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Nursing practice guidelines for needling of arteriovenous fistula/grafts: Beni Suef city, Egypt

Magda Bayoumi[1,2]*, Leena Khonji[3]

[1]Medical-Surgical Nursing Department, Faculty of Nursing, Beni-Suef University, Egypt, [2]Medical-Surgical Nursing Department, Nursing Division, College of Health and Sport Sciences, University of Bahrain, Bahrain, [3]Midwifery and Newborn Nursing Department, Nursing Division, College of Health and Sport Sciences, University of Bahrain, Bahrain

ABSTRACT

Introduction: Vascular access is considering to the patient undergoing hemodialysis (HD) as his/her soul which indicating patient survival, moreover, vascular access can controlling, directing the dialysis regimen effectiveness. Cannulation techniques are crucial skills for nurses to minimize arteriovenous fistula (AVF) or graft (AVG) complications.

Methods: A cross-sectional study was applied to assess vascular complications and related factors. The participants were 65 patients on maintenance HD therapy enrolled at the dialysis unit, central Ehnasa' government hospital, Beni Suef City. Data were collected using developed questionnaires regard patients' demographic data, clinical, and HD session characteristics, designed Nursing Practice guidelines for needling of AVF/AVG booklet.

Results: Statistically, the results show the most common cannulation technique which was demonstrated is an area method (65%) and needle direction is retrograde with bevel up (66.2%). whereas, the significant positive correlation shows between the cannulation techniques and vascular access complication, duration of dialysis and complication during the dialysis session. Furthermore, the most common complication related to needling practice is aneurysm (44.6%).

Conclusion: Following cannulation, technique guidelines will prevent potential complications, increase vascular access durability, and improve patients' quality of life.

Keywords: Nursing practice; needling guidelines; arteriovenous fistula/grafts; complication; hemodialysis

INTRODUCTION

End-stage renal disease (ESRD) is defined as advanced chronic kidney disease, and the endpoint to confirm the diagnosis is the presence of estimated glomerular filtration rate > 15 mL/minuets/1.73 m^2 For 3 months are categorized as ESRD, However, many patients may live years without any obvious symptoms (1).

Unfortunately, the incidence of ESRD has grown dramatically in the last few years worldwide to about 13-15% and synchronized with the increasing prevalence of diabetes and hypertension (HTN) (2).

In Egypt, the prevalence rate of ESRD is about 74/million population and the incidence of patients undergoing dialysis therapy is 264/million population (3).

*Corresponding author: Magda Bayoumi, Medical-Surgical Nursing Department, Faculty of Nursing, Beni-Suef University, Egypt.
E-mail: mbayoumi@nursing.bsu.edu.eg

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UNIVERSITY OF SARAJEVO
FACULTY OF HEALTH STUDIES

Hemodialysis (HD) is considered ordinary renal replacement therapy for treating ESRD in Egypt (4). Establishing maintenance HD therapy for the patient with ESRD, definitely required vascular access, and it depends either patient is prepared in the pre-dialysis time frame or need emergency dialysis sessions. Vascular access can be a central venous catheter (CVC), arteriovenous fistula (AVF) or graft (AVG). Vascular access such a part of a patient's soul, even the bruit should always be listening to it to feel safe, moreover, vascular access can controlling, directing the dialysis regimen effectiveness.

Parisotto et al., 2014, reported that patients on HD life span are depending on effective, patent vascular access. Furthermore, the study highlighted the impact of cannulation techniques for the maintenance of vascular access functioning (5).

An arteriovenous (AV) fistula is selected for optimum vascular access using for HD therapy with advantages as low-risk complications and excellent long-term patency rates. Despite this disadvantage remains an important source of morbidity for the patient on maintenance HD therapy (6-9).

Selecting an appropriate cannulation technique, whether rope-ladder or buttonhole techniques or area method, more probably depending on the practice of needling techniques in each HD setting facility. Meanwhile, the rope-ladder technique is defined as a change in needling puncture site in each dialysis session, which buttonhole technique is the insertion of needle puncture in the exact spot point for a sequential dialysis session, the area method defined as repeated needling at the center point over a small vessel area (5).

The direction of the blood flow from the extracorporeal circulation of the body and vice versa, the blood flow direction is playing an important subject in the dialysis efficiency. Likewise, the venous needle should always point in the direction of the blood flow (antegrade direction), and the arterial needle direction either in the same direction of the blood flow (antegrade direction) or on the contrary direction (Retrograde direction) (10,11).

Many studies already addressed the vascular access complication either AVF or AVG defiantly may affect the vascular access as well the dialysis outcome (8,9). Therefore, the vascular access complications reported as hematoma, infection, and aneurysm formation (12-14).

Lazarides et al. (2014) reported that the factor may be causing aneurysm is not defined well; however, the aneurysm may create either a result of a part of needling or from the intervention (15).

Cannulation techniques need a skillful nurse to avoid vascular access complications, which may affect vascular access survival (16). However, establish restricted cannulation techniques guidelines using it as guidance for nursing practice needling at the dialysis unit to reduce vascular access complications. A recent study highlighted that further research is needed to reduce the cannulation techniques malpractice (17). Therefore, this study aimed to identify the factors that lead to vascular access complications and develop holistic guidelines for cannulation techniques in Egypt.

Significance of the study

The main achievable objective while needling practice is using a proper cancellation technique in the vascular access to maintain proper functioning of vascular access. The vascular access complications related to malpractice are considering the most fundamental problems of the individuals undergoing HD for a long time (18).

Several studies have reported that the most common cause of hospitalization of the patient undergoing HD therapy is the complication of vascular access (19).

The limited availability and applicability of needling practice guidelines in the dialysis unit vary from a clinical setting to other clinical settings based on their historical training program (20).

Furthermore, several studies highlighted the significant relationship between vascular access complications and patients' quality of life, consequently, accurate, and proper cannulation techniques require considerable attention to decrease the incidence of vascular access complications. However, following meticulous needing guidelines in the dialysis unit is very important (21,22). The study aimed to identify the factors that lead to vascular access complications and develop holistic guidelines for cannulation techniques in Egypt.

METHODS

A cross-sectional study was applied to assess vascular complications and related factors. The study setting was HD unit at central Ehnasa's government hospital, Beni Suef City that was conducted between November 2016 and January 2017. The **p**urposive sample consisted of all patients (n = 65) on maintenance HD therapy.

Tools of the study

The tool I

Socio-demographic characteristics of patients consisted of age, sex, level of education, marital status, housing [Rural or Urban], job status, history, and family number.

Tool II

Clinical characteristics of a patient undergoing maintenance HD therapy patients, which consisted of weight gain, duration of dialysis regimen/months, type of vascular access (AVF, AVG, and CVC), number of dialysis sessions/week, number of AVF/AVG (old/new), AVF/AVG location, and current health disease (None, diabetes mellitus DM, HTN, and heart disease).

Tool III

HD session characteristics of patients, which included session duration, arm compression (patients' hands, tourniquet, NA), blood flow, needle size, venous pressure, KT/V, complication during the dialysis session, cannulation techniques, bevel position, and time of tap removal.

Tool IV

Nursing practice guidelines for needling of AVF/AVG booklet in Arabic and English languages (23-26).

Pre-needling principles, Cannulation techniques (Figure 1), disconnecting techniques, and cannulation problem-solving approach.

Ethical considerations

This study was approved by the director of Ehnasa's government hospital, Beni Suef City, the oral verbal consent of the nurses and patients was obtained before the administration of the questionnaire. The head nurse and nursing staff were informed about the purpose of the study and the researcher was explained that the participation not obligatory and they had the right to refuse to participate, and all right of confidentiality was maintained.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS ver.22) was used for data entry and analysis. Data were presented using: Descriptive statistics in the form of frequencies, and percentages. Bivariate correlation analysis was used for the assessment of the inter-relationships among quantitative variables.

RESULTS

The socio-demographic characteristics of patients in the study sample are described in Table 1. Patients' age ranged between 20 and 60 years, sadly, the one-third of the study sample allocated between 20 and 39 years old, sex distribution was females (56.9%) slightly more than males (43.1%). Education was mostly educated near to half of the study sample with the secondary school (46.2.0 %). Around two-thirds of the patients were married (75.4%), and unemployed or housewives (75.4%). As for their residence, the table shows that most of the patients (86.2%) were from rural dwellings.

Table 2 shows the clinical characteristics of the patient undergoing maintenance HD therapy that the duration of dialysis ranged between 6 months and 60 months and 26.2% of the total patients have been on dialysis for 60 months or more. More than half of the patients, their weight gain between sessions around 2 and <3 kg, the most vascular access using is AVF (87.7%) and has the vascular access on the left arm, and has only one AVF. Unfortunately, around 70.8% of the study sample doing only 2 sessions/week. More than half of the study, the sample has DM (21.5%), HTN (31.8), heart disease (7.7%), and diabetes and heart disease (4.6%).

HD session characteristics of patients are displayed in Table 3. As Table 3 shows that about three-fourth (73.8%) were on dialysis session duration from 3 to 4 hours, and (78.5%) using their hands to compress the arm before cannulation, around half of the study sample the blood flow of dialysis session was from 250 to 300 ml/minutes, with needle size 17 G (66.2%), one-third of the study sample their KT/V

TABLE 1. Socio-demographic characteristics of patients in the study sample (n=65)

Variable	No. (%)
Age (years)	
20-39	27 (41.5)
40-59	24 (36.9)
≥60	14 (21.5)
Sex	
Female	37 (56.9)
Male	28 (43.1)
Education	
Illiterate	6 (9.4)
Read/Write	9 (13.8)
Primary	17 (26.2)
Secondary	30 (46.2)
University	3 (4.6)
Marital	
Single	15 (23.1)
Married	49 (75.4)
Divorced	1 (1.5)
Housing	
Rural	56 (86.2)
Urban	9 (13.8)
Job	
Not-working	49 (74.4)
Retired	2 (3.1)
Famer	8 (12.3)
Employee	6 (9.2)
History	
DM	26 (40)
HTN	33 (50.8)
Unknown	6 (9.2)
Family	
No children	21 (32.3)
≤3	3 (4.6)
>3	63.1

was <1.2 and had no complications during the dialysis session. Moreover, 47.7% of the total study sample have patent vascular access, 44.6% have an aneurysm and 7.7% have an infection.

Figure 2 demonstrates the cannulation techniques either rope-ladder or area method at the AVF/AVG, around 65% reported that nurses using an area technique. Moreover, the bevel position is illustrated in Figure 3 as the most bevel position was retrograde with bevel up (66.2%).

TABLE 2. Clinical characteristics of a patient undergoing maintenance hemodialysis therapy patients in the study sample (n=65)

Variable	No. (%)
Weight	
<2	12 (18.5)
2<3	30 (46.2)
3<4	19 (29.2)
≥4	4 (6.2)
Dialysis duration (month)	
<6	8 (12.3)
6–<12	13 (20)
12–<36	15 (23.1)
36–<60	12 (18.5)
≥60	17 (26.2)
Vascular access	
AVF	57 (87.7)
AVG	5 (7.7)
CVC	3 (4.6)
Session number/week	
Once weekly	2 (3.1)
2 session/week	46 (70.8)
3 session/week	17 (26.2)
No AV	
One AVF/AVG	59 (90.8)
One old and one new	3 (4.6)
CVC+New AV	3 (4.6)
AVF/AVG location	
RT	9 (13.8)
LT	53 (81.5)
CVC	3 (4.6)
Current health disease	
Non	31 (47.7)
DM	14 (21.5)
HTN	9 (13.8)
Heart disease	5 (7.7)
DM and heart disease	3 (4.6)
HTN and DM	1 (1.5)
HTN and heart disease	2 (3.1)

CVC: Central venous catheter, AVF: Arteriovenous fistula, AVG: Arteriovenous graft, DM: Diabetes mellitus, HTN: Hypertension, SD: Standard deviation

Table 4 shows the correlation matrix of cannulation techniques, bevel position, needle size, tap removal, complications during the dialysis session, blood flow, AVF locations, duration of the dialysis session, and KT/V.

TABLE 3. Hemodialysis session characteristics of patients in the study sample (n=65)

Session duration	No. (%)
<3 h	17 (26.2)
3-4 h	48 (73.8)
Arm compression	
Patients' hands	51 (78.5)
Tourniquet	11 (16.9)
NA	3 (4.6)
No AV	
One AVF	59 (90.8)
One old and one new	3 (4.6)
CVC+New AV	3 (4.6)
AV location	
RT	9 (13.8)
LEFT	53 (81.5)
CVC	3 (4.6)
Current health disease	
Non	31 (47.7)
DM	14 (21.5)
HTN	9 (13.8)
Heart disease	5 (7.7)
DM and heart disease	3 (4.6)
HTN and DM	1 (1.5)
HTN and heart disease	2 (3.1)
Blood flow (ml/minuets)	
<250	17 (26.2)
250-300	29 (44.6)
>300	19 (29.2)
Needle size	
16 G	22 (33.8)
17 G	43 (66.2)
Venous pressure (mmHg)	
100-150	59 (90.8)
>150-200	6 (9.2)
Complication of the vascular access	
Patent	31 (47.7)
Aneurysm	29 (44.6)
Infection	5 (7.7)

CVC: Central venous catheter, AVF: Arteriovenous fistula, AVG: Arteriovenous graft, DM: Diabetes mellitus, HTN: Hypertension, SD: Standard deviation

The initial evaluation of all the foregoing models was a correlation matrix for all variables, Table 4. Variables included in the matrix were cannulation techniques, vascular access complication, bevel position, needle size, tape removal, complications during the dialysis session, blood flow, AVF locations, duration of dialysis session, and Kt/V. The table shows, simple analysis, the inverse correlation (r = –0.766, $p > 0.000$) between tape removal time and vascular access complication, needle size and blood flow correlation (r = –0.452, $p > 0.000$), vascular access location and tape removal time (r = –0.452, $p > 0.000$), vascular access location and vascular access complications (r = –0.279, $p > 0.024$), cannulation techniques and duration of dialysis session (r = –0.300, $p > 0.015$), Kt/V and complication of vascular access complication (r = –0.251, $p > 0.043$), and Kt/V and complication during dialysis session (r = –0.342, $p > 0.005$).

The positive correlation is between the cannulation techniques and vascular access complication (r = 0.269, $p > 0.030$) and the duration of dialysis session and complication during dialysis session (r = 0.518, $p > 0.000$).

Finally, trials were made to construct models for the effect of various calculation techniques on AVF/AVG the score of each separate domain. The only valid model was concerning the complications, presented in Table 5. The model indicates that the statistically significant predictor of the most common complication related to the cannulation technique is an aneurysm (Figure 4) with a mean square is 1.838. Their effect was positive, as evident from their coefficient. The model explains 36.7% of the variation in the score, as indicated by the value of the r - square, 0.198.

DISCUSSION

Cannulation techniques are considering a crucial skill for nurses to minimize AVF/AVG complications. Many recent studies reported that the AVF is the priority option for patients on HD therapy. Absolutely malpractice cannulation impacts negatively on patient experience and may cause permanent complications, particularly by novice nurses (5,14). A recent study done over 7000 patients and found that Cannulation techniques were using is inferior to the rope-ladder and to buttonhole for maintenance of vascular access functionality (5).

Analyses of the results of the present study have shown that the most common calculation technique was using an area calculation technique which

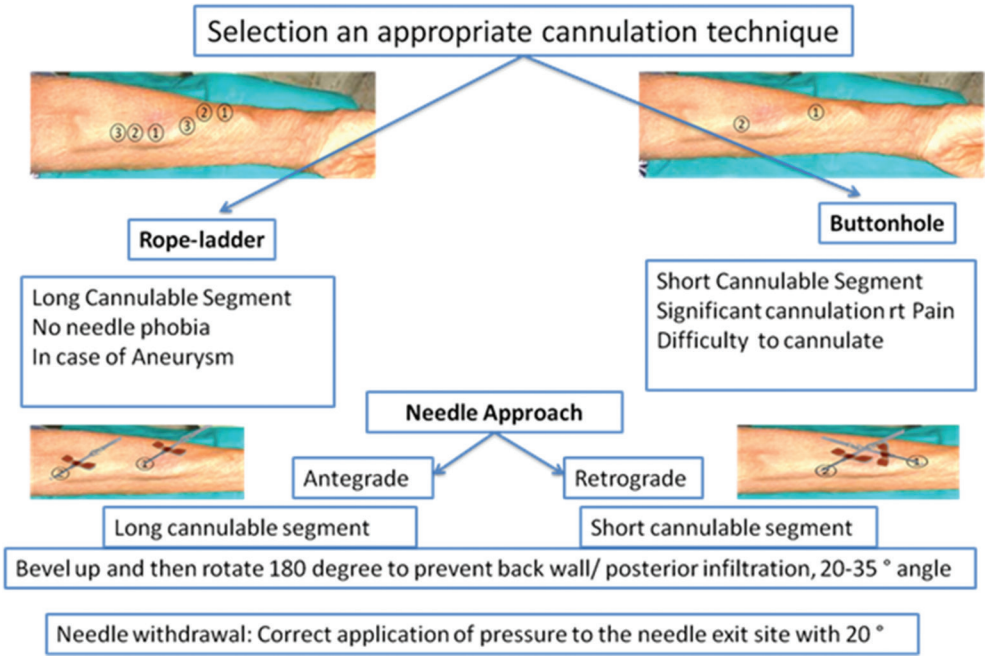

FIGURE 1. Selection an appropriate cannulation technique.

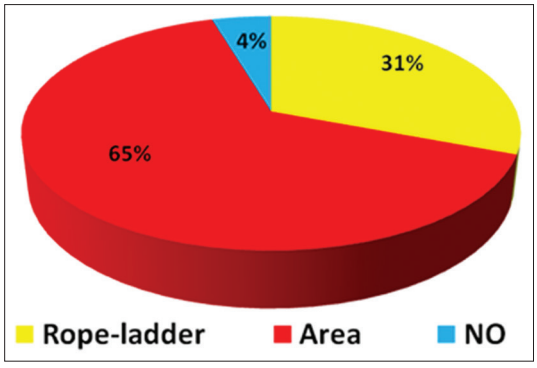

FIGURE 2. Cannulation techniques in vascular access.

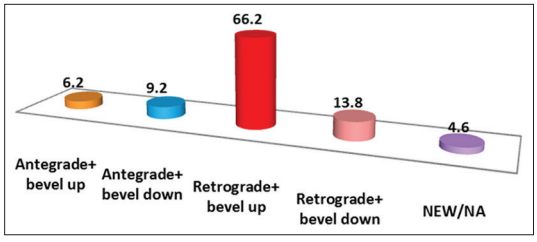

FIGURE 3. Bevel position during needling vascular access.

significantly with complication and study also reported that the aneurysm is the most common

FIGURE 4. Aneurysm in AVF.

complication happen in the vascular access, this is in agreement with Mudoni et al. (2015) who have emphasized on the most common and predominantly tough complication seen with vascular access (27), furthermore, Ball (2010) reported that the buttonhole technique is the best practice to reduce infection in the vascular access (28).

Patel and Vachharajani, (2018) reported that the complications that came across with AVG are stenosis, infection, thrombosis, and pseudoaneurysm formation, moreover, they reinforce on educating the staff in the dialysis unit about cancellation techniques to minimize the risk of pseudoaneurysm formation (29).

Certainly, the cannulation techniques in the vascular access are considered vital variable for effective HD,

TABLE 4. Correlation matrix of cannulation techniques, bevel position, needle size, tap removal, and complications

Variable	Cannulation techniques	Bevel position	Needle size	Tap removal	Complication	Blood flow	AVF location	Duration	KT/V
Cannulation techniques									
Bevel position	r=0.110 *p*>0.384								
Needle size	r=0.062 *p*>0.623	r=0.208 *p*>0.096							
Tap removal	r=−0.070 *p*>0.580	r=−0.001 *p*>0.994	r=−0.035 *p*>0.783						
Complication	r=0.269* *p*>0.030	r=0.072 *p*>0.567	r=−0.077 *p*>0.540	r=−0.766** *p*>0.000					
Blood flow	r=−0.061 *p*>0.629	r=−0.151 *p*>0.230	r=−0.370** *p*>0.002	r=−0.149 *p*>0.235	r=−0.096 *p*>0.446				
AV-fistula location	r=0.241 *p*>0.053	r=0.044 *p*>0.727	r=0.069 *p*>0.583	r=−0.452** *p*>0.000	r=−0.279* *p*>0.024	r=−0.040 *p*>0.750			
Duration	r=−0.300* *p*>0.015	r=0.151 *p*>0.230	r=−0.056 *p*>0.659	r=−0.197 *p*>0.116	r=−0.129 *p*>0.305	r=0.212 *p*>0.090	r=0.030 *p*>0.810		
KT/V	r=−0.226 *p*>0.071	r=0.035 *p*>0.782	r=0.031 *p*>0.808	r=0.391* *p*>0.001	r=−0.251* *p*>0.043	r=−0.073 *p*>0.566	r=−0.074 *p*>0.555	r=−0.758* *p*>0.000	
Complication/ dialysis session	r=0.076 *p*>0.545	r=0.110 *p*>0.382	r=−0.167 *p*>0.382	r=−0.060 *p*>0.632	r=0.037 *p*>0.767	r=0.315* *p*>0.001	r=0.006 *p*>0.959	r=0.518** *p*>0.000	r=−0.342** *p*>0.005

CVC: Central venous catheter, AVF: Arteriovenous fistula, AVG: Arteriovenous graft, DM: Diabetes mellitus, HTN: Hypertension, SD: Standard deviation

TABLE 5. Best fitting multiple regression model for complication as a dependent factor, and cannulation techniques as an independent factor

Independent variables	Mean±SD	r-square	ANOVA (*p*-value)
Total complications	1.73±0.53	0.198	<0.001

SD: Standard deviation

which improve the adequacy of dialysis and minimize complication, Kim and Kim (2013) studied the clinical effects of buttonhole cannulation technique on HD patients and found that the buttonhole techniques were significantly reduced the pain experienced by patients on HD therapy without any effect on vascular access function or adequacy of dialysis compared to rope-ladder technique. Moreover, the level of stress for nurses decreased and reported that the buttonhole cannulation technique may effectively with the patient has a limited vein to be calculated or experiencing severe pain (30).

There is little published research about the effect of cancellation techniques on vascular access outcomes, Van Loon et al. (2010) highlighted that the buttonhole technique is a valuable method with reported few complications such as hematoma, aneurysm formation, and recommended with meticulous an aseptic and correct cannulation buttonhole technique to avoid occur an infection (31).

Interestingly, the nurses who recognize successful cannulation applied required guided information and a combination of feelings and emotions of others and themselves, which is conspiring a form of social intelligence called emotional intelligence (32). Sadly, many patients on maintenance HD therapy dislike an AVF because they have experience in their peers as pain and bruising while cannulation to vascular access (33).

Furthermore, the positioning of the bevel and size of needle gauge was significant with better access survival, in the present study, the most common direction of the bevel was retrograde with bevel up, another study in the same line highlighted that antegrade positioning of the arterial needle with bevel up was a significant association with better vascular access than retrograde positioning with the bevel down, furthermore using of larger needle gauge for increase vascular access potency and durability (16).

Nevertheless, no practice guidelines for best practice of needling of vascular access are available in Egypt. Worldwide, few international institutions as a national kidney foundation established and published some clinical practice guidelines and recommendations for vascular access, adequacy of HD dialysis, and adequacy of peritoneal dialysis (7).

Skillful nurses are playing an important role to maintain vascular access free from complication as infection and thrombosis (21).

In this regard, crucial action should be established as follows restricted guidelines for best practice of needling either AVF or AVG. A recent study was done by Firoozjayi et al., 2016, who was highlighted the importance of conducting constant training of nurses and developing a holistic protocol for improvement of cannulation techniques from the needle insertion to withdrawal which including the pressure on the puncture site (34).

Interestingly, Sousa et al., 2018, stated to provide an educational program to improve self-care patients' behavior toward vascular access (35). Defiantly, conducting continuous education for turning dialysis nurses, nephrologists, and patients as well to minimize vascular access complications, and prolong its life span (16).

In Egypt, the health-care sector ministry of health tries to develop policies and guidelines to improve the quality of care (36,37). The development of cannulation technique guidelines not yet established in Egypt, which is considered an important indicator that affects patients' quality of life.

CONCLUSION

This study demonstrated the most common cannulation technique which was demonstrated is an area method and needle direction is retrograde with the bevel up. Likewise, the positive correlation variables are between cannulation techniques and vascular access complications, duration of dialysis and complication during the dialysis session. Furthermore, the most common complication related to needling practice is an aneurysm. Defiantly following cannulation technique guidelines will prevent potential complications, increase vascular access durability and improve patients' quality of life. Further research is needed to analyze the factors that may be affecting vascular access patency and evaluate the application of cannulation technique guidelines as a prospective study to identify the clinical relevance for vascular access complications.

Recommendations

- Develop a teaching lab session that includes demonstration and re-demonstration for correct cannulation techniques for new and old AVF/AVG for the nurses who are working in the dialysis unit.
- Design vascular access self-learning package for the patient undergoing HD therapy to be engaged in the vascular access process maintenance.
- Distribute and hanging cannulation techniques paradigm posters everywhere at the dialysis unit at each center in Egypt.

CONFLICTS OF INTEREST

The author declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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