Knowledge of vascular access among hemodialysis unit nurses and its influencing factors: a cross-sectional study

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Background: Nurses in hemodialysis (HD) units are the main performers in the maintenance and management of HD patients' vascular access, and the cognition degree of their specialized knowledge of vascular access directly affects the quality of vascular access management. However, most of the investigations on the cognition of vascular access knowledge take HD patients as the research subjects, while there are few studies on nurses in HD units as the research subjects. Herein, we explored the knowledge of vascular access among HD unit nurses and its influencing factors, aiming to inform the training of HD unit nurses on vascular access management.

Methods: By using a convenience sampling method, we investigated the knowledge of vascular access in terms of basic knowledge, vascular access assessment and arteriovenous fistula (AVF) puncture technique knowledge of dialysis unit nurses who volunteered to engage in hemodialysis clinical nursing for more than 6 months in HD units in Sichuan Province from March 2022 to May 2022. Data were collected on demographic characteristics, hospital nature, the city and region where the hospital is located, the working time of hemodialysis. Analysis of variance was used to analyze the score of vascular access specialist knowledge of HD unit nurses, and multiple linear regression was used to explore the influencing factors of vascular access specialist knowledge of HD unit nurses.

Results: A total of 222 nurses in HD units were included. The total score of the knowledge of vascular access was 87.52 ± 13.71 points, of which the basic knowledge scored 3.88 ± 0.60 points, the vascular access assessment scored 3.62 ± 0.65 points, and the AVF puncture techniques scored 3.22 ± 0.71 points. Multiple linear regression analysis showed that longer working years [beta: 0.381, 95% confidence interval (CI): 3.064–7.188, P=0.000], more advanced training [beta: 0.206, 95% CI: 2.817–10.672, P=0.001], and public hospital [beta: 0.138, 95% CI: 0.839–12.342, P=0.025] positively predicted higher knowledge of vascular access scores among HD unit nurses (all P<0.05).

Conclusions: The cognitive degree of vascular access specialized knowledge of hemodialysis nurses is affected by different working years, training experience and the nature of the hospital. Nursing managers can develop different training and assessment programs for vascular access specialized knowledge according to different influencing factors.

Keywords: Vascular access; HD unit nurses; knowledge; influencing factors

Introduction

Vascular access is often known as the "lifeline" to hemodialysis (HD). The maintenance of well-functioning vascular access is a prerequisite for preserving HD, and the quality of vascular access directly affects the dialysis outcomes and the quality of life of HD patients. However, the service life of vascular access can be affected by a variety of factors. In addition to the patient's vascular status, primary disease, and self-management ability, the correct creation, use, and maintenance of vascular access by medical staff are also critical (1). HD unit nurses play a key role in assessing, establishing, maintaining, and monitoring vascular access as well as in patient education, and their knowledge of vascular access directly affects its quality control (2). Because the specialized knowledge of vascular access is affected by its specialty, only simple explanations of vascular access types are carried out in the teaching process of medical students in China, and the knowledge of how to evaluate, monitor and manage vascular access is less involved. You can only continue your study by taking a job in the major. The past few years have seen dramatic progress in vascular access management in China following a series of academic exchanges and technical training events (3). However, there are still gaps in vascular access knowledge among HD unit nurses at all levels (4). Most of the currently available surveys on the knowledge of vascular access were performed in HD patients (5,6), and few studies involving HD unit nurses have been conducted. Herein, we performed a survey to investigate the knowledge of vascular access among HD unit nurses and its influencing factors, aiming to provide a theoretical basis for the training and continuing education programs on vascular access creation and care. We present the following article in accordance with the SURGE reporting checklist (available at https://apm.amegroups.com/article/view/10.21037/apm-22-1204/rc).

Methods

Subjects

This study was a cross-sectional study using convenience sampling. Kendall sample estimation method was used in this study, and the sample size was 5–10 times of the number of items in the scale. In order to reduce the error, it will be expanded by 20%. The survey scale contains 24 items. The sample size was 24*5/80%=150. We enrolled 222 certified HD unit nurses from 13 prefecture-level hospitals and 10 county-level hospitals in Sichuan province from March 2022 to May 2022. The inclusion criteria were as follows: (I) having been working in HD settings for ≥6 months; and (II) voluntarily attended this study and signed the informed consent forms. The exclusion criteria were as follows: (I) interns and trainees; and (II) nurses on sick leave or maternity leave. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Biomedical Ethics Committee of West China Hospital, Sichuan University [No. 2022 Review (318)] and informed consent was taken from all the patients.

Study methods

Design of the questionnaire

The questionnaire was compiled and revised after a literature review (2,3,7-10) and pilot survey. The contents of the questionnaire included the following. (I) *General information:* including age, professional title, position, education, nature of the hospital, city/area where the hospital is located, years of serving as a HD unit nurse, employment mode, monthly income, marital status, and children. (II) *Knowledge of vascular access (Table 1):* (i) basic knowledge (13 items), including the basic principles of creating vascular access, appropriate type and location of vascular access, key points of nursing after vascular access creation, timing of using autologous arteriovenous fistula (AVF) or arteriovenous graft (AVG), AVF puncture techniques, monitoring of vascular access, and management of common complications; and (ii) vascular access assessment (four items), including pre-treatment AVF assessment, physical assessment methods, ultrasound assessment before AVF puncture, and pre-treatment assessment of tunnel-cuffed catheter (TCC). (III) AVF puncture techniques (seven items), including knowledge of the rope ladder (RL) puncture method, the buttonhole (BH) technique, use of trocars, and ultrasound puncture. Each item was rated on a five-point Likert scale ranging from 1 (Not At All) to 5 (Very Much), with higher scores indicating greater knowledge. The Cronbach's α coefficient, which measures internal consistency, was 0.896.

Survey methods

The questionnaire was prepared using the WJX.cn online platform. An informed consent option was displayed on the first page of the questionnaire, explaining the objectives and relevance of the survey as well as the method of filling

Table 1 Dimensions and items of the knowledge of vascular access

Items (score for each item ranged 1 to 5, total score ranged 24–120)

Basic knowledge

  1. Selection of type and location of vascular access

  2. Basic principles for establishing vascular access

  3. Key points of postoperative nursing of vascular access

  4. Timing of use of arteriovenous fistula

  5. Timing of the use of arteriovenous graft

  6. Puncture method of internal fistula

  7. Problems and nursing countermeasures of puncture of arteriovenous fistula

  8. Complications of internal fistula

  9. Management of internal fistula complications

  10. Monitoring methods of arteriovenous fistula

  11. Type of tunnel-cuffed catheter

  12. Prevention and treatment of complications of tunnel-cuffed catheter

  13. Application of ultrasound in the assessment of vascular access

Vascular access assessment

  1. Are you familiar with the contents and physical evaluation methods of arteriovenous fistula before puncture

  2. Are you familiar with pre-treatment evaluation of tunnel-cuffed catheter

  3. Are you familiar with ultrasound evaluation methods for arteriovenous fistula before puncture

  4. Are you familiar with ultrasound interpretation of arteriovenous fistula examination results

Arteriovenous fistula puncture techniques

  1. Are you skilled in arteriovenous fistula rope ladder puncture method

  2. Are you skilled in blunt needle puncture

  3. Are you skilled in trocar puncture for arteriovenous fistula

  4. Are you skilled in ultrasound-guided puncture of the arteriovenous fistula

  5. Are you skilled in puncture of new arteriovenous fistula

  6. Are you skilled in puncture of high arteriovenous fistula

  7. Are you skilled in puncture of arteriovenous graft

out the questionnaire. All respondents were required to consent to participate in the survey. The respondents filled out the questionnaire anonymously by scanning the Quick Response (QR) code on their WeChat app. Each item was set as a mandatory question, and each WeChat user was allowed to fill out the questionnaire once. Repeated answering was not allowed. Finally, 225 responses were collected, among which 222 (98.67%) were valid after three responses were removed due to incorrect fillings.

Statistical analysis

Descriptive statistics were applied to analyze the knowledge of vascular access among the HD unit nurses. Statistical analyses of the data were performed using the SPSS software package (IBM SPSS Statistics for Windows, Version 21.0, IBM Corp., Armonk, NY, USA). Measurement data are presented as $\bar{x} \pm SD$ (standard deviation) and count data as frequencies and constituent ratios. The *t*-test and one-way ANOVA (analysis of variance) were applied to compare the

Table 2 Knowledge of vascular access among HD unit nurses ($\bar{x}\pm$SD)

Dimension	Item	Score	Score percentage (%)
Basic knowledge	13	3.88±0.60	77.60
Vascular access assessment	4	3.62±0.65	72.40
Arteriovenous fistula puncture techniques	7	3.22±0.71	64.40
Total score	24	87.52±13.71	72.93

HD, hemodialysis; SD, standard deviation.

vascular access knowledge scores among HD nurses with different characteristics. The total score of vascular access knowledge of hemodialysis nurses was taken as the dependent variable, and the variables with statistical significance (P<0.05) in univariate analysis were taken as the independent variables, multiple linear regression was used to analyze the factors influencing vascular access knowledge. A P value of less than 0.05 was considered statistically significant.

Results

A total of 222 HD unit nurses were included in the final analysis. There were 211 females (95.0%) and 11 males (5.0%), aged 31.47±6.53 years. Among the included nurses, 174 (78.4%) were in municipal HD units and 48 (21.6%) were in county-level hospitals, and 202 (91.0%) were in public hospitals and 20 (9.0%) were in private hospitals. Their education backgrounds included technical secondary school (n=3, 1.4%), junior college (n=82, 36.9%), and college (n=137, 61.7%). Among them, 49 nurses (22.1%) had been engaged in HD for less than 2 years, 63 nurses (28.4%) for 2–5 years, 72 nurses (32.4%) for 5–10 years, and 38 nurses (17.1%) for more than 10 years. The professional titles included nurse (n=56, 25.2%), senior nurse (n=110, 49.5%), supervisor nurse (n=47, 21.2%), and deputy chief nurses and above (n=9, 4.1%). In addition, 172 nurses (77.5%) had received training on vascular access in the past year, and 81 nurses (36.5%) had received the blood purification nursing certification.

Knowledge of vascular access among HD unit nurses

In this survey, the total score knowledge of vascular access among HD unit nurses ranged from 24 to 120 points, with a mean score of 87.52±13.71 and an average score of 3.88±0.60. The knowledge of the assessment of vascular access scored 3.62±0.65 points, and the knowledge of AVF puncture scored 3.22±0.71 points (*Table 2*).

Univariate analysis of the knowledge of vascular access among HD unit nurses under different conditions

There were statistically significant differences (all P<0.05) in the knowledge of vascular access among HD unit nurses in terms of professional title, nature of the hospital, years of service, and whether they had received training on vascular access in the past year (*Table 3*).

Regression analysis of factors influencing the knowledge of vascular access among HD unit nurses

Multivariate linear regression analysis was performed with the knowledge scores as the dependent variables and the other variables as independent variables (see *Table 4* for specific assignments), as shown in *Table 5*. Linear regression showed significant correlations between three variables (including years of service, training on vascular access in the past year, and hospital nature) and vascular access-related knowledge scores (all P<0.05). The multivariate correlation coefficient "R" in the final formula was 0.448 and the coefficient of determination R^2 (after adjustment) was 0.186, indicating that these three independent variables could jointly explain 18.6% of the variance in the variable "Total score of knowledge of vascular access among HD unit nurses". Among the unstandardized coefficients, those for years of service, training on vascular access in the past year, and hospital nature were positive, suggesting that these three variables had significant positive impacts on the total score of knowledge of vascular access among HD unit nurses (P<0.05).

Discussion

Knowledge of vascular access among HD unit nurses needs to be further improved

As shown in our current survey, the total score of knowledge on vascular access among HD unit nurses was 87.52±13.71,

Table 3 Knowledge of vascular access among HD unit nurses under different conditions ($\bar{x}\pm$SD)

Item	Groups	n	Mean scores of knowledge of vascular access		
			$\bar{x}\pm$SD	t/F	P
Gender	Female	211	87.16±13.65	t=−1.751	0.081
	Male	11	94.55±13.49		
Age (years)	18–25	35	85.14±13.98	F=2.133	0.078
	26–30	79	85.59±14.53		
	31–35	66	87.95±11.78		
	36–40	22	91.45±16.21		
	>40	20	93.55±11.04		
Educational background	Technical secondary school	3	83.67±10.12	F=1.216	0.298
	Junior college	82	85.80±14.67		
	College	137	88.64±13.13		
Professional title	Nurse	56	84.09±16.39	F=2.839	0.039
	Senior nurse	110	87.97±12.14		
	Supervisor nurse	47	88.74±12.89		
	Deputy chief nurses and above	9	97.00±13.63		
Post	Primary nurse	178	87.48±13.69	F=0.796	0.453
	Nursing team (deputy) leader	28	85.71±13.97		
	Head nurse	16	91.13±13.59		
Province, city, and area	Municipal hospitals	174	88.37±12.71	t=1.758	0.080
	County-level hospitals	48	84.46±16.62		
Employment mode	Contractual	162	86.80±13.91	F=1.170	0.312
	Via personnel agent	4	84.00±12.91		
	Regularly employed	56	89.86±13.11		
Nature of hospital	Public hospital	202	88.31±13.75	t=2.768	0.006
	Private hospital	20	79.55±10.60		
Years of service	Under 2 years	49	81.08±15.80	F=11.645	0.000
	2–5 years	63	84.00±11.64		
	5–10 years	72	91.22±10.97		
	More than 10 years	38	94.66±13.60		
Monthly income	<3,000 yuan	13	79.85±9.67	F=2.000	0.080
	3,000–3,999 yuan	32	82.88±14.40		
	4,000–5,999 yuan	77	89.18±14.59		
	6,000–6,999 yuan	50	89.20±12.35		
	7,000–7,999 yuan	34	88.24±13.92		
	>8,000 yuan	16	88.31±11.76		

Table 3 (*continued*)

Table 3 (*continued*)

Item	Groups	n	$\bar{x}\pm$SD	t/F	P
			Mean scores of knowledge of vascular access		
Marital status	Married	162	88.17±13.77	F=2.762	0.065
	Unmarried	54	84.57±13.51		
	Divorced or widowed	6	96.50±7.84		
Children	No	70	85.57±13.91	F=1.135	0.323
	One child	107	88.10±14.03		
	Two or more children	45	89.18±12.51		
Training on vascular access in the past year	Yes	172	89.25±13.72	t=3.574	0.000
	No	50	81.58±12.01		
Whether the nurse had obtained a specialist nurse certificate?	Yes	81	89.60±12.51	t=1.723	0.086
	No	141	86.33±14.25		

HD, hemodialysis; SD, standard deviation.

Table 4 Assignment of independent variable in regression analysis of factors influencing the knowledge of vascular access among HD unit nurses

Variables	Meaning	Assignment
x_1	Professional title	Dummy variables were used with nurse as reference: a_1=1, a_2=0, a_3=0 for senior nurse; a_1=0, a_2=1, a_3=0 for supervisor nurse; a_1=0, a_2=0, a_3=1 for deputy chief nurses and above
x_2	Nature of hospital	x_2=0 for private hospital; x_2=1 for public hospital
x_3	Years of service	x_3=1 for <2 years; x_3=2 for 2–5 years; x_3=3 for 5–10 years; x_3=4 for >10 years
x_4	Training on vascular access in the past year	x_4=0 for no; x_4=1 for yes

HD, hemodialysis.

Table 5 Analysis of the factors influencing the knowledge of vascular access among HD unit nurses

Variables	Unstandardized coefficient		Standardized coefficient	t value	P value	95% CI
	Partial regression coefficient	Standard error	Beta			
Constant	66.055	3.767	–	17.537	0.000	58.631–73.479
Years of service	5.126	1.046	0.381	4.899	0.000	3.064–7.188
Training on vascular access in the past year	6.744	1.993	0.206	3.384	0.001	2.817–10.672
Nature of the hospital	6.590	2.918	0.138	2.258	0.025	0.839–12.342

Model R=0.448, R^2=0.201, adjusted R^2=0.186, F=13.648. HD, hemodialysis; CI, confidence interval.

which was at a moderately low level (72.93%), especially in vascular access assessment methods (72.40%) and AVF puncture techniques (64.40%). These results are consistent with the findings of a foreign study (11), indicating that the HD unit nurses' knowledge of vascular access is not satisfactory and may not meet clinical requirements. As

the "users and guards" of vascular access, HD unit nurses must have comprehensive knowledge of vascular access. Nurses must perform an assessment and evaluation during each HD session. Only with solid knowledge of vascular access can nurses provide proper nursing and instructions to HD patients and promptly identify vascular access-related complications, which will help patients to improve their capabilities in maintaining vascular access and thus prolong the patency of vascular access. Studies (12,13) have shown that the training of HD unit nurses on vascular access has a positive impact on the quality management of vascular access by improving the AVF puncture techniques, reducing vascular access complications (e.g., thrombosis and stenosis), and prolonging the patency of vascular access. Therefore, hospital managers should strengthen the training and assessment of HD unit nurses' knowledge of vascular access, especially in terms of vascular access assessments, AVF puncture techniques, and other practical skills.

Years of service affects the knowledge of vascular access among HD unit nurses

Our survey revealed that there was a significant difference in the total knowledge of vascular access scores among HD unit nurses with different years of service (P<0.05). The total knowledge score increased with the increased years of service, which is consistent with a foreign study (14). Naturally, HD unit nurses with more working years are exposed to more HD patients with vascular access-related nursing problems than those with fewer working years, and also have more work experience. For example, AVF cannulation is managed with graded authorization based on working years, and the cannulation of new and difficult AVFs is mainly performed by nurses with more working years (13). Therefore, HD unit nurses have more knowledge of vascular access. In addition, HD training is highly specialized, and only nurses who have completed a certain number of years of service are allowed to attend specialized training on blood purification, during which they will receive systematic training on HD (including knowledge of vascular access) (15). Such training will also improve the vascular access-specific knowledge and clinical skills of senior HD unit nurses. It is therefore recommended that, before performing training on vascular access for HD unit nurses, their knowledge and skills should be evaluated before developing tailored training and assessment programs for nurses at different levels. Meanwhile, the assessment and use of vascular access should be conducted under the leadership of high-level talents and

with the engagement of both senior and junior HD nurses, so as to improve the knowledge and skills of junior HD unit nurses on vascular access.

Impact of different training experiences on the knowledge of vascular access among HD unit nurses

Nursing education is a lifelong pursuit that requires nurses to continuously learn new theoretical knowledge and practical techniques (16). Our survey showed that HD unit nurses who had participated in training on vascular access-related knowledge in the past year had significantly higher total scores in vascular access-related knowledge than those who had not participated in such events (P<0.05), which is consistent with the finding of a foreign study (11). Both national and international guidelines (2,3) have recommended that all medical staff involved in vascular access management or puncture for HD patients must receive adequate training and that HD units must develop continuing training programs on vascular access management. Since training on vascular access is highly specialized, the training offered by vascular access experts can provide more detailed and systematic explanations on this topic for HD unit nurses. Such training sessions can rapidly narrow the knowledge gap in vascular access and correct common misconceptions, thereby improving HD unit nurses' knowledge of vascular access.

Impact of hospital nature on the knowledge of vascular access among HD unit nurses

Our survey showed that HD unit nurses in public hospitals had higher overall scores on the knowledge of vascular access than their counterparts in private hospitals (P<0.05). One possible explanation for this is the different management policies, promotion systems, and nursing practices in these two different hospital systems. In terms of management, the HD units in a public hospital focus more on the essence of medical services and perform better in terms of improving medical resource allocation, dialysis quality control, and value-added services. In contrast, HD units in capital-dominated private hospitals typically prefer market-based operations (e.g., rapid expansion and standardization), leading to unreasonable planning and management of HD units; as a result, the cooperation between hospital investors and the healthcare team leaders is prone to break down due to inconsistencies in the operating philosophy, which affects the career development of HD nurses (17).

In addition, public hospitals (especially high-level public hospitals) have stricter management policies for nurses. Thus, HD unit nurses in public hospitals will be more proactive in improving their professionalism in all aspects, so as to achieve professional title promotion or avoid dismissal (18). Moreover, medical staff in public hospitals have more training opportunities and wider channels to acquire knowledge related to vascular access than those in private hospitals, and thus, they have greater knowledge related to vascular access.

Furthermore, since HD units in public hospitals have a sound, standardized, and systematic management system, the vast majority of patients with multiple or more serious chronic complications choose to go to public hospitals for dialysis. In contrast, private HD units tend to receive HD patients in good overall health condition, owing to the safety of the patients they manage and the long-term development of HD quality in these facilities (19). This means that HD unit nurses in public hospitals are exposed to more difficult cases of vascular access, and as a result, HD unit nurses in these hospitals are more motivated to gain new knowledge about vascular access to improve their professionalism and meet clinical needs.

Partnerships among HD units in both public and private hospitals should be established, and nurses from public HD units with solid knowledge and skills in vascular access are encouraged to offer relevant training in private HD units. In some private HD units, the clinical courses may only offer general knowledge, which cannot meet the needs of high-level talent training. Thus, hospital managers should provide more opportunities for nurses to receive training and internship in other institutions to update their knowledge of vascular access and improve the management of HD patients in private HD units.

However, our current study had some limitations that should be noted. Firstly, this was a cross-sectional survey conducted in a single province in China, and involved a small sample size. More multi-province, large-sample studies are required to further investigate the knowledge of vascular access among nurses in HD units. Secondly, the survey was based on a self-designed questionnaire focusing on the subjective perceptions of vascular access among HD unit nurses. In our future studies, more objective items will be included in the questionnaire.

Conclusions

In conclusion, the knowledge of vascular access among HD unit nurses is unsatisfactory, especially in vascular access assessment and AVF puncture techniques. Years of service, training experience, and hospital nature can affect the knowledge of vascular access among HD unit nurses. Training on vascular access for HD unit nurses should be tailored, based mainly on their years of service and training experience. In addition, private hospitals should establish partnerships with public hospitals when offering tailored training on vascular access for HD unit nurses to maximize the training effectiveness and further improve the professional capabilities of HD unit nurses.

Footnote

Reporting Checklist: The authors have completed the SURGE reporting checklist. Available at https://apm.amegroups.com/article/view/10.21037/apm-22-1204/rc

Data Sharing Statement: Available at https://apm.amegroups.com/article/view/10.21037/apm-22-1204/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://apm.amegroups.com/article/view/10.21037/apm-22-1204/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Biomedical Ethics Committee of West China Hospital, Sichuan University [No. 2022 Review (318)] and informed consent was taken from all the patients.

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