Advanced Practice of Total Parenteral Nutrition by Physicians in Saudi Arabia

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ABSTRACT

Objectives: To explore the physician's advanced practice of Total Parenteral Nutrition in Saudi Arabia. Methods: It analyzes a cross-sectional survey that discussed advanced physician practice of Total Parenteral Nutrition services (TPNs) in Saudi Arabia. The survey consisted of respondents' demographic information about physicians and Advanced Practice Total Parenteral Nutrition services (TPNs) by Physicians, the types of prescribing, preparations, and administrations of the Total Parenteral Nutrition services (TPNs) system, The responsibility of Total Parenteral Nutrition services (TPNs). The 5-point Likert response scale system was used with closed-ended questions. The survey was validated through the revision of expert reviewers and pilot testing. Besides, various tests of the reliability of McDonald's w, Cronbach alpha, Gutmann's $\lambda 2$, and Gutmann's $\lambda 6$ were done with the study. In addition, the data analysis of the Pharmacist practice of Cardiopulmonary Resuscitation (CPR) medications is done through the survey monkey system. Besides, the Statistical Package of Social Sciences (SPSS), Jeffery's Amazing Statistics Program (JASP), and Microsoft Excel sheet version 16. **Results:** A total number of 409 physicians responded to the questionnaire. Of them, almost one-half responded from the Northern region (186 (45.48%)), and one Quarter responded from the central area (106 (25.92%)), with statistically significant differences between the provinces (p=0.000). Females responded more than males (268 (65.53%)) versus 141 (34.47%)), with statistically significant differences between all levels (p=0.001). Most of the responders were in the age group of 36-45 years (198 (48.41%)) and 46-55 years (109 (26.65%)), with statistically significant differences between all age groups (p=0.000). Almost one-half of responders, 176 (43.03%), worked at an organization that had Parenteral Nutrition services (TPNs) services, with only 86 (21.03%) had been ever requested any Parenteral Nutrition services (TPNs) with statistically significant differences between all answers (p=0.000). The average score of items for advanced practicing Total Parenteral Nutrition services (TPNs) was (3.48). The "Patient safety system for TPN" item scored the highest (3.74). Followed by The element "Pediatrics TPN forms" (3.73) and The element "Clean room for TPN preparation" (3.73). Most physicians had Customized Total Parenteral nutrition for geriatrics 228 (55.75%) and Pediatric 225 (55.01%). In using Standardized Total Parenteral nutrition, most physicians used for geriatrics, 283 (69.19%) and 189 (46.21%), do not know how to use it. In Pre-mixed Total Parenteral nutrition, most physicians used geriatrics 211 (51.59%) and adolescents 209 (51.10%). Conclusion: The advanced practice of parenteral nutrition by physicians was adequate. One-half of physicians practice the New model of parenteral nutrition. The physician had negative perceptions of the parenteral nutrition responsibilities of the pharmacist. The advanced practice of TPN should be considered for further evaluation and accountability in medical care

Keywords: Practice, Parenteral, Nutrition, Physicians, Saudi Arabia.

INTRODUCTION

Over the years, nutrition support services advanced significantly, including have the development of enteral or parenteral nutrition, which has evolved from simple onecomponent preparations to multiple contents.^[1] Today, automated compounding systems and outsourcing of ready-made parenteral nutrition therapy are widely used, making the process more efficient and less burdensome on the healthcare system.^[2-6] The transition from manual handwriting prescriptions to computerized physician orders for nutrition support^[1,2,7-9] has resulted in standardized procedures that prevent nutrition-related problems and avoid

unnecessary economic burdens on the healthcare system. $^{\left[7,8,10\text{-}12\right]}$

However, to ensure that the role of healthcare providers is well-documented based on international guidelines,^[1,7-9] various developments and methods are required to clarify physicians' job descriptions when prescribing TPN order forms for neonates, pediatrics, and adults. Physicians are crucial in designing patient safety systems during parenteral nutrition therapy, from prescribing to administering TPN contents and monitoring patients for complications and nutrition-related problems.^[7]

Despite the availability of new technologies and developments, there is a lack of research on the advanced practice of physicians in nutrition support therapy.^[7,12,18] There is a need to explore

the advanced practice of parenteral nutrition by physicians in Saudi Arabia, where standardized and customized parenteral nutrition and outsourcing are widely used.^[19,20] This crosssectional study aims to fill this gap and explore the actual advanced practice of physicians in parenteral nutrition therapy in Saudi Arabia. The study aims to shed light on using premixed parenteral nutrition or outsourcing and physicians using standardized or customized parenteral nutrition therapy.^[13,14] Ultimately, the study's findings will provide insights into the current advanced practice of physicians in nutrition support therapy and help improve patient care and outcomes.

The overall aim of this study is to investigate the advanced practice of Total Parenteral Nutrition by physicians in Saudi Arabia by exploring their utilization of standardized or customized TPN prescribing, premixed parenteral nutrition or outsourcing, identifying challenges they face, and providing recommendations for improving their practice, emphasizing Specific objectives that include investigating the current advanced practice of physicians in Total Parenteral Nutrition (TPN) therapy locally, examining the utilization of standardized or customized TPN prescribing by physicians, and assessing the utilization of pre-mixed parenteral nutrition or outsourcing by physicians in Saudi Arabia. Besides, identify the challenges physicians face in TPN therapy, and provide recommendations for improving the advanced practice of physicians in TPN therapy in Saudi Arabia.

METHODS

This study employed a cross-sectional survey design to explore the advanced practice of Total Parenteral Nutrition (TPN) by physicians in Saudi Arabia. An electronic survey utilizing a 5-point Likert response scale system with closed-ended questions was self-reported by physicians ranging from internship to consultant levels across various specialties in Saudi Arabia. Non-physicians, students, and incomplete or unqualified surveys were excluded from the study. The survey consisted of questions on the respondents' demographic information, advanced practice of TPN by physicians, types of TPN prescribing, preparations and administrations, and responsibility of TPN services. (TPNs).[12-18] The sample size was calculated to be between 380-420, with a confidence level of 95%, a margin of error of 5%, a population percentage of 50%, and a drop-out rate of 10%.^[21-24] The response rate required for the calculated sample size is at least 60-70% and above.^[23,24] The survey was distributed through social media platforms such as WhatsApp and

Telegram groups of physicians, and a reminder message was sent every 1-2 weeks. The survey was validated through expert review and pilot testing, and various reliability tests were conducted. Data was analyzed using the SurveyMonkey system, the Statistical Package for Social Sciences (SPSS), Jeffery's Amazing Statistics Program (JASP), and Microsoft Excel Sheet Version 16. The analysis included descriptive and frequency analysis, goodness of fitness analysis, correlation analysis, and linear regression analysis was used to determine factors affecting the advanced practice of TPN by physicians and the responsibility of TPN services. The study followed the STROBE (Strengthening the reporting of observational studies in epidemiology statement: guidelines for reporting observational studies) guidelines for reporting observational studies in epidemiology.^[25,26]

RESULTS

A total number of 409 physicians responded to the questionnaire. Of them, almost onehalf responded from the Northern region (186 (45.48%)), and one Quarter responded from the Central region (106 (25.92%)), with statistically significant differences between the provinces (p=0.000). Most of the responders were from National Guard Hospitals (90 (22.00%)), Military hospitals (79 (19.32%)), Ministry of Health (MOH) hospitals (53 (12.96%%)), and University Hospitals (51 (12.47%%)), with a statistically significant difference between working sites (p=0.000). Females responded more than males (268 (65.53%)) versus 141 (34.47%)), with statistically significant differences between all levels (p=0.001). Most of the responders were in the age group of 36-45 years (198 (48.41%)) and 46-55 years (109 (26.65%)), with statistically significant differences between all age groups (p=0.000). Most of the pharmacists were residents (133 (32.52%)) and General practitioners (110 (26.89%)), with statistically significant differences between all levels (p=0.000). Most of the responders worked as Assistant directors of the medical unit (228 (55.75%)) and Medical Directors (90 (22.00%)), with a statistically significant difference between positions (p=0.000). Most physicians had a work experience of 1-3 years (176 (43.03%)) and 4-6 years (137 (33.50%)), with a statistically significant difference between years of experience (p=0.000). Most of physician's specialties was emergency (86 ((20.05%%)), Surgery (79 ((19.32%)), Psychiatry (78 ((19.07%)), and Obstetrics and Gynecology (74 ((18.09%)) with statistically significant differences between all specialties (p=0.000). Almost one-half of responders,

176 (43.03%), worked at an organization that had Parenteral Nutrition services (TPNs) services, with only 86 (21.03%) had been ever requested any Parenteral Nutrition services (TPNs) with statistically significant differences between all answers (p=0.000). There are nonstatistically significant correlations between all demographic variables (p>0.05) (Tables 1 and 2). The average score of items for advanced practicing Total Parenteral Nutrition services (TPNs) was (3.48). The "Patient safety system for TPN" item scored the highest (3.74). Followed by The element "Pediatrics TPN forms" (3.73) and The element "Clean room for TPN preparation" (3.73). In contrast, the lowest score was obtained for the component "Electronic Prescribing of TPN" (2.94). The score for the element "TPN automated compounding system" was (2.87) with a statistically significant difference between the responses (p < 0.000). All aspects of the items for practicing Total Parenteral Nutrition services (TPNs) were statistically significant between responses (p<0.000) (Table 3). Most physicians had Customized Total Parenteral nutrition for geriatrics 228 (55.75%) and Pediatric 225 (55.01%). In using Standardized Total Parenteral nutrition, most physicians employed for geriatrics, 283 (69.19%) and 189 (46.21%), do not know how to use it. In Pre-mixed Total Parenteral nutrition, most physicians used geriatrics 211 (51.59%) and adolescents 209 (51.10%). Most physicians had Outsourcing Total Parenteral Nutrition for Adolescents 207 (50.74%) and geriatrics 288 (46.08%) (Table 4). Most physicians agreed that Pharmacy technicians (2.56) and physicians (2.58) responsible for Total Parenteral Nutrition services (TPNs) are responsible. In contrast, the physicians who decided the least reliable TPN services were clinical pharmacists (1.82) and pharmacists (1.95), with a statistically significant difference between the responses (p < 0.000). All aspects of responsible of Total Parenteral Nutrition services (TPNs) were statistically significant between responses (p < 0.000) (Table 5). The score for single-test reliability analysis of McDonald's ω was 0.685, Cronbach's α was 0.678, Gutmann's was $\lambda 2$, 0.718, Gutmann's λ6 was 0.885, and Greater Lower Bound was 0.957 with statistically significant (p < 0.05).

Factors affecting physician advanced practicing Total Parenteral Nutrition services (TPNs) at the institution. Factors affecting the perception were analyzed. We adjusted the significant values using the independent samples Kruskal–Wallis test and the Bonferroni correction for multiple tests. Advanced practicing Total Parenteral Nutrition services (TPNs) at the institution

Table 1: Demographie	c, social information.		
Nationality	Response Count	Response Percent	<i>p</i> -value (X2)
Central area	106	25.92%	0.000
North area	186	45.48%	
South area	68	16.63%	
East area	36	8.80%	
West area	13	3.18%	
Answered question	409		
Skipped question	0		
Site of work	Response Count	Response Percent	<i>p</i> -value (X²)
MOH Hospitals	53	12.96%	0.000
Military hospitals	79	19.32%	
National Guard Hospital	90	22.00%	
Security forces hospitals	39	9.54%	
University Hospital	51	12.47%	
MOH primary care centers	12	2.93%	
Private hospitals	30	7.33%	
Private ambulatory care clinics	47	11.49%	
Private primary healthcare center	7	1.71%	
Community pharmacy	0	0.00%	
University (academia)	1	0.24%	
Answered question	409		
Skipped question	0		
Gender	Response Count	Response Percent	
Male	141	34.47%	0.000
Female	268	65.53%	
Answered question	409		
Skipped question	0		
Age	Response Count	Response Percent	
24-35	63	15.40%	0.000
36-45	198	48.41%	
46-55	109	26.65%	
> 55	39	9.54%	
Answered question	409		
Skipped question	0		

Table 2: Demographic, social in	formation.		
Physician Qualifications	Response Count	Response Percent	p-value (X2)
Intern	34	8.31%	0.000
Resident	133	32.52%	
General practitioner	110	26.89%	
Specialist	73	17.85%	
Consultant	59	14.43%	
Answered question	409		
Skipped question	0		
Position Held	Response	Response	
	Count	Percent	
Director of the medical unit	54	13.20%	0.000
Assistant director of a medical unit	228	55.75%	
Medical Director	90	22.00%	
Supervisor	1	0.24%	
Physician staff	36	8.80%	
Answered question	409		
Skipped question	0		
Years of experience in a	Response	Response	
medical career	Count	Percent	0.000
<1	9	2.20%	0.000
1-5	1/6	43.03%	
4-6 7 0	137	33.50%	
10.12	4/	(26%	
10-12	26	0.30% 3.42%	
Answered question	14	5.42%	
Skipped question	409		
Physician Specialties	Response	Response	
nysician speciaties	Count	Percent	
Critical Care	3	0.73%	0.000
Emergency	82	20.05%	
Medical	33	8.07%	
Surgical	79	19.32%	
Pediatrics	23	5.62%	
Anesthesia	36	8.80%	
Psychiatry	78	19.07%	
Obstetrics and Gynecology	74	18.09%	
Family medicine	1	0.24%	
Answered question	409		
Skipped question	0		
The availabilities of Parenteral Nutrition services (TPNs) at the institution	Response Count	Response Percent	<i>p</i> -value (X²)
Yes	176	43.03%	0.000
No	160	39.12%	
I do not know	73	17.85%	
Answered question	409		
Skipped question	0		
Have you	Response	Response	
ever requested any Parenteral Nutrition services (TPNs)?	Count	Percent	
Yes	86	21.03%	0.000
No	179	43.77%	
I do not know	144	35.21%	
Answered question	409		
Skipped question	0		

able 3: Advanced practice Total Parent	eral Nutriti	on services (1	rPNs) by Ph	ysicians.									
	No activit impleı	iy had been mented.	lt was f discuss consic but it w implen	ormally ed and lered, vas not nented	It is pa implemo hospitals or all areas drugs	rrtially ented in for some s, patients, , staff	lt is f implemen hospital f areas, p drugs, a	ully ted in the for some atients, nd staff	It is f implen through hospita patients, c sta	fully nented nout the I for all frugs, and sff	Total	Weighted Average	p-value (X2)
- Adults TPN form	0.50%	2	34.17%	136	21.86%	87	18.34%	73	25.13%	100	398	3.33	0.000
- Pediatrics TPN forms	2.99%	12	16.71%	67	20.70%	83	23.69%	95	35.91%	144	401	3.73	0.000
- Neonatal TPN form	0.50%	7	10.30%	41	37.94%	151	30.15%	120	21.11%	84	398	3.61	0.000
- Cleanroom for TPN preparation	3.26%	13	8.77%	35	29.32%	117	28.57%	114	30.08%	120	399	3.73	0.000
- Sterile area for TPN preparation	0.49%	7	10.27%	42	40.59%	166	38.88%	159	9.78%	40	409	3.47	0.000
- Patient safety system for TPN	0.49%	7	3.18%	13	42.79%	175	29.10%	119	24.45%	100	409	3.74	0.000
- Standardized TPN System	2.20%	6	3.91%	16	49.14%	201	26.41%	108	18.34%	75	409	3.55	0.000
- TPN automated compounding system	0.49%	7	16.38%	67	45.72%	187	34.47%	141	2.93%	12	409	3.23	0.000
- Electronic Prescribing of TPN	3.42%	14	22.98%	94	49.39%	202	24.21%	66	0.00%	0	409	2.94	0.000
unswered											409		
kipped											0		

	Total	409	409	409	408	409	0
	know how culate it	109	189	75	43		
	l do not l to calc	26.65%	46.21%	18.34%	10.54%		
	atrics	228	283	211	188		
	Geri	55.75%	69.19%	51.59%	46.08%		
	ults	154	175	189	177		
Ns) system.	Ad	37.65%	42.79%	46.21%	43.38%		
ervices (TPI	scent	168	66	209	207		
Nutrition s	Adole	41.08%	16.14%	51.10%	50.74%		
Parenteral	atric	225	103	52	12		
of the Total	Pedi	55.01%	25.18%	12.71%	2.94%		
nistrations	nates	27	1	б	1		
i, and admi	Neoi	6.60%	0.24%	0.73%	0.25%		
: The types of prescribing, preparations	Items	Customized Total Parenteral nutrition	Standardized Total Parenteral nutrition	Pre-mixed Total Parenteral nutrition	Outsourcing Total Parenteral nutrition	Answered	Skipped
Table 4:	°N N	1	3	ю	4		

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Table	5: The responsibility of	Total Pa	renteral	Nutrition	service	es (TPNs).								
No	ltems	Stroi agr	ngly ee	Agre	e	Uncert	ain	Disag	ree	Stron disag	gly ree	Total	Weighted Average	<i>p</i> -value (X2)
1	Physician	2.93%	12	36.43%	149	11.25%	46	14.43%	59	34.96%	143	409	2.58	0.000
2	Clinical pharmacist	1.22%	5	7.58%	31	13.94%	57	26.41%	108	50.86%	208	409	1.82	0.000
3	Pharmacist	0.74%	3	5.88%	24	23.53%	96	27.45%	112	42.40%	173	408	1.95	0.000
4	Nurses	0.98%	4	9.78%	40	7.58%	31	53.30%	218	28.36%	116	409	2.02	0.000
5	Nutritionist	1.47%	6	8.07%	33	14.67%	60	53.06%	217	22.74%	93	409	2.12	0.000
6	Pharmacy technicians	2.20%	9	3.91%	16	53.30%	218	38.14%	156	2.44%	10	409	2.65	0.000
	Answered											409		
	Skipped											0		

include location, worksite, gender, Physician qualification, Physician specialties, years of experience, current position, presence of the Parenteral Nutrition services (TPNs) at the institution, Requisitions of any Parenteral Nutrition services (TPNs) before, Number of TPN orders, and Number of patients needed for TPN. The western region showed the lowest scores (3.1026), with statistically significant differences between regions (p=0.000). Ten worksites affected the institution's advanced practicing Total Parenteral Nutrition services (TPNs). The lowest scores (3.1342) and (3.2350) were obtained from MOH hospitals and University hospitals, respectively, with statically significant differences among all sites (p=0.004). The physician's gender did not affect the advance practicing Total Parenteral Nutrition services (TPNs) at an institution with a non-statistically significant difference (p=0.138). The age of the responders affected the advancement of practicing Total Parenteral Nutrition services (TPNs) at the institution. Physicians aged >55 and 24-35 showed the lowest score (3.1425) and (3.1711), respectively, with a statistically significant difference between all age groups (p=0.000). Five levels of academic qualifications affected the advance practicing Total Parenteral Nutrition services (TPNs) with the lowest score (3.1830) and (3.2382) obtained for the intern physician and consultants, respectively, with a statistically significant difference between all levels (p=0.000). Nine types of physician specialties affected the advance practicing Total Parenteral Nutrition services (TPNs) at the institution, with the lowest score (3.2996) obtained for the surgeon with a statistically significant difference between all levels (p=0.000). Six levels of work experience affected the institution's advanced practicing Total Parenteral Nutrition services (TPNs). The lowest score (3.0952) was obtained for those with work experience of >12 years, with a statistically significant difference between all levels (p=0.008). Five levels of the position

affected the advance practicing Total Parenteral Nutrition services (TPNs) at the institution, with the lowest score (3.2716) of physician staff with a statistically significant difference between all levels (p=0.000). The physician did not present the Parenteral Nutrition services (TPNs) at the institution with the lowest score (3.3255) affected advanced practicing Total Parenteral Nutrition services (TPNs) at the institution, with a statistically significant difference between all answers (p=0.000). The physician requested any Parenteral Nutrition services (TPNs) before, with the lowest score (3.3380) affecting advanced practicing Total Parenteral Nutrition services (TPNs) at the institution, with a statistically significant difference between all answers (p=0.000). The total number of patients needed for TPN orders (81-100) daily had the highest score (3.6674) affected advanced practicing Total Parenteral Nutrition services (TPNs) at the institution, with a statistically significant difference between all answers (p=0.000). The total number of TPN orders had the highest score (3.5532) affected advanced practicing Total Parenteral Nutrition services (TPNs) at the institution, with a statistically significant difference between all answers (p=0.000) (Table 6).

The relationship between the physician items for advanced practicing Total Parenteral Nutrition services (TPNs) at an institution and factors such as location, worksite, age (years), gender, qualifications, specialties, years of experience, position held, Present of the Parenteral Nutrition services (TPNs) at the institution, Requisitions of any Parenteral Nutrition services (TPNs) before, Number of TPN orders, and Number of patients needed for TPN. The multiple regression analysis considered perception as the dependent variable and factors affecting it as an expletory variable. There was a medium relationship (R=0.460 with p=0.000) between the physician items for advanced practicing Total Parenteral Nutrition services (TPNs) and its factors.

Seven factors (worksite, specialties, years of experience, position held, Present of the Parenteral Nutrition services (TPNs) at the institution, Requisitions of any Parenteral Nutrition services (TPNs) before, and Number of TPN orders) out of twelve were nonsignificant differences (p>0.05). However, multiple regression analysis confirmed that five factors (i.e., locations and physician qualification) explained 15.4% and 11.2%, respectively, of the negative relationship to the variation in practice, with a statistically significant difference (p=0.003) and (p=0.021). The bootstrap model was also confirmed. Furthermore, the relationship was verified by the non-existence of multicollinearity with the two factors (locations and physician qualification) with a variance inflation factor (VIF) of 1.288 and 1.178, respectively less than three or five as a sufficient number of VIF. Besides, three factors (age, gender, and the number of patients needed for TPN) explained 28.2%, 29.5%, and 40.8%, of the positive relationship to the variation in practice, with a statistically significant difference (p=0.000)(*p*=0.000), and (*p*=0.000), respectively. The bootstrap model was also confirmed. Furthermore, the relationship was verified by the non-existence of multicollinearity with the three factors (age, gender, and the number of patients needed for TPN) with a Variance Inflation Factor (VIF) of 1.902, 1.359, and 1.799, respectively less than three or five as an adequate number of VIF.^[27-29] (Table 6).

Factors affecting the practice responsibility of the Total Parenteral Nutrition services (TPNs) at the institution

Factors affecting the perception were analyzed. We adjusted the significant values using the independent samples Kruskal–Wallis test and the Bonferroni correction for multiple tests. *Practice responsibility of the Total Parenteral Nutrition services (TPNs) at the institution* includes location, worksite, gender, Physician qualification, Physician specialties, years of experience, and current position. In addition

	Model	æ	R Square	L	Sig.	Unstar Coef	ndardized ficients	Standardized Coefficients	+	Sig.	95.0% Confid fo	ence Interval · B	Collinear Statistic	ity is
						8	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
	(Constant)	.460 b	.188	8.861	q000.	3.050	.127		23.962	000.	2.800	3.300		
	Location					059	.019	154	-3.038	.003	097	021	.776	1.288
	Site of work					006	600.	035	643	.521	024	.012	.686	1.458
	Age (years)					.131	.029	.282	4.590	.000	.075	.187	.526	1.902
	Physician gender					.242	.043	.295	5.665	.000	.158	.326	.736	1.359
	Physician qualification					037	.016	112	-2.311	.021	068	005	.849	1.178
	Physician specialties					014	600.	081	-1.514	.131	033	.004	669.	1.430
	Years of experience in a medical career					.027	.020	.075	1.360	.174	012	.066	.649	1.542
	Position Held					046	.021	119	-2.183	.030	087	005	.665	1.504
	The presence of Parenteral Nutrition services (TPNs) at the institution					085	.032	161	-2.656	.008	148	022	.545	1.836
	Requisitions of any Parenteral Nutrition services (TPNs) before					.001	.027	.003	.050	960	052	.054	.773	1.293
	Number of TPN orders					019	.011	093	-1.758	.080	039	.002	.710	1.408
	Number of patients needed for TPN					.095	.014	.408	6.814	000.	.067	.122	.556	1.799
a. exț nee	Dependent Variable: Advanced practice Total perience, current position, Present of the Paren eded for TPN.	l Parenter iteral Nuti	al Nutritior rition servic	1 services (ces (TPNs)	(TPNs) by at the insti	r Physician itution, Re	ns, Predictors: quisitions of a	(Constant), loca my Parenteral Nu	ıtion, work trition serv	site, gender ices (TPNs)	;, Physician quali) before, Number	ication, Physician of TPN orders, and	specialties, you Number of p	ears of atients

B	potstrap for Coefficients						
	Model	8	Bias		Boot	strap ^a	
				Std. Error	Sig.	95% Confide	ince Interval
					(2-tailed)	Lower	Upper
-	(Constant)	3.050	.020	.205	.001	2.666	3.446
	Location	059	001	.016	.001	090	026
	Site of work	006	.001	.018	.764	040	.026
	Age (years)	.131	004	.049	.004	.038	.227
	Physician gender	.242	004	.066	.001	.115	.369
	Physician qualification	037	002	.015	.018	067	008
	Physician specialties	014	9.667E-05	.010	.174	035	.006
	Years of experience in a medical career	.027	001	.031	.385	031	060.
	Position Held	046	.000	.036	.208	117	.025
	The presence of Parenteral Nutrition services (TPNs) at the institution	085	.003	.058	.148	201	.026
	Requisitions of any Parenteral Nutrition services (TPNs) before	.001	.002	.032	.977	062	.062
	Number of TPN orders	019	.000	.014	.195	048	600.
	Number of patients needed for TPN	.095	002	.024	.001	.048	.141

to the presence of the Parenteral Nutrition services (TPNs) at the institution, Requisitions of any Parenteral Nutrition services (TPNs) before, the Number of TPN orders, and the number of patients needed for TPN. The Southern and Northern regions showed the lowest scores (2.0098) and (2.0986), respectively, with statistically significant differences between regions (p=0.000). Ten worksites affected the *practice responsibility* of the institution's Total Parenteral Nutrition services (TPNs). The lowest scores (1.9451), (2.0759), and (2.0815) were obtained from Military hospitals, National Guard hospitals, and University hospitals, respectively, with statically significant differences among all sites (p=0.004). The physician's gender did not affect the Total Parenteral Nutrition services (TPNs) practice responsibility at an *institution* with a non-statistically significant difference (p=0.156). The age of the responders did not affect the *practice responsibility of the* Total Parenteral Nutrition services (TPNs) at the institution, with a non-statistically significant difference (p=0.250). Five levels of academic qualifications affected the *practice* responsibility of the institution's Total Parenteral Nutrition services (TPNs), with the lowest score (1.9749) obtained for the resident physician, with a statistically significant difference between all levels (p=0.000). Nine types of physician specialties affected the practice responsibility of the Total Parenteral Nutrition services (TPNs) at the institution, with the lowest score (1.9756) obtained for the emergency physician with a statistically significant difference between all levels (p=0.000). Six levels of work experience affected the practice responsibility of the institution's Total Parenteral Nutrition services (TPNs). The lowest score (1.9645) was obtained for those with work experience of 7-9 years, with a statistically significant difference between all levels (p=0.000). Five levels of the position affected the practice responsibility of the Total Parenteral Nutrition services (TPNs) at the *institution*, with the lowest score (2.0724) for the assistant director of the medical unit with a statistically significant difference between all levels (p=0.000). The presence of the Parenteral Nutrition services (TPNs) at the institution did not affect the *practice responsibility of the* Total Parenteral Nutrition services (TPNs) at the institution, with a non-statistically significant difference between all answers (p=0.606). The requesting of any Parenteral Nutrition services (TPNs) before did not affect the practice responsibility of the Total Parenteral Nutrition services (TPNs) at the institution, with a non-statistically significant difference between all answers (p=0.931). The total number of patients needed for the TPN

order did not affect the practice responsibility of the Total Parenteral Nutrition services (TPNs) at the *institution*, with a non-statistically significant difference between all answers (p=0.150). The total number of TPN orders (6-10) had the lowest score (1.9652) affected *practice responsibility of the Total Parenteral Nutrition services (TPNs) at the institution*, with a statistically significant difference between all answers (p=0.000) (Table 6).

The relationship between the practice responsibility of the Total Parenteral Nutrition services (TPNs) at the institution and factors such as location, worksite, age (years), gender, qualifications, specialties, years of experience, position held, Present of the Parenteral Nutrition services (TPNs) at the institution, Requisitions of any Parenteral Nutrition services (TPNs) before, Number of TPN orders, and Number of patients needed for TPN. The multiple regression analysis considered perception as the dependent variable and factors affecting it as an expletory variable. There was a medium relationship (R=0.437 with p=0.000) between the practice responsibility of the institution's Total Parenteral Nutrition services (TPNs) and its factors. Eight factors (location, worksite, age (years), years of experience, position held, presence of the Parenteral Nutrition services (TPNs) at the institution, Requisitions of any Parenteral Nutrition services (TPNs) before, and the number of patients needed for TPN) out of twelve were non-significant differences (p>0.05). However, multiple regression analysis confirmed that one factor (i.e., gender) explained 20.2% of the negative relationship to the variation in practice, with a statistically significant difference (p=0.000). The bootstrap model was also confirmed. Furthermore, the relationship was verified by the non-existence of multicollinearity with a Variance Inflation Factor (VIF) of 1.359, less than three or five as a sufficient number of VIF. Besides, three factors (physician qualifications, physician specialties, and Number of TPN orders) explained 18.1%, 20.5%, and 28.8%, respectively of the positive relationship to the variation in practice, with a statistically significant difference (p=0.000), (p=0.000), and (p=0.000), respectively. The bootstrap model was also confirmed. Furthermore, the relationship was verified by the nonexistence of multicollinearity with a Variance Inflation Factor (VIF) of 1.178, 1.430, and 1.408, respectively less than three or five as an adequate number of VIF.^[27-29] (Table 7).

DISCUSSION

In recent years, the process of preparing TPN has evolved significantly from manual preparation done by pharmacists to more

advanced automatic preparations.^[1,2,7-9] These technological advancements have led to a reduction in the time required to prepare TPN and have significantly reduced the incidence of errors.^[1,2,7-9] The use of standardized physician orders and electronic prescribing of TPN has also made the process easier and prevented prescribing errors by physicians.^[9,20] Electronic prescribing of TPN is an additional new development that physicians need to practice daily.^[2,7] Recently, ready-made and utilization of outsourcing companies' TPN components of all TPN are much cheaper and prevent contamination errors during preparation.^[3-6,10,1,19,30,31] The physicians must know all ready-made content and the appropriate prescribing for individual patients. However, adopting these new procedures and techniques in TPN requires the cooperation of healthcare professionals such as physicians, pharmacists, and nutritionists. A recent crosssectional study of physicians revealed that the average advanced practice of physicians in TPN was acceptable. Most physicians practiced a patient safety system for TPN, which is expected since international and national quality management standards and accreditation agencies require it. The present research consists of a wide range of physicians' demographic characteristics that can reflect the physician's culture, similar to previous studies. ^[2,15,14] The findings showed that the average advanced practice by physicians was acceptable. Most physicians practice a patient safety system for TPN; that has expected because international and national quality management standards and accreditation agencies require it. Thus, there is no previous investigation to compare with the current findings.

The second most common practice item by physicians was using a pediatric TPN form and a clean room for TPN preparation. Using the pediatric form for prescription makes life easier and prevents unnecessary mistakes. However, the adult form of TPN was less found in practice, possibly due to its unavailability at some healthcare facilities. A clean room area is required for the aseptic TPN preparation technique, although physicians do not prepare the TPN. The TPN services are managed by the pharmacy department or administered by nurses in the ward.

The lowest practice item among physicians was electronic prescribing of TPN, which is expected because the physician's order entry system was unavailable for most local healthcare organizations.^[32,33] Additionally, implementing IV admixture emphasizing TPN services is not widely available at most local hospitals.^[32,33] The study showed that most pediatrics and adults used customized TPN,

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	Model	æ	R Square	u.	Sig.	Unstan Coef	idardized ficients	Standardized Coefficients	÷	Sig.	95.0% Confic fo	lence Interval r B	Collinear Statistic	ity is
						8	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
-	(Constant)	.437 b	191.	7.779	d000.	2.089	.179		11.686	000.	1.737	2.440		
	Location					.026	.027	.049	.955	.340	028	.080	.776	1.288
	Site of work					.015	.013	.066	1.218	.224	-000	.040	.686	1.458
	Age (years)					092	.040	144	-2.309	.021	171	014	.526	1.902
	Physician gender					230	.060	202	-3.836	000.	348	112	.736	1.359
	Physician qualification					.082	.022	.181	3.679	000.	.038	.126	.849	1.178
	Physician specialties					.050	.013	.205	3.796	000.	.024	.076	669.	1.430
	Years of experience in the medical career					057	.028	115	-2.042	.042	112	002	.649	1.542
	Position Held					060.	.030	.168	3.036	.003	.032	.148	.665	1.504
	The presence of Parenteral Nutrition services (TPNs) at the institution					075	.045	102	-1.667	960.	163	.013	.545	1.836
	Requisitions of any Parenteral Nutrition services (TPNs) before					013	.038	018	356	.722	088	.061	.773	1.293
	Number of TPN orders					.079	.015	.288	5.359	.000	.050	.109	.710	1.408
	Number of patients needed for TPN					031	.019	095	-1.568	.118	069	.008	.556	1.799
a. CU	Dependent Variable: the responsibility of the rrent position. Present of the Parenteral Nutrit	Total Par- ion servic	enteral Nuti es (TPNs) a	rition servic t the institu	ces (TPNs tion, Requ), Predicto isitions o	ors: (Constant f any Parenter), location, work al Nutrition servi	ite, gender ces (TPNs)	; Physician before, Nu	qualification, Ph mber of TPN ord	ysician specialties, ers, and Number c	years of expend f patients need	rience, led for

B	otstrap for Coefficients						
	Model	8	Bias		Boot	strap ^a	
				Std. Error	Sig.	95% Confide	nce Interval
					(2-tailed)	Lower	Upper
	(Constant)	2.089	016	.298	.001	1.457	2.675
	Location	.026	.001	.036	.460	048	.093
	Site of work	.015	001	.020	.451	029	.051
	Age (years)	092	.002	.063	.151	210	.047
	Physician gender	230	.001	.083	.007	382	060
	Physician qualification	.082	-1.335E-06	.029	.008	.026	.139
	Physician specialties	.050	.000	.021	.015	.008	.088
	Years of experience in a pharmacy career	057	001	.059	.364	160	.061
	Position Held	060.	001	.054	.100	015	.198
	The presence of Parenteral Nutrition services (TPNs) at an institution	075	9.215E-05	.072	.287	224	.066
	Requisitions of any Parenteral Nutrition services (TPNs) before	013	.002	.052	.814	116	.086
	Number of TPN orders	.079	.001	.015	.001	.053	.110
	Number of patients needed for TPN	031	.000	.028	.275	083	.029

TPN.

possibly due to physicians' lack of familiarity with standardized TPN or ready-made pre-mixed TPN for neonates or pediatrics. Therefore, most standardized TPN or readymade or outsourced TPN is almost used for geriatric and adults better than in previous study because lag time between the current research and the old one.^[2] The physicians thought TPNs' responsibilities should be under physicians or pharmacy technicians. That's related to most physicians dealing with pharmacy technicians, not pharmacists, during prescribing TPN. Moreover, it might be unavailability of an expert pharmacist in the TPN or clinical pharmacist at the healthcare organization. Thus, there is no previous investigation to compare with the current findings.

Various factors might affect the advanced practice of TPN by physicians. The location emphasized that the western region had the lowest advanced practice of TPN, which might have used the old TPN system or nonavailable TPN services at healthcare facilities. The MOH and University hospitals had the most insufficient advanced practice of TPN because of non-developed TPN at healthcare facilities. The older age of physicians with high qualifications, such as consultants or intern physicians, and more years of experience had the lowest advanced practice of TPN. They are not the current practice of TPN because they are busy if administrative work. The intern physicians need more experience to gain knowledge of advanced TPN. The surgeon specialist had the lowest practice of TPN because there might be pharmacist-covered TPN services or they are busy and focusing on surgical procedures. Non-presence of TPN at the hospital and never requesting of TPN order had the lowest advanced practice of TPN by physicians. That has anticipated because they need essential practice before transferring to advanced TPN services. In contrast, The study also showed that a high number of TPN prescriptions with increased practice requirements leads to more advanced TPN practice by physicians. The most dependable factors that might negatively affect physicians' advanced practice of TPN were locations and physician's qualifications. In contrast, age, gender, and the number of patients required for TPN might positively affect the increased advanced practice of TPN. Higher age had gained more experience in advanced TPN, and prescribing for many patients might gain more excellent expertise in advancing the practice of TPN. Thus, there is no previous investigation to compare with the current findings.

Most physicians prefer the TPN responsibility were pharmacy technicians and physicians. While not choosing the clinical pharmacist or pharmacist to be responsible for TPN. That is related might most physicians deal with the pharmacy technicians who prepare TPN in the pharmacy department. Various factors affect the perception of responsibility for TPN services. The location affected physicians' perception; the northern and southern areas had the lowest agreement with physician's responsibilities for TPN, while the central area had a higher deal of physician's duties but did not agree with clinical pharmacists. That has related might more educated physicians in TPN in the central region than in southern and northern areas. The northern area is more agreed for clinical pharmacists for TPN responsibility might relate to available TPN clinical pharmacists. The working sites like the Military, national guard, and university hospitals were lower agreements of physician's responsibilities for TPN, which might be related to the availability of clinical pharmacists to take care of TPN services. Thus, The military and national guard hospitals agreed more with clinical pharmacists for TPN responsibilities. The female gender disagrees with physician's responsibilities for TPN because most involved in the TPN process were female physicians, which might show the difficulties of TPN services. However, they still disagree with the clinical pharmacist for TPN responsibility; it might deal with pharmacy technicians. Thus, there is no previous investigation to compare with the current findings.

The academic qualifications might affect physicians' perception of TPN responsibilities; the resident agreed little with the physician's duties, while the consultant agreed with responsibilities related to inadequate clinical pharmacists early and took care of TPN responsibilities. In contrast, today, general practitioners found that pharmacists taking care of them decreases the physician's work and responsibilities. The physician specialties might have the perception of responsibility, such as emergency physicians highly disagree with TPN responsibilities for TPN because of the high workload in the emergency and might difficulties educating TPN services. While they prefer the physician responsible for TPN, it might contradict with pharmacist's responsibility for TPN because most patients used only four TPN administrations, which was not the preferred physician's indication. The experience might affect the physician responsible for TPN; less experienced physicians disagree with responsibility because they might find difficulties in the TPN prescribing alone, and

available pharmacists can do the job without any problems. Thus, most with 1-3 years of experience prefer the clinical pharmacist for TPN responsibility. Most physicians did not agree with the physician's TPN responsibility with the presence of TPN services at healthcare facilities or physicians prescribing TPN most physicians disagree with TPN responsibility by physicians. With The high number of patients required for TPN or the number of TPN orders, the physician disagrees with the TPN's responsibility. The most dependable factor was female gender affected physician's responsibilities negatively for TPN, as explored earlier. However, other factors, such as the physician's qualifications, specialty, and number of TPN, disagree with the physician's responsibilities for TPN services. Thus, there is no previous investigation to compare with the current findings.

LIMITATIONS

Despite there are advantages of current research of advanced practice of TPN and reflecting the accurate picture in medical care. There are various disadvantages, such as the samplings method was not randomized and included a wide range of demographic characteristics of subjects. Besides, the reliability test was not optimal. Future research about advanced TPN with randomized sampling techniques and high-reliability results is highly suggested.

CONCLUSION

The physician's practice of advanced total parenteral nutrition was adequate. The physicians practice common elements of TPN, such as patient safety and using TPN ordering forms. In contrast, the physician's lease practice of an electronic prescribing of TPN or automated preparation of TPN. Various factors might be affected positively of practice, such as age, gender, and the number of patients. In contrast, other factors, like location and physician qualifications, might negatively affect the practice. One of the physician's responders did not practice a new model of prescribing TPN. Most physicians agreed that the TPN services take care of by physicians and pharmacy technicians, with negative approval with pharmacist or clinical pharmacist responsibilities in parenteral nutrition. Various factors might negatively affect the duties, such as physician's qualifications, specialties, and the number of TPN prescriptions. Other factors might positively influence gender. The advanced practice of TPN with the model of prescribing should be reviewed thoughtfully with TPN teams emphasizing the pharmacist and clinical pharmacist to improve the TPN practice in Saudi Arabia.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

CONSENT FOR PUBLICATIONS

Informed consent was obtained from all the participants.

ETHICAL APPROVAL

This research was exempted from research and ethical committee or an institutional review board (IRB) approval.

https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts-2018/index.html

ABBREVIATIONS

MOH: Ministry of Health; **KSA:** Kingdom of Saudi Arabia; **TPNs:** Total Parenteral Nutrition Services; **SPSS:** Statistical Package for Social Sciences; **JASP:** Jeffery's Amazing Statistics Program; **STROBE:** Strengthening the reporting of observational studies in epidemiology statement.

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