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ORIGINAL RESEARCH

Enteral Nutrition Practices and Complications in ICU Settings: A Cross-Sectional Study of Healthcare Professionals' Perspectives in Saudi Arabia

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Background: Enteral Nutrition (EN) is the preferred method for providing nutritional support in intensive care units (ICUs) compared to parenteral nutrition (PN) due to its physiological advantages, safety profile, and cost-effectiveness compared to parenteral nutrition (PN). However, evidence suggests that EN might be associated with some complications. In this study, we aimed to identify the most common EN complications, as reported by healthcare professionals (HCPs) working in adult and paediatric ICUs (PICUs) in Saudi Arabia. We also investigated the factors influenced the HCPs' perception in reporting these EN complications.

Methods: In this cross-sectional pilot study, data was collected through an online survey from 25 December 2022 to the end of February 2023. All dietitians, physicians and nurses working in adult and PICUs in Saudi-Arabia were eligible to participate. The survey collected information about the demographic data of the participants, some of the EN related practice in intensive care settings as well as the frequency of the reported EN complications.

Results: A total of 173 respondents were included in the study. The most frequently reported complications were diarrhoea [3.06 ±1.197], aspiration [2.88 ±1.261], and constipation [2.85 ±1.11]. A statistical difference was recorded in the frequency of some of the reported EN complications between HCPs working in adults and paediatric ICUs ($p<0.05$). The participant's profession ($r=-2.84$, $p<0.05$) and years of experience ($r=-0.5$, $p<0.05$) appeared to statistically influence the perception of HCPs regarding EN complications.

Conclusion: This study highlighted the commonly reported complications associated with EN, with differences observed between adult and paediatric settings. The variation in reported complications may be attributed to differences in practitioner characteristics. These findings may emphasize the importance of targeted training, standardized reporting, and evidence-based practices to optimize EN management and improve patient outcomes in ICU settings.

Keywords: enteral nutrition, ICU, PICU, EN complications

Introduction

Proper nutrition intervention is crucial in determining the clinical outcomes of critically ill patients and is a vital component of their therapeutic plan.[1] The majority of critically ill patients cannot meet their nutritional requirements orally due to reduced levels of consciousness caused by induced sedation.[2,3] In these situations, nutrition support in the form of Parenteral Nutrition (PN) or Enteral Nutrition (EN) is indicated to provide all the essential nutrients and requirements.

In intensive care settings (ICU), EN is considered the preferred route for providing nutritional support for patients with a functioning gastrointestinal tract (GIT) due to its physiological benefits and cost-effectiveness.[2] The unique physiological properties linked with EN include maintaining GIT mucosal integrity and function, lowering the risk of bacterial colonization, septic infections, decreasing catabolic responses, and reducing inflammation.[4,5] The American

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Society for Parenteral and Enteral Nutrition (ASPEN) guidelines indicate that EN is a safe procedure and tolerable by most critically ill patients.[6]

However, considerable data shows that the provision of EN might be suboptimal and associated with some complications. The main challenges remain in achieving the targeted calories due to feed intolerance and elevated risk of aspiration pneumonia.[5,7] The sources of EN potential complication could be related to the recipient/patient or from inappropriate practice provided by health care providers (HCPs). Overall, human errors are the third leading cause of increasing mortality among hospitalized patients,[7,8] and one in ten patients experiences EN procedure-related complications either at insertion time or subsequently.[4] National Health Services (NHS) in the UK reports over 790,000 feeding tubes are inserted annually, which is possibly accompanied by critical EN complications that can disproportionately impact sensitive populations such as critically ill patients.[9] Some of the commonly reported EN complications in intensive care settings include diarrhea, aspiration, constipation, and tube-related issues.[7,8]

Therefore, the EN in ICU settings must be handled appropriately with a bundle of precautions and monitored regularly to attain the nutritional therapy's goals safely.[1] Several studies worldwide have been conducted to discuss tube feeding potential complications in critical care settings.[4,7,8] However, according to the European Society for Clinical Nutrition and Metabolism (ESPEN), there is a gap between current nutritional practices in ICU and the guidelines, highlighting the need for further studies to investigate all EN-related parameters and complications.[2]

In the Middle East, including Saudi Arabia, there is a scarcity of available data and solid protocols related to EN practices, especially in the ICU. For instance, in previous studies in Saudi Arabia, the participants declared the absence of a clear protocol for EN practice in critical care settings.[10,11] Given the documented tube feeding barriers and the paucity of evidence about the efficacy of the different EN administration methods among critical care patients, it remains unclear what is the perception of HCPs regarding EN-related problems. Therefore, this study aimed to investigate the current practices in EN provision and identify the most common EN-related complications as reported by healthcare professionals in adult and paediatric ICUs in Saudi Arabia. Given that clinical nutrition is a relatively new field in the region and nutritional training remains limited, highlighting these complications will help standardize the reporting of EN complications and establish an evidence-based approach to optimize EN management and improve patient outcomes in ICU settings.

Methods

Ethical Consideration

This study was performed according to the Declaration of Helsinki, ethical approval was obtained from the ethics committee at Taibah University (Certificate no.2023/153/203 CLN). Participants' informed consent was gathered via the inclusion of an obligatory question confirming their agreement to participate in the study.

Study Design and Participants

In this cross-sectional study, all dietitians, physicians, and nurses working in adult ICUs or Paediatric intensive care units (PICUs) in KSA were eligible to participate. Data collection began on 25 December 2022 for a duration of ten weeks. The survey was initially distributed via various social media platforms, including X, WhatsApp, and LinkedIn. Then, a chain-referral sampling technique was implemented, where key HCPs involved in the nutrition intervention process (such as heads of ICUs and heads of clinical nutrition departments) were contacted to help in recruiting adequate convenience sample of HCPs working in both adult ICUs and PICUs in Saudi Hospitals. Since this was a pilot study, no specific sample size was calculated; the achieved sample size within the recruitment period was used.

Survey Development

Validation

The survey was developed in English Language by the researchers following a review of the available research literature concerning complications associated with EN.[11–13] Expert validation of the survey was conducted with nine dietitians,

two physicians, and two nurses, and the survey was subsequently modified according to their feedback. The data obtained from the 13 participants for validation were excluded from the statistical analysis of the current study.

Description of Items

A total of 28 items were included in the questionnaire that collected information about the participants demographics, EN practices and EN complications.

The first section of the questionnaire consists of 8 items that collected information about the participants demographics including the which region of KSA, education level, type of health care facility participants worked at, and their years of experience.

The second section of the questionnaire included 3 questions regarding EN practice such the most common EN access used, method of administration used and the type of EN formula system used (Open system [formula in can or bottle poured into the feeding bag] or Closed system [A sterile prefilled formula that is spiked by the feeding tube]).

The last section of the questionnaire consisted of 18 items, where the participants were asked to report the frequency of each EN complications, on a Likert scale from 1 (never), 2 (rarely), 3 (occasionally), 4 (frequently) to 5 (very frequently). The complications of EN were categorised into 5 domains: Domain 1 comprised 1 question regarding access complications, Domain 2 comprised 6 questions regarding GI complications, Domain 3 comprised 5 questions regarding mechanical complications, Domain 4 comprised 5 questions regarding metabolic complications, and Domain 5 comprised 1 question regarding dehydration (Survey attached in the Appendix). The Cronbach's alpha value of the instrument was determined as (0.899). Therefore, the instrument's internal reliability is considered good.

Statistical Analysis

Data was analysed using the Statistical Package for Social Sciences software program version 22 (SPSS Inc). (SPSS 22, SPSS Inc., Chicago, IL, USA). The normality of continuous variables was assessed using the Shapiro–Wilk test. Continuous variables were presented as mean ± standard deviation (SD) and median (interquartile range [IQR]). Frequencies and percentages were also presented to describe the data. Mean (±SD) and median (IQR) were calculated to determine the most and least frequently reported EN complications by HCPs working in adult ICUs and PICUs.

Kruskal–Walli's test was used to compare the Likert rating scores of the complication's domains and Mann–Whitney *U*-test was performed to compare the frequency of each reported EN complication between HCPs working in adult ICUs and PICUs.

A stepwise linear regression analysis was performed to identify the factors that influenced the reporting of EN complications by HCPs working in intensive care settings. In the regression models, the score of cumulative frequency of the reported complications was calculated for each participant and used as the outcome variable. The independent variables used in the models were the participants characteristics including their gender (female coded as 1 and male coded as 2), education level (intern coded as 1, bachelor's coded as 2, master's coded as 3, board coded as 4, residency coded as 5, fellowship coded as 6, and doctorate coded as 7), years of experience as a numerical variable, type of healthcare facility (university teaching hospital coded as 1, specialised hospital coded as 2, private hospitals coded as 3, National Guard hospital coded as 4, Ministry of Health coded as 5, military hospital coded as 6, and medical cities coded as 7), region (Central coded as 1, Eastern coded as 2, Northern coded as 3, Southern coded as 4, and Western coded as 5), profession (dietitians coded as 1, nurses coded as 2, and physicians coded as 3), and setting (adult ICU coded as 1 and PICU coded as 2). P-value is statistically significant at < 0.05 level.

Results

A total of 173 hCPs working in adult and paediatric ICUs across KSA were recruited in the study. Of those, 59.6% (n=103) were dietitians, 30% (n=52) nurses, and 10.4% (n=18) physicians. Most participants were female 78.03% (n=135) and 84.4% were working in adult ICUs. Around 46% of the participants (n=80) were based in the Western KSA region. The mean years of experience of the included HCPs was 3.26 (± 3.9) years. Other characteristics of the study participants are presented in Table 1.

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Table 1 General Characteristics of the Study Participants

		Adult ICU (n=146)			Paediatric ICU (n=27)		
		Dieticians (n=90)	**Nurses (n=43)**	**Physicians (n=13)**	**Dieticians (n=13)**	**Nurses (n=9)**	**Physicians (n=5)**
Region	*Central region*	20 (11.56%)	8 (4.62%)	2 (1.16%)	2 (1.16%)	1 (0.58%)	3 (1.73%)
	Eastern region	14 (8.09%)	7 (4.05%)	2 (1.16%)	2 (1.16%)	3 (1.73%)	1 (0.58%)
	Northern region	3 (1.73%)	7 (4.05%)	1 (0.58%)	1 (0.58%)	2 (1.16%)	0
	Southern region	7 (4.05%)	4 (2.31%)	0	2 (1.16%)	1 (0.58%)	0
	Western region	46 (26.59%)	17 (9.83%)	8 (4.62%)	6 (3.47%)	2 (1.16%)	1 (0.58%)
Education and training	*Intern*	8 (4.62%)	8 (4.62%)	7 (4.05%)	3 (1.73%)	2 (1.16%)	1 (0.58%)
	Bachelor's	81 (46.82%)	30 (17.34%)	2 (1.16%)	10 (5.78%)	7 (4.05%)	1 (0.58%)
	Master`s	0	0	0	0	0	0
	Board	1 (0.58%)	1 (0.58%)	0	0	0	1 (0.58%)
	Residency	0	3 (1.73%)	3 (1.73%)	0	0	2 (1.16%)
	Fellowship	0	0	1 (0.58%)	0	0	0
	Doctorate	0	1 (0.58%)	0	0	0	0
	Other	0	0	0	0	0	0

Type of health care facility	*University teaching hospitals*	4 (2.31%)	3 (1.74%)	0	0	0	0
	Specialized hospitals	8 (4.63%)	2 (1.16%)	0	0	4 (2.31%)	0
	Private hospitals	51 (29.48%)	25 (14.45%)	6 (3.48%)	6 (3.46%)	4 (2.31%)	3 (1.74%)
	National guard hospitals	3 (1.73%)	1 (0.58%)	0	0	0	1 (0.58%)
	Ministry Of Health (MOH) hospitals	15 (8.67%)	5 (2.89%)	1 (0.58%)	5 (2.89%)	0	0
	Military hospitals	7 (4.05%)	4 (2.32%)	3 (1.74%)	2 (1.16%)	1 (0.58%)	1 (0.58%)
	Medical cities	2 (1.16%)	3 (1.73%)	3 (1.74%)	0	0	0
	Others	0	0	0	0	0	0
Years of experience	**Mean ±SD**	3.26 (± 3.9)					
	Median (IQR)	2 (4–1)					
	Less than one year	17 (9.83%)	10 (5.78%)	4 (2.31%)	2 (1.16%)	1 (0.58%)	1 (0.58%)
	1–5 years	58 (33.53%)	28 (16.18%)	7 (4.05%)	7 (4.05%)	7 (4.06%)	3 (1.74%)
	6–10 years	9 (5.2%)	2 (1.16%)	1 (0.58%)	4 (2.32%)	1 (0.58%)	0
	More than 10 years	6 (3.47%)	3 (1.74%)	1 (0.58%)	0	0	1 (0.58%)

Note: Data is presented as frequencies and percentages.

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Comparison Between Enteral Nutrition Practice in Adult and Paediatric ICUs

In adult ICUs, HCPs reported that Nasogastric tube (NGT) was the most frequently used route of EN delivery (54.3%), followed by Orogastric tube (OGT) (16.93%) and gastrostomy tube (14.56%) while the least reported route of enteral feeding was gastro-jejunal (2.4%). In PICUs, the most reported type of EN used was NGT (50%), followed by OGT (20.83%).

In adults ICUs, the use of open systems for the administration of enteral feeding was frequently reported (76.71%), while the use of closed systems was less reported (23.29%). Similarly, in PICUs, open systems were more frequently reported (77.78%) compared to closed systems (22.22%).

Approximately more than half of the HCPs working in adult ICUs reported the use of continuous feeding for patients (63.70%) followed by bolus feeding (19.18%), while intermittent feeding was reported less frequently (17.12%). In the PICUs on the other hand, the frequency of using both administration methods the continuous and bolus feeding was equally reported by the participants, (Table 2).

EN Complications as Reported by HCPs in Adults and Paediatric ICUs

The results show that diarrhoea related to EN was the most frequently reported EN complication in the gastrointestinal complication domain [3.06 ±1.197, 3(4–2)]. The second most frequently reported complication was aspiration, which was included in the mechanical complication's domain [2.88 ±1.261, 3(4–2)]. Constipation, included in the GI complications domain, was the third most reported complication during EN delivery [2.85 ±1.116,3(3–2)]. Rhinitis, otitis, and parotitis, included in the mechanical complication's domain, were the least reported complications [1.72 ±0.906, 1(2–1)]. A statistical difference in the total Likert rating score of the five EN complications domains (P-value <0.01) (Table 3).

Table 2 Comparison of the EN Practices in Adults and Paediatrics Intensive Care Settings as Reported by HCPs

	Frequency of use in adult ICUs	**Frequency of use in PICUs**
*Routes of feeding		
Nasogastric Tube (NGT)	138 (54.3%)	24 (50%)
Nasoduodenal Tube (NDT)	8 (3.14%)	0
Nasojejunal Tube (NJT)	8 (3.14%)	1 (2.08%)
Orogastric Tube (OGT)	43 (16.93%)	10 (20.83%)
Gastrostomy Tube	37 (14.56%)	10 (20.83%)
Jejunostomy Tube	14 (5.51%)	2 (4.16%)
Gastro-jejunal Tube	6 (2.4%)	1 (2.08%)
Total responses	254	48
Method of administration		
Bolus	28 (19.18%)	10 (37.03%)
Continuous	93 (63.70%)	10 (37.03%)
Intermittent	25 (17.12%)	7 (25.93%)
Total responses	146	27
Enteral feeding system		
Closed	34 (23.29%)	6 (22.22%)
Open	112 (76.71%)	21 (77.78%)
Total responses	146	27

Note: The percentages were calculated based on a total response as the participants were allowed to choose more than one option.

Table 3 Frequencies of EN Complications as Perceived by the Medical Staff Working in Adults and Paediatric ICUs

Domain	Questions	1 (never)	2 (rarely)	3 (occasionally)	4 (frequently)	5 (very frequently)	Mean (±SD) Likert rating	Median (IQR) Likert rating
		N (%)						
Domain 1 Access complications	***Infection related to EN***	55 (31.8%)	63 (36.4%)	36 (8.7%)	15 (8.7%)	4 (2.3%)	2.13 (± 1.034)	2 (1–3)
Mean ±SD Likert rating score	2.13 (± 1.034)							
Median (IQR) Likert rating score	2(1–3)							
Domain 2 GI complications	***Diarrhoea***	19 (11%)	39 (22.5%)	49 (28.3%)	44 (25.4%)	22 (12.7%)	3.06 (±1.197)	3 (2–4)
	Delayed gastric emptying	24 (13.9%)	53 (30.6%)	59 (34.1%)	32 (18.5%)	5 (2.9%)	2.66 (±1.025)	3 (2–3)
	Abdominals distention	28 (16.2%)	54 (31.2%)	51 (29.5%)	33 (19.1%)	7 (4%)	2.64 (±1.089)	3 (2–3)
	Malabsorption	29 (16.8%)	76 (43.9%)	49 (28.3%)	9 (5.2%)	10 (5.8%)	2.39 (±1.015)	2 (2–3)
	Oesophageal reflux	36 (20.8%)	49 (28.3%)	58 (33.5%)	20 (11.6%)	10 (5.8%)	2.53 (±1.118)	2 (2–3)
	Constipation	20 (11.6%)	49 (28.3%)	54 (31.2%)	37 (21.4%)	13 (7.5%)	2.85 (±1.116)	3 (2–3)
Mean ±SD Likert rating score	**2.68 (± 1.113)**							
Median (IQR) Likert rating score	**3**(2–3)							

(*Continued*)

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Table 3 (Continued).

Domain	Questions	1 (never)	2 (rarely)	3 (occasionally)	4 (frequently)	5 (very frequently)	Mean (±SD) Likert rating	Median (IQR) Likert rating
		N (%)						
Domain 3 Mechanical complications	***Aspiration***	28 (16.2%)	42 (24.3%)	47 (27.2%)	34 (19.7%)	22 (12.7%)	2.88 (±1.261)	3(2–4)
	Tube malposition	51 (29.5%)	63 (36.4%)	28 (16.2%)	26 (15.0%)	5 (2.9%)	2.25 (±1.123)	2(1–3)
	Tube clogging	49 (28.3%)	60 (34.7%)	38 (22.0%)	20 (11.6%)	6 (3.5%)	2.27 (±1.1)	2(1–3)
	Rhinitis, otitis, parotitis	90 (52%)	51 (29.5%)	26 (15.0%)	3 (1.7%)	3 (1.7%)	1.72 (±0.906)	1(1–2)
	Pharyngitis, oesophagitis	83 (48.0%)	55 (31.8%)	29 (16.8%)	3 (1.7%)	3 (1.7%)	1.77 (±0.909	2(1–2)
Mean ±SD Likert rating score	2.18 (± 1.147)							
Median (IQR) Likert rating score	**2**(1–3)							
Domain 4 Metabolic complications	***Refeeding syndrome (Hypophosphatemia/Hypokalemia)***	41 (23.7%)	61 (35.3%)	43 (24.9%)	20 (11.6%)	8 (4.6%)	2.38 (±1.107)	2 (2–3)
	Hyponatremia	29 (16.8%)	59 (34.1%)	50 (28.9%)	24 (13.9%)	11 (6.4%)	2.59 (±1.115)	2 (2–3)
	Hypernatremia.	34 (19.7%)	48 (27.7%)	50 (28.9%)	28 (16.2%)	13 (7.5%)	2.64 (±1.186)	3 (2–3)
	Hypoglycemia	36 (20.8%)	59 (34.1%)	46 (26.6%)	18 (10.4%)	14 (8.1%)	2.51 (±1.169)	2 (2–3)
	Hyperglycemia	23 (13.3%)	52 (30.1%)	56 (32.4%)	26 (15%)	16 (9.2%)	2.77 (±1.143)	3 (2–3)
Mean ±SD Likert rating score	2.58 (± 1.150)							
Median (IQR) Likert rating score	**2**(2–3)							

Domain 5 Other complications	***Dehydration***	39 (22.5%)	45 (26.0%)	58 (33.5%)	25 (14.5%)	6 (3.5%)	2.5 (±1.098)	3 (2–3)
Mean ±SD Likert rating score	2.5 (± 1.098)							
Median (IQR) Likert rating score	**3**(2–3)							
P- value	**0.00***							

Notes: Data presented as frequencies and percentage. Kruskal Wallis test was conducted to compare the median of the 5 domains. *P-value is statistically significant at < 0.05 level.

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We then compared the frequencies of the reported EN complication between HCPs working in adult and paediatric ICUs. A significant difference was recorded in the responses of HCPs based on their work setting for the following complications: delayed gastric emptying (p=0.033) [Figure 1A], refeeding syndrome (p=0.019) [Figure 1B], and

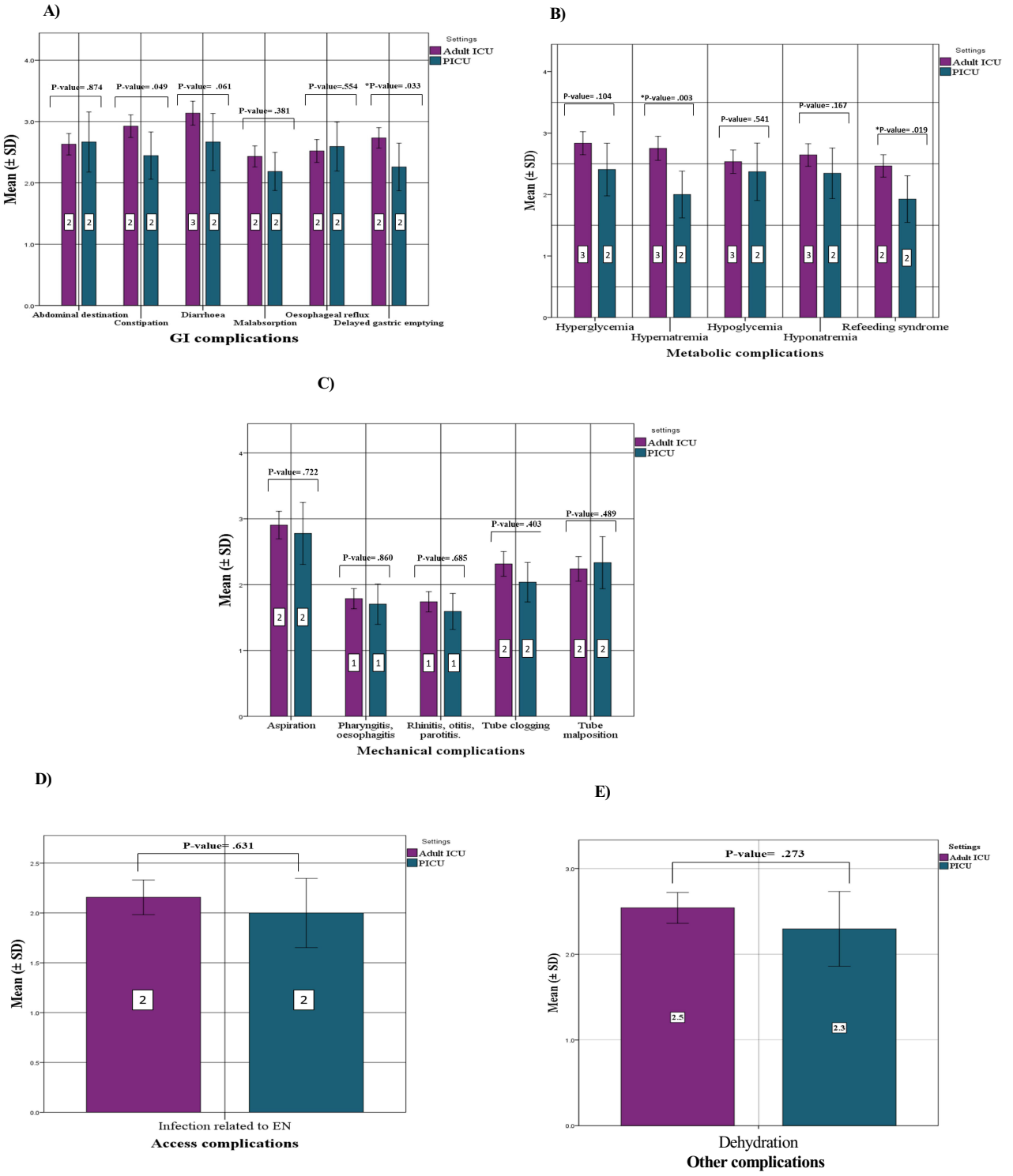

Figure 1 Comparison of the reported EN complications between HCPs working in adults and paediatric intensive care settings. The above figure compares the mean Likert rating scale of the reported EN complications by HCPs. According to (**A**) delayed gastric emptying was reported significantly more by HCPs working in adult ICUs than those in PICUs, (**B**) indicated that refeeding syndrome and hypernatremia were reported significantly more by HCPs working in adult ICUs than those in PICUs. No statistical difference was recorded between the responses of HCPs based on their work settings regarding the rest of EN complications. (**C–E**). * P value is statistically significant at < 0.05 level.

hypernatremia (p=0.003 [Figure 1B]. The previously mentioned complications were reported more frequently by HCPs working in adult ICUs than those in PICUs. No statistical difference was recorded between the responses of HCPs based on their work settings regarding the rest of EN complications (Figure 1C–E).

Investigation of the Factors Influencing the Reporting of EN Complications by HCPs

A stepwise linear regression analysis was performed to identify the factors that influenced the cumulative frequencies of the complications reported by HCPs. In the regression model, profession was the only variable that statistically influenced the cumulative frequency score of the reported complications (r= −2.84, p=0.035) (Table 4). Dietitians appeared to have a higher cumulative frequency score of the reported complications [45 (37–54)] compared to nurses [43.5 (34–53)] and physicians [43.5 (32–53)]. In a sub-analysis of HCPs working in adult intensive care settings, years of experience statistically influenced the cumulative frequency score of the complications reported by the participants; the model showed that HCPs with more years of experience had a lower cumulative frequency score of the reported complications (r=−0.5, p=0.037), (Table 4).

Table 4 Regression Analysis to Identify the Factors Influenced the Responses of Health Care Professionals Regarding the EN Complications Reported in ICU Settings

Combined sample (Health care professionals working in Adult ICUs and PICUs)			
Model 1 Outcome variable: The cumulative frequencies of all reported complications	R	R 2	Adjusted R 2
***Dependent variable* (n=*173*)**	0.161	0.026	0.020
	Beta		*P value*
Profession (dietitians, nurses, physicians)[a]	−2.84		0.035*
Work settings (adult ICU or PICU)[b]	−0.125		0.102
Gender[b]	−0.021		0.785
Educational level[b]	−0.037		0.63
Years of experience[b]	−0.141		0.064
Region[b]	0.019		0.801
Type of health care facility[b]	−0.044		0.57
Health care professionals working in Adult ICUs			
Model 2 Outcome variable: The cumulative frequencies of all reported complications	R	R 2	Adjusted R 2
***Dependent variable* (n=*146*)**	0.172	0.030	0.023
	Beta		*P value*
Years of experience[a]	−0.516		0.037*
Profession (dietitians, nurses, physicians)[b]	−0.127		0.129
Gender[b]	−0.022		0.791
Educational level[b]	−0.048		0.569
Region[b]	−0.033		0.697
Type of health care facility[b]	−0.085		0.307

(*Continued*)

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Table 4 (Continued).

Health care professionals working in PICUs			
Model 3 Outcome variable: The cumulative frequencies of all reported complications	R	R 2	Adjusted R 2
Dependent variable (n=27)	*Beta*		*P value*
Profession (dietitians, nurses, physicians)[b]	−0.233		0.121
Gender[b]	−0.099		0.312
Educational level[b]	−0.123		0.271
Years of experience[b]	0.088		0.331
Region[b]	0.216		0.14
Type of health care facility[b]	−0.055		0.393

Notes: [a]Predictors: (constant). [b]Excluded variables. *P value is statistically significant at < 0.05 level.

Discussion

The present study is the first to describe and compare EN-related practices and complications as perceived by HCPs working in adult and paediatric ICUs in Saudi Arabia. This study highlighted certain EN-related practices in intensive care settings, including the access and type of EN system used, as well as the method of EN administration. Additionally, our data indicated that the common frequently reported EN complications in intensive care settings were diarrhoea, aspiration, and constipation. Regarding the variation in the reported complications between adults and paediatric ICUs, delayed gastric emptying, hypernatremia, and refeeding syndrome were reported more frequently by HCPs working in adult ICUs compared to PICUs. Finally, this study also showed that HCPs' characteristics, including their professions, working settings, and years of experience influenced their perception regarding EN complications.

Our findings are aligned with existing literature, showing that NGT is the most preferred route of enteral nutrition in both adult and pediatric ICUs, followed by orogastric tubes (OGTs) and gastrostomy tubes. Despite being used for over a century, NGTs remain a widely accepted nutritional tool for critically ill patients due to their ease of placement, cost-effectiveness, and low complication rates.[12] However, several studies have highlighted the advantages of naso-jejunal tubes (NJTs) in ICU settings, citing issues with NGTs such as prolonged length of stay 9LOS), inadequate calorie delivery, and an increased risk of nosocomial infections.[14–16] Furthermore, for patients requiring long-term (>3 weeks) enteral nutrition, gastrostomy tubes are often preferred as they provide more efficient delivery of caloric and nutrient needs compared to NGTs.[17] However, further research is needed to validate the indications and benefits of NGTs compared to other EN accesses in critical care and assess the generalizability of these findings to broader populations.

Interestingly, we found that open systems were commonly used in both adult and paediatric ICUs, whereas closed systems were less frequently reported. This finding was inconsistent with previously published studies highlighting the privilege of using a closed system over an open system.[7] In recent years, more literature has emphasized that closed systems are practical and convenient, allow for longer hanging time, less contamination, and reduce nursing time compared to open systems.[7] In addition, empirical evidence has indicated that the open system formula was associated with higher waste, ranging from 20% to 60%, compared to only 3% of waste in the closed system.[5] However, the high frequency of using the open system in our study could be explained by the fact that this study is focused on ICU settings where the patients' requirements need to be individualized. Modular formulas, which are often used to tailor nutritional requirements such as calories, protein, and fiber, are more easily accommodated by open systems. Further studies need to be done to speculate the reason for the increased dependency on open systems in Saudi hospitals despite the known better outcomes associated with closed systems in critically ill patients.

In the current study, we have shown that continuous feeding was the most frequently used method of EN administration in adult ICUs. This is mainly because continuous feeding is associated with better tolerance, especially in critically ill patients, and as a result, the patients can achieve their caloric requirements.[18] Lee et al, (2022) found that continuous feeding significantly facilitated the achievement of 80% of the targeted nutritional requirement.[18] On the other hand, bolus feeding is often used for medically stable patients, and HCPs may not favour delivering EN by bolus feeding for several reasons.[19] For instance, a higher risk of aspiration, delayed stomach emptying, or osmotic diarrhoea could result from EN by bolus feeding.[19] A randomized controlled trial that examined enteral feeding routes in critically ill patients found that bolus feeding frequently resulted in high gastric residual volume (GRV) on the second and third days, while continuous feeding had relatively fewer complications.[20] However, in PICUs, both bolus and continuous feeding were used equally, but bolus feeding is preferred as it mimics the physiological feeding pattern. In addition, it is cost-effective as no pump is required and may provide greater volumes in less time.[5] In addition, bolus feeding in children, has shown to provides better energy and protein delivery compared to continuous gastric feeding.[21] However, continuous feeding is preferable and better tolerated when children exhibit any signs of feeding intolerance or are at risk of aspiration.[5]

Regarding the frequency of EN complications, diarrhoea was the most frequently reported complication in both paediatric and adult ICUs. This is consistent with the findings of other studies that recorded a high incidence of diarrhoea among critically ill patients.[22–24] The high incidence of EN-related diarrhoea might be related to a delay in initiating bowel activity and the high rate of EN feeding.[22–24] We have also shown that the participants frequently reported aspiration as an EN complication. This finding is in line with the findings of another study, where they indicated that aspiration is frequently reported in both adult and paediatric ICUs, but it was not usually clinically detected.[25,26] This indicates that there is a need to improve HCPs' awareness regarding several EN complications to help in their early detection and management and subsequently improve EN delivery. Constipation was also one of the most frequently reported complications associated with EN feeding in adult and paediatric ICUs. In a previously published year-long study of 127 critically adult patients, the incidence of constipation was up to 72%, and authors indicated that bed rest, insufficient fluid administration, and lack of fiber in enteral feeding were among the risk factors for developing constipation.[27] Furthermore, a retrospective observational study of 145 critically ill children in a tertiary children's hospital found that 46.7% of the participants developed constipation.[28] They indicated that the risk of constipation was associated with EN-related factors such as delayed EN administration and electrolyte imbalances.[28] Management of gastrointestinal complications is crucial to ensure the optimum delivery of the nutritional requirements. Many studies have shown that gastrointestinal complications were identified as one of the main reasons for delaying EN initiation.[22,29,30]

When we compared the frequencies of the reported EN complications between HCPs working in adult and paediatric ICUs, a significant difference was recorded in the responses of HCPs based on their work settings for the following complications: delayed gastric emptying, refeeding syndrome, and hypernatremia. The differences in HCPs' perceptions based on their work settings may stem from varying levels of nutritional training received in each setting, potentially affecting their ability to observe and report EN-related complications. For instance, in the United Kingdom, nutrition training is mandatory for both nursing and medical staff in PICUs.[31]

Our results also showed that the participants' characteristics, such as their profession and years of experience statistically influenced their perception regarding EN complications. Dietitians reported a higher cumulative Likert rating score of all EN complications compared to physicians and nurses. This might indicate that they are more aware of the EN complications and therefore can easily detect and report these complications in higher frequency. Our findings regarding the variation in the perception of HCPs about EN complications based on their profession are consistent with previously published study where they recorded a variation in HCPs' perceptions regarding EN barriers in intensive care settings.[32] However, other study indicated that there were no significant differences between the perception of nurses and physicians when it come to the implementation of guideline recommendations and EN delivery to ICU patients.[33] In another study, they have shown that the that participants' confidence in practicing enteral nutrition was significantly influenced by their profession and the nutritional qualifications they have.[11]

The participants' years of experience in the current study also appeared to statistically influence the participant's perception regarding EN complications. We recorded a negative association between reported complications and the

participant's years of experience. This might indicate that the more experienced staff reported lower cumulative Likert rating scores because they are able to effectively distinguish if these complications are related to EN or other medical factors. It was previously reported that the confidence level in practicing enteral and parenteral nutrition was significantly influenced by the participant's years of experience.[11]

Strengths and Limitations

A key strength of the current study is that it generated cross-sectional data on some of the EN-related practices and the perception of HCPs regarding EN complications in Saudi Arabia. In addition, our study's design allowed for a relatively short recruitment period, providing a snapshot of the EN practices and complications in the region, which serves as a foundation for future research on nutrition support practices in the region. However, the current study was associated with some limitations related to sample size, although our sample size was comparable to most studies that have examined EN complications in intensive care settings.[10,11,34] The recruitment methods also created another challenge in this study, as the nature of convenience sampling resulted in unequal proportions of HCPs working in adult and paediatric ICUs. Additionally, the self-reported nature of the data leaves room for potential misrepresentation and may raise concerns about verifying the professional credentials and work settings of the participants. However, measures were taken to mitigate this issue, such as distributing the survey through professional networks also the questionnaire included a mandatory screening question at the beginning, requiring participants to confirm their profession. In future studies, we could address this limitation by incorporating additional verification methods, such as requiring institutional Email addresses to validate the participant's credentials.

Conclusion

The current study provided a snapshot of the EN practices in Saudi hospitals, examining the most frequent EN complications and practices as reported by HCPs. Our findings showed that NGT was the most frequently used access device for EN delivery in adult and paediatric ICUs, and continuous feeding was the most common method for providing EN. Overall, EN complications were frequently reported by HCPs, and the rate of reporting EN complications was influenced by the participant's characteristics. These findings highlight the need to establish a standard system for implementing EN while increasing healthcare practitioners' awareness regarding EN complications management. In addition, the findings of this study also shed light on the nutritional practice in Saudi hospitals, allowing for identifying areas of improvement in EN practice and eventually help in advancing the field of critical care nutrition in the region. Future studies targeting HCPs working in intensive care settings are recommended to understand the practices that lead to EN complications in Saudi Arabia. In particular, observational studies are needed to closely monitor and assess day-to-day EN complications in intensive care settings in Saudi Arabia. Developing preventative measures and management protocols for EN complications in Saudi hospitals will help in reduce the incidence of these complications, achieve optimal nutritional support for ICU patients, and illuminate the gaps in knowledge and current practices. This will eventually improve the overall quality of care provided for critically ill patients.

Data Sharing Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

Ethical approval was authorized by the Research Ethics Committee, at the Faculty of Applied Medical Sciences, Taibah University (Certificate no.2023/153/203 CLN). Participants' informed consent was obtained by including a mandatory question in the online survey confirming their consent to participate in the study after reviewing the information sheet.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests in this work.

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