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RESEARCH ARTICLE

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Effectiveness of a checklist for enteral medication administration: A randomized controlled trial

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Abstract

Background: Enteral nutrition protocols are used when oral nutrition is contraindicated. Medications may be administered through enteral feeding tubes when alternative routes of administration are not available. A brief review of the literature shows a lack of knowledge and inconsistent behaviours among nurses regarding enteral medication administration, which may pose a threat to patient safety.

Aim: This study was conducted to evaluate the effectiveness of an enteral medication administration checklist in reducing medication administration errors via enteral feeding tubes.

Study Design: A randomized, controlled, triple-blind, experimental design was used. The study was conducted between 2022 March and June in five different intensive care units of a research and training hospital in X city, XX country. Sixty-nine volunteer nurseswere divided into two groups: intervention ($n = 34$) and control ($n = 35$) by stratified randomization method. The study was conducted in two steps. First, a checklist for enteral medication administration was developed according to the recommendations of the American Society for Parenteral and Enteral Nutrition, the European Society for Clinical Nutrition and Metabolism and the British Association of Parenteral and Enteral Nutrition. Second, the effectiveness of the checklist on the intervention group in reducing implementation errors was examined. Four data collection tools, including a descriptive information form, enteral medication administration evaluation form, knowledge assessment form and observation form, were used in the study.

Results: In the pretest phase, the mean error rate of the control group was 37.49 ± 18.42, while in the intervention group it was 38.23 ± 15.08; in the post-test phase, the mean total error rate of the control group was 26.88 ± 17.56, and it was 2.21 ± 4.05 in the intervention group. Accordingly, it was determined that the post-test total error rate mean of the intervention group was statistically significantly lower than that of the control group ($p < 0.05$, $t = -8.096$ [−30.846; −18.502]).

Conclusion: The enteral medication administration checklist reduced errors in the administration of medications through enteral feeding tubes. Therefore, the checklist can be used to reduce errors in medication administration.

Relevance to Clinical Practice: This study was conducted to reduce errors in enteral drug administration reported in the literature. With the developed checklist, these errors were reduced, and a standard practice approach was provided to intensive care nurses.

KEYWORDS
checklist, enteral feeding tube, enteral medication administration, medication administration errors, nurse

1 | INTRODUCTION

An enteral nutrition protocol is recommended when oral nutrition is contraindicated and the patient does not have gastrointestinal dysfunction.[1–3] Medications can be administered via enteral feeding tube when oral administration is necessary, but alternative routes are not available.[4,5] It has become common practice to check for drug incompatibility when drugs are added to parenteral nutrition mixtures or when drugs are used together through the same catheter. However, it has been reported that the same level of care is not applied to enteral medication administration.[6,7] As nurses are largely responsible for medication administration, they should be equipped with the knowledge and skills required for enteral medication administration.[8,9] Compared with other health care professionals, nurses are more likely to make errors in medication administration because they play an active role in various stages of medication administration.[10] Although medication errors are among the most common medical errors, they are preventable.[11]

What is known about the topic

- Nurses' level of knowledge about enteral medication administration is insufficient.
- Errors are made by nurses during enteral medication administration.
- These errors negatively affect patient and employee safety.

What this paper adds

- A checklist for enteral medication administration was developed.
- With this checklist, error rates during enteral medication administration were significantly reduced.

2 | BACKGROUND

Errors and lack of knowledge about enteral medication administration can lead to complications and ultimately jeopardize patient care.[7,8] A number of studies have reported errors and complications associated with enteral medication administration.[9,12,13] Incorrect medication administration through enteral feeding tubes can lead to a number of measurable complications, including enteral tube obstruction, decreased drug efficacy and increased drug toxicity.[13,14] Other complications include diarrhoea, aspiration pneumonia, adverse drug reactions and even mortality.[8,9,15]

Patient safety is one of the most important elements of an institutional culture in health care.[16–18] The primary goal of patient safety is to establish a system that prevents medical errors during the delivery of care, protects the patient from potential harm caused by errors and eliminates the possibility of errors.[16,19] A brief review of the literature shows a lack of knowledge and inconsistent behaviours among nurses regarding enteral medication administration, which may pose a threat to patient safety.[15,20,21] Other studies have focused on educational interventions to prevent errors in enteral medication administration.[9,12,22] Recent studies have examined checklists as an evidence-based effective method for preventing errors and reducing complications.[23–25] Standardizing the process of enteral medication administration using a checklist can help guide nursing practice and reduce errors and complications.[26] Although checklists have been developed and used in various health care settings,[27] we did not find a checklist developed specifically for enteral medication administration. Such a checklist may help maintain patient safety by contributing to the reduction of medication administration errors.

3 | AIMS

This study had two aims:

1. What are the error rates in enteral medication administration?
2. What is the effect of the checklist developed for enteral medication administration on administration errors?

4 | DESIGN AND METHODS

4.1 | Design

It is a randomized controlled, triple-blind, experimental study. Participants, observer and statistician were blinded. This study was

conducted in two steps. First, an enteral medication administration checklist was developed. The second step utilized a randomized, controlled, triple-blind, experimental design to evaluate the effectiveness of the checklist in reducing medication administration errors.

4.2 | Population and sampling

Enteral drug administration is actively used in intensive care units (ICU). Therefore, intensive care nurses were preferred in this study. The study was conducted between March and June 2022 with nurses working in anaesthesia and reanimation, general surgery, internal medicine, neurosurgery and cardiology ICUs of X hospital in X city of X country and who agreed to participate in the study. The sample size of the study was calculated using the G. Power 3.1.7 program, with a margin of error of 0.05 at a test power of 0.80, with 32 control and 32 intervention groups, and at least 64 people in total. We intended to collect data from a total of 80 nurses because of possible data loss and ended the pretest phase when 80 nurses were reached. Descriptive information form, enteral medication administration evaluation form, enteral medication administration knowledge assessment form and enteral medication administration observation form were used in the pretest phase. After the pretest, 11 nurses withdrew from the study because of a change in the ICUs where they worked. Consequently, the study was completed with a total of 69 nurses (Intervention = 34, Control = 35).

4.3 | Randomization

With 80 nurses, the pretest phase was completed by filling the descriptive information form, enteral medication administration evaluation form, enteral medication administration knowledge assessment form and enteral medication administration observation form. After the pretest, the nurses were randomized into the control and intervention groups with 40 participants in each group using a stratified randomization method based on education and gender. Then, the intervention group was made to practice by using the control list developed. The study used triple blinding. Participants, the volunteer researcher and the statistician were blinded. The participants did not know which group they were in, the volunteer researcher did not know the groups when she watched the videos, and the statistician did not know the groups when she did the analysis.

4.4 | Data collection tools

After developing the enteral medication administration checklist, the descriptive information form, the enteral medication administration evaluation form, the enteral medication administration knowledge assessment form and the enteral medication administration observation form were used for data collection.

4.4.1 | Descriptive information form

The form was developed by the researcher and consisted of a total of six questions about age, gender, education level, total years of employment in nursing and ICU and the ICU in which the participants worked.

4.4.2 | Enteral medication administration evaluation form

The form, which was developed by the researcher using the relevant literature,[9,12,13] consisted of a total of nine questions about training in enteral medication administration, perceived competency in enteral medication administration, tablet splitting method, method of unclogging the enteral feeding tube, challenges in enteral medication administration, suggestions for overcoming challenges, consultants and complications of enteral medication administration errors. The form was reviewed by 14 experts in the fields of pharmacology and nursing education and finalized in line with expert opinions. After the expert opinions, content validity ratios (CVR) were calculated, and the Content Validity Index (CVI) was found to be 0.91. The answers were prepared in multiple-choice format.

4.4.3 | Enteral medication administration knowledge assessment form

The form, which was developed by the researcher based on the relevant literature,[9,12,13] consisted of a total of 20 multiple-choice questions on identifying dosage form, medication preparation, tube flushing and medication dilution, and drug–drug and drug–nutrient interactions. The form was reviewed by 14 experts in the fields of pharmacology and nursing education and finalized in line with expert opinions. After the expert opinions, the CVRs were calculated, and the CVI was found to be 0.83. The answers were prepared in multiple-choice format.

4.4.4 | Observation form for enteral medication administration

The form, which was developed by the researcher using the relevant literature,[9,28,29] consisted of a total of 19 questions about medication preparation, drug–drug and drug–nutrient interactions, tube flushing and medication dilution, and identifying dosage forms. The form was reviewed by 14 experts in the fields of pharmacology and nursing education and finalized in line with expert opinions. After the expert opinions, the CVRs were calculated, and the CVI was found to be 0.93. The answers to the form are prepared as yes/no.

CVI was used to evaluate the content and content validity of the forms. The Lawshe technique was used for the appropriateness of the data collection forms, and the experts were asked to make an

evaluation by giving points as not appropriate (1 point), appropriate but needing modification (2 points), appropriate (3 points). The number of experts who gave a score of 3 for the scale items was divided by half of the total number of experts, and one less was taken, and the content validity rate (CVR) was calculated. The CVI is calculated as the ratio of the sum of all CVRs to the number of items. Content validity was considered significant if the CVR ratio was 0.51 according to the number of 14 experts and the CVI >CVR.

4.5 | Procedures

4.5.1 | Step I: Development of the enteral medication administration checklist

The enteral medication administration steps were constructed by the researcher using the current recommendations of the American Society for Parenteral and Enteral Nutrition (ASPEN), the European Society for Clinical Nutrition and Metabolism (ESPEN) and the British Association of Parenteral and Enteral Nutrition (BAPEN).[14,28,30] These steps were evaluated by a specialist in pharmacology and revised according to expert opinion. The checklist was reviewed by three nursing academics and a language expert for clarity and grammatical errors and finalized after necessary corrections.

4.5.2 | Step II: Evaluation of the effectiveness of the checklist

Descriptive information form, the evaluation form and the knowledge assessment form were self-reported. To prevent bias, the participants' administration of enteral medication was videotaped by the researcher and an observation form was completed by the volunteer researcher to evaluate the errors made by the participants in the administration of enteral medication (Volunteer researcher: the researcher who watched the videos taken by the researcher during enteral medication administration to prevent bias and evaluated the observation form, a nurse with a 4-year nursing bachelor's degree, an expert in the field of surgical diseases nursing, 10 years of professional experience and experience in enteral medication administration). All four forms were completed within 1 month as a pretest, and participants were randomized to intervention and control groups after the pretest (Pretest phase: the process of data collection forms collected from nurses before the intervention). The following month, participants in the control group continued to administer enteral medications using their own methods. Participants in the intervention group administered enteral medications using the enteral medication checklist we developed. However, they received training on how to use the checklist before using it. This training was videotaped as both theoretical (8 min) and practical (16 min) and shown to the intervention group. The researcher presented the videos at the participants' convenience, answered their questions after watching the video, delivered the video course and the checklist to the participants in the intervention group and asked them not to share the documents with other participants in the control group. After participants understood how to use the checklist, they began to administer enteral medications. As a result, the control group administered enteral medications using the traditional method, while the intervention group administered enteral medications using the enteral medication checklist. Finally, participants were asked to fill out the knowledge form again. The researcher also shot a video again for the observation form. Thus, the post-test phase was completed (Post-test phase: the process of data collection forms collected from the nurses after the intervention). Pretest and post-test data were compared to evaluate the effectiveness of the enteral medication administration checklist.

4.6 | Statistical analysis

The collected data were analysed using IBM SPSS version 23.0. Normality of data was analysed using the Kolmogorov–Smirnov test, and parametric tests were used. Mean and standard deviation were used to present numerical variables. The dependent and independent sample *t*-tests were employed for the analysis of numerical data. The chi-square test was used for the examination of categorical data. Statistical significance was set at $p < .05$.

5 | RESULTS

Of the 80 participants who participated in the study, 40 were randomly assigned to the intervention group and 40 to the control group. Of the 80 participants, 69 successfully completed the study, resulting in a retention rate of 86%. A total of 11 participants withdrew from the study before the implementation phase due to changes in intensive care: five from the control group and six from the intervention group (Figure 1). The study was conducted from March to June 2022.

When the socio-demographic characteristics of the intervention and control groups were compared, there was no statistically significant difference between the two groups (Table 1, $p > .05$).

It is seen that more than 97% of the participants in both groups received training on enteral medication administration (Table 2). The majority of the participants received in-service training or education at school or university. Nurses most frequently recommend the development of an automatic drug pump to overcome the challenges of enteral medication administration (82.4%–71.4%). Finally, 55.9% of the participants in the intervention group and 57.1% of the participants in the control group felt competent in enteral medication administration. When the enteral medication administration of the intervention and control groups was compared, there was no statistically significant difference between the two groups ($p > .05$).

The results of the information form are seen in four dimensions (Table 3). The table shows a statistically significant difference between the pretest and post-test scores and the total mean knowledge scores in both groups ($t = -19.771$ [−49.302;

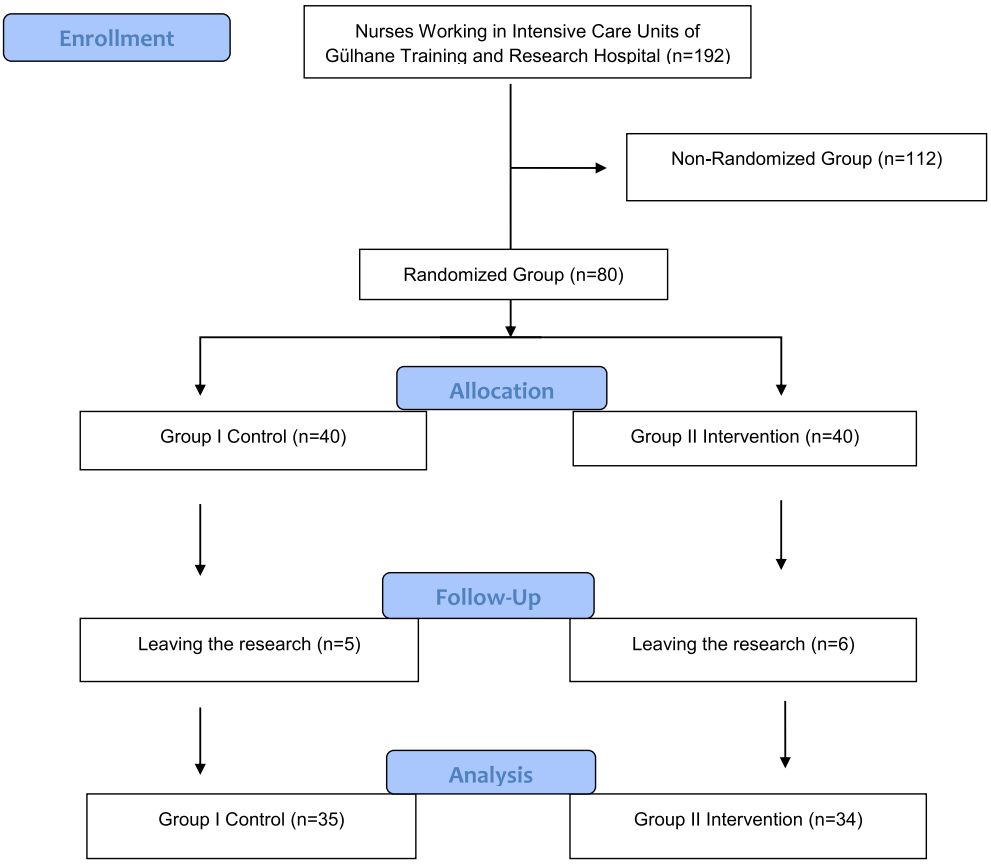

FIGURE 1 The effect of the checklist developed for drug administration from enteral nutrition tube on administration errors.

−40.092], $p < .05$; $t = -2.452$ [−11.756; −1.101], $p < .05$). However, the total mean score of the intervention group was significantly higher than that of the control group ($t = 14.346$ [32.122; 42.580], $p < .05$).

Pretest and post-test error scores of nurses in enteral medication administration are given (Table 4). The table shows that the post-test error scores of the intervention and control groups were statistically significantly different ($t = 12.717$ [30.260; 41.787], $p < .05$; $t = 2.765$ [2.812; 18.399], $p < .05$). The observation-based error score of the intervention group was significantly lower than that of the control group ($t = -8.096$ [−30.846; −18.502], $p < .05$).

6 | DISCUSSION

6.1 | Discussion of the results of the knowledge form on enteral medication administration

Existing studies in the literature have reported a lack of knowledge about enteral medication administration, which has been identified as a cause of concern.[12,31,32] These studies demonstrated the importance of educational interventions to increase the level of knowledge.[9,12,33] Similar to these studies, the participants in this study did not have an adequate level of knowledge about enteral medication administration. However, the total mean knowledge score of the intervention group exceeded 90% after using the checklist. These results indicated that the enteral medication administration checklist had a significant contribution to nurses' knowledge levels.

6.2 | Discussion of the findings on the errors in enteral medication administration

The observation form evaluated the errors in enteral medication administration in four dimensions, namely, identifying dosage forms, medication preparation, drug–drug and drug–nutrient interactions, and tube flushing and medication dilution.

6.2.1 | Identifying dosage forms

Dosage forms that can be administered through the feeding tube are divided into liquid and solid dosage forms. Dosage forms that cannot be administered through the enteral feeding tube are referred to as modified-release dosage forms and are divided into delayed-release and extended-release dosage forms based on their functionality. Extended-release dosage forms can be further subdivided into sustained-release and controlled-release dosage forms.[3] Similar to the literature,[34–36] the participants in our study did not have sufficient knowledge about the dosage forms of enteral medications and therefore used inappropriate dosage forms. Although not statistically

TABLE 1 Socio-demographic characteristics ($N = 69$).

	Intervention ($n = 34$)		Control ($n = 35$)			
	n	%	*n*	%	χ^2	*p*
Age (in years)						
18–28	27	79.4	28	80.0	0.004	.952
29 and over	7	20.6	7	20.0		
Gender						
Female	27	79.4	28	80.0	0.004	.952
Male	7	20.6	7	20.0		
Education level						
High school-associate	5	14.7	4	11.4	0.163	.686
Bachelor's and over	29	85.3	31	88.6		
Nursing experience						
5 years and below	26	76.5	27	77.1	0.004	.947
6 years and above	8	23.5	8	22.9		
ICU experience						
5 years and below	29	85.3	29	82.9	0.076	.782
6 years and above	5	14.7	6	17.1		
Type of ICU department						
Anaesthesia	9	26.5	7	20.0	1.300	.861
Surgical	7	20.6	10	28.6		
Internal medicine	9	26.5	8	22.9		
Cardiology	4	11.8	3	8.6		
Brain and neurosurgery	5	14.7	7	20.0		

Abbreviations: ICU, intensive care unit; *n*, number; χ^2, chi-square test.

significant, the use of the checklist helped the participants in the intervention group to differentiate between appropriate and inappropriate medication administration through the enteral feeding tube. This finding may be explained by the fact that nurses do not have prescribing authority, which is limited to physicians in Türkiye and abroad.[37,38]

6.2.2 | Preparation of medications

Crushing drugs with teratogenic, carcinogenic or cytotoxic properties, such as antineoplastics, hormones and prostaglandin analogs, should be avoided because aerosolized particles may be harmful to health care personnel.[20] Tablets should be crushed to a fine powder, preferably in a closed system, and mixed with purified water.[28,39] Enteral medications should be prepared in a pharmacy or prepared by nurses in a dedicated and clean area.[39] A sterile enteral syringe should be used to administer enteral medications.[28,39] However, similar to the literature,[9,12,40] nurses in our study were not adequate in medication preparation. The post-test error score obtained from the medication preparation dimension of the observation form was significantly lower than the pretest score obtained before using the checklist, indicating the effectiveness of the checklist for enteral medication administration.

6.2.3 | Tube flushing and medication dilution

The enteral tube should be flushed with at least 15 mL of water before administration. In addition, tablets and capsules should be mixed with purified water before administration.[28,39] Existing studies have reported that the enteral tube was not flushed prior to enteral medication administration and that tap water was used to dilute medications.[34,36,41] Dilution may be necessary for the enteral administration of liquid medications to reduce viscosity or osmolality. Not diluting liquid medications may result in a significant decrease in drug delivery and bioavailability.[28] Although a 1:1 volume dilution is sufficient to reduce the viscosity of medications, a dilution volume of up to 10:1 may be required to reduce the final osmolality depending on the initial value of the liquid medications.[39] After enteral administration, the tube should be flushed again with at least 15 mL of water.[28,39] Analysis of the literature shows that nurses are not at an adequate level in the dilution of enteral medications and tube flushing.[9,42] In parallel with the literature, similar errors in tube flushing and medication dilution were made by the participating nurses. However, the error rates of the intervention group decreased significantly after using the checklist, indicating the effectiveness of the checklist for enteral medication administration.

TABLE 2 Distribution of groups according to enteral medication administration practices ($N = 69$).

	Intervention ($n = 34$)		Control ($n = 35$)			
	n	%	*n*	%	χ^2	*p*
Received training on enteral medication administration						
Yes	33	97.1	35	100.0	1.045	.493
No	1	2.9	0	0.0		
Place of training on enteral medication administration						
School/university	24	72.7	25	71.4	0.014	.905
Training course	2	6.1	1	2.9	0.413	.608
In-service training	24	72.7	18	51.4	3.263	.071
Seminar/Symposium	3	8.8	0	0.0	3.329	.109
Perceived competency in enteral medication administration						
Yes	19	55.9	20	57.1	0.011	.994
Partial	14	41.2	14	40.0		
No	1	2.9	1	2.9		
Tablet splitting method						
Manuel tablet splitting device	21	61.8	16	45.7	1.787	.181
Mortar and pestle	0	0.0	3	8.6	3.047	.239
Package and bag	25	73.5	25	71.4	0.038	1.000
Method of unclogging enteral feeding tube						
Warm water	28	82.4	28	80.0	0.062	.803
Soda water	13	38.2	15	42.9	0.153	.696
Sodium bicarbonate	6	17.6	4	11.4	0.538	.463
Pancreatic enzyme	1	2.9	0	0.0	1.045	.493
Milking	1	2.9	1	2.9	0.000	1.000
Challenges in enteral medication administration						
Preparation	20	58.8	13	37.1	3.249	.071
Administration	8	23.5	9	25.7	0.044	.833
Identifying medications	2	5.9	5	14.3	1.336	.428
Drug–drug and drug–nutrient interactions	18	52.9	17	48.6	0.132	.717
Suggestions to overcome challenges in enteral medication administration						
Development of standard protocols	6	17.6	8	22.9	0.289	.591
Development of checklists	5	14.7	7	20.0	0.336	.562
Development of medication pumps	28	82.4	25	71.4	1.156	.282
Educational support	7	20.6	8	22.9	0.052	.819
Consultants for enteral medication administrations						
Physician	1	2.9	1	2.9	3.236	.198
Pharmacist	3	8.8	0	0.0		
Nurse	30	88.2	34	97.1		
Possible complications of enteral medication administration errors						
Tube obstruction	30	88.2	34	97.1	2.036	.198
Diarrhoea	20	58.8	16	45.7	1.188	.276
Reduced therapeutic efficacy	13	38.2	15	42.9	0.153	.696
Pulmonary aspiration	16	47.1	16	45.7	0.013	.911
Infection	16	47.1	19	54.3	0.360	.548
Nutrient loss	20	58.8	16	45.7	1.188	.276
Drug dose loss	29	85.3	30	85.7	0.002	.960
Drug toxicity	13	38.2	12	34.3	0.116	.733

(Continues)

TABLE 2 (Continued)

	Intervention ($n = 34$)		Control ($n = 35$)			
	n	%	*n*	%	χ^2	*p*
Cost increase	13	38.2	15	42.9	0.153	.696
Prolonged hospitalization	11	32.4	14	40.0	0.437	.509
Allergic reaction	6	17.6	13	37.1	3.285	.070
Death	4	11.8	7	20.0	0.873	.350

Abbreviations: *n*, number; χ^2, chi-square test.

TABLE 3 Comparison of the pretest and post-test scores obtained from the knowledge assessment form for enteral medication administration ($N = 69$).

	Intervention ($n = 34$)		Control ($n = 35$)			
	Mean	SD	Mean	SD	*t* (95% CI)	p^1
Identifying dosage forms (Pretest)	29.83	16.63	30.61	17.02	−0.193 (−8.871; 7.309)	.848
Identifying dosage forms (Post-test)	86.97	14.66	31.84	21.38	12.458 (46.302; 63.969)	**.000***
t/p^2 (95% CI)	**−16.493/0.000* (−64.190; −50.093)**		−0.368/0.715 (−7.997; 5.546)			
Medication preparation (Pretest)	64.12	20.17	65.14	22.93	−0.197 (−11.413; 9.363)	.844
Medication preparation (Post-test)	95.88	9.57	71.43	20.74	6.317 (16.670; 32.237)	**.000***
t/p^2 (95% CI)	**−7.824/0.000* (−40.025; 23.505)**		−1.360/0.183 (−15.6778; 3.106)			
Tube flushing and medication dilution (Pretest)	58.82	19.51	59.18	20.83	−0.074 (−10.054; 9.333)	.941
Tube flushing and medication dilution (Post-test)	97.90	5.14	70.61	17.30	8.933 (21.114; 33.460)	**.000***
t/p^2 (95% CI)	**−11.768/0.000* (−45.831; −32.321)**		**−3.356/0.002* (−18.347; −4.509)**			
Drug–drug and drug–nutrient interactions (Pretest)	32.35	47.49	42.86	50.21	−0.892 (−34.001; 12.993)	.375
Drug–drug and drug–nutrient interactions (Post-test)	91.18	28.79	51.43	50.71	4.018 (19.917; 59.578)	**.000***
t/p^2 (95% CI)	**−6.866/0.000* (−76.254; −41.393)**		−0.828/0.413 (−29.601; 12.458)			
Total mean score (Pretest)	48.68	10.61	49.86	12.40	−0.424 (−6.733; 4.371)	.673
Total mean score (Post-test)	93.64	6.76	56.29	13.74	14.346 (32.122; 42.580)	**.000***
t/p^2 (95% CI)	**−19.771/0.000* (−49.302; −40.092)**		**−2.452/0.019* (−11.756; −1.101)**			

Abbreviations: 1, independent sample *t*-test; 2, dependent sample *t*-test; *n*, number.

6.2.4 | Drug–drug and drug–nutrient interactions

Although time-consuming, separating each medication administered through an enteral tube reduces the risk of tube obstruction and interactions.[28] It is generally accepted that medications should not be mixed prior to enteral administration because of the risk of drug–drug interaction and that the enteral tube should be flushed between feeds and/or medications.[29] In addition, enteral tubes should be flushed with at least 15 mL of water after each medication, taking into account the patient's volume status.[28] A review of the literature shows that more than one medication was administered through the enteral feeding tube and the tube was not flushed between the administration of medications.[34,36,43] On the other hand, ASPEN recommends holding the feeding for at least 30 min if separation is indicated to avoid altered drug bioavailability and to restart the feeding in a timely manner to avoid compromising nutrition status.[14] However, existing studies have reported that nurses do not use a standard time interval to hold feeding during enteral medication administration.[34,44] Proton pump inhibitors (PPIs) such as omeprazole, lansoprazole and pantoprazole should be taken on an empty stomach before meals.[45] Enteral nutrition formula is not an ideal drug solvent, so medication is not added to the feeding.[39] Analysis of the literature shows that nurses were not at an adequate level in terms of drug–drug and drug–nutrient interaction.[9,36] Similar errors regarding drug–drug and drug–nutrient interaction in enteral medication administration were also made by the participants in this study. After using the enteral medication administration checklist, errors were significantly reduced in the intervention group, indicating the effectiveness of the checklist.

TABLE 4 Comparison of the pretest and post-test error scores based on the observation of enteral medication administration by the participants ($N = 69$).

	Intervention ($n = 34$)		Control ($n = 35$)			
	Mean	SD	Mean	SD	t (95% CI)	p^1
Identifying dosage forms (Pretest)	25.98	33.57	40.48	46.84	−1.474 (−34.129;5.137)	.145
Identifying dosage forms (Post-test)	19.61	35.64	27.14	42.60	−0.796 (−26.439;11.369)	.429
t/p^2 (95% CI)	0.769/0.447 (−10.491;23.237)		1.328/0.193 (−7.065;33.732)			
Medication preparation (Pretest)	41.18	22.93	46.43	21.98	−0.971 (−16.052;5.548)	.335
Medication preparation (Post-test)	7.35	14.47	13.57	18.53	−1.556 (−14.203;1.766)	.125
t/p^2 (95% CI)	**7.799/0.000* (25.000;42.647)**		**7.399/0.000* (23.833;41.881)**			
Tube flushing and medication dilution (Pretest)	43.28	33.28	44.24	20.79	−0.144 (−14.399;12.464)	.886
Tube flushing and medication dilution (Post-test)	16.47	26.27	21.71	27.60	−0.808 (−18.198;7.711)	.422
t/p^2 (95% CI)	**4.252/0.000* (13.981;39.632)**		**4.657/0.000* (12.699;32.362)**			
Drug–drug and drug–nutrient interactions (Pretest)	25.88	25.16	25.92	30.30	−0.005 (−13.409;13.337)	.996
Drug–drug and drug–nutrient interactions (Post-test)	7.56	17.47	7.86	18.04	−0.069 (−8.827;8.239)	.945
t/p^2 (95% CI)	**3.602/0.001* (7.972;28.666)**		**2.840/0.008* (5.136;30.986)**			
Enteral medication administration total error score (Pretest)	38.23	15.08	37.49	18.42	0.183 (−7.359;8.847)	.855
Enteral medication administration total error score (Post-test)	2.21	4.05	26.88	17.56	−8.096 (−30.846;-18.502)	**.000***
t/p^2 (95% CI)	**12.717/0.000* (30.260;41.787)**		**2.765/0.009* (2.812;18.399)**			

Abbreviations: 1, independent sample t-test; 2, dependent sample t-test; n, number.

The nurses suggested the development of automatic drug pumps to overcome the challenges of enteral medication administration. Although there are manual or automatic tablet crushing devices on the market, there are no automatic devices that crush the tablet and deliver it to the patient. The development of these devices can be convenient for nurses as well as patient and staff safety.

7 | LIMITATIONS

This study had three limitations. First, the study was conducted in a single centre. Second, participants working in the same ICU may have shared information about the study and influenced each other. Third, the administration of enteral medication was videorecorded by the researcher to be evaluated by the volunteer researcher, which may have affected participants' practices.

8 | IMPLICATIONS AND RECOMMENDATIONS FOR PRACTICE

In intensive care units, enteral medication administration is frequently performed. It is important to reduce errors in these administrations to ensure patient and staff safety. Errors in enteral medication administration can be reduced with checklists, which are the simplest and least expensive method. It is recommended that similar studies be conducted in more than one centre. More randomized controlled studies with intensive care nurses are needed.

9 | CONCLUSION

In conclusion, there are variations in enteral medication administration among nurses, and many of these variations include medical errors. This situation indicates that enteral medication administration is not considered a high-risk practice and that current guidelines and a standard protocol are not being followed by the nurses. Errors in enteral medication administration can be prevented with evidence-based practices. Checklists are used in health care services to prevent medical errors. They improve performance by aiding memory, reducing the negative effects of stress and fatigue, standardizing treatment, encouraging best practices and promoting communication among team members.[46] After the use of the enteral medication administration checklist, participating nurses' knowledge levels increased by 93%, and error rates decreased by 95%. The H1 hypothesis was accepted. Therefore, the enteral medication administration checklist is recommended as an effective, practical and inexpensive tool that can be easily applied in intensive care units.

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There is no financing.

CONFLICT OF INTEREST STATEMENT

No conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Ethical approval has been received (Ethical approval was obtained from the Medical Specialty Education Board (dated 01.07.2021) and the Clinical Research Ethics Committee (No. 2021/29; dated 08.02.2022) of Gülhane Research and Training Hospital in University of Health Sciences). This study was conducted under the supervision of the Institute of Gülhane Health Sciences, University of Health Sciences, and was produced from the doctoral thesis accepted in 2023.

PATIENT CONSENT STATEMENT

Nurse approval was obtained.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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