

Hemodialysis nurses' knowledge, attitude, and practices in managing vascular access

A cross-sectional study in Saudi Arabia

Enad Alsolami, MD^{a,*} , Sami Alobaidi, MD^a

Abstract

Hemodialysis continues to be the primary approach for renal replacement therapy. Vascular access (VA), particularly arteriovenous fistula or arteriovenous graft, is the preferred technique for establishing hemodialysis access due to its lower risk of infection and central venous stenosis compared to catheters. The aim of this cross-sectional investigation was to examine hemodialysis nurses' knowledge, confidence, and practices in managing VA in Saudi Arabia. This is an online cross-sectional survey study that was conducted in Saudi Arabia between June and August 2023. This study utilized a previously validated questionnaire. Examined dialysis nurses' knowledge, attitude, practice, and self-efficacy pertaining to VA cannulation and evaluation. Binary logistic regression analysis was used to identify predictors of better knowledge of dialysis VA. A total of 197 participants were involved in this study. Around one-third of the study participants (37.0%) reported that they have received specialized training in managing VA. Participants agreement (answered agree or strongly agree) on statements that examined attitudes toward dialysis VA cannulation and management was high and ranged between 75.0% and 93.0%. The majority of participants (97.5%) reported that they perform this assessment. Most nurses (65%) preferred the rope-ladder technique. Participants agreement on statements that examined self-efficacy on dialysis VA cannulation and management was high and ranged between 72.1% and 98.0%. The most commonly agreed upon statement was that "they have confident in performing hemodialysis access (arteriovenous fistula and arteriovenous graft) assessment before cannulation." With 98.0% (answered agree and strongly agree). The mean knowledge score for our study sample was 6.4 (SD: 2.0) out of 12 (53.3%); which reflects marginal-level of knowledge on dialysis VA. Binary logistic regression analysis identified that nurses who have undergraduate degree are 92% more likely to be knowledgeable on dialysis VA compared to others ($P < .05$). Concerning VA, the level of knowledge among hemodialysis nurses working in Saudi Arabia was inadequate. Nurses who hold an undergraduate degree are presumed to have a more extensive understanding of dialysis VA. Further education programs are necessary for HD nurses to enhance their knowledge of VA, thereby optimizing their professional practices and enhancing the outcomes for their patients.

Abbreviations: AVF = arteriovenous fistula, AVG = arteriovenous graft, HD = hemodialysis, SD = standard deviation, VA = vascular access.

Keywords: hemodialysis, knowledge, nurses, Saudi Arabia, vascular access

1. Introduction

Globally, there has been a notable rise in both the incidence and prevalence rates of individuals suffering from end-stage kidney disease.^[1] Hemodialysis (HD) remains the predominant method for renal replacement therapy.^[1] Vascular access (VA), specifically arteriovenous fistula (AVF) or arteriovenous graft (AVG), is the preferred method for establishing HD access due to its reduced risk of infection and central venous stenosis when compared to catheters.^[2,3] However, stenosis may occur spontaneously within the arteriovenous circuit, impacting its

functionality and patency.^[4-6] Several additional problems, such as severe infection or hematoma, could also potentially compromise the lifetime of the VA system.^[7,8]

There are several aspects that contribute to the longevity of VA, including the decision and technique used in surgery,^[9,10] the method of monitoring and surveillance,^[11] the self-care practices of patients, and the techniques used for cannulation.^[12,13] While there are other elements that contribute to the functioning of the VA, including those connected to patients and physicians, the nursing management within the VA assumes a crucial responsibility in ensuring its effective operation. Dialysis nurses

Informed consent was obtained from all subjects involved in the study.

The authors have no funding and conflicts of interest to disclose.

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

This study was approved by Bioethics Committee of Scientific and Medical Research at Jeddah University, Jeddah, Saudi Arabia (application number: UJ-REC-137).

^a Department of Internal Medicine, University of Jeddah, Jeddah, Saudi Arabia

* Correspondence: Enad Alsolami, Department of Internal Medicine, University of Jeddah, Jeddah, Saudi Arabia (e-mail: eaalsolami@uj.edu.sa).

Copyright © 2024 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial License 4.0 (CCBY-NC), where it is permissible to download, share, remix, transform, and buildup the work provided it is properly cited. The work cannot be used commercially without permission from the journal.

How to cite this article: Alsolami E, Alobaidi S. Hemodialysis nurses' knowledge, attitude, and practices in managing vascular access: A cross-sectional study in Saudi Arabia. *Medicine* 2024;103:13(e37310).

Received: 4 December 2023 / Received in final form: 15 December 2023 /

Accepted: 29 January 2024

<http://dx.doi.org/10.1097/MD.0000000000037310>

are healthcare professionals that closely oversee the administration of dialysis treatment to patients at the VA, typically on a biweekly or triweekly basis. The manner in which dialysis nurses monitor and manage the VA has the potential to impact the identification and progression of problems, eventually influencing the patency and longevity of the VA.^[13–15]

A prior research conducted in Singapore explored the knowledge, attitude, practice, and self-efficacy of dialysis nurses in relation to VA. The findings of the study revealed that the participants exhibited a satisfactory level of knowledge, while certain gaps in their understanding were detected.^[16] The study also showed a high level of self-efficacy and a positive attitude among nurses regarding the adoption of ultrasound in venous access cannulation within the VA setting.^[16] Insufficient data exists addressing the knowledge, attitude, practice, and self-efficacy of dialysis nurses in relation to VA management in the Middle East region, and specifically in Saudi Arabia. Assessing HD nurses' knowledge, attitude, practice in managing VA is important for patients' safety, complications prevention, efficient resources utilization, insuring the implementation of best practices for quality improvement, and for the achievement of optimal patient outcomes. The aim of this cross-sectional investigation was to examine hemodialysis nurses' knowledge, confidence, and practices in managing VA in Saudi Arabia.

2. Methods

2.1. Study design and settings

This is an online cross-sectional survey study that was conducted in Saudi Arabia between June and August 2023.

2.2. Study population

All nurses who are currently working in HD units in Saudi Arabia have formed the study population. The inclusion criteria were nurses who are currently working in HD units, practice VA within their practice settings, and practicing in Saudi Arabia. The exclusion criteria were nurses who are not currently working in HD units or those did not provide their consent to participate. The inclusion and exclusion criteria for the study population were mentioned in the cover letter of the questionnaire to enable participants who only meet the inclusion criteria to participate in the study.

2.3. Sampling strategy

This study utilized convenience sampling technique. The survey link was distributed to the target study population using social media platforms (WhatsApp), colleagues in the medical field, charges nurses in dialysis units, dialysis center directors. This sampling technique is a type of nonprobability sampling that helped us in recruiting the study participants in timely manner.

2.4. Study tool and data extraction

This study utilized a previously validated questionnaire by Meng et al^[16]; who examined dialysis nurses' knowledge, attitude, practice, and self-efficacy pertaining to VA cannulation and evaluation. The internal consistency coefficients demonstrated satisfactory reliability of the instrument. The KR-20 coefficient was 0.55 and 0.76 for the knowledge and practice domains, while Cronbach's α was 0.85 and 0.64 for the self-efficacy and attitude domains. The exploratory factor analysis revealed that the measure was able to explain 64.0% of the total variance in attitude and 53.0% of the total variance in self-efficacy.

The development of this was based on the framework of knowledge, attitude, practice, and self-efficacy.^[17–19] The self-efficacy domain assesses the perceptual abilities of individual

nurses in the specific field of VA management, as well as their confidence in carrying out specific tasks. The questionnaire comprised of demographic information (9 items), specific knowledge on VA (10 items), personal attitude toward VA care practices (6 items), usual practice (7 items), and self-efficacy in VA cannulation and management (6 items).

2.5. Ethical approval

This study was approved by Bioethics Committee of Scientific and Medical Research at Jeddah University, Jeddah, Saudi Arabia (Application number: UJ-REC-137).

2.6. Statistical analysis

The Statistical Package for Social Science Software, version 29 was used to analyze the data for this study. Categorical data were presented as frequencies and percentages. Continuous data were presented as mean and standard deviation (SD) for normally distributed data and median and interquartile range for nonnormally distributed data. Chi-square test was used to examine the difference in proportion between nurses who government versus private settings. Binary logistic regression analysis was used to identify predictors of better knowledge of dialysis VA. The mean knowledge score for the study sample was used to identify the dummy variable used in the regression analysis. A significant value of <0.05 was assigned for this study. Odds ratio for the logistic regression analysis was presented along with the 95% confidence interval.

3. Results

Table 1 presents the practice characteristics of the study participants. A total of 197 participants were involved in this study. More than half of the study participants (56.0%) were aged 30–39 years. The vast majority of the study participants (85.0%) were females. Around half of the study participants (52.0%) reported that they hold undergraduate degree and are nurse technician (53.0%). The majority of the study participants (81.0%) reported that they work at government inpatient and outpatient dialysis center. Around 44.0% of the study participants reported that they work at the Southern region of the country. The median years of service as a hemodialysis nurse was 9.0 years (interquartile range 5.0–15.0). Around one-third of the study participants (37.0%) reported that they have received specialized training in managing VA.

3.1. Participants' knowledge on dialysis VA

Table 2 presents the participants' responses to knowledge items on dialysis VA. The majority of participants (81.7%) correctly identified infection as a concern if part of a patient's fistula appeared swollen and red. When asked about the auscultation sign of high-grade stenosis, 33.5% of participants correctly identified a high-pitched sound with systolic components. Participants were shown pictures depicting different cannulation methods and were asked to indicate the correct method for each picture. The responses of participants who chose the correct response were as follows: picture 1: buttonhole method (77.2%), picture 2: rope-ladder method (85.3%), and picture 3: area method (53.9%). There were no statistically significant differences between the government and private groups for any of the pictures ($P > .05$).

About 60% of participants correctly responded false when asked if buttonhole cannulation could be used for AVF graft. Participants were asked to identify the disadvantage of using the area method for cannulation. The majority (72%) correctly identified aneurysmal change and skin erosion as the

Table 1
Participants' practice characteristics.

Variable	Categories	Full cohort (n = 197)	Government (n = 159)	Private (n = 38)
Age category, n (%)	20–29 yr	30 (15.0%)	21 (70.0%)	9 (30.0%)
	30–39 yr	110 (56.0%)	92 (83.6%)	18 (16.4%)
	40–49 yr	42 (21.0%)	35 (83.3%)	7 (16.6%)
	50–59 yr	15 (8.0%)	11 (73.3%)	4 (26.6%)
Gender, n (%)	Male	28 (14.0%)	23 (82.1%)	5 (17.8%)
	Female	169 (85.0%)	136 (80.4%)	33 (19.5%)
Educational level, n (%)	Diploma	89 (45.0%)	77 (86.5%)	12 (13.4%)
	Undergraduate degree	103 (52.0%)	78 (75.7%)	25 (24.3%)
	Postgraduate degree	5 (3.0%)	4 (80.0%)	1 (20.0%)
Designation, n (%)	Nurse technician	105 (53.0%)	83 (79.0%)	22 (20.9%)
	Nurse specialist	90 (46.0%)	75 (83.3%)	15 (16.6%)
	Nurse senior specialist	2 (1.0%)	1 (50.0%)	1 (50.0%)
Primary Practice setting, n (%)	Government inpatient dialysis unit	81 (41.0%)		
	Government (or government-affiliated) outpatient dialysis center	78 (40.0%)		
	Private inpatient dialysis unit	10 (5.0%)		
	Private outpatient dialysis center	28 (14.0%)		
Region of working in KSA	Central	18 (9.0%)	11 (61.0%)	7 (38.8%)
	Western	46 (23.0%)	29 (63.0%)	17 (36.9%)
	Northern	41 (21.0%)	34 (82.9%)	7 (17.0%)
	Eastern	5 (3.0%)	2 (40.0%)	3 (60.0%)
	Southern	87 (44.0%)	83 (95.4%)	4 (4.6%)
Years of service as a hemodialysis nurse, median (Interquartile range)		9.0 (5.0–15.0)	10.0 (5.0–15.0)	8.0 (5.0–15.0)
Specialised training, n (%)	Yes	73 (37.0%)	61 (83.5%)	12 (16.4%)
Source of training in dialysis access				
Society meeting, n (%)	Yes	16 (5.0%)	12 (7.0%)	4 (10.0%)
Live conference, n (%)	Yes	36 (11.0%)	28 (18.0%)	8 (21.0%)
Simulated training, n (%)	Yes	60 (19.0%)	53 (33.0%)	7 (18.0%)
Online resource, n (%)	Yes	40 (12.0%)	35 (22.0%)	5 (13.0%)
On job training, n (%)	Yes	172 (53.0%)	140 (88.0%)	32 (84.0%)

disadvantage. When asked about the correct amount of pressure to apply on a cannulation site after needle removal, the majority (78.7%) chose the response “Light, just enough to stop bleeding.” Only 23.8% of participants correctly chose “Access venous outflow stenosis” when presented with potential causes of difficult hemostasis over needling sites postdialysis.

3.2. Attitudes toward dialysis VA cannulation and management

Table 3 presents the participants' attitudes toward dialysis VA cannulation and management. The responses are categorized based on the Likert scale, ranging from “Strongly disagree” to “Strongly agree.” Participants agreement (answered agree or strongly agree) on statements that examined attitudes toward dialysis VA cannulation and management was high and ranged between 75.0% and 93.0%. The most commonly agreed upon statements that examined participants' attitudes toward dialysis VA cannulation and management was that “they have good understanding of the anatomy of the VA (various AVF and AVG) and they had sufficient training and supervision in my early dialysis nurse career before performing actual cannulation.” with 93.0%. The least commonly agreed upon statement was that “they in their current practice, the communication between hospital care and community dialysis center is efficient” with 75.0%.

3.3. Practices on dialysis VA cannulation and management

Table 4 presents the participants' practices regarding dialysis VA cannulation and management and its association with working setting. Participants were asked about their practice of assessing the VA and surrounding area prior to every cannulation. The majority of participants (97.5%) reported that they perform this assessment. Most nurses (65%) preferred

the rope-ladder technique, followed by buttonhole (18.3%), and area (14.7%) techniques. Similar percentages were found in their preferred cannulation technique for existing AVGs. Fifty-six percent reported that they always perform cannulation planning. Participants were asked whether physicians (vascular surgeon/nephrologist) assist with cannulation. A higher percentage of participants in the private sector (42.1%) reported that a vascular surgeon assists with cannulation compared to the government sector (19.5%, $P = .002$).

3.4. Participants' self-efficacy on dialysis VA cannulation and management

Table 5 presents the participants' self-efficacy on dialysis VA cannulation and management. Participants agreement on statements that examined self-efficacy on dialysis VA cannulation and management was high and ranged between 72.1% and 98.0%. The most commonly agreed upon statement was that “they have confident in performing HD access (AVF and AVG) assessment before cannulation.” With 98.0% (answered agree and strongly agree). The least commonly agreed upon statement was that “they have confident in creating buttonhole” with (72.1%).

3.5. Predictors of participants' knowledge on dialysis VA

The mean knowledge score for our study sample was 6.4 (SD: 2.0) out of 12 (53.3%); which reflects marginal-level of knowledge on dialysis VA. Binary logistic regression analysis identified that nurses who have undergraduate degree are 92% more likely to be knowledgeable on dialysis VA compared to others ($P < .05$). On the other hand, nurses who practice in the southern region were less likely to be knowledgeable on dialysis VA compared to others ($P < .05$, Table 6).

Table 2
Participants' knowledge on dialysis vascular access (N = 197).

Question	Correct response	Full cohort	Government	Private	P-value
		n (%)	n (%)	n (%)	
1. What should your concern be if part of a patient's fistula looks swollen and red?	Infection	161 (81.7)	132 (83)	29 (76.3)	0.49
2. During auscultation, which is a sign of high-grade stenosis?	High pitched with systolic components	66 (33.5)	53 (33.3)	13 (34.2)	0.59
3. Please indicate the cannulation methods shown in the pictures below:					
3.1. Picture 1	Buttonhole	152 (77.2)	123 (77.4)	29 (76.3)	0.87
3.2. Picture 2	Rope-ladder	168 (85.3)	143 (84.3)	34 (89.5)	0.75
3.3. Picture 3	Area	124 (53.9)	96 (60.4)	28 (73.7)	0.12
4. Buttonhole cannulation can be used for arteriovenous fistula graft (AVG).	False	117 (59.4)	97 (61)	20 (52.6)	0.29
5. What is the disadvantage of using area method to cannulate?	Aneurysmal change and skin erosion	142 (72)	116 (72.9)	26 (68.4)	0.38
6. What is the correct amount of pressure to hold on a cannulation site after removing the needle?	Light, just enough to stop bleeding	155 (78.7)	122 (76.7)	33 (86.8)	0.41
7. What could be the cause(s) of difficult haemostasis over needling sites postdialysis?	Access venous outflow stenosis	47 (23.8)	39 (24.5)	8 (21)	0.65
8. Which of the following is well-known complication(s) relating to a pseudoaneurysm in a dialysis access?	Rupture	93 (47.2)	77 (48.4)	16 (42.1)	0.02
9. Clinical evaluation of a hemodialysis access before cannulation includes: (multiple answers question)					
	Inspection	152 (27)	123 (28)	29 (27)	0.012
	Palpation for thrill and pulsation	191 (35)	154 (34)	37 (35)	0.013
	Auscultation	146 (26)	118 (27)	28 (26)	0.01
	Arm elevation	63 (12)	50 (11)	13 (12)	0.01
10. What could be the cause for high recirculation?	Significant outflow obstruction	80 (19)	69 (20)	11 (16)	0.09
	A needle and V needle too close	170 (41)	137 (40)	33 (49)	0.88

AVG = arteriovenous fistula graft.

Table 3
Participants' attitude toward dialysis vascular access cannulation and management (N = 197).

Items	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. I have good understanding of the anatomy of the vascular access (various AVF and AVG).	0	0	6.0%	50.0%	43.0%
2. I had sufficient training and supervision in my early dialysis nurse career before performing actual cannulation.	0.5%	1.5%	5.0%	43.0%	50.0%
3. The use of ultrasound-guided cannulation would be helpful in facilitating cannulation.	0	3.0%	10.0%	47.0%	40.0%
4. Diagrammatic illustration of anatomy of HD access and suggested needling sites from access surgeon is helpful.	0	0.5%	6.5%	48.0%	45.0%
5. In your current practice, the communication between hospital care and community dialysis center is adequate.	0	3.0%	21.0%	50.0%	26.0%
6. In your current practice, the communication between hospital care and community dialysis center is efficient.	0	5.0%	20.0%	48.0%	27.0%

AVF = arteriovenous fistula, AVG = arteriovenous graft, HD = hemodialysis.

4. Discussion

Hemodialysis requires adequate blood flow to the dialyzer in order to address issues related to volume, waste products, and electrolyte imbalances. Establishing VA for hemodialysis is a crucial clinical procedure for patients undergoing this treatment, and it is essential for clinicians to implement a VA management plan to ensure optimal patient care outcomes.^[20] Additionally, nurses play a significant role in the VA management process as they are responsible for applying their professional knowledge and technology in clinical practice, as well as educating and motivating patients to take care of their VA. Effective preservation of VA necessitates a strong collaboration between healthcare providers and patients.^[21] Consequently, the objective of this study was to evaluate the level of knowledge, confidence, and practical skills in the management of VA among hemodialysis nurses in Saudi Arabia.

Within the cohort of participants under investigation, approximately one-third (37.0%) reported having received specialized training in the management of VA. Notably, this specialized training was found to have a significant impact on the knowledge of hemodialysis nurses with regards to VA management. Specifically, nurses working in the hemodialysis unit who had undergone training related to VA demonstrated markedly higher overall scores in their knowledge of VA compared to those who had not participated in such training activities.^[22] Furthermore, established guidelines recommend that comprehensive and specialized training is crucial for all medical personnel involved in the management of VA for hemodialysis patients. Additionally, these guidelines advocate for the implementation of ongoing training programs within hemodialysis units that specifically focus on the management of VA.^[2,22,23]

Table 4
Participants' practice on dialysis vascular access cannulation and management (N = 197).

Question response	Full cohort	Government	Private	P-value
	n (%)	n (%)	n (%)	
1. I do assessment of vascular access and surrounding area: Prior to every cannulation	192 (97.5%)	156 (98.1%)	36 (94.7%)	0.250
2. My preferred cannulation technique for existing AVF is:				0.930
Rope-ladder	128 (65.0%)	102 (64.4%)	26 (68.4%)	
Buttonhole	36 (18.3%)	30 (18.8%)	6 (15.7%)	
Area	29 (14.7%)	24 (15.0%)	5 (13.1%)	
3. My preferred cannulation technique for existing AVG is:				0.670
Rope-ladder	136 (69.0%)	111 (69.9%)	25 (65.7%)	
Buttonhole	38 (19.3%)	31 (19.6%)	7 (18.6%)	
Area	23 (11.7%)	17 (10.5%)	6 (15.7%)	
4. I do cannulation planning for new AVGs and newly matured AVFs:				0.060
Always	128 (65.0%)	98 (61.6%)	30 (78.9%)	
Occasional	62 (31.5%)	56 (35.2%)	6 (15.8%)	
Never	7 (3.5%)	5 (3.2%)	2 (5.3%)	
5. Did physicians (vascular surgeon/nephrologist) assist with cannulation (if applicable)?				0.002**
Vascular surgeon	47 (23.8%)	31 (19.5%)	16 (42.1%)	
Nephrologist	59 (29.9%)	48 (30.2%)	11 (28.9%)	
NO	86 (43.6%)	76 (47.8%)	10 (26.5%)	
No physician	5 (2.4%)	4 (2.5.0%)	1 (2.6%)	
6. I understand vascular maintenance and evaluation. I suspect abnormalities and refer patients to the doctors/hospital nurse specialist when (select all applicable):				
Access flow < 600 mL/min	58 (29.0%)	47 (30.0%)	11 (28.0%)	0.940
Kt/v < 1.4	67 (34.0%)	60 (38.0%)	7 (18.0%)	0.300
Excessive AP/VP value	116 (58.0%)	95 (60.0%)	21 (55.0%)	0.670
Poor thrill	187 (95.0%)	150 (94.0%)	37 (97.0%)	0.470
Pulsation	86 (44.0%)	76 (48.0%)	10 (26.0%)	0.190
Blood clot in the tubing	121 (61.0%)	102 (64.0%)	19 (50.0%)	0.250
Redness of the HD access	166 (84.0%)	134 (84.0%)	32 (84.0%)	1
Pain of the ipsilateral hand with HD access	154 (78.0%)	126 (79.0%)	28 (74.0%)	0.560
7. I routinely conduct education of the following aspect(s) to dialysis patients (select all applicable):				
Vascular access terminology	75 (38.0%)	57 (36.0%)	18 (47.0%)	0.410
Daily essential care	161 (82.0%)	128 (80.0%)	33 (87.0%)	0.350
Hand exercise	164 (83.0%)	129 (81.0%)	35 (92.0%)	0.120
Vascular access cleaning before dialysis	158 (80.0%)	129 (81.0%)	29 (76.0%)	0.540
Complications associated with dialysis access	168 (85.0%)	134 (84.0%)	34 (89.0%)	0.470
Complications need to seek medical attention	156 (79.0%)	125 (79.0%)	31 (81.0%)	1
None	2 (1.0%)	2 (1.0%)	0.0%	1

AP = arterial pressure, AVF = arteriovenous fistula, AVG = arteriovenous graft, HD = hemodialysis, VP = venous pressure.

**P < .01.

Table 5
Participants' self-efficacy on dialysis vascular access cannulation and management.

Variable	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am confident in performing HD access (AVF and AVG) assessment before cannulation.	0.0%	0.5%	1.5%	30.5%	67.5%
I am confident in cannulating newly created AVG	0.5%	4.1%	16.2%	33.5%	45.7%
I am confident in cannulating newly created and matured AVF	0.0%	1.5%	12.2%	39.6%	46.7%
I am confident in cannulating existing in-use AVF	1.0%	0.5%	4.6%	33.0%	60.9%
I am confident in managing cannulation related complications (e.g., infiltration, infection, hematoma, thrombosis, etc)	0.5%	1.5%	9.6%	45.2%	43.1%
I am confident in creating buttonhole	0.5%	6.6%	20.8%	43.7%	28.4%

AVF = arteriovenous fistula, AVG = arteriovenous graft, HD = hemodialysis. All items subject to missing data from 3 participants.

The findings of the study indicate that a significant proportion of participants (81.7%) demonstrated accurate recognition of infection as a potential issue when observing swelling and redness in a patient's fistula. Furthermore, when asked about the auscultation sign of high-grade stenosis, 33.5% of participants correctly identified a high-pitched sound with systolic components. In comparison, a study conducted in Singapore reported that only 25.7% of their participants were able to correctly identify this specific auscultation sign.^[16] It is worth noting that VA infections pose a significant concern in hemodialysis patients,

as they exhibit a considerable incidence and are associated with various risk factors.

Approximately 60% of the individuals included in our study provided an accurate response of "false" when queried about the suitability of buttonhole cannulation for AVG. It was observed that buttonhole cannulation is more frequently employed in the context of home hemodialysis. However, it is important to note that buttonhole cannulation poses significant and severe infectious risks to patients undergoing hemodialysis, particularly in a home environment.^[24,25] Furthermore, the utilization

Table 6
Predictors of participants' knowledge on dialysis vascular access.

Variable	Categories	Odds ratio of being more knowledgeable (95% confidence interval)	P-value
Age category	20–29 yr (reference group)	1.00	
	30–39 yr	1.25 (0.55–2.85)	0.590
	40–49 yr	1.49 (0.58–3.86)	0.411
	50–59 yr	1.85 (0.52–6.55)	0.343
Gender	Female (reference group)	1.00	
	Male	1.32 (0.59–2.95)	0.503
Educational level	Diploma (reference group)	1.00	
	Undergraduate degree	2.04 (1.15–3.63)	0.015*
	Postgraduate degree	2.11 (0.34–13.25)	0.426
Designation	Nurse technician (reference group)	1.00	
	Nurse specialist	0.68 (0.39–1.19)	0.178
	Nurse senior specialist	–	
Primary practice setting	Government inpatient dialysis unit (reference group)	1.00	
	Government (or government-affiliated) outpatient dialysis center	0.76 (0.41–1.42)	0.389
	Private inpatient dialysis unit	0.53 (0.14–2.04)	0.357
	Private outpatient dialysis center	0.80 (0.34–1.89)	0.611
Region of working in KSA	Central (reference group)	1.00	
	Western	0.60 (0.18–1.97)	0.397
	Northern	0.37 (0.11–1.22)	0.101
	Eastern	0.10 (0.01–1.08)	0.058
	Southern	0.31 (0.10–0.95)	0.041*
Years of service as a hemodialysis nurse	<9 yr (reference group)	1.00	
	9 yr and more	0.86 (0.49–1.51)	0.595
Specialised training	No (reference group)	1.00	
	Yes	0.62 (0.35–1.11)	0.110

*P < .05

of buttonhole cannulation necessitates additional support from staff.^[26] Additionally, it was determined that buttonhole cannulation is not appropriate for AVF graft procedures.^[27]

In the present investigation, participants were requested to discern the drawback associated with employing the area method for cannulation. The majority of participants (72%) correctly identified aneurysmal change and skin erosion as disadvantages. Similarly, in a study conducted in Singapore, 82.6% of the participants were able to accurately identify the disadvantages of the area method for cannulation.^[16] This study confirmed that noncompliance with the area technique can result in aneurysmal deformation and skin pigmentation.^[28] Furthermore, when comparing the area method with other techniques, it was found that the buttonhole method offers easier cannulation and fewer instances of unsuccessful attempts, while the area method was associated with a higher risk of access failure.^[29,30]

Furthermore, during the survey, participants were queried regarding the appropriate level of pressure to be exerted on a cannulation site subsequent to needle removal. A significant majority (78.7%) of respondents indicated that the optimal approach is to apply “light pressure, sufficient to halt bleeding..” It is worth noting that pressure is typically employed on the site of cannulation in instances where bleeding occurs. It is recommended to maintain pressure for a duration of 5 minutes subsequent to needle removal.^[31] However, if blood is observed seeping through the gauze, it is advised to reapply pressure until there is no discernible presence of fresh blood at the cannulation site. This methodology was employed to ascertain the achievement of hemostasis subsequent to needle removal.^[31] Furthermore, it is worth noting that only 23.8% of the participants accurately identified “Access venous outflow stenosis” as a potential cause of challenging hemostasis over needling sites after dialysis. This condition, characterized by the narrowing of the venous pathway, is often caused by venous intimal hyperplasia, which can be influenced by various factors including

surgical trauma and hemodynamic shear stress.^[32] The presence of such stenosis can give rise to complications such as AVF aneurysms, which frequently necessitate percutaneous angioplasty to enhance blood outflow.^[33] Additionally, it has been observed that hemodynamic changes resulting from altered access flow can lead to venous hypertension, arterial steal syndrome, and high-output cardiac failure.^[34]

The findings of this study indicate that a majority of participants expressed a high level of understanding regarding the anatomy of VA for dialysis, including AVF and AVG. Furthermore, participants reported receiving adequate training and supervision in the early stages of their careers as dialysis nurses prior to performing cannulation procedures.^[22] This highlights the crucial role of specialized training for hemodialysis nurses, as emphasized by 93.0% of participants. Additionally, the study revealed a notable positive attitude toward the cannulation and management of dialysis VA. However, the participants expressed significant concern regarding the communication between hospital care and community dialysis centers. The statement that received the least agreement was that the current communication between hospital care and community dialysis centers is efficient, with only 75.0% agreement. This finding emphasizes the variability in the quality of communication and the potential for adverse events due to inadequate communication.^[35] It also underscores the importance of ongoing adaptation and problem-solving in dialysis care, as these efforts may have a positive impact on communication.^[36]

The results of the study indicated that a significant majority (97.5%) of participants reported incorporating routine assessment of the VA and its surrounding area before each cannulation into their practice. This finding is consistent with a study conducted in Singapore, where 94.1% of participants reported performing VA assessment prior to every cannulation.^[16] Additionally, 93.9% of participants in the Singapore study reported using the rope-ladder method as their preferred cannulation technique for AVGs.^[16] Similarly, our surveyed nurses

also exhibited a preference for the rope-ladder technique, with 65% reporting this as their preferred method. The buttonhole technique was preferred by 18.3% of nurses, while the area technique was preferred by 14.7% of nurses. Comparable proportions were noted in their preferred method of cannulation for preexisting AVGs. Specifically, the rope-ladder technique has been the favored approach for cannulating AVFs in hemodialysis patients.^[37] However, buttonhole cannulation has emerged as a viable and secure alternative to the established gold-standard technique.^[38] Furthermore, when comparing the area method with buttonhole cannulation, it was found that the buttonhole method facilitates easier cannulation and is linked to a reduced occurrence of unsuccessful attempts.^[29,30] Furthermore, within the scope of our research, the individuals involved demonstrated a notable degree of concurrence with the statements used to evaluate their self-efficacy in the areas of dialysis VA cannulation and maintenance. The agreement levels ranged from 72.1% to 98.0%. The statement that received the highest level of agreement, with 98.0% of respondents indicating agreement or strong agreement, was related to the confidence in performing HD access (AVF and AVG) assessment before cannulation. On the other hand, the statement that received the lowest level of agreement, with 72.1% of respondents indicating agreement, was related to the confidence in creating a buttonhole. It is worth noting that when comparing the self-efficacy scores to a previous study conducted in Singapore, participants in our study also demonstrated a high level of self-efficacy in dialysis vascular cannulation and management, as well as confidence in performing HD access (AVF and AVG) assessment before cannulation. However, the lower level of confidence observed in creating a buttonhole may be attributed to the specialized skill set required for this procedure, which typically takes several weeks to master.^[16] The procedure entails the repeated cannulation of AVFs between 6 to 9 instances, while ensuring a consistent location and angle. This process is carried out by a single nurse with the aim of establishing the tunnel.^[25,39]

The findings of the study revealed that the average knowledge score for the sample population was 6.4 out of 12 (53.3%), indicating a moderate level of knowledge regarding dialysis VA. This result is consistent with a previous study conducted in Singapore.^[16] Various factors, such as experience and specialized training,^[15,40] have been identified as influential contributors to the knowledge score among participants. It is worth noting that an increase in years of expertise, coupled with appropriate and specialized training on dialysis VA, is likely to significantly enhance the knowledge score. In the present investigation, a binary logistic regression analysis was conducted to ascertain the association between nurses' educational attainment and their knowledge on dialysis VA. The results revealed that nurses with an undergraduate degree exhibited a 92% higher likelihood of possessing knowledge on this subject, in comparison to their counterparts. Additionally, it was observed that medical staff had greater access to training opportunities and a wider range of resources for acquiring knowledge pertaining to VA. Consequently, individuals in this group exhibit a heightened level of knowledge regarding VA.^[41] In contrast, nurses practicing in the southern region had a lower level of knowledge regarding dialysis VA compared to their counterparts. This disparity can be attributed to variations in management policies and nursing practices.^[22]

Based on our study findings we suggest several recommendations for improving VA management among hemodialysis nurses in Saudi Arabia. These include giving priority to specialized training programs, implementing ongoing training initiatives focused on VA management, and addressing knowledge gaps related to complications and proper cannulation techniques. It is crucial to prioritize avoiding buttonhole cannulation for AVF grafts due to the significant risks of infection. Improving the communication between hospitals and community dialysis clinics is extremely important.

This requires implementing ways to increase nurses' trust and self-assurance, particularly in specialized skills like buttonhole installation. Developing training programs that consider the educational backgrounds of nurses and address regional variations can significantly improve understanding and facilitate the implementation of appropriate practices in the dialysis VA setting. This study has limitations. The use of convenience sampling technique might have affected the generalisability of our study findings. The cross-sectional study design restricted our ability to examine causality among the study variables. Self-administered questionnaire study design is susceptible for social desirability bias. Selection bias is another type of bias that is common among survey studies that employ convenience sampling technique, however, considering multiple data collection channels in our study minimized the possibility of this type of bias. Therefore, our findings should be interpreted carefully.

5. Conclusion

The level of knowledge among HD nurses in Saudi Arabia regarding VA was limited. Nurses with an undergraduate degree are more likely to possess a higher level of knowledge regarding dialysis VA. Additional training programs are required for HD nurses to expand their understanding of VA, which will ultimately optimize their professional practices and improve patients' outcomes.

Author contributions

Conceptualization: Enad Alsolami, Sami Alobaidi.

Data curation: Enad Alsolami, Sami Alobaidi.

Formal analysis: Enad Alsolami, Sami Alobaidi.

Funding acquisition: Enad Alsolami, Sami Alobaidi.

Investigation: Enad Alsolami, Sami Alobaidi.

Methodology: Enad Alsolami, Sami Alobaidi.

Project administration: Enad Alsolami, Sami Alobaidi.

Resources: Enad Alsolami, Sami Alobaidi.

Software: Enad Alsolami, Sami Alobaidi.

Supervision: Enad Alsolami, Sami Alobaidi.

Validation: Enad Alsolami, Sami Alobaidi.

Visualization: Enad Alsolami, Sami Alobaidi.

Writing – original draft: Enad Alsolami, Sami Alobaidi.

Writing – review & editing: Enad Alsolami, Sami Alobaidi.

References

- [1] Thurlow JS, Joshi M, Yan G, et al. Global epidemiology of end-stage kidney disease and disparities in kidney replacement therapy. *Am J Nephrol.* 2021;52:98–107.
- [2] Lok CE, Huber TS, Lee T, et al.; National Kidney Foundation. KDOQI clinical practice guideline for vascular access: 2019 Update. *Am J Kidney Dis.* 2020;75(4 Suppl 2):S1–S164.
- [3] Yevzlin AS. Hemodialysis catheter-associated central venous stenosis. *Semin Dial.* 2008;21:522–7.
- [4] Al-Jaishi AA, Oliver MJ, Thomas SM, et al. Patency rates of the arteriovenous fistula for hemodialysis: a systematic review and meta-analysis. *Am J Kidney Dis.* 2014;63:464–78.
- [5] Halbert RJ, Nicholson G, Nordyke RJ, et al. Patency of ePTFE arteriovenous graft placements in hemodialysis patients: systematic literature review and meta-analysis. *Kidney360.* 2020;1:1437–46.
- [6] Hussein WF, Mohammed H, Browne L, et al. Prevalence and correlates of central venous catheter use among haemodialysis patients in the Irish health system - a national study. *BMC Nephrol.* 2018;19:1–9.
- [7] Al-Jaishi AA, Liu AR, Lok CE, et al. Complications of the arteriovenous fistula: a systematic review. *J Am Soc Nephrol.* 2017;28:1839–50.
- [8] Johny SPB, Pawar B. Complications of arteriovenous fistula for haemodialysis access. *Int Surg J.* 2018;5:439–44.
- [9] Thomas M, Nesbitt C, Ghouri M, et al. Maintenance of hemodialysis vascular access and prevention of access dysfunction: a review. *Ann Vasc Surg.* 2017;43:318–27.

- [10] Tordoir JH, van Loon MM, Peppelenbosch N, et al. Surgical techniques to improve cannulation of hemodialysis vascular access. *Eur J Vasc Endovasc Surg.* 2010;39:333–9.
- [11] Tessitore N, Poli A. Pro: vascular access surveillance in mature fistulas: is it worthwhile? *Nephrol Dial Transplant.* 2019;34:1102–6.
- [12] Costa Pessoa NR, de Souza Soares Lima LH, Dos Santos GA, et al. Self-care actions for the maintenance of the arteriovenous fistula: an integrative review. *Int J Nurs Sci.* 2020;7:369–77.
- [13] Parisotto MT, Pelliccia F, Grassmann A, et al. Elements of dialysis nursing practice associated with successful cannulation: result of an international survey. *J Vasc Access.* 2017;18:114–9.
- [14] Qin HY, Jia P, Liu H. Nursing strategies for patients with chronic renal failure undergoing maintenance hemodialysis treatment by arteriovenous fistula. *Iran J Public Health.* 2016;45:1270–5.
- [15] Wilson B, Harwood L, Oudshoorn A, et al. The culture of vascular access cannulation among nurses in a chronic hemodialysis unit. *CANNT J.* 2010;20:35–42.
- [16] Meng L, Guo W, Lou L, et al. Dialysis nurses' knowledge, attitude, practice and self-efficacy regarding vascular access: a cross-sectional study in Singapore. *J Vasc Access.* 2023;27:11297298231162766.
- [17] Ariffin F, Ahmad-Roslan AM, Isa MR, et al. Development and validation of the Self-efficacy, Knowledge, Attitude and Practice towards Environmental Tobacco Smoke (SE-KAP-ETSQ) in the Malay language for mothers with children below 6 years old. *IJUM Med J Malaysia.* 2022;21:96–108.
- [18] Goodarzi M, Ebrahimzadeh I, Rabi A, et al. Impact of distance education via mobile phone text messaging on knowledge, attitude, practice and self efficacy of patients with type 2 diabetes mellitus in Iran. *J Diabetes Metab Disord.* 2012;11:10.
- [19] Wang L, Liang C, Yu H, et al. Reliability and validity evaluation of the appropriate antibiotic use self-efficacy scale for Chinese adults. *BMC Public Health.* 2022;22:1–15.
- [20] Duval L. Quality improvement project: hemodialysis vascular access management trends report. *J Ark Med Soc.* 2012;109:36–7.
- [21] Bai YL, Hung SY, Chiou CP. [Vascular access management and education for hemodialysis patients]. *Hu Li Za Zhi = J Nurs.* 2014;61:93–8.
- [22] Chen H, Chen L, Zhang Y, et al. Knowledge of vascular access among hemodialysis unit nurses and its influencing factors: a cross-sectional study. *Ann Palliat Med.* 2022;11:3494–502.
- [23] Zhang H, Lu H, Li W, et al.; Expert Group of Nephrology Branch of China Academy of Chronic Disease Urology Nephrology and Blood Purification Commission of China Medical Education Association. Expert consensus on the establishment and maintenance of native arteriovenous fistula. *Chronic Dis Translat Med.* 2021;7:235–53.
- [24] MacRae JM. Should buttonhole cannulation of arteriovenous fistulas be used? CON. *Kidney360.* 2020;1:322–5.
- [25] Nadeau-Fredette AC, Johnson DW. Con: buttonhole cannulation of arteriovenous fistulae. *Nephrol Dialysis Transplant.* 2016;31:525–8.
- [26] Muir CA, Kotwal SS, Hawley CM, et al. Buttonhole cannulation and clinical outcomes in a home hemodialysis cohort and systematic review. *Clin J Am Soc Nephrol.* 2014;9:110–9.
- [27] Labriola L. Should buttonhole cannulation of arteriovenous fistulas be used? PRO. *Kidney360.* 2020;1:318–21.
- [28] Pinto R, Ferreira E, Sousa C, et al. Skin pigmentation as landmark for arteriovenous fistula cannulation in hemodialysis. *J Vasc Access.* 2023;11297298231193477:1–11.
- [29] Parisotto MT, Schoder VU, Miriunis C, et al. Cannulation technique influences arteriovenous fistula and graft survival. *Kidney Int.* 2014;86:790–7.
- [30] Verhallen AM, Kooistra MP, van Jaarsveld BC. Cannulating in haemodialysis: rope-ladder or buttonhole technique? *Nephrol Dialysis Transplant.* 2007;22:2601–4.
- [31] Wong B, Muneer M, Wiebe N, et al. Buttonhole versus rope-ladder cannulation of arteriovenous fistulas for hemodialysis: a systematic review. *Am J Kidney Dis.* 2014;64:918–36.
- [32] Remuzzi A, Ene-Iordache B. Novel paradigms for dialysis vascular access: upstream hemodynamics and vascular remodeling in dialysis access stenosis. *Clin J Am Soc Nephrol.* 2013;8:2186–93.
- [33] Patel MS, Street T, Davies MG, et al. Evaluating and treating venous outflow stenoses is necessary for the successful open surgical treatment of arteriovenous fistula aneurysms. *J Vasc Surg.* 2015;61:444–8.
- [34] Nagaraj RD, Settupalli S, Sandeep P, et al. Vascular access related complications with ipsilateral upper limb oedema in hemodialysis. *Indian J Vasc Endovasc Surg.* 2019;6:89–98.
- [35] Reilly JB, Marcotte LM, Berns JS, et al. Handoff communication between hospital and outpatient dialysis units at patient discharge: a qualitative study. *Jt Comm J Qual Patient Saf.* 2013;39:70–6.
- [36] Perl J, Brown EA, Chan CT, et al.; for Conference Participants. Home dialysis: conclusions from a kidney disease: improving global outcomes (KDIGO) controversies conference. *Kidney Int.* 2023;103:842–58.
- [37] Birchenough E, Moore C, Stevens K, et al. Buttonhole cannulation in adult patients on hemodialysis: an increased risk of infection? *Nephrol Nurs J.* 2010;37:491–8, 555; quiz499.
- [38] Smyth W, Hartig V, Manickam V. Outcomes of buttonhole and rope-ladder cannulation techniques in a tropical renal service. *J Ren Care.* 2013;39:157–65.
- [39] Kal O, Duman E, Kal A. Dialysis efficacy and pain levels in relation to cannulation distance using the buttonhole technique. *Ren Replace Ther.* 2020;6:1–7.
- [40] Giannerini D, Rossi F, Bocci Benucci S, et al. [The specialist skills of the nurse in hemodialysis: report of an explorative survey. A challenge for professional recognition]. *G Ital Nefrol.* 2020;37:2020–vol5.
- [41] Wang YY, Xiong Y, Zhang Y, et al. Compassion fatigue among haemodialysis nurses in public and private hospitals in China. *Int J Nurs Pract.* 2022;28:e13011.