


# The Practice of Pharmacokinetics Services by Nurses in Saudi Arabia

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Received: 18-06-2023;

Accepted: 29-09-2023.

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[www.ptbreports.org](http://www.ptbreports.org)

DOI:  
10.5530/PTB.2024.10.2

## ABSTRACT

**Objectives:** To explore the essential practice of Pharmacokinetics Services by Nurses in Saudi Arabia.

**Materials and Methods:** It analyzes a cross-sectional survey discussing the essential practice of Pharmacokinetics Services by Saudi Arabian nurses. The survey consisted of respondents' demographic information about The crucial practice of Pharmacokinetics Services by the nurses at the institution. The availability of Drug-level services at the institution, the nurses requested any pharmacokinetics or drug level, the Number of patients needing drug-level services, and the Number of drug levels observed/suspected daily. Besides, most medications are requested to check blood levels. 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  $\omega$ , Cronbach alpha, Gutmann's  $\lambda_2$ , and Gutmann's  $\lambda_6$  were done with the study. The data analysis was done through the Survey Monkey system. Besides, the Statistical Package of Social Sciences (S.P.S.S.), Jeffery's Amazing Statistics Program (J.A.S.P), and Microsoft Excel sheet version 16. **Results:** A total number of 408 nurses responded to the questionnaire. Of them, almost two-thirds responded from the central region (140 (34.31%)) and southern areas (119 (29.17%)), with statistically significant differences between the provinces ( $p=0.000$ ). Most of the responders were from Ministry of Health (M.O.H.) hospitals (267 (65.44%)), with a statistically significant difference between working sites ( $p=0.000$ ). Males responded more than females (210 (52.24%)) versus 192 (47.76%)), with statistically significant differences between all levels ( $p=0.000$ ). Most of the responders were in the age group of 36-45 years (227 (55.91%)) and 46-55 years (99 (24.38%)), with statistically significant differences between all age groups ( $p=0.000$ ). The majority of responders, 372 (91.85%), worked at an organization that had drug levels form, with most of them, 378 (93.33%), ever requesting Pharmacokinetics services or drug levels with statistically significant differences between all answers ( $p=0.000$ ). The total Number of patients serviced of drug levels requested was (2,609) daily, with an average number (of 6.58) per hospital. Those drug levels requested were needed for (16.82) patients daily per hospital, with a total number of patients being (6,663); The average Number of drug levels requested orders per patient was (2.55) (Table 3). The average score of practice items for Pharmacokinetics Services at the institution was (3.79). The "Mission of Pharmacokinetics Services system" obtained the highest score (4.00). In contrast, the lowest score was obtained for "Pharmacokinetics services and research" (3.58).

**Conclusion:** The nursing practice of pharmacokinetic services is acceptable. Most nursing responders partied in pharmacokinetics services at their healthcare organization with appropriate medications. The workload of pharmacokinetics services was high at the nursing department. The annual plan and research of pharmacokinetics services did not reach the optimal level. The nursing practice standard of pharmacokinetics services should be reviewed, and drug utilization is required to improve the nursing practice of pharmacokinetics services.

**Keywords:** Nurses, Practice, Pharmacokinetics, Drug level, Saudi Arabia.

## INTRODUCTION

The primary service of pharmaceutical care departments at healthcare facilities is providing medication to patients. There are various types of medication classifications, such as based on prescribing, for instance, prescription medications, over-the-counter medication, narcotics, and controlled medications. Another classification is based on dosage forms, such as oral, parental, and topical medications. Another classification based on safety is the Institution Safe Medication Practice (ISMP) list of high-alert medications with narrow therapeutic index and broad therapeutic index.<sup>1</sup> The drug's narrow therapeutic index needs close monitoring of the drug level, which is related to a strong correlation between the drug level and

effectiveness and safety. Each drug has a specific therapeutic range that should be reached once the medication is given to the patient within a particular time (steady state). Each drug had specific behaviors of administration, absorption, distribution, and elimination from the body. Lead to a particular time of withdrawal of drug sample from the body. All those standards of pharmacokinetics behavior should be practiced by pharmacokinetics team members such as physicians, nurses, and pharmacists. Various studies have been conducted on physicians' and pharmacists' practice of pharmacokinetics.<sup>2-10</sup> However, the nursing practice of pharmacokinetics services is rarely reported in Saudi facilities or Arabic communities. The

study aims to explore the nursing practice of pharmacokinetic services in Saudi Arabia.

## MATERIALS AND METHODS

It analyzes a cross-sectional survey discussing the nurses' basic knowledge of some items for Pharmacokinetics Services in Saudi Arabia. It self-reported an electronic survey of the nurses, including nurses from internship to consultant, nurses specialties, and Saudi Arabia. Non-nurses or students, as well as non-completed, non-qualified surveys, will be excluded from the study. The survey consisted of respondents' demographic information about The essential practice of Pharmacokinetics Services by the nurses at the institution. The availability of Drug-level services at the institution, the nurses requested any pharmacokinetics or drug level, the Number of patients needing drug-level services, and the Number of drug levels observed/suspected daily. Besides, Methods used to report the drug levels, The approach used for a patient with a high drug level?, and most medications requested for blood level.<sup>2-9</sup> The 5-point Likert response scale system was used with closed-ended questions. According to the previous literature with unlimited population size, the sample was calculated as a cross-sectional study, with a confidence level of 95% with a z score of 1.96 and a margin of error of 5%, a population percentage of 50%, and a drop-out rate of 10%. As a result, the sample size will equal 380-420 with a power of study of 80%.<sup>11-13</sup> The response rate required for the calculated sample size is at least 60-70% and above.<sup>14</sup> The survey was distributed through social media, including applications and telegram groups of nurses. The reminder message had been sent every 1-2 weeks. The survey was validated through the revision of expert reviewers and pilot testing. Besides, various tests of the reliability of McDonald's  $\omega$ , Cronbach alpha, Gutmann's  $\lambda_2$ , and Gutmann's  $\lambda_6$  been done with the study. The data analysis of the nurse's practice of some items for Pharmacokinetics Services at the institution is done through the Survey Monkey system. Besides, the Statistical Package of Social Sciences (S.P.S.S.), Jeffery's Amazing Statistics Program (J.A.S.P.), and Microsoft Excel sheet version 16. It included a description and frequency analysis, good of fitness analysis, and correlation analysis. Besides, inferential analysis of factors affecting the essential practice of Pharmacokinetics Services by the nurses with linear regression. The STROBE (Strengthening the reporting of observational studies in epidemiology statement: guidelines for reporting observational studies) guided the reporting of the current study.<sup>15</sup>

## RESULTS

A total number of 408 nurses responded to the questionnaire. Of those, almost two-thirds responded from the central region (140 (34.31%)) and southern regions (119 (29.17%)), with statistically significant differences between the provinces ( $p=0.000$ ). Most of the responders were from Ministry of Health (M.O.H.) hospitals (267 (65.44%)), with a statistically significant difference between working sites ( $p=0.000$ ). Males responded more than females (210 (52.24%)) versus 192 (47.76%), with statistically significant differences between all levels ( $p=0.000$ ). Most of the responders were in the age group of 36-45 years (227 (55.91%)) and 46-55 years (99 (24.38%)), with statistically significant differences between all age groups ( $p=0.000$ ). Most of the nurses had a bachelor's degree (372 (91.63%)), with statistically significant differences between all levels ( $p=0.000$ ). Most of the responders worked as nursing staff (342 (84.44%)), with a statistically significant difference between positions ( $p=0.000$ ). Most nurses had a work experience of 4-6 years (194 (47.67%)) and 6-9 years (126 (30.96%)), with a statistically significant difference between years of experience ( $p=0.000$ ). Most of nurses's specialties was emergency (58 ((14.46%)), critical care (58 ((14.46%)), family medicine (49 ((12.22%)),

and Anesthesia (48 ((11.97%)) with statistically significant differences between all specialties ( $p=0.000$ ). The majority of responders, 372 (91.85%), worked at an organization that had drug levels form, with most of them, 378 (93.33%), ever requesting Pharmacokinetics services or drug levels with statistically significant differences between all answers ( $p=0.000$ ). There are non-statistically significant correlations between all demographic variables ( $p>0.05$ ) (Tables 1 and 2).

**Table 1: Demographic, social information.**

Nationality	Response Count	Response Percent	p-value (X2)
Central area	140	34.31%	0.000
North area	86	21.08%	
South area	119	29.17%	
East area	48	11.76%	
West area	15	3.68%	
Answered question	408		
Skipped question	0		
Site of work	Response Count	Response Percent	p-value (X2)
M.O.H. Hospitals	267	65.44%	0.000
Military Hospitals	30	7.35%	
National Gaurd Hospital	46	11.27%	
Security Forces Hospitals	26	6.37%	
University Hospital	3	0.74%	
M.O.H. Primary Care Centers	1	0.25%	
Private Hospitals	23	5.64%	
Private Ambulatory Care Clinics	9	2.21%	
Private Primary Healthcare Center	3	0.74%	
Answered question	408		
Skipped question	0		
Gender	Response Count	Response Percent	
Male	210	52.24%	0.000
Female	192	47.76%	
Answered question	402		
Skipped question	6		
Age	Response Count	Response Percent	
24-35	76	18.72%	0.000
36-45	227	55.91%	
46-55	99	24.38%	
> 55	4	0.99%	
Answered question	406		
Skipped question	2		

The total Number of patients serviced for drug levels requested was (2,609) daily, with an average number (of 6.58) per hospital. The highest daily Number of drug levels requested daily in the range (1-5) and (6-10) were 150 ((36.76%) and 145 (35.54%), respectively. Those drug levels requested were needed for (16.82) patients daily per hospital with a total number of patients were (6,663); the highest range number of

<b>Table 2: Demographic, social information.</b>				
<b>Nurses Qualifications</b>	<b>Response Count</b>	<b>Response Percent</b>	<b>p-value (X2)</b>	
Diploma	10	2.46%	0.000	
Bachelor nursing	372	91.63%		
Master	20	4.93%		
Ph D	4	0.99%		
Answered question	406			
Skipped question	2			
<b>Position Held</b>	<b>Response Count</b>	<b>Response Percent</b>		
Director of the Nursing Department	18	4.44%	0.000	
Assistant director of nursing department	25	6.17%		
Supervisor	20	4.94%		
Nursing staff	342	84.44%		
Answered question	405			
Skipped question	3			
<b>Years of experience in a nursing career</b>	<b>Response Count</b>	<b>Response Percent</b>		
< 1	15	3.69%	0.000	
1-3	38	9.34%		
4-6	194	47.67%		
6-9	126	30.96%		
> 9	34	8.35%		
Answered question	407			
Skipped question	1			
<b>The practice area</b>	<b>Response Count</b>	<b>Response Percent</b>		
Medical	41	10.22%	0.000	
Surgical	45	11.22%		
Pediatrics	39	9.73%		
Critical care	58	14.46%		
Emergency	58	14.46%		
Anesthesia	48	11.97%		
Obstetric and Gynecology	18	4.49%		
Psychiatry	18	4.49%		
Family medicine	49	12.22%		
Ambulatory care clinic	7	1.75%		
Nephrology	11	2.74%		
Cardiology	6	1.50%		
Hematology/Oncology	1	0.25%		
Administration	1	0.25%		
Education/ Training	1	0.25%		
Answered question	401			
Skipped question	7			

patients was 301 ((73.96%) in a range (1-20) patients, and 96 ((23.59%) in a field (21-40) patients daily. The average Number of drug levels requested orders per patient was (2.55) (Table 3). Most responders worked at an organization with the availability of Drug Levels services at 372 (91.85%). Most responders (378) (93.33%) had ever requested any Pharmacokinetics services or drug level, with statistically significant differences between all answers ( $p=0.000$ ). (Table 3). Most responders reported drug level by sending drug level request forms to pharmacy 229 (56.97%) and filled drug level forms 194 (48.26%). If the drug levels were high, most of the nurses contacted head nurses 315 (77.21%), investigated if the high drug level was known 199 (48.77%), and Documented the high drug level in the patient's file 125 (30.64%). Most medications requested for blood level were Gentamicin (4.49) and Digoxin (4.25). Followed by Vancomycin (4.16) and Amikacin (4.07) Table 4.

<b>Table 3: Drug levels requesting information.</b>				
<b>The availabilities of Drug Levels at the institution</b>	<b>Response Count</b>	<b>Response Percent</b>	<b>p-value (X2)</b>	
Yes	372	91.85%	0.000	
No	21	5.19%		
I do not know	12	2.96%		
Answered question	405			
Skipped question	3			
<b>Have you ever requested any Pharmacokinetics services or drug level?</b>	<b>Response Count</b>	<b>Response Percent</b>		
Yes	378	93.33%	0.000	
No	22	5.43%		
I do not know	5	1.23%		
Answered question	405			
Skipped question	3			
<b>The Number of patients requested for them daily?</b>	<b>Response Count</b>	<b>Response Percent</b>		
1-20	301	73.96%	0.000	
21-40	96	23.59%		
41-60	8	1.97%		
61-80	1	0.25%		
81-100	0	0.00%		
> 100	1	0.25%		
Answered question	407			
Skipped question	1			
<b>The Number of drug levels observed/suspected daily?</b>	<b>Response Count</b>	<b>Response Percent</b>		
1-5	150	36.76%	0.000	
6-10	145	35.54%		
11-15	30	7.35%		
16-20	14	3.43%		
21-25	7	1.72%		
26-30	7	1.72%		
I do not know, and I can not specify	55	13.48%		
Answered question	408			
Skipped question	0			

How do you report the drug levels?	Response Count	Response Percent	
I phone the laboratory	77	19.15%	
I verbally inform the patients on routine visits	107	26.62%	
I send the drug-level form to the pharmacy	229	56.97%	
I fill the drug-level form	194	48.26%	
Answered question	402		
Skipped question	6		
What would you do if a patient approached you with a high drug level?	Response Count	Response Percent	
Contact the head nurses	315	77.21%	
Investigate if the high drug level was known	199	48.77%	
Report the drug-level forms	115	28.19%	
Ask the patient to contact the doctor	9	2.21%	
Direct the patient to an emergency room	102	25.00%	
Document the high drug level in the patient's file	125	30.64%	
Recommend the patient to discontinue the drug with no further action	14	3.43%	
Answered question	408		
Skipped question	0		

The average score of practice items for Pharmacokinetics Services at the institution was (3.79). The “Mission of Pharmacokinetics Services system” obtained the highest score (4.00). The aspect “Pharmacokinetics services and education and training program” was (3.89), and the item

“The strategic plan of Pharmacokinetics services system” was (3.88). In contrast, the lowest score was obtained for “Pharmacokinetics services and research” (3.58). The score for the element “The annual plan of Pharmacokinetics services reaction ” was (3.72), and the aspect “ The vision of reporting Pharmacokinetics services system” was (3.76) with a statistically significant difference between the responses ( $p<0.000$ ). All aspects of the practice of pharmacists about practice items for Pharmacokinetics Services at the institution were statistically substantial between responses ( $p<0.000$ ) (Table 5). The score for single-test reliability analysis of McDonald's  $\omega$  was 0.905, Cronbach's  $\alpha$  was 0.900, Gutmann's  $\lambda_2$ , 0.904, Gutmann's  $\lambda_6$  was 0.921, and Greater Lower Bound was 0.954 with statistically significant ( $p<0.05$ ).

### Factors affecting the essential practice of Pharmacokinetics Services by the nurses at the institution

Factors affecting nurses' practice were analyzed. We adjusted the significant values using the independent samples Kruskal-Wallis test and the Bonferroni correction for multiple tests. The essential practice of Pharmacokinetics Services by the nurses at the institution includes Location, Site of work, Age (years), Nurse gender, and nurse qualification. Nurses' practice area, Years of experience, Position Held, Drug levels of pharmacokinetics services at the institution, Requiring any drug levels before, Number of drug levels requisition, Number of patients needed for drug levels services, Perception of drug levels services. One factor only (perception of drug level services) out of thirteen was statically significantly released ( $p<0.05$ ). The perception of drug-level services showed the lowest scores (2.1765), with statistically significant differences between regions ( $p=0.000$ ) (Table 6).

The relationship between the nurse's practice of some items for Pharmacokinetics Services at an institution and factors such as Location, Site of work, Age (years), Nurse gender, and nurse qualification. Nurses' practice area, Years of experience, Position Held, Drug levels of pharmacokinetics services at the institution, Requiring any drug levels before, Number of drug levels requisition, Number of patients needed for drug levels services, Perception of drug levels services. One

**Table 4: The medication you requested for blood level.**

	Always		Often		Sometimes		Rare		Never		Total	Weighted Average	p-value (X2)
Gentamicin	64.71%	264	23.28%	95	9.31%	38	1.47%	6	1.23%	5	408	4.49	0.000
Amikacin	30.10%	121	53.23%	214	11.94%	48	2.74%	11	1.99%	8	402	4.07	0.000
Vancomycin	38.12%	154	44.31%	179	14.85%	60	0.99%	4	1.73%	7	404	4.16	0.000
Theophylline	28.68%	115	46.13%	185	19.70%	79	2.00%	8	3.49%	14	401	3.95	0.000
Phenytoin	31.84%	128	43.53%	175	17.66%	71	4.23%	17	2.74%	11	402	3.98	0.000
Carbamazepine	30.08%	120	47.12%	188	16.54%	66	3.76%	15	2.51%	10	399	3.98	0.000
Valproic acid	32.25%	129	44.75%	179	16.50%	66	3.00%	12	3.50%	14	400	3.99	0.000
Phenobarbital	27.14%	108	41.96%	167	22.61%	90	5.28%	21	3.02%	12	398	3.85	0.000
Lithium	28.43%	114	41.40%	166	20.70%	83	5.99%	24	3.49%	14	401	3.85	0.000
Cyclosporine	22.22%	88	47.98%	190	23.48%	93	4.04%	16	2.27%	9	396	3.84	0.000
Tacrolimus	21.27%	84	47.85%	189	22.28%	88	4.81%	19	3.80%	15	395	3.78	0.000
Sirolimus	20.30%	81	47.62%	190	22.06%	88	5.01%	20	5.01%	20	399	3.73	0.000
Mycophenolate mofetil	22.64%	91	41.29%	166	26.37%	106	5.22%	21	4.48%	18	402	3.72	0.000
Methotrexate	24.88%	101	50.25%	204	15.76%	64	5.91%	24	3.20%	13	406	3.88	
Digoxin	51.50%	206	30.50%	122	12.00%	48	3.00%	12	3.00%	12	400	4.25	
Answered											408		
Skipped											0		

**Table 5: Do you have the following items for your institution's Pharmacokinetics services or drug levels?**

	76-100% implemented		51-75%		25-50%		< 25%		We do not have it		Total	Weighted Average	p-value (X2)
The vision of reporting Pharmacokinetics services system	23.02%	93	36.39%	147	35.15%	142	4.21%	17	1.24%	5	404	3.76	0.000
The mission of reporting Pharmacokinetics services system	26.62%	107	52.49%	211	16.42%	66	2.99%	12	1.50%	6	402	4.00	0.000
The strategic plan of the Pharmacokinetics services system	26.24%	106	44.56%	180	22.03%	89	5.20%	21	1.98%	8	404	3.88	0.000
The annual plan of Pharmacokinetics services reaction	14.14%	57	53.85%	217	24.81%	100	4.72%	19	2.48%	10	403	3.72	0.000
Policy and procedure of Pharmacokinetics services	20.20%	81	45.89%	184	28.18%	113	3.49%	14	2.25%	9	401	3.78	0.000
Pharmacokinetics services competency	16.17%	65	51.99%	209	25.37%	102	4.23%	17	2.24%	9	402	3.76	0.000
Pharmacokinetics services quality management	21.15%	85	45.27%	182	27.36%	110	3.98%	16	2.24%	9	402	3.79	0.000
Pharmacokinetics services and education and training program	21.63%	85	51.91%	204	20.87%	82	4.58%	18	1.02%	4	393	3.89	0.000
Pharmacokinetic services and medications errors system	17.81%	70	49.87%	196	26.46%	104	5.09%	20	0.76%	3	393	3.79	0.000
Pharmacokinetics services and adverse drug reactions system	17.05%	67	55.22%	217	21.63%	85	5.09%	20	1.02%	4	393	3.82	0.000
Pharmacokinetics services and patient satisfaction	18.11%	71	51.79%	203	22.45%	88	5.36%	21	2.30%	9	392	3.78	0.000
Pharmacokinetics services and research	13.67%	54	54.18%	214	16.20%	64	8.35%	33	7.59%	30	395	3.58	0.000
Answered											408		
Skipped											0		

factor only (perception of drug level services) out of thirteen was statically significantly released ( $p < 0.05$ ). The multiple regression analysis considered perception as the dependent variable and factors affecting it as an expletory variable. There was a weak relationship ( $R = 0.373$  with  $p = 0.000$ ) between the nurse's practice of Pharmacokinetics Services and its factors. One factor only (perception of drug level services) out of thirteen was statically significantly released ( $p < 0.05$ ). The multiple regression analysis confirmed that One factor only (perception of drug levels services) out of thirteen was statically significant had released ( $p < 0.05$ ) and explained 17.3% of the positive relationship to the variation in knowledge, with a statistically significant difference ( $p = 0.003$ ). The bootstrap model was also confirmed. Furthermore, the relationship was verified by the non-existence of multicollinearity with the One factor only (perception of drug levels services) with a Variance Inflation Factor (V.I.F.) of 1.407 less than three or five as a sufficient number of V.I.F. (Table 6).

### Factors affecting the essential practice of nurses' medication that requested blood level

Factors affecting nurses' practice were analyzed. We adjusted the significant values using the independent samples Kruskal-Wallis test and the Bonferroni correction for multiple tests. The essential practice of Pharmacokinetics Services by the nurses at the institution includes Location, Site of work, Age (years), Nurse gender, and nurse qualification. Nurses' practice area, Years of experience, Position Held, Drug levels of pharmacokinetics services at the institution, Requiring any drug levels before, Number of drug levels requisition, Number of patients needed for drug levels services, Perception of drug levels services. Four factors only (Age, The presence of Drug levels of pharmacokinetics services at the institution, Number of drug levels requisition, and Number of patients needed for drug levels services) out of thirteen were statically significant released ( $p < 0.05$ ). Of these four classes of age levels, class age

(24-35) years had the lowest level (3.6225), The presence of Drug levels of pharmacokinetics services at the institution had the highest scores (4.0388), Number of drug levels requisition with number (16-20) levels daily had highest scores (4.1095), and Number of patients needed for drug levels services (1-20) patients daily had the lowest score (3.9245) with statistically significant differences between each factor ( $p = 0.000$ ). (Table 7).

The relationship between the nurse's practice of nurses' medication requested for blood level, and factors include location, Site of work, Age (years), Nurse gender, and nurse qualification. Nurses' practice area, Years of experience, Position Held, Drug levels of pharmacokinetics services at the institution, Requiring any drug levels before, Number of drug levels requisition, Number of patients needed for drug levels services, Perception of drug levels services. Four factors only (Age, The presence of Drug levels of pharmacokinetics services at the institution, Number of drug levels requisition, and Number of patients needed for drug levels services) out of thirteen were statically significant released ( $p < 0.05$ ). The multiple regression analysis considered perception as the dependent variable and factors affecting it as an expletory variable. There was a medium relationship ( $R = 0.571$  with  $p = 0.000$ ) between the nurse's practice of nurses' medication that requested blood level and its factors. The multiple regression analysis confirmed that two factors only (Age and Number of patients needed for drug levels services) out of thirteen were statically significant and had released ( $p < 0.05$ ) explained 12.3% and 12.8%, respectively of the positive relationship to the variation practice of nurses' medication that requested for blood level, with a statistically significant difference ( $p = 0.011$ ) and ( $p = 0.006$ ) respectively. The bootstrap model was also confirmed. Furthermore, the relationship was verified by the non-existence of multicollinearity with the (Age and Number of patients needed for drug levels services,) with a variance inflation factor (V.I.F.) of .041 and .049, respectively less than three or five as a sufficient number of V.I.F. The multiple regression analysis confirmed

**Table 6: Multiple regression of Factors with the nurses' sectional practice about Pharmacokinetics Services**

Model	R	R Square	F	Sig.	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
					B	Std. Error				Beta	Lower Bound	Upper Bound	Tolerance
1	.373 <sup>b</sup>	.139	4.441	.000 <sup>b</sup>	1.989	.378		5.266	.000	1.246	2.731		
					-.015	.025	-.031	-.581	.561	-.064	.035	.860	1.162
					.016	.015	.057	1.083	.280	-.013	.045	.878	1.139
					.020	.044	.024	.442	.659	-.068	.107	.805	1.243
					.030	.056	.027	.545	.586	-.079	.140	.944	1.059
					-.252	.091	-.152	-2.774	.006	-.431	-.073	.800	1.250
					.010	.010	.052	1.041	.298	-.009	.029	.973	1.028
					-.016	.037	-.026	-.445	.657	-.088	.056	.730	1.370
					.019	.041	.026	.463	.643	-.062	.101	.780	1.282
					.236	.088	.165	2.687	.008	.063	.409	.641	1.559
					-.058	.114	-.034	-.511	.610	-.283	.166	.553	1.809
					.033	.014	.120	2.281	.023	.005	.061	.869	1.151
					-.047	.052	-.047	-.902	.368	-.149	.055	.872	1.146
					.332	.112	.173	2.972	.003	.112	.551	.711	1.407

a. Dependent Variable: Nurses' sectional practice about Pharmacokinetics services. Predictors: (Constant), including location, site of work, age (years), nurse gender, and nurse qualification. Nurses' practice area, Years of experience, Position Held, Drug levels of pharmacokinetics services at the institution, Requiring any drug levels before, Number of drug levels requisition, Number of patients needed for drug levels services, Perception of drug levels services.

**Bootstrap for Coefficients**

Model	B	Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
					Lower	Upper
1	1.989	.011	.508	.004	1.060	3.081
	-.015	-.002	.027	.585	-.073	.032
	.016	.000	.014	.268	-.015	.043
	.020	.000	.049	.707	-.078	.112
	.030	.003	.057	.603	-.076	.153
	-.252	-.013	.169	.133	-.620	.044
	.010	.000	.009	.294	-.009	.028
	-.016	-.002	.052	.741	-.113	.097
	.019	-.001	.047	.670	-.078	.112
	.236	-.012	.152	.119	-.089	.525
	-.058	.018	.168	.724	-.372	.312
	.033	.000	.017	.057	-.002	.066
	-.047	.002	.056	.375	-.164	.061
	.332	.019	.160	.027	.025	.648

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

**Table 7: Multiple regression of Factors with the nurses's medication that requested for blood level**

Model	Unstandardized Coefficients				Standardized Coefficients		t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta	t	Lower Bound	Upper Bound			Tolerance	V.I.F.		
1	(Constant)	.571 <sup>b</sup>	13.452	.000 <sup>b</sup>	4.634	.354	13.091	.000	3.938	5.330	4.634	.354
	Location				.052	.024	2.190	.029	.005	.098	.052	.024
	Site of work				.003	.014	.223	.824	-.024	.030	.003	.014
	Age (years)				.106	.041	2.562	.011	.025	.187	.106	.041
	Nurses gender				-.087	.052	-1.674	.095	-.190	.015	-.087	.052
	Nurses qualification				.097	.084	1.156	.249	-.068	.262	.097	.084
	Nurses practice area				-.002	.009	-.184	.854	-.019	.016	-.002	.009
	Years of experience in a medical career				-.034	.034	-1.005	.316	-.101	.033	-.034	.034
	Position Held				-.028	.039	-.727	.468	-.105	.048	-.028	.039
	The presence of Drug levels of pharmacokinetics services				-.433	.083	-5.221	.000	-.596	-.270	-.433	.083
	Requesting any drug levels before				-.171	.108	-1.584	.114	-.383	.041	-.171	.108
	Number of drug levels requisition				-.063	.014	-4.621	.000	-.090	-.036	-.063	.014
	Number of patients needed for drug levels of services				.136	.049	2.769	.006	.039	.233	.136	.049
	Perception of drug levels services				-.193	.105	-1.831	.068	-.400	.014	-.193	.105

a. Dependent Variable: Nurses nurses's medication you requested for blood level, Predictors: (Constant), Location, Site of work, Age (years), Nurse gender, Nurse qualification. Nurses' practice area, Years of experience, Position Held, Drug levels of pharmacokinetics services at the institution, Requiring any drug levels before, Number of drug levels requisition, Number of patients needed for drug levels services, Perception of drug levels services.

Model	Bootstrap for Coefficients					
	B	Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
					Lower	Upper
1	(Constant)	.005	.403	.001	3.866	5.440
	Location	-.001	.027	.060	.000	.107
	Site of work	-.001	.014	.816	-.025	.028
	Age (years)	.000	.043	.020	.015	.192
	Nurses gender	.003	.051	.091	-.184	.020
	Nurses qualification	-.003	.089	.278	-.078	.277
	Nurses practice area	-9.279E-05	.009	.826	-.019	.015
	Years of experience in a medical career	.001	.043	.439	-.116	.051
	Position Held	-.002	.035	.419	-.096	.042
	The presence of Drug levels of pharmacokinetics services	-.005	.165	.007	-.755	-.118
	Requesting any drug levels before	-.019	.230	.437	-.667	.248
	Number of drug levels requisition	.004	.016	.001	-.092	-.027
	Number of patients needed for drug levels of services	8.567E-05	.046	.007	.054	.234
	Perception of drug levels services	.017	.208	.341	-.579	.229

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

that two factors only (The presence of Drug levels of pharmacokinetics services at the institution and Number of drug levels requisition) out of thirteen were statically significant had released ( $p < 0.05$ ), explained 28.2%, 21.4% respectively of the negative relationship to the variation practice of nurses' medication that requested for blood level, with a statistically significant difference ( $p = 0.000$ ) and ( $p = 0.000$ ) respectively. The bootstrap model was also confirmed. Furthermore, the relationship was verified by the non-existence of multicollinearity with the (Age and Number of patients needed for drug levels services,) with a Variance Inflation Factor (V.I.F.) of .083 and .014, respectively less than three or five as a sufficient number of V.I.F. (Table 7).

## DISCUSSION

*Pharmacokinetic services* are very potential services that impact the patient clinically or economically.<sup>4</sup> The nursing staff plays an essential role. Pharmacokinetic services have the potential to impact patients clinically or financially. The nursing staff plays a critical role in the practice of the pharmacokinetics team. The knowledge of pharmacokinetics is the background of the practice. Assessing the nursing practice of pharmacokinetic services is vital and required to improve the pharmacokinetic services and related standards. The cross-sectional study calculated the number of samples better than previous physician study<sup>10</sup> and nursing study<sup>9</sup> with lower than other study,<sup>8</sup> convenience method of sampling, and high-reliability validation of the survey as previous physician study,<sup>10</sup> which gives an initial global picture of the nursing practice of pharmacokinetics services in Saudi Arabia resemble to previous non-nursing studies.<sup>10</sup> The survey respondents were from various regions; however, most were from the central and southern areas without apparent reason. Most respondents from M.O.H. hospitals related to the survey distributors have easy access to M.O.H. hospitals. The age distribution is statistically significant but not clinically significant in the practice. The age level was 35-45 years, which was an excellent sample to give the appropriate picture of the pharmacokinetic services. The nursing staff with more than four years of experience has the highest Number, which reflects an accurate practice picture of pharmacokinetic services. The nursing practice was good looks like previous physician study,<sup>10</sup> with a statistically significant distribution but not clinically significant. Most respondents had drug levels services and practiced it before, which had a good view of pharmacokinetics services.

The Number of drug levels requested averaged two and a half per patient daily, with a range of 1-10 drug level requirements like the previous physician study<sup>10</sup> and less than other pharmacy study.<sup>4</sup> That related to different perception of calculation of workload analysis. The pharmacy calculation might be more accurate due receive the precersption from all hospital sections. This high Number underscores the need for comprehensive pharmacokinetics services in each hospital. However, only half of the nursing staff sent the drug levels to the pharmacy using a form, indicating a potential lack of adherence to the policy and procedures of pharmacokinetics services or a lack of clear policies and procedures. Furthermore, one-third of them documented the drug level results in patients' profiles and the potential for medication interactions with drugs. The most medication were requested was Aminoglycoside, Digixin, and Vancomycin resemble to previous physician study<sup>10</sup> and pharmacy study.<sup>6</sup>

The average score of pharmacokinetic practice was acceptable, including the mission, strategy, and training program for pharmacokinetic services. However, it is crucial to note that surveys might overestimate this because only half needed to follow the policy and procedures. The weak points were the annual plan of pharmacokinetics services and unclear vision, which means the services will not improve like previous pharmacy study.<sup>5</sup> This underscores the importance of a clear vision and

a yearly plan. Furthermore, the research in pharmacokinetics had lower score of practice as previous physician studies<sup>8,10</sup> and and pharmacy study.<sup>6</sup> It could have been a more vital point in the services if presented. The lacking pharmacokinetics research due to unclear vision, and non-expert pharmacists in the field of pharmacokinetics services might have yet to be available. The only factor that might have affected the survey practice's positive practice is the perception of pharmacokinetics services consistent which was differed of previous physician study<sup>10</sup> with the results because they had various vital points of strategy, mission, and education programs. However, misconceptions of the benefits, outcomes, or impact of pharmacokinetics pharmacokinetics services lead to a lousy perception-besides, the absence of vision and an annual plan leads to a terrible perception of pharmacokinetics services practice.

There were various factors might affect the nursing of medication requesting drug levels, such as age and Number of patients needed for drug level, good age until 35 years, and Number of patients exceeding 1-20 patients daily improve the practice of nursing requesting the medication that's expected appropriate number patients needed of drug level and young nurses active might more requesting of drug levels. In contrast, a high workload might hurt drug levels in the range of 16-20, which is related to lousy perception and missing vision and the annual plan of pharmacokinetics services at health care organizations, there is no comparison previous studies.<sup>10</sup>

The practice of pharmacokinetics services is acceptable. However, various factors might reduce practice quality, such as a lousy perception of pharmacokinetics and poor clinical and economic documentation of pharmacokinetics impact. However, the potential for improvement is significant. A clear vision and an annual plan for pharmacokinetics services help the nursing practice of pharmacokinetics. By addressing these factors, we can significantly enhance the nursing practice of pharmacokinetics services at healthcare facilities in Saudi Arabia.

## LIMITATION

The cross-sectional study with calculated sample size and appropriate sample size provides very informative information about nursing practice pharmacokinetics services. However, there are some limitations involved in the study. For example, the sampling techniques were not randomized with a variety of responder characteristics. Overcoming all drawbacks with the future study is warned.

## CONCLUSION

The nursing practice of pharmacokinetics services is acceptable through cross-sectional surveys of practiced nursing among various healthcare organizations. Most nursing responders practice pharmacokinetics services with available services at hospital healthcare facilities. The strategies and mission of pharmacokinetics services are common findings. However, the annual planning of pharmacokinetics and clear vision for the future is unclear. The number of drug levels requested was high with various medications such as Gentamicin and Digoxin. Various factors might positively influence respondents' answers, such as Age and number of patients needed for drug-level services. During the presence of Drug levels of pharmacokinetics services at the institution, the number of drug levels requisition might affected negatively. The policy and procedures with practice standards should be reviewed thoroughly. Drug level utilization is an additional key performance indication warranted in nursing practice. Further research to monitor the nursing practice and improve pharmacokinetics is required at a healthcare organization in Saudi Arabia.

## ACKNOWLEDGEMENT

None.



## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## Funding

None

## 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 (I.R.B.) approval.

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

## ABBREVIATIONS

**MOH:** Ministry of Health; **K.S.A.:** Kingdom of Saudi Arabia; **SPSS:** Statistical Package of Social Sciences; **JASP:** Jeffery's Amazing Statistics Program; **STROBE:** Strengthening the Reporting of Observational studies in Epidemiology statement: guidelines for reporting observational studies; **VIF:** Variance Inflation Factor.

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