventilation and reduce ICU length of stay.

PURPOSE OF THE STUDY

The purpose of this study was to evaluate the effect of implementing care bundle to prevent enteral feeding complications in critically ill patients.

DEFINITION OF VARIABLES

Dependent Variables:

Enteral feeding complications: is theoretically defined as "complications associated with enteral nutrition which includes diarrhea, vomiting, abdominal distention and high gastric residual volume (Atasever et al., 2018). In the present study, enteral feeding complications are operationally defined as the presence and frequency of diarrhea, constipation, vomiting, abdominal distension and the amount of gastric residual volume as observed and recorded in the designed observational sheet. Diarrhea is operationally defined as patients passing three large watery stools per day; vomiting is operationally defined as the frequency of vomiting episode; constipation is operationally defined as patients didn't pass stool for three days; abdominal distention is operationally defined as patient's abdomen is hard and tense during palpitation and hearing hyper-resonance or dullness sound during percussion of the abdomen and increase abdominal girth as measured by measuring tape. High gastric residual volume is operationally defined as aspirated gastric contents ≥ 350 ml.

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Nutritional Status: is theoretically defined as "a requirement for one's health as determined by one's diet, the body's nutrient levels, and appropriate metabolic integrity"

(Syihab et al., 2019). In the present study, nutritional status is operationally defined as the patients' obtained score of the Modified Nutrition Risk in Critically ill patients. Score of ≥5 meaning that the patient had a higher risk of malnutrition while those with score ≤ 4 is considered low risk of malnutrition.

Duration of Mechanical Ventilation: is theoretically defined as "the number of days the patient spends on mechanical ventilation" (Ladbrook et al., 2019). In the present study, duration of mechanical ventilation is operationally defined as the number of days the patient connected to mechanical ventilator from the day of intubation until weaning the patient from mechanical ventilation or after seven days/which one comes first.

ICU Length of Stay: is theoretically defined as duration the patient spends in ICU (Hazard et al., 2020).In the present study, ICU length of stay is operationally defined as the mean or median number of days from ICU admission till ICU discharge.

Independent Variable:

Care Bundle of Enteral Feeding is theoretically defined as " a set of evidence-based interventions in which patients' outcomes are markedly better when the interventions are implemented together rather than individually" (VanBlarcom & McCoy, 2018). In the present study, Care Bundle of Enteral Feeding is operationally defined as a group of interventions performed together which includes elevate head of bed; secure nasal feeding tubes to avoid slippage and dislocation; determine the correct position of the tube; evaluate the gastric residual volume; performing abdominal massage; control the amount of nasal feeding at 500 ml/day; rinse the nasal feeding tubes with warm water. The intervention will be conducted each feeding for 7 consecutive days.

RESEARCH HYPOTHESES

1) Enteral feeding complications are less in patients who receive the care bundle of enteral feeding than control group.

2) Participants who receive the care bundle of enteral feeding will have improved nutritional status compared with the control group.

3) Participants who receive the care bundle of enteral feeding are more likely to have decreased duration of mechanical ventilation compared with the control group.

4) The patients who receive the care bundle of enteral feeding will have lower ICU length of stay than the control group.

5) There is a relationship between enteral feeding complications and duration of mechanical ventilation and ICU length of stay.

6) There is a relationship between severity of disease and comorbidity and enteral feeding complications.

2. METHODS

Research Design:

A Quasi-experimental design (study / control) was used to test the hypotheses.

Setting:

The present study was carried out in the University Hospital's neurosurgical and medical intensive care units.

Sample:

A convenient sample of 185 patients admitted to University Hospital's neurosurgery and medical intensive care units were approached over 12 months period from the beginning of May 2022 to the end of April 2023. After excluding 95 patients based on exclusion criteria, the remaining 90 patients were screened daily for possible enrollment in care bundle intervention. Forty-five patients were enrolled in the care bundle and 45 patients were not and served as the control group. Among the ten patients who did not complete the planned follow-up measurement, seven patients died, and 3 patients

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discharge before completing the intervention. The final analysis included 40 patients who were assigned in the study group and 40 patients who were assigned in the control group.

Patients who fulfilled the criteria for study inclusion included a) adult patients from both gender, age from 18 to 65 years old; and b) Individuals who recently inserted nasogastric tube for bolus enteral feeding and tolerate enteral feeding. If a patient had any of the following conditions, they were excluded a) patients whose ICU length of stays less than 48 hours; b) Patients with hemodynamic instability (decrease BL.P may predispose to bowel ischemia); c) patients who are pregnant, have just undergone abdominal surgery, have diarrhea, are actively bleeding, have spinal cord injuries are contraindicated for abdominal massage; and d) patients who have any contraindications to enteral feeding such as (bowel ischemia or necrosis, small or large bowel obstruction, Paralytic ileus, Diverticular disease and Fistula in the small bowel).

Sample Size Calculation

Power analysis and the sample size software version were used to determine the sample size. According to a power calculation, a sample size of 30 patients per group is required to detect a large effect size of 0.65 with a p-value < 0.05, 80% power, and a 95% confidence level. The current study's sample size was determined using a large effect size because, according to prior research, we expected the care bundle intervention to have a significant impact on the selected outcomes (Adam et al., 2020). Also, a large alpha level was selected because the well-established safety of the care bundle intervention. This computation indicated that a sample size of 60 was sufficient to evaluate the research hypotheses. In order to compensate for the attrition rate in critically ill patients, twenty patients were added, which is reported at 33% (National Center for Health Statistics, 2017). Thus, the final sample size was 80 patients.

Instruments of Data Collection:

I) Demographic and Clinical Data Sheet: It includes data about patient's age, sex, past medical history, admission date, the current diagnosis, duration of mechanical ventilation and ICU length of stay. Data were obtained from the patient's medical files. **Modified Nutrition Risk Assessment in Critically ill (mNUTRIC):** the scale was developed by (Heyland et al., 2011). NUTRIC was the first instrument for assessing nutritional risk that was created especially for the ICU population and it can be used to detect patients who may be malnourished.In order to evaluate nutritional risk at admission, the modified NUTRIC was later validated by (Rahman et al., 2016). This validation permits the omission of the IL-6 levels, if they are unavailable. The Modified NUTRIC was used to identify patients at risk with the following variables: age, number of co-morbidities, days from hospital to ICU admission, Acute Physiology and Chronic Health Evaluation II (APACHEII) and Sequential Organ Failure Assessment (SOFA) scores at admission. Zero to nine is the range of the modified NUTRIC score. According to Heyland et al., (2011), patients were categorized as having a high mNUTRIC score if the sum was ≥5, which indicates a higher risk of malnutrition. Conversely, a low score of 0–4 indicates a lower risk of malnutrition.

The validity of the instrument had sensitivity more than 80% for all body mass index grades, for both genders, and for data gathered from the ICU. The interrater reliability of the screening tool was interpreted as substantial, being k = 0.68 and k = 0.74) (Mirmiran et al., 2011). In the current study, SPSS was used to perform the validity of modified NUTRIC score using Pearson Product Moment Correlations depending on the internal consistency (r=0.95 P-value<0.001) and the significant value (Sig (2-tailed) <0.05. Cronbach's co-efficiency Alpha (a= 0.80), which indicates that the instrument has a high level of reliability, was used to assess the modified NUTRIC score's reliability in the current study in order to ascertain how closely the tool's components connected to one another.

II) Acute Physiology and Chronic Health Evaluation II (APACHE II) Scale: Knaus et al. (1985) developed the APACHE II to evaluate the adult patients' mortality indicator upon admission to the intensive care unit. The APACHE II assesses 12 physiologic variables, age, and chronic health status to provide a point score that runs from 0 to 71. Based on the scale's scoring method, the mortality risk for those in the range of 5 to 9 was 8%, for those in the range of 10 to 14, 15%, for those in the range of 15 to 19: 25%, for those in the range of 20 to 24: 40%, for those in the range of 25 to 29: 55%, for those in the range of 30 to 34: 75%, and for those >34 had 85% mortality. According to Park et al., (2009), the APACHE II scale has great validity when applied to critically ill patients (Bravais-Pearson correlation coefficient: 0.86,

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P<0.01). The reliability of the APACHE II scale was reported in a study of 37 critically ill patients. When utilizing Cronbach's co-efficiency Alpha to assess internal consistency, the overall scale's value was 0.91, P <.001 (Donahoe et al., 2009).

In this study, the validity of the APACHE II scale was examined Using Pearson Product Moment Correlations, which were based on the internal consistency (r=0.83 P value < 0.001) and the significant value determined by the Sig (2-tailed) <0.05. The Cronbach's co-efficiency Alpha (a=0.97) was utilized in the current study to assess the APACHE II scale's reliability. This suggests that the tool has a high level of reliability.

III) Sequential Organ Failure Assessment (SOFA) Score: was utilized to predicate the morbidity and mortality for critically ill patients according to the degree of organ malfunction using clinical data (Lambden et al., 2019). The Sequential Organ Failure Assessment (SOFA) Score is an objective and straightforward score that can be used to determine the number and severity of organ dysfunction in six different organ systems: the respiratory, cardiovascular, hepatic, coagulatory, renal, and neurological. A score ranging from 0 (normal) to 4 (sever degree of organ dysfunction) is assigned to each organ system. The SOFA score is 0–24 on a scale. The SOFA score, which varied from 0-6, 7-9, 10-12, 13–14, and 15–24, was connected with mortality rates of less than 10%, 15%–20%, 40%–50%, 50%–60%, and more than 80%, respectively. The recorded total SOFA scores' mean absolute deviation from the gold standard total SOFA scores was 0.82 (Arts et al., 2005).

In the current study, Pearson Product Moment Correlations with SPSS were utilized to examine the validity of the SOFA score. Based on the internal consistency (r=0.91 - P-value<0.001) and the significant value (Sig (2-tailed) <0.05, which show that the tool's items were valid. The reliability of the SOFA score was done to determine the extent to which items in the tool were related to each other by Cronbach's coefficiency Alpha (a= 0.95), indicating that the tool has a high level of reliability.

IV) Observational Sheet: A sheet was used to record the enteral feeding complications which include the presence and frequency of diarrhea, constipation, vomiting, abdominal distension and the amount of gastric residual volume as observed and recorded by the researcher.

Ethical Consideration

Written approval to carry out the study was granted by the Faculty of Nursing's Research Ethical Committee, with an assigned approval number (Ethics code 863) and a formal consent was taken from the hospital director to conduct the study after clarifying the study's objectives. After informing the patients' relatives of the study's purpose, methodology, and advantages, the researcher obtained their written consent to participate in the study. Patients' relatives were also informed by the researcher that participation in the study is entirely voluntary and that withdrawing at any time would not affect the patient's course of treatment. Patient data was coded, and it was stored in a locked cupboard to ensure confidentiality and anonymity.

Pilot Study

To determine if the study questionnaire was applicable and practicable, a pilot study 10% of the study sample (8 patients) was carried out. The final analysis did not include any patients who took part in the pilot study.

Data Collection Procedure

A formal approval to conduct the study was received by the researcher from the hospital director following an explanation of the study's objectives. The participants in the study who matched the criteria for inclusion were split into two groups, with each group including forty patients. The study participants were recruited 24 hours following the patient's admission to the intensive care unit and following the patient's condition stabilization. Participants were assigned randomly to either the study or the control group. Participant's assignment performed through writing the names of the patients on slips of paper, which was placed in a container and mixed well, then drew out one paper at a time until reaching the required sample size. The Study group received the care bundle of enteral feeding and only usual hospital care was provided to the control group. In order to prevent data contamination, the researcher worked with the control group first. Enteral feeding complications were assessed on daily bases to determine the presence and frequency of diarrhea, constipation, vomiting, abdominal distension and the amount of gastric residual volume as observed and recorded by the researcher in the designed observational sheet.

Feeding was stopped if patient developed vomiting and re-start feeding when vomiting stopped. When a patient passed three big, watery stools in a day, it was considered that they had diarrhea. Patients considered to be constipated if they didn't pass feces for three consecutive days. Abdominal distension was confirmed through palpitation and hearing a hyper-resonance or dullness sound on percussion of the abdomen. Distended abdomen was confirmed by hard, tender, bloating and increased abdominal diameter.

The Modified Nutrition Risk Assessment in Critically ill (mNUTRIC) scale was used to assess nutritional status for both group before the intervention and seven days post intervention.

Control Group (Routine Care)

The usual hospital care only was given to the control group which include measuring gastric residual volume and sometime rinsing nasal feeding tube after nasal feeding.

Study Group (Care Bundle Intervention)

Care bundle of enteral feeding was developed by Yan, (2017) and included elevating head of bed by 30 to 40 degrees; ensuring that nasal feeding tube is stable and unblocked; determining the correct position of the tube; evaluating gastric residual volume; performing abdominal massage; controlling the amount of nasal feeding; rinsing nasal feeding tube after each feeding.

Before every feeding, the head of the bed was raised by at least 30 degrees, and the tracheostomy or endotracheal tube's cuff was inflated to prevent formula aspiration. Also, before beginning each feeding, the tube placement was verified by looking at the visible marker level, aspirating the stomach's contents, and hearing for the sound of air being injected into the stomach by placing a stethoscope over the epigastric area and injecting air with a 50-cc syringe. Before starting feeding, abdominal massage was applied twice daily for 15 min at 8 AM and 4 PM before feeding time to avoid aspiration. Abdominal massage could stimulate parasympathetic activity that enhancing the gastrointestinal function and could be applied to accelerate peristalsis by altering intra-abdominal pressure and creating a mechanical and reflexive effect on the intestines, decreasing abdominal distension and increasing intestinal movements (Danasu & Priyanka, 2019).

The researcher began the abdominal massage by gently relaxing stroke up the abdominal wall, and then they would provide four consecutive strokes: Stroking, Effleurages, Kneading and Vibration. **Stroking** was done to the vagus nerve dermatome, followed by the iliac crease and both groin sides. The ascending colon was eroded with **effleurage** strokes, which were then transferred down to the descending colon. The large intestine was stimulated to contract, which moved stool throughout the colon and increased eating tolerance, by applying excessive pressure during these strokes. Many applications of these strokes were made. Massage therapy's most important component is palmer **kneading**, which moves from the descending colon upward to the ascending colon and back down again. It helps the fecal matter to propel into the rectum and decrease abdominal distension. In order to treat abdominal distension and flatus, **vibration** therapy was lastly performed over the abdominal wall. Fingertips were used for all strokes, applied in a clockwise circular manner (Uysal, 2017).

Assessment of the gastric residual volume: prior to feeding, the researcher used a 50 ml syringe to aspirate the stomach contents from the nasogastric tube. If there was no gastric content, the researcher repeated the aspiration process to make sure that the stomach is empty, GRV more than or equal to 350 ml considered increased, omitted feeding if gastric residual volume was more than 500 ml, return 200 mL, discard the remainder, hold enteral feeding for two hours, recheck residuals after two hours, if GRV remains >200 mL: Continue to hold tube feeding. The amount of nasal feeding was controlled at 500 ml/day according to the patient's physical function status and when patients had no complications such as diarrhea or vomiting, the amount of nasal feeding was advanced to 1000 ml to 1500 ml/day.

After feeding, 30 to 50 ml of water used to irrigate the nasogastric tube. The intervention was conducted each feeding for 7 consecutive days. The rational for the duration of the intervention was decided based on pervious study that found significant effect after 7 days (Ahmed et al., 2019; Yan et al., 2017).

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Data about duration of mechanical ventilation and length of ICU stays were collected daily and verified at discharge from the ICU. Patients were assessed by using study instruments (II, V) after 7 days to determine the effect of care bundle for preventing enteral feeding complications in critically ill patients.

Statistical Analysis

A statistical analysis was performed on the data using SPSS version 22 on IBM compatible computer. For qualitative data mean and standard deviation (X+SD), number and percentage (No & %) were utilized. Pearson Chi-square test ($\chi 2$), Student t- test, ANOVA (F) test and Pearson correlation were employed. Significance was determined based on P-values with $P > 0.05$ considered statistically insignificant, P-value ≤ 0.05 as statistically significant, and P-value ≤ 0.001 as highly significant.

3. RESULTS

Characteristics of the Sample

Eighty patients were admitted to the neurosurgical and medical intensive care units were approached over 12 months period that began in May 2022 and ended in April 2023. Eighty participants were divided into two groups (study and control).

Table (1): - Demographic Characteristics and Clinical Data of the Studied Sample (N=80)

Demographic &Clinical Characteristics	Study group (n=40)		Control group (n=40)		Total		Test	P -value
	X ± SD		X ± SD					
Age								
X ± SD	51.88 ± 8.81		53.28 ± 7.50				**t test** - 0.765 ns	0.447
	No.	**%**	**No.**	**%**	**No.**	**%**		
Sex								
Male	22	55.0%	24	60.0%	46	57.5%	**X2** 0.20 ns	0.651
Female	18	45.0%	16	40.0%	34	42.5%		
ICU diagnosis								
Respiratory Failure	9	22.5%	10	25.0%	19	23.7%	**X2** 6.86 ns	0.810
Chest infection	7	17.5%	8	20.0%	15	18.8%		
Poisoning	5	12.5%	4	10.0%	9	11.2%		
Stroke	8	20.0%	7	17.5%	15	18.8%		
Acute respiratory distress syndrome (ARDS)	4	10.0%	3	7.5%	7	8.7%		
Traumatic Brain Injury (TBI)	7	17.5%	8	20.0%	15	18.8%		
Medical history								
Cardiac disease	7	17.5%	7	17.5%	14	17.5%	**X2** 0.59 ns	0.988
Chest disease	7	17.5%	8	20.0%	15	18.8%		
Diabetes mellitus (DM)	9	22.5%	7	17.5%	16	20.0%		
Hypertension (HTN)	8	20.0%	9	22.5%	17	21.2%		
Stroke	4	10.0%	5	12.5%	9	11.3%		
No history	5	12.5%	4	10.0%	9	11.3%		

Note: (ns): not significant (p value>0.05)

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Table (1): Represents that the study's participants' mean age was (51.88 ± 8.81) years whereas the control group's mean age was (53.28 ± 7.50) years. Regarding gender, more than half of participants were male in the experimental group (55.0%) and the control group (60.0%), respectively. Concerning the diagnosis, about (22.5%) and (25.0%) of participants in the study and control group had Respiratory Failure respectively. Regarding past medical history, (22.5%) in the study group had Diabetes Mellitus & (22.5%) in the control group had Hypertension. There was no in the demographic characteristics between both groups (p value= >0.05). The demographic characteristics of the two groups did not have statistically significant difference (p value = >0.05).

Table (2): Severity of Disease and Comorbidity of the Studied Sample (N=80)

Items	Study Group (n=40)	Control Group (n=40)	T test	P -value
	X ± SD	X ± SD		
APACHE II pre intervention	20.23 ± 3.254	20.43 ± 3.096	0.282 ns	0.779
SOFA pre intervention	11.35 ± 1.875	11.93 ± 1.831	-1.388 ns	0.169

Note: (ns): not significant (p value>0.05)

Table (2): Demonstrates that the pre intervention mean APACHE II scores for the experimental group and the control group were, respectively (20.23 ± 3.254 and 20.43 ± 3.096). Regarding mean score of SOFA was (11.35 ± 1.875 and 11.93 ± 1.831) in the study and the control group respectively pre intervention. There was no statistically significant difference between both groups regarding the severity of disease and comorbidity.

Table (3):- Number and Percentage Distribution of Enteral Feeding Complications Post Intervention in the Studied Sample (N=80)

Enteral feeding complications	Study group (n=40)		Control group (n=40)		Total		X^2	P -value
	No.	%	No.	%	No.	%		
Diarrhea								
No	36	90.0%	27	67.5%	63	78.8%	6.05 S	0.014
Yes	4	10.0%	13	32.5%	17	21.3%		
Vomiting								
No	36	90.0%	26	65.0%	62	77.5%	7.16 S	0.007
Yes	4	10.0%	14	35.0%	18	22.5%		
Constipation								
No	37	92.5%	30	75.0%	67	83.8%	4.50 S	0.034
Yes	3	7.5%	10	25.0%	13	16.3%		
Abdominal Distention								
No	37	92.5%	30	75.0%	67	83.8%	4.50 S	0.034
Yes	3	7.5%	10	25.0%	13	16.3%		
High gastric residual volume								
No	35	87.5%	25	62.5%	60	75.0%	6.66 S	0.010
Yes	5	12.5%	15	37.5%	20	25.0%		

Note: (S): significant (p value<0.05) High residual volume ≥ 350ml

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Table (3): Illustrates that there is statistically significant difference between the study and the control group regarding occurrence of enteral feeding complications post intervention with percentage of the study and the control group regarding occurrence of Diarrhea (10.0%) (32.5%) respectively, Vomiting (10.0%**)** **(**35.0%) respectively, Constipation (7.5%**)** **(**25.0%) respectively, Abdominal Distention (7.5%**)** **(**25.0%) respectively and High gastric residual volume (12.5%**)** **(**37.5%) respectively post intervention (p value<0.05).

Figure (1): - Effect of the Enteral Feeding Care Bundle on Nutritional Status in the Study and Control Group Post Intervention

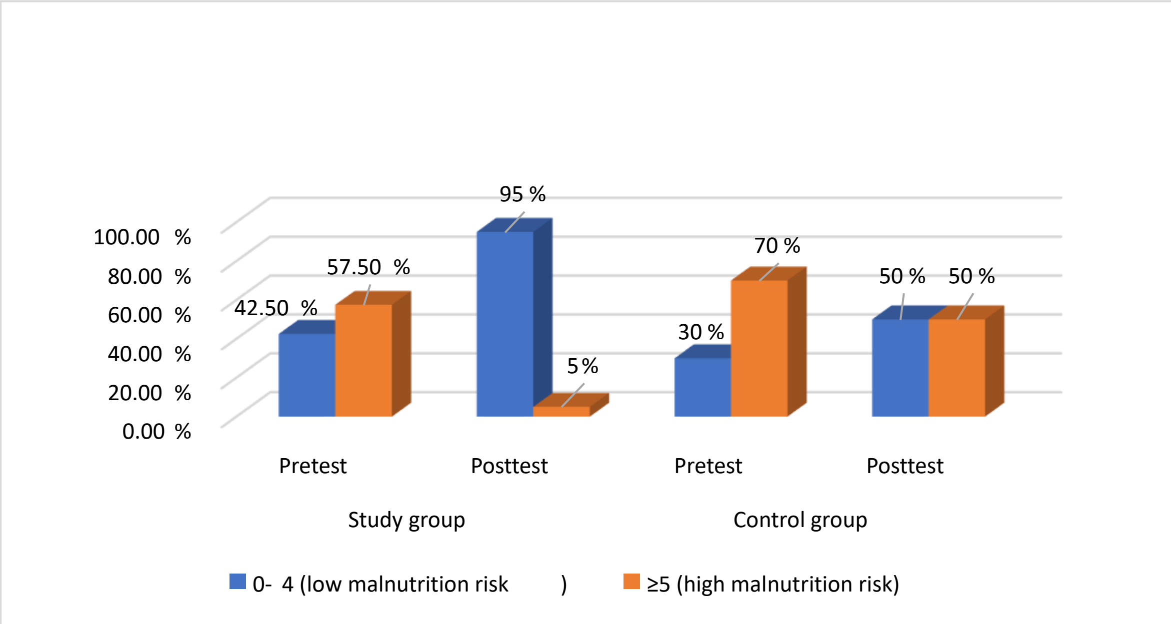

Figure (1): Shows that there is a highly statistically significant improvement in nutritional status in the study group compared to the control group after intervention. The majority of participants in the experimental group (95%) in comparison to (50%) in the control group had low malnutritional risk. While there is (5%) in the study group had high malnutritional risk compared to (50%) in the control group after intervention.

Table (4): Effect of the Care Bundle of Enteral Feeding on Duration of Mechanical Ventilation and ICU Length of Stay (N=80)

Variables	Study Group (n=40)	Control Group (n=40)	T test	P -value
	X ± SD	X ± SD		
Duration of Mechanical Ventilation/in days	4.13 ± 1.43	6.18 ± 2.17	-4.982 HS	0.000
ICU Length of Stay /in days	7.13 ± 1.95	9.05 ± 2.12	-4.222 HS	0.000

Note: (HS): High significant (p<0.001)

Table (4): Shows that, after intervention, the mean duration of mechanical ventilation was significantly shorter in the experimental group (4.13 ± 1.43) than in the non-experimental group (6.18 ± 2.17) (P<0.000). Furthermore, the mean score of the ICU length of stay (7.13 ± 1.95) in the experimental group is significantly lower than that of the control group (9.05 ± 2.12) after the intervention (P<0.000).

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Table (5): Correlation between Enteral Feeding Complications and Duration of MV and ICU length of stay

Items	Enteral feeding complications			
	Study group (n=40)		Control group (n=40)	
	r	P –value	r	P –value
Duration of MV	0.378*	0.025	0.475**	0.004
ICU length of stay	0.356*	0.036	0.819**	0.000

*. Correlation is significant at the 0.05 level (2-tailed)

**. Correlation is significant at the 0.01 level (2-tailed)

Table (5): Demonstrates that there is a statistically significant positive correlation between enteral feeding complications and duration of MV in the study and the control groups post intervention with r = 0.378 (P< 0.025) and r = 0.475 (P< 0.004) respectively. Also, there is a statistically significant positive correlation between enteral feeding complications and ICU length of stay r = 0.356 (P< 0.036) and r= 0.819 (P< 0.000) in the study and the control groups respectively. Which indicate that the participants with lower enteral feeding complications had short duration of MV and ICU length of stay.

Table (6): Correlation between Severity of Disease, Comorbidity and Enteral Feeding Complications post intervention

Items	Enteral feeding complications			
	Study group (n=40)		Control group (n=40)	
	r	P –value	r	P –value
APACHE II	0.399*	0.011	0.241*	0.013
SOFA	0.391*	0.013	0.163*	0.025

*. Correlation is significant at the 0.05 level (2-tailed)

Table (6): Shows that there is a positive relationship between APACHE II and enteral feeding complications in both groups post intervention with r = 0.399 (P< 0.011) in the study group and r = 0.241 (P< 0.013) in the control group. Also, there is a positive relationship between SOFA and enteral feeding complications in both groups post intervention with r = 0.391 (P< 0.013) in the study group and r= 0.163 (P< 0.025) in the control group. Which indicate that participants who had low mean score of APACHE II and SOFA score had lower incidence of enteral feeding complications.

4. DISCUSSION

Critically ill patients who are receiving enteral feeding are susceptible to complications such as increased gastric residual volume, vomiting, abdominal distension, and constipation. These complications can result in delayed or stopped feeding, which can exacerbate the patient's initial condition, prolong the disease's course, and lengthen hospital stays in the intensive care unit (Wang et al., 2022).

Effect of Care Bundle on Enteral Feeding Complications

Critical care nurses can prevent enteral feeding complications in critically ill patients through the use of evidence-based care bundle (Yan et al., 2017).

Finding of the present research showed a significant decrease in the incidence of enteral feeding complications in the experimental group compared to the control group after implementing the care bundle and these findings supported the study hypotheses. Similar findings have been reported by Xiaohong et al., (2022), Jiao et al., (2022), & Zhang et al.,

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(2021) & Yan et al., (2017) who found that the application of the enteral feeding care bundles can effectively reduce the incidence of enteral feeding complication among critically ill patients.

In contrast, this finding was opposed by Padar et al., (2017) who reported that there was no statistically significant difference identified in both groups regarding the prevalence of gastrointestinal complications. This discrepancy could be explained by the heterogeneity of Padar et al's study sample characteristics which included elderly patients. The gastrointestinal tract changes with age, including a decrease in stomach acid production, a slowdown in intestinal motility, and a slower rate at which food passes through the intestines, all of which increase the risk of GIT complications.

Effect of Care Bundle on Nutritional Status

Catabolic stress and a systemic inflammatory response are common features of critically ill patients. Complications that result in greater infectious morbidity, multiple organ failure, prolonged hospitalization and a higher death rate are also linked to this inflammatory response (Santos & Araújo, 2019).

The hypothesis of the current study states that people who receive the care bundle of enteral feeding will have improved nutritional status compared to the control group. The results of this study validated the hypothesis and exhibited that, there was a highly statistically significant improvement in the nutritional status of the experimental group in comparison to the control group after intervention. The same results were published by Shabaan et al., (2021), Jordan & Moore, (2020) & Adam et al., (2020) who found that nutritional status was significantly improved after implementing the care bundle of enteral feeding.

However, this finding was different from Theodorakopoulou et al., (2014) who evaluated the effect of enteral feeding protocol in septic critically ill patients and reported that there was no association between nutritional status and compliance with the feeding protocol. A possible explanation of Theodorakopoulou et al's findings may be due to that all participants had sepsis and septic shock which increase catabolism due to release of inflammatory mediators and create a distinct pathophysiology condition in critically ill patients that degradation of organ function and systematic immunity.

Effect of Care Bundle on Duration of Mechanical Ventilation

The results of that study showed a statistically significant decrease in the duration of mechanical ventilation. This result is consistent with that which was published by Bencomo (2019) & Koontalay et al., (2020) who found a significant decrease in the duration of mechanical ventilation in the intervention group after implementation of EN care bundle.

However, the current study's findings differ from Li et al., (2017) who investigated whether enteral feeding bundle was able to improve clinical outcomes in critically ill patients and found that duration of mechanical ventilator did not differ significantly between the study and the control group. The results of Li et al's study could be explained by increase severity of illness of the participants and consequently prolonged the duration of mechanical ventilation.

Effect of Care Bundle on ICU Length of Stay

The current study showed a highly statistically significant reduction in ICU length of stay post intervention. The present study findings supported the hypothesis that the patients who receive the care bundle of enteral feeding are more likely to have shorter duration of ICU length of stay than patients who do not receive the care bundle of enteral feeding. The results of the present study agree with the findings of Ahmed et al, (2019) & Kim et al., (2017), who observed a reduction in the ICU length of stay after implementation of the care bundle of EN.

Nevertheless, the results of this study differ from those of Jiang et al., (2020) who explored the impact of an enteral feeding care bundle in critically ill patients and reported that implementation of the enteral feeding bundle had no statistically significant effect on ICU length of stay and duration of mechanical ventilation. A possible explanation of Jiang et al's findings may be due to that the researcher in the corresponding study did not use all the components of the care bundle. In Jiang et al's study, the participant does not receive abdominal massages. Abdominal massage has a positive effect on reducing vomiting, distension and improves defecation patterns.. This attributed to increase complications and consequently increased ICU length of stay.

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Relationship between Enteral Feeding Complications and Duration of Mechanical Ventilation and ICU Length of Stay

Critically ill patients are unable to start an oral meal and there is feeding interruption related to enteral feeding complications such constipation, diarrhea, and excessive gastric residual volume. These complications resulted in malnutrition which can lead to decline in respiratory muscle strength and function, impairing the patient's ability to effectively breathe and participate in weaning from mechanical ventilation. The diaphragmatic muscle strength and weaning success rate of patients with improved nutritional status significantly increased, resulting in reduced the duration of mechanical ventilation, and reduce the ICU length of stay. Also, poor nutritional status has been associated with an increased risk of respiratory infections leading to increased duration of mechanical ventilation and ICU length of stay (Koontalay et al., 2020).

The current study hypothesized that there was a relationship between enteral feeding complication and duration of mechanical ventilation and ICU length of stay after intervention. The finding of the current study validated the hypothesis and demonstrated that there was a significant positive correlation between enteral feeding complications and duration of mechanical ventilation and ICU length of stay. Similar results were observed in studies by McClave et al., (2020), Hu et al., (2020), Wang et al., (2017) who found a correlation between the existence of EN complications, such as feeding intolerance and gastrointestinal dysfunction, and worse clinical outcomes, such as extended duration of mechanical ventilation and ICU length of stay.

In addition, similar results were observed in studies by Liu et al., (2022) & Atasever et al., (2018) who reported that enteral related GI complications were associated with poor outcomes including longer ICU length of stay.

Relationship between Severity of Disease, Comorbidity and enteral feeding complications

The current study revealed a positive correlation between severity of disease, comorbidity and enteral feeding complications. Which indicate that participant who had low mean score of APACHE II and low SOFA score had lower incidence of enteral feeding complications. The findings of the study agreed with Lindner et al., (2023), Yahyapoor et al., (2021) & Heyland et al., (2020) who report that increased disease severity and comorbidity may serve as a marker of increased of EN complications.

Limitation of the study: -

- The convenient sample used in this study limits the generalizability of the findings. The absence of random sampling restricts the findings' ability to be generalized and may exacerbate bias in sample selection.
- Findings should be analyzed carefully because participants were enrolled from only one hospital.

5. CONCLUSION

The finding of the current study supported the use of care bundle of enteral feeding in clinical practice as an effective, safe and feasible nursing intervention that has a positive effect on reducing enteral feeding complications, improving nutritional status and reducing duration of mechanical ventilation and ICU length of stay among critically ill patients.

6. RECOMMENDATIONS

Implication for Nursing Practice

- Care bundle of enteral feeding should be incorporated as a routine practice in the ICU to prevent the enteral feeding complications and promote patient’s nutritional status.
- Continuing training for critical care nurses to apply care bundle of enteral feeding into practice as a regular procedure of critically ill patients is crucial.

Implication for Future Research

- Replication of the study with large probability sample and different geographical area is recommended.
- Conducting comparative studies to evaluate the effectiveness of applying care bundles in different methods of enteral feeding.

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