



## Exploring agreement and feasibility between virtual home visits and in-person home visits for peritoneal dialysis patients—a paired study

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### ABSTRACT

**Introduction:** Virtual home visits may improve chronic disease management. However, whether they are suitable for peritoneal dialysis (PD) patients has not yet been fully investigated. This study aimed to compare the agreement and acceptance of virtual home visits and in-person home visits in PD patients.

**Methods:** This was a paired, single center, noninferiority trial. Participants received a virtual home visit and an in-person home visit simultaneously. A home visit checklist was built for standardization visits. The content was divided into three parts: domestic habits (57 items), bag exchange procedures (56 items), and exit site care (53 items). Satisfaction questionnaires for both patients and nurses were designed to assess attitudes toward home visits and socio-economic effects.

**Results:** A total of 30 PD patients were enrolled in a single center. The information collected from virtual home visits and in-person home visits was found to be highly consistent. The perfect agreement was found in 52/57, 49/56, and 44/53 items (Cohen's kappa 0.81–1.00), substantial agreement in 4/57, 7/56, and 8/53 items (Cohen's kappa 0.61–0.80). Patients reported almost identical satisfaction for virtual home visits and in-person home visits ( $Z = 0.39$ ,  $p = 0.70$ ). PD nurses reported similar feasibility and patient cooperation for the two visit types ( $Z = 0.99$ ,  $p = 0.33$ ;  $Z = 1.65$ ,  $p = 0.10$ , respectively). In addition, virtual home visits were found to be more cost-effective than in-person home visits.

**Conclusions:** Virtual home visits information collection was similar to in-person home visits in PD. There were no differences in participant satisfaction and feasibility between the two visit types.

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Peritoneal dialysis; telehealth; virtual home visits; agreement; feasibility

## Background

Peritoneal dialysis (PD) is widely used for end-stage renal disease treatment [1]. PD was introduced in China in the 1960s and has developed rapidly. A 2016 Chinese survey reported an age-adjusted prevalence of PD of 34.99 per million people [2]. The total number of PD patients had increased to 103,348 in 2019. Development of therapeutic technique and patient management improved clinical outcomes in past years [3]. However, regional variation in patient survival was observed in PD centers owing to a lack of standard care protocols and operating procedures [4].

Home visits are an important part of PD patient management that can improve patient survival and

reduce peritonitis and hospitalization rates [5–7]. At present, there are no published guidelines for PD home visits in China. It is generally accepted that home visits should evaluate the dialysis environment, PD fluid storage, personal hygiene, and PD skills and knowledge [8]. However, service delivery is not always satisfactory. In a survey of PD home visits in the US, 52% of centers were found to make initial home visits and at least one follow-up visit, 16% made home visits as needed, and 21% did not carry out home visits at all. Home visits represent a major expenditure of time and manpower [9]. During the COVID-19 pandemic, the need for social distancing and self-quarantine has made home visits even more challenging.

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Telemedicine has grown rapidly in recent years, and especially during the pandemic. Research in China found 93.8% of Chinese tertiary hospitals provide a wide range of telemedicine services for patients [10], and hypertension and diabetes mellitus are successfully managed *via* telemedicine [11,12]. Online consulting, tele-education and virtual visits are common telehealth services. A virtual visit is the use of internet video technology to transfer information between medical staff and patients and provide a complete medical service [13]. This form of the visit has several benefits, including flexible visiting times, cost and time savings, and high patient satisfaction [14,15]. Virtual visits have proved to be effective tools in the management of chronic disease [16–20]. However, the purpose of virtual visits inpatient management varies and medical protocols need to be designed, implemented and evaluated according to the characteristics of each disease [14,21–24].

Despite eHealth interventions to support PD patients in the delivery and management of home care, evidence of effectiveness is limited [25,26]. In particular, unlike other chronic diseases, PD home visits cannot be fully evaluated by outcome indicators. PD nurses must be familiar with the patient's daily routines and ensure that patient carefully follows the step-by-step dialysis exchange and exit site care procedure. To the best of our knowledge, no research has been conducted on the effectiveness of PD virtual home visits. Therefore, this study focuses specifically on the consistency of information collection and visit satisfaction between virtual home visits and in-person home visits.

## Methods

### Study design

This study was a paired, single center, noninferiority trial to identify the consistency of information collection and participant satisfaction during virtual home visits and in-person home visits. This study had three phases: checklist and questionnaire design, virtual home visit pilot, and visit implementation. Patients received a virtual home visit and an in-person home visit at the same time. Recruitment occurred from November 1 to 30, 2020. Visits were completed between November 5 and December 8, 2020. The study protocol and consent forms were approved by Sichuan Provincial People's Hospital (NO. 2020312). All participants provided written informed consent.

### Participants

All participants were recruited from the PD center of Sichuan Provincial People's Hospital, one of the largest

PD centers in Southwest China, and included patients from across the province. Inclusion criteria included age >18 years, on PD >12 months and with previous experience of in-person home visits. Exclusion criteria included the inability of patients or caregivers to complete PD procedures independently, lack of an internet-connected device with a webcam, residence outside central Chengdu city owing to traffic restrictions during the COVID-19 pandemic. One hundred and twenty-three patients were assessed for eligibility, 31 were enrolled. One patient withdrew by breaching the visiting appointment, and 30 completed their visits. Two nephrologists acted as investigators, and four PD nurses carried out the visits.

### Checklist and questionnaire preparation

Evidence supports the use of checklists in medical care to improve safety and reduce risk by ensuring that all steps are taken, clinic accountability is improved, and better communication is facilitated [8,27–30]. Therefore, for this study, we developed a home visit checklist based on a literature review and our previous experience [31–35]. The checklist included three sections: (1) domestic habits: an evaluation of the home environment and personal living habits (57 items), (2) bag exchange procedure: an evaluation of peritoneal dialysis fluid replacement practice (56 items), and (3) exit site care: an evaluation of nursing practices at the exit site of the PD catheter (53 items). Except for a few items, results are presented in the form of “yes or no” answers to ensure accuracy of judgment (see Figure 1). To better manage visit time, we added a few items to the checklist about PD knowledge during the fluid input and output process. The checklist was tested and verified in simulation scenarios. The patient questionnaire included 10 questions exploring satisfaction with the quality of the visit, convenience, barriers to acceptance, and future visit preference (see Figure 2). PD patients completed the questionnaire by combining their in-person home visit experience with the virtual visit experience. The nurse questionnaire investigated the experience of visit implementation, patient cooperation, personal safety and internet speed (see Figure 3).

### Training nurses and patients/caregivers for home visits

Visits were implemented by four PD nurses who were trained to follow the checklist and assess the results. Assessment agreement was ensured through scenario simulation and real-world situations between October 28 and November 3, 2020. Following enrollment, all

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## Items

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### Domestic habits

1. Does the PD fluids storage room ventilate well
  2. Is there junk around the PD fluids
  3. Is the floor of PD fluids storage room damp
  4. Do the PD fluids get sunburn
  5. Do the PD fluids packages place on the ground without shelf
  6. Are the PD fluids packages layers more than 5
  7. Do the PD fluids packages place according to indicated direction
  8. How long do the PD fluids stored supply for dialysis, <1week or 1-2 weeks or >2 weeks
  9. Which room is PD room, bedroom or living room or special room
  10. Do the room windows close when patient exchange PD fluids
  11. Are the curtains of PD room wash regularly
  12. Does the PD room be ventilate before procedure
  13. Is the PD room in a mess
  14. Are there air conditioner/ fan in the PD room
  15. Does the direction of air conditioner/fan/ ventilator turn to PD worktop
  16. Is there a UV germicidal lamp with correct ratio off area/ watts fin PD room
  17. Does patient close the door and windows when room has been disinfected
  18. How long are the UV germicidal lamp used for disinfection,<30 min or 30-60min
  19. Is the UV germicidal lamp expire
  20. Do pets come in and out of the PD room
  21. Is the inner face of PD fluids heater clean
  22. Is there digital scale for body and PD fluids
  23. What kind of material does the surface of worktop make from, wood or stainless steel or plastic or others
  24. Is the surface area of worktop more than 50\*40 cm<sup>2</sup>
  25. Is the hand sanitizer expire
  26. Is the cotton swab expire (It were expire If opened)
  27. Is the iodine solution expire (<1 moth when opened)
  28. Are the minicaps expire
  29. Are gauze pads expire (It were expire If opened)
  30. Is the sterile saline expire (It were expire If opened)
  31. Is the isopropyl alcohol expire
  32. Is the antibiotic ointment expire
  33. Are the blue clamps clean
  34. Are the blue clamps disinfect daily with 75% isopropyl alcohol
  35. Are there adhesive plaster and masks
  36. Are there shower protector shields or colostomy bag
  37. Is there a basket placing the drainage bag with washing daily
  38. Is there a blood pressure monitor corrected regularly
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Figure 1. Checklist of a home visit.

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39. Are there daily records (sample the PD record for a month)
  40. How long does the patient not record the PD data
  41. Which items are completely recorded, blood / weight/dialysis time, volume poured in and drain/total volume of urine
  42. Does the patient/ operator keep their nails short
  43. Are the nails clean
  44. Does the patient/ operator wear too many jewelries in the hands
  45. Does the patient/ operator wear nail polish
  46. How often does the patient take shower
  47. How often does the patient wash hair
  48. Are shower products share with family members
  49. Does the patient take blood pressure medication followed the doctor's advice
  50. Does the patient take other medicine followed the doctor's advice
  51. Does the patient inject EPO followed the doctor's advice
  52. Where does the patient accept EPO treatment, Community Healthcare Center/ hospital/ home
  53. Who does PD fluids exchange procedure
  54. Is the patient disable
  55. Could the patient do housework by himself
  56. What kind of sports does the patient do and how long did it last
  57. Does the patient know how to contact PD center when he faced with emergency
- 

### **Bag exchange procedure**

1. Does the operator prepare the equipment & accessories (warmed PD fluids, minicap, blue clamps, gauze, alcohol)
  2. Does the operator wash hands before procedure
  3. Is the procedure of seven steps hand-washing correct if the operator did this procedure
  4. Does the operator clean the worktop with alcohol
  5. Does the operator clean the worktop one-way/inside-out
  6. Does the operator wash hands by alcohol or antibacterial sanitizer after open the outer wrapper of PD fluid
  7. Does the operator place PD fluid on the other side of worktop
  8. Does the operator check the integrity of PD bag, green frangible, pull ring and injection port
  9. Does the operator check drainage bag
  10. Does the operator hold the transfer set correctly
  11. Does the operator hold the patient connector end of PD bag correctly
  12. Does the operator remove the pull ring from patient connector end of PD bag correctly
  13. Does the operator remove the minicap from transfer set correctly
  14. Does the operator connect transfer set to patient connector end of PD bag correctly
  15. Does the operator hold the end of Y connection by the index finger and thumb
  16. Does the operator touch the dark blue part of transfer set
  17. Does the operator keep t transfer set pointing down
  18. Does the operator discard pull ring
  19. Does the operator discard minicap and not reuse
  20. Does the operator protect dark blue part of transfer set by gauze
  21. Does the operator clamp the gauze around dark blue part by a clamp
  22. Does the patient answer the questions correct completely or partly (included how to deal with when he have peritonitis, breaks or contamination in peritoneal dialysis system)
- 

**Figure 1.** Continued.

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23. Does the patient know what should do immediately when peritoneal dialysis system broken
  24. Does the patient know what should do immediately when transfer set drop off
  25. Does the patient know what should do immediately when drainage bag broken
  26. Does the patient know what signs means drainage off effluent completely
  27. Does the operator lock the twist clamp of transfer set
  28. Does the operator place the fingers in transfer set correctly
  29. Does the operator fingers touch the dark blue party of transfer set
  30. Does the operator break the green frangible near solution bag correctly
  31. Does the operator flush fill line at least 5 seconds and expel air
  32. Does the operator open the transfer set
  33. Is the distance between the both ends of green frangible more than 1 cm
  34. Is the distance between bottom of PD bag when it be hanged and transfer set more than 40cm
  35. Does the patient answer the questions correct completely or partly
  36. Does the patient know the tips of fasten catheter
  37. Does the patient know the tips of protection exit side
  38. Does the patient know the symptom of exit side infection
  39. Does the operator lock the twist clamp of transfer set again
  40. Does the patient clamp fill line by blue clamp when infusion was completely
  41. Does the operator check expiry date of minicap and integrity of wrapper
  42. Does the operator check sponge in cap visually for wetness
  43. Does the operator open the gauze around the end of transfer set
  44. Does the operator hold the sagging of transfer set by direction finger and thumb of right hand, end of Y connection by direction finger and thumb of left hand to disconnect PD bag from transfer set
  45. Does the operator twist minicap onto transfer set until firm with tip of transfer set pointing down
  46. Does the operator put transfer set into punch and tie it around waist
  47. Is the transfer set in the punch without pulling and twisting
  48. Does the operator put the pull ring on the end of Y connection
  49. Does the operator examine the drainage effluent through the method of putting picture/newspaper under the bag and observing them clearly or not
  50. Does the operator weigh the bag of effluent bag and calculate volume ultrafiltration correct
  51. Where does the operator drain the effluent into toilet or sewer
  52. Does the operator cut the effluent bag by special scissors
  53. Does the scissors keep at special place
  54. Does the operator clean the toilet with chlorine containing disinfectant
  55. Does the operator dispose the waste PD bag into rubbish bin or collection container
  56. How often does the operator damp the waste bag
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### **Exit site care**

1. Is there a worktop doing exit site care
  2. Is there a mess in the worktop
  3. Does the operator prepare the medical supplies before exit site care
  4. Does the operator wash hands before exit site care
  5. Does the operator finish seven steps hand-washing before exit side care
  6. Does the operator rub hands palms to palm
- 

**Figure 1.** Continued.

- 
7. Does the operator right palm over left dorsum with interlaced fingers and vice versa
  8. Does the operator palm to palm with fingers interlaced
  9. Does the operator backs of fingers to opposing palms with fingers interlocked
  10. Does the operator rotational rubbing of left thumb clasped in right palm and vice versa
  11. Does the operator rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa
  12. Does the operator rub wrists in a rotating manner
  13. Does the operator wash hands more than one minutes with 15 seconds for each step
  14. Does the operator dry hands by paper towel /cloth towel or did not dry
  15. Did the operato turn off the tap by hand or elbow or single use towel
  16. Does the operator clean the worktop with ethanol
  17. Does the operator clean the worktop by paper towel or reuse cloth towel
  18. Does the operator clean the worktop one-way/inside-out
  19. Is the patient proper body position, Supine position/ sitting position
  20. Does the operator wear mask
  21. Does the catheter fix by butterfly adhesive without pulling
  22. Is the dialysis belt clean
  23. How often does the patient change the dialysis belt
  24. Does the patient disinfect the dialysis belt regularly
  25. Does the exit side cover by dressing
  26. Does the operator remove dressing roughly
  27. Is the dressing clean or having discharge
  28. Is the skin surrounding the exist side normal or redness and/or swelling
  29. Does operator wash hands again by antibacterial sanitizer
  30. Does the operator check the package of saline and cotton swab
  31. Does the operator clean the exit site by cotton swab dipped in saline
  32. Does the operator clean the skin around exit site
  33. Does the operator reuse the swab dipped in saline
  34. Does the operator sterilise the skin around exit side by iodine cotton swab
  35. How many times does the operator sterilize the skin around exit side,  $<3$  or  $\geq 3$
  36. Dose the operator reuse the iodine cotton swab
  37. Dose the skin of exit site dry naturedly
  38. Is the time for dry more than 1 minute
  39. Is the order of using saline cotton swab and iodine cotton swab correctly
  40. Does the operator cover the exit site by sterile dressings
  41. Does the operator fasten the catheter by adhesive plaster
  42. Does the catheter put into pouch and tie it around belt
  43. What does the operator do when dressings and crust gummed together
  44. What does the operator do when exit side has been crust
  45. How often does the patient do exit side care
  46. How often does the patient do exit side care when it infected
  47. Does the patient protect exit side when he /she take a shower
  48. What kinds of protector is used to protect exit side, Shower Protector Shields or colostomy bag or towel
  49. Is the direction of the shower flow from top to bottom
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Figure 1. Continued.

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50. Does the patient use to bathe
51. Does the patient use to go to hot spring bath
52. Does the patient use to swim
53. How does the patient deal with exit care after shower/bathe/swimming
- 

**Figure 1.** Continued.

1. How satisfied are you with quality of virtual home visit?
- I. Very dissatisfied II. Not satisfied III. General IV. Satisfied V. Very satisfied
2. How difficult are you feel with completing virtual home visit ?
- I. Very difficult II. Difficult III. Average IV. Simple V. Very simple
3. What did you find uncomfortable during the virtual home visit?
- I. Technical factors II. Privacy III. Risks of infection and personal safety
4. Do you want accept virtual home visit again?
- I. Yes II. No
5. How satisfied are you with quality of in-person home visit ?
- I. Very dissatisfied II. Not satisfied III. General IV. Satisfied V. Very satisfied
6. How difficult are you with completing in-person home visit ?
- I. Very difficult II. Difficult III. Average IV. Simple V. Very simple
7. What did you find uncomfortable during the in-person home visit?
- I. Technical factors II. Privacy III. Risks of infection and personal safety
8. Do you want accept in-person home visit again?
- I. Yes II. No
9. Which type of visit do you prefer to receive in future?
- I. Virtual home visit II. In-person home visit III. Both types
10. Is there anything you'd like to share with us about advantage of virtual home visit or in-person home visit?

**Figure 2.** Questionnaire to measure the satisfaction of the patient.

patients/caregivers were trained in the use of the WeChat app, the adjustment of the device camera and microphone, and how to cooperate with the nurses' visits.

### *Piloting home visits*

Firstly, PD nurses made appointments and checked internet transmission conditions to visit patients. According to the research plan, in-person home visits were implemented by a nurse and a volunteer (to ensure personal safety and to help patients who lacked caregivers or other helpers to complete their virtual

home visit) and virtual home visits were simultaneously completed by another nurse. For virtual home visits, the patients used the WeChat App on their smartphones to log onto the hospital website and connect to the PD center. Under the guidance of the virtual home visit nurse, the patient or a caregiver/volunteer held the smartphone to show the environment and the PD procedure during the visit. Virtual visit nurses logged onto the app by computer at the PD center and guided the camera operators to take videos according to the checklist. The in-person home visit nurse kept a note of each item on the checklist but did not participate in the inquiry or discussions with either the patient or the virtual visit nurse. At the end of each visit, patients and nurses completed their respective questionnaires. Visit data were recorded and stored in WJX.cn (a professional online questionnaire survey platform). The video recording of each patient's virtual home visit was reserved for identification by two researchers. If any dispute arose, it was resolved through discussion or consensus. Final outcomes also emerged following discussion and consensus.

### *Statistical analysis*

We described the study population using the mean and standard deviation or median and interquartile range for continuous variables, and frequency and proportion for categorical variables. Cohen's kappa was used to measure the inter-rater agreement of the collected checklist information for both visit types. The agreement was established when data results from virtual home visits and in-person home visits were the same. Disagreement was established in cases where virtual home visit data did not reflect in-person home visit data. If items were omitted by one type of visit and recorded by other type visits, we thought they were different. The agreement was almost perfect when Cohen's kappa 0.81–1.00, substantial when 0.61–0.80, moderate when 0.41–0.6, fair when 0.21–0.40, and slight when 0.0–0.20. The Wilcoxon signed-rank test and Chi-Square test were used to evaluate the questionnaire outcomes. Analyses were performed with Medcalc 11.4.2.0 and SPSS 26.0, and the significance level was 0.05 for the two-sided test.

**Virtual home visit**

1. How satisfied are you with quality of virtual home visit ?
  - I. Very dissatisfied II. Not satisfied III. General IV. Satisfied V. Very satisfied
2. How satisfied are you with patient / caregiver cooperation of virtual home visit ?
  - I. Very dissatisfied II. Not satisfied III. General IV. Satisfied V. Very satisfied
3. How difficult are you feel with completing virtual home visit ?
  - I. Very difficult II. Difficult III. Average IV. Simple V. Very simple
4. How satisfied are you with personal safety / privacy during virtual home visit?
  - I. Very poor II. Poor III. Moderate IV. Very good V. Excellent
5. How satisfied are you with internet speed?
  - I. Poor II. Moderate III. Good IV. Very good
6. Is there anything you'd like to share with us about advantage of virtual home visit or in-person home visit?

**In-person home visit**

1. How satisfied are you with quality of in-person home visit ?
  - I. Very dissatisfied II. Not satisfied III. General IV. Satisfied V. Very satisfied
2. How satisfied are you with patient / caregiver cooperation of in-person home visit ?
  - I. Very dissatisfied II. Not satisfied III. General IV. Satisfied V. Very satisfied
3. How difficult are you feel with completing in-person home visit ?
  - I. Very difficult II. Difficult III. Average IV. Simple V. Very simple
4. How satisfied are you with personal safety / privacy during virtual home visit?
  - I. Very poor II. Poor III. Moderate IV. Very good V. Excellent
5. Is there anything you'd like to share with us about advantage of virtual home visit or in-person home visit?

**Figure 3.** Questionnaire to measure completing of a nurse.



## Results

### Participant demographic characteristics

Table 1 summarizes the characteristics of the enrolled patients. The mean subject age was 55.3 years with male predominance. Half of the participants had not attained high school education. Just under one quarter

**Table 1.** Demographic and clinical characteristics of the study sample.

Participant characteristics	N = 30
Age, mean years (SD)	55 (44.8–68)
Male, %	60
Race, %	
Han	96.7
Tibetan	3.3
Dialysis vintage, mean months	47 (16.3–73.8)
Diabetes, %	20
Charlson comorbidity score	3 (2–5)
Education, %	
<High school	50
High school	23.3
College or higher	26.7
Annual income per person (¥), %	
<24,000	10
24,000–60,000	36.7
>60,000	53.3
Distance of return journey, kilometers, %	
<10	30.0
11–20	23.3
21–30	46.7
Network, %	
WIFI (4G/5G)	80
Mobile wireless (4G/5G)	20
Virtual completer, %	
Patient/volunteer	43.3
Family member	56.7
Automated peritoneal dialysis, %	3.3
Creatine, umol/L	1110.1 ± 55.1
Serum urea nitrogen, mmol/L	20.5 ± 1.1
Hemoglobin, g/L	101.0 (89.0–118.0)
Albumin, g/L	36.1 (32.9–38.7)
parathyroid hormone, pg/ml	417.0 (232.5–592.5)

of participants (23.3%) lived more than 10 kilometers from the PD center, and 46.7% lived more than 20 kilometers away. Approximately 80% of participants had 4G/5G WiFi service. Checklist information collection consistency between virtual and in-person home visits.

A high coefficient of information collection was observed between virtual home visits and in-person home visits. The perfect agreement was found in 52/57, 49/56, and 44/53 items, substantial agreement in 4/57, 7/56, and 8/53 items for domestic habits, bag exchange procedure, and exit site care, respectively (Table 2). Action items were mainly disagreement items in the visits. Patient satisfaction and virtual home visit vs in-person home visit feasibility.

Table 3 summarizes the outcome of the PD patient questionnaire. No statistically significant difference was found in satisfaction levels between virtual home visits and in-person home visits (24 vs 25,  $Z = -0.39$ ,  $p = .70$ ). In addition, participants noted a number of positive aspects of virtual visits, including flexibility in arranging visits, less time required for the visit, and a reduction in the work required of medical staff (see Table 4).

The majority of nurses reported the greater ease of completing virtual home visits, with 86.6% rating the internet speed as good or very good. In addition, no difference was reported in patients' cooperation and personal safety between the two visit types (Table 5). Nurses noted the benefits of virtual home visits, including safety, cost-effectiveness, and a good working environment (see Table 4).

The average total visit time included travel, parking, waiting, appointments and training for virtual home visits was 100.6 min compared to 158.8 min for in-person

**Table 2.** Comparing disagreement items between virtual home visits and in-person home visits.

	Cases	Inconsistent items	K	CI
Domestic habits (57 items)	0	33	1**	
	1	11	0.91**	(0.74, 1.00)
	2	8	0.81**	(0.57, 1.00)
	3	3	0.73*	(0.45, 1.00)
	4	1	0.66*	(0.35, 0.97)
	5	1	0.56	(0.21, 0.90)
Bag exchange procedure (56 items)	0	30	1**	
	1	14	0.91**	(0.74, 1.00)
	2	5	0.81**	(0.57, 1.00)
	3	3	0.73*	(0.45, 1.00)
	4	4	0.66*	(0.35, 0.97)
Exit site care (53 items)	0	24	1**	
	1	10	0.91**	(0.74, 1.00)
	2	10	0.81**	(0.57, 1.00)
	3	4	0.73*	(0.45, 1.00)
	4	6	0.66*	(0.35, 0.97)
	5	1	0.56	(0.21, 0.90)

Cohen's kappa: 0.0–0.20 slight, 0.21–0.40 fair, 0.41–0.6 moderate, 0.61–0.80 substantial, 0.81–1.00 almost perfect\*.

**Table 3.** PD patient satisfaction with virtual home visits and in-person home visits.

Survey question	Virtual visit (N = 30)	Home visit (N = 30)	Z/c2	P value
Comfort of visit				
Very dissatisfied	0	0	-0.39	0.7
Not satisfied	0	0		
General	1	0		
Satisfied	5	5		
Very satisfied	24	25		
Difficulty in completing visit				
Very difficult	0	0	-0.83	0.41
Difficult	1	0		
Average	0	1		
Simple	9	6		
Very simple	20	23		
What did you find uncomfortable?%				
Technical factors	43.3	33.3	3.07	0.22
Privacy	40	30		
Risks of infection and personal safety	16.7	36.7		
Patient willingness for repeat of this visit type?%				
Virtual visit				
Home visit	-	40		
Both	-	46.7		
		13.3		

**Table 4.** Comments from PD patients and nurses.

	Virtual home visits	In-person home visits
PD patient	Flexibility of visit arrangement Less time for visit	Face-to-face communication Providing humanistic care
PD nurse	Reducing work of medical staff Guaranteeing personal safety Saving time and cost Providing pleasant working environment	Convenient for the elderly Better visit view Intuitive cognition for visits Unaffected by internet speed

**Table 5.** Virtual home visit versus in-person home visit feasibility for PD nurses.

Survey question	Virtual visit <sup>a</sup>	Home visit <sup>a</sup>	Z/x <sup>2</sup>	P value
Difficulty in completing visit				
Very difficult	0	0	-0.99	0.33
Difficult	2	0		
Average	6	7		
Simple	19	17		
Very simple	3	6		
Patient cooperation			-1.65	0.10
Extremely dissatisfied	0	0		
Not satisfied	0	0		
General	0	1		
Satisfied	14	19		
Extremely satisfied	16	10		
Personal safety/Privacy			-0.54	0.18
Excellent	9	8		
Very good	12	7		
Moderate	6	3		
Poor	3	7		
Very poor	0	5		
Internet speed <sup>b</sup> , %				
Very good	20	-		
Good	56.6	-		
Moderate	16.7	-		
Poor	6.7	-		

<sup>a</sup>Total study sample (N = 30).

<sup>b</sup>Internet speed was defined by completing the visit without the connection freezing or going offline, freezing occasionally without going offline, freezing sometimes and going offline  $\leq 1$ , freezing frequently and going offline  $\geq 2$ .

\* $p < 0.05$ .

home visits. The proportion of all visits spent without medical service was higher in in-person home visits than virtual home visits. In addition, the average

transportation and manpower costs per visit were lower for virtual home visits than for in-person visits (229.2 vs 377.1) (Table 6).

## Discussion

In this paired study of virtual home visits and in-person home visits with peritoneal dialysis patients, we found strong consistency in the information collected by the two visit types. The majority of patients reported similar satisfaction with the implementation of virtual home visits and in-person home visits. Furthermore, less time was required of PD nurses to complete virtual home visits. There was reduced manpower expenditure and eliminated personal safety concerns.

PD home visit is a form of care work. In this complex situation, mistakes can easily be made. This home visit checklist was easy to implement and qualitatively beneficial in guiding complex home visits to ensure that all facets of care were addressed and that the quality of visits was effectively evaluated. The development of a well-designed checklist usually follows three steps—literature review, incident analysis, and structure interview with operators [36]. It is important that home visit checklists are customized to local PD center protocols and procedures. Although further research is required to quantify the value of the checklist with regard to

**Table 6.** Cost-effectiveness outcomes for virtual home visits versus in-person home visits.

Outcome	Virtual home visit	In-person home visit	<i>t</i>	<i>P</i>	95% CI
Mean time spent (in mins), including travel, parking, and waiting	105.8	168.0	-8.59	<i>P</i> < 0.001	[-76.78, -47.62]
Mean time spent (in mins), including appointments and training	15.1	7.2	13.14	<i>P</i> < 0.001	[6.7, 9.2]
Proportion of visit spent without medical service	0.14	0.44	-12.46	<i>P</i> < 0.001	[-0.35, -0.25]
Mean cost in gas, tickets, wages lost (in RMB)	229.2	377.1	-8.92	<i>P</i> < 0.001	[-181.2, -114.4]

outcome needs, it has been shown to be a valid tool for effectively completing home visits and for measuring agreement between the two visit types.

Our study confirmed that information collected from virtual home visits is highly consistent with that of in-person home visits. However, inconsistency was observed in some items. Human error may have been a contributing factor to this inconsistency. Inevitably, PD nurse subjectivity leads to differences in judgment. For example, when looking back at the video, we found that the nurse made a judgment that disagreed on the same item for the same patient. In addition, unclear instructions make the camera holder fail to capture the procedure and lead to error judgment in virtual home visits. Other important factors affecting the consistency rate in collecting information included technical factors. Some virtual home visit nurses reported that internet network instability resulted in occasional video freezing or crashing, leading to the loss of some information. Poor consistency of action items was observed in virtual visits. It was a challenge for PD nurses to continuously track and recognize a series of movements during a prolonged home visit. Previous studies used motion capture systems to gauge the kinematic features of motion, providing a means to collect action information resolution [37,38]. We recommend the development of software to capture body movements using a higher resolution web camera, such as Kinect for Windows, to facilitate better information collection in future research.

Other recent studies show similar satisfaction levels for virtual visits and in-person visits [24,39,40]. The questionnaire survey revealed that technical factors were the main cause of dissatisfaction. A study found slightly less use of the internet among patients aged 65 years and older, and that health literacy, annual income, and educational attainment levels impacted interest in using telehealth applications [41]. Given the fact that most PD patients are elderly and have lower levels of education, simple e-communication platforms should be used to allow for greater ease of communication between patients and medical staff. Moreover, quick and easy access to mobile internet applications will increase patients' comfort with virtual home visits.

Privacy was also a leading factor affecting patient satisfaction with virtual home visits. Patients were

concerned about the privacy and security of their personal health information, worrying that it could potentially be compromised online and disclosed to others, or used by others to infringe on their rights [42]. This suggests that government should legislate for the improvement of telemedicine regulations before this form of consultation is widely available to patients. In addition, telehealth institutions should build communication protocols and protect the privacy and security of patient data to meet the stringent patient privacy regulations dictated by existing laws [42,43]. A successful virtual visit project must also remove barriers by establishing confidence between patients and visitors, thus ensuring greater willingness to make use of virtual visits [44].

In this research, we observed similar feasibility of virtual home visits compared to in-person home visits. However, nurses in the in-person home visit group presented an evaluation of poor or very poor for personal safety/privacy, although the difference was not statistically significant. Anxiety about violence and road safety risks usually arise when PD nurses carry out in-person home visits alone. In general, PD nurses receive less training than district nurses in risk management, personal safety, and handling aggressive behavior. Research has found that the risk of sustaining an injury from physical assault is 9% higher for lone workers in health and social care than for non-lone workers [45]. Virtual home visits could eliminate these potential risks. Previous studies have shown that virtual home visits also have socioeconomic advantages, each visit requires less time and the costs are reduced. Our results confirm these findings [24,38,46]. The average total visit time and cost for virtual home visits was less than in-person home visits. However, further research is needed to explore the relationship between the care delivery modality, total costs, and clinical outcomes.

The strengths of this study include the collection and comparison of virtual home visits and in-person home visit information through the use of a checklist to ensure the uniformity and objectivity of evaluation criteria. In addition, to better understand the factors affecting satisfaction and flexibility, we conducted a survey of patient attitudes toward the two types of visits.

However, the current study has some limitations. The study was performed at a single center, thus limiting generalizability. The contents of the checklist require further iterations to make them suitable for different PD center contexts. Although the study passed the implementation consistency evaluation, visitors were not randomized for infectious disease prevention and limited manpower due to the COVID-19 pandemic. This may have led to bias in the visit questionnaire. To ensure consistency of information sources, virtual home visits and in-person home visits were conducted simultaneously which may have confused patients' evaluation of satisfaction, although in-person home visit evaluations were based on past and present experiences. Finally, this short-term study was designed to focus on information consistency to test the efficiency of virtual home visits. Other aspects of PD care, such as peritonitis, survival, and hospitalization rates, were not investigated. Follow-up research needs to be conducted to better understand these endpoints. For better evaluating the feasibility of telemedicine in PD patients, we also need to carry out more research to compare the visit protocol, suitable population, artificially intelligent assistant and so on between virtual visits and an in-person home visit.

During the pandemic, the various applications of telemedicine for a home visit in dialysis are explored rapidly. With limited investments, telemedicine offers many advantages such as facilitated contact with patients, humanizing care. A virtual visit is generally useful and promising among them. But telemedicine requires an adaptation of work organization and they cannot replace the welfare deficiencies of the health system at this stage.

In conclusion, this study suggested that virtual home visits have similar information collection consistency as in-person home visits in PD patients. Both patients and nurses reported satisfaction and feasibility with virtual home visits. The network should be checked before visits to ensure virtual transmission quality. If given similar quality, feasibility, and socioeconomic advantages, virtual home visits are a worthwhile application in the management of PD and are deserving of further research.

### Disclosure statement

No potential conflict of interest was reported by the author(s).

### Data availability statements

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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