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Knowledge, attitudes and practices regarding arteriovenous fistulas among uremic patients undergoing haemodialysis in China: a cross-sectional study

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ABSTRACT

Objectives This study aimed to investigate the relationship between knowledge, attitude and practice (KAP) regarding arteriovenous fistula (AVF) care in uremic patients undergoing haemodialysis (HD).

Design A web-based cross-sectional study was conducted among uremic patients receiving HD at the First Affiliated Hospital of Chongqing Medical University between April 2023 and June 2023.

Setting The study took place at the First Affiliated Hospital of Chongqing Medical University.

Participants A total of 522 valid questionnaires were collected from patients undergoing HD, representing 85.57% of the 610 patients eligible for the study.

Interventions Pathway analysis was used to assess the interplay among KAP scores related to AVF care in the participants.

Primary and secondary outcome measures The study evaluated KAP scores (ranging 0–20, 8–40 and 6–30, respectively) to gauge patients' KAP regarding AVF care.

Results The findings indicated that patients exhibited adequate knowledge, positive attitudes and proactive practices towards AVF care. Patients' knowledge directly influenced their attitudes and practices, with attitudes also positively impacting practices. Additionally, knowledge indirectly affected practices through attitudes.

Conclusions Uremic patients undergoing HD demonstrated satisfactory understanding, favourable attitudes and proactive behaviours concerning AVF care. The pathway analysis provided insights into the relationships between KAP, illustrating the direct and indirect effects of these factors on each other in the context of AVF care among patients.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study achieved a response rate of 85.57%, with 522 valid questionnaires collected, indicating strong engagement and participation from uremic patients undergoing haemodialysis (HD) at the hospital.
⇒ The utilisation of pathway analysis allowed for a detailed assessment of the intricate relationships among knowledge, attitude and practice (KAP) scores related to arteriovenous fistula (AVF) care, providing a comprehensive understanding of how these factors interact in the patient population.
⇒ The study's findings of patients exhibiting sufficient knowledge, positive attitude and proactive practice towards AVF care offer actionable insights for healthcare providers to optimise patient education and interventions in HD settings, potentially improving outcomes and care quality.
⇒ This was a single-centre study, with a sample size that was not sufficiently large, higher KAP scores might result from specific regional educational programmes, and those results could not be directly compared with other areas.
⇒ It was possible to overlook other barriers to treatment compliance due to the initially high KAP scores and the inability to account for issues other than those covered by the questionnaire.

INTRODUCTION

The number of patients with end-stage renal disease has been steadily increasing worldwide, resulting in a growing demand for haemodialysis (HD) as a renal replacement therapy.[1] The two main modalities of permanent vascular access for HD are central venous catheters and arteriovenous access, such as grafts and arteriovenous fistula (AVF).[2 3] Recently, AVF has been discussed as the gold standard for maintenance HD, due to its superior patency and long-term durability.[4 5] Moreover, it has been associated with lower complication rates, including thrombosis and infection,[6] directly affecting the life quality of patients on HD.[6] Although lower complication rates and durability are important factors, better knowledge and practice of self-care methods for fistulas among maintenance HD patients can further improve the lifespan of vascular access.[2 7] In addition, behaviour modification should be based on the pragmatic, patient-centred approach; for shared decision-making, patients need

access to relevant information about treatment options and reasonable alternatives to fully comply with their HD plan.[1 3] Thus, sufficient knowledge and active participation are crucial for effective management.

A knowledge, attitude and practice (KAP) study is based on the notion that knowledge positively influences attitude, which in turn influences practice.[8] A few previous studies assessed KAP in different countries, reporting low or inadequate knowledge among HD patients.[9 10] Liu *et al*[11] suggested that the knowledge–attitude–behaviour model is a valuable tool for the health education of HD patients. A recent meta-analysis revealed that adequate practice of AVF self-care ranged from 59% to 99% in southern Asian countries,[10] while AVF self-care behaviour was at a low or moderate level in about 69.9% of HD patients in China.[12] Identifying gaps in KAP might help reveal barriers to treatment compliance and behaviour changes relevant to maintenance HD patients.[13] However, there are only a few comprehensive studies with large samples focusing on Chinese patients, and KAP towards AVF is rarely discussed. Therefore, this study aimed to investigate KAP regarding AVF among uremic patients on HD.

METHODS

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Study design and patients

Uremic patients receiving HD in the First Affiliated Hospital of Chongqing Medical University between April 2023 and June 2023 were enrolled in this web-based cross-sectional study. Inclusion criteria were the following: (1) age 17–90 years old; (2) diagnosed as uraemia according to the glomerular filtration rate<15 mL/min; (3) regular outpatient HD for more than 1 month. Exclusion criteria were: (1) concurrent peritoneal dialysis and (2) consciousness impairment, cognitive impairment or severe complications, such as infection, thrombogenesis or stenosis.

Questionnaires and quality control

The questionnaire was designed based on the previously published studies on KAP in HD,[14–16] expert consensus on the establishment and maintenance of AVF published by China Medical Education Association[13] and Vascular access guidelines by Kidney Disease Outcomes Quality Initiative released in 2019.[7] A small pilot test (n=84) was conducted, and Cronbach's alpha was 0.776, indicating good reliability of the questionnaire. The results of the confirmatory factor analysis (n=522) indicated that the questionnaire has good reliability (comparative fit index=0.897 (>0.800 is good); root mean square error of approximation=0.066 (<0.08 is good); Tucker-Lewis index=0.877 (>0.080 is good)).

The final questionnaire comprised 41 items, divided into four sections: demographic information (15 items), knowledge (11 items), attitude (9 items) and practice (6 items). For the knowledge section, scoring varied by item type. Item K1 was awarded 2 points for a correct answer and 0 points for incorrect or unclear responses. Items K2–K10 were scored as follows: 'know well' = 2 points, 'partially know' = 1 point and 'don't know' = 0 points. Item K11 served as a quality control measure to identify and exclude logically inconsistent responses. The total possible knowledge score ranged from 0 to 20. Item A9 assessed patients' attitudes towards the correlation between puncture pain and nurses' skills, a neutral topic without a clear positive or negative tendency and was therefore not scored. Items A2–A8 were rated on a five-point Likert scale: 'strongly agree' = 5 points, 'agree' = 4 points, 'neutral' = 3 points, 'disagree' = 2 points and 'strongly disagree' = 1 point. Item A1 was reverse scored. The total attitude score ranged from 8 to 40. For the practice section, responses were rated from 'completely obedient' (5 points) to 'never obedient' (1 point), yielding a total practice score ranging from 6 to 30. A score of 70% or more of the maximum score for KAP was considered an indicator of 'sufficient knowledge', 'positive attitude' and 'proactive practice'.[17]

Participants were recruited through ads posted on social media, such as WeChat Messenger. Data were collected through the paper questionnaires given on-site by the nurses in the HD unit when the patient was undergoing HD. All data were collected anonymously. If difficulties were encountered during the process of answering, the nurse on duty timely addressed the issue. After data collection was completed, the questionnaires were checked for quality by team members. Obvious logical errors, such as mutually exclusive answers to the quality control items or a pattern of choosing exactly the same answer options, were considered invalid.

Sample size

The formula for calculating the sample size in cross-sectional surveys is $n = \left(\frac{Z_{1-\alpha/2}}{\delta}\right)^2 \times p \times (1-p)$. In the formula, 'n' represents the sample size for each group, 'α' represents the type I error, which is typically set at 0.05, $Z_{1-\alpha/2}$=1.96, δ represents the allowable error, typically set at 0.05 and 'p' is set at 0.5 (as setting it at 0.5 maximises the value and ensures a sufficiently large sample size). The calculated sample size 'n' is 384. Considering an estimated questionnaire response rate of 80%, the final plan is to collect 480 valid questionnaires.

Statistical analysis

Stata V.17.0 (Stata Corporation, College Station, Texas, USA) was used for statistical analysis. A confirmatory factor analysis was performed to determine the questionnaire's reliability. Continuous variables were expressed as means and SD, an independent t-test was used for comparisons between two groups and one-way analysis

of variance (ANOVA) was used for comparisons between multiple groups. Categorical variables were expressed as n (%). Pathway analysis was conducted to test the hypothesis that (H1) knowledge directly affects attitude; (H2) knowledge directly affects practice; (H3) knowledge indirectly affects practice through attitude. Multivariate logistic regression analysis was used to determine the factors influencing 'sufficient knowledge', 'positive attitude' and 'proactive practice', classified as achieving the highest possible score of 70%. The selection method for variables is stepwise forward. A two-sided p value<0.05 was considered statistically significant.

RESULTS

A total of 610 questionnaires were collected, of which 88 were excluded due to obvious logical errors in the quality control item (K11) or patterns of answering by choosing the same option, resulting in 522 valid questionnaires (85.57%). The majority of participants were men (55.56%), aged 46–60 years old (43.10%) and married (83.14%). More than half of the participants (55.36%) received HD for over 3 years and 81.42% still used their first AVF (online supplemental table S1).

The KAP scores were 16.24±3.88 (possible range: 0–20), 33.31±3.32 (possible range: 8–40) and 28.69±2.74 (possible range: 6–30), respectively. The knowledge item with the highest rate of 'know well' answers (91.95%) was (K6) stating that the arm on the side of the fistulas should not be used for blood pressure measurement, intravenous infusion, intravenous blood collection, heavy lifting and bearing pressure. The item with the lowest rate of 'know well' answers (54.60%) was (K3) stating that if anticoagulation medication is not taken on time as prescribed by the doctor, it will affect the lifespan of the fistulas (table 1). Patients participated in relevant education in fistula care or management (p value<0.001), and those with other family members on HD had higher knowledge scores.

For the attitude items, the majority of participants (84.87%) strongly agreed that 'it is important to wash the skin around the fistula before each puncture to prevent local infection' (A5), while the item with the highest rate of disagreement was that 'as long as the place is right, the different ways of puncture have no direct impact on the lifespan of the fistulas' (A8), with 28.16% of participants strongly disagreeing with this notion. Items on the subject of the attitude towards nurses, such as 'there is no need to insist on a nurse with many years of work experience to perform the puncture' (A7) and 'level of pain during puncture is one of the most important criteria for evaluating the puncture skills of nurses' (A9) had an almost equal number of participants strongly agreeing and strongly disagreeing (40.04% vs 22.8% for A7; 34.87% vs 25.1% for A9) (table 2).

The highest compliance rate of 88.12% for the practice items was linked with avoiding pressure or strain on the fistula side (P5). The lowest compliance rate of 76.44% was found for the following item: 'If you find bleeding at the puncture site of fistulas on your way home or at home, you can handle it without fear or panic' (table 3).

Table 1 Responses to the questions in the knowledge dimension

Items	Correct, n (%)	Wrong, n (%)	Unclear, n (%)
For the first haemodialysis (HD), a central venous catheter should be chosen instead of fistulas.	302 (57.85)	96 (18.39)	124 (23.75)
	Know well, n (%)	Partially know, n (%)	Don't know, n (%)
A correct range of blood pressure and haemoglobin control in blood will help prolong the fistulas' lifespan.	313 (59.96)	140 (26.82)	69 (13.22)
If anticoagulation medication is not taken on time as prescribed by the doctor, it will affect the lifespan of the fistulas to some extent.	285 (54.6)	124 (23.75)	113 (21.65)
Excessive compression of the fistulas at the end of haemodialysis can reduce the lifespan of the fistulas to some extent.	407 (77.97)	80 (15.33)	35 (6.7)
A weight gain of more than 5% of dry weight during the haemodialysis interval will affect the fistulas' lifespan.	331 (63.41)	108 (20.69)	83 (15.9)
The arm on the side of the fistula should not be used for blood pressure measurement, intravenous infusion and blood collection, heavy lifting or bearing pressure.	480 (91.95)	38 (7.28)	4 (0.77)
The vessels of the fistulas should not be used for anything other than haemodialysis and emergency rescue.	455 (87.16)	56 (10.73)	11 (2.11)
Daily inspection of the arteriovenous fistulas by the patient/families and at least one palpation or auscultation is an effective measure to detect the possible problems in fistulas promptly.	432 (82.76)	72 (13.79)	18 (3.45)
Keeping the skin on the side of the fistula intact and clean, especially by effectively washing the skin before puncture, helps to prevent local skin infections in the fistulas.	456 (87.36)	53 (10.15)	13 (2.49)
In case of a fear of or intolerance for punctures, you will inform the healthcare provider to choose another puncture option that suits you.	398 (76.25)	87 (16.67)	37 (7.09)

Table 2 Responses to the questions in the attitude dimension

Items	Strongly agree, n (%)	Agree, n (%)	Neutral, n (%)	Disagree, n (%)	Strongly disagree, n (%)
The lifespan of the arteriovenous fistulas is mainly determined by the material used, and there is little influence by how it is cared for.	142 (27.2)	49 (9.39)	60 (11.49)	79 (15.13)	192 (36.78)
For the care of arteriovenous fistulas, keeping your blood pressure within the range recommended for your age is important.	407 (77.97)	87 (16.67)	21 (4.02)	1 (0.19)	6 (1.15)
It is important to use anticoagulants as prescribed by your doctor to keep the fistulas flowing.	375 (71.84)	95 (18.2)	50 (9.58)	1 (0.19)	1 (0.19)
It is necessary to check your fistulas at least once every day.	416 (79.69)	65 (12.45)	21 (4.02)	12 (2.3)	8 (1.53)
Is it important to wash the skin around the fistula before each puncture to prevent local infection at the site?	443 (84.87)	58 (11.11)	19 (3.64)	1 (0.19)	1 (0.19)
It is the patient's responsibility to decide on the puncture site with the nurse for each puncture.	389 (74.52)	83 (15.9)	39 (7.47)	7 (1.34)	4 (0.77)
As long as it is a one-time success and has no effect on the lifespan of the fistulas, there is no matter how many years of work experience the nurses have, and there is no need to insist on a nurse with many years of work experience to perform the puncture.	209 (40.04)	104 (19.92)	55 (10.54)	35 (6.7)	119 (22.8)
As long as the place is right, the different ways of puncture (rope ladder cannulation, buttonhole cannulation or area cannulation) have no direct impact on the lifespan of the fistulas.	186 (35.63)	68 (13.03)	70 (13.41)	51 (9.77)	147 (28.16)
The level of pain experienced by the patient during a puncture is one of the most important criteria for evaluating the puncture skills of nurses.	182 (34.87)	98 (18.77)	69 (13.22)	42 (8.05)	131 (25.1)

The practice score was higher in patients older than 60 years (p value=0.004) and those who had participated in relevant education in fistula care or management (p value<0.015).

The pathway analysis was performed to test the hypothesis regarding the effect of knowledge on practice and attitude (figure 1). Patients' knowledge directly affected their attitude (β=0.29, 95% CI: 0.22 to 0.35, p value<0.001)

Table 3 Responses to the questions in the practice dimension

Items	Completely obedient, n (%)	Relatively obedient, n (%)	Moderately, n (%)	Relatively not obedient, n (%)	Never obedient, n (%)
You will contact and inform your healthcare provider if there is redness, warmth, pain, swelling or purulent discharge on the skin around the fistula.	454 (86.97)	45 (8.62)	21 (4.02)	0 (0)	2 (0.38)
You will contact and inform your healthcare provider if there are any abnormalities during haemodialysis, such as weakness or loss of pulsation in the blood vessels near your fistula.	452 (86.59)	50 (9.58)	18 (3.45)	0 (0)	2 (0.38)
You would not use the arm on the fistula's side to draw blood or intravenous infusions.	458 (87.74)	41 (7.85)	16 (3.07)	2 (0.38)	5 (0.96)
You would not use the arm on the fistula's side to lift heavy objects.	452 (86.59)	47 (9)	17 (3.26)	2 (0.38)	4 (0.77)
You would not use the arm on the fistula's side to be under pressure; for example, do not use it to measure blood pressure and sleep on it.	460 (88.12)	32 (6.13)	23 (4.41)	3 (0.57)	4 (0.77)
After haemodialysis, if you find bleeding at the puncture site of your fistulas on your way home or at home, you can handle it without fear or panic.	399 (76.44)	72 (13.79)	39 (7.47)	8 (1.53)	4 (0.77)

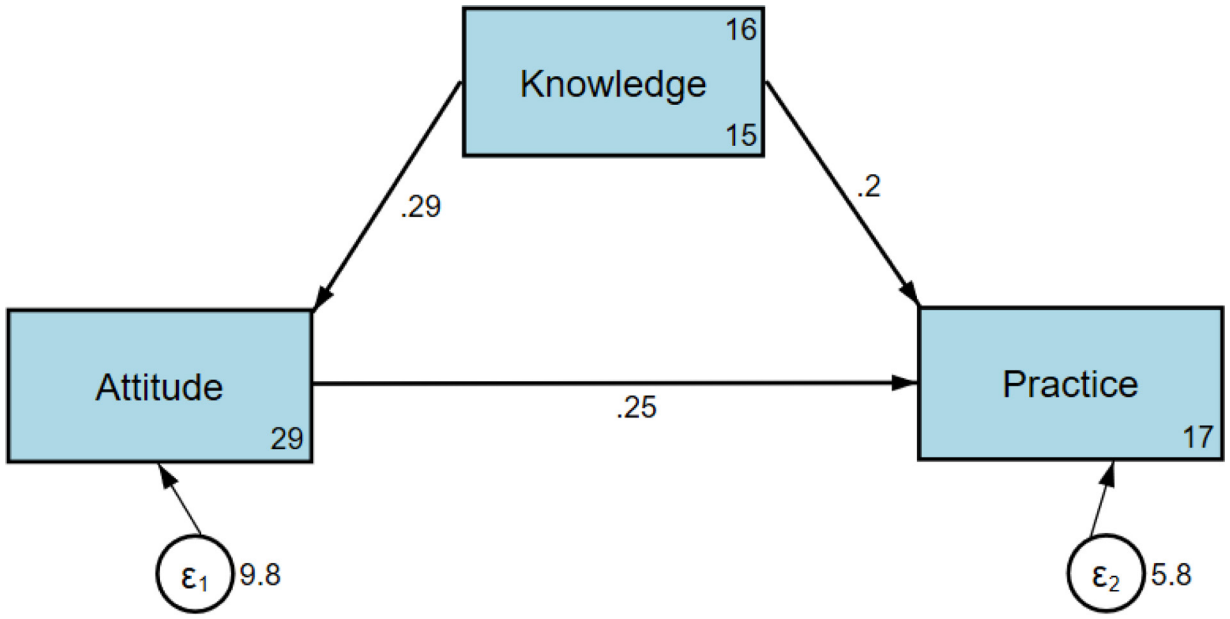

Figure 1 Results of the structural equation modelling.

and practice (β=0.20, 95% CI: 0.14 to 0.26, p value<0.001) towards AVF. Patients' attitudes towards AVF had a direct and positive effect on practice (β=0.25, 95% CI: 0.19 to 0.32, p value<0.001). Knowledge also indirectly affected practice through attitude (β=0.07, 95% CI: 0.05 to 0.10, p value<0.001) (table 4).

Multivariate logistic regression analysis showed that longer duration of HD was associated with good knowledge (1–2 years OR=2.245, 95% CI: 1.08 to 4.64, p value=0.029; 2–3 years OR=2.188, 95% CI: 1.00 to 4.77, p value=0.049; >3 years OR=3.639, 95% CI: 2.13 to 6.20, p value<0.001), while absence of medical insurance (OR=0.163, 95% CI: 0.02 to 0.98, p value=0.048), not participating in educational interventions (OR=0.235, 95% CI: 0.10 to 0.54, p value=0.001) and receiving guidance from nurse as compared with the doctor (OR=0.328, 95% CI: 0.17 to 0.61, p value=0.001) were associated with insufficient knowledge (table 5).

As demonstrated in table 6, only higher knowledge scores were associated with a positive attitude (OR=1.254, 95% CI: 1.16±1.34, p value<0.001).

Higher knowledge scores were also associated with proactive practice (OR=1.226, 95% CI: 1.11 to 1.35, p value<0.001), along with older age (OR=8.617, 95% CI: 1.07 to 69.2, p value=0.043), while not receiving guidance on fistula care was associated with inactive practice (OR=0.124, 95% CI: 0.02 to 0.58, p value=0.009) (table 7).

DISCUSSION

The present study demonstrated that patients on HD had sufficient knowledge, positive attitude and proactive practice regarding AVF. Knowledge directly and positively affected attitude and practice, while attitude also indirectly affected knowledge and practice.

Previous KAP studies conducted among HD patients with AVF reported mixed results that seem region-specific, indicating that educational programmes might result in better practice; however, in some cases, attitude influenced practice to the same or even higher degree.[9 18] The population in the present study was characterised by sufficient knowledge, positive attitude and proactive practice, which seems promising compared with other studies conducted in China.[11 12] Knowledge and practice scores were significantly higher in those who participated in relevant education programmes, especially knowledge. The logistic regression analysis confirmed that longer duration of HD correlated with better knowledge, whereas the absence of medical insurance, lack of participation in educational interventions and receiving guidance from nurses rather than doctors were linked to lower knowledge levels. Importantly, higher knowledge scores were associated with improved attitudes, emphasising the role of education in shaping perceptions. Furthermore, better practice scores were tied to higher knowledge and older age, while a lack of guidance on fistula care emerged

Table 4 The model paths of structural equation modelling

Model paths	Direct effect		Indirect effect	
	β (95% CI)	P value	β (95% CI)	P value
K → A	0.29 (0.22, 0.35)	<0.001	–	–
A → P	0.25 (0.19, 0.32)	<0.001	–	–
K → P	0.20 (0.14, 0.26)	<0.001	0.07 (0.05, 0.10)	<0.001

Table 5 Factors influencing good knowledge

	OR	95% CI	P value
Medical insurance type			
Social medical insurance only	Ref		
Commercial medical insurance only	–	–	–
Both social and commercial medical insurance	–	–	–
No medical insurance	0.163	0.02 to 0.98	0.048
Duration of the haemodialysis, years			
<1	Ref		
≥1 to <2	2.245	1.08 to 4.64	0.029
≥2 to <3	2.188	1.00 to 4.77	0.049
≥3	3.639	2.13 to 6.20	<0.001
Participation in relevant education in fistula care or management			
Yes	Ref		
No	0.235	0.10 to 0.54	0.001
Guidance on fistula care received from			
Doctor	Ref		
Nurse	0.328	0.17 to 0.61	0.001
Doctor and nurse	–	–	–
Not received in hospital	–	–	–

as a significant barrier to optimal practice. These findings underscore the importance of targeted education and comprehensive care strategies to enhance patient outcomes. However, according to pathway analysis, knowledge had only a weak direct effect on attitude and practice, suggesting an influence of other factors. Previously discussed major factors associated with KAP in HD patients include educational status, gender, age, time of HD start and guidance of healthcare personnel.[9 10 12]

The present study found that the most noticeable difference was among the different types of medical insurance. Although participants with commercial insurance demonstrated higher knowledge and practice scores compared with those with social medical insurance, the score in the practice dimension was significantly higher in participants with social medical insurance compared with commercial. This might be partly explained by the fact that many participants with social medical insurance were retired, thus having more free time to practice self-care. In addition, the population covered by this study included some categories with higher risk of AVF failure, in need of regular surveillance and improved self-care to minimise this risk.[19] Almost one-third of participants (32.95%) were older than 60 and 44.44% of participants were women, both are significantly associated with the occurrence of AVF failure in previous reports.[20 21]

Table 6 Factors influencing positive attitude

	OR	95% CI	P value
Knowledge	1.254	1.16 to 1.34	<0.001

Diabetes mellitus, another risk factor for poor adaptive remodelling and AVF dysfunction,[22 23] was diagnosed in 28.35% of participants in the present study, which might contribute to the better attention of HD patients to educational interventions and guidance and eventually to higher KAP scores.

With generally high scores, all KAP questions related to the usage of the arm on the side of the fistula (washing skin, avoiding blood pressure measuring and drawing blood, avoiding unnecessary strain, etc) were answered with high correctness, which is consistent with the previous study reported by Ozen *et al*.[16] This confirms that patients can remember instructions repeated continuously by doctors and nurses. However, among the most important findings of this study is the negative attitude and lack of trust in

Table 7 Factors influencing proactive practice

	OR	95% CI	P value
Knowledge	1.226	1.11 to 1.35	<0.001
Age, years			
18–45	Ref		
46–60	–	–	–
>60	8.617	1.07 to 69.2	0.043
Guidance on fistula care received from			
Doctor	Ref		
Nurse	–	–	–
Doctor and nurse	–	–	–
Not received in hospital	0.124	0.02 to 0.58	0.009

the nurse–patient relationship. Those participants who received guidance from doctors had significantly higher levels of knowledge, better attitude and acceptable practice than those who received guidance from nurses. At the same time, more than half of the participants insisted that only very experienced nurses should perform the puncture (question A7), and the pain level during puncture is one of the most important criteria for evaluating the puncture skills of nurses (question A9). Cannulation of AVF is technically challenging and demands special education from nurses.[5 24] The process might be painful for patients, affecting their relationship with the nurse.[25] Conversely, it might influence the acceptance of guidance, making patients trust doctors more than nurses. Structured training of clinical personnel could solve part of these issues, but it is impossible to make cannulation painless to 100%. Consequently, expecting nurses to be fully responsible for building trust only puts more strain on them. Instead, discussing the expectations for the cannulation process with patients in more detail might be beneficial.

Questioning different methods of puncture (rope ladder cannulation, buttonhole cannulation and area cannulation) was also challenging, as 35.63% of participants strongly agreed that it had no direct impact, while 28.16% strongly disagreed with that and other results. Although buttonhole cannulation has some benefits compared with other options, it increases the risk of infection, while rope ladder cannulation is challenging to implement, resulting in the limited choice of cannulator in daily practice.[26] This question is still under discussion, which might influence the attitude of patients. However, the absence of a strong opinion might also result from the lack of specific knowledge, suggesting that additional education guidance is needed for this point. Another issue discussed is the regular use of anticoagulants; 28.16% of participants remain unclear about the regular usage of anticoagulants. Anticoagulation therapy was previously reported to be associated with lower complication and mortality rates in patients with AVF and arteriovenous graft[27 28]; however, this protective effect was not confirmed by other studies.[2 20] This discrepancy may be the source of confusion among patients and healthcare providers, who obtain information from different sources.

The present study has several limitations. First, this was a single-centre study with a sample size that was not sufficiently large; higher KAP scores might result from specific regional educational programmes, and those results could not be directly compared with other areas. Second, it is possible that other barriers to treatment compliance were overlooked due to initially high KAP scores and the inability to account for issues beyond those covered by the questionnaire. Accordingly, new questions should be introduced to further analyse the identified factors, especially in practice. Finally, potential social expectation bias should be considered, as the results of the questionnaire were self-reported, which may have led to bias in the analysis. In addition, while the questionnaire was developed based on prior studies and expert experience, a comprehensive evaluation of its validity, such as content validity, construct validity or criterion validity, was not conducted. Future studies should incorporate formal validity testing to enhance the robustness of the questionnaire. In conclusion, the study population exhibited sufficient knowledge, a positive attitude and proactive practices. The findings revealed that knowledge has a direct and positive effect on both attitude and practice, while attitude also has an indirect effect on knowledge and practice. Additionally, beyond financial factors, new barriers were identified in the attitude dimension, specifically the negative attitudes and lack of trust in the nurse–patient relationship concerning the abilities of puncture nurses.

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Patient consent for publication Not applicable.

Ethics approval The ethical committee of the First Affiliated Hospital of Chongqing Medical University (K2023-103) approved the study. Participants gave informed consent to participate in the study before taking part.

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Data availability statement All data relevant to the study are included in the article or uploaded as online supplemental information. All data generated or analysed during this study are included in this published article.

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